TA-035

PRELIMINARY ENVIRONMENTAL SITE ASSESSMENT:

Old Alaska Highway Mile 836 to 883

Canol Camp-Johnson's Crossing

Squanga Lake Airstrip

Canol Pump Station W (Big Devil)

and

Marsh Lake Maintenance Camp

Prepared for:

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EXECUTIVE SUMMARY

This report presents the results of preliminary environmental site investigations at Canol Camp - Johnson's Crossing, Squanga Lake Airstrip, Canol Pump Station W and Sawmill Site (Big Devil Pump Station), and Marsh Lake Maintenance Camp. These sites are situated along the Old Alaska Highway, between Whitehorse and Teslin, Yukon. The main objective of the study was to provide a preliminary assessment of the presence and concentrations of contaminants due to past practices and land use. The sites were used as pumping stations, highway maintenance camps, and for a variety of military operations.

Following a review of historical data, the sites were visited by members of the Applied Research Division, Royal Roads University from the 11th to 19th of September, 1996. Physical hazards at each site were identified and surface and subsurface soil samples were collected as follows; Johnson's Crossing (31 samples total), Squanga Lake Airstrip (9 samples), Canol Pump Station W (12 samples) and Marsh Lake Camp (10 samples). To determine the possible degree and extent of contamination, the samples were analyzed for one or more of the following groups of substances: metals, organochlorine pesticides, polychlorinated biphenyls, and petroleum hydrocarbons.

The analytical results obtained for each site were interpreted on the basis of observed site-specific conditions and contaminant benchmarks, including the Canadian Council of Ministers of the Environment (CCME) and British Columbia soil quality values for residential/parkland usage. This formed the basis for a preliminary assessment of the impact of any contamination. The data were also interpreted in the light of site-specific contaminant migration and exposure pathways, and possible human or ecological health risks. The results were used to derive recommendations for further assessment and/or remediation.

Overall, the findings indicate that the sites presently have only minor contaminant problems relative to several other contaminated abandoned military sites in the Yukon. Contaminants found at concentrations in soils that were greater than background levels were primarily hydrocarbons and metals. Chlorinated organic pesticides or PCBs were not indicated to be contaminants of concern at any of these sites. Some limited potential exists for the future discovery of buried contaminated materials, but no evidence was found for serious contaminant problems in suspected areas based on the re-construction of land use patterns. A summary of the results for each of the individual sites is presented below.

Canol Camp Johnson's Crossing: This site, located just east of the Teslin River (Mile 836 of the Old Alaska Highway) and at the junction of the South Canol Highway, was operated as a Construction and Maintenance Camp and US Army Telephone Relay Station along the Canol No. 1 pipeline. Three main dumps, which contain appreciable quantities of debris, were located: an Old Army Lodge Dump near the western shore of the Teslin River, an Old 1.5 Mile Army Dump and a vehicle dump at Canol Camp. In addition, high levels of hydrocarbons were detected in two discrete surface stains in clearings on an access road to the north of the vehicle dump, as well as subsurface soils beneath an above-

ground storage tank located at the Canol Road junction, south of the new Alaska Highway. The possible ecological risk at all of these locations at Johnson's Crossing is probably very low since the contaminated areas appear to be localized and small. The hydrocarbon contamination beneath the above-ground storage tank is perhaps the largest single contaminant source at the site and requires further investigation.

Squanga Lake Airstrip: This Emergency Flight Strip is situated 10 km west of Johnson's Crossing, north of the new Alaska Highway (Mile 843 Old Alaska Highway). An area to the south of the highway was also the site of a former Army Construction. Overall, no evidence was found during the preliminary investigation for substantial soil contamination. Only a very limited volume of soil underneath the old vehicle service ramp was contaminated with hydrocarbons and lead. A small amount of debris was also scattered to the east of the private residence. This should probably be buried on-site, or removed, for aesthetic purposes.

Canol Pump Station W (Big Devil Pump Station): This site is located south of Summit Lake (formerly known as Big Devil Lake) at Mile 855 of the Old Alaska Highway. The remains of a sawmill which was associated with the Pump Station are also present about 1 km north of the Historic Highway Marker (855), along a seasonal road. No evidence of contaminant concerns requiring more detailed investigation was found during this assessment. A small amount of debris was noted in the vicinity of the sawmill, and in the small dump west of the pump station - an aesthetic concern that could be addressed by burial.

Marsh Lake Maintenance Camp: This former Military Maintenance Camp is situated close to the shore of Marsh Lake at Mile 883 of the Old Alaska Highway. Two small areas, including a surface stain near the garage pad and the collection sump on the garage pad, were contaminated with either metals or hydrocarbons and require measures to isolate them from the surrounding environment. Cleanup at this site might also involve the re-burial of the small amount of debris noted in the dump.

TABLE OF CONTENTS

EXECUTIVE SUMMARY i

LIST OF TABLES vi

LIST OF MAPS vii

LIST OF PHOTOGRAPHS viii

LIST OF APPENDICES xi

1. INTRODUCTION 1-1

1.1 BACKGROUND 1-1

1.2 PURPOSE AND SCOPE OF WORK 1-4

1.3 ASSESSMENT CRITERIA 1-6

2. METHODS 2-1

2.1 REVIEW OF EXISTING INFORMATION 2-1

2.1.1 Canol Camp Johnson's Crossing 2-1

2.1.2 Squanga Lake Airstrip 2-2

2.1.3 Canol Pump Station W (Big Devil) 2-3

2.1.4 Marsh Lake Camp 2-3

2.2 FIELD INVESTIGATION 2-7

2.2.1 General Approaches 2-7

2.2.2 Site Reconnaissance 2-7

2.2.3 Surface Soil Sampling 2-8

2.2.4 Subsurface Soil Sampling 2-8

2.2.5 Sample Pretreatment 2-9

2.3 ANALYTICAL PROGRAM 2-9

2.3.1 Field Screening for Volatile Organic Compounds (VOCs) 2-9

2.3.2 Laboratory Analysis 2-10

2.3.2.1 Moisture Content 2-10

2.3.2.2 Metals in Soil 2-10

2.3.2.3 Non-Halogenated Volatiles in Soil - Headspace method 2-10

2.3.2.4 Volatile Petroleum Hydrocarbons in Soil 2-11

2.3.2.5 Light Hydrocarbons in Soil 2-11

2.3.2.6 Extractable Petroleum Hydrocarbons (EPH) in Soil 2-11

2.3.2.7 Polycyclic Aromatic Hydrocarbons (PAHs) in Soil 2-12

2.3.2.8 Light and Heavy Extractable Petroleum Hydrocarbons in Soil 2-12

2.3.2.9 Organochlorine Pesticides (OCPs) in Soil 2-12
2.3.2.10 Polychlorinated Biphenyls (PCBs) in Soil 2-13

3. RESULTS OF STUDY 3-1
3.1 CANOL CAMP JOHNSON'S CROSSING 3-1
3.1.1 Site Description 3-1
3.1.1.1 Old Army Lodge Dump 3-1
3.1.1.2 Camp Canol 3-2
3.1.1.3 Canol Road 1.5 Mile Dumps and Landfill 3-2
3.1.2 Site Conditions and Sampling Program 3-7
3.1.2.1 Old Army Lodge Dump 3-7
3.1.2.2 Camp Canol 3-7
3.1.2.3 Vehicle Dump 3-7
3.1.2.4 Above Ground Storage Tank and Garage 3-8
3.1.2.5 Army Relay Station 3-9
3.1.2.6 Community Dump 3-9
3.1.2.7 Canol Road 1.5 Mile Dump and Landfill 3-9
3.1.3 Subsurface Soil Conditions 3-18
3.1.3.1 Above Ground Storage Tank and Garage 3-18
3.1.3.2 Camp Canol 3-19
3.1.3.3 Canol Road 1.5 Mile Old Army Dump 3-19
3.1.4 Contamination Considerations 3-21
3.1.4.1 Summary of Sampling and Analytical Program 3-22
3.1.4.2 Soil Quality Criteria 3-23
3.1.4.3 Metal Contamination 3-24
3.1.4.4 Hydrocarbons 3-25
3.1.4.5 PCBs and Chlorinated Pesticides 3-27
3.2 SQUANGA LAKE AIRSTRIP 3-28
3.2.1 Site Description and Conditions 3-28
3.2.1.1 Airstrip 3-28
3.2.1.2 Army Construction Camp 3-29
3.2.2 Subsurface Soil Conditions 3-36
3.2.3 Contamination considerations 3-36
3.2.3.1 Summary of Sampling and Analytical Program 3-36
3.2.3.2 Soil Quality Criteria 3-37
3.2.3.3 Metal Contamination 3-37
3.2.3.4 Hydrocarbons 3-38

3.2.3.5 PCBs and Chlorinated Pesticides 3-39
3.3 CANOL PUMP STATION W (BIG DEVIL) AND MILE 854.5 SAWMILL SITE 3-40
3.3.1 Site Description, Conditions and Sampling Program 3-40
3.3.1.1 Historic Mile 855 and Sawmill Site 3-40
3.3.1.2 Pump Station W 3-41
3.3.2 Subsurface Soil Conditions 3-47
3.3.3 Contamination Considerations 3-47
3.3.3.1 Summary of Sampling and Analytical Program 3-48
3.3.3.2 Soil Quality Criteria 3-49
3.3.3.3 Metal Contamination 3-49
3.3.3.4 Hydrocarbons 3-50
3.3.3.5 PCBs and Chlorinated Pesticides 3-50
3.4 MARSH LAKE CAMP 3-51
3.4.1 Site Description, Conditions and Sampling Program 3-51
3.4.2 Subsurface Soil Conditions 3-58
3.4.3 Contamination Considerations 3-59
3.4.3.1 Summary of Sampling and Analytical Program 3-60
3.4.3.2 Soil Quality Criteria 3-61
3.4.3.3 Metal Contamination 3-61
3.4.3.4 Hydrocarbons 3-62
3.4.3.5 PCBs and Chlorinated Pesticides 3-62

4. INTERPRETATION AND PRELIMINARY RISK ASSESSMENT 4-1
4.1 FRAMEWORK FOR INTERPRETATION 4-1
4.2 CANOL CAMP JOHNSON'S CROSSING 4-4
4.3 SQUANGA LAKE AIRSTRIP 4-9
4.4 CANOL PUMP STATION W (BIG DEVIL) 4-10
4.5 MARSH LAKE 4-10

5. CONCLUSIONS AND RECOMMENDATIONS 5-1
5.1 CANOL CAMP JOHNSON'S CROSSING 5-1
5.2 SQUANGA LAKE AIRSTRIP 5-3
5.3 CANOL PUMP STATION W (BIG DEVIL) 5-3
5.4 MARSH LAKE 5-3

6. REFERENCES 6-1

LIST OF TABLES

Table 1-1: CCME (1991) Interim Environmental Quality Criteria for Contaminated Sites - Assessment Criteria 1-9
Table 1-2: Relevant Soil Remediation Criteria/Standards 1-10
Table 1-3: CCME (1991) and BCMELP (1995) Water Criteria (all values in µg/L) 1-11
Table 3.1.1: Summary of the Sampling and Analytical Program - Johnson's Crossing 3-23
Table 3.2.1: Summary of Sampling and Analytical Program - Squanga Lake Airstrip 3-37
Table 3.3.1: Summary of Sampling and Analytical Program - Big Devil Pump Station 3-49
Table 3.4.1: Summary of Sampling and Analytical Program - Marsh Lake Camp 3-61

LIST OF MAPS

Map 1.1: Locations of Study Sites 1-3
Map 3.1.1: General Layout of Canol Camp Johnson's Crossing and Surrounding Areas 3-3
Map 3.1.2: Johnson's Crossing Old Army Lodge Dump - Layout and Sampling Locations 3-4
Map 3.1.3: Camp Canol - Layout and Sampling Locations 3-5
Map 3.1.4: Old 1.5 Mile Army Dump and 1975/76 Landfill - Layout and Sampling Locations 3-6
Map 3.2.1: General Layout of Squanga Lake Airstrip and Sampling Locations 3-31
Map 3.3.1: General layout of Canol Pump Station W (Big Devil) and Sampling Locations 3-42
Map 3.4.1: Marsh Lake Camp - Layout and Sampling Locations 3-53

LIST OF PHOTOGRAPHS

Photograph 2.1: Historic mile post locate at Johnson's Crossing Lodge 2-5
Photograph 2.2: Squanga Lake Airstrip historic mile post 2-5
Photograph 2.3: Historic mile post located near Canol Pump Station W (Big Devil) 2-6
Photograph 2.4: Marsh Lake Camp historic mile post 2-6
Photograph 3.1.1: Typical debris noted on the southern side of the Old Army Lodge Dump located near Teslin River 3-10
Photograph 3.1.2: Debris including oil and paints cans, barrels, 10 gallon drums and wood present on the northeastern side of the Old Army Lodge Dump 3-10
Photograph 3.1.3: Marshy area below the Old Army lodge Dump with Teslin River in the background 3-11
Photograph 3.1.4: Old army vehicle hulks located in the vehicle dump northwest of Camp Canol 3-11
Photograph 3.1.5: Pile of metallic debris including a car at the southern side of the vehicle dump 3-12
Photograph 3.1.6: Old army vehicle hulks piled along the edge of the ring road at the vehicle dump 3-12
Photograph 3.1.7: Pile of wood and metallic debris found in the central area within the ring road at the vehicle dump 3-13
Photograph 3.1.8: Two batteries of 1960 - 1970 vintage found amongst the debris at the vehicle dump 3-13
Photograph 3.1.9: Large stained area on top of a knoll located 300 m north of the vehicle dump along the access road 3-14
Photograph 3.1.10: Test pit excavation near the above ground storage tank located south of the Alaska Highway and Canol Road junction. Note cut-outs along the bottom part of the tank. 3-14
Photograph 3.1.11: View of the old garage situated south of the Alaska Highway and Canol Road junction 3-15
Photograph 3.1.12: Miscellaneous metallic debris scattered on the floor of the derelict garage. 3-15
Photograph 3.1.13: Crushed barrel and other metallic debris excavated during a routine grading at the Community Dump 3-16
Photograph 3.1.14: View of the 1975/76 Cleanup Landfill from the south 3-16
Photograph 3.1.15: Partially buried debris at the old 1.5 Mile Army Dump 3-17
Photograph 3.1.16: Some of the empty barrels scattered in piles at the old 1.5 Mile Army Dump 3-17
Photograph 3.1.17: Test Pit 2 excavated in the soakaway pit near the above

ground storage tank 3-20
Photograph 3.1.18: Empty crushed barrels and metal pipes excavated from Test Pit 5 excavated in the old 1.5 Mile Army Dump 3-20
Photograph 3.2.1: View of Squanga Lake Airstrip 3-32
Photograph 3.2.2: Squanga Lake Airstrip Old beacon tower showing a large nest which is used by a breeding pair of osprey 3-32
Photograph 3.2.3: Collapsed wooden generator shack located near the beacon tower 3-33
Photograph 3.2.4: A berm composed of rocks with a few tin cans located between the airstrip and the Alaska Highway 3-33
Photograph 3.2.5: Remnants of a wooden loading ramp situated south of the highway 3-34
Photograph 3.2.6: Typical debris scattered in the dump east of the private residence 3-34
Photograph 3.2.7: Partially-collapsed wood frame house and debris including 10 gallon drums, old electrical equipment and barrels located east of the private residence 3-35
Photograph 3.2.8: Tires and electrical boxes in the dump near the partially collapsed house east of the private residence 3-35
Photograph 3.3.1: Historic Mile Post 855 showing the gravel work area in the background 3-43
Photograph 3.3.2: A tree with a piece of 2 inch pipeline 3-43
Photograph 3.3.3: Typical slab pile spread over muskeg south east of the actual sawmill site 3-44
Photograph 3.3.4: Partially-collapsed log building currently located at the sawmill site 3-44
Photograph 3.3.5: Remains of a trailer found in the wooded area the sawmill site 3-45
Photograph 3.3.6: Site of the pump station marked by a large clearing located 1 km west of the Historic Milepost marker. 3-45
Photograph 3.3.7: Wooden foundation located north of the large clearing at the pump station. 3-46
Photograph 3.3.8: A pit with wooden sides situated north of the large clearing at the pump station. 3-46
Photograph 3.4.1: Partially-excavated remains of the Canol Pipeline noted at the northeast corner of the site along the south west edge of the Alaska Highway 3-54
Photograph 3.4.2: Collection sump on the north end of the garage foundation containing stained sand and gravel and other metallic debris 3-54
Photograph 3.4.3: A stained area present east of the garage foundation 3-55

Photograph 3.4.4: Typical debris scattered in the dump near the lake..... 3-55
Photograph 3.4.5: Profile of test pit excavated in the dump showing debris was surficial..... 3-56
Photograph 3.4.6: Site of the pump station marked by a large clearing located 1 km west of the Historic Milepost marker..... 3-56
Photograph 3.3.7: Wooden foundation located north of the large clearing at the pump station. 3-57
Photograph 3.3.8: A wood-lined pit located along the main access road on the eastern side of the site..... 3-57

LIST OF APPENDICES

APPENDIX A: Sampling Locations and Test Pit Logs
APPENDIX B: Analytical Results
APPENDIX C: Hydrocarbon Distribution Reports
APPENDIX D: Quality Assurance/Quality Control (QA/QC)

1. INTRODUCTION

1.1 Background

The Arctic Environmental Strategy (AES) Action on Waste program is researching environmental issues related to the operations of the Abandoned Waste and Disposal Sites throughout the Yukon. The main objective of this study is to provide a preliminary environmental assessment of the impact of past practices and land use such as pumping stations, highway maintenance, exploration, mining, industrial or military operations. Information gathered will be used towards recommendations for future assessments or remediation. This is consistent with the AES - Action on Waste's commitment to "eliminate unsafe, hazardous and unsightly waste" (DIAND 1991).

The program discussed in this report consists of preliminary environmental site investigations at four sites along the Alaska Highway, between Whitehorse and Johnson's Crossing, Yukon. The sites include:

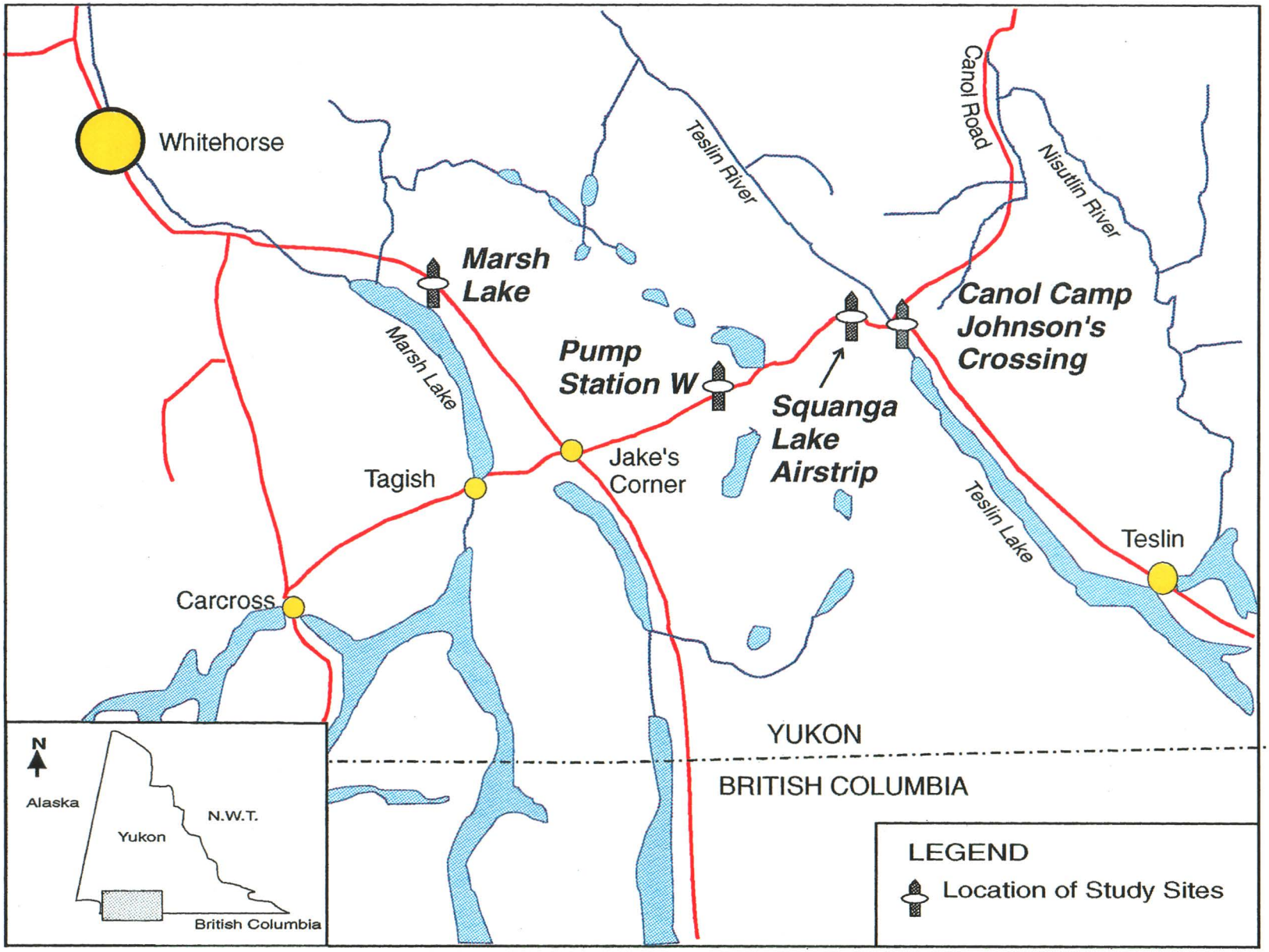
- **Canol Camp Johnson's Crossing**: This site is located just east of the Teslin River (Mile 836 of the Old Alaska Highway) and at the junction of the South Canol Highway. It was operated as a Maintenance Camp and U.S. Army Telephone Relay Station along the Canol No. 1 pipeline.

- **Squanga Lake Airstrip**: This Emergency Flight Strip is situated 10 km west of Johnson's Crossing, north of the new Alaska Highway (Mile 843 Old Alaska Highway) with the site of a former Army Construction Camp to the south of the new highway.

- **Canol Pump Station W (Big Devil Pump Station)**: This site is located about 30 km east of Jakes's Corner, south of Summit Lake (formerly known as Big Devil Lake) and at Mile 855 of the Old Alaska Highway. The remains of a sawmill, associated with the Pump Station, is also present along a trail about 1 km north of the Historic Highway Marker (855). Big Devil was used as a pumping station along the Canol No. 3 Pipeline which carried aviation gasoline from Whitehorse to Watson Lake.

- **Marsh Lake Maintenance Camp**: This former Military Maintenance Camp (Army Camp 4E) is situated close to the shore of Marsh Lake at Mile 883 of the old highway.

The general locations of these sites, which are along the Alaska Highway, between Whitehorse and Teslin, are shown on Map 1.1.



Map 1.1:Locations of Study Sites

1.2 Purpose and Scope of Work

The objectives and scope of work at each site are as follows:

- a review of historical data, including archival search, aerial photographs, site maps, anecdotal information, interviews;
- identification of physical hazards;
- surface and subsurface soil sampling and analysis, as required, to determine the possible degree and extent of contamination;
- preliminary assessment of the impact of any contamination, including determining contaminant migration and human or environmental health risk;
- characterization of the biophysical environment including vegetation, fauna and land use; and,
- development of recommendations for further assessment and/or remediation.

The layout of this report is based on the outline proposed in Appendix D: Statement of Work of the Articles of Agreement between Indian and Northern Affairs Canada and Royal Roads University - Applied Research Division dated 19 th July 1996.

- **Chapter 1**: Outlines the objectives of the study and discusses appropriate environmental criteria.
- **Chapter 2**: Section 2.1 reviews existing information on the four study sites. Section 2.2 presents a detailed description of the field program. The analytical program, including both field screening and laboratory analysis, is presented in Section 2.3.
- **Chapter 3**: The results of the field and analytical programs for each of the four sites are presented in separate sections in this chapter.

- **Chapter 4**: Presents the interpretation of the results and preliminary environmental assessment for each of the four sites.

- **Chapter 5**: Conclusions and recommendations are given in this chapter.

- **Chapter 6**: The list of references cited are presented alphabetically in this chapter.

Appendices: Includes a description of the sample locations and test pit logs (Appendix A), the analytical results (Appendix B), hydrocarbon distribution reports (Appendix C) and a summary of the Quality Assurance/Quality Control Program (Appendix D).

1.3 Assessment Criteria

In order to minimize or eliminate environmental impact, it is necessary to anticipate concentrations of contaminants which could lead to a decrease in environmental quality and respond accordingly. This requires a method for predicting levels of contaminant loading which could harm the environment. Guidance on acceptable levels of analytes in soil samples for the preliminary study was obtained from the following sources:

- **CCME (Canadian Council of Ministers of the Environment) Interim Environmental Quality Criteria for Contaminated Sites, 1991 (CCME, 1991).**

- **BC Ministry of Environment, Lands and Parks (BCMELP) Draft Contaminated Sites Regulation** (Draft 3 - Dec. 4, 1995, BCMOE, 1995) (guidance on extractable hydrocarbon levels only)

The comparison of contaminant concentrations in samples collected from a specific site with various soil and water quality benchmarks provide a simple, screening-level evaluation of the likelihood of risk to humans, other animals, plants, and other living receptors that use the site or are part of the larger ecosystem. Contaminant concentrations that exceed the benchmarks do not necessarily result in harmful impacts; rather, environmental concentrations below the benchmarks are very unlikely to cause harm. Contaminant concentrations in excess of the relevant criterion or standard may or may not lead to elevated risk depending on a large suite of site specific conditions, including the organisms present. During preliminary site investigations, soil and water quality criteria are appropriately used as benchmarks only in order to determine the need for more detailed study.

The CCME environmental quality criteria include tabulated benchmarks for contaminant concentrations in soil or water below which adverse effects to living organisms are exceedingly unlikely. The CCME criteria are considered to be interim, pending more information about some contaminants, and future advances in the scientific understanding of contaminant dose - impact relationships. In particular, substantial revisions to the 1991

criteria are presently being considered by CCME. Such revisions may impose conditions on the interpretation of risk due to contaminated soils or surface water in association with site specific conditions.

CCME (1991) defines two classes of criteria for both soil and water - Assessment Criteria and Remediation Criteria. The CCME Interim Assessment Criteria (Table 1-1) indicate the background concentrations or analytical detection limit for contaminants. Soil and water with concentrations that do not exceed these limits are considered to be clean; i.e., free of any contamination. The Assessment Criteria may also be considered as a list of the minimum analytical detection limits that must be achieved in order to discount the contamination of a given sample by a specific analyte. The detection of substances at concentrations higher than the Assessment Criteria may or may not be indicative of contamination or pollution, but rather indicate the need for further investigation. Results of such investigations are evaluated in terms of the CCME Interim Remediation Criteria for soils, and are divided into three categories - agricultural (AG), residential/parkland (R/P), and commercial/industrial (C/I). A list of the CCME R/P criteria are provided in Table 1-2. CCME remediation criteria, in turn, serve as benchmarks to evaluate the need for further investigation or remediation with respect to a specified land use.

CCME Remediation Criteria for Water (Table 1-3) are divided into four usage categories - freshwater aquatic life, irrigation, livestock watering, and drinking water. The criteria for freshwater aquatic life are adopted unmodified from the Canadian Water Quality Guidelines (CWQG; CCREM, 1987). Guidelines for drinking water are taken unamended from the Guidelines for Canadian Drinking Water (GCDWQ; Health and Welfare Canada, 1989), and are the maximum acceptable concentrations for unfiltered samples at the point of consumption.

For surface soils at Johnson's Crossing, Squanga Lake Airstrip, Big Devil Pump Station or Marsh Lake Camp, the residential/parkland criteria are clearly the most appropriate. It might be argued that the CCME agricultural criteria are more appropriate in areas where food substances are collected; however, the agricultural criteria were developed for land

use involving intensive and repeated sowing and harvesting of plants and intense livestock husbandry, and are based on scientific information such as the bioaccumulation of contaminants by livestock feeding exclusively on plants grown in contaminated soils. Whereas the agricultural criteria are generally lower than the residential/parkland criteria for most substances, they are higher for some substances including barium, chromium, copper, nickel and zinc.

For surface waters at the sites, remediation criteria for freshwater aquatic life are relevant, as are drinking water standards where there is some reasonable expectation that the water might be used by humans for drinking.

Screening level guidance for hydrocarbons is generally 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). BC (1995) Draft Soil Standards for VPHs, LEPHs, and HEPHs have been used as part of this preliminary site investigation to initially interpret the soil data (see Table 1.2). There are no standards of criteria for VPHs, LEPHs, or HEPHs in sediment, groundwater, or river water either in British Columbia or elsewhere.

Table 1-1: CCME (1991) Interim Environmental Quality Criteria for Contaminated Sites - Assessment Criteria (Notes are shown at the end of Table 1-3)

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

1: --- not evaluated by CCME or too little information

Table 1-2: Relevant Soil Remediation Criteria/Standards (all values in µg/g dry weight) (Notes are shown at the end of Table 1-3)

Substance	CCME (1991) Residential/ Parkland	BCMELP (1995) Draft 3 Numerical Soil Standards Urban Park/ Residential	Substance	CCME (1991) Residential/ Parkland	BCMELP (1995) Draft 3 Numerical Soil Standards Urban Park/ Residential
Inorganics			***Phenolic Compounds***		
aluminum	---		non-chlorinated[2] (each)	1	
ammonia	---		chlorophenols[4] (each)	0.5	
antimony	20				
arsenic	30		***Polycyclic Aromatic Hydrocarbons (PAHs)***		
barium	500		PAHs (Total)		
beryllium	4		benzo(a)anthracene	1	
boron (total)	---		benzo(a)pyrene	1	
cadmium	5		benzo(b)fluoranthene	1	
chromium (+6)	8		benzo(k)fluoranthene	1	
chromium (total)	250		dibenz(a,h,)-anthracene	1	
cobalt	50		indeno(1,2,3-c,d)-pyrene	1	
copper	100		naphthalene	5	
cyanide (free)	10		phenanthrene	5	
cyanide (total)	50		pyrene	10	
fluoride (total)	400		chrysene	---	
iron	---		3-methylcholanthrene	---	
lead	500		benzo(g,h,i)-perylene	---	
manganese	---		dibenzo(a,h)pyrene	---	
mercury	2		dibenzo(a,i)pyrene	---	
molybdenum	10		dibenzo(a,l)pyrene	---	
nickel	100		acenaphthene	---	
selenium	3		acenaphthylene	---	
silver	20		anthracene	---	
thallium	---		fluoranthene	---	
tin	50		fluorene	---	
vanadium	200				
zinc	500		***Chlorinated Hydrocarbons***		
			chlorinated aliphatics[5] (each)	5	
Monocyclic Aromatic Hydrocarbons			chlorobenzenes[6] (each)	2	
benzene	0.5		hexachlorobenzene	2	
chlorobenzene	1		hexachloro-cyclohexane	---	
1,2-dichlorobenzene	1		chlorinated pesticides		
1,3-dichlorobenzene	1		PCBs[7]	5	
1,4-dichlorobenzene	1		PCDDs and PCDFs[8]	0.001	
ethylbenzene	5		***Miscellaneous Organics***		
styrene	5		2,4-D	---	
toluene	3		2,4,5-T	---	
xylenes	5		Volatile Petroleum Hydrocarbons	---	200
			Light Extractable Petroleum Hydrocarbons	---	1000
			Heavy Extractable Petroleum Hydrocarbons	---	1000
			Non-aqueous phase liquids	---	not present

Table 1-3: CCME (1991) and BCMELP (1995) Water Criteria (all values in μg/L)

(Notes are shown at the end of Table 1-3)

	CCME (1991)		BCMELP (1995) (where different from CCME Criteria)	
Substance	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

Table 1-3 (continued)

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

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

n.a.: not applicable.

1. ---.: not established.

2: Set equal to CCME Agricultural Remediation Criterion

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

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

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

6: Including all tri- and tetrachlorobenzene isomers, pentachlorobenzene

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

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

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

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

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

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

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

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

15: Tentative value due to insufficient evidence.

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

17: Guidelines vary with hardness.

18: Tentative Drinking Water Guideline due to insufficient evidence.

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

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

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

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

23: Value varies depending on pH.

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

2. METHODS

2.1 Review of Existing Information

2.1.1 Canol Camp Johnson's Crossing

The Canol pipeline was built in 1943 to carry oil from the new oil field at Norman Wells to a refinery in Whitehorse. Refined products were distributed via a number of other pipelines, including Canol No. 3. This provided fuel in support of the war effort and also for the construction of the Alaska Highway and Northwest Staging Route airports in the Yukon and Alaska. The Canol No.1 pipeline consisted of a 4 inch diameter pipeline from Norman Wells to Johnson's Crossing, and from there a 6 inch pipeline to Whitehorse. There were a total of 10 pump stations, 6 US Army Relay Stations, 13 Maintenance Camps and 32 emergency shelters located along the pipeline. The pipeline operated for 16 months and was closed in 1946 (Bisset, 1995).

Canol Camp Johnson's Crossing (latitude 60° 30' N, longitude 133° 16' W) is located in southern Yukon at the intersection of South Canol Road and Alaska Highway near the Teslin River at an elevation of 870 m above sea level. Whitehorse is approximately 140 km by road to the northwest. Johnson's Crossing served as a Maintenance Camp, and a Relay Station, providing supply and administration for the western portion of the Canol. The Maintenance and Relay stations had accommodation facilities, administration buildings, garage, inspection shed and gasoline and oil dispensing facilities. A lodge was also located across Teslin River (Map 3.1.1).

The Canol Camp was closed in 1945 and the relay station was dismantled in 1947. From the late 1940's through the 1960's, private companies and their contractors salvaged materials from the Canol Road (Bisset, 1995). It was not until the period between 1974 and 1976 that the site was cleaned up. Telephone wires were gathered in 1974. All the combustible debris, including buildings, were burned. A D-8 cat was used to dig a hole and bury debris at a landfill located 1.5 miles along the Canol Road. All buildings and structures were removed except a 125,000 gallon above ground storage tank and a garage

which were left on site. These are currently located at the junction of Canol Road, south of the Alaska Highway. Salvageable materials between Johnson's Crossing and Mile 73.5 of the South Canol Road were all brought to Johnson's Crossing. Vehicle hulks were lined up at a location northwest of the camp.

Two Historic Mileposts were erected at Johnson's Crossing in 1992 to commemorate the 50th Anniversary of the construction of the Alaska Highway. The first is situated at the entrance to Camp Canol and has an interpretative panel on the Canol Project. The second milepost (Photograph 2.1) marks the location of Johnson's Crossing Lodge.

2.1.2 Squanga Lake Airstrip

As the route of the Alaska Highway was being considered, eight intermediate flight strips were constructed. These included Squanga Lake which was built at Mile 843 of the old highway (Bisset 1995). A historic milepost has been erected near the entrance to the site (Photograph 2.2). This site, also known as US Military Flight Strip No. 6, is located along the Alaska Highway approximately 100 km southeast of Whitehorse by road (60° 29' N, 133° 27'W) at an elevation of 870 m above sea level. The site was used by the US Army as an emergency flight strip until the end of the Second World War, and serviced an Army construction camp (5 E) and gas station. The maintenance camp consisted of a garage, utility building (electrical generators and water pumping system) and quarters which were located on the south side of the highway. The Public Road Administration (PRA) who worked alongside the military personnel during the construction of Pioneer Road also built a winter camp at Squanga Lake in 1942. Camp facilities were predominantly prefabricated frame buildings.

The original camp consisting of six buildings has since been removed. The area has been heavily overgrown by second generation pine forests, with bare patches in more recently-disturbed and actively-used areas. A private residence (Lot 15, Group 805) is currently located on the southern end of the site (Map 3.2.1).

2.1.3 Canol Pump Station W (Big Devil)

Canol Pump Station W (60° 24'N, 134° 43' W) also known as Big Devil Pump Station, was constructed at mile 855 of the old Alaska Highway (Photograph 2.3), near Summit Lake (formerly Big Devil Lake). The site was one of a series of five pump stations along the Canol No. 3 pipeline. This line consisted of a 2 inch pipeline which transported mostly aviation fuel from the refinery in Whitehorse to Watson Lake. No records regarding the maintenance and operation of this pipeline were found (Bisset, 1995). Facilities at the site included a main pumping building, water tank house, garage and shop, truck and barrel loading facilities, above ground storage tanks and accommodation building. The site was decommissioned with the rest of Canol 3 in 1947/48, at which time the pipeline was deemed unfit for operation or re-fit and was subsequently drained and removed.

All the buildings and facilities have since been removed. Several building foundations were located at the site of the demolished pump station, including one thought to be a large garage/maintenance complex. The area has been largely overgrown by mixed white-spruce (*Picea glauca*) and willow (*Salix* sp.) forests, but a large more recently cleared area is still visible from the road. Areas further to the north of the highway are dominated by muskeg and wet areas with mixed woods in higher and drier areas.

A sawmill, which is associated with the Pump Station, is situated about 1 km northeast of the highway, along an access old road limited to foot travel (Map 3.3.1). This site currently contains slab piles over muskeg and a partially collapsed log house. A food cellar, which was partially built into the side of the sawmill slope and insulated with sawdust, was found still intact.

2.1.4 Marsh Lake Camp

Marsh Lake Camp(60° 31'N, 134° 21'W), formerly a US Army Highway Construction Maintenance Camp (4E), is located near Milepost 883 (Photograph 2.4) on the south side of the Alaska Highway at an elevation of 730 m above sea level (Map 3.4.1) The site is approximately 60 km southeast of Whitehorse along the shore of Marsh Lake. The original

military camp which operated in 1941 was reported to consist of 11 buildings by 1945 (Bissett, 1995). It ceased operations as a military facility at the end of the second world war.

Of the four sites investigated, Marsh Lake has been used most extensively by various parties since the original occupation by the U.S. Military as a highways construction and maintenance camp. The original camp buildings were re-fitted and the site was operated as a lodge (Marsh Lake Lodge) with a boat launch until 1979, when the private business was lost to a fire. At the present time, the site is used frequently for recreational activities such as camping and boat launching. The remains of several cooking fires were evident in the clearing near the boat ramp, as well as in the main clearing off the highway.



Photograph 2.1: Historic mile post located at Johnson's Crossing Lodge



Photograph 2.2: Squanga Lake Airstrip historic mile post



Photograph 2.3: Historic mile post located near Canol Pump Station W (Big Devil)



Photograph 2.4: Marsh Lake Camp historic mile post

2.2 Field Investigation

The Field Investigation Team consisted of Doug Bright and Matt Dodd of the ARD and Riel Sidney, a representative of the Tlingit First Nations, Teslin, YT. The team members, who were equipped with the necessary personal protective equipment, visited the sites from the 11th to 19th of September, 1996. The duration of the field program at each site depended on the size of the site and the extent of contamination encountered.

2.2.1 General Approaches

A site reconnaissance was carried out as a first step. The potential contaminant sources, pathways, the extent of migration of contaminants, the physical condition of the sites and the potential hazards associated with the debris were examined. Based on the past activities that had occurred at these sites, the potential pathways for the introduction of contaminants to the local environment included, but was not limited to:

- direct spillage or discharge of contaminant-containing materials onto the soil or into a surface water body;
- burial of contaminated or hazardous materials; and/or
- surface or subsurface migration of contaminants from a primary source.

Surface and sub-surface samples were, therefore, collected from general areas around structures and foundations, landfills/dumps, disturbed/worked area, and along potential contaminant migration pathways. Observed land use patterns and air photo interpretations were also used to guide the selection of sampling locations.

2.2.2 Site Reconnaissance

This involved the identification and delineation of visible physical debris and an inspection of all remaining facilities. The potential sources of contamination (e.g., dumps, spills, leachate) were also noted and documented during this phase of the project. These observations are discussed in Chapter 3.

2.2.3 Surface Soil Sampling

A Surficial Soil Sampling Program using stainless steel scoops, a hand auger and a shovel was carried out at all sites. Sampling locations were identified based on information collected during the information review and site reconnaissance survey. Discrete soil samples were collected from areas suspected of being contaminant sources. Test portions of the samples were collected with stainless steel scoops (which had been pre-cleaned, baked and wrapped in aluminum foil to preclude contaminants), placed into either a 125 mL or 250 mL glass jar, and sealed with a Teflon lined-lid. The sample containers were labeled and placed in coolers.

Samples were usually taken in duplicate (one set was be used for field screening and the second for laboratory analyses). The physical characteristics of each sample and photographs of sampling locations were taken.

2.2.4 Subsurface Soil Sampling

A Subsurface Soil Sampling Program was also used in conjunction with the surficial soil sampling program to identify and begin delineation of the extent of contaminants. The use of test pits also allowed visual inspection of possible physical and chemical contamination at depth. A backhoe excavator was used to excavate test pits up to a two or three metre depth as required.

Test pits were also used as a screening tool to identify areas of hydrocarbon contamination in shallow soils. An historical input of hydrocarbons leaking or discharged from a utility (above-ground storage tank, pipeline or other structure) should lead to a continuous zone of hydrocarbon contamination, starting at the surface and variously distributed with increasing subsurface depth. Detection of hydrocarbon contamination at or near the surface, therefore, is useful in the identification of the original source of input.

Samples were obtained from the walls of test pits to a depth of approximately 1.0 m. During sampling, a clean stainless steel scoop was used to scrape the wall surface, followed by the collection of the test sample. At a depth greater than 1.0 m, a stainless

steel scoop was used to extract a portion of soil safely from the backhoe bucket. The test pits were backfilled after sampling. At the time of sampling, in addition to the physical characteristics, the stratigraphy of each test pit was recorded and photographs were taken.

2.2.5 Sample Pretreatment

All soil samples were collected, transported, and stored under conditions required for maintaining sample integrity. The general protocols presented in Guidance Manual on Sampling, Analysis, and Data Management for Contaminated Sites (CCME, 1993) was used. Samples were collected and treated as previously described. Sample information was recorded on the chain-of-custody forms and the coolers were shipped to the laboratory via air freight an accompanying chain-of-custody form.

2.3 Analytical Program

The analytical program consisted of a field screening component, which utilized portable analytical equipment, and an analytical laboratory component which involved more detailed characterization. The advantage of incorporating field analytical work into this program was the ability to direct both the continuing field work and the selection of analytes for further laboratory analysis. The method involved the use of a photoionization detector to detect the volatile organic compounds.

Laboratory analyses were carried out at Analytical Services Laboratories Ltd. (ASL), Vancouver, BC. The analytes included metals, BETX and volatile petroleum hydrocarbons (VPH), light (C8-C19) and heavy (C20-C32) extractable hydrocarbons (LEPH and HEPH respectively), PCBs, organochlorine pesticides, PAHs and moisture content.

2.3.1 Field Screening for Volatile Organic Compounds (VOCs)

A soil vapour probe survey was carried out using a PE Photovac Photoionization Air Monitor (Model 2020). This detector, which was equipped with a 10.6 eV UV lamp, measures the air concentrations of VOCs in the 1-2000 ppm range. Soil samples were collected in 125 mL glass jars and sealed with aluminum lined screw-on lids. The jars were

half filled with soil and shaken thoroughly for 30 s. The headspace was allowed to equilibrate for 10 min, then the lid was carefully removed leaving the aluminum foil lining in place. The foil was pierced using the vapour probe and care was taken to sample only the headspace. The maximum reading was recorded.

2.3.2 Laboratory Analysis

2.3.2.1 Moisture Content

The percentage content of moisture in the soil samples was determined gravimetrically by drying the sample to constant weight at 103 °C.

2.3.2.2 Metals in Soil

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 procedure involves a digestion using a 1:1 ratio of nitric acid and hydrochloric acid, with hot plate or microwave heating. Instrumental analysis is by atomic absorption spectrophotometry (EPA Method 7000) and/or inductively coupled plasma - optical emission spectrophotometry. A limitation of this method is that 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. 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).

2.3.2.3 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). The procedure involves extracting the sample with methanol. An aliquot of this methanol extract is 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 analyzed by gas chromatography with photo-ionization detection (GC-PID) in conjunction with flame ionization detection (GC-FID).

2.3.2.4 Volatile Petroleum Hydrocarbons in Soil

The analysis was carried out in accordance with the BC Ministry of Environment Land and Parks Method "Volatile Petroleum Hydrocarbons Soil". The procedure involves extracting the sample with methanol and adding an aliquot of this methanol extract to a 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 analyzed by gas chromatography with flame ionization detection (GC-FID).

2.3.2.5 Light Hydrocarbons in Soil

The analysis was carried out in accordance with US EPA Method 3810/8015 (Publ. # SW-846, 3rd ed., Washington DC 20460). The procedure involves extracting the sample with methanol and adding an aliquot of the methanol to a 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 analyzed by gas chromatography with flame ionization detection (GC-FID). This analysis covers carbon atoms in the C5 - C9 range.

2.3.2.6 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). The procedure involves hexane/acetone extraction and analysis using GC/FID. EPH results are presented for components in the C10 to C18 and C19 to C32 ranges.

2.3.2.7 Polycyclic Aromatic Hydrocarbons (PAHs) in Soil

Several samples were also analyzed for PAHs in accordance with US 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 cleanup on a silica gel column. This cleanup effectively removes aliphatic and heterocyclic hydrocarbons which could potentially interfere with the analysis. The final extract is analyzed by capillary column GC with mass spectrometric detection. 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.

2.3.2.8 Light and Heavy Extractable Petroleum Hydrocarbons in Soil

This method 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) are derived by the subtraction of naphthalene concentrations from the EPH (C10-C18) values. Similarly, heavy extractable hydrocarbons (HEPH) are 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.

2.3.2.9 Organochlorine Pesticides (OCPs) in Soil

Organochlorine pesticides in soils were determined with methodology adapted from US EPA Methods 3540, 3610 and 8081 (Publ. # SW-846, 3rd ed., Washington DC 20460). The procedure involves a soxlet extraction with dichloromethane. The extract is then solvent exchanged to hexane followed by an alumina column clean up. The final extract is analyzed by dual capillary column gas chromatography with electron capture detector.

The analytes included the following pesticides: Aldrin, alpha-BHC (Benzene HexaChloride or hexachlorocyclohexane), beta-BHC, delta-BHC, cis-Chlordane, trans-Chlordane, o,p'-DDD (Dichloro Diphenyl Dichloroethane), p,p'-DDD, o,p' DDE (Dichloro Diphenyl Ethylene) p,p'-DDE, o,p'-DDT (Dichloro Diphenyl Trichloroethane), p,p'-DDT, Dieldrin, Endosulfan, Endrin, Heptachlor, Heptachlor epoxide, Lindane, Metoxychlor, Mirex, cis-Nonachlor, trans-Nonaclor, Oxychlordane and Toxaphene.

2.3.2.10 Polychlorinated Biphenyls (PCBs) in Soil

This analysis was carried out using a procedure adapted from EPA Method 8082 (Publ. # SW-846, 3rd ed., Washington DC 20460). The procedure involves a solid-liquid extraction of the sample with hexane/acetone and back extraction with water. The hexane extract is cleaned and analyzed by capillary column gas chromatography with electron capture detection. The results are reported as total polychlorinated biphenyls.

3. Results of Study

3.1 Canol Camp Johnson's Crossing

3.1.1 Site Description

Canol Camp Johnson's Crossing (60° 30' N, 133° 16' W) is located in southern Yukon at the intersection of South Canol Road and Alaska Highway near the Teslin River at an elevation of 870 m above sea level. Whitehorse is approximately 140 km by road to the northwest. The site covers approximately 10 ha in total area and was the former location of a Maintenance Camp and a Relay Station which provided supply and administration to the Yukon side of the Canol Road. A general layout of the site is presented in Map 3.1.1. The Old Alaska Highway Historic Milepost 836, which marks the location of Johnson's Crossing Lodge, is situated at the southern portion of the site across the Teslin River.

The entire Johnson's Crossing site is heavily overgrown by mixed, second generation pine (*Pinus* sp.) forests including balsam poplar (*Populus balsamifera*), and willow (*Salix* sp.) in the wetter areas. A few open and bare patches occur in those areas which are more recently disturbed or have possibly been affected by contaminant spills. Soils in the area generally consist of sand and gravel.

3.1.1.1 Old Army Lodge Dump

A small dump (referred to as Old Army Lodge Dump in this report) is situated below a ridge at the southwest end of the site, close to the south shore of the river and west of the highway (Map 3.1.2). Marshland, consisting of sedge (*Carex* sp.) and horsetail (*Equisetum* sp.), lies beyond the area and drains into the river. A sawmill is positioned on the top part of the ridge. Two properties are located along the road to the dump and sawmill. The first property belongs to the Wilkinsons, who live there during the summer months, while the second adjacent property belongs to the Allens, a Tlinqit family who operate a boat outfitting business along the shore of the Teslin River near the sawmill. A roadway leads into this area off the Alaska Highway. To the east of the area are Johnson's

Crossing supply store, gas station, lodge and camping area which are located near the historic milepost along the west side of the Alaska Highway.

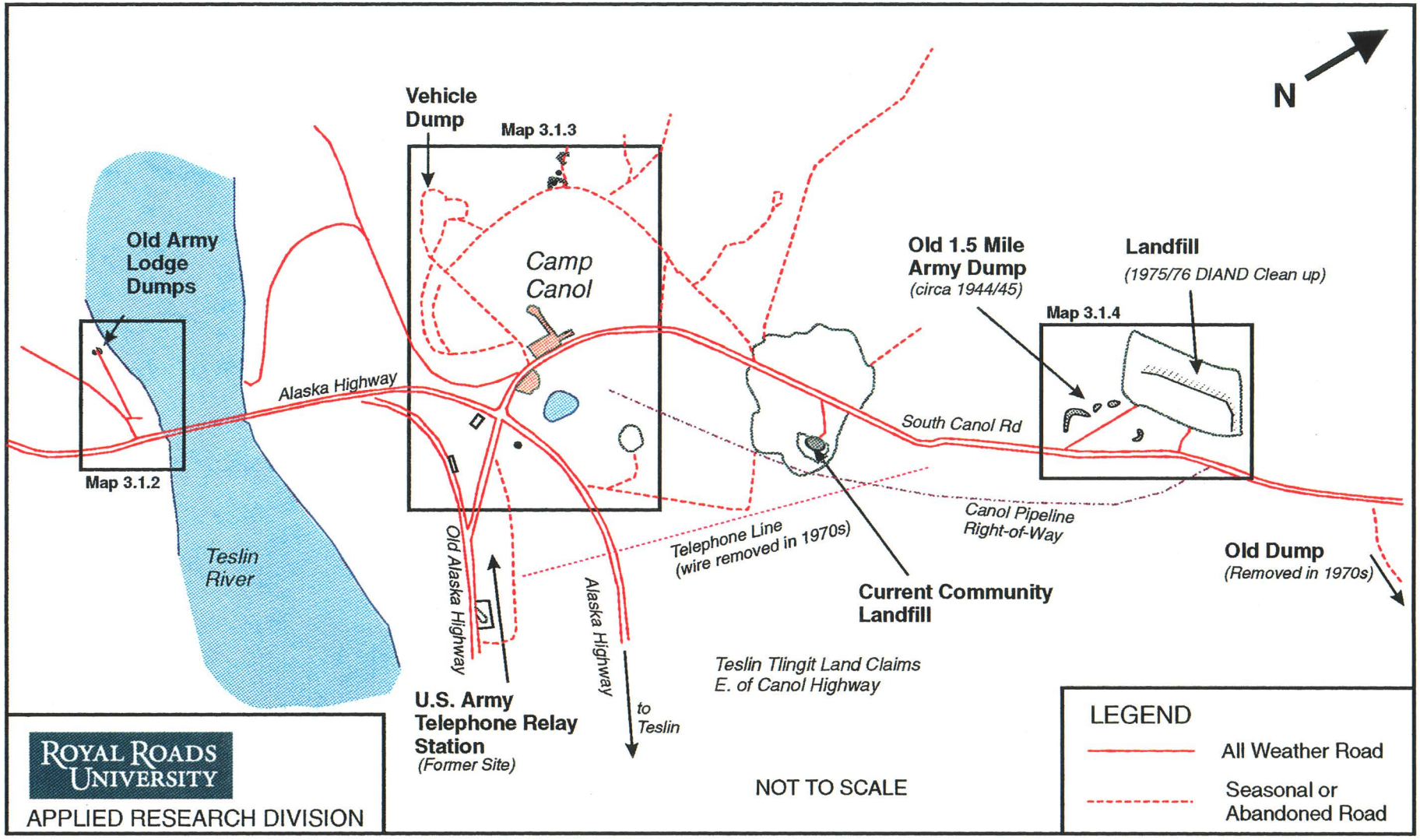
3.1.1.2 Camp Canol

Along the north side of the river, just west of the intersection of the South Canol Road and Alaska highway, is the former Canol Camp site (Map 3.1.3). The facilities at the camp were demolished and removed in 1975/76 during a cleanup by Indian and Northern Affairs (DIAND). A network of old back-roads occurs to the west of the camp. An old remaining wooden garage structure and 125,000 gallon fuel tank are found on the east side of the Alaska Highway opposite the camp site. Further to the east, along the remaining portion of the Old Alaska Highway, are some building foundations of the former U.S. Army Relay Station (Map 3.1.1). A private residence is located just to the east of the foundations.

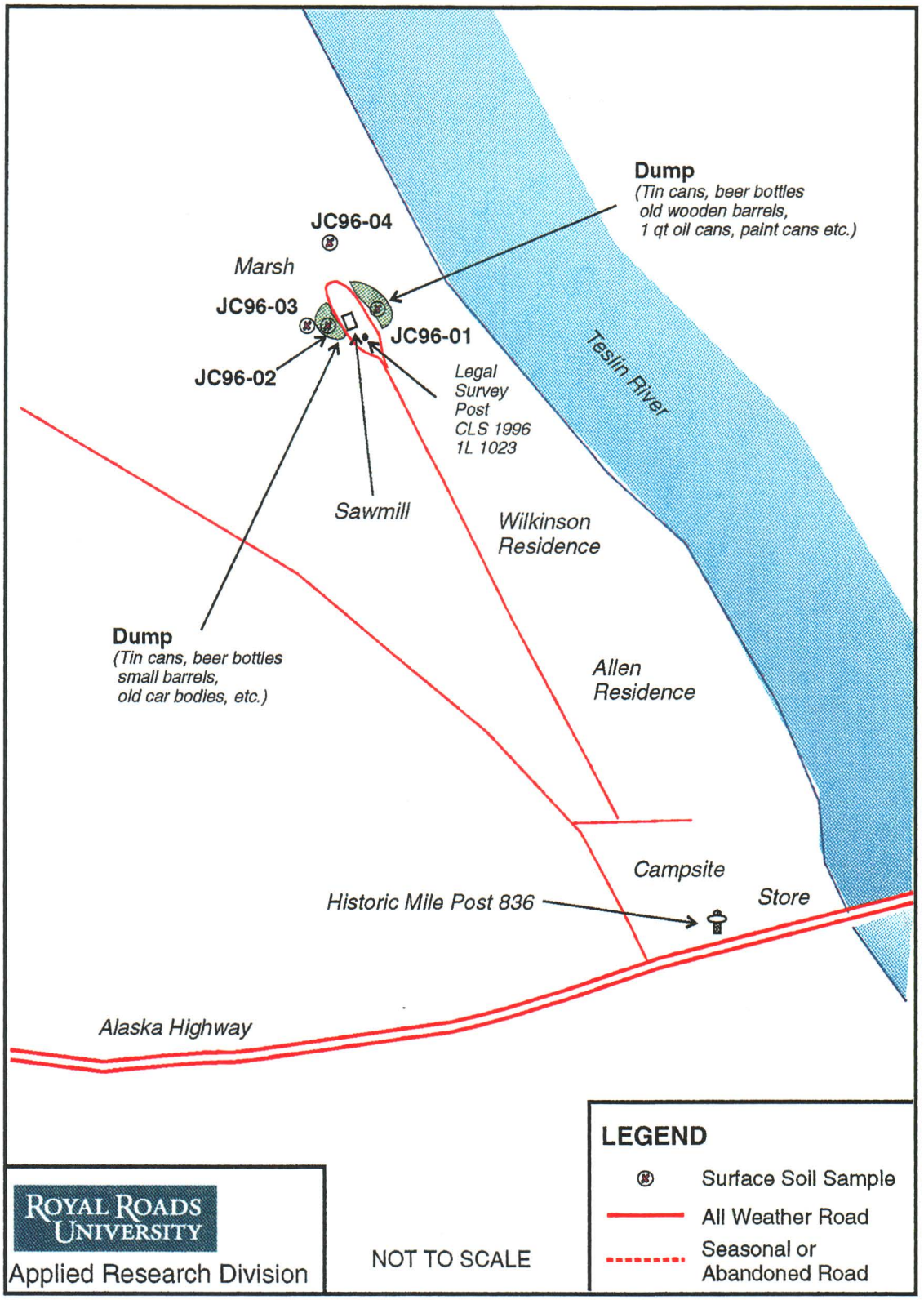
Original right-of-ways for the Canol pipeline and telegraph lines run roughly parallel to the Canol Road along its east side. A number of dumps and gravel borrows are interspersed in the wooded areas along the Canol Road on the northern part of the site. This includes the community dump which is situated off the east side of the Canol Road. An old overgrown gravel borrow, which was originally used for the construction of Canol Pipeline, exists further north down the road along the east side.

3.1.1.3 Canol Road 1.5 Mile Dumps and Landfill

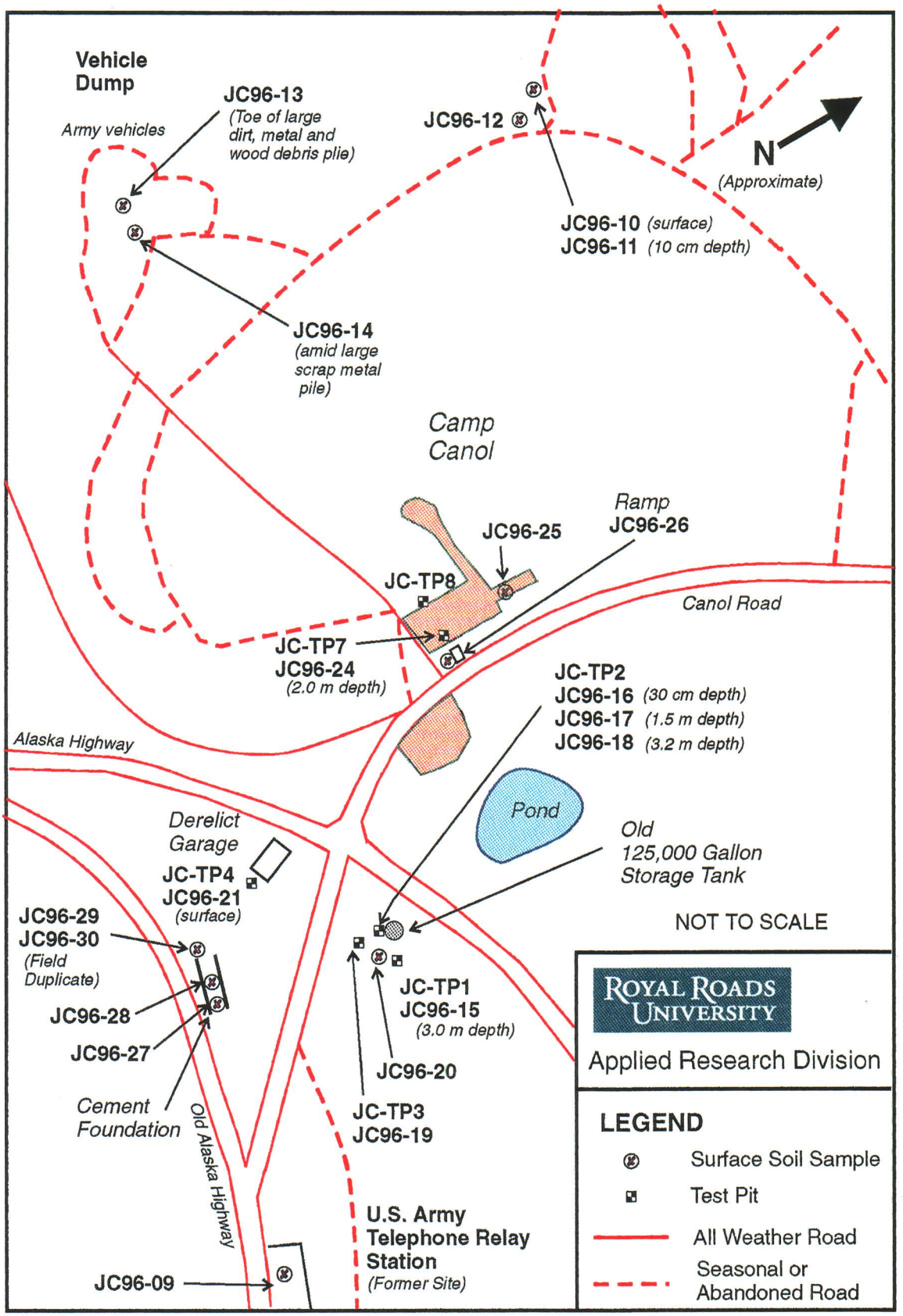
To the north at Mile 1.5 is an old US Army dump (Map 3.1.4). This dump is spread out along the west side of the road and measures approximately 300 x 300 m with a maximum estimated depth of 1.3 m. The dump was abandoned at the end of the second world war and the area is now overgrown. Next to this area is a large landfill containing debris which was buried during the DIAND cleanup in 1975/76. Another old dump is also located 1.6 miles along a service road on the east side of the Canol Road. This dump was cleaned up in the 1970's.



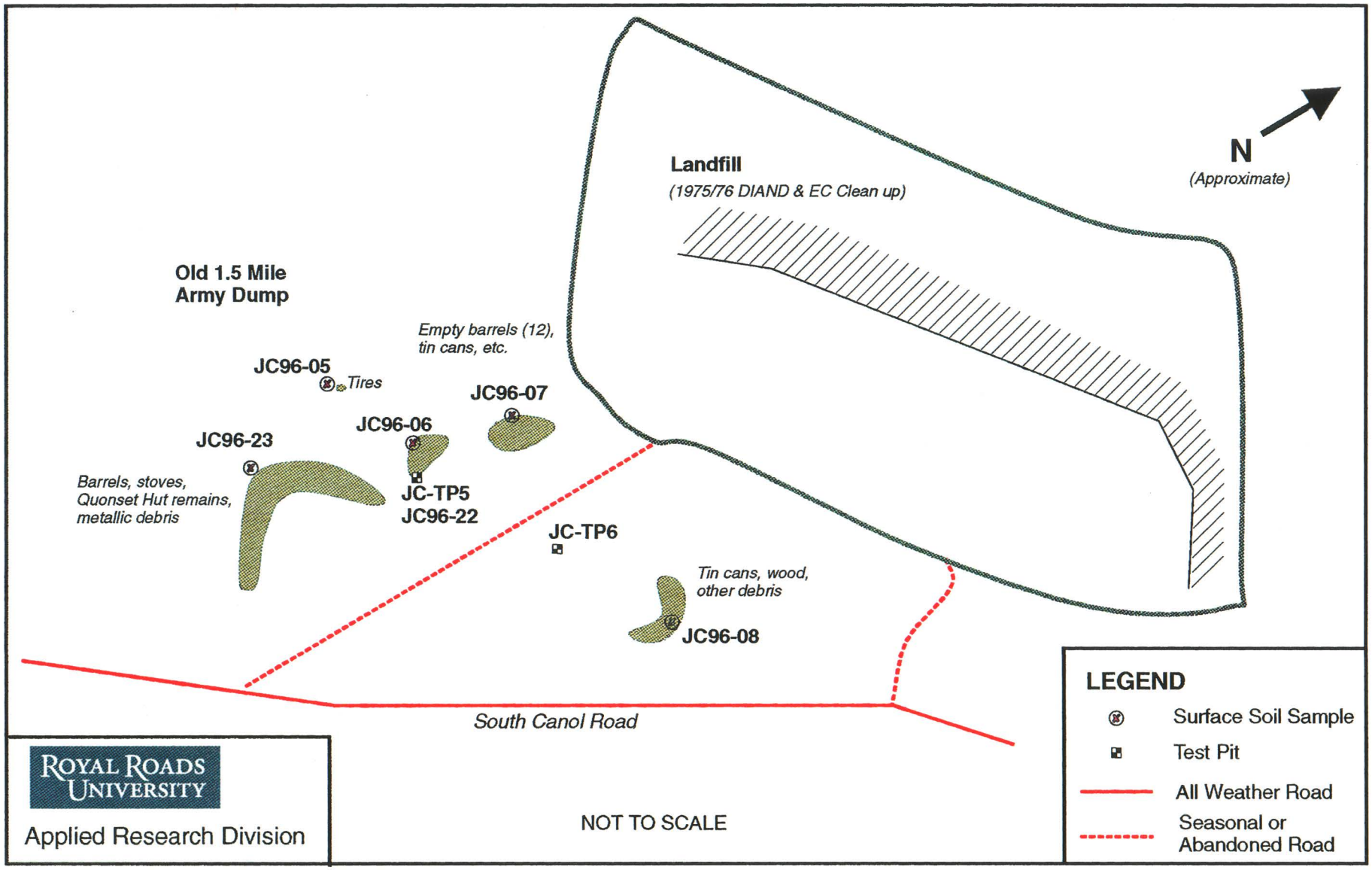
Map 3.1.1: General Layout of Canol Camp Johnson's Crossing and Surrounding Areas



Map 3.1.2: Johnson's Crossing Old Army Lodge Dump - Layout and Sampling Locations



Map 3.1.3: Camp Canol - Layout and Sampling Locations



Map 3.1.4: Old 1.5 Mile Army Dumps and 1975/76 Landfill - Layout and Sampling Locations

3.1.2 Site Conditions and Sampling Program

3.1.2.1 Old Army Lodge Dump

The dump at the bottom edge of the ridge below the sawmill, referred to as the Old Army Lodge Dump in this study, was previously used by the U.S. Army and Johnson's Crossing Lodge. Debris largely consists of unconsolidated materials, including old wooden barrels, bottles, oil and paint cans, antifreeze containers and old car and truck bodies (Photographs 3.1.1 and 3.1.2). Drainage from this area flows into a marsh which drains into Teslin River (Photograph 3.1.3). Beyond the obvious debris, the site is relatively clean with no evidence of surface staining or leaching. Substrate in the area consists of a mixture of organic material over sandy soil, with the organic layer ranging from loam to organic-rich peat in wetter areas near the marsh. Three soil samples (JC96-01 to JC96-03) were collected amid the debris and a fourth sample (JC96-04) was taken from the marsh below the dump (Map 3.1.2).

3.1.2.2 Camp Canol

The infrastructure at Camp Canol proper was cleaned up in 1975/76 by DIAND. A limited amount of debris still exists along the access roads leading into the site including domestic waste, scrap metal, plastics, woods and other general litter. Except for recently worked areas, the site is heavily overgrown and relatively clean with little evidence of staining. Some overgrown berms exist which may be indicative of old building foundations. Three soil samples (JC96-24 to JC96-26) were collected from stained areas at Camp Canol (Map 3.1.3).

3.1.2.3 Vehicle Dump

A large vehicle dump exists on the west side of the camp and contains both World War II vintage vehicles (Photograph 3.1.4) and other vehicles (Photograph 3.1.5) probably dumped by residents in the area. Some of the vehicles are piled along the edge of a ring road (Photograph 3.1.6). Barrels, crushed and intact, are also scattered throughout the

area, but there are few indications of barrels with either liquid contents or other hazardous debris. A large scrap pile of wood and metal debris is present in the centre area within the ring road (Photograph 3.1.7). Two batteries of 1960 - 1970 vintage are among the debris (Photograph 3.1.8), as well as some empty cans clearly marked as poisonous and a few small surface stains. Two soil samples (JC96-13 and JC96-14) were collected from locations near the debris (Map 3.1.3).

Along the access road, 300 m north from the vehicle dump, a large stained area is found on a knoll on top of a series of plateaus. The affected area, roughly 15 m x 20 m, appears to be fairly shallow (~ 5 cm deep) and, with the exception of a few young saplings of pine and balsam poplar, is clearly demarcated by a lack of vegetation (Photograph 3.1.9). Two samples (JC96-10 and JC96-11) were collected from this stain. An old log bank supports the slope below the knoll and a few opened barrels are found just south of this area. A tar-based surface stain (2.5 x 4 m) is also located on a second plateau south of the previously mentioned stain. The stain appears to have run off the edge of the plateau into a wooded area to the south. Sample JC96-12 was obtained from the tar like stain on the plateau.

3.1.2.4 Above Ground Storage Tank and Garage

A faint surface staining is found immediately west of the old above ground storage tank, (AGST) located near the intersection of the Alaska Highway and South Canol Road. The tank is empty and cut open in four places (Photograph 3.1.10). Recently disturbed areas near the AGST consist of clean clay-sand fill which was probably excavated during the rerouting of the Alaska Highway. Six soil samples (JP96-15 to JC96-20) were collected from surface stains and test pits around the AGST (Map 3.1.3).

Sample (JC96-21) was taken from a stained areas near the derelict garage (Photograph 3.1.11) situated across the road from the AGST. The floor of the garage is littered with miscellaneous metallic debris (Photograph 3.1.12). Four soil samples (JC96-27 to JC96-30) were also collected from locations near a concrete foundation to the south of the garage.

3.1.2.5 Army Relay Station

A large "L"-shaped foundation exists between the new and old highways at the location of the former U.S. Army Relay Station. A number of old timber piles - remnants of collapsed buildings - are also scattered throughout the site which is heavily overgrown with young pine balsam poplar forest. Sample JC96-09 was obtained near the concrete foundation.

3.1.2.6 Community Dump

The community dump, located along the Canol Road at Mile 1.1 on the east side, consists mostly of consolidated domestic waste including cans, appliances and metal debris. A soil sample was collected from an area, containing a crushed barrel and other metallic debris, which was excavated during a routine grading of the dump (Photograph 3.1.13). The area south of the dump has scattered debris on both sides of the road, including empty barrels and other metallic objects.

3.1.2.7 Canol Road 1.5 Mile Dump and Landfill

The DIAND landfill at Mile 1.5, along the west side of Canol Road has been completely covered and capped with clean fill over its entire 300 m x 300 m area (Photograph 3.1.14); buried materials probably include both old army waste and debris from cleanup operations at Camp Canol in 1975-1976. The area is relatively clean and is being re-claimed by the surrounding forest vegetation.

Some scattered debris is found in an over-grown dump to the south of the landfill. Debris in this Old Army Dump includes old army truck tires, cans, metal piping, scrap metal, wood debris, appliances, and barrels scattered and in piles (Photographs 3.1.15 and 3.1.16). To the north of the access road is a ridge containing a young pine and balsam poplar forest, while further to the north of this lies a depression; both of these areas are littered with debris. Samples JC96-06 to JC96- 08 and JC96-22 to JC96-23 were obtained from the dumps.



Photograph 3.1.1: Typical debris noted on the southern side of the Old Army Lodge Dump located near Teslin River

Photograph 3.1.2: Debris including oil and paints cans, barrels, 10 gallon drums and wood present on the northeastern side of the Old Army Lodge Dump





Photograph 3.1.3: Marshy area below the Old Army lodge Dump with Teslin River in the background



Photograph 3.1.4: Old army vehicle hulks located in the vehicle dump northwest of Camp Canol.



Photograph 3.1.5: Pile of metallic debris including a car at the southern side of the vehicle dump



Photograph 3.1.6: Old army vehicle hulks piled along the edge of the ring road at the vehicle dump



Photograph 3.1.7: Pile of wood and metallic debris found in the central area within the ring road at the vehicle dump.



Photograph 3.1.8: Two batteries of 1960 - 1970 vintage found amongst the debris at the vehicle dump



Photograph 3.1.9: Large stained area on top of a knoll located 300 m north of the vehicle dump along the access road



Photograph 3.1.10: Test pit excavation near the above ground storage tank located south of the Alaska Highway and Canol Road junction. Note cut-outs along the bottom part of the tank.



Photograph 3.1.11: View of the old garage situated south of the Alaska Highway and Canol Road junction.



Photograph 3.1.12: Miscellaneous metallic debris scattered on the floor of the derelict garage.



Photograph 3.1.13: Crushed barrel and other metallic debris excavated during a routine grading at the Community Dump.



Photograph 3.1.14: View of the 1975/76 Cleanup Landfill from the south.



Photograph 3.1.15: Partially buried debris at the old 1.5 Mile Army Dump



Photograph 3.1.16: Some of the empty barrels scattered in piles at the old 1.5 Mile Army Dump

3.1.3 Subsurface Soil Conditions

A total of eight test pits were excavated at this site focusing on suspected locations of buried debris and the potential sub-surface migration of contaminants from stained areas. Locations included areas around the AGST, garage, Camp Canol and the 1.5 Mile dumps.

3.1.3.1 Above Ground Storage Tank and Garage

Three test pits were dug in the vicinity of the AGST. Test Pit 1 (JC-TP1) was excavated 20 metres south of the tank along the berm of a worked area (Map 3.1.3). The pit was dug to a maximum depth of 2 m. Although no surface staining was evident, a dark layer of approximately 15 cm was observed in the profile at a depth of 1.5 m. A portion of an orange tarp, possibly a liner for the facility, was also identified at this depth. No hydrocarbon odour was noted at 1.5 m and the Photo Ionization Detection (PID) reading for volatile organic compounds (VOCs) was below detection (<10 ppm). Test pit 2 (JC-TP2) was excavated in a soakaway pit on the northeast corner of the AGST. Surface hydrocarbon staining was noted in the profile to a depth of 30 cm with a VOC reading of 10 ppm and a strong hydrocarbon odour was detected up to the maximum depth of 3.2 m. VOC readings exceeded 2000 ppm at 1.5 and 3 m, respectively (Photograph 3.1.17). The third test pit (JC-TP3) was dug 25 m to the west of the tank (Map 3.1.3) to detect potential subsurface migration from the hydrocarbon stain. Soils were excavated to a maximum depth of 3 m, but no hydrocarbon odour or staining was discernible.

Test pit 4 (JC-TP4) was excavated 5-7 m from the southern bay door of the garage near the Canol camp (Map 3.1.3) to a maximum depth of 3 m. Staining was evident in the first 10 cm depth of the profile, but no obvious staining or hydrocarbon odour was detected at the 1 m depth or beyond. This was confirmed by the VOC reading at this same depth which was below detection (< 10 ppm).

3.1.3.2 Camp Canol

Two test pits were excavated in the vicinity of the Canol camp site. Test pit 7 (JC-TP7) was dug in a stained location in the first worked area north of the access road leading to

the camp (Map 3.1.3). Surface debris in the area included tin cans, metal, glass and wood. Staining was apparent to a depth of 15 cm, but no further discoloration was observed to the maximum profile depth of 2 m. The second test pit (JC-TP8) at the edge of the worked area was excavated in the berm, which was suspected of being an old tent or building foundation. No visible debris or staining was encountered in the sandy loam profile, which extended to a maximum depth of 2 m.

3.1.3.3 Canol Road 1.5 Mile Old Army Dump

A test pit (JC-TP5) was dug in the 1.5 Mile Old Army Dump amid some debris on the western side (Map 3.1.4). Metallic debris, including empty barrels, was uncovered in the excavation (Photograph 3.1.18), which was conducted to a maximum depth of 2 m, but no visible staining or hydrocarbon odour was present in the profile. Two other pits were excavated in the dump and found to have similar profiles to that of JC-TP5. Another pit (JC-TP6) was excavated along a sandy bank immediately to the north of the road leading to the DIAND Landfill (Map 3.1.4). The soil was found to be clean in the profile, which extended to a maximum depth of 2 m, with no obvious staining or odour.



Photograph 3.1.17: Profile of Test Pit 2 excavated in the soakaway pit near the above ground storage tank

Photograph 3.1.18: Empty crushed barrels and metal pipes excavated from Test Pit 5 excavated in the old 1.5 Mile Army Dump



3.1.4 Contamination Considerations

Given the site history of Canol Camp and surrounding areas (Section 3.1.1), contaminants may have been released as a result of a variety of practices. The camp itself was primarily a residential tent camp (primarily Quonset huts) and messing area for the employees involved in the construction of the Canol road and Canol No. 1 pipeline. Up to 1945, there was limited power generation capabilities or need for large amounts of electrical equipment, which would limit the amount of PCB dielectric fluids (e.g. transformer fluids) potentially used and disposed of. Some use of small volumes of transformer fluids might have occurred in the proximity of the U.S. Army Telephone Relay Station.

The available archival records (Bright, *unpublished results*) suggest that pesticides such as DDT were not used at or near military sites in Alaska or the Canadian Arctic until later in the decade, around 1947-49. On the other hand, the large amount of road and pipeline construction equipment probably necessitated the use, and possible disposal of, large quantities of lubricating fluids, especially around major vehicle maintenance areas. Other areas of residual hydrocarbon contamination could include spills along the pipeline right-of-way and places where burial of used oils in barrels took place either during the operational period of Canol Camp or subsequent to decommissioning in 1945. The activities carried out around Canol Camp up to 1945 might also contribute metal contamination (e.g., as lead batteries) to the surrounding environment.

There has been some uncontrolled dumping of waste materials in the western portion of Canol Camp subsequent to 1945; a practice that has continued in recent times. Recently discarded, visible debris at Canol Camp includes old vehicles, heavy equipment, automotive batteries, and general household refuse.

The Old Army Dump located 1.5 mile (~2.5 km) up the Canol Road was not investigated nor reclaimed during the 1970s clean-up effort by DIAND. This was considered, during this preliminary study, as a major candidate area for burial and surface disposal of materials such as barrels with contaminated waste oils, transformer fluids, industrial cleaners, pesticides and preservatives. The major landfill, constructed during the 1970s

clean up, was not investigated through the use of electromagnetic surveys or test pits. It was felt that the majority of buried material was ferrous metal debris (e.g., pipe, derelict vehicles and empty, crushed barrels). However, there is a limited possibility that some used, and potentially contaminated, oils and/or other fluids were buried in barrels as part of the clean up (Lorne Gay, DIAND; *personal communication*). Even if sources of contaminants exist within the 1970s landfills, the only mechanism of contaminant migration into the surrounding ecosystem is *via* groundwater. Risks to ecological receptors would only be plausible where the groundwater emerged at either the ground surface, or into a down gradient body of water within a small radius of the site. There is little, if any, possibility of this at Johnson's Crossing.

3.1.4.1 Summary of Sampling and Analytical Program

A total of 31 surface or subsurface soil samples were collected during the preliminary site investigation of Canol Camp and the surrounding disturbed areas at Johnson's Crossing (Maps 3.1.2 to 3.1.4). Sample locations are given in detail in Appendix A. These included;

- four samples from surface areas within or near the Old Army Lodge Dump on the western side of the Teslin River;
- five samples from the toe of, or run-off areas, down slope from the old 1.5 Mile Army Dump, as well as one subsurface sample in the dump;
- one sample within the cement foundation of a building of the U.S. Army Telephone Relay Station;
- three samples from stains within clearings along the road at Canol Camp;
- two surface and five subsurface soil samples in the vicinity of the above-ground storage tank/garage complex, and four surface soil samples from within or around the large cement foundation located to the south of the garage;
- two samples within the vehicle dump in the western portion of Canol Camp; and,

- one sample in the present community landfill to the north of Canol Camp.

A synopsis of the sampling and analytical program is provided in Table 3.1.1 The analytical results for the soil samples are tabulated in Appendix B.

Table 3.1.1: Summary of the Sampling and Analytical Program - Johnson's Crossing

	No. Collected	No. Analyzed					
		Metals	Extractable Petroleum Hydrocarbons	BETX and VPH	PAHs	PCBs	Chlorinated Pesticides
Surface soils	25	10	11	0	4	15	6
Subsurface soils (test pit samples)	6	1	4	3	1	1	0

3.1.4.2 Soil Quality Criteria

With regard to the CCME soil quality criteria, there are two levels of interpretation that may be applied.

1. Samples with analyte concentrations that exceed the range expected for natural or background concentrations may, in some cases, indicate the past use and disposal of substances as a part of human activities. The background concentration of total PCBs in surface soils from the Canadian arctic or sub-arctic is generally less than 0.001 to 0.010 mg/kg (or less than 1 to 10 ppb) (Bright, *unpublished results)*. Concentrations of PCBs that are generally much lower than 10 ppb may be attributable to wide-scale deposition from the atmosphere arising from various sources through the northern hemisphere. Concentrations of total PCBs in soil that exceed 10 ppb probably indicate either direct local spillage or inputs from a local source area via short range atmospheric or water-borne transport. Similarly, chlorinated pesticide levels (e.g., DDT) that exceed 0.001 mg/kg or 1 ppb in Yukon soils may indicate a local source. A simple method for determining if analyte concentrations in a soil sample exceed expected background levels is to compare the analytical data to the relevant CCME

Soil Assessment Criteria (see Chapter 1.3). Occasionally, metal levels in soils or water may exceed the Assessment Criteria due to local, natural geological conditions.

2. Soil and water samples that have been contaminated through inputs from local sources probably do not constitute a risk to human health or other biota in the immediate vicinity unless the level of contamination is sufficiently high to induce adverse biochemical, physiological and population level effects. In general, there is potential for adverse effects from a contaminant only if the concentrations exceed the CCME Remediation Criteria. As discussed in Chapter 1, the use of CCME Residential/Parkland (R/P) Criteria is considered the most appropriate given the present and possible future uses of the sites.

3.1.4.3 Metal Contamination

A total of eleven soil samples from Johnson's Crossing were analyzed for metals. All or most of these samples exceed the CCME Soil Assessment Criteria for barium (criterion = 200 mg/kg), chromium (criterion = 20 mg/kg), cobalt (criterion = 10 mg/kg), copper (criterion = 30 mg/kg), nickel (criterion = 20 mg/kg), vanadium (criterion = 25 mg/kg) and zinc (criterion = 60 mg/kg). These elements, therefore, exhibit high soil concentrations due to background geological conditions, and the delineation of local contaminant sources should take this into consideration.

Sample JC96-08 contains a tin concentration (16 mg/kg) that exceeds the Assessment Criterion but is lower than the R/P remediation criterion. Samples JC96-01, -07, -14 and -25 exhibit lead concentrations that exceed the Assessment Criterion but are lower than the R/P remediation criterion. Finally, samples JC96-02, -04, -07, and -25 have arsenic concentrations that exceed or are similar to the Assessment Criterion but are lower than the R/P remediation criterion.

Four of the eleven soil samples contained metal concentrations that exceed the CCME R/P criteria for one or more metals. These are -

- **JC96-02**: 114 mg/kg tin (CCME R/P criterion = 50 mg/kg);
- **JC96-05**: 531 mg/kg barium (CCME R/P criterion = 500 mg/kg);
- **JC96-06**: 415 mg/kg lead (CCME R/P criterion = 400 mg/kg); and
- **JC96-07**: 123 mg/kg copper, 431 mg/kg tin (CCME R/P criterion = 100 and 50 mg/kg respectively);

The locations of these samples and possible contaminant sources are discussed in more detail in Chapter 4.

3.1.4.4 Hydrocarbons

Of the 31 soil samples collected, 15 were analyzed for extractable petroleum hydrocarbons. The naturally-occurring concentrations of hydrocarbons in soils is highly variable from region to region. It is difficult to discriminate between natural and anthropogenic sources without evaluating the relative contribution of various components of the hydrocarbon mixture.

The Draft 3 B.C. Numerical Soil Standards (1995) for extractable hydrocarbons (see Chapter 1) was used as a benchmark of hydrocarbon concentration in soils below which biological effects may be ruled out. For the B.C. standards, a soil concentration of 200 mg/kg volatile petroleum hydrocarbons (VPHs), or 1000 mg/kg of either light extractable petroleum hydrocarbons (LEPHs) or heavy extractable petroleum hydrocarbons (HEPHs) are used here as triggers for further investigation or action. VPHs include hydrocarbons with a carbon skeleton comprised of five to nine carbons (C5-C9), but excluding aromatic hydrocarbons in the same molecular weight range. Derivation of a concentration for VPHs requires a separate laboratory analysis of the aromatic fraction, which is then subtracted from the total concentration of extractable petroleum hydrocarbons in the C5 to C9 range (EPH C5-C9). Similarly, LEPH and HEPH concentrations are derived from the subtraction of specific suites of polycyclic aromatic hydrocarbons from concentrations of EPH (C10-C18) and EPH (C19-C31) respectively. For this study, the B.C. draft standards

were used as benchmarks for results expressed as *either* VPHS, LEPHs and HEPHs *or* EPH (C5-C9), EPH(C10-C18) and EPH (C19-C31) respectively. It is rare that the aromatic component of the hydrocarbon fraction comprises more than 1 to 10% of the total mixture (e.g., see analytical results for sample JC96-12; Appendix B). Therefore, the difference between concentrations of hydrocarbons corrected for the aromatic fraction and the uncorrected values is usually smaller than the analytical variation for the method.

Samples that contained hydrocarbons in excess of the B.C. draft standards include -

- **JC96-11**: 1,810 mg/kg EPH (C10-C18);
- **JC96-12**: 6,340 mg/kg EPH (C10-C18) or LEPHs and 165,000 mg/kg EPH(C19-C31) or HEPHs;
- **JC96-17**: 1,460 mg/kg VPHs, and 962 mg/kg EPH (C10-C18);
- **JC96-18**: 937 mg/kg VPHs; and
- **JC96-23**: 3,590 mg/kg EPH (C10-C18) and 5,790 mg/kg EPH (C19-C31).

Gas chromatographic traces showing the distribution of hydrocarbons in the samples are given in Appendix C. Three of the samples were analyzed for a subset of the individual volatile non-chlorinated organics that are often referred to as the BETX contaminant suite; i.e., benzene, ethylbenzenes, toluene and xylenes. The only detected analytes are xylenes (**JC96-17**: 159 mg/kg total xylenes; **JC96-18**: 85 mg/kg total xylenes). These concentrations greatly exceed the CCME residential/parkland (R/P) soil remediation criterion of 5 mg/kg xylenes).

Five of the samples, JC96-10, -12, -13, -18 and -26 were also analyzed for PAHs. Individual PAHs exceed the relevant CCME R/P criteria in only one soil sample:

- **JC96-12**: benzo(k)fluoranthene = 2 mg/kg.

3.1.4.5 PCBs and Chlorinated Pesticides

Sixteen soil samples were analyzed for total PCBs. The soil concentrations are less than the analytical detection limit of 0.05 mg/kg in fourteen of the sixteen samples. Samples **JC96-14** and **JC96-28** contain PCBs at concentrations of 0.30 mg/kg and 0.06 mg/kg respectively, which exceed the CCME assessment criterion of 0.01 mg/kg, but are lower than R/P remediation criterion of 5 mg/kg. The PCB concentrations in these sample were undoubtedly associated with local inputs. The implications are discussed in Chapter 4.

Six soil samples, selected as most likely to represent hotspots of contamination, were analyzed for chlorinated pesticides: JC96-01, -02, -06, -07, -14, and -22. All chlorinated pesticides are lower in concentration than the analytical detection limits (< 0.001 to < 0.030) with a few minor exceptions: Sample **JC96-02**, collected from the toe of the dump, near the western shore of the Teslin River, exhibits detectable levels of DDTs and related isomers DDEs and DDDs. The maximum soil concentration observed is 0.027 mg/kg p,p'-DDT (or, 4,4'-DDT), the primary constituent of DDT-containing insecticidal formulation. Also detected in this sample are p,p'-DDD (0.008 mg/kg), p,p'-DDE (0.003 mg/kg), o,p'-DDT (0.001 mg/kg) and dieldrin (0.003 mg/kg). Concentrations of the parent insecticidal compound approaches the detection limit in samples JC96-06, and -07 (0.002 mg/kg p,p'-DDT in both). These chlorinated pesticide concentrations are more than one magnitude lower than soil concentrations that have been associated with adverse effects to living organisms in past field or laboratory toxicology studies, and any possibility of an associated risk can be ruled out. The implications with regard to local source inputs, however, are discussed in more detail in Chapter 4.

3.2 Squanga Lake Airstrip

3.2.1 Site Description and Conditions

Squanga Lake Airstrip, formerly known as U.S. Military Flight Strip No. 6, is located along the Alaska Highway approximately 100 km southeast of Whitehorse by road (Map 3.2.1) at Mile 843. This site is also approximately 10 km west of Johnson's Crossing and 10 km east of Squanga Lake. It was used by the U.S. Army as an emergency flight strip until the end of the Second World War, and serviced an Army construction camp (5 E), located on the south side of the highway. The original camp, consisting of six buildings, has been removed. The area is heavily overgrown by second generation pine (*Pinus* sp.) forests, with bare patches in more recently-disturbed and actively-used areas. Soils in the area generally consist of sand and gravel.

3.2.1.1 Airstrip

The huge, well-maintained, sand and gravel airstrip measuring approximately 1.8 km long, still exists at the site (Photograph 3.2.1); no dumps were identified along its perimeter. A large old beacon tower is located near the centre of the facility along the south side. The top of this structure is crowned by a large nest (Photograph 3.2.2) which is used by a breeding pair of osprey. A small, collapsed wooden generator shack is found near the tower (Photograph 3.2.3), and a small surface stain area is located between the shack and the airstrip to the north. An old building foundation (approximately 3 x 5 m) is also found to the west of the airstrip access road and tower. A four inch diameter pipe sticks out of this cement foundation and extends approximately 2 m into the air. Four soil samples (SQ96-06 to -09) were collected from locations around the two foundations.

A few berms, composed of large rocks, are present in the wooded area between the airstrip and the Alaska Highway. These rocks may have been excavated during the airstrip's construction. Small amounts of debris in piles, including wood scraps and cans, are also found in this area (Photograph 3.2.4) .

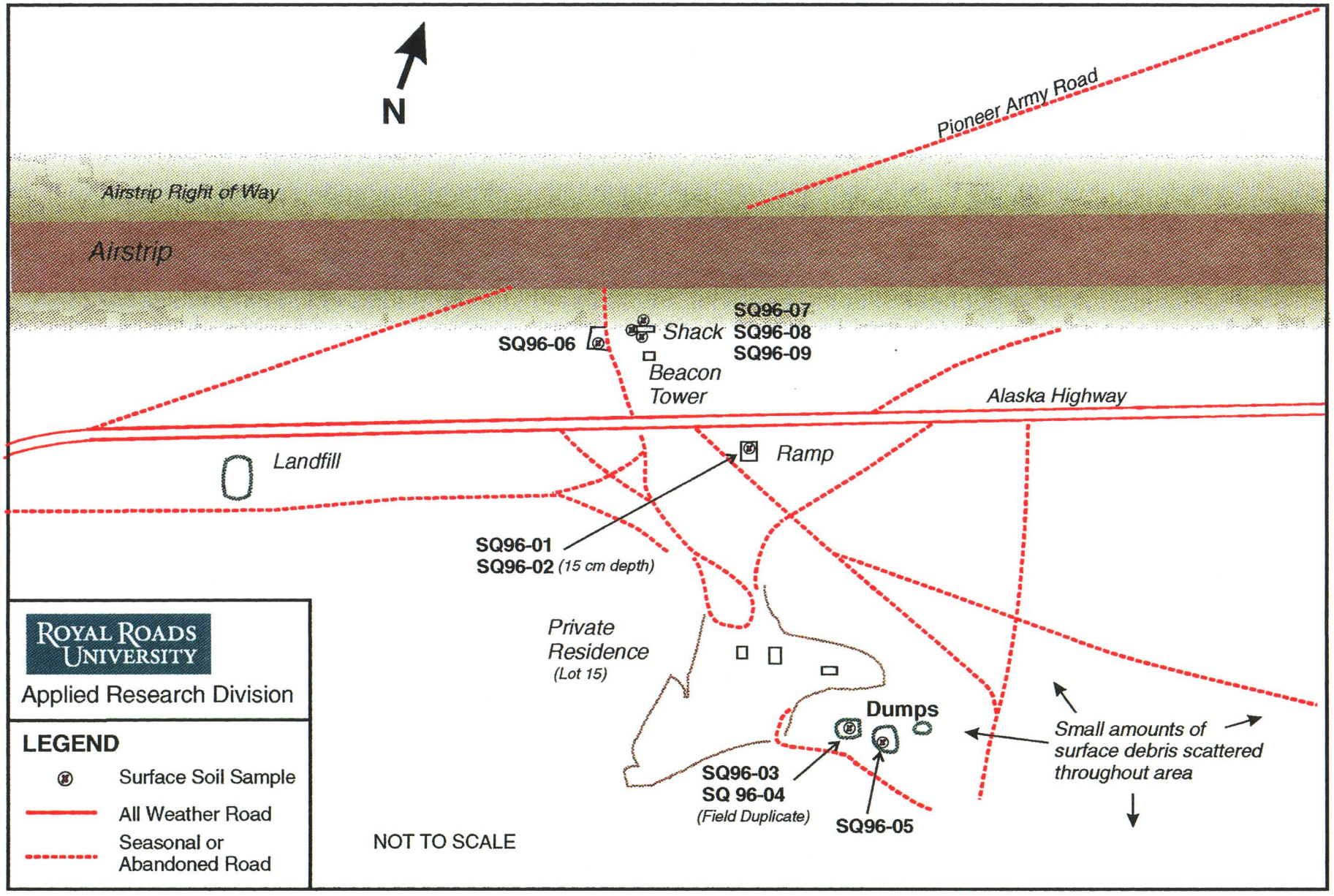
3.2.1.2 Army Construction Camp

To the south of the highway is the site of the original construction camp which is linked with the airstrip through a network of old interconnecting access roads (Map 3.2.1). The original camp facilities are no longer evident, with the exception of a wooden loading ramp (Photograph 3.2.5) - possibly part of the camp garage - and cement pad which is currently built on. A number of old wooden building foundations are also found to the southeast. A private lot (No. 15 Group 805) currently exists at the former campsite along the south side of the Alaska Highway. The owner has used the cement pad to build a shop and residence, in addition to some outbuildings (sheds) nearby. The property is presently found to be in good physical condition with little evidence of past U.S. Military activity. No soil samples were collected near the private property; however, two samples were obtained from a dark stained area near the ramp.

In the 1970's, dump sites were reported at locations to the east and west of the camp site (Bisset, 1995). Debris in the dump to the west of the site was removed during the 1975-1976 cleanup by Indian and Northern Affairs. The east dump is found in brush just to the east of the residence (Map 3.2.1). Small amounts of surface debris including a few empty electrical panels, an old fire extinguisher, metal debris, cable, and some empty barrels and cans are scattered in the area.

A group of dumps and scattered debris are also found along an old access road leading to the southeast from the original construction camp site. One surface dump, approximately 5 x 10 m, is located in a rectangular depression along the north site of the access road. This dump consists of old machinery parts, cans, a wood stove, as well as some old turpentine cans, barrels and empty 20 gallon drums (Photograph 3.2.6). A field duplicate sample (SQ96-03 and -04) was collected from a low area in the dump. A second dump, approximately 10 x 10 m, is located around a partially-collapsed wood frame house just to the southeast and contains old tires, 10 gallon drums, old electrical equipment (timers and switches) and lights from the airstrip (Photograph 3.2.7 and 3.2.8). Sample SQ96-05 was collected from this location.

One recently disturbed area, identified along an old access road running west from the former construction camp site, is believed to be the burial site of an old truck. The soil appears to be excavated, backfilled and re-contoured, and signs of heavy equipment use are evident, including the scraping of adjacent pine trees in the area. No soil sample was collected from this area.



Map 3.2.1: General Layout of Squanga Lake Airstrip and Sampling Locations



Photograph 3.2.1: View of Squanga Lake Airstrip



Photograph 3.2.2: Old beacon tower at Squanga Lake airstrip containing a large nest which is used by a breeding pair of osprey



Photograph 3.2.3: Collapsed wooden generator shack located near the beacon tower



Photograph 3.2.4: A berm composed of rocks with a few tin cans located between the airstrip and the Alaska Highway



Photograph 3.2.5: Remnants of a wooden loading ramp situated south of the highway



Photograph 3.2.6: Typical debris scattered in the dump east of the private residence



Photograph 3.2.7: Partially-collapsed wood frame house and debris including 10 gallon drums, old electrical equipment and barrels located east of the private residence



Photograph 3.2.8: Tires and electrical boxes in the dump near the partially collapsed house east of the private residence

3.2.2 Subsurface Soil Conditions

A couple of exploratory test pits were hand-dug by shovel and/or soil auger in areas where surface debris was encountered. One 1 m test pit was excavated near soil sample SQ96-06 by the old building foundation to the west of the airstrip access road and tower (Map 3.2.1). The profile was found to be clean with no evidence of buried materials, staining or odour. Similar results were found for shallow excavations conducted just to the east of the beacon tower, as well as shallow subsurface areas immediately to the north of the old cement garage ramp near the camp (near samples SQ96-01 and 02). Excavations in the dumps also indicated debris was surficial.

3.2.3 Contamination considerations

The Squanga Lake site, like the other sites, has undergone substantial modification since the original construction and operation of the site by the military. Following a thorough reconnaissance of the site, a small number of areas were considered to be possible candidates for the presence of contaminants. The collapsed power house to the Beacon might have contained PCB-containing equipment. The old vehicle maintenance area to the south of the new Alaska Highway, and now possibly located on privately occupied lands, was undoubtedly used for the changing of crankcase oil and lubricating fluids in heavy equipment and motor vehicles as well as for general maintenance. The ramp may also have been used by a variety of parties after the period of military occupation. The soil beneath the ramp is obviously stained. Finally, two surface dumps and scattered piles of debris throughout the pine forest to the south east of the present residential site (Lot 15) are considered to be major candidates as contaminant source areas.

3.2.3.1 Summary of Sampling and Analytical Program

A total of nine surface or subsurface soil samples were collected during the preliminary site investigation of Squanga Lake Airstrip (see section 3.2.1 for sample locations and Appendix A for detailed sample descriptions). These included -

- A surface and subsurface sample collected beneath the vehicle maintenance ramp;

- three surface soil samples in low areas along the toe of the two surface dumps;
- a surface sample in an overgrown and poorly discernible building foundation between the airstrip and highway, and to the west of the airstrip access road; and
- three surface soil samples from within or beneath the collapsed power house by the airstrip beacon tower.

The analytical results for the soil samples are tabulated in Appendix B. A synopsis of the sampling and analytical program is provided in Table 3.2.1 below:

Table 3.2.1: Summary of Sampling and Analytical Program - Squanga Lake Airstrip

	No. Collected	No. Analyzed					
		Metals	Extractable Petroleum Hydrocarbons	BETX	PAHs	PCBs	Chlorinated Pesticides
Surface soils	8	5	2	1	1	5	2
Subsurface soils (hand excavated test pit)	1	0	1	0	0	0	0

3.2.3.2 Soil Quality Criteria

With regard to the CCME soil quality criteria, there are two levels of interpretation that may be applied - Assessment Criteria and Remediation Criteria. These have been discussed in Section 3.1.4.2.

3.2.3.3 Metal Contamination

A total of five soil samples from Squanga Lake Airstrip were analyzed for metals. All of these samples exceed the CCME Soil Assessment Criteria for chromium (criterion = 20 mg/kg), lead (criterion = 25 mg/kg), nickel (criterion = 20 mg/kg), vanadium (criterion = 25 mg/kg) and zinc (criterion = 60 mg/kg). These elements, therefore, exhibit high soil

concentrations due to background geological conditions, and delineation of local contaminant sources should take this into consideration.

The barium concentration exceeds the assessment criterion in SQ96-01, and copper exceeds the assessment criterion in SQ96-01 and -05. Sample **SQ96-01** also contains lead (798 mg/kg) at a concentration that exceeds the CCME R/P remediation criterion of 400 mg/kg. Arsenic in **SQ96-06** (37 mg/kg) also exceeds the CCME R/P remediation criterion of 30 mg/kg.

3.2.3.4 Hydrocarbons

Of the nine soil samples collected, two were analyzed for extractable hydrocarbons. The naturally-occurring concentrations of hydrocarbons in soils is highly variable from region to region, and it is difficult to discriminate between natural and anthropogenic sources without evaluating the relative contribution of various components of the hydrocarbon mixture.

The Draft 3 B.C. Numerical Soil Standards (1995) for extractable petroleum hydrocarbons (see Chapter 1) was used as a benchmark of hydrocarbon concentration in soils below which biological effects may be ruled out. This has been discussed in Section 3.1.4.4.

Sample **SQ96-01** contains concentrations of LEPHs (886 mg/kg) and HEPHs (23,300 mg/kg) that exceed the B.C. draft standards. EPH (C19-C31) is also present in the subsurface sample SQ96-02 collected in the same area as SQ96-01 at a concentration of only 564 mg/kg. Also, **SQ96-08** has a concentration of 3,360 mg/kg EPH (C19-C31), which exceeds the B.C. standard of 1,000 mg/kg for HEPHs.

BETX constituents and PAHs were also analyzed in sample SQ96-01. All BETX analyte concentrations are less than the detection limit of 0.05 mg/kg. The highest concentration for individual PAHs is 0.82 mg/kg for pyrene. None of the PAH concentrations exceed the CCME R/P criteria.

3.2.3.5 PCBs and Chlorinated Pesticides

Five soil samples were analyzed for total PCBs. Concentrations are less than the analytical detection limit of 0.05 mg/kg in all samples.

Two soil samples were analyzed for chlorinated pesticides: SQ96-03 and -04. All chlorinated pesticides are lower than the analytical detection limits (< 0.001 to < 0.030 mg/kg).

3.3 Canol Pump Station W (Big Devil) and Mile 854.5 Sawmill Site

3.3.1 Site Description, Conditions and Sampling Program

Canol Camp Pump Station W, also known as Big Devil Pump Station, is located near Mile 855 on the north side of the Alaska Highway, and was one of a series of five pumping stations transporting mostly aviation gasoline along a 2" pipeline between Whitehorse and Watson Lake (Bisset, 1995) (Map 3.3.1). The site was decommissioned with the rest of Canol 3 in 1947/48, at which time the pipeline was deemed unfit for operation or re-fit and was subsequently drained. All original buildings and most facilities were removed in the years following, with a major cleanup probably occurring as part of DIAND activities in 1975-1976.

The area is largely overgrown by mixed white-spruce (*Picea glauca*) and willow (*Salix* sp.) forests, but three partial clearings are still visible from the road. Areas further to the north of the highway are dominated by muskeg and wet areas, with mixed woods in higher and drier areas. Soils in the area generally consist of sand and gravel.

3.3.1.1 Historic Mile 855 and Sawmill Site

The north side of the highway above the historic milepost (Photograph 3.3.1) was worked and contains an old cement foundation, some visible metallic debris, old army truck tires, and wood. A long piece of the original 2 inch pipeline is found in this area (Photograph 3.3.2). Three samples BD96-04 to -06 were collected in this area.

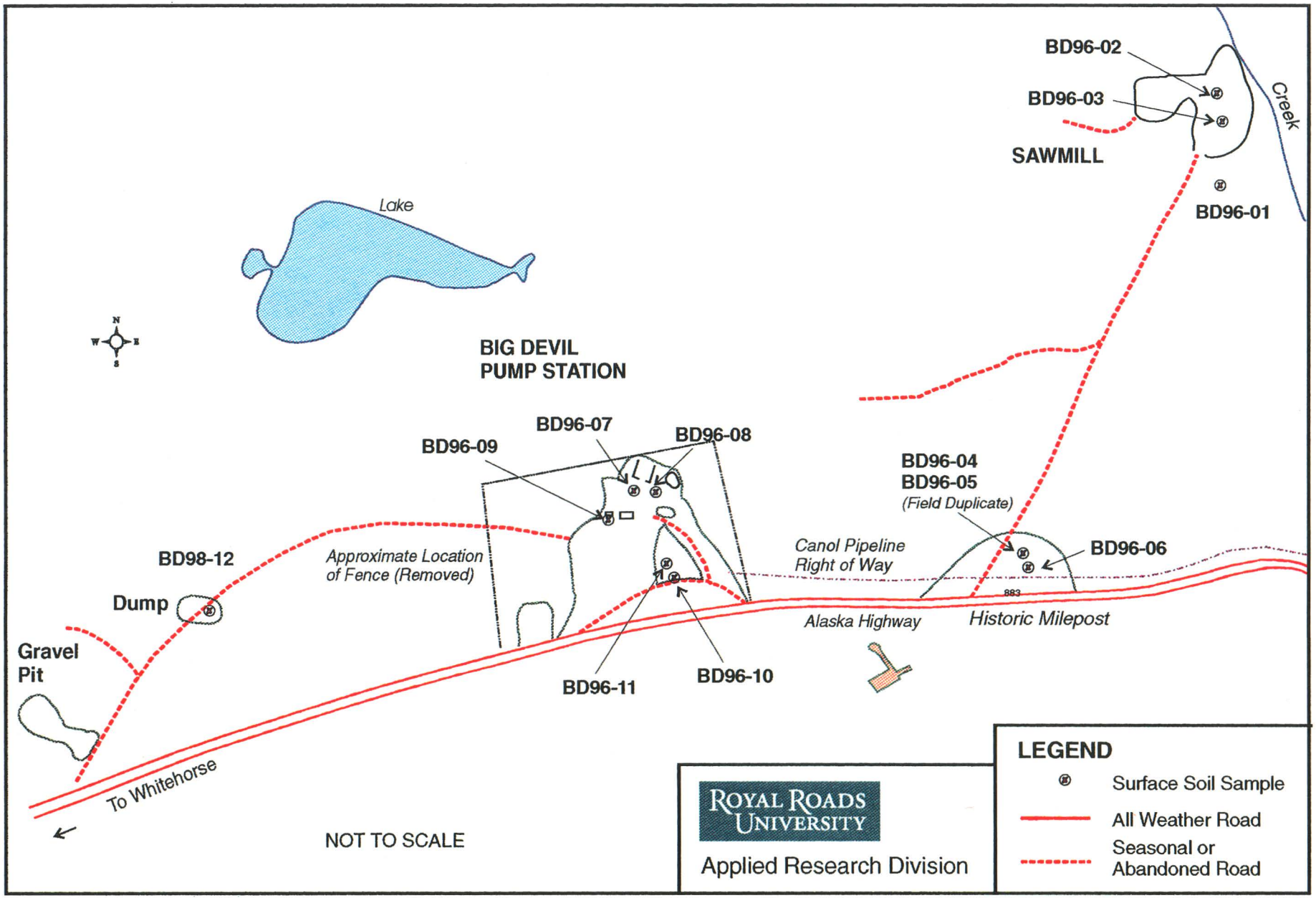
An old access road, limited to foot travel, extends from the northeast of the worked area for approximately 800 m, through muskeg to an old sawmill site (Mile 854.5 Sawmill). The mill is spread over a 0.5-1 hectare area and is believed to have been used by the U.S. Army. A number of old logging roads also lead from this site in various directions. Slab piles (Photograph 3.3.3) are spread over muskeg, with the actual mill located on higher ground in white spruce and willow woods to the northeast, and a small creek beyond. The original log building housing the mill has partially collapsed (Photograph 3.3.4) and there are two completely flattened buildings nearby. A food cellar, partially built into the side of

the sawmill slope and insulated with sawdust was found still intact. Other debris in the vicinity includes a couple of rotting skid frames, sawdust piles, an old wood stove, empty barrels, old tin cans and machinery parts (Photograph 3.3.5). Samples BD96-01 to BD96-03 were collected from the sawmill site.

3.3.1.2 Pump Station W

A large clearing is located 1 km west of the Historic Milepost marker, on the north side of the highway (Photograph 3.3.6). This is believed to be the original pump station site. Measuring approximately 2 ha, the site was previously surrounded by a barbed wire fence which has since been removed. As suggested by the relatively new vegetation regeneration, the southeast portion of the site has been recently reworked. Two wooden foundations (Photograph 3.3.7) and a pit (Photograph 3.3.8) are found north of the clearing, otherwise the site is relatively clean with no visible debris or signs of recent major disturbances. Samples BD96-07 and BD96-11 were taken from locations near the foundations and the more recently worked area.

An old access road to the north of the Alaska Highway extends in an arch to the west of this clearing and connects with a small dump and gravel pit, before joining with the highway, approximately 2 km to the west of the milepost (Map 3.3.1). This dump was described by Eddy (1976) as Dump no. 1. It was roughly oval, being 3 x 7 m in area with a depth of approximately 60 cm. Contents in the dump include old scrap metal, wood, fibre board, building materials, tin cans (also scattered in the bush), an empty barrel (partially buried), a section of asbestos tile and some remnants of a cement foundation. Sample BD96-12 was collected from this dump. The gravel pit, which was just north of the highway, appears to have been recently reclaimed.



Map 3.3.1: Canol Pump Station W (Big Devil) and Mile 854.5 Sawmill Site - Layout and Sampling Locations



Photograph 3.3.1: Historic Mile Post 855 showing the gravel work area in the background



Photograph 3.3.2: A piece of an old Canol 2-inch pipeline grafted into a tree located north of the Historic Milepost 855



Photograph 3.3.3: Typical slab pile spread over muskeg south east of the actual sawmill site



Photograph 3.3.4: Partially-collapsed log building currently located at the sawmill site



Photograph 3.3.5: Remains of a trailer found in the wooded area near the sawmill site



Photograph 3.3.6: Site of the pump station marked by a large clearing located 1 km west of the Historic Milepost marker



Photograph 3.3.7: Wooden foundation located north of the large clearing at the pump station



Photograph 3.3.8: A pit with wooden sides situated north of the large clearing at the pump station.

3.3.2 Subsurface Soil Conditions

A couple of exploratory test pits were hand-dug by shovel and/or soil auger in the dump area along the access trail at the west end of the site in the vicinity of soil sample BD98-12 (Map 3.3.1). These excavations indicate that debris is surficial and limited to the top 50 cm. A second series of shallow pits were also excavated in the vicinity of soil samples BD96-10 and 11, which were situated in the larger clearing, 1 km to the west of the historic milepost along the Alaska Highway. No subsurface debris, staining or odours were encountered to a depth of about 1 m at these locations.

3.3.3 Contamination Considerations

Areas investigated in the general proximity of the Big Devil Pump Station include the old sawmill to the northeast of the site, the gravel pit and disturbed area at the junction of the sawmill road with the Alaska Highway, and the pump station itself.

Prior to the sampling and analytical program, it was assumed that there was little potential for the discovery of substantial contaminant sources or contaminated soils and water in the vicinity of the abandoned sawmill. There is some evidence of the original two inch pipeline and a few pieces of circa 1940s army debris (old army vehicle tires) in the vicinity of the gravel pit above the historic sign post. One small wooden building foundation is also found in this area.

The pump station site, while extensive in size, was thoroughly reclaimed during the 1970s clean up. The barb wire fence around the site perimeter was completely removed; however, the cut off fence posts and their bases are still evident. The field team walked the entire fence perimeter. Materials removed during the 1970s clean up are presumed, by the team, to have been deposited in a large landfill in the eastern portion of the pump station reserve, marked by coarse, obviously worked sand, gravel and boulder cover, and limited vegetative cover of plants, shrubs and juvenile trees. The clean up of the entire site was apparently very thorough, since in spite of extensive searching, it was difficult to locate more than approximately one dozen pieces of debris, such as old oil cans. From an aesthetic perspective, this is by far the most clean site investigated during this study.

Several building foundations are located at the site of the demolished pump station, including one thought to be a large garage/maintenance complex. Soil samples were collected from the foundations in order to investigate the presence of contaminants.

3.3.3.1 Summary of Sampling and Analytical Program

A total of twelve surface or subsurface soil samples were collected during the preliminary site investigation of Big Devil Pump Station (see Section 3.3.1 for sample locations and Appendix A for detailed descriptions). These included -

- three surface samples from the sawmill site, including one amongst extensive slab piles, and two in the vicinity of the mill site proper, sawdust pile and partially collapsed buildings;
- two samples from the gravel borrow area, and one sample from the small building foundation above the historic sign post;
- one sample below a sawed off power pole at the former pump station;
- two samples from within overgrown building foundations at the former pump station;
- one sample at 95 cm depth near the centre of a recently disturbed area, and one surface soil sample from the toe of the disturbance; and
- one sample from an older surface dump on the access road to the east of the site.

A synopsis of the sampling and analytical program is provided in Table 3.3.1 below. The analytical results for the soil samples are tabulated in Appendix B.

Table 3.3.1: Summary of Sampling and Analytical Program - Big Devil Pump Station

	No. Collected	No. Analyzed					
		Metals	Extractable. Petroleum Hydrocarbons	BETX	PAHs	PCBs	Chlorinated Pesticides
Surface soils	11	7	6	0	0	4	1
Subsurface soils (test pit samples)	1	1	0	0	0	0	0

3.3.3.2 Soil Quality Criteria

With regard to the CCME soil quality criteria, there are two levels of interpretation that may be applied - Assessment Criteria and Remediation Criteria. These have been discussed in Section 3.1.4.2.

3.3.3.3 Metal Contamination

A total of eight soil samples from either the vicinity of the former pump station or the old sawmill site to the northeast were analyzed for metals. All of these samples exceed the CCME Soil Assessment Criteria for barium (criterion = 200 mg/kg), chromium (criterion = 20 mg/kg), cobalt (criterion = 10 mg/kg), nickel (criterion = 20 mg/kg), and vanadium (criterion = 25 mg/kg). These elements, therefore, exhibit high soil concentrations due to background geological conditions, and delineation of local contaminant sources should take this into consideration.

Several samples also contain other metals at concentrations approaching or exceeding the assessment criterion, but lower than the CCME R/P remediation criterion. Copper concentrations exceed the assessment criterion (30 mg/kg) in three of the eight samples. Zinc exceeds the assessment criterion in two of eight samples.

Only two samples exceeding the CCME R/P remediation criteria were noted: Sample **BD96-02** contains 170 mg/kg nickel, which exceeds the R/P criterion of 100 mg/kg, as

well as the concentrations measured in any of the other soil samples (≤ 66 mg/kg). Sample **BD96-05** contains 536 mg/kg barium (R/P criterion = 500 mg/kg); however, given the elevated concentrations of barium in all samples from the site, this is probably attributable to natural levels rather than contaminant inputs.

3.3.3.4 Hydrocarbons

Of the twelve soil samples collected, six were analyzed for extractable hydrocarbons. All analytical results for extractable petroleum hydrocarbons are less than the method detection limit of 250 mg/kg for EPH(C10-C18) and EPH(C19-C31). No samples were analyzed for either BETX or PAHs.

3.3.3.5 PCBs and Chlorinated Pesticides

Four soil samples were analyzed for total PCBs. The soil concentrations are less than the analytical detection limit of 0.05 mg/kg in all samples except one: Sample **BD96-06** contains 0.16 mg/kg total PCBs, a result that exceeds the CCME assessment criterion of 0.01 mg/kg, but is much lower than the R/P remediation criterion of 5 mg/kg.

One sample, BD96-10, was analyzed for chlorinated pesticides. All chlorinated pesticides are lower in concentration than the analytical detection limits (< 0.001 to < 0.030).

3.4 Marsh Lake Camp

3.4.1 Site Description, Conditions and Sampling Program

Marsh Lake, formerly a U.S. Army Maintenance Camp (4E), is located near Milepost 883 on the south side of the Alaska Highway (Map 3.4.1). The site is approximately 60 km southeast of Whitehorse along the shore of Marsh Lake. The original military camp, which operated in 1941, was reported to consist of 11 buildings by 1945 (Bisset, 1995). It ceased operations as a military facility at the end of the second world war. The original camp buildings were re-fitted and the site was operated as a lodge (Marsh Lake Lodge), with a boat launch, until 1979 when the private business was lost to a fire.

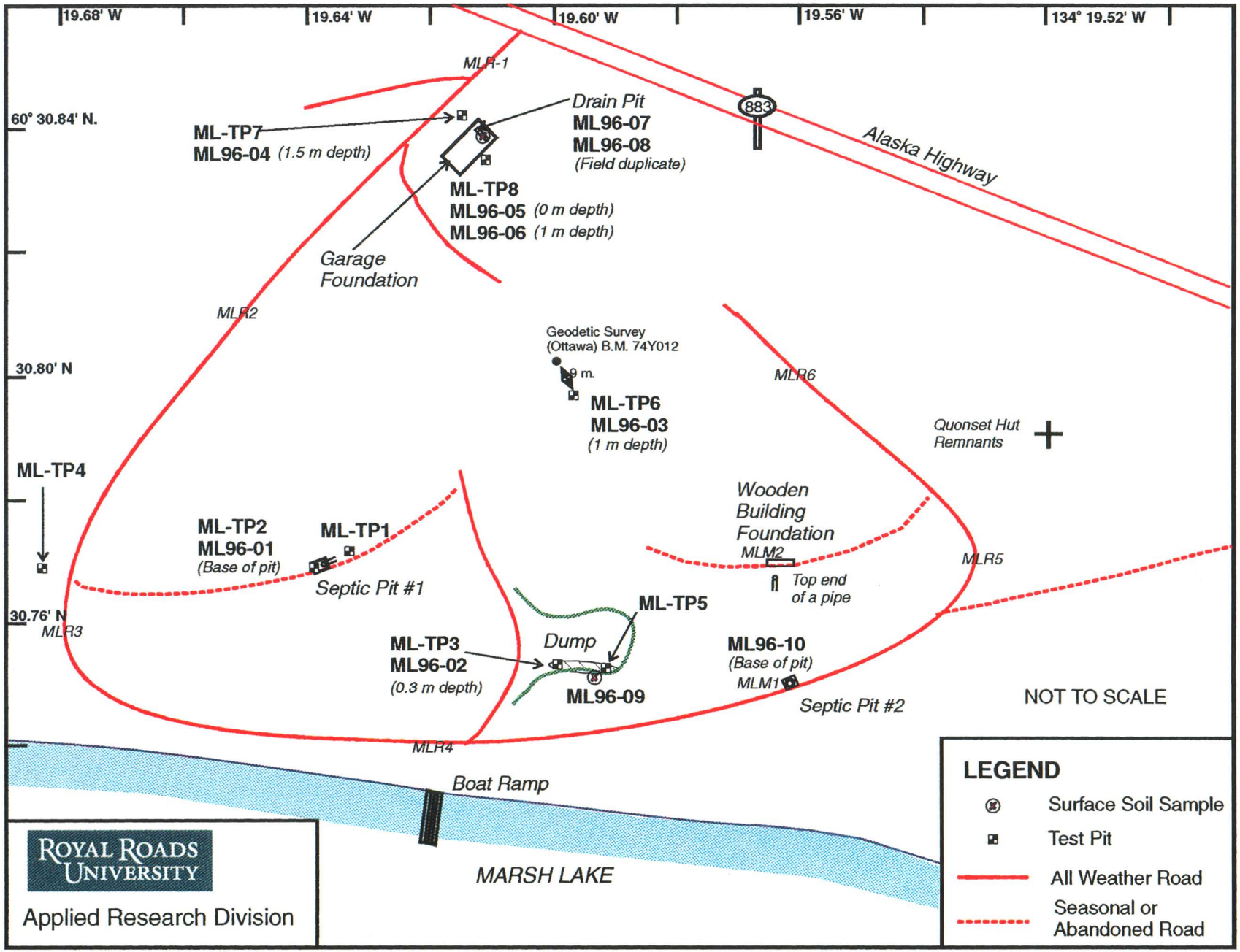
The current site is heavily overgrown by mixed white spruce (*Picea* sp.) and willow (*Salix* sp.) forest, as well as balsam poplar (*Populus* sp.) in a few of the more open areas. Soils in the area generally consist of gravel and sand mixed with clay.

Some old, partially-excavated remains of the Canol Pipeline (6") are present at the northeast corner of the site, along the southwest edge of the Alaska Highway (Photograph 3.4.1). An old cement garage foundation is located on the southwest side of the main access road from the Alaska Highway (Map 3.4.1). The north-most bay of the garage contains a collection sump or pit, and stained soil is present in this pit (Photograph 3.4.2). A stained area was also noted east of the garage foundation (Photograph 3.4.3). Samples ML96-04 to ML96-08 were collected from locations around the garage. One sample (ML 96-03) was also taken from a test pit dug near a protruding pipe located southeast of the garage, about 9 m from a geodetic survey marker.

Further along the access road to the southwest, a secondary trail branches to the east and leads to an old septic pit (#1) containing wood frame sides. The sump is approximately 50 cm wide by 3 m deep. At the west edge of the pit is an old ceramic pipe, and a few boards and scrap iron are at the bottom of the sump. Sample ML 96-01 was collected from this pit. A berm containing a small amount of twisted metallic and wood debris is also found further along the trail to the north of the septic pit.

The main access road continues to the south and then veers east, running parallel to the shore of Marsh Lake (Map 3.4.1). A small surface dump is located along the east side of a secondary road which branches north from the main access road above the boat ramp. The dump consists mostly of old shingles, building materials, and some scrap metal (Photographs 3.4.4 and 3.4.5). Two samples (ML96-02 and ML96-09) were taken from the dump.

A second septic pit (#2) is located further along the main access road to the east and consists of a wood-lined collection sump (Photograph 3.4.6). Sample ML96-10 was collected from this pit. To the north of this location, a wooden building foundation is located in a small clearing reached by a trail leading west from the main access road as it jackknifes to the northwest (Map 3.4.1). Some old Quonset hut remains are also observed to the northeast of the access road.



Map 3.4.1: Marsh Lake Camp - Layout and Sampling Locations



Photograph 3.4.1: Partially-excavated remains of the Canol Pipeline noted at the northeast corner of the site along the south west edge of the Alaska Highway



Photograph 3.4.2: Collection sump on the north end of the garage foundation containing stained sand and gravel and other metallic debris



Photograph 3.4.3: A stained area present east of the garage foundation



Photograph 3.4.4: Typical debris scattered in the dump near the lake



Photograph 3.4.5: Profile of test pit excavated in the dump showing debris was surficial



Photograph 3.4.6: One of the wood-lined pit located at Marsh Lake Camp

3.4.2 Subsurface Soil Conditions

A total of eight test pits were excavated at this site to examine suspected locations of buried debris and/or the potential sub-surface migration of contaminants from stained areas.

Two test pits were dug in the vicinity of the garage foundation. The first (ML-TP7) was located 7 m east of the foundation and was excavated to a maximum depth of 1.5 m (Map 3.4.1). No visible staining, odour or debris was noted in the profile. Test pit 8 (ML-TP8) was dug in a black-stained area 1 m west of the foundation. Surface staining was observed to a depth of 5 cm and white ash was noted in the profile at 30 cm, probably remnant from the previous fire. No additional discoloration was observed to the maximum pit depth of 1.5 m.

One test pit (ML-TP4) was excavated in an overgrown clearing 7 m west of the main access road, across from the secondary trail leading to Septic Pit #1. No debris or anomalies were encountered through most of the 1.5 m profile, with the exception of an ash layer at 60 cm.

Two test pits were dug in the vicinity of Septic Pit #1 . The first (ML-TP2) was excavated in the collapsed drain pit to a maximum depth of 2 m. Aside from the boards and scrap iron noted above, no staining or odours were detected. Test pit 1 (ML-TP1) was located to the north of the septic pit, in a berm where a small amount of twisted metallic and wood debris is found. No additional staining, odour or debris was encountered beyond the surface materials.

Test pits were also excavated in the dump area north of the lake, boat ramp and main access road. Pit 3 (ML-TP3) was located on the northwest side of the dump and was dug to a maximum depth of 1.5 m. Surficial debris, including old shingles, metal and building materials (noted above) only extended to 30 cm in the profile; soil below this depth appeared to be clean with no evidence of staining, debris or odour. A second test pit (ML-

TP5) was located 15 m southeast of ML-TP3 towards the opposite end of the dump. Aside from obvious surface metal debris, the 1.5 m profile was found to be clean.

Test pit 6 (ML-TP6) was dug 9 m from the Geodetic Survey benchmark by the protruding underground water pipe near the centre of the site. Soil in the 1.5 m profile of the pit was found to be clean.

3.4.3 Contamination Considerations

Of the four sites investigated, Marsh Lake has been used most extensively by various parties since the original occupation by the U.S. Military as a highways construction and maintenance camp. At the present time, the site is also frequently used for recreational activities such as camping and boat launching. The remains of several cooking fires are evident in the clearing near the boat ramp, and in the main clearing off the highway.

Several features were identified during the site visit as having potential to contain contaminated soils or other materials. These include the cement foundation and floor of the old garage near the entrance from the highway, two areas of visually detectable surface staining around the pad and numerous small stains on the pad itself. A soak-away, or oil change pit is present on the foundation where the north-most garage bay was probably once located. The soak away pit contains stained sandy soil.

Some portions of a six inch pipeline and berm where the pipeline was routed, are evident immediately to the south of the highway along the edge of the site. Two separate septic pits, lined with a wooden frame constructed of 1" x 4" planks on a 2" x 4" frame at 24" intervals, are obvious potential collection areas for substances disposed down the drains of buildings that previously stood at the site. Anecdotal information from Mr. Peter Schaefer, the owner of the residence immediately west of the Marsh Lake lodge site, suggested some possibility of large quantities of buried refuse in the area near the lake shore and to the west of the site.

One major surface dump was located in the area near the lake and immediately east of the boat ramp. Overall a total of eight test pits were excavated at the site in order to

investigate the possible presence of buried debris. Subsurface soils in all test pits were observed to be clean: No buried debris was found.

3.4.3.1 Summary of Sampling and Analytical Program

A total of ten surface or subsurface soil samples were collected during the preliminary site investigation of Marsh Lake Camp. Sampling locations are discussed in Section 3.4.2 above and detailed sampling locations and descriptions are given in Appendix A. Samples collected at Marsh Lake Camp include -

- one soil sample each from the base of the two septic pits noted;
- two samples from test pits (test pits 3, 4,) excavated in the overgrown and disturbed areas, to investigate possible subsurface debris and contamination;
- two (duplicate) samples from the oil collection sump in the garage foundation, at a depth of 50 cm;
- a surface sample and subsurface soil sample at 1 m depth in a stained area to the immediate east of the garage;
- one surface sample in an area of bare soil to the west of the north bay of the garage (7 m away from the foundation); and
- a surface sample from the toe of the surface dump near the boat ramp.

A synopsis of the sampling and analytical program is provided in Table 3.4.1. The analytical results for the soil samples are tabulated in Appendix B.

Table 3.4.1: Summary of Sampling and Analytical Program - Marsh Lake Camp

	Number Collected	Number Analyzed					
		Metals	Extractable Petroleum Hydrocarbons	BETX	PAHs	PCBs	Chlorinated Pesticides
Surface soils	4	2	1	1	1	3	2
Subsurface soils (test pit samples)	6	3	5	0	2	2	1

3.4.3.2 Soil Quality Criteria

With regard to the CCME soil quality criteria, there are two levels of interpretation that may be applied - Assessment Criteria and Remediation Criteria. These have been discussed in Section 3.1.4.2.

3.4.3.3 Metal Contamination

A total of five soil samples from Marsh Lake were analyzed for metals. All of these samples exceed or approach the CCME Soil Assessment Criteria for barium (criterion = 200 mg/kg), chromium (criterion = 20 mg/kg), copper (criterion = 30 mg/kg), nickel (criterion = 20 mg/kg), and vanadium (criterion = 25 mg/kg). Four of the five samples exceed the assessment criterion for zinc (60 mg/kg). These elements, therefore, exhibit high soil concentrations due to background geological conditions, and delineation of local contaminant sources should account for this fact.

Cobalt concentrations are comparable to the assessment criteria (10 mg/kg) in two samples (ML96-02 and -03). Sample ML96-10 also contains tin at a concentration that exceeds the assessment criterion of 5 mg/kg.

Only one of the five samples exhibits metal levels that are higher than the CCME R/P remediation criteria. **ML96-05** contains 369 mg/kg antimony, 741 mg/kg barium, 21 mg/kg cadmium, 10,800 mg/kg copper, 1,200 mg/kg lead, 65 mg/kg tin and 46,700 mg/kg zinc.

3.4.3.4 Hydrocarbons

Of the ten soil samples collected, six were analyzed for extractable petroleum hydrocarbons. The naturally-occurring concentrations of hydrocarbons in soils is highly variable from region to region, and it is difficult to discriminate between natural and anthropogenic sources without evaluating the relative contribution of various components of the hydrocarbon mixture.

The Draft 3 BC Numerical Soil Standards (1995) for extractable hydrocarbons (see Chapter 1) is used as a benchmark of hydrocarbon concentration in soils below which biological effects may be ruled out. A discussion of these benchmarks may also be found in Section 3.2.3.4.

Extractable petroleum hydrocarbons (both the light and heavy fraction) are present in concentrations below a method detection limit of 250 mg/kg in samples ML96-02, -03, -04, and -06. Samples that contained hydrocarbons at concentrations exceeding the B.C. draft standards included:

- **ML96-05:** HEPHs and EPH(C19-C31) = 10,500 mg/kg;
- **ML96-07**: HEPHs and EPH(C19-C31) = 18,100 mg/kg.

BETX constituents were analyzed in one sample only: ML96-07. All constituents are below the method detection limits (< 0.05 to <0.1 mg/kg). PAHs were also analyzed in the samples ML96-05 and -07. The maximum concentration encountered is 1.8 mg/kg pyrene in ML96-07. Although a large number of individual PAHs are detected in both samples, none of the PAH concentrations exceed the CCME R/P remediation criteria.

3.4.3.5 PCBs and Chlorinated Pesticides

Five soil samples were analyzed for total PCBs. The soil concentrations are less than the analytical detection limit of 0.05 mg/kg to 0.2 mg/kg in all samples.

Three samples, ML96-01, -02, and -10, were analyzed for chlorinated pesticides. All chlorinated pesticides are lower in concentration than the analytical detection limits (< 0.001 to < 0.030) in ML96-02. Both samples ML96-01 and ML96-10 contains detectable concentrations of DDT isomers. ML96-01 contains 0.024 mg/kg p,p'-DDT, 0.013 mg/kg o,p'-DDT and 0.020 mg/kg p,p'-DDE. The concentrations of detectable chlorinated pesticides in sample ML96-10 are 0.53 mg/kg p,p'-DDD., 0.36 mg/kg p,p'-DDT, 0.17 mg/kg o,p'-DDT, 0.13 mg/kg o,p'-DDD, 0.097 mg/kg p,p'-DDE and 0.005 mg/kg o,p'-DDE (total concentration of DDTs = 1.3 mg/kg).

There is no generally accepted soil quality benchmark for DDTs in Canada; however, a localized concentration of 1.3 mg/kg total DDTs over a small area is undoubtedly much lower than levels known to induce effects to organisms in direct contact with the contaminated soil through soil ingestion, dermal exposure or inhalation. The implications are discussed in Chapter 4.

4. INTERPRETATION AND PRELIMINARY RISK ASSESSMENT

4.1 Framework for Interpretation

Chapter 3 includes a discussion of the soil samples that were found to be contaminated at each of the four sites. A sample was considered to be contaminated if the concentration of one or more analytes exceeded a concentration that might occur either naturally or as a result of broader regional inputs, such as those associated with long range transport of contaminants in the atmosphere. The overall objective of sample collection, conducted for this preliminary investigation, was to screen for contaminant types and locations based on the collection of samples that might represent a worst case scenario. This was based on a re-construction of past site activities and disposal practices, in conjunction with an understanding of probable areas where contaminants would collect if released (for example, at the toe of landfills where leachate would emanate).

The identification of a substance as a probable contaminant, based on local inputs at a site, gives rise to at least two major lines of questioning:

1. Regardless of the concentration observed, what are the characteristics of the contaminant source, in terms of size and possible co-contaminants, and what is the range of concentration and spatial extent in the surrounding environment? and

2. Is there a possibility of deleterious effects on humans or other living organisms due to the presence and redistribution of contaminants (in other words - what is the risk)?

This study was a preliminary environmental assessment only; the provision of detailed answers to the above questions was beyond the scope of the investigation. The thorough delineation of contaminant distribution, for example, would require collection and analysis of a larger number of samples. This and other preliminary site investigations will, however, allow environmental managers and stakeholders to provisionally rule out specific sites or areas within sites. This includes areas where no evidence was found of local contamination and the future discovery of large contaminant issues is unlikely in light of the site history.

This in turn will allow the prioritization of subsequent, more detailed investigations across the much larger suite of candidate sites.

With regard to the first question, the major problem that arises for each contaminated soil sample or area (as discussed in Chapter 3) is whether the analytical result(s) represent a worst-case concentration, or whether the presence of contaminants is indicative of a much larger contaminant source. We have attempted to shed some light on this issue by examining the possible activities and disposal practices that might have resulted in the original environmental inputs.

With regard to the second question, additional action at the sites would only be required *if* contaminated areas were found (or a reasonable possibility existed that contaminated areas may be found in the future) *and* there is some possibility that the contaminants could lead to adverse effects on biological 'receptors' in the proximity of the site.

Environmental risk can be estimated using a wide variety of methods. A necessary condition for there to be an environmental risk due to a contaminant is the immediate or future presence of bioavailable forms. If a contaminant is present and available to living organisms, then the associated risk varies as a function of the exposure concentration, longevity of exposure, size of the contaminated area, sensitivity and other characteristics of the local ecosystem (microbes, flora, fauna). Risk assessments often involve the separate delineation of direct human health risks, and ecological risks (i.e., risks to living organisms other than humans).

The assessment of human health risk is simplified by the fact that there is large body of knowledge on the likely mechanisms of human exposure to contaminants and associated health risks. For most metals and organic contaminants, the major pathways of human exposure include:

- Ingestion of soil;
- Inhalation of volatiles, fine particulates and airborne dust;

- Absorption of contaminants through the skin (dermal absorption);
- Consumption of contaminated drinking water (groundwater or surface water; and
- Ingestion of bioaccumulative, persistent organic contaminants in food substances.

For each of Johnson's Crossing, Squanga Lake Airstrip, Big Devil Pump Station and Marsh Lake Camp, possible pathways of exposure of humans are examined qualitatively, based on known or anticipated use of the site. The possibility of human health risks should 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.

Ecological 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 ecological risk, therefore, is considerably more complicated than human health risk. Assessment and remediation criteria established by the Canadian Council of Ministers of the Environment (CCME, 1991), however, are designed to minimize ecological risk, subject to site-specific conditions. As discussed in Chapter 1, use of CCME Residential/Parkland soil remediation criteria is a reasonable approach to providing a preliminary ecosystem risk assessment at these sites.

For this study, the assessment of ecological risk was based first on whether contaminated soil and water were found. If all contaminants were found only at levels below CCME Residential/Parkland 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. Evidence of risk also included visual evidence of the use of a contaminated area by wild

life and humans, as well as direct signs of impact such as the presence of dead or stunted vegetation.

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

4.2 Canol Camp Johnson's Crossing

Ten of 31 soil samples collected from areas around Johnson's Crossing exhibited analyte concentrations that exceeded either the CCME Residential/Parkland (R/P) Remediation Criteria for metals or the appropriate benchmark for hydrocarbon constituents.

Sample **JC96-2** was collected from the toe of **the old Lodge Army Dump close to the western shore of the Teslin River**, and the only analyte exceeding the CCME R/P criterion is tin. The elevated concentration of tin is not surprising, given the large number of tin cans and other metal objects in the dump. Based on the materials found in it, the dump undoubtedly dates back to the mid-1940s, but additional debris has been placed in the dump in subsequent years. It is unlikely that any metal contamination arising from the dump has been re-distributed to any great extent. The organic-rich soils and humic substances within the marsh below the dump would tend to adsorb any metals leached from the dump and render them insoluble. Sample JC96-4, was collected in the marsh at a distance of approximately 20 m from the toe of the dump, where runoff from the dump would be channeled enroute to the Teslin River. The tin concentration in this soil sample is < 10 mg/kg and all other metals are deemed to be within the range of natural soils in the area. **The data suggest that, although the dump contains substantial amounts of metallic objects, such as old car bodies, metal contaminants have not been introduced in substantial quantities to the wetland below the dump or to the Teslin River.** In particular, the subset of metals with greater known toxicological significance - including lead, mercury, cadmium, silver or copper - are not found to be contaminants in the four samples analyzed.

One sample from the toe of the dump was analyzed for hydrocarbons, and two samples were analyzed for PCBs and chlorinated pesticides. PCBs and hydrocarbons are not detected. There is evidence that DDT-containing containers or materials have be placed in the dump sometime in the past, based on slightly elevated levels of DDT isomers in sample **JC96-2**. The DDT concentrations, however, (0.027 mg/kg p,p'-DDT) are lower than levels that could lead to toxicological effects. **There remains some possibility that small volumes of DDT-containing fluids could be in the dump; however, it is unlikely that any major source is present.**

The dump is located in close proximity to several residential properties as well as to the boat ramp and staging area for a local outfitter. Discussions between the field team and some of the local residents suggested that the dump is of concern. The excellent condition of some of the cans and bottles, many of World War II vintage, in this dump suggest that the dump may also be of some historical value.

Samples **JC96-05 , -06, and -07** were collected from the **old Army dump** located approximately 2.5 km north of Canol Camp along the Canol Road (**1.5 Mile Dump**) and immediately south of the access road to the large clearing which probably arose from the 1970s clean up. The only contaminant of concern in JC96-5 is barium, which is probably attributable to natural geological conditions in the region. Samples JC96-06 and -07, collected from the toe of the old landfill are contaminated with lead and copper respectively. The analyte concentrations in these samples should reflect any leaching from different portions of the dump; other areas down slope from the dump or lateral to these areas would be expected to exhibit lower analyte concentrations based on the sampling location. Sample JC96-05 was collected in a bowl-like depression down hill from the dump face at a distance of approximately 20 to 100 m from various points of the toe. Lead is below the detection limit in this sample (<50 mg/kg) and copper is within the range of natural soils in the area. The metal concentrations in the contaminated samples could probably be accounted for by the introduction of rust particles into the soil within the immediate vicinity of barrels or other metallic debris along the toe of the dump.

Hydrocarbon concentrations were investigated in only one sample collected from the 1.5 mile Army dump: **JC96-23** contains 3,590 mg/kg and 5,790 mg/kg EPH(C10-C18) and (C19-C31) respectively, values that exceed the BC standards. **This might indicate the past burial of barrels or material containing hydrocarbon products. All barrels exposed along the face of the dump or uncovered during the excavation of test pits, however, were observed to be empty.**

Four soil samples collected from the dump were analyzed for PCBs. None contain detectable PCB concentrations. In addition, three samples were analyzed for chlorinated pesticides. All pesticide results are either less than or within the range of the detection limits. PCBs and chlorinated pesticides, therefore, are not considered to be contaminants of concern in association with this dump.

Hydrocarbon contamination was detected at two other areas at Johnson's Crossing. **Two discrete soil stains were sampled in clearings to the west of the road leading north from Canol Camp** (samples JC96-10, -11, -12; Map 3.1.3). The first stain was sampled at the surface (**JC96-10**) and at a depth exceeding 10 cm (**JC96-11**). Only the sample at depth exhibits hydrocarbon or PAH levels in excess of the bench marks discussed in Chapter 1. The concentration of EPH(C10-19) in JC96-11 was 1,810 mg/kg which exceeds the BC soil standard of 1,000 mg/kg. The spatial extent of the stain, based on visual appearance, is approximately 15 m x 20 m. There has been limited re-vegetation within the stain relative to the surrounding soils, indicating some past phytotoxicity. The lower surficial hydrocarbon concentrations, however, suggest that the degradation of hydrocarbons has occurred through volatilization, photolysis and/or biological degradation. Hydrocarbons at the surface, to which plants and animals would be exposed, are lower in concentration than the levels that could cause risk at the present time. The decline in hydrocarbon concentration in near-surface soils within the stain and recovery of vegetation will undoubtedly continue if left undisturbed. It should be noted, however, that no analyses were done for substances other than hydrocarbons in samples from the stain.

Sample JC96-12 was collected from a stained soil area in an adjacent clearing. This stain was slightly smaller and obviously tar-like in appearance. The extremely high concentrations of heavy extractable hydrocarbons in this sample (165,000 mg/kg) are not surprising, given the appearance and odor of the sample. It was not possible to investigate the vertical extent of hydrocarbon contamination, since attempts to hand-excavate through the hard-packed tar-like surface were unsuccessful. The approximate size of the stain was 2.5 m x 4 m. Substances other than hydrocarbons were not analyzed in this sample.

One other area of hydrocarbon contamination was discovered as part of this preliminary investigation. **Hydrocarbon-contaminated soils are found by the above-ground storage tank in the area immediately to the south of the new Alaska Highway, across the turn-off to the Canol Road.** A small trapezoidal-shaped, wood-lined drain pit is beneath the valve at the northwest edge of the partially disassembled storage tank. Sample JC96-16, -17, and -18 were collected from a test pit, excavated where the drain pit is located at depths of 0.3, 1.5 and 3.2 m respectively. Strong hydrocarbon odours were noted from the surface of the test pit to the maximum depth of excavation. The maximum depth of the hydrocarbon contamination was not determined. Samples JC96-17 and -18 contain 1460 and 937 mg/kg volatile petroleum hydrocarbons (C5-C9) respectively, which exceed the BC draft standard of 200 mg/kg. The regional groundwater flow beneath the AST is undoubtedly toward the Teslin River which is located approximately 0.5 km away. **The extent of contamination, fate, or possible effects cannot be determined without subsequent investigation.** However, based either on soil staining or vegetative stress, there is no sign of re-emergence of hydrocarbon contaminated soils along slopes leading from the site down to the Teslin River.

Two other issues deserve mention. **PCBs** were detected in only two of sixteen soil samples, but at concentrations lower than the CCME R/P criterion of 5 mg/kg. **Analysis of PCBs in sample JC96-14, collected in the vehicle dump at Canol Camp, and JC96-28, inside the large cement foundation south of the garage (possibly a vehicle loading ramp), provided evidence for local PCB inputs.** However, for both sampling locations there is little, if any, possibility that areas of higher PCB concentrations exist but

have yet to be discovered. The possible source of PCBs in the vehicle dump at Canol Dump was the disposal of small household electronic components (e.g., resistors and capacitors) which are evident in some areas of the dump.

The second issue is that small quantities of hazardous materials were observed in the vehicle dump, including in particular, intact and broken, lead-containing vehicle batteries, and a limited number of discarded electronic appliances. Uncontrolled dumping of household and other refuse has occurred primarily in the area where World War II vintage vehicles were left during the 1970s clean up (Lorne Gay, DIAND; *pers. com.*); however, small amounts of refuse with origins in the last two to three decades may be found through out the area where Canol Camp once stood. The problem is primarily an aesthetic one; however, the present state of the site may encourage continued waste disposal on site, which could lead to contamination in the future.

Overall, areas around Johnson's Crossing that showed signs of contamination in soil samples included -

- the dump near the western shore of the Teslin River (metals and DDT);
- the 1.5 mile old Army dump (metals and hydrocarbons);
- two discrete surface stains in clearings on the access road to the north of Canol Camp (hydrocarbons); and
- subsurface soils beneath the above-ground storage tank to the south of the new Alaska Highway (hydrocarbons).

The possible ecological risk at all of these locations is probably negligible, or very small, since the contaminated areas appear to be localized and small. In addition there is no indication of any large sources of either toxicologically important metals or persistent organic contaminants, such as PCBs or chlorinated pesticides. The hydrocarbon contamination beneath the above-ground storage tank is, perhaps, the largest single contaminant source at the site.

4.3 Squanga Lake Airstrip

Evidence for the presence of contaminants was found at three discrete locations at the Squanga Lake Airstrip. These included -

- soil beneath the old vehicle service ramp to the south of the highway (**SQ96-01** - lead and hydrocarbon contamination);
- a soil sample from within the foundation of a building near the airstrip and across the access road from the beacon tower (**SQ96-06** - arsenic contamination); and
- small volumes of soil within the cement foundation of the stove pad in the generator shed beneath the beacon tower (**SQ96-08** - heavy extractable hydrocarbons: EPH(C19-C31)).

The heavy hydrocarbon constituents measured in sample SQ96-08 are probably attributable to the use of coal or heating oil in the stove that originally sat on the stove pad. There was no evidence of staining beyond the pad, and the risk associated with elevated hydrocarbons in this soil sample to either humans or other animals and plants is probably negligible.

The implications of apparently elevated arsenic concentrations in sample SQ96-06 are not clear; however, no other metal is observed to occur in this soil sample at concentrations greater than natural background concentrations for the area. The result may be an analytical artifact from the analysis by ICP due to interferences.

Finally, a very limited volume of soil underneath the old vehicle service ramp, not surprisingly, is contaminated with hydrocarbons and lead. The small area of contamination would preclude risks to living organisms, except perhaps to soil invertebrates and plants within the contaminated soil itself.

The analysis of soil samples collected from the two surface dumps to the south of the airstrip did not provide any evidence of contaminant sources or redistribution.

Overall, no evidence was found during the preliminary investigation for substantial soil contamination or any other environmental problems.

4.4 Canol Pump Station W (Big Devil)

Limited evidence for the presence of contaminants was found in only two samples collected from the Big Devil Pump Station: the historic sawmill to the northeast, and the disturbed area where the sawmill road meets the highway.

One of these samples, **BD96-02,** exhibited a nickel concentration (170 mg/kg) that exceeded the CCME R/P criterion. This was not expected since the sample was collected within 6 m of the sawdust pile at the old sawmill site. No other analytes were detected in this sample at concentrations exceeding natural or background levels. One possible explanation is that the result represents an analytical artifact. Regardless, the limited toxicity of nickel suggests that any risk would be very unlikely.

The second sample, **BD96-06**, was collected from the disturbed area, used in the past as a gravel borrow area, at the junction of the sawmill road and the highway. The concentration of total PCBs in this sample (0.16 mg/kg) is substantially lower than the CCME R/P criterion of 5 mg/kg and, hence, much lower than any concentration that could represent a human health or ecological risk. The PCB concentration, however, is considerably higher than the expected background concentrations of PCBs. The original source of PCBs is no longer evident.

Overall, no evidence of contaminant concerns worthy of more detailed investigation was found during the preliminary environmental assessment of the Big Devil Pump Station.

4.5 Marsh Lake

Contaminated soils at Marsh Lake were found in two major areas:

- Two wood-lined septic pits, soil samples from which (**ML96-01 and -10**) contained slightly elevated levels of DDT isomers.

- Stained soils behind the garage (**ML96-05:** antimony, barium, cadmium, copper, lead, tin, zinc, and hydrocarbon contamination) and beneath the oil soak away pit (**ML97-07:** heavy extractable hydrocarbons) in the garage floor.

The **septic pits** were considered to be good candidate areas for the investigation of contaminants since they would have received substances disposed down the drains. The concentrations of DDT isomers in the septic pits provide evidence that DDT was used at the site, but possibly in small quantities as an insecticide in domestic formulations - relatively common in the 1950s and 60s. The concentrations of DDT are much lower than concentrations known to cause effects in sensitive species, and there is expected to be no risk associated with the concentrations of DDT found.

The surface soil sample from stain to the east of and immediately adjacent to the garage pad was contaminated with both metals and hydrocarbons. The apparent depth of contamination is probably less than 1 m, since sample ML96-06, collected at 1 m in test pit ML96-T8, does not contain extractable hydrocarbons above the detection limit of <250 mg/kg, whereas sample ML96-05, collected at the surface, contains 10,500 mg/kg HEPHs.

One surface dump was located near the boat ramp. Concentrations of metals, hydrocarbons, PCBs and chlorinated pesticides in samples ML96-02 and/or ML96-09 were all within the range of natural or background concentrations.

A total of eight test pits were excavated, using the back hoe, in areas chosen as candidates for the past burial of waste. **No evidence of buried material was found.**

Of the four sites investigated, this site was in closest proximity to a major water body. In addition, the extensive use of the site by campers and boaters, as well as the proximity to residential properties, would increase the likelihood of human exposure if contaminants were present within surface soils or water. Any risk to humans or other living organisms, however, appears very unlikely since the area of contamination around the garage is

extremely limited in size and no other evidence was found for the presence of contaminants at toxicologically significant levels.

5. CONCLUSIONS AND RECOMMENDATIONS

The analytical results and interpretations presented in the preceding chapters provided a basis for the derivation recommendations. For all situations where there is a reasonable possibility of elevated risk to humans or other ecological receptors, recommendations are provided for more detailed investigations or remedial action.

5.1 Canol Camp Johnson's Crossing

Overall, areas around Johnson's Crossing that contained visible debris or showed signs of contamination in soil samples included -

- the Old Army Lodge Dump near the western shore of the Teslin River;
- the Old 1.5 Mile Army Dump;
- the vehicle dump at Camp Canol;
- two discrete surface stains in clearings on the access road to the north of the vehicle dump; and
- subsurface soils beneath the above-ground storage tank located at the Canol Road junction, south of the new Alaska Highway.

The Old Army Lodge Dump contained substantial amounts of metallic objects such as old car bodies; however, the data suggested that metals with greater known toxicological significance - including lead, mercury, cadmium, silver or copper have not been introduced in substantial quantities to the wetland below the dump or to the Teslin River. Discussions between the field team and some of the local residents suggested that the dump is of concern. The cans, bottles, and vehicles of World War II vintage noted in this dump suggest that the dump may be of some historical value. Any action taken at this dump should include a consultation with the local residents.

Hydrocarbon concentrations in one sample collected from the 1.5 Mile Army Dump exceeded BC standards, which suggested the probable past burial of barrels or material containing hydrocarbon products. However, all barrels exposed along the face of the dump or uncovered during the excavation of test pits, were observed to be empty. It appears the problem at the dump is primarily an aesthetic one and cleanup would involve removal or re-burial of the exposed debris.

The vehicle dump contains World War II vintage vehicles along with small quantities of hazardous materials, including lead containing vehicle batteries and discarded electronic appliances. Uncontrolled dumping of household and other refuse has also occurred. The problem is primarily an aesthetic one; however, the present state of the site may encourage continued waste disposal on site, which could lead to contamination in the future.

Two discrete soil stains in clearings to the west of the road leading north from Canol Camp contained high concentrations of hydrocarbons. There was some evidence of hydrocarbon degradation and re-vegetation. In this preliminary investigation samples collected from these stains were not analyzed for any other substances; further characterization is therefore required, given the high levels of hydrocarbons detected. If no other parameters of toxicological significance are found, degradation of hydrocarbons in the eastern-most of the two stains may be increased by reworking the soils, which would enhance volatilization, sunlight-mediated photolysis and microbial degradation. The second stain which contained heavy extractable petroleum hydrocarbons may be remedied by the removal of the tar-like material. The remaining soils could then be reworked to enhance in-situ degradation of any residual hydrocarbons.

Samples collected from a test pit excavated near the above-ground storage tank, situated south of the new Alaska Highway and the Canol Road junction, contained volatile petroleum hydrocarbons in excess of the BC draft standards. The regional groundwater beneath the AST may flow toward the Teslin River which is located approximately 0.5 km away. A more detailed investigation is therefore required in this area to determine the extent and fate of the hydrocarbon contamination.

The possible ecological risk at all of these locations at Johnson's Crossing is probably negligible or very small, since the contaminated areas appear to be localized and small, and there is no indication of any large sources of either toxicologically important metals or persistent organic contaminants, such as PCBs or chlorinated pesticides. The hydrocarbon contamination beneath the above-ground storage tank is, perhaps, the largest single contaminant source at the site and requires further investigation.

5.2 Squanga Lake Airstrip

Overall, no evidence was found during the preliminary investigation for substantial soil contamination or any other environmental problems. Only a very limited volume of soil underneath the old vehicle service ramp was contaminated with hydrocarbons and lead. The small area of contamination would preclude risks to living organisms, except perhaps to soil invertebrates and plants within the contaminated soil itself. A small amount of debris was scattered to the east of the private residence. This could be buried on-site, or removed, for aesthetic purposes.

5.3 Canol Pump Station W (Big Devil)

No evidence of contaminant concerns worthy of more detailed investigation was found during the preliminary environmental assessment of the pump station and the sawmill site. A small amount of debris was noted in the vicinity of the sawmill in the small dump west of the pump station - an aesthetic concern that could be addressed by removal and burial.

5.4 Marsh Lake

A surface stain near the garage pad was contaminated with both metals and hydrocarbons. In addition the collection sump on the garage pad contained petroleum hydrocarbons exceeding BC draft standards. These two contaminated areas were very small in size. No other contaminants were found in the samples collected from other areas of the site, including the surface dump located near the boat ramp. Of the four sites investigated, this site was in closest proximity to a major water body. In addition, the extensive use of the site by campers and boaters, as well as close proximity to residential properties, would

increase the likelihood of human exposure if contaminants were present within surface soils or water. On the basis of the results obtained in this preliminary investigation, any risk to humans or other living organisms, however, appears minimal. Cleanup at this site might involve the re-burial of the small amount of debris noted in the dump. The small volume of hydrocarbon and metal contaminated soils in the collection sump and outside the garage pad should be treated to isolate them from the surrounding environment.

6. REFERENCES

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APPENDICES

A: Sampling Locations and Test Pit Logs
B: Analytical Results
C: Hydrocarbon Distribution Reports
D: Quality Assurance/Quality Control (QA/QC)

APPENDIX A:
SAMPLING LOCATIONS AND TEST PIT LOGS

A. SAMPLING LOCATIONS AND TEST PIT LOGS

A.1 Sampling Locations and Descriptions for Johnson's Crossing

Sample No.	Location	Description/Observations	Soil/Sample Description
Old Lodge Army Dump			
JC96-01	Base of dump towards river. bottom of refuse pile, approximately 10 m from the top with a slope of about 30^{o}	Excavation with a shovel indicated debris is surficial with an average depth of 30 cm.	Moss with some organic material on the surface Sample coarse organic-rich sands directly beneath humus
JC96-02	Centre of dump on the side away from the river. approximately 15 m from the sawmill, 1.5 m from car body	Debris included tin cans, car body, sampled at 40 cm depth	Mostly organic loam, including partially decomposed needles, leaves, moss
JC96-03	Toe of dump, small depression, 2 m from truck body	Drainage catchment from dump	Top 5 cm of soil under a few mm of moss
JC96-04	In marsh down slope of the dump	Discharge into Teslin River about 150 m away	Wet organic rich sediment in sedge and horsetail swamp
Old 1.5 Mile Army Dump			
JC96-05	Bottom of gully, below the dump	Old truck tires near sampling location	Sandy loam with moss on the surface
JC96-06	Base of pushout near top part of the dump, with 35 cm of partially buried debris	Debris included 45 gal drums, old vehicle parts, excavation with a shovel indicated depth greater than 1 m.	Sandy loam
JC96-07	Toe of dump, west of JC96-06, amid debris.	Debris included partially crushed barrels, vehicle parts, bed springs	Organic layer over sandy loam
JC96-08	Toe of dump, 20 m west of Canol Road and 30 m north of access road to 1975/76 DIAND Cleanup landfill	Debris consisted of wood, tin cans and barrels. Excavation with a shovel suggested debris confined to top 20 cm.	Sandy loam
Vicinity of Old US Army Telegraph Station			
JC96-09	Just outside L-shaped foundation between new and old highway	No visible debris in the area	Sand

Sampling Locations and Descriptions for Johnson's Crossing - Continued

Sample No.	Location	Description/Observations	Soil/Sample Description
Vehicle Dump			
JC96-10 Surface	Stained area at a knoll, along road, about 300 m north of vehicle dump. Plateau supported by log embankment. Surface sample	Stain (15 m x 20 m, 5 cm depth). Two 45 gal drums and three 20 gal drums, all opened just south of the area	Sandy clay soil
JC96-11	Taken at a depth of 10 cm below the stain at JC96-10	No visible stain	Sand
JC96-12	Tar-like stain, on a plateau just below previous stained area (JC96-10)	Stain was approximately 2.5 x 4 m. Very little growth of vegetation	Sandy clay soil
JC96-13	Base of south face of pile below dirt pile	metal and wood debris	Sandy clay
JC96-14	Amid large scrap pile in the centre of Army vintage waste	metal scrap	Sandy clay
Above Ground Storage Tank and Garage			
JC96-15	1.5 m depth in Test Pit 1, 20 m south of AGST	See Test Pit log (Appendix A.2)	
JC96-16	30 cm depth in Test Pit 2, at soak away pit near AGST	See Test Pit log (Appendix A.2)	
JC96-17	1.5 m depth in Test Pit 2	See Test Pit log (Appendix A.2)	
JC96-18	3.2 m depth in Test Pit 3	See Test Pit log (Appendix A.2)	
JC96-19	3.0 m in Test Pit 3, 25 m west of AGST	See Test Pit log (Appendix A.2)	
JC96-20	Faint surface staining throughout the worked area near the AGST	Stain was approximately 25 m x 30 m. Some aspen, spruce, willow regeneration	Sandy clay with lichen on the surface
JC96-21	5 m from southern bay door of garage.	Surface staining confined to the top 10 cm. Inside floor of garage covered with metallic debris	Sandy clay soil
Old 1.5 Mile Army Dump			
JC96-22	2.0 m depth in Test Pit 5 amid debris at Old 1.5 mile Army Dump	See Test Pit log (Appendix A.2)	
JC96-23	Below partially buried barrels along the south edge side of the dump	Partially buried barrels and other metallic debris. No discernible staining or odour	Clay

Sampling Locations and Descriptions for Johnson's Crossing - Continued

Sample No.	Location	Description/Observations	Soil/Sample Description
Canol Camp			
JC96-24	Surface sample in Test Pit 7 excavated in first worked area along main road leading to Canol Camp	See Test Pit log (Appendix A.2)	
JC96-25	Surface stains to the north of first worked area at Canol Camp	Debris included tin cans, metal, glass, wood etc.	Sand and gravel
JC96-26	1 m west of the base of cement ramp at the entrance to Canol Camp	Dark brown stain (3 m x 5 m)	Sand and clay
Foundations South of Garage			
JC96-27	Low area between two concrete foundations north of Old Alaska Highway and south of the derelict garage. Sample location 3 m from the southwest corner.	Foundations cover an area of approximately 20 m x 16 m, overgrown with aspen and willow. A 4 inch pipeline was noted nearby	Sand and clay with greenish- brown moss on the surface
JC96-28	Low area within foundations near the eastern edge	Same as JC96-27	Same as JC96-27
JC96-29 JC96-30	3 m outside north end of concrete foundation. Field duplicate samples	Same as JC96-27	Same as JC96-27
Community Dump			
JC96-31	Community dump, in excavated area containing crushed barrels and other debris	Debris included an old dryer and an empty barrel	Sand and clay

A.2 Johnson's Crossing Test Pit Log

Test Pit No.	Location	Maximum Depth	Description/ Observations	Sample Depth
JC-TP1	Approximate 20 m south of AGST (above ground storage tank), along the berm of worked area	2.0 m	No visible staining to 1.5 m. Orange-coloured rag at 1.5 m with 15 cm of darker layer below it. No hydrocarbon odour	JC96-15 at 1.5 m, PID < 10 ppm
JC-TP 2	Soak away pit on the northwest corner of the AGST.	3.2 m	Surface hydrocarbon staining to a depth of 30 cm. Strong hydrocarbon odour to a depth of 3.2 m	JC96-16 at 30 cm, PID 10 ppm JC96-17 at 1.5 m, PID >2000 ppm JC96-18 at 3.2 m, PID >2000 ppm
JC-TP3	25 m west of AGST, to detect possible lateral movement of hydrocarbons	3.0 m	No discernible hydrocarbon odour or staining	JC96-19 at 3.0 m
JC-TP4	5 - 7 m from the southern bay door of garage.	2.0 m	Stain at surface (10 cm). No obvious stain or hydrocarbon odour at 1.0 m	JC96-21 taken at surface JC96-21B taken at 1 m, PID < 10 ppm
JC-TP5	Old Army 1.5 mile Dump, amid debris on western side	2.0 m	Metallic debris including empty barrels uncovered. No visible staining or hydrocarbon odour	JC96-22 taken at 2.0 m
JC-TP6	Immediately north of road to DIAND/EC. Landfill, in sandy bank	2.0 m	Appears to be clean sand to 2 m. No visible debris, obvious staining or odour	No samples collected for lab analysis. Test kit sample at 1.0 m
JC-TP7	Stain at first worked area north of road leading to Canol Camp	2.0 m	Surface stain (to 15 cm). No further staining observed to 2 m. Debris in the area included tin cans, metal, glass, wood	JC96-24 taken at the surface
JC-TP8	In berm at the edge of worked area; appears to be a foundation for a building or tent	2.0 m	No visible debris or staining encountered to 2.0 m.	Sampled for Test kits only. Sandy loam

A.3 Sampling Locations and Descriptions for Squanga Lake Airstrip

Sample No.	Location	Description/Observations	Soil/Sample Description
SQ96-01	In the centre of old vehicle maintenance ramp, south of the Alaska Highway and east of access road to the private residence, 8 m from a Geodetic Survey marker	dark staining to a depth of 10 cm with surface layer of duff (aspen and pine needles).	Sandy soil with oily odour
SQ96-02	15 cm depth at SQ96-01	Clean looking sand beneath the stained layer	Sandy soil
SQ96-03 SQ96-04	In the lowest area inside a rectangular bowl-like depression containing debris (Dump 1), east of Lot 15. Field duplicate	Debris included old machinery parts, tin cans, oil cans, empty 20 gal drums, wood stove, etc. Area approximately 5 m x 10 m	Sandy soil, no obvious odour
SQ96-05	Further east of Dump 1, in an area containing old wood frame house surrounded by garbage	Debris included old tires, electrical towers, switches, runway lights, empty 10 gal drums, wood, etc. Area of approximately 10 m x 10 m	Sandy soil, no obvious stain or odour
SQ96-06	In old building foundation west of the airstrip access road and tower	Foundation 3 m x 5 m with a 10 cm metal pipe sticking out of a cement pad to a height of approximately 2 m	Sand and surface layer of duff (pine needles)
SQ96-07	In the base of pit along the south edge of the remains of a shack (generator building) located near the beacon tower	Pit approximately 0.5 m X 1 m, 40 cm deep. A 2 cm metal pipe leading from building into the ground	Dark wet sand
SQ96-08	On a cement pad within the foundation of the shack and at the southwest corner near where a wood stove once stood	Pad was approximately 1.5 x 1.5 m and had a lip. It was covered with a greasy-oily stained moss	Sand and moss
SQ96-09	North side of shack under foundation.	Electrical conduit noted near sampling location	Sand

A.4 Sampling Locations and Descriptions for Canol Pump Station W (Big Devil) and Sawmill Site

Sample No.	Location	Description/Observations	Soil/Sample Description
Sawmill Site			
BD96-01	In muskeg among slag pile at the sawmill	Slab piled in various locations in the muskeg	Silt and organic material
BD96-02	6 m down slope of sawdust pile on the southeast side of the sawmill	Two main sawdust piles noted at the sawmill site	Sand
BD96-03	1 m from door of log house	Log house partially collapsed	sand and silt
Historic Mile 855			
BD96-04 BD96-05	Drainage below berm above highway, Field duplicate samples	Old tires and wood debris scattered in the area	Sand and organic material
BD96-06	Near centre of old foundation at the top of bank, north of highway	2 inch pipeline near sampling location	Sand and organic material
Pump Station W			
BD96-07	Outside edge of wood foundation on the north part of the Pump Station	Foundation is 7 m x 14 m	Sand and gravel
BD96-08	Approximately 3 m from sawed off pole near foundation	Surface stain	Sandy
BD96-09	Inside the base of a square foundation of about 1 m depth	Wooden sides (2 m x 2 m) with lots of organic material and detritus inside	Organic and detritus
BD96-10	Drainage path at the toe of worked area west of road leading to the Pump Station	Area graded and contoured with no visible debris	Hard packed clay
BD96-11	Near centre of disturbed area at 0.95 m depth	No debris was encountered in 3 holes excavated with a hand auger to depths of about 1 m each	Hard packed clay
Dump			
BD96-12	Small dump along west road	Debris included tin cans, wood, fibre board, scrap metal etc.	Sand

A.5 Sampling Locations and Descriptions for Marsh Lake Camp

Sample No.	Location	Description/Observations	Soil/Sample Description
ML96-01	Near side of Test Pit 2 where a pipe enters the pit	See Test Pit Descriptions in Appendix A.6.	Clay and silt
ML96-02	30 cm in Test Pit 3 at old dump near Marsh lake	See Test Pit Descriptions in Appendix A.6.	Clay and silt with some roots
ML96-03	1.5 m depth in Test Pit 6 near partially buried water pipe	See Test Pit Descriptions in Appendix A.6.	
ML96-04	1.5 m depth in Test Pit 7 west of garage foundation	See Test Pit Descriptions in Appendix A.6.	
ML96-05	Surface sample in Test Pit 8 at a black stained area east of garage foundation	See Test Pit Descriptions in Appendix A.6.	
ML96-06	1.0 m depth in Test Pit 8	See Test Pit Descriptions in Appendix A.6.	
ML96-07 ML96-08	Oil collection pit in cement floor of garage foundation. Pit is 2.5 m x 0.5 m. Field duplicate samples collected at 50 cm depth	Black stain but no odour. Hand excavation indicated depth greater than 0.5 cm. Rusty nails in the pit	Sand and gravel
ML96-09	Toe of dump near lake and 6 m south of Test Pit	Wood debris from collapsed shed in the area	Sand and organic material
ML96-10	In wood lined collection sump halfway between clearing and lake	Approximately 2 m x 2 m x 2m and may be a septic tank	Sand and organic material

A.6 Marsh Lake Camp Test Pit Log

Test Pit No	Location	Maximum Depth	Description/Observations	Sample Depth
JC-TP1	In a berm with a small amount of metallic debris north of dump	2.0 m	Twisted sheet metal and wood on the surface only, no visible debris or obvious odour at depth.	No lab sample take. Test kit only
JC-TP2	Collapsed drain pit with wooden sides amid 5 m high willow and spruce. Ceramic pipe empties into the west end of the pit	2.0 m	A couple of boards and scrap iron noted at the bottom of the pit.	ML96-01 from the side near point where pipe enters pit. No odour or visible stain
JC-TP3	Northwestern side of dump near lake	1.5 m	Surficial debris including old shingles, metal and building materials at surface (30 cm). No debris or staining below 30 cm and down to 1.5 m	ML96-02 at 30 cm
JC-TP4	Overgrown clearing 7 m west of road, near lake	1.5 m	No debris encountered. Ash layer at 60 cm.	No sample taken
JC-TP5	15 m southeast of Test Pit 3 in dump near lake	1.5 m	Surface metal debris	No lab sample. Test kit only
JC-TP6	9 m from Geodetic Survey benchmark (74 Y012) Ottawa	1.5 m	Buried water pipe protruding in the area	ML96-03 at 1.5 m
JC-TP7	7 m east of garage foundation	1.5 m	No staining, odour or debris noted.	ML96-04 at 1.5 m
JC-TP8	Black stained area 1 m west of garage foundation	1.5 m	Surface staining to a depth of 5 cm with stressed vegetation. White ash layer at 30 cm. No further staining to a depth of 1.5 m.	ML96-05 at surface ML96-06 at 1.0 m

APPENDIX B:
ANALYTICAL RESULTS

B.1 JOHNSON'S CROSSING SOIL SAMPLES

B.1.1 Inorganic Elements Results for Johnson's Crossing

Sample ID	JC 96-1	JC 96-2	JC 96-3	JC 96-4	JC 96-5	JC 96-6	CCME or BC
Date Collected	96/09/12	96/09/12	96/09/12	96/09/12	96/09/12	96/09/12	**Soil Quality**
Time	11:30	11:50	12:10	12:30	13:40	14:10	**Benchmark**
Moisture %	24.2	35	26.3	51.2	38.9	20.5	**(Residential/ Parkland**
Aluminum (Al)	20300	13900	16200	19700	12400	17800	
Antimony (Sb)	<20	<20	<20	<20	<20	<20	20
Arsenic (As)	2.58	8.32	2.58	4.9	0.88	1.36	30
Barium (Ba)	297	306	265	345	531	275	500
Beryllium (Be)	0.5	<0.5	<0.5	0.6	<0.5	<0.5	4
Bismuth (Bi)	15	16	15	26	12	11	
Cadmium (Cd)	<2	<2	<2	<2	<2	<2	5
Calcium (Ca)	9320	12600	9880	11100	4640	8420	
Chromium (Cr)	64	75	58	60	23	59	250
Cobalt (Co)	13	12	11	13	8	11	50
Copper (Cu)	32	84	34	47	20	48	100
Iron (Fe)	29700	73100	27100	27400	12700	32300	
Lead (Pb)	<50	57	<50	<50	<50	415	400
Lithium (Li)	11	8	10	13	6	10	
Magnesium (Mg)	8410	7920	10200	10500	2700	7540	
Manganese (Mn)	519	560	337	366	1790	530	
Mercury (Hg)	0.035	0.115	0.032	0.041	0.012	0.026	2
Molybdenum (Mo)	<4	4	<4	<4	<4	<4	10
Nickel (Ni)	45	64	51	55	22	44	100
Phosphorus (P)	665	702	653	1130	1450	401	
Potassium (K)	2410	2100	1400	1810	851	1720	
Selenium (Se)	<0.1	1.2	0.2	0.7	0.1	<0.1	3
Silver (Ag)	<2	<2	<2	<2	<2	<2	20
Sodium (Na)	758	625	812	751	535	545	
Tin (Sn)	<10	114	<10	<10	<10	<10	50
Titanium (Ti)	1300	1240	1320	1680	709	736	
Vanadium (V)	73	50	62	69	32	63	200
Zinc (Zn)	86	346	66	72	131	133	500
Location	Base of old Army Lodge dump towards river. Bottom of refuse pile	Centre of Old Army Lodge dump on the side away from the river	Toe of Old Lodge Army dump, small depression, 2 m from truck body	In marsh down slope of the old lodge dump	1.5 Mile Army dump, bottom of gully below dump	1.5 Mile Army dump, base of push-out near partially buried debris	

Notes
All results are expressed as mg/kg (ppm)
< = Less than the detection limit indicated

Inorganic Elements Results for Johnson's Crossing - Continued

Sample ID	**JC 96-7**	**JC 96-8**	**JC 96-13**	**JC 96-14**	**JC 96-25**	**CCME or BC**
Date Collected	96/09/12	96/09/12	96/09/12	96/09/12	96/09/13	**Soil Quality**
Time	14:30	15:00	18:30	18:50	16:30	**Benchmark**
Moisture %	6.9	7.5	21	16	9.2	**(Residential/ Parkland**
Aluminum (Al)	11100	18300	20700	18200	16800	
Antimony (Sb)	<20	<20	<20	<20	<20	20
Arsenic (As)	8.32	1.77	1.11	4.27	5.89	30
Barium (Ba)	260	260	361	275	231	500
Beryllium (Be)	<0.5	<0.5	0.6	<0.5	<0.5	4
Bismuth (Bi)	12	17	15	14	14	
Cadmium (Cd)	<2	<2	<2	<2	13	5
Calcium (Ca)	24300	6820	12900	8360	8010	
Chromium (Cr)	40	43	70	69	37	250
Cobalt (Co)	9	10	14	13	10	50
Copper (Cu)	123	18	60	72	94	100
Iron (Fe)	51800	21300	39400	44600	28800	
Lead (Pb)	170	<50	<50	293	247	400
Lithium (Li)	7	11	12	12	12	
Magnesium (Mg)	6870	5980	9340	8020	10200	
Manganese (Mn)	708	729	646	665	561	
Mercury (Hg)	0.021	0.008	0.027	0.037	0.014	2
Molybdenum (Mo)	<4	<4	<4	<4	<4	10
Nickel (Ni)	41	30	54	47	33	100
Phosphorus (P)	1370	559	310	408	537	
Potassium (K)	1260	1320	1990	1540	1070	
Selenium (Se)	<0.1	<0.1	<0.1	<0.1	<0.1	3
Silver (Ag)	<2	<2	<2	<2	<2	20
Sodium (Na)	448	356	716	536	296	
Tin (Sn)	431	16	<10	<10	<10	50
Titanium (Ti)	146	751	852	871	607	
Vanadium (V)	38	59	73	69	68	200
Zinc (Zn)	317	102	143	190	358	500
Location	Toe of dump, west of JC96-06, amid debris.	1.5 mile Army dump, toe of dump, 20 m west of Canol Road	Vehicle dump, base of south face of pile below dirt pile	Vehicle dump, amid large scrap pile in the centre of waste	Surface stains at the north end of first worked area at Canol Camp	

Notes

All results are expressed as mg/kg (ppm)

< = Less than the detection limit indicated

B.1.2 Hydrocarbon Results for Johnson's Crossing

Sample ID	**JC96-1**	**JC96-11**	**JC96-12**	**JC96-13**	**JC96-15**	**CCME or BC**
Date Collected	96/09/12	96/09/12	96/09/12	96/09/12	96/09/13	**Soil Quality**
Time	11:30	18:05	18:15	18:30	12:30	**Benchmark**
Moisture %	24.2	15.1	12.1	21	6.6	**(Residential/ Parkland**
Non-halogenated Volatiles						
Benzene	-	-	-	-	-	0.5
Ethylbenzene	-	-	-	-	-	5
Toluene	-	-	-	-	-	3
meta- & para-Xylene	-	-	-	-	-	5
ortho-Xylene	-	-	-	-	-	
Light Hydrocarbons (C5-9)	-	-	-	-	-	
VPH	-	-	-	-	-	200
Extractables						
EPH (C10-18)	<250	1810	6340	<250	<250	
EPH (C19-31)	<250	<250	165000	359	<250	
LEPH	-	-	6340	<250	-	1000
HEPH	-	-	165000	359	-	1000
PAHs						
Acenaphthene	-	-	<1	0.02	-	
Acenaphthylene	-	-	<1	<0.01	-	
Anthracene	-	-	<1	0.01	-	
Benzo(a)anthracene	-	-	<1	0.02	-	1
Benzo(a)pyrene	-	-	<1	0.01	-	1
Benzo(b)fluoranthene	-	-	<1	0.03	-	1
Benzo(g,h,i)perylene	-	-	<1	0.01	-	
Benzo(k)fluoranthene	-	-	2	0.01	-	1
Chrysene	-	-	7	0.03	-	
Dibenz(a,h)anthracene	-	-	<1	<0.01	-	1
Fluoranthene	-	-	1	0.06	-	
Fluorene	-	-	<1	0.01	-	
Indeno(1,2,3-c,d)pyrene	-	-	<1	<0.01	-	1
Naphthalene	-	-	<1	0.06	-	5
Phenanthrene	-	-	<1	0.06	-	5
Pyrene	-	-	6	0.05	-	10
Location	Base of Old Army Lodge dump towards river. Bottom of refuse pile	Stained area along road 300 m north of vehicle dump	Tar-like stain, on a plateau just below previous stained area (JC96-10)	Vehicle dump, base of south face of pile below dirt pile	1.5 m depth in Test Pit 1, 20 m south of AGST	

All results are expressed as mg/kg (ppm)
< = Less than the detection limit indicated
VPH = Volatile Petroleum Hydrocarbon
EPH = Extractable Petroleum Hydrocarbon
LEPH & HEPH = Light & Heavy Extractable Petroleum Hydrocarbon
PAH = Polycyclic Aromatic Hydrocarbon

Hydrocarbon Results for Johnson's Crossing - Continued

Sample ID	**JC96-16**	**JC96-17**	**JC96-18**	**JC96-19**	**JC96-20**	**CCME or BC**
Date Collected	96/09/13	96/09/13	96/09/13	96/09/13	96/09/13	**Soil Quality**
Time	12:40	12:45	12:50	13:10	13:30	**Benchmark**
Moisture %	3.9	22.6	17.6	15.6	10.1	**(Residential/ Parkland**
Non-halogenated Volatiles						
Benzene	<0.05	<0.1	<2	-	-	0.5
Ethylbenzene	<0.05	<10	<2	-	-	5
Toluene	<0.05	<2	<3	-	-	3
meta- & para-Xylene	<0.1	126	67.2	-	-	5
ortho-Xylene	<0.05	32.5	17.6	-	-	
Light Hydrocarbons (C5-9)	14	3040	1850	-	-	
VPH	<10	1460	937	-	-	200
Extractables						
EPH (C10-18)	-	962	555	<250	<250	
EPH (C19-31)	-	<250	<250	<250	<250	
LEPH	-	-	553	-	-	1000
HEPH	-	-	<250	-	-	1000
PAHs						
Acenaphthene	-	-	0.01	-	-	
Acenaphthylene	-	-	<0.01	-	-	
Anthracene	-	-	<0.01	-	-	
Benzo(a)anthracene	-	-	<0.01	-	-	1
Benzo(a)pyrene	-	-	<0.01	-	-	1
Benzo(b)fluoranthene	-	-	<0.01	-	-	1
Benzo(g,h,i)perylene	-	-	<0.01	-	-	
Benzo(k)fluoranthene	-	-	<0.01	-	-	1
Chrysene	-	-	<0.01	-	-	
Dibenz(a,h)anthracene	-	-	<0.01	-	-	1
Fluoranthene	-	-	<0.01	-	-	
Fluorene	-	-	<0.01	-	-	
Indeno(1,2,3-c,d)pyrene	-	-	<0.01	-	-	1
Naphthalene	-	-	1.87	-	-	5
Phenanthrene	-	-	0.02	-	-	5
Pyrene	-	-	<0.01	-	-	10
Location	30 cm depth in Test pit 2, at soak away pit near AGST	1.5 m depth in Test Pit 2	3.2 m depth in Test Pit 2	3.0 m in Test pit 3, 25 m west of AGST	Faint surface staining at worked area near AGST	

All results are expressed as mg/kg (ppm)
< = Less than the detection limit indicated
VPH = Volatile Petroleum Hydrocarbon
EPH = Extractable Petroleum Hydrocarbon
LEPH & HEPH = Light & Heavy Extractable Petroleum Hydrocarbon
PAH = Polycyclic Aromatic Hydrocarbon

Hydrocarbon Results for Johnson's Crossing - Continued

Sample ID	**JC96-21**	**JC96-23**	**JC96-24**	**JC96-26**	**CCME or BC**
Date Collected	96/09/13	96/09/13	96/09/13	96/09/13	**Soil Quality**
Time	13:40	15:00	16:00	17:20	**Benchmark**
Moisture %	11.9	21	17.4	13.7	**(Residential/ Parkland**
Non-halogenated Volatiles					
Benzene	-	-	-	-	0.5
Ethylbenzene	-	-	-	-	5
Toluene	-	-	-	-	3
meta- & para-Xylene	-	-	-	-	5
ortho-Xylene	-	-	-	-	
Light Hydrocarbons (C5-9)	-	-	-	-	
VPH	-	-	-	-	200
Extractables					
EPH (C10-18)	<250	3590	<250	<250	
EPH (C19-31)	574	5790	318	<250	
LEPH	-	-	-	<250	1000
HEPH	-	-	-	<250	1000
PAHs					
Acenaphthene	-	-	-	<0.01	
Acenaphthylene	-	-	-	0.01	
Anthracene	-	-	-	0.01	
Benzo(a)anthracene	-	-	-	0.08	1
Benzo(a)pyrene	-	-	-	0.07	1
Benzo(b)fluoranthene	-	-	-	0.1	1
Benzo(g,h,i)perylene	-	-	-	0.04	
Benzo(k)fluoranthene	-	-	-	0.04	1
Chrysene	-	-	-	0.1	
Dibenz(a,h)anthracene	-	-	-	<0.01	1
Fluoranthene	-	-	-	0.17	
Fluorene	-	-	-	<0.01	
Indeno(1,2,3-c,d)pyrene	-	-	-	0.05	1
Naphthalene	-	-	-	0.01	5
Phenanthrene	-	-	-	0.05	5
Pyrene	-	-	-	0.16	10
Location	5 m from southern bay door of old garage	Below barrels, south edge of 1.5 mile Army dump	Surface sample in Test Pit 7 in first worked area at Canol Camp	1 m west of base of cement ramp at the entrance to Canol Camp	

All results are expressed as mg/kg (ppm)
< = Less than the detection limit indicated
VPH = Volatile Petroleum Hydrocarbon
EPH = Extractable Petroleum Hydrocarbon
LEPH & HEPH = Light & Heavy Extractable Petroleum Hydrocarbon
PAH = Polycyclic Aromatic Hydrocarbon

B.1.3 Polychlorinated Biphenyls (PCB) Results for Johnson's Crossing

Sample ID	JC 96-1	JC 96-2	JC 96-6	JC 96-7	JC 96-9	JC96-14	JC96-21	JC 96-22
Date Collected	96/09/12	96/09/12	96/09/12	96/09/12	96/09/12	96/09/12	96/09/13	96/09/13
Time	11:30	11:50	14:10	14:30	16:40	18:50	13:40	14:30
Moisture (%)	24.2	35	20.5	6.9	7	16	11.9	2.6
Total PCBs	<0.05	<0.05	<0.05	<0.05	<0.05	0.3	<0.05	<0.05
Location	Base of old Army Lodge dump towards river. Bottom of refuse pile	Centre of old Army Lodge dump on the side away from the river	1.5 mile Army dump, base of push-out near partially buried debris	Toe of dump, west of JC96-06, amid debris.	Tele-phone station, by cement found-ation	Vehicle dump, amid large scrap pile in the centre of waste	5 m from southern bay door of old garage	2.0 m depth in Test Pit 5 amid debris at Old Army 1.5 mile Dump

All results are expressed as mg/kg (ppm)
< = Less than the detection limit indicated

Polychlorinated Biphenyls (PCB) Results for Johnson's Crossing - Continued

Sample ID	JC 96-23	JC 96-24	JC 96-27	JC 96-28	JC 96-29	JC 96-30	JC96-31	CCME
Date Collected	96/09/13	96/09/13	96/09/13	96/09/13	96/09/13	96/09/13	96/09/19	Soil Quality
Time	15:00	16:00	17:40	17:45	17:50	17:55	11:30	Benchmark
Moisture %	21	17.4	7.4	7.2	12.6	12.9	8.0	(Residential/ Parkland
Total PCBs	<0.05	<0.05	<0.05	0.06	<0.05	<0.05	<0.05	5
Location	Below barrels, south edge of 1.5 mile Army dump	Surface sample in Test Pit 7 in first worked area at Canol Camp	Low area between two concrete founda-tions south of garage	Low area within founda-tions near the eastern edge	3 m outside north end of concrete founda-tion.	Field duplicate of JC96-29	Commun-ity dump, in excavated area	

All results are expressed as mg/kg (ppm)
< = Less than the detection limit indicated

B.1.4 Organochlorine Pesticides Results for Johnson's Crossing

Sample ID	JC 96-1	JC 96-2	JC 96-6	JC 96-7	JC96-14	JC 96-22
Date Collected	96/09/12	96/09/12	96/09/12	96/09/12	96/09/12	96/09/13
Time	11:30	11:50	14:10	14:30	18:50	14:30
Moisture %	24.2	35	20.5	6.9	16	2.6
Aldrin	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
alpha-BHC	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
beta-BHC	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
delta-BHC	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
cis-Chlordane (alpha)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
trans-Chlordane (gamma)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
2,4'-DDD	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
4,4'-DDD	<0.001	0.008	<0.001	<0.001	<0.001	<0.001
2,4'-DDE	<0.002	<0.002	<0.002	<0.002	<0.003	<0.002
4,4'-DDE	<0.001	0.003	<0.001	<0.001	<0.002	<0.001
2,4'-DDT	<0.001	0.001	<0.001	<0.001	<0.009	<0.001
4,4'-DDT	<0.002	0.027	0.002	0.002	<0.004	<0.002
Dieldrin	<0.0030	0.003	<0.003	<0.003	<0.003	<0.001
Endosulfan I	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Endosulfan II	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Endosulfan Sulfate	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Endrin	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Endrin Aldehyde	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Heptachlor	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Heptachlor Epoxide	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lindane (gamma - BHC)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Methoxychlor	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Mirex	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
cis-Nonachlor	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
trans-Nonachlor	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Oxychlordane	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Toxaphene	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Location	Base of old Army Lodge dump towards river. Bottom of refuse pile	Centre of old Army Lodge dump on the side away from the river	1.5 mile Army dump, base of push-out near partially buried debris	Toe of dump, west of JC96-06, amid debris	Vehicle dump, amid large scrap pile in the centre of waste	2.0 m depth in Test Pit 5 amid debris at Old Army 1.5 mile Dump

Notes:
All results are expressed as mg/kg (ppm)
< = Less than the detection limit indicated
No CCME or BC Soil Quality Benchmark available

B.2 SQUANGA LAKE AIRSTRIP SOIL SAMPLES

B.2.1 Inorganic Elements Results for Squanga Lake

Sample ID	**SQ96-01**	**SQ96-03**	**SQ96-04**	**SQ96-05**	**SQ96-06**	**CCME or BC**
Date Collected	960915	960915	960915	960915	960915	**Soil Quality**
Time	11:10	11:30	11:35	11:45	13:00	**Benchmark**
Moisture %	12.1	20.4	17.5	5.9	16	**(Residential/ Parkland**
Aluminum (Al)	15700	13000	14200	12500	17500	
Antimony (Sb)	<20	<20	<20	<20	<20	20
Arsenic (As)	3.8	2.45	2.4	1.85	37	30
Barium (Ba)	314	148	169	183	311	500
Beryllium (Be)	<0.5	<0.5	<0.5	<0.5	<0.5	4
Bismuth (Bi)	11	13	12	14	11	
Cadmium (Cd)	<2	<2	<2	<2	<2	5
Calcium (Ca)	5850	7180	8100	6190	6010	
Chromium (Cr)	56	45	46	47	37	250
Cobalt (Co)	7	8	8	6	9	50
Copper (Cu)	82	20	19	55	17	100
Iron (Fe)	18700	23400	21100	15600	17400	
Lead (Pb)	798	75	82	260	<50	400
Lithium (Li)	10	7	8	7	10	
Magnesium (Mg)	7020	7450	7650	6110	5690	
Manganese (Mn)	240	331	356	249	486	
Mercury (Hg)	0.011	0.012	0.008	0.008	0.011	2
Molybdenum (Mo)	<4	<4	<4	<4	<4	10
Nickel (Ni)	40	39	38	31	32	100
Phosphorus (P)	495	453	431	381	839	
Potassium (K)	1470	712	978	981	1350	
Selenium (Se)	0.1	<0.1	<0.1	<0.1	<0.1	3
Silver (Ag)	<2	<2	<2	<2	<2	20
Sodium (Na)	271	<200	202	<200	216	
Tin (Sn)	<10	<10	<10	13	<10	50
Titanium (Ti)	802	513	663	536	793	
Vanadium (V)	50	47	51	42	50	200
Zinc (Zn)	85	59	60	63	118	500
Location	In the centre of old vehicle mainten-ance ramp, south of the Alaska Highway	Lowest area at dump east of private residence (Lot 15)	Field duplicate of SQ96-03	Further east first dump, in an area with old wooden frame and garbage	In old building foundation west of the airstrip access road and tower	

Notes
All results are expressed as mg/kg (ppm)
< = Less than the detection limit indicated

B.2.2 Hydrocarbon Results for Squanga Lake Airstrip

Sample ID	**SQ96-01**	**SQ96-02**	**SQ96-08**	**CCME or BC**
Date Collected	960915	960915	960915	**Soil Quality**
Time	11:10	11:15	13.25	**Benchmark**
Moisture %	12.1	9.3	62.6	**(Residential/ Parkland**
Non-halogenated Volatiles				
Benzene	<0.05	-	-	0.5
Ethylbenzene	<0.05	-	-	5
Toluene	<0.05	-	-	3
meta- & para-Xylene	<0.05	-	-	5
ortho-Xylene	<0.05	-	-	
Light Hydrocarbons (C5-9)	-	-	-	
VPH	<10	-	-	200
Extractables				
EPH (C10-18)	886	<250	<250	
EPH (C19-31)	23300	564	3360	
LEPH	886	-	-	1000
HEPH	23300	-	-	1000
PAHs				
Acenaphthene	0.03	-	-	
Acenaphthylene	0.03	-	-	
Anthracene	0.03	-	-	
Benzo(a)anthracene	0.1	-	-	1
Benzo(a)pyrene	0.04	-	-	1
Benzo(b)fluoranthene	0.17	-	-	1
Benzo(g,h,i)perylene	0.15	-	-	
Benzo(k)fluoranthene	0.03	-	-	1
Chrysene	0.62	-	-	
Dibenz(a,h)anthracene	<0.01	-	-	1
Fluoranthene	0.3	-	-	
Fluorene	<0.01	-	-	
Indeno(1,2,3-c,d)pyrene	<0.01	-	-	1
Naphthalene	0.04	-	-	5
Phenanthrene	0.07	-	-	5
Pyrene	0.82	-	-	10
Location	In the centre of old vehicle maintenance ramp, south of the Alaska Highway	15 cm depth at SQ96-01	On a cement pad on the foundation	

All results are expressed as mg/kg (ppm)
< = Less than the detection limit indicated
VPH = Volatile Petroleum Hydrocarbon
EPH = Extractable Petroleum Hydrocarbon
LEPH & HEPH = Light & Heavy Extractable Petroleum Hydrocarbon
PAH = Polycyclic Aromatic Hydrocarbon

B.2.3 Polychlorinated Biphenyls (PCBs) and Organochlorine Pesticides Results for Results for Squanga Lake Airstrip

Sample ID	**SQ 96-01**	**SQ 96-03**	**SQ 96-04**	**SQ 96-07**	**SQ 96-09**	**CCME**
Date Collected	960915	960915	960915	960915	960915	**Soil Quality**
Time	11:10	11:30	11:35	13:15	13:35	**Benchmark**
Moisture %	12.1	20.4	17.5	15.9	3.3	**(Residential/ Parkland**
Polychlorinated Biphenyls						
Total PCBs	<0.2	<0.05	<0.05	<0.05	<0.05	5
Organochlorine Pesticides						
Aldrin	-	<0.001	<0.001	-	-	-
alpha-BHC	-	<0.001	<0.001	-	-	-
beta-BHC	-	<0.002	<0.002	-	-	-
delta-BHC	-	<0.001	<0.001	-	-	-
cis-Chlordane (alpha)	-	<0.001	<0.001	-	-	-
trans-Chlordane (gamma)	-	<0.001	<0.001	-	-	-
2,4'-DDD	-	<0.001	<0.001	-	-	-
4,4'-DDD	-	<0.001	<0.001	-	-	-
2,4'-DDE	-	<0.002	<0.002	-	-	-
4,4'-DDE	-	<0.001	<0.001	-	-	-
2,4'-DDT	-	<0.001	<0.001	-	-	-
4,4'-DDT	-	<0.002	<0.002	-	-	-
Dieldrin	-	<0.001	<0.001	-	-	-
Endosulfan I	-	<0.001	<0.001	-	-	-
Endosulfan II	-	<0.001	<0.001	-	-	-
Endosulfan Sulfate	-	<0.001	<0.001	-	-	-
Endrin	-	<0.005	<0.005	-	-	-
Endrin Aldehyde	-	<0.001	<0.001	-	-	-
Heptachlor	-	<0.002	<0.002	-	-	-
Heptachlor Epoxide	-	<0.001	<0.001	-	-	-
Lindane (gamma - BHC)	-	<0.001	<0.001	-	-	-
Methoxychlor	-	<0.005	<0.005	-	-	-
Mirex	-	<0.001	<0.001	-	-	-
cis-Nonachlor	-	<0.001	<0.001	-	-	-
trans-Nonachlor	-	<0.001	<0.001	-	-	-
Oxychlordane	-	<0.001	<0.001	-	-	-
Toxaphene	-	<0.030	<0.030	-	-	-
Location	In the centre of old vehicle mainten-ance ramp, south of the Alaska Highway	Lowest area at dump east of private residence (Lot 15)	Field duplicate of SQ96-03	In pit along south edge of remains of generator shack near beacon tower	North side of shack under foundation	

Notes
All results are expressed as mg/kg (ppm)
< = Less than the detection limit indicated

B.3 CANOL PUMP STATION W (BIG DEVIL) SOIL SAMPLES

B.3.1 Inorganic Elements Results for Canol Pump Station W (Big Devil)

Sample ID	BD 96-02	BD 96-03	BD 96-04	BD 96-05	CCME or BC
Date Collected	960914	960914	960914	960914	**Soil Quality**
Time	14:45	15:00	15:30	15:35	**Benchmark**
Moisture %	13.1	27.3	24.8	26.5	**(Residential/ Parkland**
Aluminum (Al)	23300	15200	15300	17500	
Antimony (Sb)	<20	<20	<20	<40	20
Arsenic (As)	4.44	1.2	2.99	3.33	30
Barium (Ba)	298	331	395	536	500
Beryllium (Be)	0.5	<0.5	<0.5	<1	4
Bismuth (Bi)	18	19	12	<20	
Cadmium (Cd)	<2	<2	<2	<4	5
Calcium (Ca)	7910	7610	12300	18000	
Chromium (Cr)	171	117	42	46	250
Cobalt (Co)	15	12	8	10	50
Copper (Cu)	26	19	19	31	100
Iron (Fe)	27600	18500	16400	17000	
Lead (Pb)	<50	<50	<50	<100	400
Lithium (Li)	12	8	9	10	
Magnesium (Mg)	13900	7960	5720	5890	
Manganese (Mn)	345	899	625	1060	
Mercury (Hg)	0.013	0.016	0.022	0.024	2
Molybdenum (Mo)	<4	<4	<4	<8	10
Nickel (Ni)	170	66	31	32	100
Phosphorus (P)	395	537	684	1020	
Potassium (K)	1600	1320	1360	2100	
Selenium (Se)	<0.1	<0.1	0.3	0.5	3
Silver (Ag)	<2	<2	<2	<4	20
Sodium (Na)	278	435	288	433	
Tin (Sn)	<10	<10	<10	<20	50
Titanium (Ti)	946	968	853	1050	
Vanadium (V)	69	55	47	52	200
Zinc (Zn)	50	82	44	55	500
Location	6 m down slope of sawdust pile on the southeast side of the sawmill	1 m from door of partially collapsed log house	Drainage below berm above historic milepost 855	Field duplicate of BD96-04	

Notes
All results are expressed as mg/kg (ppm)
< = Less than the detection limit indicated

Inorganic Elements Results for Canol Pump Station W (Big Devil) - Continued

Sample ID	**BD96-09**	**BD96-10**	**BD96-11**	**BD96-12**	**CCME or BC**
Date Collected	960919	960919	960919	960919	**Soil Quality**
Time	15:00	16:45	16:30	17:00	**Benchmark**
Moisture %	23.1	14.7	9.8	12.6	**(Residential/ Parkland**
Aluminum (Al)	-	-	-	-	
Antimony (Sb)	<20	<20	<20	<20	20
Arsenic (As)	7.1	1	0.64	12.5	30
Barium (Ba)	404	337	338	385	500
Beryllium (Be)	0.6	<0.5	0.5	0.5	4
Bismuth (Bi)	-	-	-	-	
Cadmium (Cd)	<2	<2	<2	<2	5
Calcium (Ca)	-	-	-	-	
Chromium (Cr)	60	58	61	50	250
Cobalt (Co)	10	9	9	9	50
Copper (Cu)	29	27	30	20	100
Iron (Fe)	-	-	-	-	
Lead (Pb)	<50	<50	<50	<50	400
Lithium (Li)	-	-	-	-	
Magnesium (Mg)	-	-	-	-	
Manganese (Mn)	-	-	-	-	
Mercury (Hg)	0.026	0.023	0.035	0.015	2
Molybdenum (Mo)	<4	<4	<4	<4	10
Nickel (Ni)	48	47	52	29	100
Phosphorus (P)	-	-	-	-	
Potassium (K)	-	-	-	-	
Selenium (Se)	0.2	<0.1	<0.1	0.1	3
Silver (Ag)	<2	<2	<2	<2	20
Sodium (Na)	-	-	-	-	
Tin (Sn)	<30	<30	<30	<30	50
Titanium (Ti)	-	-	-	-	
Vanadium (V)	62	57	60	65	200
Zinc (Zn)	75	46	51	42	500
Location	Inside the base of a square foundation of about 1 m depth	Drainage path at the toe of large worked area at the Pump Station	Near centre of large worked area at 0.95 m depth	Small dump along west road near pump station	

Notes

All results are expressed as mg/kg (ppm)

< = Less than the detection limit indicated

B.3.2 Hydrocarbon Results for Canol Pump Station W (Big Devil)

Sample ID	**BD 96-01**	**BD 96-04**	**BD 96-05**	**BD96-07**	**BD96-08**	**BD96-12**	**CCME or BC**
Date Collected	960914	960914	960914	960919	960919	960919	**Soil Quality**
Time	14:30	15:30	15:35	13:30	14:30	17:00	**Benchmark**
Moisture %	87.2	24.8	26.5	9.8	24.8	12.6	**(Residential/ Parkland**
Non-halogenated Volatiles							
Benzene	-	-	-	-		-	0.5
Ethylbenzene	-	-	-	-		-	5
Toluene	-	-	-	-		-	3
meta- & para-Xylene	-	-	-	-		-	5
ortho-Xylene	-	-	-	-		-	
Light Hydrocarbons (C5-9)	-	-	-	-		-	
VPH	-	-	-	-		-	200
Extractables							
EPH (C10-18)	<250	<250	<250	<250	<250	<250	
EPH (C19-31)	<250	<250	<250	<250	<250	<250	
LEPH	-	-				-	1000
HEPH	-	-				-	1000
PAHs							
Acenaphthene	-	-				-	
Acenaphthylene	-	-				-	
Anthracene	-	-				-	
Benzo(a)anthracene	-	-				-	1
Benzo(a)pyrene	-	-				-	1
Benzo(b)fluoranthene	-	-				-	1
Benzo(g,h,i)perylene	-	-				-	
Benzo(k)fluoranthene	-	-				-	1
Chrysene	-	-				-	
Dibenz(a,h)anthracene	-	-				-	1
Fluoranthene	-	-				-	
Fluorene	-	-				-	
Indeno(1,2,3-c,d)pyrene	-	-				-	1
Naphthalene	-	-				-	5
Phenanthrene	-	-				-	5
Pyrene	-	-				-	10
Location	In muskeg among slag pile at the sawmill	Drainage below berm above historic milepost 855	Field duplicate of BD96-04	Outside edge of wood foundation north part of Pump Station	3 m from sawed off pole near foundation north part of the site	Small dump along west road near pump station	

All results are expressed as mg/kg (ppm)
< = Less than the detection limit indicated
VPH = Volatile Petroleum Hydrocarbon
EPH = Extractable Petroleum Hydrocarbon
LEPH & HEPH = Light & Heavy Extractable Petroleum Hydrocarbon
PAH = Polycyclic Aromatic Hydrocarbon

B.3.3 Polychlorinated Biphenyls (PCBs) and Organochlorine Pesticides Results for Canol Pump Station W (Big Devil)

Sample ID	**BD 96-06**	**BD96-07**	**BD96-08**	**BD96-10**	**CCME**
Date Collected	960914	960919	960919	960919	**Soil Quality**
Time	15:45	13:30	14:30	16:45	**Benchmark**
Moisture %	16.3	9.8	24.8	14.7	**(Residential/ Parkland**
Polychlorinated Biphenyls					
Total PCBs	0.16	<0.05	<0.05	<0.05	5
organochlorine Pesticides		-	-		
Aldrin	-	-	-	<0.001	-
alpha-BHC	-	-	-	<0.001	-
beta-BHC	-	-	-	<0.002	-
delta-BHC	-	-	-	<0.001	-
cis-Chlordane (alpha)	-			<0.001	-
trans-Chlordane (gamma)		-	-	<0.001	-
2,4'-DDD	-	-	-	<0.001	-
4,4'-DDD	-	-	-	<0.001	-
2,4'-DDE	-	-	-	<0.002	-
4,4'-DDE	-	-	-	<0.001	-
2,4'-DDT	-			<0.001	-
4,4'-DDT		-	-	<0.002	-
Dieldrin	-	-	-	<0.001	-
Endosulfan I	-	-	-	<0.001	-
Endosulfan II	-	-	-	<0.001	-
Endosulfan Sulfate	-	-	-	<0.001	-
Endrin	-	-	-	<0.005	-
Endrin Aldehyde		-	-	<0.001	-
Heptachlor	-	-	-	<0.002	-
Heptachlor Epoxide	-	-	-	<0.001	-
Lindane (gamma - BHC)	-	-	-	<0.001	-
Methoxychlor	-	-	-	<0.005	-
Mirex	-			<0.001	-
cis-Nonachlor		-	-	<0.001	-
trans-Nonachlor	-	-	-	<0.001	-
Oxychlordane	-	-	-	<0.001	-
Toxaphene	-	-	-	<0.030	-
Location	Near centre of old foundation at the top of bank, north of historic milepost	Outside edge of wood foundation on the north part of Big Devil Pump Station	3 m from sawed off pole near foundation, north part of the site	Drainage path at the toe of large worked area at the Pump Station	

Notes
All results are expressed as mg/kg (ppm)
< = Less than the detection limit indicated

B.4 MARSH LAKE CAMP SOIL SAMPLES

B.4.1 Inorganic Elements Results for Marsh Lake Camp

Sample ID	**ML 96-02**	**ML 96-03**	**ML 96-05**	**ML 96-09**	**ML 96-10**	**CCME or BC**
Date Collected	960914	960914	960914	960914	960914	**Soil Quality**
Time	10:30	11:10	11:30	13:00	13:40	**Benchmark**
Moisture %	5.2	10	38.5	15.4	7.7	**(Residential/ Parkland**
Aluminum (Al)	16500	15700	20500	6140	18100	
Antimony (Sb)	<20	<20	369	<20	<20	20
Arsenic (As)	4.08	0.63	5.85	1.59	1.83	30
Barium (Ba)	245	341	741	385	270	500
Beryllium (Be)	0.5	<0.5	<0.5	<0.5	0.5	4
Bismuth (Bi)	14	20	32	14	16	
Cadmium (Cd)	<2	<2	21	<2	<2	5
Calcium (Ca)	21700	33700	47400	18400	19600	
Chromium (Cr)	65	71	75	56	76	250
Cobalt (Co)	10	10	8	5	9	50
Copper (Cu)	30	30	10800	64	73	100
Iron (Fe)	23700	20100	35500	7960	23600	
Lead (Pb)	<50	<50	1200	<50	53	400
Lithium (Li)	10	11	7	4	12	
Magnesium (Mg)	10500	13400	9640	5680	12200	
Manganese (Mn)	394	420	303	572	320	
Mercury (Hg)	0.074	0.054	0.054	0.062	0.086	2
Molybdenum (Mo)	<4	<4	<4	<4	<4	10
Nickel (Ni)	50	57	65	33	52	100
Phosphorus (P)	346	179	1940	1140	615	
Potassium (K)	1340	1670	2350	2000	2180	
Selenium (Se)	<0.1	<0.1	0.4	0.5	<0.1	3
Silver (Ag)	<2	<2	<2	<2	4	20
Sodium (Na)	448	466	1280	681	467	
Tin (Sn)	<10	<10	65	<10	15	50
Titanium (Ti)	684	404	639	462	416	
Vanadium (V)	62	57	38	23	62	200
Zinc (Zn)	42	47	46700	315	425	500
Location	30 cm in Test Pit 3 at old dump near Marsh lake	1.5 m depth in Test Pit 6 near partially buried water pipe	Surface sample in Test Pit 8 at stain east of garage foundation	Toe of dump, near lake and 6 m south of Test Pit	In wood lined collection sump halfway between clearing and lake	

Notes
All results are expressed as mg/kg (ppm)
< = Less than the detection limit indicated

B.4.2 Hydrocarbon Results for Marsh Lake Camp

Sample ID	**ML96-02**	**ML96-03**	**ML96-04**	**ML96-05**	**ML96-06**	**ML96-07**	**CCME or BC**
Date Collected	960914	960914	960914	960914	960914	960914	**Soil Quality**
Time	10:30	11:10	11:20	11:30	11:40	12:20	**Benchmark**
Moisture %	5.2	10	20	38.5	13.8	16.6	**(Residential/ Parkland**
Non-halogenated Volatiles							
Benzene	-	-	-	-	-	<0.05	0.5
Ethylbenzene	-	-	-	-	-	<0.05	5
Toluene	-	-	-	-	-	<0.05	3
meta- & para-Xylene	-	-	-	-	-	<0.1	5
ortho-Xylene	-	-	-	-	-	<0.05	
Light Hydrocarbons (C5-9)	-	-	-	-	-	-	
VPH	-	-	-	-	-	<10	200
Extractables							
EPH (C10-18)	<250	<250	<250	<250	<250	<250	
EPH (C19-31)	<250	<250	<250	10500	<250	18100	
LEPH	<250	-	-	<250	-	<250	1000
HEPH	<250	-	-	10500	-	18100	1000
PAHs							
Acenaphthene	<0.01	-	-	0.02	-	0.03	
Acenaphthylene	<0.01	-	-	0.05	-	0.13	
Anthracene	<0.01	-	-	0.04	-	0.11	
Benzo(a)anthracene	<0.01	-	-	0.07	-	0.15	1
Benzo(a)pyrene	<0.01	-	-	0.17	-	0.55	1
Benzo(b)fluoranthene	<0.01	-	-	0.19	-	0.42	1
Benzo(g,h,i)perylene	<0.01	-	-	0.27	-	0.53	
Benzo(k)fluoranthene	<0.01	-	-	0.04	-	0.07	1
Chrysene	<0.01	-	-	0.27	-	0.3	
Dibenz(a,h)anthracene	<0.01	-	-	<0.01	-	<0.01	1
Fluoranthene	<0.01	-	-	0.17	-	0.26	
Fluorene	<0.01	-	-	0.03	-	0.08	
Indeno(1,2,3-c,d)pyrene	<0.01	-	-	0.12	-	0.29	1
Naphthalene	<0.01	-	-	0.94	-	0.36	5
Phenanthrene	<0.01	-	-	0.27	-	0.34	5
Pyrene	<0.01	-	-	0.44	-	1.79	10
Location	30 cm in Test Pit 3 at old dump near Marsh lake	1.5 m depth in Test Pit 6 near partially buried water pipe	1.5 m depth in Test Pit 7 west of garage foundation	Surface sample in Test Pit 8 at stain east of garage foundation	1.0 m depth in Test Pit 8	50 cm depth in oil collection pit on garage foundation	

All results are expressed as mg/kg (ppm)
< = Less than the detection limit indicated
VPH = Volatile Petroleum Hydrocarbon
EPH = Extractable Petroleum Hydrocarbon
LEPH & HEPH = Light & Heavy Extractable Petroleum Hydrocarbon
PAH = Polycyclic Aromatic Hydrocarbon

B.4.3 Polychlorinated Biphenyls (PCBs) and Organochlorine Pesticides Results for Results for Marsh Lake Camp

Sample ID	ML 96-01	ML 96-02	ML 96-07	ML 96-08	ML 96-10	CCME
Date Collected	960914	960914	960914	960914	960914	**Soil Quality**
Time	10:00	10:30	12:20	12:25	13:40	**Benchmark**
Moisture %	3.7	5.2	16.6	17.4	7.7	**(Residential/ Parkland**
Polychlorinated Biphenyls						
Total PCBs	<0.05	<0.05	<0.2	<0.05	<0.05	5
Organochlorine Pesticides						
Aldrin	<0.001	<0.001	-	-	<0.001	-
alpha-BHC	<0.001	<0.001	-	-	<0.001	-
beta-BHC	<0.002	<0.002	-	-	<0.002	-
delta-BHC	<0.001	<0.001	-	-	<0.001	-
cis-Chlordane (alpha)	<0.001	<0.001	-	-	<0.03	-
trans-Chlordane (gamma)	<0.001	<0.001	-	-	<0.03	-
2,4'-DDD	<0.001	<0.001	-	-	0.134	-
4,4'-DDD	<0.001	<0.001	-	-	0.529	-
2,4'-DDE	<0.002	<0.002	-	-	0.005	-
4,4'-DDE	0.02	<0.001	-	-	0.097	-
2,4'-DDT	0.013	<0.001	-	-	0.168	-
4,4'-DDT	0.024	<0.002	-	-	0.357	-
Dieldrin	<0.001	<0.001	-	-	<0.003	-
Endosulfan I	<0.001	<0.001	-	-	<0.001	-
Endosulfan II	<0.001	<0.001	-	-	<0.001	-
Endosulfan Sulfate	<0.001	<0.001	-	-	<0.001	-
Endrin	<0.005	<0.005	-	-	<0.005	-
Endrin Aldehyde	<0.001	<0.001	-	-	<0.001	-
Heptachlor	<0.002	<0.002	-	-	<0.002	-
Heptachlor Epoxide	<0.001	<0.001	-	-	<0.001	-
Lindane (gamma - BHC)	<0.001	<0.001	-	-	<0.001	-
Methoxychlor	<0.005	<0.005	-	-	<0.02	-
Mirex	<0.001	<0.001	-	-	<0.001	-
cis-Nonachlor	<0.001	<0.001	-	-	<0.01	-
trans-Nonachlor	<0.001	<0.001	-	-	<0.03	-
Oxychlordane	<0.001	<0.001	-	-	<0.001	-
Toxaphene	<0.030	<0.030	-	-	<0.030	-
Locations	In Test Pit 2 at a septic pit, where a pipe enters the pit	30 cm in Test Pit 3 at old dump near Marsh lake	50 cm depth in oil collection pit on garage foundation	Field duplicate of ML96-07	In wood lined collection sump halfway between clearing and lake	

Notes
All results are expressed as mg/kg (ppm)
< = Less than the detection limit indicated

APPENDIX C:
HYDROCARBON DISTRIBUTION REPORTS

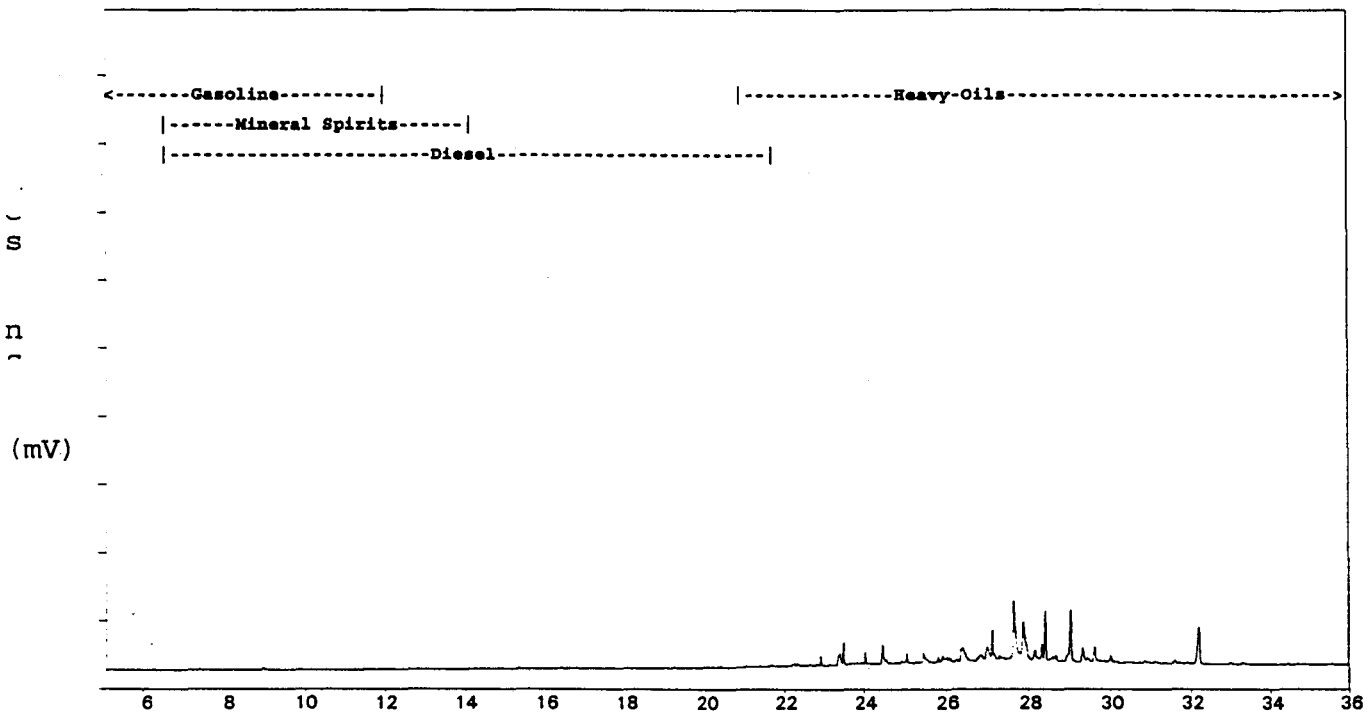
HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: JC 96-1

Sample acquired: SEP 22, 1996 17:40:20

File Name: c:\TEH\TEHSEP22.07R , Sample Name: G5130 1

Sequence file: TEHSEP22



<C9-----C10----------C20----------C30---------->

ASL Sample ID: G5130 1* 8.0Dilution

HYDROCARBON RANGE (C#)		RELATIVE AMOUNT (%)
Less than Carbon 10	(<C10)	0.1
Carbon 10 to Carbon 20	(C10-C20)	2.1
Carbon 20 to Carbon 30	(C20-C30)	26.9
Greater than Carbon 30	(>C30)	71.2

The Hydrocarbon Distribution Report is intended to assist you in characterizing the hydrocarbon product present in a given sample. The scale at the top of the chromatographic trace represents the hydrocarbon range of common petroleum products. Comparison of this report with those of reference standards may also assist you in the identification of the hydrocarbon product detected in your sample. The second part of the report is a table that expresses the relative amount of hydrocarbon product present in the ranges specified.

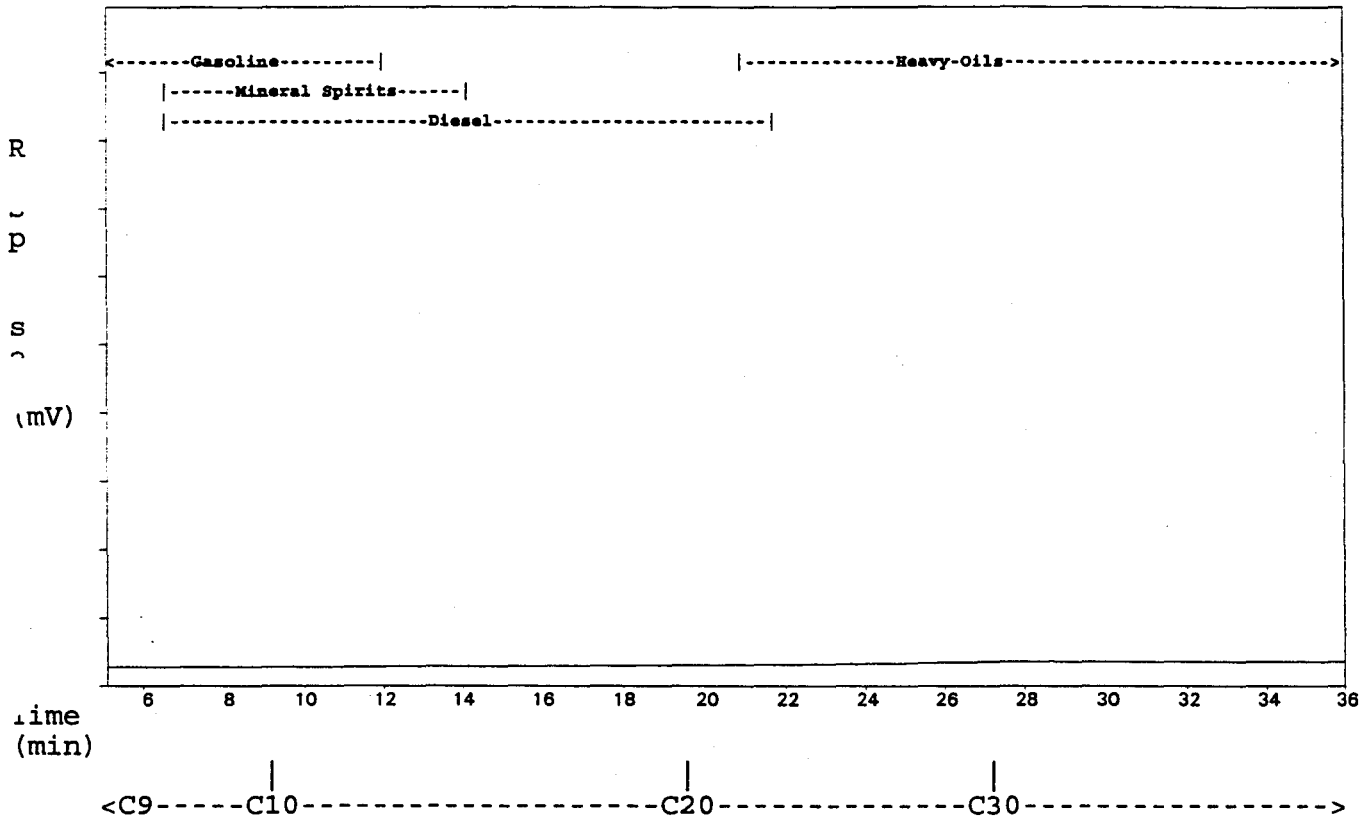
HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: JC 96-10

Sample acquired: SEP 22, 1996 18:27:37

File Name: c:\TEH\TEHSEP22.09R , Sample Name: G5130 10

Sequence file: TEHSEP22



ASL Sample ID: G5130 10* 8.0Dilution

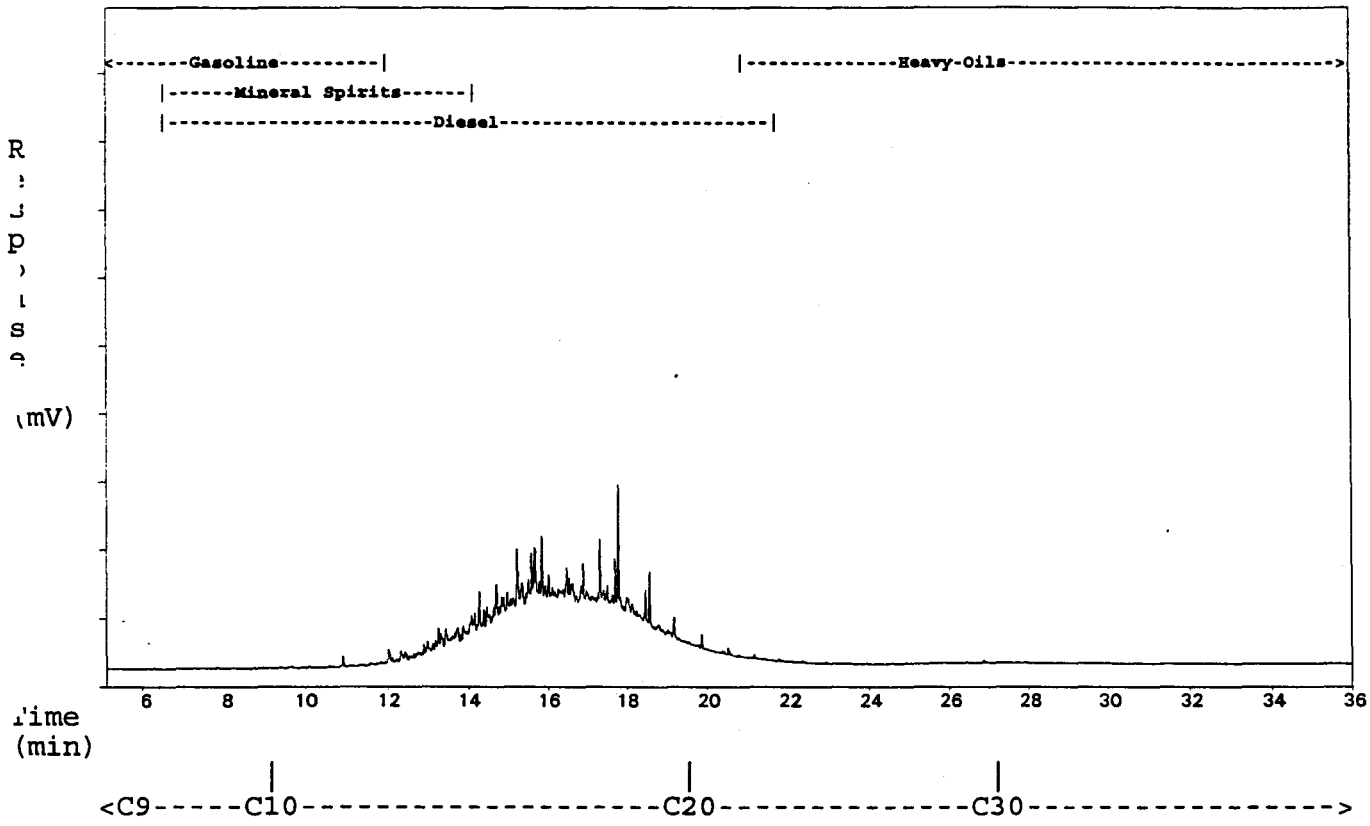
HYDROCARBON RANGE (C#)		RELATIVE AMOUNT (%)
Less than Carbon 10	(<C10)	0.0
Carbon 10 to Carbon 20	(C10-C20)	0.2
Carbon 20 to Carbon 30	(C20-C30)	42.3
Greater than Carbon 30	(>C30)	57.7

The Hydrocarbon Distribution Report is intended to assist you in characterizing the hydrocarbon product present in a given sample. The scale at the top of the chromatographic trace represents the hydrocarbon range of common petroleum products. Comparison of this report with those of reference standards may also assist you in the identification of the hydrocarbon product detected in your sample. The second part of the report is a table that expresses the relative amount of hydrocarbon product present in the ranges specified.

HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: JC 96-11

Sample acquired: SEP 22, 1996 18:27:37
File Name: c:\TEH\TEHSEP22.10R , Sample Name: G5130 11
Sequence file: TEHSEP22



ASL Sample ID: G5130 11* 8.0Dilution

HYDROCARBON RANGE (C#)		RELATIVE AMOUNT (%)
Less than Carbon 10	(<C10)	0.2
Carbon 10 to Carbon 20	(C10-C20)	96.4
Carbon 20 to Carbon 30	(C20-C30)	2.9
Greater than Carbon 30	(>C30)	0.6

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 amount of hydrocarbon product present in the ranges specified.

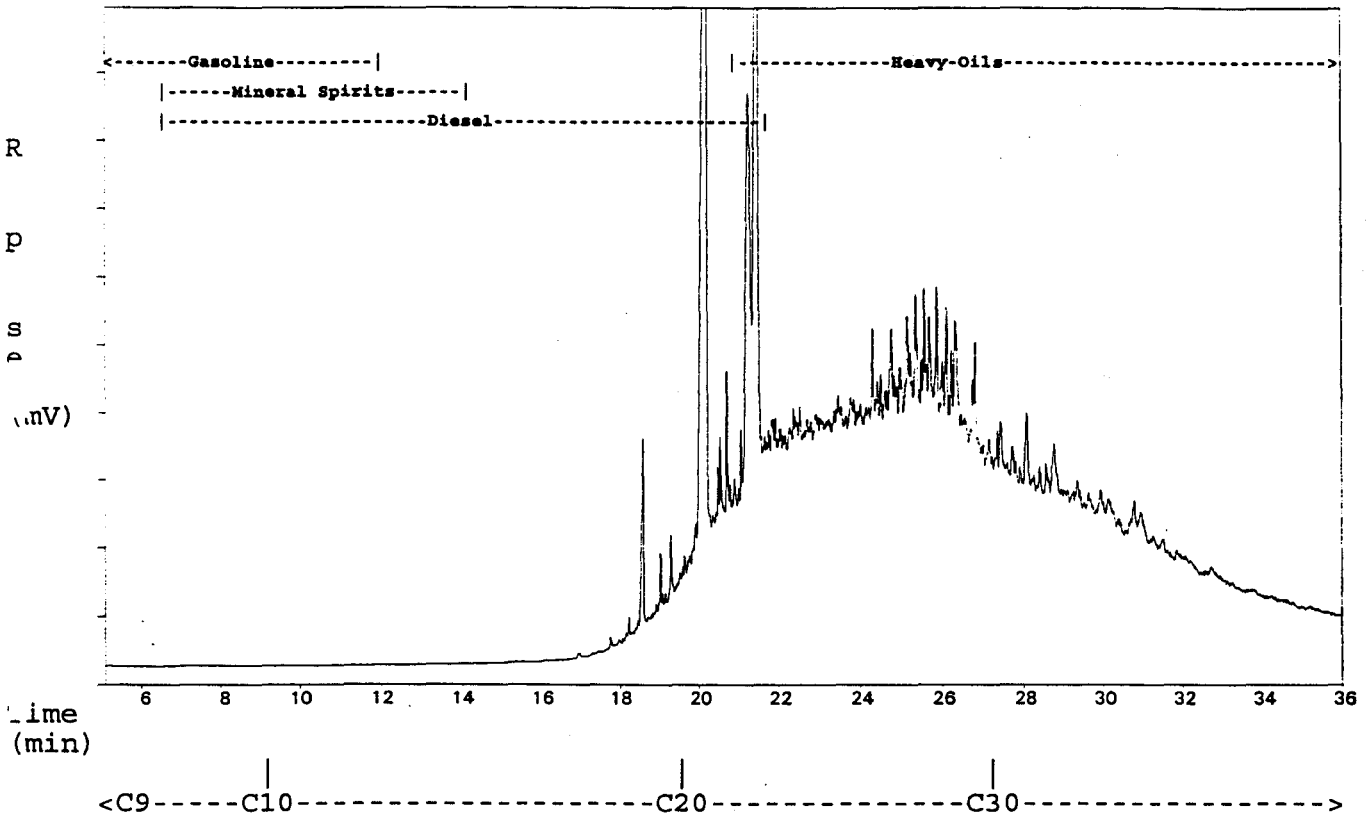
HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: **JC 96-12**

Sample acquired: SEP 23, 1996 14:58:44

File Name: c:\TEH\TEHSEP23.09R , Sample Name: G5130 12#RX5

Sequence file: TEHSEP23



ASL Sample ID: G5130 12#RX5* 40.0Dilution

HYDROCARBON RANGE (C#)		RELATIVE AMOUNT (%)
Less than Carbon 10	(<C10)	0.0
Carbon 10 to Carbon 20	(C10-C20)	12.2
Carbon 20 to Carbon 30	(C20-C30)	53.2
Greater than Carbon 30	(>C30)	34.6

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 amount of hydrocarbon product present in the ranges specified.

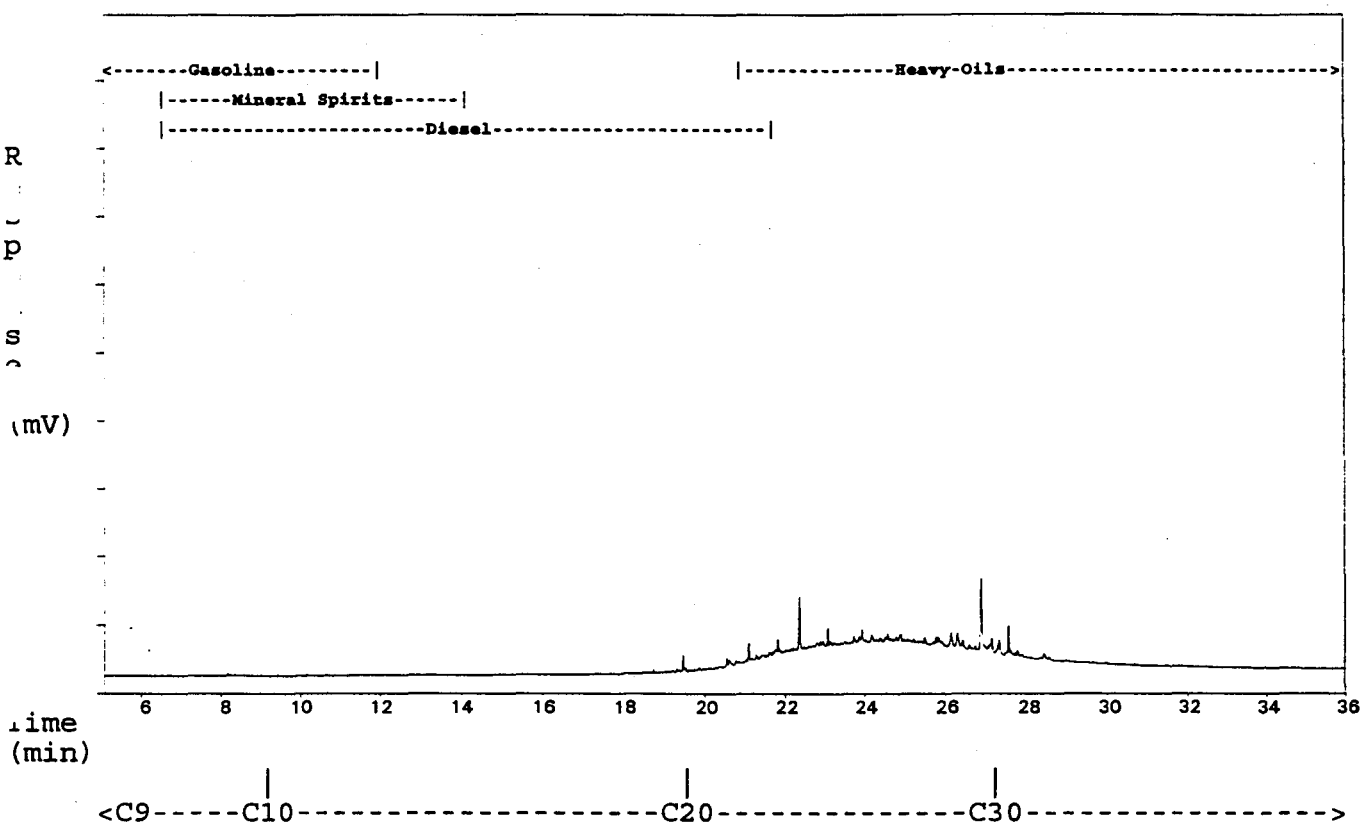
HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: JC 96-13

Sample acquired: SEP 22, 1996 19:14:55

File Name: c:\TEH\TEHSEP22.12R , Sample Name: G5130 13

Sequence file: TEHSEP22



ASL Sample ID: G5130 13* 8.0Dilution

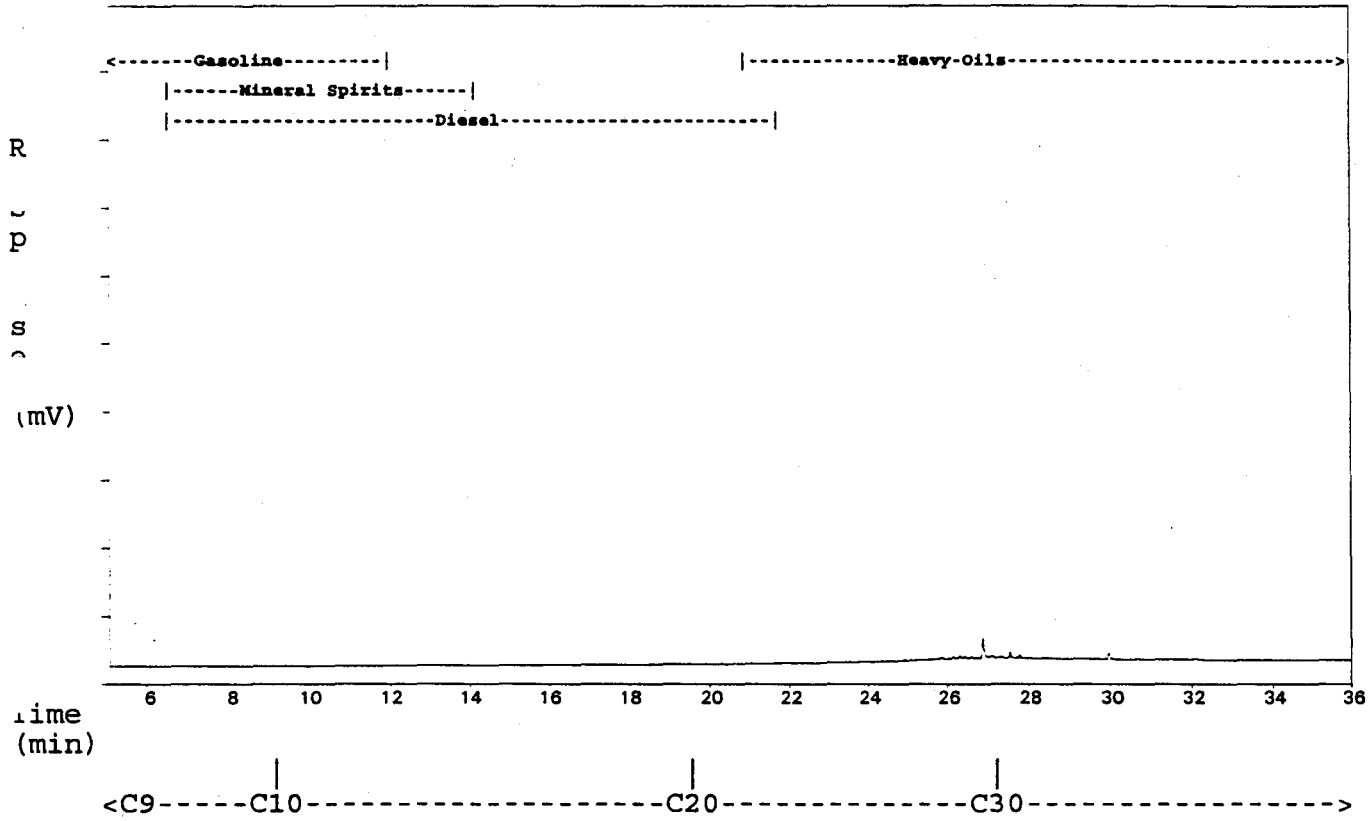
HYDROCARBON RANGE (C#)		RELATIVE AMOUNT (%)
Less than Carbon 10	(<C10)	0.1
Carbon 10 to Carbon 20	(C10-C20)	3.3
Carbon 20 to Carbon 30	(C20-C30)	69.4
Greater than Carbon 30	(>C30)	27.4

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 amount of hydrocarbon product present in the ranges specified.

HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: JC 96-15

Sample acquired: SEP 22, 1996 20:02:03
File Name: c:\TEH\TEHSEP22.14R , Sample Name: G5130 15
Sequence file: TEHSEP22



ASL Sample ID: G5130 15* 8.0Dilution

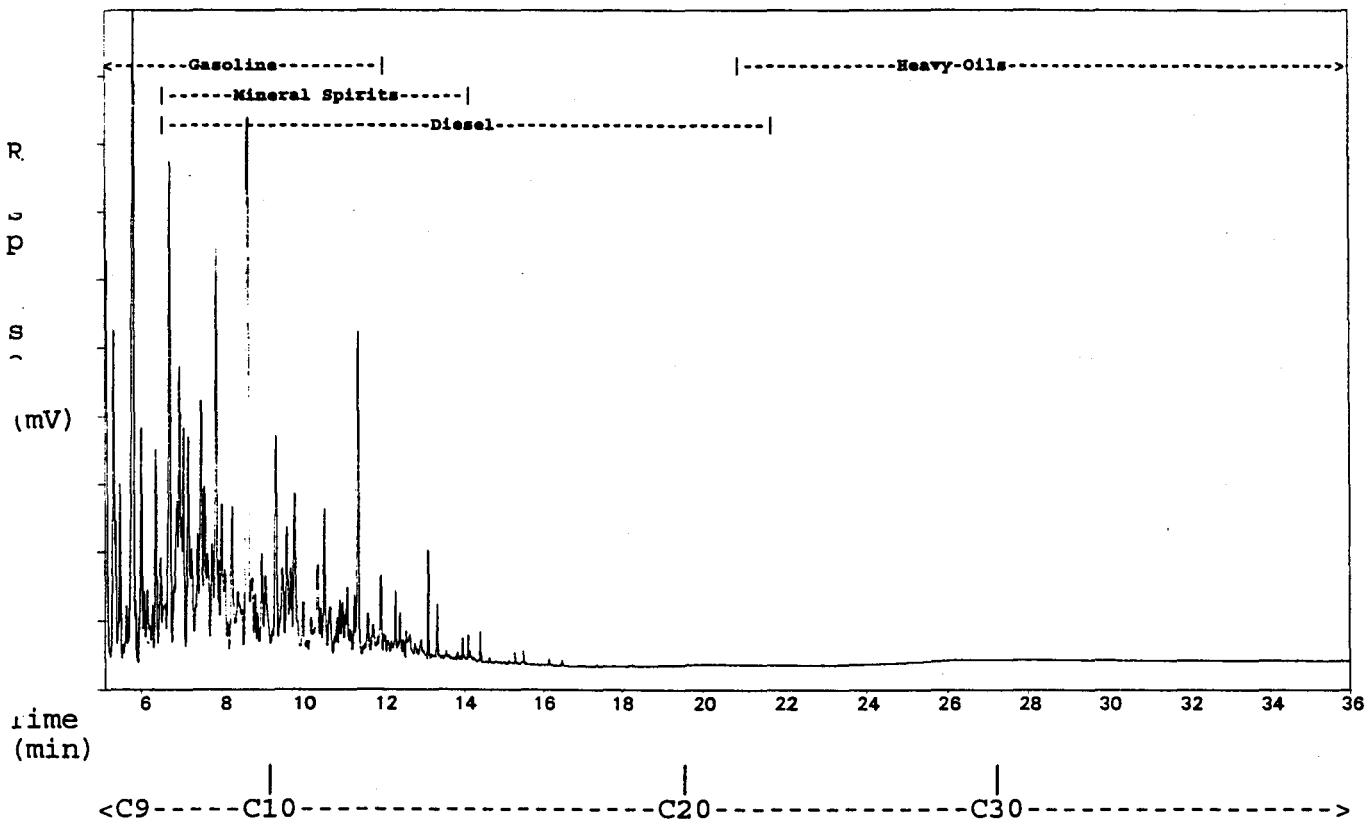
HYDROCARBON RANGE (C#)		RELATIVE AMOUNT (%)
Less than Carbon 10	(<C10)	0.1
Carbon 10 to Carbon 20	(C10-C20)	0.4
Carbon 20 to Carbon 30	(C20-C30)	27.5
Greater than Carbon 30	(>C30)	72.4

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 amount of hydrocarbon product present in the ranges specified.

HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: JC 96-17

Sample acquired: SEP 22, 1996 20:48:59
File Name: c:\TEH\TEHSEP22.15R , Sample Name: G5130 17
Sequence file: TEHSEP22



ASL Sample ID: G5130 17* 8.0Dilution

HYDROCARBON RANGE (C#)		RELATIVE AMOUNT (%)
Less than Carbon 10	(<C10)	72.7
Carbon 10 to Carbon 20	(C10-C20)	26.2
Carbon 20 to Carbon 30	(C20-C30)	0.5
Greater than Carbon 30	(>C30)	0.6

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 amount of hydrocarbon product present in the ranges specified.

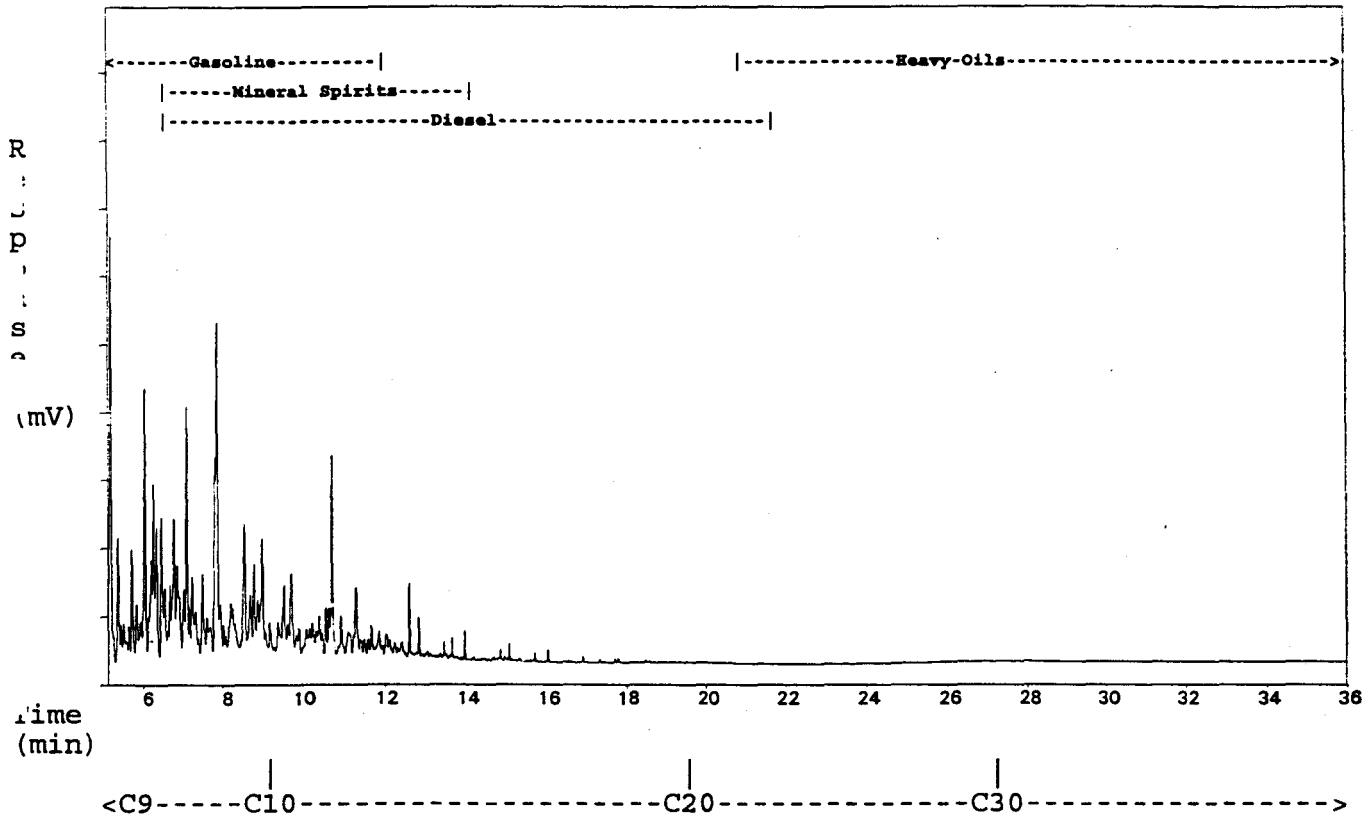
HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: **JC 96-18**

Sample acquired: SEP 22, 1996 20:48:59

File Name: c:\TEH\TEHSEP22.16R , Sample Name: G5130 18

Sequence file: TEHSEP22



ASL Sample ID: G5130 18* 8.0Dilution

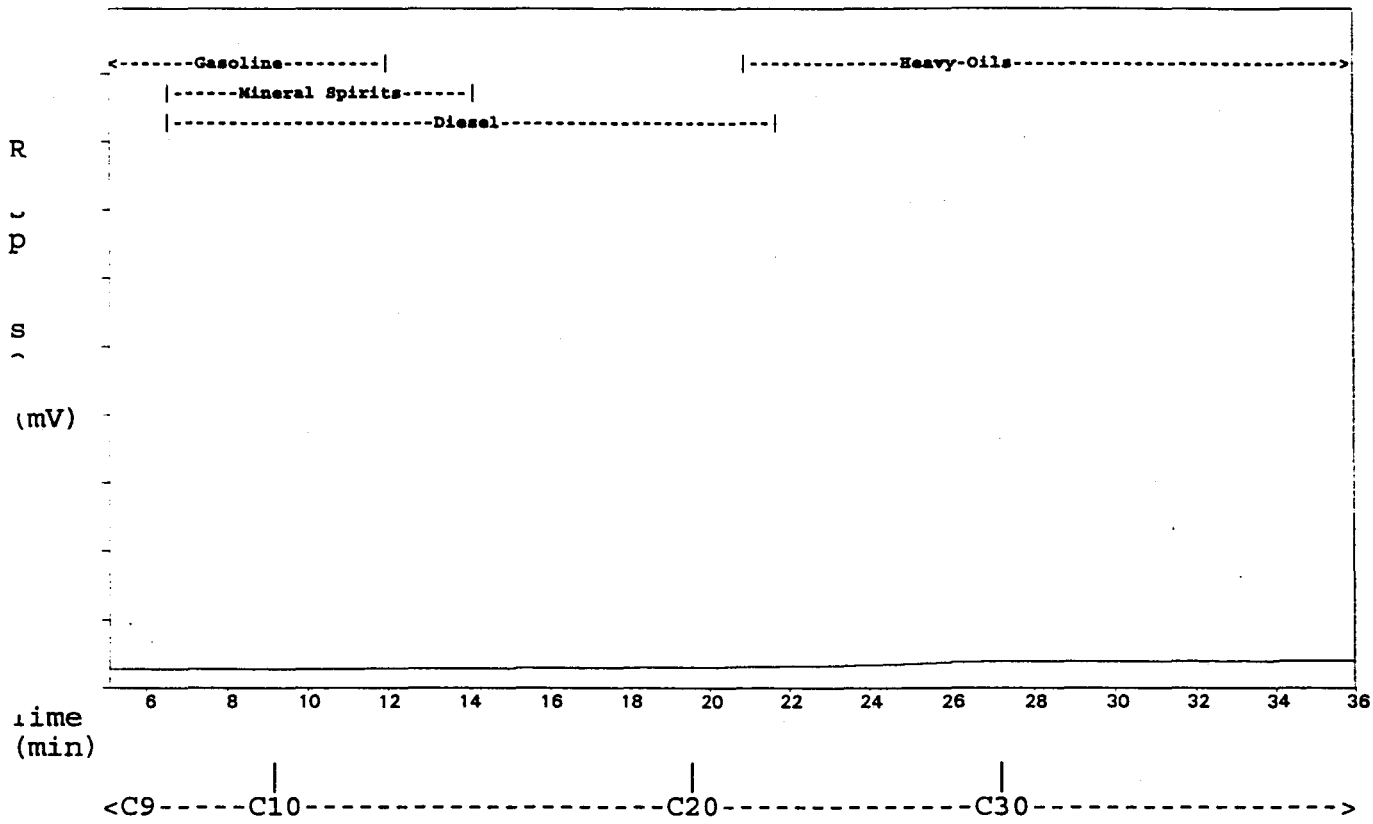
HYDROCARBON RANGE (C#)		RELATIVE AMOUNT (%)
Less than Carbon 10	(<C10)	68.3
Carbon 10 to Carbon 20	(C10-C20)	31.2
Carbon 20 to Carbon 30	(C20-C30)	0.2
Greater than Carbon 30	(>C30)	0.3

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 amount of hydrocarbon product present in the ranges specified.

HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: JC 96-19

Sample acquired: SEP 22, 1996 21:35:47
File Name: c:\TEH\TEHSEP22.17R , Sample Name: G5130 19
Sequence file: TEHSEP22



ASL Sample ID: G5130 19* 8.0Dilution

HYDROCARBON RANGE (C#)		RELATIVE AMOUNT (%)
Less than Carbon 10	(<C10)	0.0
Carbon 10 to Carbon 20	(C10-C20)	0.0
Carbon 20 to Carbon 30	(C20-C30)	0.0
Greater than Carbon 30	(>C30)	100.0

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 amount of hydrocarbon product present in the ranges specified.

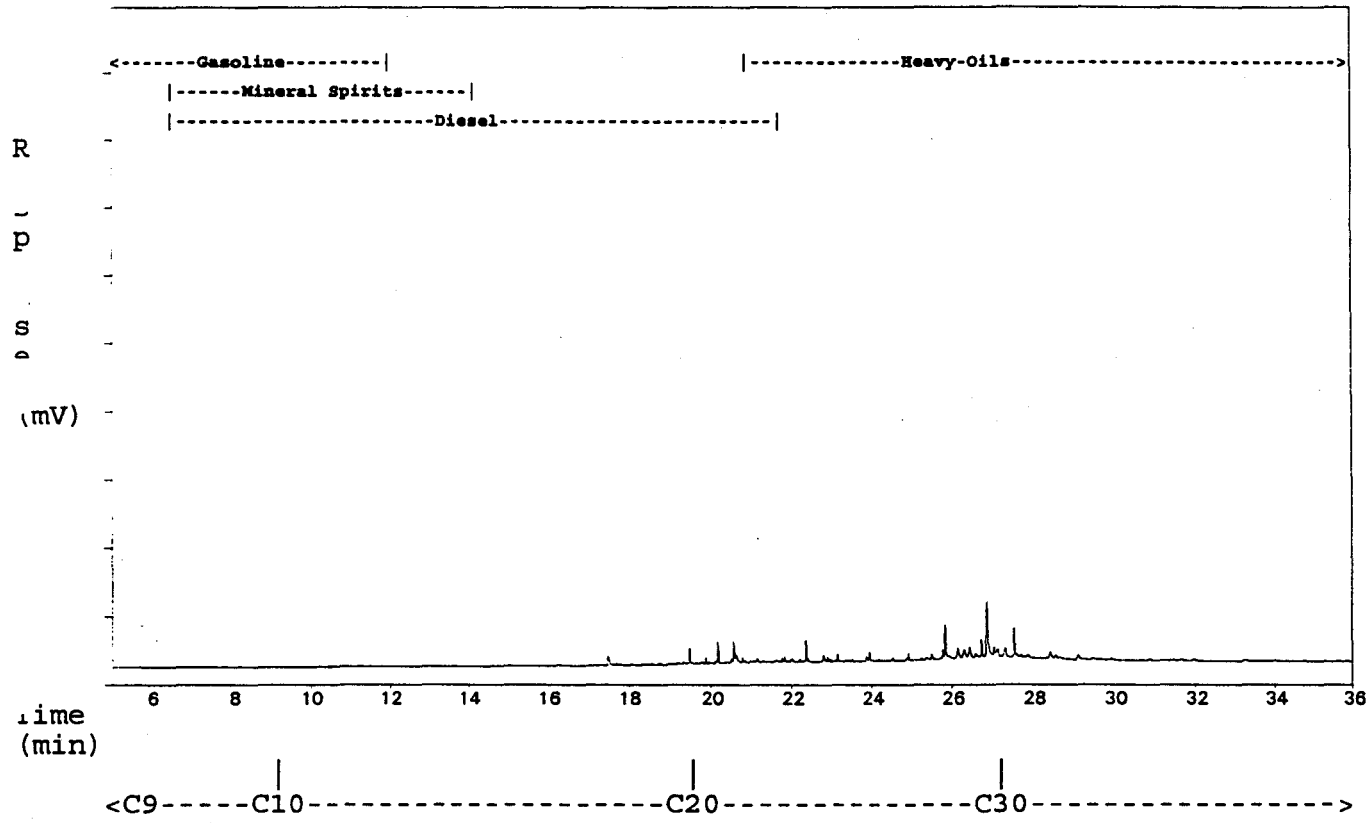
HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: JC 96-20

Sample acquired: SEP 22, 1996 21:35:47

File Name: c:\TEH\TEHSEP22.18R , Sample Name: G5130 20

Sequence file: TEHSEP22



ASL Sample ID: G5130 20* 8.0Dilution

HYDROCARBON RANGE (C#)		RELATIVE AMOUNT (%)
Less than Carbon 10	(<C10)	0.1
Carbon 10 to Carbon 20	(C10-C20)	9.8
Carbon 20 to Carbon 30	(C20-C30)	39.6
Greater than Carbon 30	(>C30)	50.8

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 amount of hydrocarbon product present in the ranges specified.

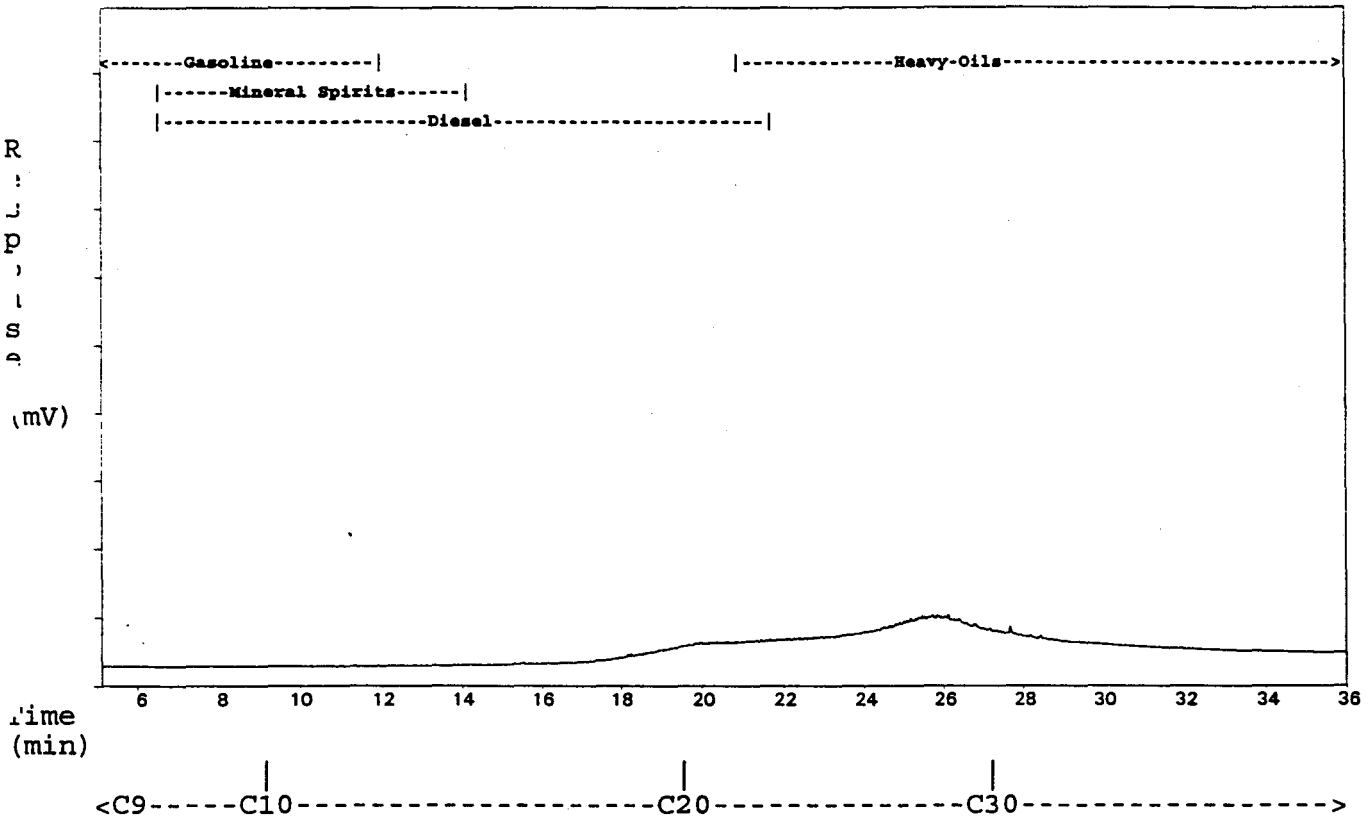
HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: JC 96-21

Sample acquired: SEP 22, 1996 22:22:34

File Name: c:\TEH\TEHSEP22.19R , Sample Name: G5130 21

Sequence file: TEHSEP22



ASL Sample ID: G5130 21* 8.0Dilution

HYDROCARBON RANGE (C#)		RELATIVE AMOUNT (%)
Less than Carbon 10	(<C10)	0.2
Carbon 10 to Carbon 20	(C10-C20)	14.1
Carbon 20 to Carbon 30	(C20-C30)	52.3
Greater than Carbon 30	(>C30)	33.6

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 amount of hydrocarbon product present in the ranges specified.

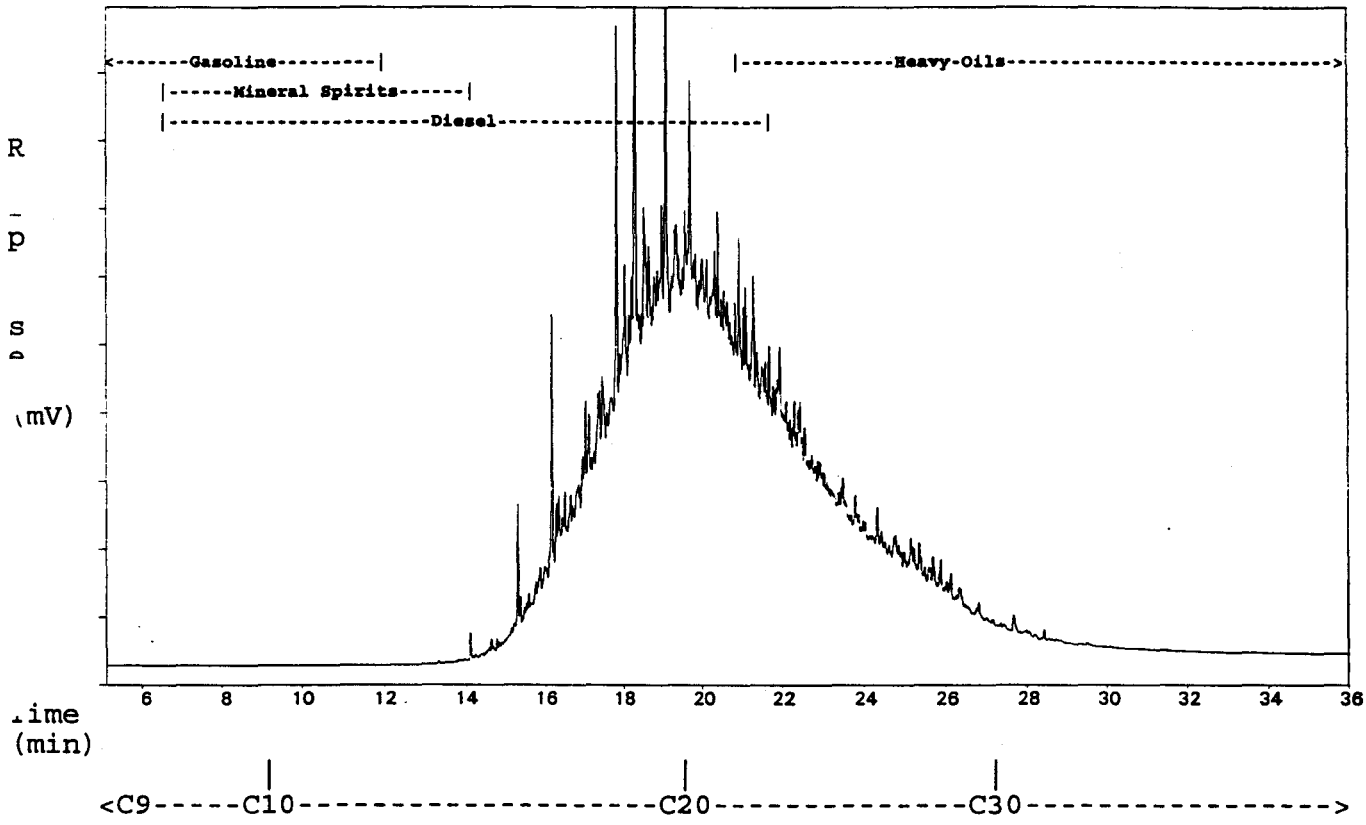
HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: JC 96-23

Sample acquired: SEP 22, 1996 23:09:34

File Name: c:\TEH\TEHSEP22.21R , Sample Name: G5130 23

Sequence file: TEHSEP22



ASL Sample ID: G5130 23* 8.0Dilution

HYDROCARBON RANGE (C#)		RELATIVE AMOUNT (%)
Less than Carbon 10	(<C10)	0.0
Carbon 10 to Carbon 20	(C10-C20)	55.9
Carbon 20 to Carbon 30	(C20-C30)	40.2
Greater than Carbon 30	(>C30)	3.8

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 amount of hydrocarbon product present in the ranges specified.

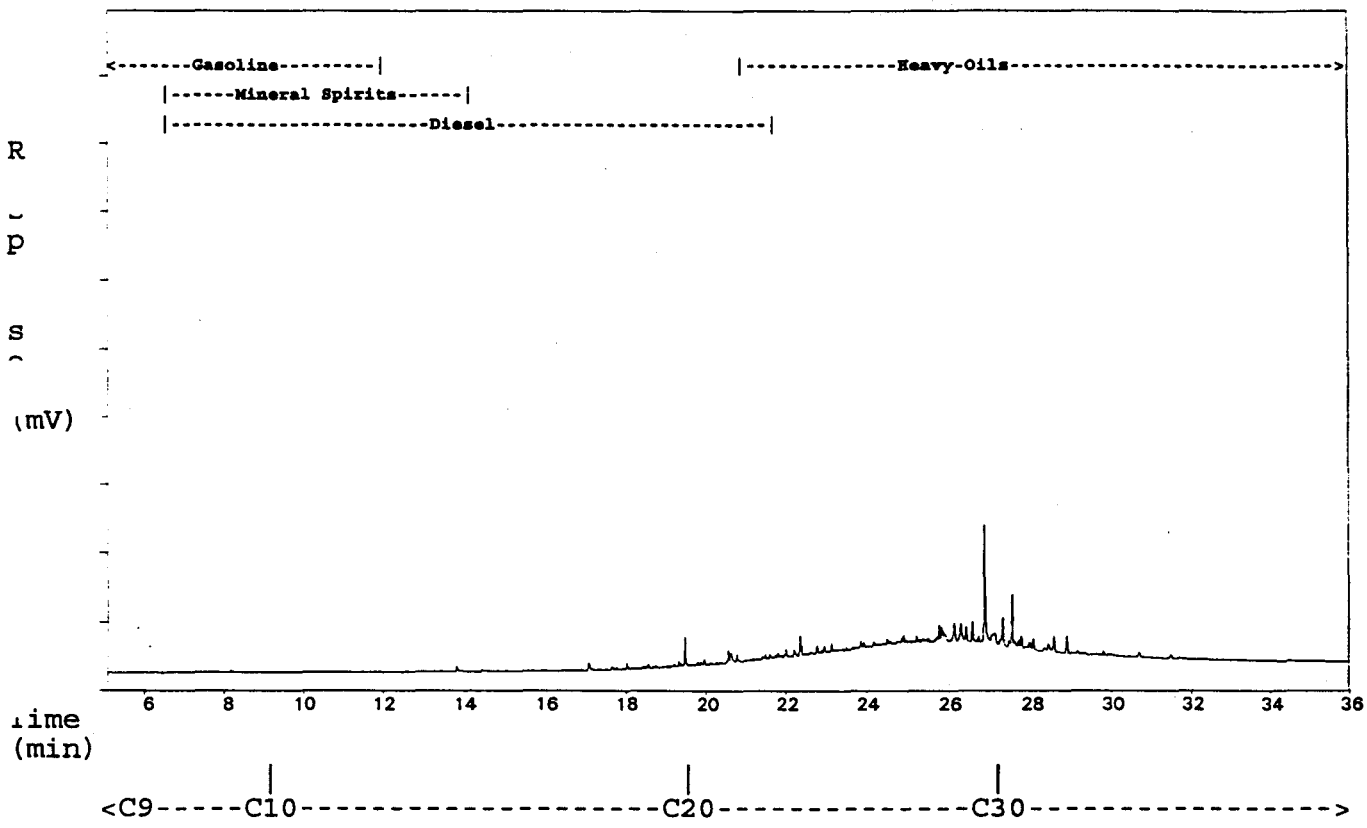
HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: JC 96-24

Sample acquired: SEP 22, 1996 23:09:34

File Name: c:\TEH\TEHSEP22.22R , Sample Name: G5130 24

Sequence file: TEHSEP22



ASL Sample ID: G5130 24* 8.0Dilution

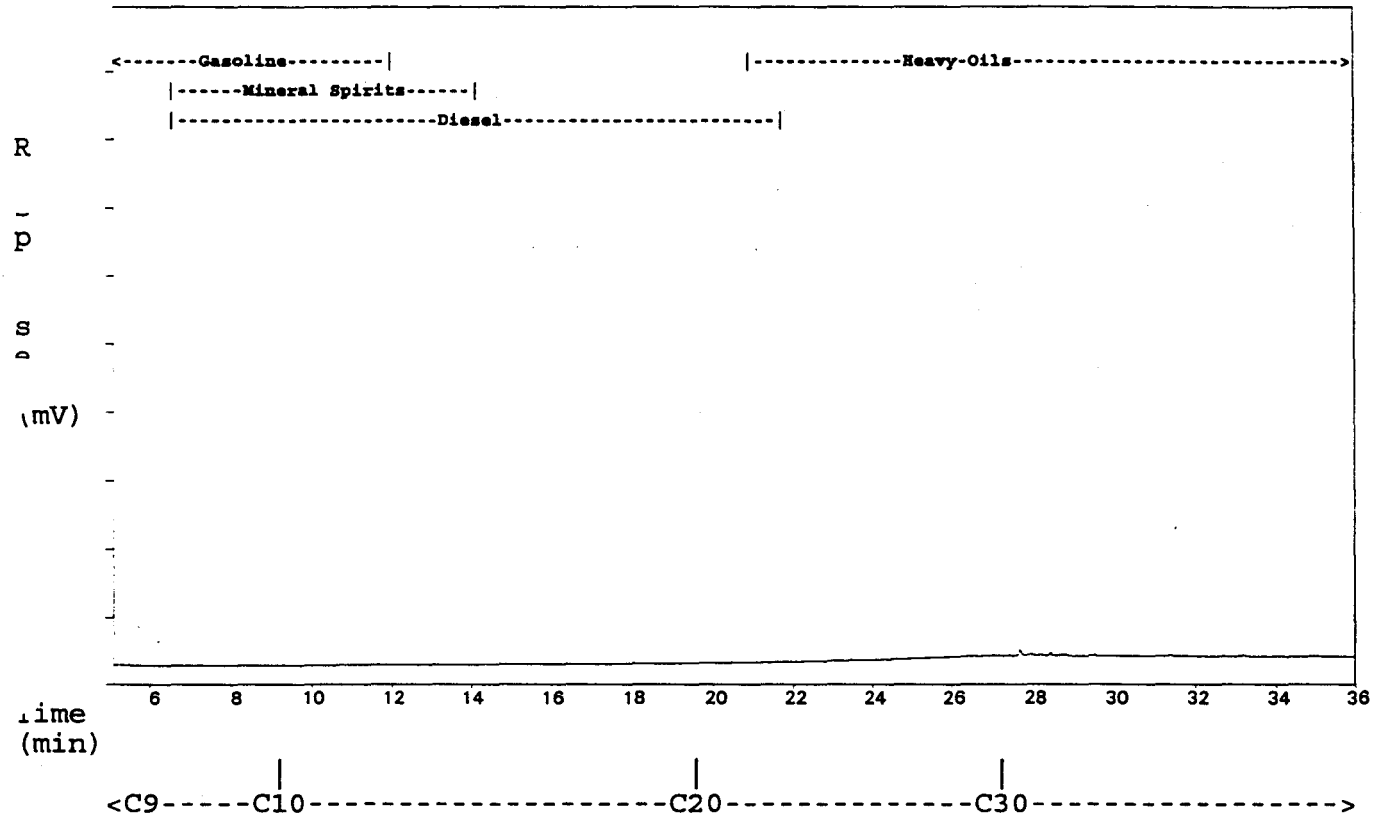
HYDROCARBON RANGE (C#)		RELATIVE AMOUNT (%)
Less than Carbon 10	(<C10)	0.2
Carbon 10 to Carbon 20	(C10-C20)	6.4
Carbon 20 to Carbon 30	(C20-C30)	52.2
Greater than Carbon 30	(>C30)	41.4

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 amount of hydrocarbon product present in the ranges specified.

HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: JC 96-26

Sample acquired: SEP 22, 1996 23:56:26
File Name: c:\TEH\TEHSEP22.23R , Sample Name: G5130 26
Sequence file: TEHSEP22



ASL Sample ID: G5130 26* 8.0Dilution

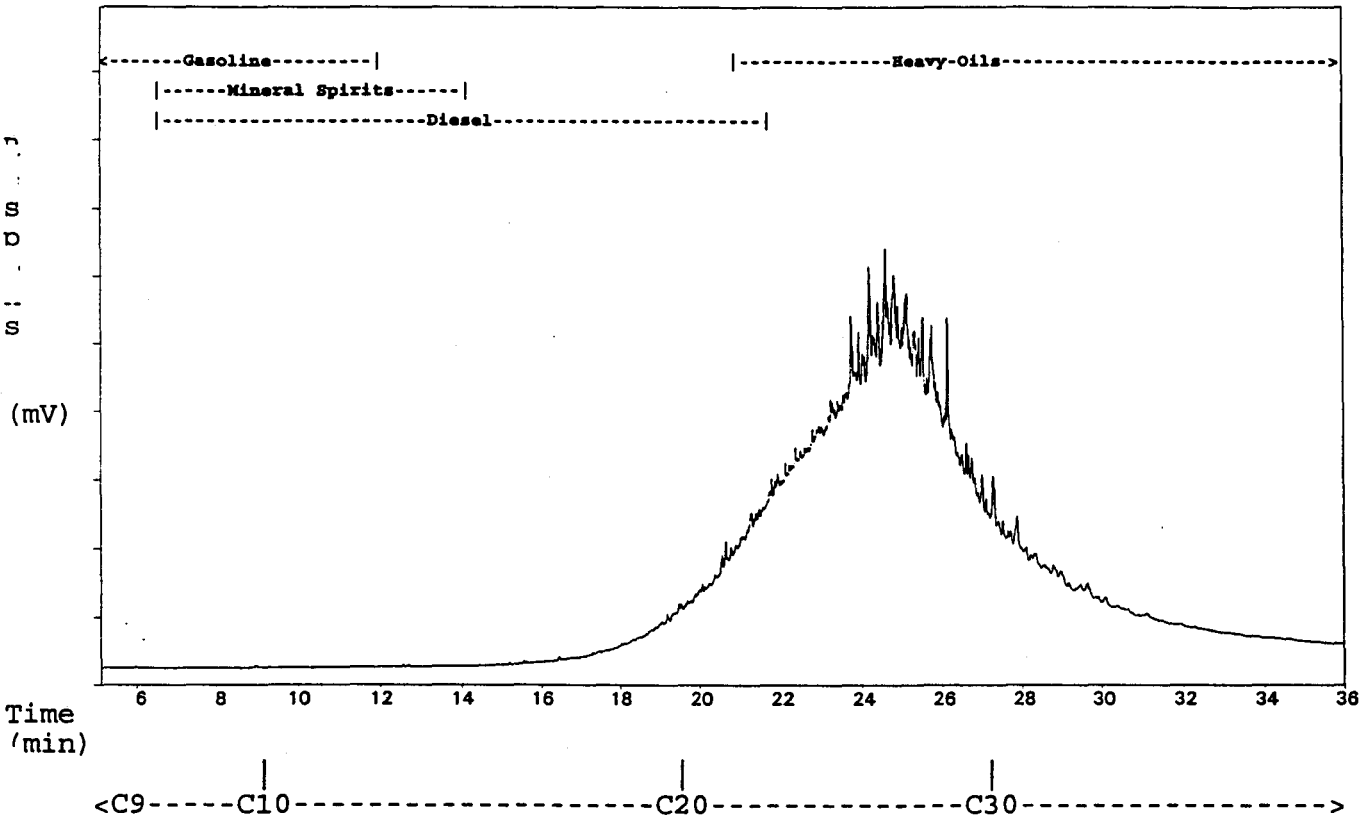
HYDROCARBON RANGE (C#)		RELATIVE AMOUNT (%)
Less than Carbon 10	(<C10)	0.0
Carbon 10 to Carbon 20	(C10-C20)	0.1
Carbon 20 to Carbon 30	(C20-C30)	27.3
Greater than Carbon 30	(>C30)	72.7

The Hydrocarbon Distribution Report is intended to assist you in characterizing the hydrocarbon product present in a given sample. The scale at the top of the chromatographic trace represents the hydrocarbon range of common petroleum products. Comparison of this report with those of reference standards may also assist you in the identification of the hydrocarbon product detected in your sample. The second part of the report is a table that expresses the relative amount of hydrocarbon product present in the ranges specified.

HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: **SQ 96-01**

Sample acquired: SEP 24, 1996 18:00:00
File Name: c:\TEH\TEHSEP24.16R , Sample Name: G5130 47#Rx5
Sequence file: TEHSEP24



ASL Sample ID: G5130 47#Rx5* 40.0Dilution

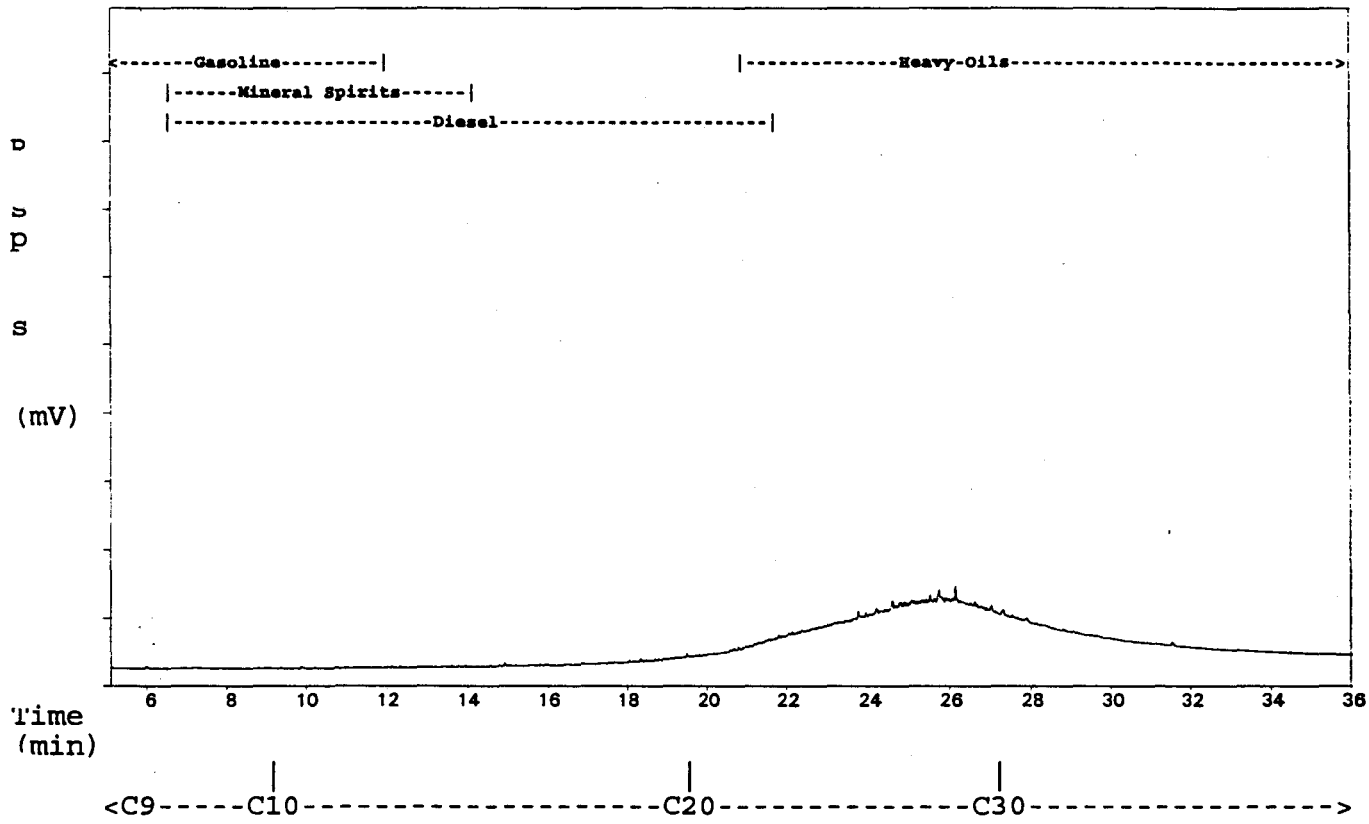
HYDROCARBON RANGE (C#)		RELATIVE AMOUNT (%)
Less than Carbon 10	(<C10)	0.1
Carbon 10 to Carbon 20	(C10-C20)	6.2
Carbon 20 to Carbon 30	(C20-C30)	67.6
Greater than Carbon 30	(>C30)	26.1

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 amount of hydrocarbon product present in the ranges specified.

HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: **SQ 96-02**

Sample acquired: SEP 23, 1996 04:36:00
File Name: c:\TEH\TEHSEP22.36R , Sample Name: G5130 48
Sequence file: TEHSEP22



ASL Sample ID: G5130 48* 8.0Dilution

HYDROCARBON RANGE (C#)		RELATIVE AMOUNT (%)
Less than Carbon 10	(<C10)	0.3
Carbon 10 to Carbon 20	(C10-C20)	4.8
Carbon 20 to Carbon 30	(C20-C30)	57.5
Greater than Carbon 30	(>C30)	37.5

The Hydrocarbon Distribution Report is intended to assist you in characterizing the hydrocarbon product present in a given sample. The scale at the top of the chromatographic trace represents the hydrocarbon range of common petroleum products. Comparison of this report with those of reference standards may also assist you in the identification of the hydrocarbon product detected in your sample. The second part of the report is a table that expresses the relative amount of hydrocarbon product present in the ranges specified.

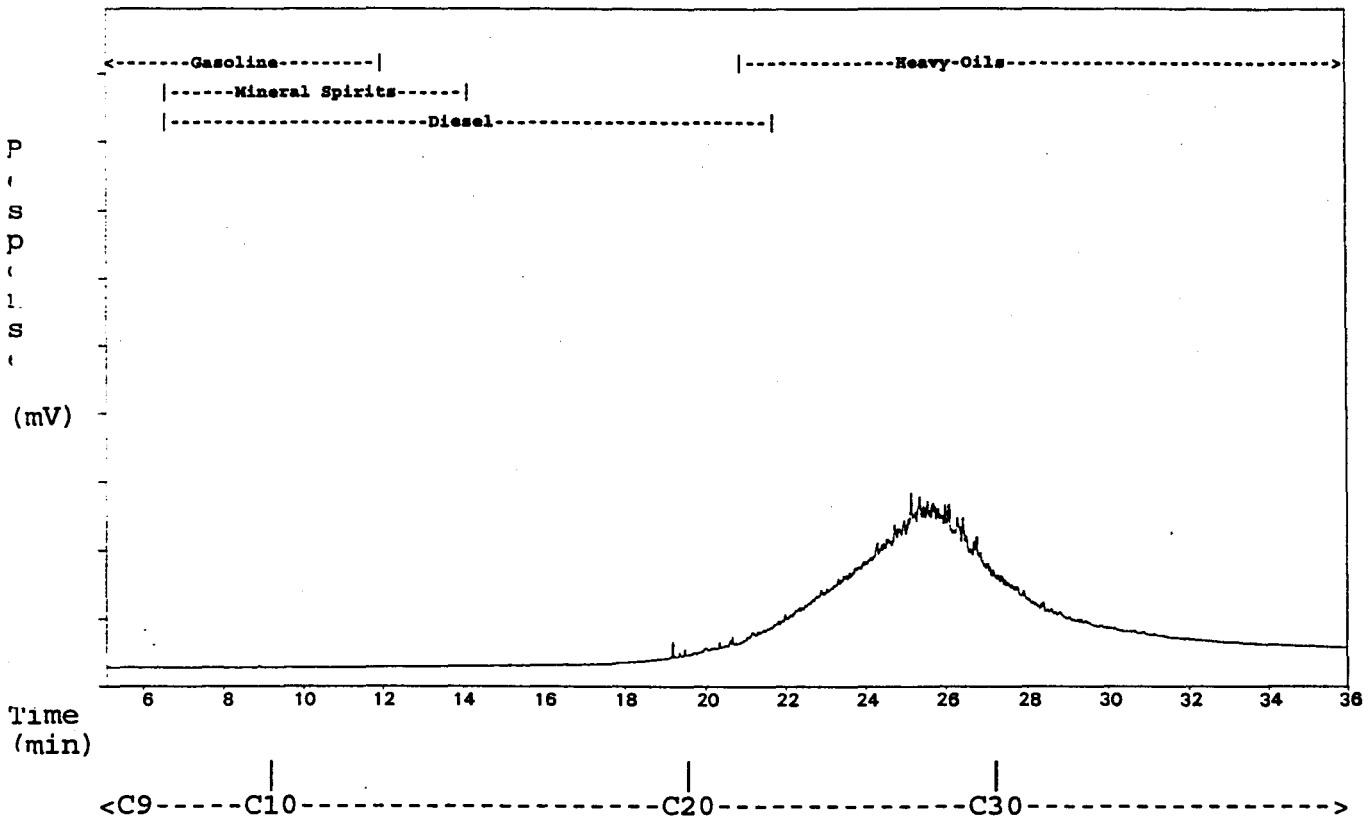
HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: SQ 96-08

Sample acquired: SEP 24, 1996 18:47:17

File Name: c:\TEH\TEHSEP24.17R , Sample Name: G5130 53#Rx1

Sequence file: TEHSEP24



ASL Sample ID: G5130 53#Rx1* 8.0Dilution

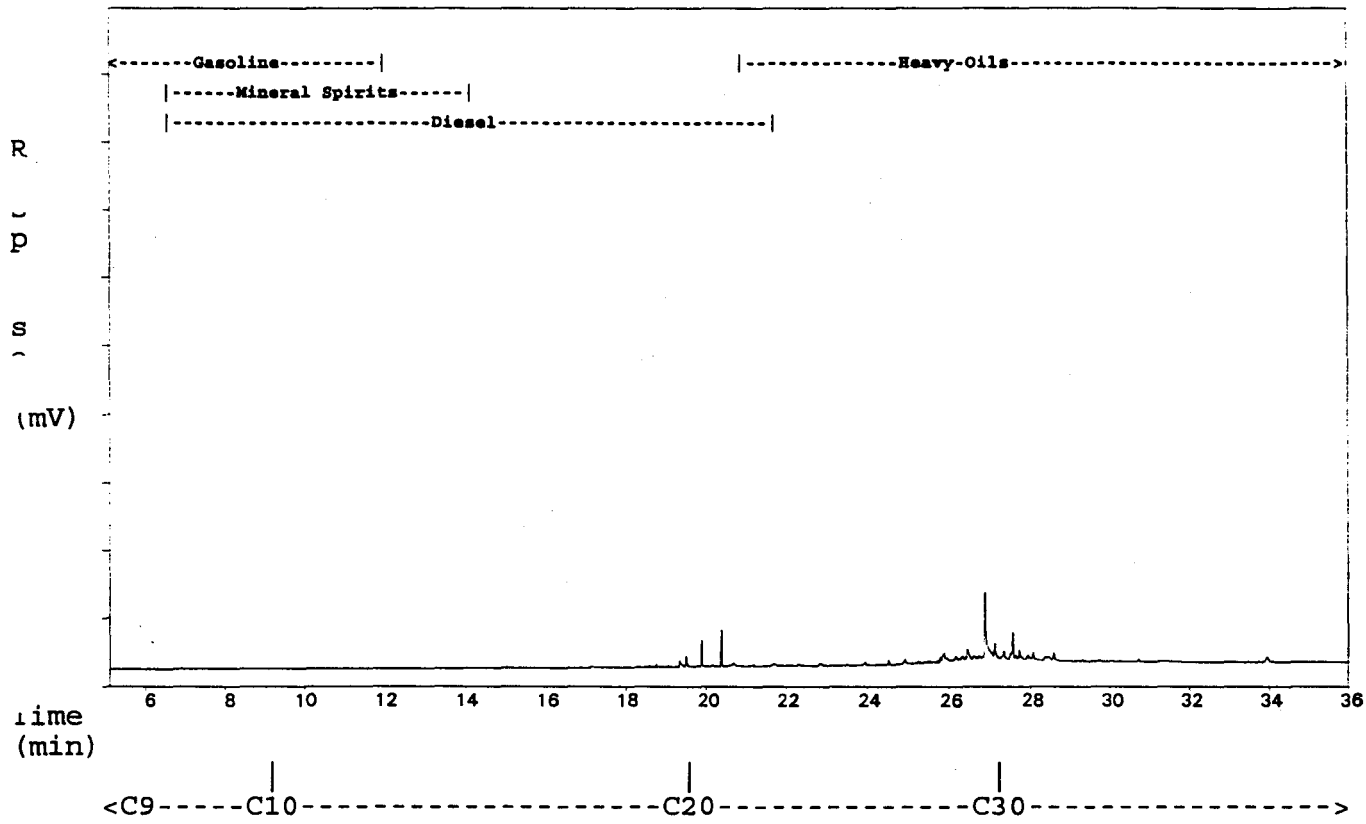
HYDROCARBON RANGE (C#)		RELATIVE AMOUNT (%)
Less than Carbon 10	(<C10)	0.1
Carbon 10 to Carbon 20	(C10-C20)	2.5
Carbon 20 to Carbon 30	(C20-C30)	62.2
Greater than Carbon 30	(>C30)	35.3

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 amount of hydrocarbon product present in the ranges specified.

HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: **BD 96-01**

Sample acquired: SEP 23, 1996 03:02:36
File Name: c:\TEH\TEHSEP22.32R , Sample Name: G5130 41
Sequence file: TEHSEP22



ASL Sample ID: G5130 41* 8.0Dilution

HYDROCARBON RANGE (C#)		RELATIVE AMOUNT (%)
Less than Carbon 10	(<C10)	0.0
Carbon 10 to Carbon 20	(C10-C20)	9.1
Carbon 20 to Carbon 30	(C20-C30)	21.0
Greater than Carbon 30	(>C30)	70.2

The Hydrocarbon Distribution Report is intended to assist you in characterizing the hydrocarbon product present in a given sample. The scale at the top of the chromatographic trace represents the hydrocarbon range of common petroleum products. Comparison of this report with those of reference standards may also assist you in the identification of the hydrocarbon product detected in your sample. The second part of the report is a table that expresses the relative amount of hydrocarbon product present in the ranges specified.

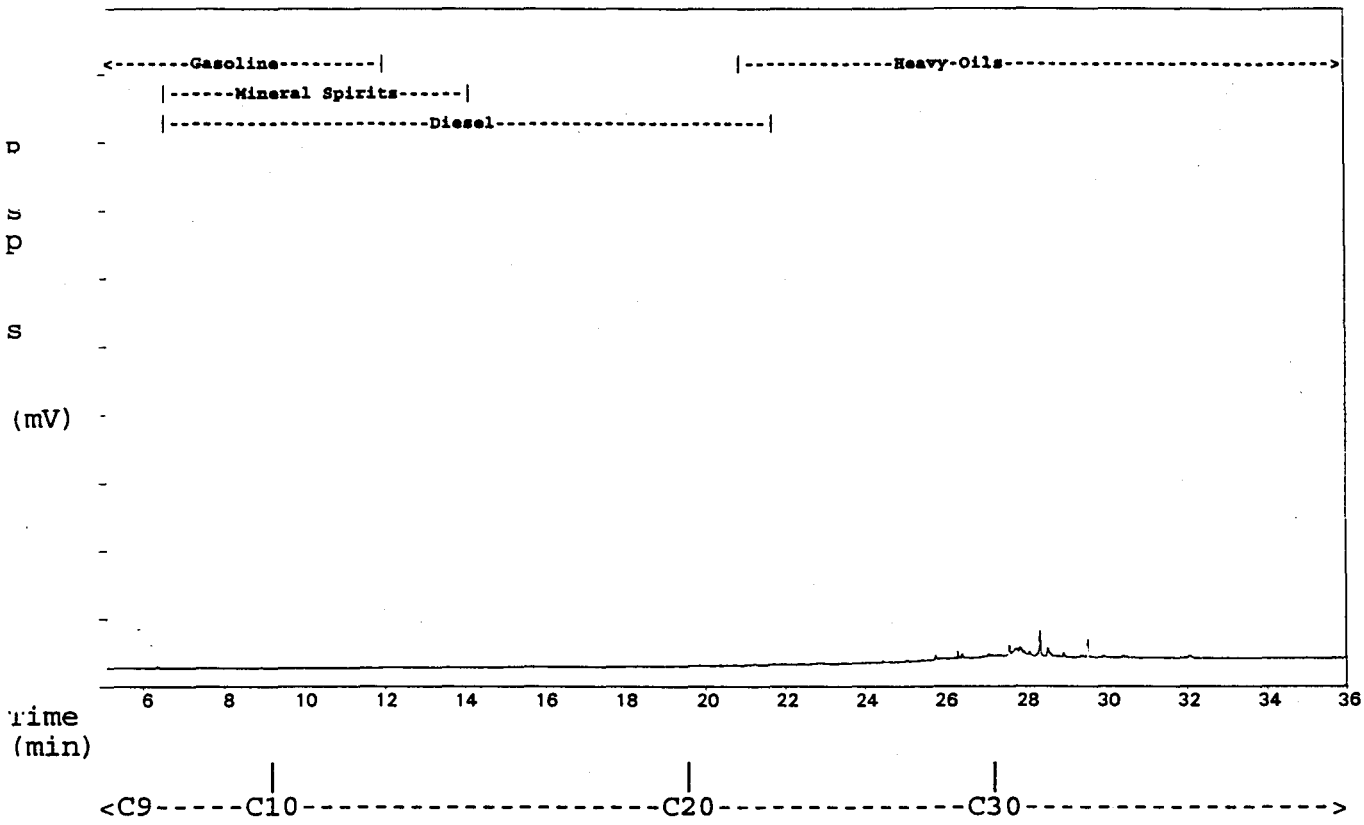
HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: BD 96-04

Sample acquired: SEP 24, 1996 18:00:00

File Name: c:\TEH\TEHSEP24.15R , Sample Name: G5130 44#Rx1

Sequence file: TEHSEP24



ASL Sample ID: G5130 44#Rx1* 8.0Dilution

HYDROCARBON RANGE (C#)		RELATIVE AMOUNT (%)
Less than Carbon 10	(<C10)	0.3
Carbon 10 to Carbon 20	(C10-C20)	1.0
Carbon 20 to Carbon 30	(C20-C30)	15.0
Greater than Carbon 30	(>C30)	84.5

The Hydrocarbon Distribution Report is intended to assist you in characterizing the hydrocarbon product present in a given sample. The scale at the top of the chromatographic trace represents the hydrocarbon range of common petroleum products. Comparison of this report with those of reference standards may also assist you in the identification of the hydrocarbon product detected in your sample. The second part of the report is a table that expresses the relative amount of hydrocarbon product present in the ranges specified.

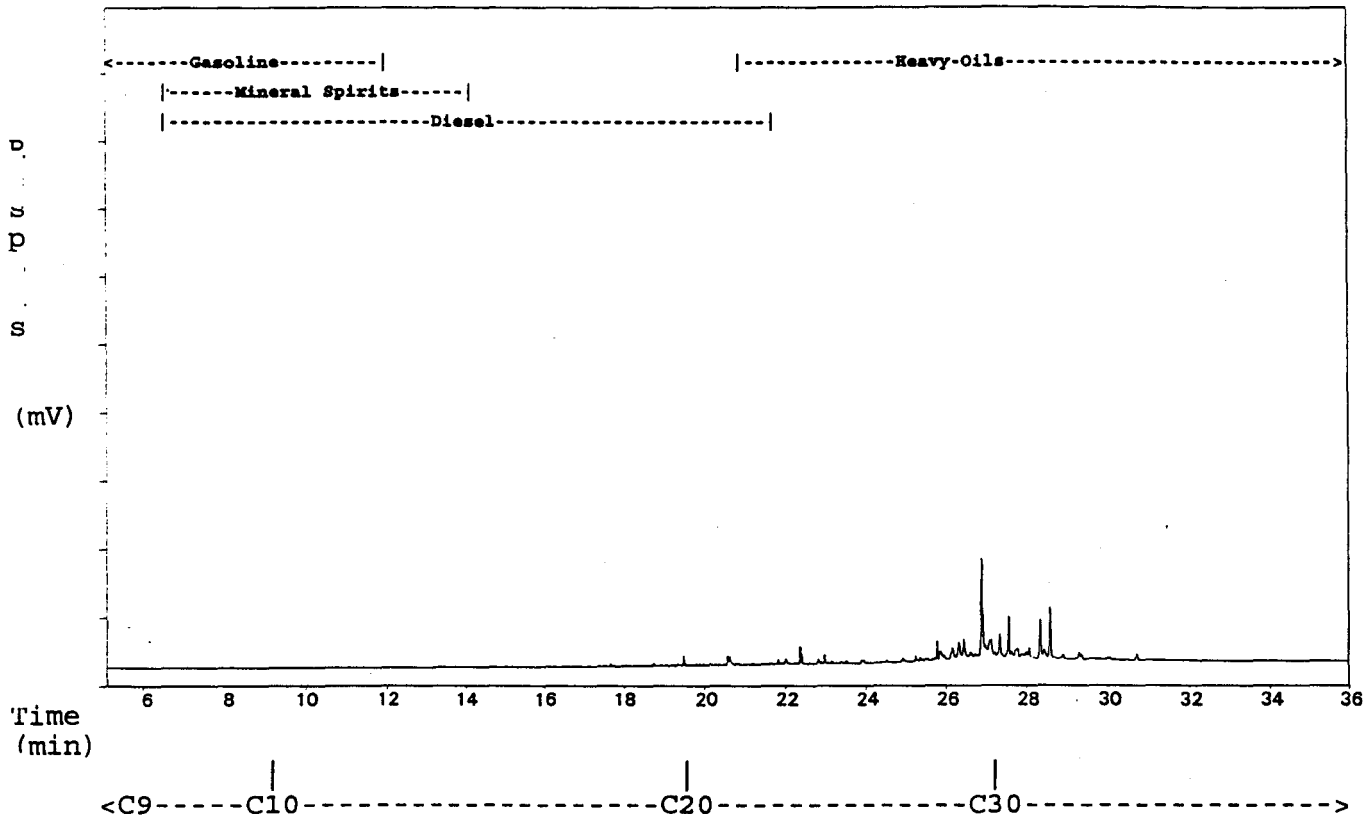
HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: BD 96-05

Sample acquired: SEP 23, 1996 03:49:21

File Name: c:\TEH\TEHSEP22.34R , Sample Name: G5130 45

Sequence file: TEHSEP22



<C9-----C10----------C20----------C30---------->

ASL Sample ID: G5130 45* 8.0Dilution

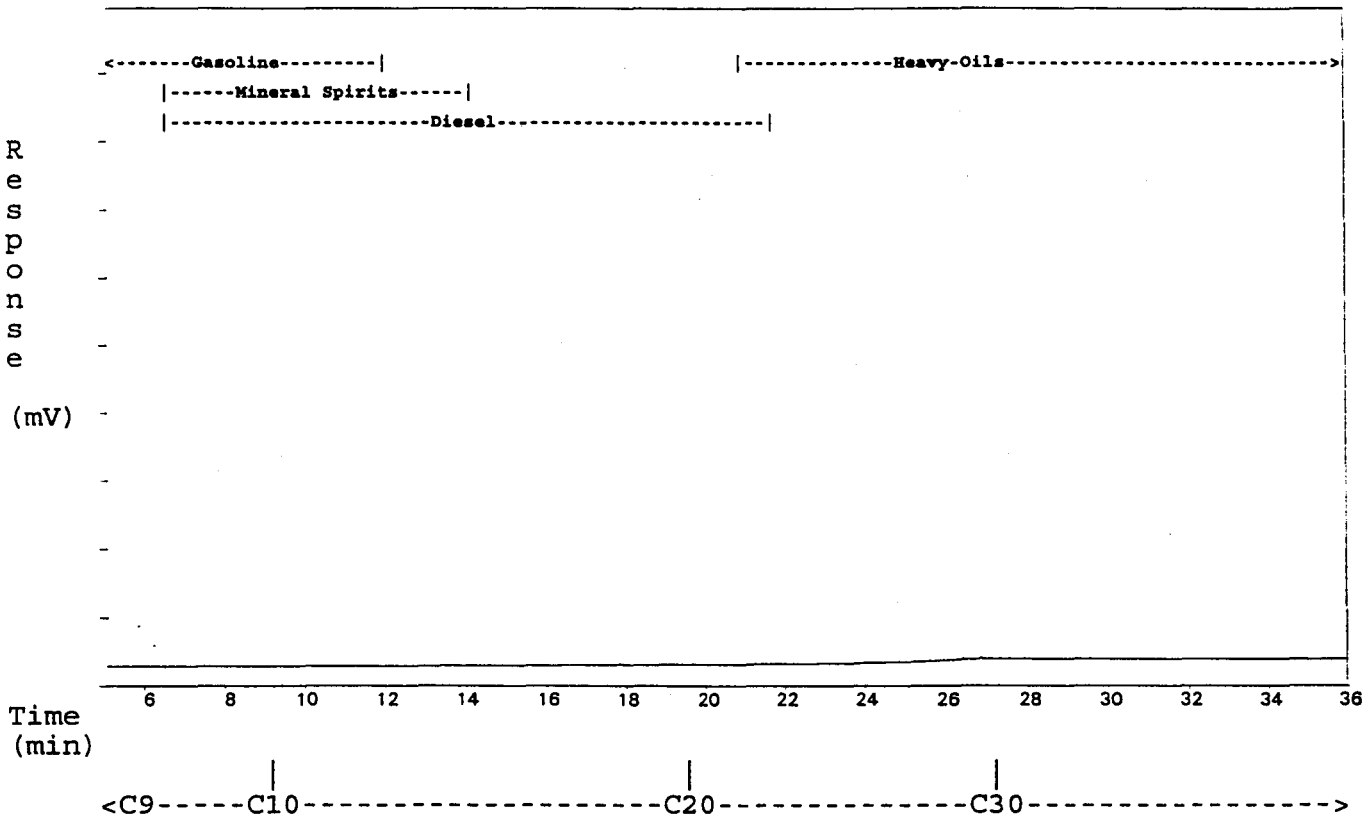
HYDROCARBON RANGE (C#)		RELATIVE AMOUNT (%)
Less than Carbon 10	(<C10)	0.1
Carbon 10 to Carbon 20	(C10-C20)	4.4
Carbon 20 to Carbon 30	(C20-C30)	26.3
Greater than Carbon 30	(>C30)	69.6

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 amount of hydrocarbon product present in the ranges specified.

HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: **BD96-07**

Sample acquired: SEP 29, 1996 00:40:46
File Name: c:\TEH\TEHSEP27.86R , Sample Name: G5283 13
Sequence file: TEHSEP27



ASL Sample ID: G5283 13* 8.0Dilution

HYDROCARBON RANGE (C#)		RELATIVE AMOUNT (%)
Less than Carbon 10	(<C10)	0.0
Carbon 10 to Carbon 20	(C10-C20)	1.3
Carbon 20 to Carbon 30	(C20-C30)	25.0
Greater than Carbon 30	(>C30)	73.6

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 amount of hydrocarbon product present in the ranges specified.

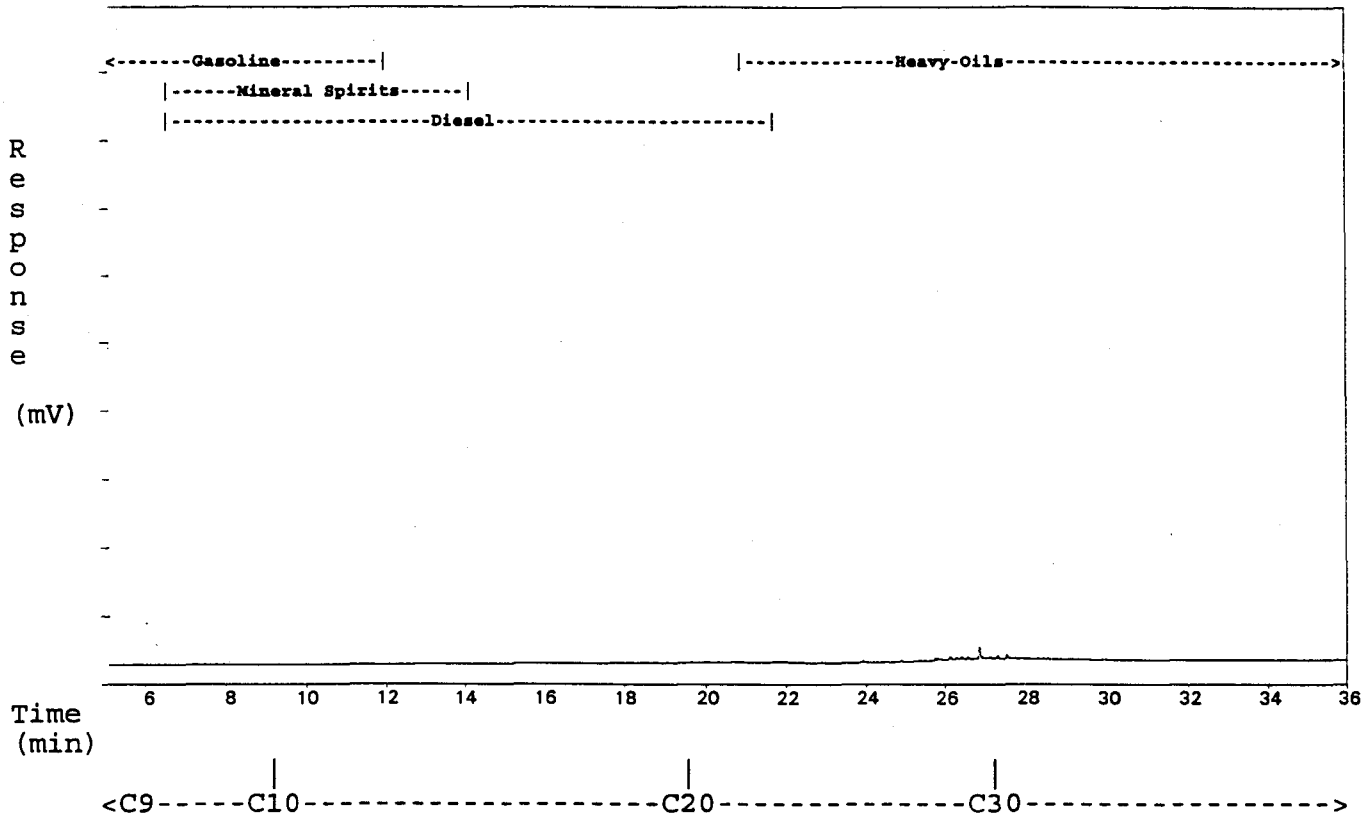
HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: **BD96-08**

Sample acquired: SEP 29, 1996 01:27:00

File Name: c:\TEH\TEHSEP27.88R , Sample Name: G5283 14

Sequence file: TEHSEP27



ASL Sample ID: G5283 14* 8.0Dilution

HYDROCARBON RANGE (C#)		RELATIVE AMOUNT (%)
Less than Carbon 10	(<C10)	0.1
Carbon 10 to Carbon 20	(C10-C20)	5.5
Carbon 20 to Carbon 30	(C20-C30)	30.0
Greater than Carbon 30	(>C30)	64.7

The Hydrocarbon Distribution Report is intended to assist you in characterizing the hydrocarbon product present in a given sample. The scale at the top of the chromatographic trace represents the hydrocarbon range of common petroleum products. Comparison of this report with those of reference standards may also assist you in the identification of the hydrocarbon product detected in your sample. The second part of the report is a table that expresses the relative amount of hydrocarbon product present in the ranges specified.

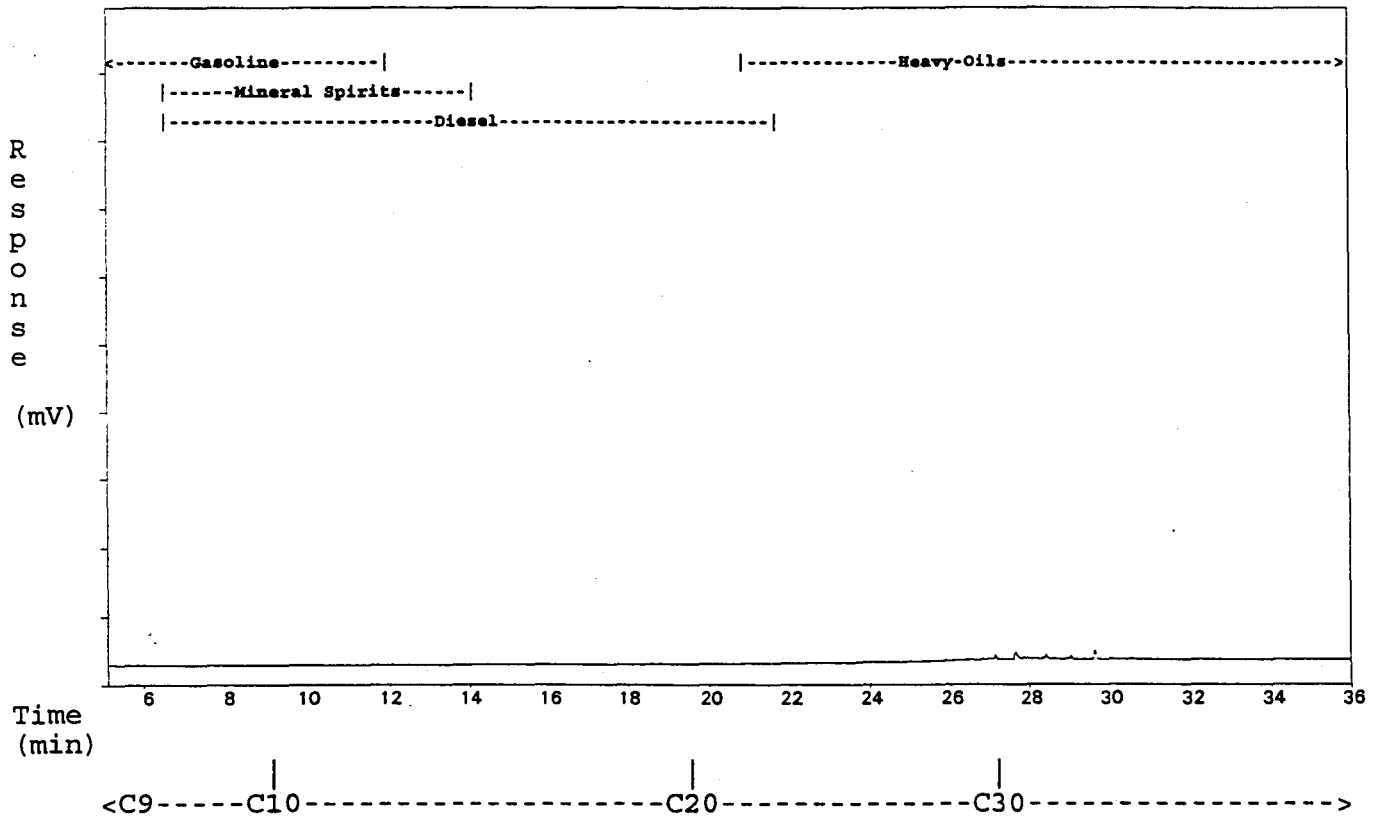
HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: **BD96-12**

Sample acquired: SEP 29, 1996 02:13:16

File Name: c:\TEH\TEHSEP27.89R , Sample Name: G5283 18

Sequence file: TEHSEP27



ASL Sample ID: G5283 18* 8.0Dilution

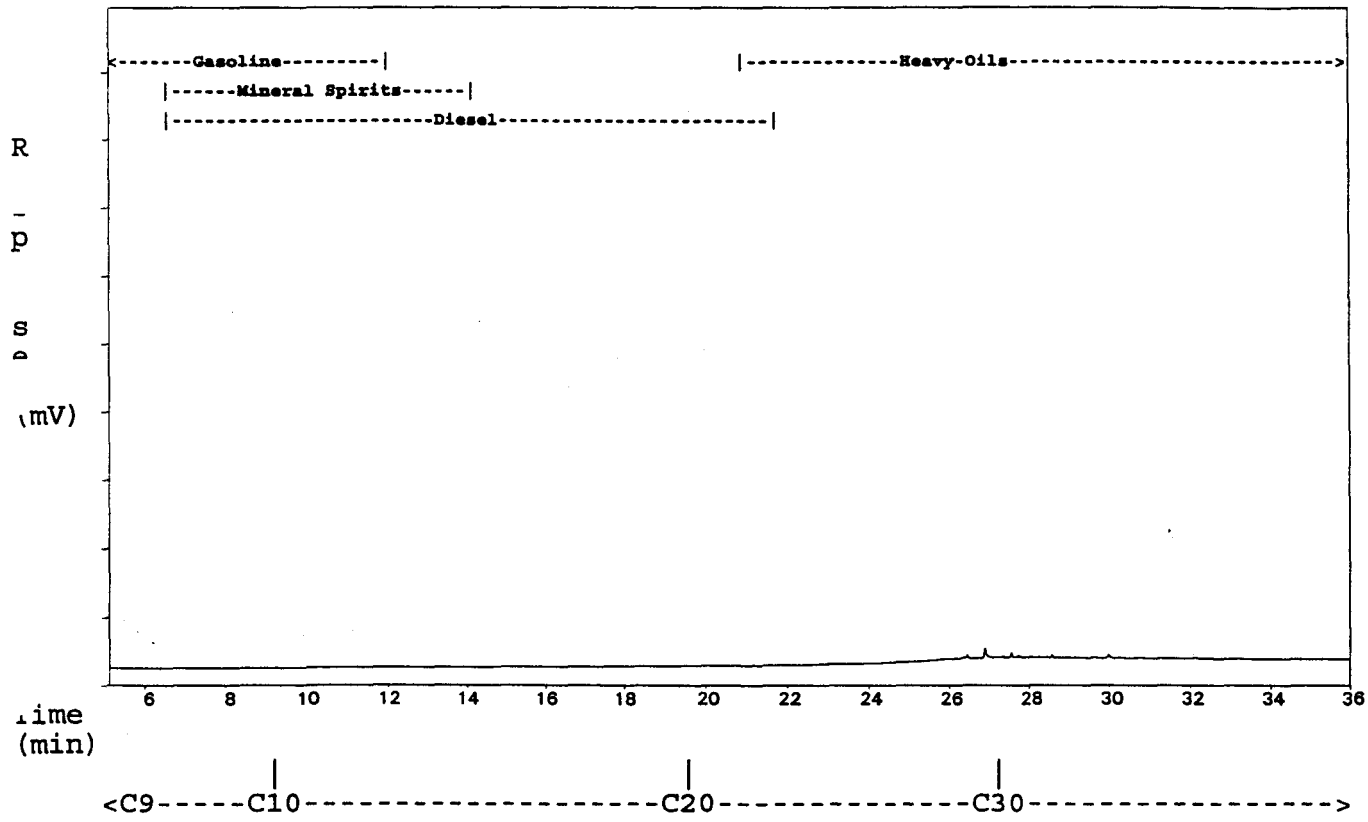
HYDROCARBON RANGE (C#)		RELATIVE AMOUNT (%)
Less than Carbon 10	(<C10)	0.1
Carbon 10 to Carbon 20	(C10-C20)	0.0
Carbon 20 to Carbon 30	(C20-C30)	15.8
Greater than Carbon 30	(>C30)	84.3

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 amount of hydrocarbon product present in the ranges specified.

HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: **ML 96-02**

Sample acquired: SEP 22, 1996 23:56:26
File Name: c:\TEH\TEHSEP22.24R , Sample Name: G5130 32
Sequence file: TEHSEP22



ASL Sample ID: G5130 32* 8.0Dilution

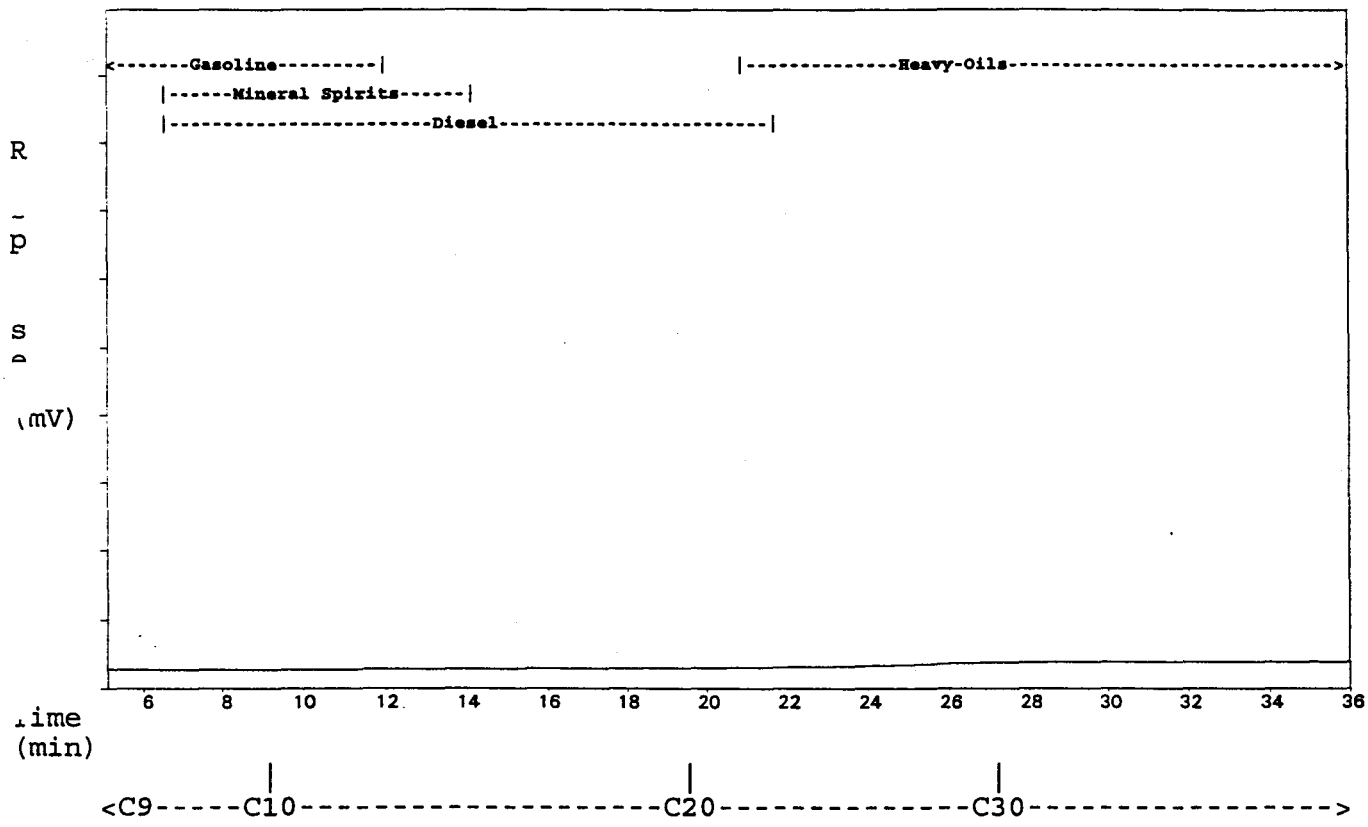
HYDROCARBON RANGE (C#)		RELATIVE AMOUNT (%)
Less than Carbon 10	(<C10)	0.0
Carbon 10 to Carbon 20	(C10-C20)	0.8
Carbon 20 to Carbon 30	(C20-C30)	18.5
Greater than Carbon 30	(>C30)	81.2

The Hydrocarbon Distribution Report is intended to assist you in characterizing the hydrocarbon product present in a given sample. The scale at the top of the chromatographic trace represents the hydrocarbon range of common petroleum products. Comparison of this report with those of reference standards may also assist you in the identification of the hydrocarbon product detected in your sample. The second part of the report is a table that expresses the relative amount of hydrocarbon product present in the ranges specified.

HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: **ML 96-03**

Sample acquired: SEP 23, 1996 00:42:56
File Name: c:\TEH\TEHSEP22.25R , Sample Name: G5130 33
Sequence file: TEHSEP22



ASL Sample ID: G5130 33* 8.0Dilution

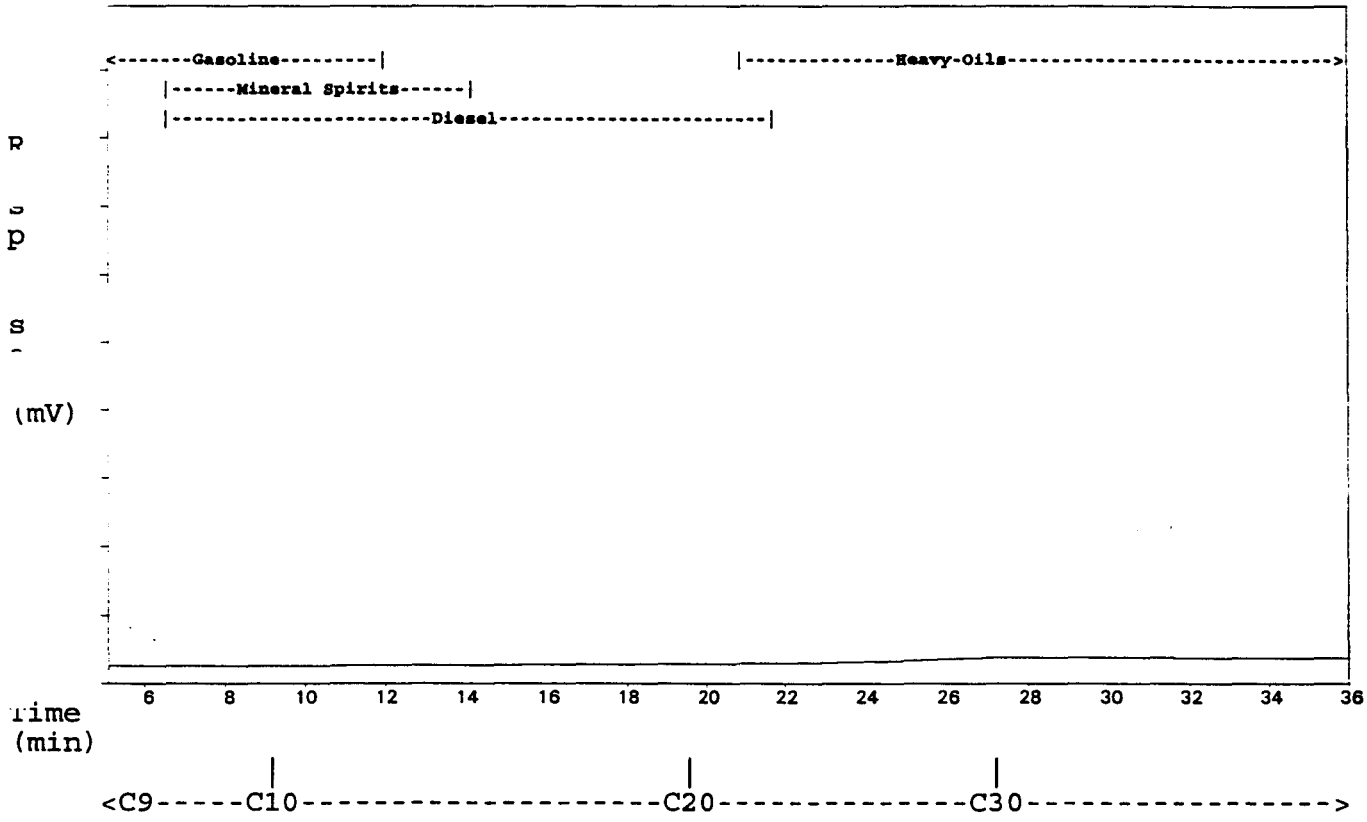
HYDROCARBON RANGE (C#)		RELATIVE AMOUNT (%)
Less than Carbon 10	(<C10)	0.0
Carbon 10 to Carbon 20	(C10-C20)	0.0
Carbon 20 to Carbon 30	(C20-C30)	0.0
Greater than Carbon 30	(>C30)	100.0

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 amount of hydrocarbon product present in the ranges specified.

HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: **ML 96-04**

Sample acquired: SEP 23, 1996 00:42:56
File Name: c:\TEH\TEHSEP22.26R , Sample Name: G5130 34
Sequence file: TEHSEP22



ASL Sample ID: G5130 34* 8.0Dilution

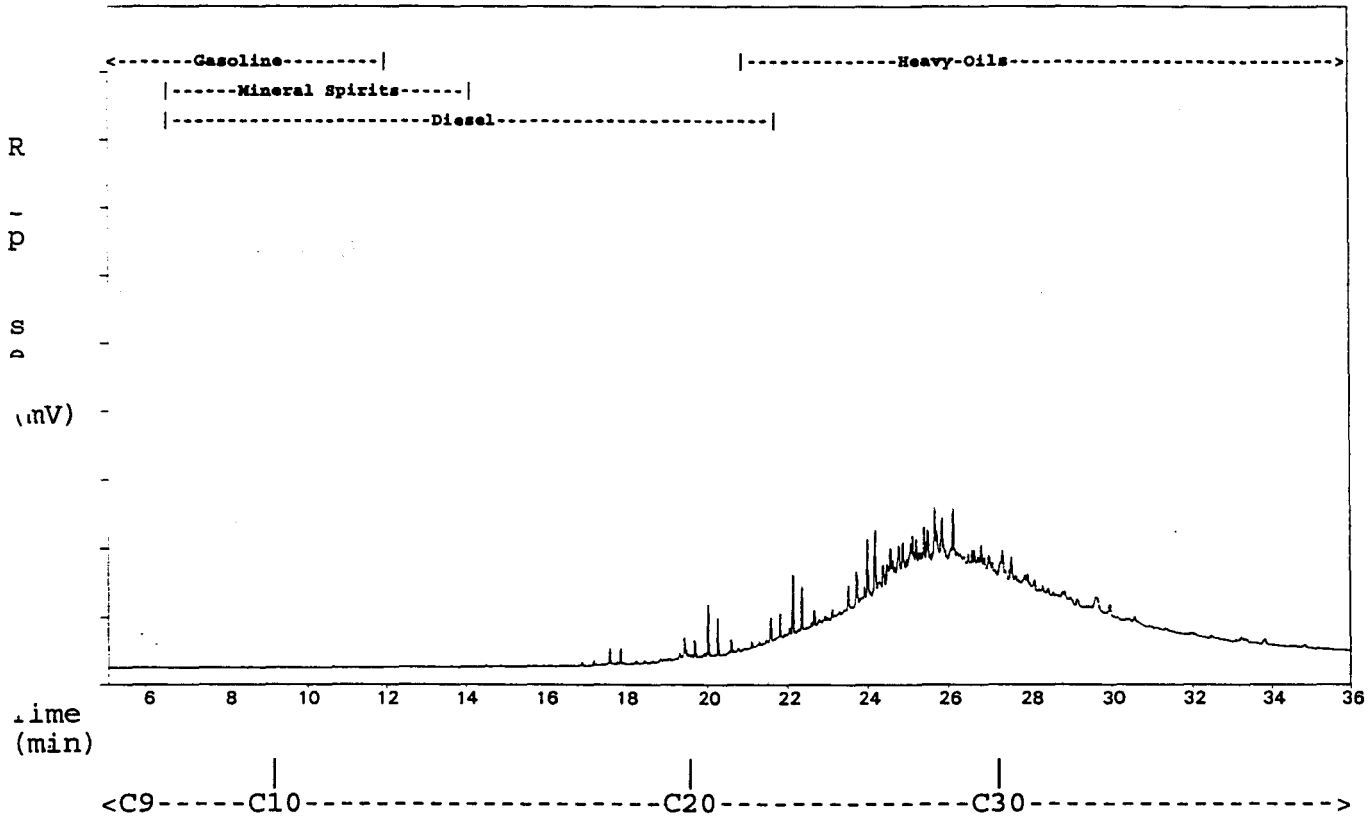
HYDROCARBON RANGE (C#)		RELATIVE AMOUNT (%)
Less than Carbon 10	(<C10)	0.1
Carbon 10 to Carbon 20	(C10-C20)	0.0
Carbon 20 to Carbon 30	(C20-C30)	32.1
Greater than Carbon 30	(>C30)	68.4

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 amount of hydrocarbon product present in the ranges specified.

HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: **ML 96-05**

Sample acquired: SEP 23, 1996 14:58:44
File Name: c:\TEH\TEHSEP23.10R , Sample Name: G5130 35#RX5
Sequence file: TEHSEP23



ASL Sample ID: G5130 35#RX5* 40.0Dilution

HYDROCARBON RANGE (C#)		RELATIVE AMOUNT (%)
Less than Carbon 10	(<C10)	0.0
Carbon 10 to Carbon 20	(C10-C20)	2.6
Carbon 20 to Carbon 30	(C20-C30)	48.9
Greater than Carbon 30	(>C30)	48.5

The Hydrocarbon Distribution Report is intended to assist you in characterizing the hydrocarbon product present in a given sample. The scale at the top of the chromatographic trace represents the hydrocarbon range of common petroleum products. Comparison of this report with those of reference standards may also assist you in the identification of the hydrocarbon product detected in your sample. The second part of the report is a table that expresses the relative amount of hydrocarbon product present in the ranges specified.

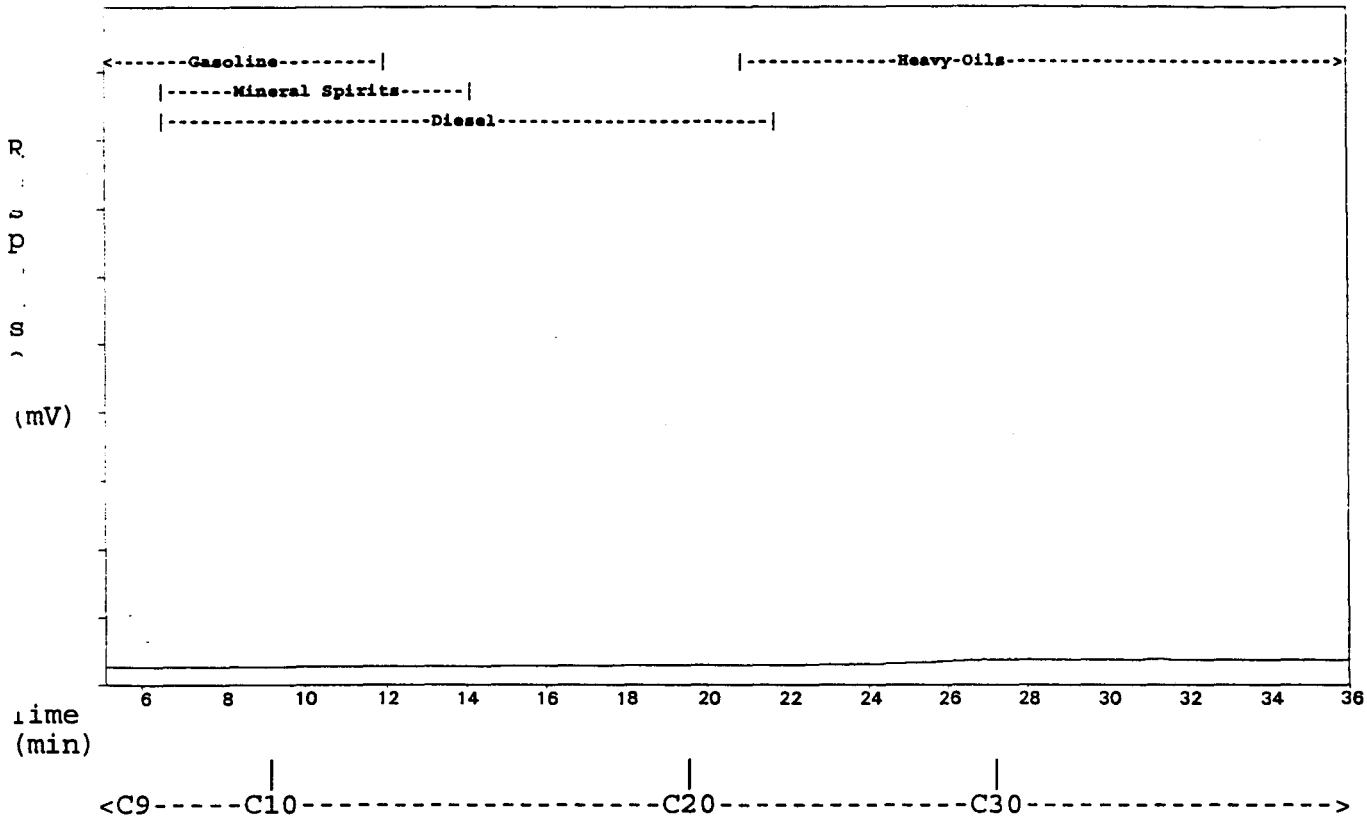
HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: ML 96-06

Sample acquired: SEP 23, 1996 01:29:35

File Name: c:\TEH\TEHSEP22.28R , Sample Name: G5130 36

Sequence file: TEHSEP22



ASL Sample ID: G5130 36* 8.0Dilution

HYDROCARBON RANGE (C#)		RELATIVE AMOUNT (%)
Less than Carbon 10	(<C10)	0.0
Carbon 10 to Carbon 20	(C10-C20)	0.4
Carbon 20 to Carbon 30	(C20-C30)	19.9
Greater than Carbon 30	(>C30)	80.2

The Hydrocarbon Distribution Report is intended to assist you in characterizing the hydrocarbon product present in a given sample. The scale at the top of the chromatographic trace represents the hydrocarbon range of common petroleum products. Comparison of this report with those of reference standards may also assist you in the identification of the hydrocarbon product detected in your sample. The second part of the report is a table that expresses the relative amount of hydrocarbon product present in the ranges specified.

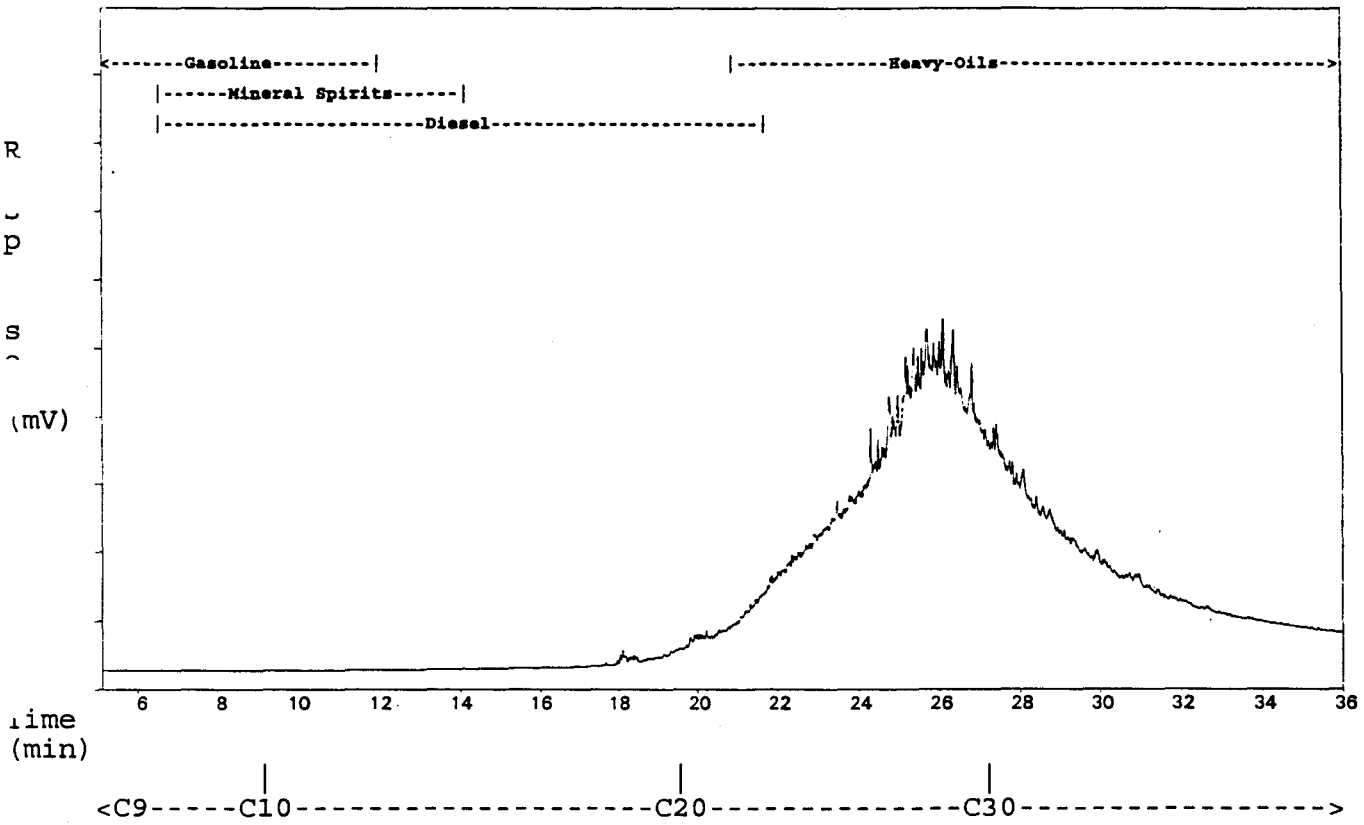
HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: **ML 96-07**

Sample acquired: SEP 23, 1996 15:46:42

File Name: c:\TEH\TEHSEP23.11R , Sample Name: G5130 37#RX5

Sequence file: TEHSEP23



ASL Sample ID: G5130 37#RX5* 40.0Dilution

HYDROCARBON RANGE (C#)		RELATIVE AMOUNT (%)
Less than Carbon 10	(<C10)	0.0
Carbon 10 to Carbon 20	(C10-C20)	1.9
Carbon 20 to Carbon 30	(C20-C30)	50.4
Greater than Carbon 30	(>C30)	47.7

The Hydrocarbon Distribution Report is intended to assist you in characterizing the hydrocarbon product present in a given sample. The scale at the top of the chromatographic trace represents the hydrocarbon range of common petroleum products. Comparison of this report with those of reference standards may also assist you in the identification of the hydrocarbon product detected in your sample. The second part of the report is a table that expresses the relative amount of hydrocarbon product present in the ranges specified.

APPENDIX D:
QUALITY ASSURANCE/QUALITY CONTROL
(QA/QC)

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 for at least 10% of all samples;
- analytical or procedural duplicates of samples to monitor the precision or repeatability of the results; and.
- data validation.

D.2 Field Program

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

shipped to the laboratory. Time and date of sampling were indicated on the containers and the chain-of custody forms accompanied the samples to ensure that time sensitive analytes such as volatile hydrocarbons were analyzed quickly. One field duplicate sample was collected from each site to check on the precision of the field sampling process.

D.3 Laboratory Analysis

The laboratory QA/QC program included the analysis of field duplicates and analytical or procedural duplicates. Duplicate samples were collected to check on the precision of the field sampling process to monitor the precision or repeatability of the results

D.3.1 Inorganic Element (Metal)

Two pairs of field duplicates (Table D.1) were analyzed to monitor the precision of the field sampling process; two pairs of laboratory duplicates (Table D.2) were also analyzed to check on analytical precision. 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. The only exception was the RSD for manganese in the field duplicate samples BD96-04 and BD96-05 (37%), however, the average RSD for the two sets of field duplicate sample was 21%.

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

Total Metals	SQ96-03	SQ96-04	Mean	RSD	BD 96-04	BD 96-05	Mean	RSD (%)
	Concentration (mg/kg)			(%)	Concentration (mg/kg)			(%)
Aluminum	13000	14200	13600	**6.2**	15300	17500	16400	**9.5**
Antimony	<20	<20			<20	<40		
Arsenic	2.45	2.40	2.43	**1.5**	2.99	3.33	3.16	**7.6**
Barium	148	169	159	**9.4**	395	536	466	**21**
Beryllium	<0.5	<0.5			<0.5	<1		
Bismuth	13	12	12.50	**5.7**	12	<20		
Cadmium	<2	<2			<2	<4		
Calcium	7180	8100	7640	**8.5**	12300	18000	15150	**27**
Chromium	45	46	46	**1.6**	42	46	44	**6.4**
Cobalt	8	8	8	**0.0**	8	10	9	**16**
Copper	20	19	20	**3.6**	19	31	25	**34**
Iron	23400	21100	22250	**7.3**	16400	17000	16700	**2.5**
Lead	75	82	79	**6.3**	<50	<100		
Lithium	7	8	7.50	**9.4**	9	10	9.5	**7.4**
Magnesium	7450	7650	7550	**1.9**	5720	5890	5805	**2.1**
Manganese	331	356	344	**5.1**	625	1060	843	**37**
Mercury	0.012	0.008	0.01	**28**	0.022	0.024	0.023	**6.1**
Molybdenum	<4	<4			<4	<8		
Nickel	39	38	39	**1.8**	31	32	32	**2.2**
Phosphorus	453	431	442	**3.5**	684	1020	852	**28**
Potassium	712	978	845	**22**	1360	2100	1730	**30**
Selenium	<0.1	<0.1			0.3	0.5	0.4	**35**
Silver	<2	<2			<2	<4		
Sodium	<200	202	202		288	433	361	**28**
Tin	<10	<10			<10	<20		
Titanium	513	663	588	**18**	853	1050	952	**15**
Vanadium	47	51	49	**5.8**	47	52	50	**7.1**
Zinc	59	60	60	**1.2**	44	55	50	**16**

RSD = Relative Standard Deviation
< = Less than the detection limit indicated

Table D.2: Inorganic Elements Results for Laboratory Replicates

Total Metals	JC96-01	JC96-01 Duplicate	Mean	RSD	JC96-13	JC96-13 Duplicate	Mean	RSD
	Concentration (mg/kg)			(%)	Concentration (mg/kg)			(%)
Aluminum	20300	21500	20900	**4.1**	20700	20700	20700	**0.0**
Antimony	<20	<20			<20	<20		
Arsenic	2.58	2.06	2.3	**16**	1.11	1.55	1.33	**23**
Barium	297	327	312	**6.8**	361	351	356	**2.0**
Beryllium	0.5	0.5	0.5	**0.0**	0.6	0.6	0.6	**0.0**
Bismuth	15	15		**0.0**	15	15	15	**0.0**
Cadmium	<2	<2			<2	<2		
Calcium	9320	9620	9470	**2.2**	12900	12900	12900	**0.0**
Chromium	64	67	66	**3.2**	70	64	67	**6.3**
Cobalt	13	13	13	**0.0**	14	13	14	**5.2**
Copper	32	31	32	**2.2**	60	56	58	**4.9**
Iron	29700	30100	29900	**0.9**	39400	35800	37600	**6.8**
Lead	<50	<50			<50	<50		
Lithium	11	11	11.00	**0.0**	12	12	12.00	**0.0**
Magnesium	8410	8620	8515	**1.7**	9340	9510	9425	**1.3**
Manganese	519	497	508	**3.1**	646	628	637	**2.0**
Mercury	0.035	0.035	0.04	**0**	0.027	0.029	0.03	**5**
Molybdenum	<4	<4			<4	<4		
Nickel	45	46	46	**1.6**	54	54	54	**0.0**
Phosphorus	665	556	611	**12**	310	330	320	**4.4**
Potassium	2410	2540	2475	**3.7**	1990	1970	1980	**0.7**
Selenium	<0.1	<0.1			<0.1	<0.1		
Silver	<2	<2			<2	<2		
Sodium	758	803	781		716	712	714	**0.4**
Tin	<10	<10			<10	<10		
Titanium	1300	1200	1250	**6**	852	991	922	**11**
Vanadium	73	76	75	**2.8**	73	74	74	**1.0**
Zinc	86	80	83	**5.1**	143	140	142	**1.5**

Notes
RSD = Relative Standard Deviation
< = Less than the detection limit indicated

D.3.2 Polychlorinated Biphenyls (PCBs) in Soils

Three pairs of field duplicate soil samples were analyzed to monitor precision. The concentrations of total PCBs in all these samples were below detection (Table D.3).

Table D.3: Polychlorinated Biphenyls (PCBs) Results for Field Duplicate Samples

	JC96-29	JC96-30	ML96-07	ML96-08	SQ96-03	SQ96-04
	Field Duplicate		Field Duplicate		Field Duplicate	
Total PCBs	<0.05	<0.05	<0.2	<0.05	<0.05	<0.05

< = Less than the detection limit indicated
Results are expressed as mg/kg or ppm

Analytical precision was monitored internally by ASL using three sets of replicates. The concentration of PCBs in these samples were also below detection (Table D.4)

Table D.4: Polychlorinated Biphenyls (PCBs) Results for Laboratory Replicates

	JC 96-1	JC 96-1 Duplicate	JC 96-21	JC 96-21 Duplicate	SQ 96-04	SQ 96-04 Duplicate
Total PCBs	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

< = Less than the detection limit indicated
Results are expressed as mg/kg or ppm

D.3.3 Organochlorine Pesticides in Soils

One set of field duplicates (JC96-29 and JC96-30) and two pairs of analytical duplicates were analyzed to monitor reproducibility. The concentrations of all organochlorine pesticides in these samples were below detection (Table D.5).

Table D.5: Organochlorine Pesticides Results for Field and Laboratory Duplicate Samples

	JC96-29	JC96-30	JC96-1	JC96-1	SQ96-04	SQ96-04
	Field Duplicate		Lab Duplicate		Lab Duplicate	
Aldrin	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
alpha-BHC	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
beta-BHC	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
delta-BHC	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
cis-Chlordane (alpha)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
trans-Chlordane (gamma)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
2,4'-DDD	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
4,4'-DDD	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
2,4'-DDE	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
4,4'-DDE	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
2,4'-DDT	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
4,4'-DDT	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Dieldrin	<0.001	<0.001	<0.0030	<0.0030	<0.001	<0.001
Endosulfan I	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Endosulfan II	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Endosulfan Sulfate	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Endrin	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Endrin Aldehyde	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Heptachlor	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Heptachlor Epoxide	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lindane (gamma - BHC)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Methoxychlor	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Mirex	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
cis-Nonachlor	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
trans-Nonachlor	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Oxychlordane	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Toxaphene	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030

Notes
All results are expressed as mg/kg (ppm)
< = Less than the detection limit indicated

D.3.4 Extractable Hydrocarbons in Soils

The concentration of extractable hydrocarbons EPH (C10-18) and EPH (C19-31) in a field duplicate sample (BD96-04 and BD96-05) were all below detection. Three soil samples were analyzed in duplicates to monitor analytical precision (Table D.6). Good agreement was found between both detectable (based on relative standard deviations which ranged between 0.0 and 8.2%) and non-detectable analytes (based on similar detection limit values).

Table D.6: Extractable Petroleum Hydrocarbons (EPH) Results for Laboratory Replicates

	JC96-1 Duplicates		JC96-13 Duplicates	JC 96-13	Mean	RSD %	JC96-21 Duplicates	JC96-21	Mean	RSD %
EPH (C10-18)	<250	<250	<250	<250			<250	<250		
EPH (C19-31)	<250	<250	359	355	357	**0.8**	574	645	609	**8.2**
LEPH	-	-	<250	<250			-	-		
HEPH	-	-	359	359	359	**0.0**	-	-		

Results are expressed as mg/kg or ppm
RSD = Relative Standard Deviation
< = Less than the detection limit indicated

D.3.5 Polycyclic Aromatic Hydrocarbons in Soils

One soil sample was analyzed in duplicate to monitor analytical precision (Table D.7). Good agreement was found for the replicates on the basis of relative standard deviations (RSD) or similar detection limit values for the analytes with the exception of benzo(a)pyrene. The relatively high RSD for benzo(a)pyrene (47%) was attributed to the fact that concentrations detected in the replicates (0.01 and 0.02 mg/kg) were near the analytical detection limit of <0.01 mg/kg.

Table D.7: Polycyclic Aromatic Hydrocarbons Results for Laboratory Duplicate Sample

	JC96-13	JC 96-13	Mean	RSD
	Concentration (mg/kg or ppm)			%
Acenaphthene	0.02	<0.01	-	
Acenaphthylene	<0.01	<0.01		
Anthracene	0.01	0.01	0.01	**0.0**
Benzo(a)anthracene	0.02	0.02	0.02	**0.0**
Benzo(a)pyrene	0.01	0.02	0.015	**47**
Benzo(b)fluoranthene	0.03	0.04	0.035	**20**
Benzo(g,h,i)perylene	0.01	0.01	0.01	**0.0**
Benzo(k)fluoranthene	0.01	0.01	0.01	**0.0**
Chrysene	0.03	0.04	0.035	**20**
Dibenz(a,h)anthracene	<0.01	<0.01		
Fluoranthene	0.06	0.06	0.06	**0.0**
Fluorene	0.01	0.01	0.01	**0.0**
Indeno(1,2,3-c,d)pyrene	<0.01	<0.01		**0.0**
Naphthalene	0.06	0.05	0.055	**13**
Phenanthrene	0.06	0.05	0.055	**13**
Pyrene	0.05	0.06	0.055	**13**