PHASE 2 OF THE HOPE BAY PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT

Appendix V5-4F

Hope Bay Belt Site Assessment 1999

BHP Diamonds Inc.

HOPE BAY BELT
SITE ASSESSMENT
1999

Prepared for:

BHP Diamonds Inc.
Yellowknife, Northwest Territories

Prepared by:

Rescan™ Environmental Services Ltd.
Vancouver, British Columbia
Yellowknife, Northwest Territories

October 1999

Introduction

Rescan™

INTRODUCTION

This report presents the results of a soil and water sampling survey conducted in July 1999 and a follow-up soil survey in August 1999 at various sites within the Hope Bay Belt. The main objective of the sampling survey was to identify any possibly contaminated soils and waters, compare them to site remediation guidelines, and to make recommendations.

Rescan personnel were on-site from July 13 to July 17, 1999. Major tasks completed during the survey included: assessment of barrels containing hydrocarbon contaminated soils at Boston Camp, assessment of various hydrocarbon and salt spill sites in the vicinity of Boston Camp, assessment of any runoff from the stockpiles/orepiles at Boston Camp, assessment of hydrocarbon and salt spills at Windy Camp and near Patch Lake, and the collection of water quality samples from Aimaoktak, Windy, and Wolverine lakes.

Results from the July sampling survey indicated contaminated soils were present in the vicinity of the settling ponds at Boston Camp and a second sampling survey was conducted on August 31, 1999 in order to better delineate the contaminated soil footprint. Results from the second survey are also included in this report.

All soil and water samples were sent to Analytical Service Laboratories (ASL) in Vancouver, B.C. for analysis. The laboratory results for all samples are provided in Appendix 1 of this report.

Table of Contents

HOPE BAY BELT
SITE ASSESSMENT
1999

TABLE OF CONTENTS

INTRODUCTION i

TABLE OF CONTENTS ii
  List of Figures iii
  List of Tables iv
  List of Plates iv

1. ASSESSMENT OF BARRELS CONTAINING HYDROCARBON CONTAMINATED SOIL AT BOSTON CAMP 1-1
  1.1 Results from Hydrocarbon Assessment 1-2
  1.2 Recommendations 1-3

2. SOIL SAMPLING AT BOSTON CAMP 2-1
  2.1 TPH Results 2-3
  2.2 Salt Parameter Results 2-4
  2.3 Metal Sample Results: Sites 4 and 5 2-5
  2.4 Recommendations 2-7
    2.4.1 Bentonite/TPH/Salt Areas 2-7
    2.4.2 TPH/Salt Areas 2-8
    2.4.3 Salt Areas 2-9
    2.4.4 Sites 4 and 5; Downslope of Settling Ponds 2-9
    2.4.5 Other Areas 2-10

3. WATER SAMPLING OF STOCKPILES/OREPILES AT BOSTON CAMP ... 3-1
  3.1 Results and Discussion 3-2
  3.2 Conclusions and Recommendations 3-4

4. SOIL SAMPLING AT PATCH LAKE AND WINDY CAMP 4-1

5. WATER QUALITY SAMPLING AT WINDY CAMP 5-1

6. WATER QUALITY SAMPLING OF AIMAOKTAK, WINDY AND WOLVERINE LAKES 6-1
  6.1 Methods 6-1
  6.2 Results 6-1
    6.2.1 Aimaoktak Lake 6-1
    6.2.2 Windy Lake 6-2
    6.2.3 Wolverine Lake 6-3

7. ADDITIONAL SOIL SAMPLING AT BOSTON CAMP 7-1
7.1 Methods..7-1
7.2 Results..7-4
7.3 Recommendations...7-6

REFERENCES R-1

APPENDICES

Appendix 1 - Analytical Results from Soil and Water Samples, Hope Bay Belt, July 1998

Appendix 2-1 - Photographic Record of Soil Sampling Sites 4 - 18, Boston Camp, July 1999

Appendix 3-1 - Photographic Record of Stockpile Water Sampling Sites 1-3, Boston Camp, July and August 1999

Appendix 4-1 - Photographic Record of Sampling Sites from Windy Camp and Patch Lake, July 1999

Appendix 7-1 - Photographic Record of Soil Sampling Locations Downstream of Settling Ponds, Boston Camp, August 1999

Appendix 7-2 - Analytical Results from Soil Samples, Boston Camp, August 1999

List of Figures

Figure Page
2-1 Site Sampling Locations, Boston Camp, July 1999..2-2
7-1 Location of Tundra Burn Area Assessed on August 31, 1999..........................7-2
7-2 Areas of Contamination Within the Tundra Burn Downslope of Settling Ponds, Boston Camp, August 31, 1999...7-5

List of Tables

Table Page

1-1 Results from Contained Hydrocarbon-Contaminated Soils, Boston Camp, July 1999 1-2

2-1 Soil Sampling Summary Table for Boston Sites, July 1999 2-1

2-2 Results from TPH Sampling, Boston Camp, July 1999 2-3

2-3 Results from Salt Sampling, Boston Camp, July 1999 2-4

2-4 Results from 1998 and 1999 Salt Testing for Site 14 Salt Burn, Boston Property 2-5

2-5 Results of Soil Metal Sampling, Sites 4 and 5, Boston Camp, July 1999 2-7

2-6 Results of Water Sampling from Site 4, Boston Camp, July 1999 2-8

3-1 Water Quality Results, Boston Stockpiles, July 1999 3-2

4-1 Analytical Results for Patch Lake and Windy Camp Soil Samples 4-1

7-1 Selected Results from Additional Soil Sampling, Boston Camp, August 1999 7-6

1. Assessment of Barrels Containing Hydrocarbon Contaminated Soil at Boston Camp

1. ASSESSMENT OF BARRELS CONTAINING HYDROCARBON CONTAMINATED SOIL AT BOSTON CAMP

Over 100 barrels were examined for their contents at Boston Camp. Barrels were stacked upright for the most part, the lids previously removed with a cutting torch, the rims bent, and the tops covered with heavy plastic sheeting and duct tape. A significant number of barrels thought to contain hydrocarbon contaminated soil contained other material such as scrap metal, used oil filters, garbage, *etc*. If the barrel did not contain soil, the general contents of the barrel were recorded on an orange flag, and the labelled flag secured to the barrel for future reference.

For barrels containing soils (pad material; 85 barrels in total), the soil was initially 'sniffed' with an Eagle Series Portable Gas Monitor for hydrocarbon vapor or combustible gas content. Approximately 250 grams of sample was placed in a polyethylene bag. The bag was closed so as to trap air and set aside for three to five minutes to allow vapor to collect within the air space. The amount of hydrocarbon vapor released by the soil indicated the presence or absence of hydrocarbon in the soil. It does not indicate parts per million of hydrocarbon in the soil, nor does it indicate the type of hydrocarbon present. Gasoline, for example, will volatilize faster than oil. Overall, the hydrocarbon vapor content of most barrels was low, and vapor content was not very useful as a screening device for total petroleum hydrocarbon (TPH) contamination of these soils. However, as there were no other real criteria for collecting subsamples (besides obvious staining and odor) those soils which exhibited high vapor content were sampled in the field for TPH screening using a PetroFlag instrument. The results of the field TPH analysis using the PetroFlag method correlated fairly well (same order of magnitude) with laboratory analysis performed later. Hence, PetroFlag screening was very useful and it is recommended that this field technique be used in any future hydrocarbon screenings on-site for fuel spills.

85
barrels
containing
Soils

A subset of nine barrels was sampled for TPH to be analyzed in the laboratory. Due to time constraints, it was not possible to dump out the contents of the barrels and obtain a homogenous subsample. All soil samples were collected from the top of the barrel, and should therefore be considered conservative as volatilization is most likely to have already occurred near the surface. The barrels did have headspace during storage, and hydrocarbon vapor was very evident by smell upon initial opening of the barrel (*i.e.* removal of the plastic covering).

1.1 Results from Hydrocarbon Assessment

The barrel numbers, vapor content, field TPH concentration (if measured), and laboratory TPH concentrations are provided in Table 1-1. Also provided is a column indicating whether the analytically measured TPH values exceed the Nunavut Territory criterion for industrial sites. The current criteria for Nunavut Territory consider TPH to include C_6-C_{31} hydrocarbons. The industrial criterion is set at 2,500 ppm, and the residential/parkland criterion is 500 ppm. Only results from an accredited analytical laboratory are accepted by the regulators; the PetroFlag values are not considered reliable enough for direct comparison with the Nunavut Territory site remediation guidelines.

Table 1-1
Results from Contained Hydrocarbon-Contaminated Soils, Boston Camp, July 1999

	Field Screening		Laboratory		
Barrel Number	HVC (ppm)	PetroFlag TPH (ppm)	Analytical TPH (ppm)	Comments:	Exceeds Industrial Criterion? (2,500 ppm)
1-5	0	ns	ns		
5	15	22,300	ns		likely (not proven)
6	20	31,540	21,100	some staining	yes
7-9	5	ns	ns		
10	0	ns	2,141	no staining	likely (barrel sampled from top)
11	0	ns	ns		
12	100	769	629	wet sample, volatilizes quickly as water evaporates, no staining	
13-23	0	ns	ns		
24	0	ns	22,320	easily visible black staining	yes
25-32	0	ns	ns		
33	25	>10,000	13,686	some staining	yes
34-38	0	ns	ns		
39	15	12,740	14,930	some staining	yes
40-52	0	ns	ns		
53	15	12,190	ns	some staining	likely (not proven)
54-59	0	ns	ns		
60	60	5,170	4,142	wet sample, volatilizes quickly as water evaporates	yes
61	0	ns	ns		
62	0	20,640	ns	heavy black motor oil staining	likely (not proven)
63	0	26,510	32,180	heavy black motor oil staining	yes
64	0	ns	ns	heavy black motor oil staining	likely (not proven)
65-69	0	ns	ns		
70	5	10,990	23,660	some staining	yes
71-85	0	ns	ns		

Notes: HVC=Hydrocarbon Vapor Content; TPH=Total Petroleum Hydrocarbon; ns=not sampled.

Soil (pad material) from twelve of the 85 barrels likely exceeded the industrial criterion for TPH. In addition, most TPH concentrations measured were well above the industrial criterion. Of all of the barrels sampled for laboratory analysis, only one barrel did not exceed the criterion (but it did exceed the residential criterion of 500 ppm).

1.2 Recommendations

To be prudent, it should be assumed that all 85 barrels contain hydrocarbon contaminated soil. As the measured concentrations of TPH were well above the industrial criterion in many cases, it is recommended that all 85 barrels be shipped south to an approved facility for remediation. On-site remediation is very difficult in this remote Arctic location, and impractical if personnel are not on-site to regularly monitor and maintain a biopile, landfarm or other such facility. The TPH concentrations will remain above industrial levels as long as the contents remain in the barrels.

In the short term, the barrels should be sealed/covered properly as soon as possible to avoid exposure to precipitation which may cause overflow. Over the long term, it is unlikely that the regulators will permit soils even above the residential/park criterion to remain on-site, and any opportunity to move the barrels south on back haul trips should be taken. Currently, the contaminated soils are sufficiently contained to avoid further environmental contamination, and as long as they are covered properly, could be stored as they are until they can be transported off-site.

2. Soil Sampling at Boston Camp

2. SOIL SAMPLING AT BOSTON CAMP

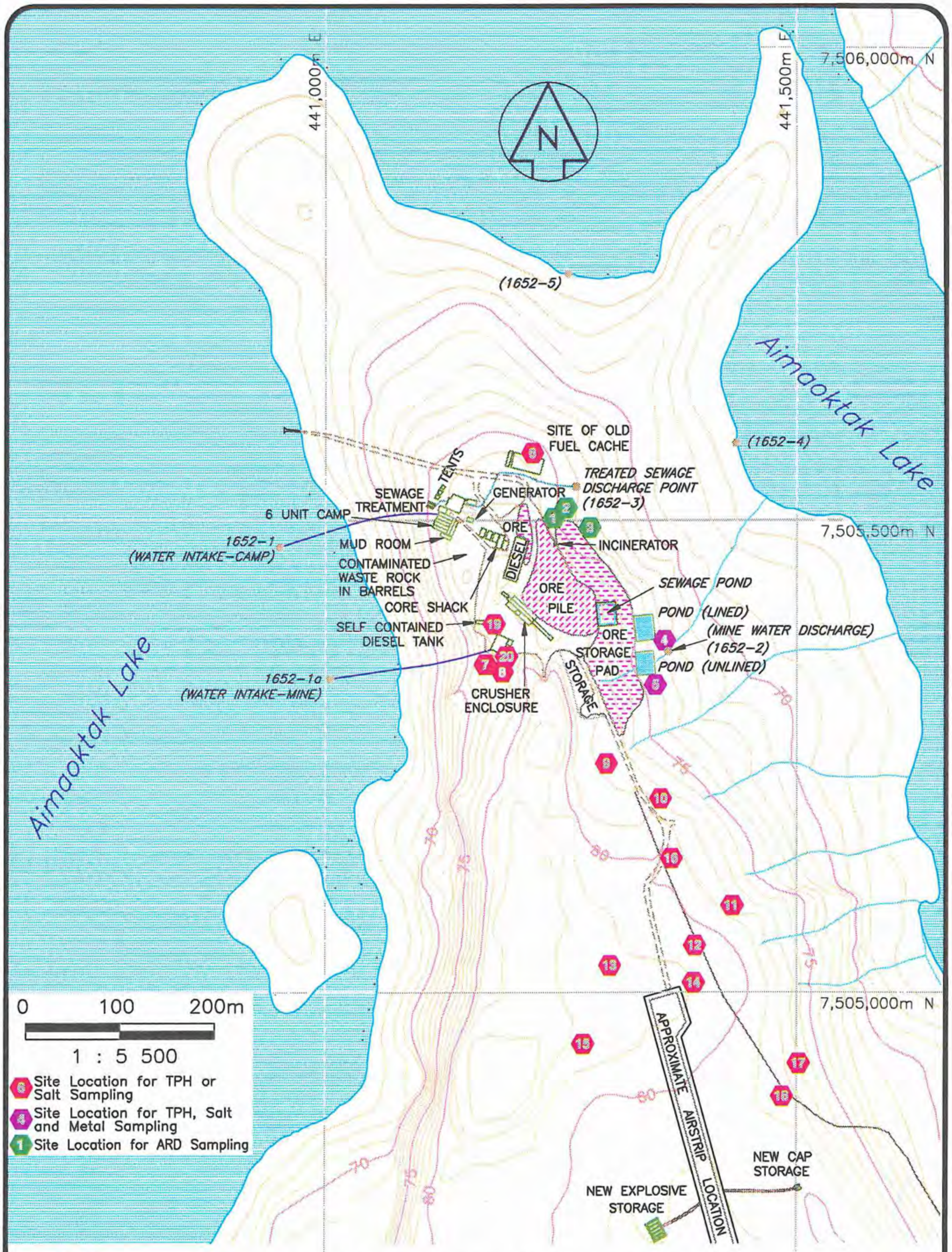
Soil samples were collected from various sites in the vicinity of Boston Camp from July 14 through July 16, 1999. Chris Hanks from BHP toured the site with Rescan personnel and identified where samples were to be taken.

Figure 2-1 indicates site locations where samples were obtained, or where the site was inspected. Table 2-1 indicates the type of samples collected at each site. A photographic record of all site locations is provided in Appendix 2-1.

Table 2-1
Soil Sampling Summary Table for Boston Sites, July 1999

Site Number	Sample Collected for TPH?	Sample Collected for Salts?	Other/Comments
4	yes	yes	samples collected for metals, no odor, impacted vegetation, bentonite slurry material or other sediment (light grey) on native soils; sample was mostly sediment
5	yes	yes	samples collected for metals, no odor, impacted vegetation, bentonite slurry material or other sediment on native soils; sample was mixture of native soil and sediment
6 center	yes	yes	no staining, no odor, impacted vegetation
6 north	no	no	no staining, no odor, impacted vegetation
6 south	no	no	no staining, no odor, impacted vegetation
6 east	yes	yes	no staining, no odor, impacted vegetation
6 west	no	no	no staining, no odor, impacted vegetation
7 middle south	yes	yes	
7 middle	yes	yes	some staining, odors to sampler
7 north	yes	yes	no odor
8	yes	yes	salt burn south of Procon Shop
9	yes	yes	salt burn south of Ore Storage Pad, some greenish colored bentonite
10	yes	yes	salt burn south of Ore Storage Pad, closer to runway than site 9
11	yes	yes	salt burn northeast of runway
12	yes	yes	salt burn northeast of runway, closer to runway than site 11
13	yes	yes	salt burn eastnortheast of northern end of runway, in low lying area
14	yes	yes	salt burn immediately northeast of the runway, no staining, no odor, impacted vegetation, bentonite present
15	yes	yes	salt burn west of northern end of runway, light visible green staining of bentonite, impacted vegetation
16	yes	yes	salt burn east of midpoint on road to runway, no staining, impacted vegetation, bentonite present
17	yes	yes	salt burn, long and linear extends east, no staining, no odor, impacted vegetation, bentonite present near old drill location
18	yes	yes	salt burn, long and linear extends east, no staining, no odor, impacted vegetation, bentonite present near old drill location
19	no	no	hydrocarbon spill at the east end of the Above Ground Storage Tank, visibly stained waste rock pad material due to spillage
20	no	no	hydrocarbon present near the southeast corner of Procon Shop, visibly stained waste rock in pad over very small area

Note: Hydrocarbon Vapor Content was measured using a combustible gas monitor at multiple locations for Sites 6 and 7. All sampled soils were found to have 0 ppm hydrocarbon vapor. It was found that hydrocarbon vapor content was not an indicator of hydrocarbon spills at Boston Camp, but field screening using a PetroFlag instrument was indicative of hydrocarbon presence and correlated fairly well with laboratory results.



BHP

Site Sampling Locations
Boston Camp, July 1999

Figure 2-1

Cad No. C1024 Sht. 1 View L1 1 : 5.5 Job No. 526-9 1999 Hope Bay Belt Projet 08/24/1999- 11:17am RES_AP

2.1 TPH Results

Table 2-2 presents the results from the Total Petroleum Hydrocarbon (TPH) samples collected from various sites. The current criteria for Nunavut consider TPH to include C_6-C_{31} hydrocarbons, and the industrial criterion is set at 2,500 ppm. The residential/parkland criterion is 500 ppm.

Table 2-2
Results from TPH Sampling, Boston Camp, July 1999

Location	Description	Pad or Native Soil	Measured TPH(C_6-C_{31}) (ppm)	Exceeds Industrial Criterion? (2,500 ppm)
Site 4	unknown burn	native soil	10,043	yes
Site 5	unknown burn	native soil	1,380	no
Site 6 east	old fuel cache	native soil	0	no
Site 6 center	old fuel cache	native soil	219	no
Site 7 middle south	behind Procon shop	native soil	0	no
Site 7 middle	behind Procon shop	native soil	31,310	yes
Site 7 north	behind Procon shop	native soil	0	no
Site 8	salt burn	native soil	1,890	no
Site 9	salt burn	native soil	4,070	yes
Site 10	salt burn	native soil	315	no
Site 11	salt burn	native soil	3,435	yes
Site 12	salt burn	native soil	2,149	no
Site 13	salt burn	native soil	726	no
Site 14	salt burn	native soil	3,569	yes
Site 15	salt burn	native soil	7,260	yes
Site 16	salt burn	native soil	1,020	no
Site 17	salt burn	native soil	1,275	no
Site 18	salt burn	native soil	3,630	yes

Notes: TPH=Total Petroleum Hydrocarbons, defined by Nunavut as C_6 to C_{31} (Nunavut is using the GNWT RWED guidelines at present).

As indicated in Table 2-2, soil in the area behind the Procon Shop is highly contaminated. In addition, the soil at Site 4, which is downstream of the settling ponds, was also well over the criterion.

Soils from five of the salt burns (old burn sites; Site 9, 11, 14, 15, 18) tested in the vicinity of the airstrip exceeded the criterion for TPH. Site 12 was very close to exceedance. Some of these salt burns had visible bentonite on the surface of the native soils.

2.2 Salt Parameter Results

Table 2-3 presents the results from the salt parameter sampling for the salt burns in the vicinity of the airstrip. These areas are former drilling platforms, where calcium chloride was used for winter drilling, and sodium chloride for summer drilling to prevent freezing of the drillrods while drilling through the permafrost. Note that no guidelines exist in Canada (Federal, Provincial, or Territorial) for salt content in soils.

Table 2-3
Results from Salt Sampling, Boston Camp, July 1999

Parameter	Units	Site 4	Site 5	Site 6 East	Site 6 Center	Site 7 Middle South	Site 7 Middle
Conductivity	µmhos/cm	659	744	29	28	20	14
% Moisture	%	54.4	52	3.2	9.6	14.1	10.8
pH	pH units	7.22	6.96	5.58	5.87	5.38	5.98
Chloride	mg/dry kg	4620	1860	48	63	26	23
Sodium	mg/dry kg	<0.1	<0.05	<20	<20	<20	<20
Sulphate	mg/dry kg	762	447	24	<10	32	29
Calcium	mg/dry kg	0.29	<0.04	31.4	11.7	9.1	13.6
Magnesium	mg/dry kg	<0.1	<0.05	10	5	3	4
Potassium	mg/dry kg	<0.1	<0.05	<20	<20	<20	<20
SAR		<0.1	<0.05	<0.1	<0.1	<0.1	<0.1

Parameter	Units	Site 7 North	Site 8	Site 9	Site 10	Site 11	Site 12
Conductivity	µmhos/cm	15	350	205	271	454	313
% Moisture	%	12.5	71.5	28.7	23.9	26.8	15
pH	pH units	5.62	7.16	7.87	6.92	7.83	7.72
Chloride	mg/dry kg	11	3110	199	634	1530	955
Sodium	mg/dry kg	<20	206	26	70	106	71
Sulphate	mg/dry kg	23	326	344	49	47	35
Calcium	mg/dry kg	8.9	1530	416	501	907	629
Magnesium	mg/dry kg	4	261	102	130	146	115
Potassium	mg/dry kg	<20	121	24	55	83	44
SAR		<0.1	0.4	<0.1	0.2	0.3	0.2

Parameter	Units	Site 13	Site 14	Site 15	Site 16	Site 17	Site 18
Conductivity	µmhos/cm	388	1090	4750	769	726	3460
% Moisture	%	22.2	17.9	25.2	32.1	25.2	16.6
pH	pH units	7.96	7.84	7.45	7.69	7.8	7.57
Chloride	mg/dry kg	1200	3440	20900	2960	2530	14200
Sodium	mg/dry kg	29	119	1090	293	261	412
Sulphate	mg/dry kg	80	807	1740	66	178	396
Calcium	mg/dry kg	286	1260	7540	1440	1270	5630
Magnesium	mg/dry kg	68	292	1570	344	154	875
Potassium	mg/dry kg	23	223	244	117	197	153
SAR		0.1	0.2	0.9	0.6	0.6	0.4

Note: SAR=Sodium Absorption Ratio, defined as $[Na^{+}]/[Ca^{2}+ + Mg^{2+}]^{0.5}$.

The chloride content of native soils was especially high at Site 15 (20,900 mg/dry kg). Sites can be qualitatively categorized by chloride content in descending order as follows:

- Very High Chloride Levels (>10,000 mg/dry kg): Sites 15, 18;
- High Chloride Levels (1,000-5,000 mg/dry kg): Sites 4, 14, 8, 16, 17, 5, 11, 13;
- Medium Chloride Levels (100-1,000 mg/dry kg): Sites 12, 10, 9; and
- Low Chloride Levels (<100 mg/dry kg): Sites 6, 7.

Soil samples were collected in 1998 in a grid pattern within the area of the 1999 Site 14. Table 2-4 presents results from the salt parameters for this location. From the comparison of 1998 data to 1999 data, there has not been a substantial improvement in the salt content of native soils from this site.

Table 2-4
Results from 1998 and 1999 Salt Testing for Site 14 Salt Burn, Boston Property

Parameter	Units	September 10, 1998[1]	July 15, 1999	1999 compared to 1998?
Conductivity	µmhos/cm	460-1,700	1,090	same
% Moisture	%	20-34	17.9	
pH	pH units	4.8-7.4	7.84	
Chloride	mg/dry kg	1,340-6,180	3,440	same
Sodium	mg/dry kg	56-174	119	same
Sulphate	mg/dry kg	<10-501	807	increase
Calcium	mg/dry kg	570-2,950	1,260	same
Magnesium	mg/dry kg	141-309	292	same
Potassium	mg/dry kg	27-171	223	increase
SAR		0.45-0.81	0.2	reduction

Notes:

1: Three soil samples from 6 cm depth were collected within the Site 14 salt burn in 1998; the range of all three values is presented.

2: SAR=Sodium Absorption Ratio, defined as $[Na^{+}]/[Ca^{2}+ + Mg^{2+}]0.5$.

2.3 Metal Sample Results: Sites 4 and 5

Plate 2-1 indicates the location of Sites 4 and 5 on an aerial photograph. As these sites were downslope of the settling ponds, and the cause of the tundra burns was not completely known, metal samples were collected in addition to TPH and salt parameter samples. The sample collected at Site 4 was probably comprised of drill cuttings, and not native soil. The sample was light grey in color. Soil from Site 5 was a mixture of native soil and sediment/drill cuttings, again with the sedi-

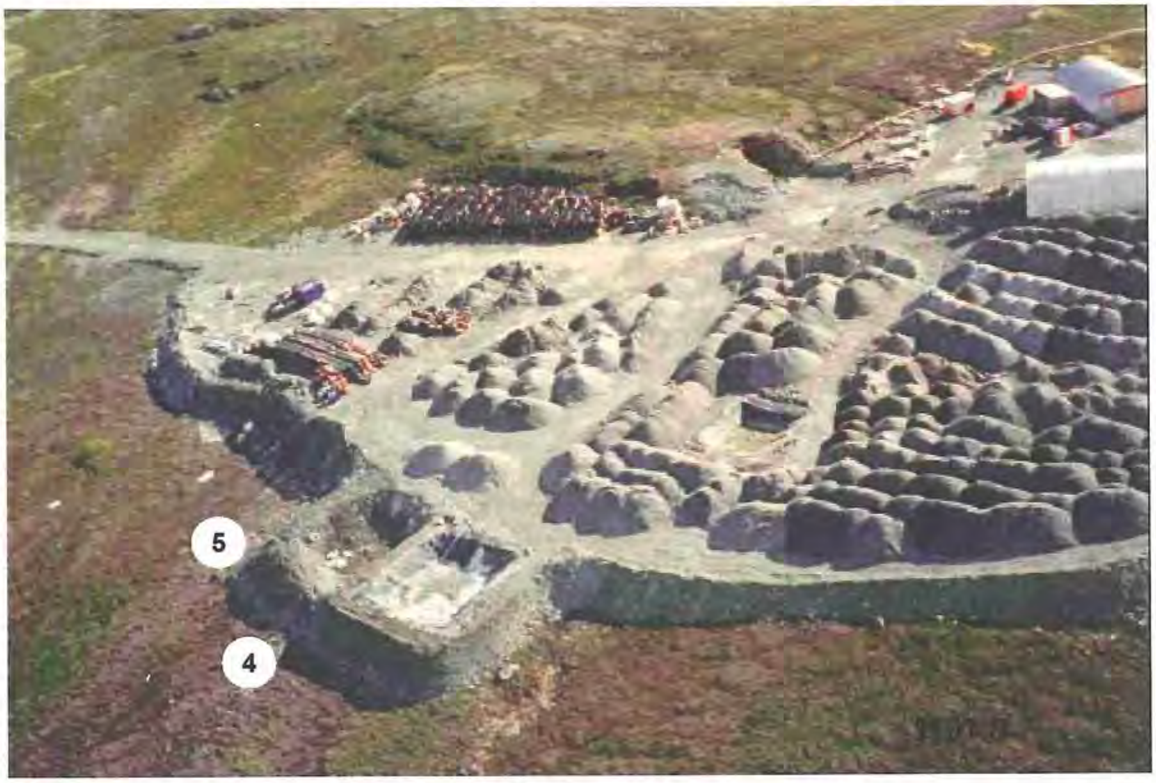


Plate 2-1 - Aerial photograph of Sites 4 and 5, Boston Camp, July 1999.

ment being light grey in color. Samples were collected from the 'most impacted' area within the burn.

Table 2-5 presents the results from the soil metal analyses, along with Federal guidelines for environmental protection. Arsenic and chromium concentrations were extremely high in the sediment found at Site 4. While an environmental concern, these high metal concentrations likely did not cause the tundra burn, as high levels of TPH and chloride were also present.

The likely source of the sedimentary material was drill cuttings which were stored in 'supersacks' and placed inside the unlined southern pond. The drill cuttings would also have contained salt. It is possible that some of the drill cutting material escaped the bags and was washed over/out of the pond onto the tundra during spring runoff.

A water quality sample was collected from standing water located at Site 4, which was in contact with the light grey sedimentary material. Table 2-6 presents the results. The water was slightly acidic, and exceeded the Federal guidelines for the protection of freshwater aquatic life for total arsenic, copper, lead, and nickel. No

Table 2-5
Results of Soil Metal Sampling, Sites 4 and 5, Boston Camp, July 1999

Parameter (mg/dry kg)	Site 4 sediment	Site 5 sediment/ native soil	Federal Soil Guidelines for Environmental Health[1] Industrial	Federal Soil Guidelines for Environmental Health[1] Residential	Comments
Total Metals					
Antimony	<20	<20			
Arsenic	253	19	26	19	Site 4 exceeds criteria
Barium	50	43			
Beryllium	<0.5	<0.5			
Cadmium	<0.5	<0.5	27	10	
Chromium	295	17	87	64	Site 4 exceeds criteria
Cobalt	42	5			
Copper	97	22	100	63	Site 4 almost exceeds upper criterion
Lead	<50	<50	400	250	
Mercury	0.026	0.054	30	10	
Molybdenum	<4	<4			
Nickel	192	15			
Selenium	0.3	0.2			
Silver	5	<2			
Tin	<10	<10			
Vanadium	81	12			
Zinc	118	9	380	200	

1: Canadian Council of Ministers of the Environment, 1997.

samples were collected for dissolved metals. However, these results indicate that the high metal sediment material present on the tundra at Site 4 should be removed.

2.4 Recommendations

2.4.1 Bentonite/TPH/Salt Areas

For native soil sites which had visible bentonite and drilling wastes coating the tundra vegetation along with high TPH concentrations, it is recommended that the bentonite layer be physically removed to the greatest extent possible without further damage to the underlying tundra, followed by the application of fertilizer. The bentonite should be removed gently using hand tools (rake and shovel), and care should be taken to NOT damage the tundra layer.

After removal of the bentonite, standard fertilizer (*e.g.*15/15/15) should be applied topically to the area, ideally in the spring, to facilitate *in situ* bioremediation of

Table 2-6
Results of Water Sampling from Site 4, Boston Camp, July 1999

Parameter	Site 4	CCREM Guidelines
On-Site Parameters		
pH (pH units)	6.64	6.5-9.0
Temperature (°C)	5.4	
Conductivity (mS/cm)	9.75	
Comments:	standing water downstream of bentonite; water was greenish/brownish	
Physical/Nutrients (mg/L)		
Acidity (to pH 8.3)	67	
Alkalinity (Total)	70	
Sulphate	510	
Total Metals (mg/L; ppm)		
Aluminum	0.03	0.005-0.1*
Arsenic	**0.12**	0.05
Chromium	<0.002	0.002
Copper	**0.017**	0.002
Iron	0.07	0.3
Lead	**0.002**	0.001
Mercury	<0.00005	0.0001
Nickel	**0.373**	0.025
Silver	<0.0002	0.0001
Zinc	0.03	0.03

*Total aluminum should not exceed 5 ppb in waters of pH < 6.5. 100 ppb should not be exceeded at pH > 6.5.

Note: Bold values indicate exceedance of CCREM guidelines for the protection of freshwater aquatic life.

residual hydrocarbons. The soils should be moist when the fertilizer is applied, and the fertilizer should be applied as early as possible during the snow-free season to allow for the longest exposure to sun and warm temperatures (but applied after major spring runoff to avoid washout of the fertilizer).

This procedure should be applied to Sites 9, 14, 15, (16), (17), and 18. Sites 16 and 17 do not exceed the industrial TPH criterion, but are still twice as high as the residential criterion and would benefit from similar treatment. Any other areas with obvious bentonite layers should be treated similarly.

2.4.2 TPH/Salt Areas

It is recommended that fertilizer be applied to Site 11 as previously described. Sites 12 and 8 approached the TPH industrial criterion limit, and should also be treated.

2.4.3 Salt Areas

Sites 15 and 18 had exceptionally high concentrations of chloride and other ions. One risk of such high salt concentrations is that it could potentially cause melting of the permafrost. Localized melting of the permafrost could result in subsidence over time.

Holes or obvious depressions found at any of the salt burn areas should be filled with gravel or available uncontaminated soil. Where possible, the existing tundra should be initially removed and placed back over the area once it has been back filled. Any pits or excavations that are dug should not be left open longer than 24 hours. This will ensure that an insulating layer remains over the permafrost, and help prevent thawing.

2.4.4 Sites 4 and 5; Downslope of Settling Ponds

Sites 4 and 5 represent single soil samples that were collected within a large disturbed area downslope of the settling ponds, and were collected at the 'most impacted' locations within the burn. The soil sample collected at Site 4 was sedimentary in nature and not tundra/organic. Based on the analysis, all of the sedimentary material at this location should be considered to be high in arsenic and chromium (copper as well) and should be removed and contained as soon as possible. The water quality sample collected at Site 4 indicated that metals were present in standing water in contact with the high metal sedimentary material.

It is recommended that the sedimentary material, which is light grey in color, be physically removed (using shovels and rakes) as soon as possible from the tundra and placed into lined barrels or other leak-proof containers. This material is high in arsenic and chromium (and copper), and should be removed prior to freeze up and spring runoff in the year 2000. In its present condition, the sediment material could be transported further towards Aimaoktak Lake during spring runoff if it is not removed.

The majority of the tundra burn could likely benefit from a topical fertilizer application, as described previously for the TPH and salt burn sites.

A second more thorough assessment of this area will be conducted on August 31, 1999, in which the extent of the contamination will be delineated. Other samples within the burn but outside of the sediment (possibly drill cuttings) will be collected, as well as samples below the sediment in order to determine if native soils have been impacted by the high metal laden sediment.

2.4.5 Other Areas

The area behind the Procon shop and immediately below the pad on the native soil was visually inspected. Based on the observations it is recommended that fertilizer be applied on the waste rock and tundra in this area.

On the pad, there were several areas with obvious hydrocarbon staining, primarily around the Procon shop and the above ground fuel storage tank. The regular spilling of fuel while refuelling could be reduced by modifying the hose to accommodate the required sizes of quick-clip connectors (likely two). There should be a catchment basin present during active fuelling periods.

3. Water Sampling of Stockpiles/Orepiles at Boston Camp

3. WATER SAMPLING OF STOCKPILES/OREPILES AT BOSTON CAMP

A brief assessment of the stockpiles/orepiles at Boston Camp was conducted on July 14, 1999 and a follow-up assessment was conducted on August 31, 1999. No standing or running water was evident amongst the piles or downstream from the pad during either assessment.

During the July assessment, on-site water quality parameters (pH, temperature, conductivity) were measured at three sites and samples for laboratory analysis were collected from two of the sites. During the August assessment, a water quality sample for laboratory analysis was collected from one site. Plate 3-1 indicates the location of Sites 1, 2 and 3. Photographs of each site are provided in Appendix 3-1. The August sample was collected from Site 1 and the July samples were collected from Sites 2 and 3.

Plate 3-1 - Aerial photograph of water sampling locations (Sites 1 to 3), Boston Camp, July 1999.

As can be seen from the photographs, standing water of a brownish color was present at Sites 1 and 2 in both July and August. There was no obvious surface drainage of this water onto the tundra. At Site 3 in July, water was present below the pad under large boulders, where there was an abundance of green algal growth. In addition, it appeared that water had been flowing downslope (towards the lake), and both filamentous and bulbous green algae were present in the drainage area. A water sample was collected at Site 3 immediately downstream of where the pad meets the tundra.

3.1 Results and Discussion

Table 3-1 presents the results of on-site and laboratory measurements. All raw data from the analytical laboratory are provided in Appendix 1.

Table 3-1
Water Quality Results, Boston Stockpiles, July 1999

Parameter	Site 1 (July 14, 1999)	Site 1 (Aug. 31, 1999)	Site 2 (July 14, 1999)	Site 3 (July 14, 1999)	CCREM Guidelines
On-site Parameters					
pH (pH units)	8.22	7.48	8.36	7.74	6.5 - 9.0
Temperature (°C)	8.6		9.0	5.9	
Conductivity (mS/cm)	2.81	3.47	2.83	2.45	
Comments:	standing water on road between piles; near the incinerator	standing water on road between piles; near the incinerator	standing water on northern-most part of pad next to piles	filamentous and bulbous green algae present in runoff; under rocks and downstream of drainage	
Physical/Nutrients (mg/L)					
Acidity (to pH 8.3)	see results for Site 2	22	18	39	
Alkalinity (Total)		282	230	286	
Sulphate		597	355	380	
Ammonia				13.3	1.37 - 2.20
Nitrate				8.18	
Total Phosphate				1.31	
Total Metals (mg/L; ppm)					
Aluminum	see results for Site 2	**0.500**	**0.103**	**0.318**	0.005-0.1*
Arsenic		**1.80**	**2.02**	**1.16**	0.05
Calcium		230	169	171	
Chromium		**0.008**	<0.003	<0.003	0.002
Copper		**0.0180**	**0.0161**	**0.0139**	0.002
Iron		**3.91**	**2.8**	**2.6**	0.3
Lead		**0.0020**	**0.0015**	**0.0024**	0.001
Magnesium		120	73.4	73.7	
Mercury		<0.00005	<0.00005	<0.00005	0.0001
Nickel		**1.16**	**1.12**	**0.989**	0.025
Potassium		64	40	38	
Silver		0.0001	0.00009	**0.00011**	0.0001
Sodium		344	209	203	
Zinc		0.011	0.009	0.013	0.03

***Total aluminum should not exceed 5 ppb in waters of pH < 6.5. 100 ppb should not be exceeded at pH > 6.5.**
Notes: Bold values indicate exceedance of CCREM guidelines for the protection of freshwater aquatic life.
August 31 pH and conductivity were not measured on-site; values from the analytical laboratory are reported.

Although the pH of the water samples is somewhat basic (7.5 - 8.4), the water chemistry suggests that acid has been produced by the material in the stockpiles and has been neutralized. Acid generation is indicated by a number of parameters, including conductivity, sulphate and various metals.

Conductivity reflects the ionic strength of a solution and it is strongly influenced by sulphate concentration. The high values of conductivity (2.5 - 3.5 mS/cm) correspond to the high sulphate concentrations (355 - 597 mg/L) measured in the samples. High sulphate concentrations are indicative of sulphide oxidation, which in turn is associated with acid production; depending on the sulphide mineral, increased sulphide oxidation usually results in increased acid production. The release of acid by the stockpile material was likely caused the dissolution of neutralizing minerals such as carbonates and/or feldspars. The dissolution of neutralizing minerals is most likely responsible for the high concentrations of base cations (Ca, Mg, K, Na) measured in the water samples. The high calcium and magnesium concentrations can be attributed to carbonate dissolution (most likely dolomite), while the elevated potassium and sodium concentrations are probably due to feldspar dissolution. The basic pH measured in the samples indicates that dissolution of neutralizing minerals was sufficient to buffer acid production.

The elevated concentrations of arsenic (1.2 - 2.0 mg/L), iron (2.6 - 3.9 mg/L) and nickel (1.0 - 1.2 mg/L) are consistent with the results of kinetic testing conducted on samples of Boston Property rock in 1997 and 1998. The results of this testwork indicated that certain metals, in particular arsenic and nickel, could be expected to leach preferentially from Boston rock, especially rock originating from in and around the ore zone (*e.g.* B2 mineralized zone or B3 alteration halo). Iron concentrations are typically high in acid rock drainage due to the oxidation of sulphides, which frequently contain iron. In the case of Boston material, mineralogical analyses detected the presence of arsenopyrite and chalcopyrite. Furthermore, ankerite (an iron carbonate) is common throughout the Boston deposit and dissolution of ankerite due to acid production could also contribute to the observed iron concentrations.

3.2 Conclusions and Recommendations

The results of water quality analyses performed on samples collected in the region of the stockpiles/orepiles and pad during the July, 1999 assessment and the follow-up assessment in August, 1999 are what would be expected based on kinetic testwork performed on Boston material in 1997 and 1998. High conductivity and elevated concentrations of sulphate and various metals (base cations, arsenic, iron, nickel) are indicative of sulphide oxidation and subsequent acid production. As was recommended in the report submitted in February, 1999 (Acid Rock Drainage Characterization - Boston Property (Waste Rock); Rescan, 1999), the stockpiles/orepiles should be covered to minimize infiltration and a collection/diversion system should be installed to prevent drainage from entering receiving waters.

4. Soil Sampling at Patch Lake and Windy Camp

4. SOIL SAMPLING AT PATCH LAKE AND WINDY CAMP

Site assessments were conducted and samples collected at the major salt burn at the south end of Patch Lake, the all terrain vehicle burn at the south end of Patch Lake, and at two areas behind tents at Windy Camp. A soil sample for salt parameter analysis was collected at the two Patch Lake sites, and a soil sample for TPH analysis was collected at the all terrain vehicle site and the two tent sites at Windy Camp. Photographs of all sites are provided in Appendix 4-1. Table 4-1 presents selected analytical results from the four sites.

Table 4-1
Analytical Results for Patch Lake and Windy Camp Soil Samples

Parameter (mg/kg dry wt)	Patch Lake Salt Burn	All Terrain Vehicle Burn	4th Tent from North	7th Tent from North
Salt Parameters				
Conductivity (µmhos/cm)	419	29		
% Moisture	21.5	40.2	34.2	43.2
pH	6.16	6.76		
Chloride	48	40		
Sodium	42	41		
Sulphate	1570	66		
Calcium	71.8	52.5		
Magnesium	100	28		
Potassium	52	<20		
Sodium Adsorption Ratio (SAR)	0.2	0.4		
TPH (C_6-C_{31})		5,521	13,096	16,054

Patch Lake Salt Burn: The chloride concentration in the native soil at the Patch Lake salt burn was low relative to other salt spill areas at Boston Camp. Only one sample was collected from within the burn area, however. The area showed signs of recovery, as native vegetation was beginning to regrow within the burn area. The area should be left to naturally recover.

Patch Lake All Terrain Vehicle Burn: The soil sample collected within this burn area indicated that TPH concentrations were over the remediation criterion of 2,500 ppm. The area is quite small, and signs of natural revegetation around the periphery of the area were observed. It is recommended that fertilizer be applied topically after spring runoff and the small area be allowed to recover naturally.

Tent Sites at Windy Camp: Both areas tested behind tents at Windy Camp recorded levels well over the remediation criterion for TPH. However, some of the spilled diesel fuel was likely a result of the wind storm which moved the tents/platforms/barrels.

It is highly recommended that the manner in which the diesel barrels are stored behind the tents for the diesel stoves be modified and that damages caused by the wind storm be repaired. The barrels should be relocated off of the tundra, and have a catchment (*i.e.* impermeable barrier/liner) installed under them. A PVC pipe should be used to capture any dripping fuel from the fuel line (this set-up was observed behind some of the tents), which would be collected in the catchment basin. Ideally the volume of the catchment basin should be large enough to contain any spill which may occur. Some type of covering should be placed over the barrels to prevent precipitation from overflowing the catchment, and the catchment should be monitored regularly and cleaned up as necessary with sorbents.

It is recommended that the areas examined be physically tidied up as much as possible, and that the barrels be set up in a manner where spilled diesel can be contained, and that affected areas be treated with fertilizer as described previously.

5. Water Quality Sampling at Windy Camp

5. WATER QUALITY SAMPLING AT WINDY CAMP

Samples for water quality were collected from two locations at Windy Camp, downstream of the incinerator, and downstream of the fuel barrel cache. Both locations had standing water present. Samples were analyzed for physical parameters, fecal coliform, total metals, and TPH.

Results from the analyses are provided in Appendix 1 along with all other analytical results. Water quality results obtained at the two sites were compared to the Federal guidelines for the protection of freshwater aquatic life. All parameters measured were below the guideline for the protection of aquatic life, with most parameters being well below the relevant criteria. The only exception was total iron measured downstream of the incinerator. This result could have arisen from the inclusion of a small amount of sediment material.

There was a slight sheen on the standing water in both areas. However, natural sheens do occur, and no extractable hydrocarbons were detected in the water samples (however no attempt was made to collect only the surface of the water).

The results of the fecal coliform analysis were negative; there was no fecal coliform in any of the samples. A water sample was also collected from the tap in the Windy kitchen, and no fecal coliform was detected.

Overall, there was no evidence of contamination for metals or bacteria of water that was sampled downstream of the incinerator and fuel caches at Windy Camp in July of 1999.

6. Water Quality Sampling of Aimaoktak, Windy, and Wolverine Lakes

6. WATER QUALITY SAMPLING OF AIMAOKTAK, WINDY AND WOLVERINE LAKES

Water samples were collected in Aimaoktak, Windy, and Wolverine lakes in order to fulfill water license requirements and to examine whether any runoff from camp activities was entering/affecting the shore region of each lake. Samples collected from the middle of the lakes corresponded with existing baseline stations in order to utilize the results in future monitoring programs.

6.1 Methods

Samples were collected using a Teflon-lined 5 L Go-Flo bottle, metered cable, and Teflon-coated messengers. All samples were collected in duplicate. Samples collected over the deep parts of the lakes, labelled as 'control' in the analytical results, were collected from 1 m depth. Samples collected from nearshore were collected below the surface at approximately 0.3 m depth.

For Aimaoktak Lake, a boat and engine stationed at Boston Camp were used. Samples were collected near Station 6 in Aimaoktak Lake and at Station 2 near the freshwater intake for the camp.

For Windy Lake, a boat and engine stationed at Windy Camp were used. After the Windy Lake sampling was completed, the boat was slung by helicopter to Wolverine Lake, and returned to Windy Camp after the sampling at Wolverine Lake was completed. Nearshore samples were collected from the docks on both lakes.

6.2 Results

There was a continuous, strong wind present during the field trip, which was causing suspension of sediment material in the nearshore areas of all major lakes observed (Plate 6-1). This caused naturally elevated concentrations of aluminum, iron, and some other metals in the nearshore water samples from the two larger lakes, Aimaoktak and Wolverine.

6.2.1 Aimaoktak Lake

Results from the fecal coliform analysis were negative.

A comparison of data from Station 6 (offshore, deep part of lake) and Station 2 (nearshore next to freshwater intake) indicated no major differences between the

Plate 6-1 - Suspension of nearshore sediment from strong winds, July 1999.

water quality nearshore and offshore. Total aluminum, iron, silicon, and total suspended solids were greater at Station 2 compared to Station 6 due to the suspension of nearshore sediments by wind action.

All metal parameters were below the Federal guidelines for the protection of freshwater aquatic life. The only exception was replicate 2 from nearshore, which had a total mercury concentration matching the criterion.

Overall, there was no evidence of Boston Camp activities detrimentally affecting the water quality along the shore of Aimaoktak Lake northwest of camp (Station 2).

6.2.2 Windy Lake

Results from the fecal coliform analysis were negative.

Water quality in Windy Lake was similar for the nearshore and offshore areas sampled. Total aluminum, iron, and silicon were greater nearshore compared to offshore due to the suspension of nearshore sediments by wind action. This phenomenon also occurred at Aimaoktak Lake.

All metal concentrations measured in Windy Lake were below the Federal guidelines for the protection of freshwater aquatic life. The only exception was total aluminum in the nearshore samples, which were at the criterion concentration. Again, the elevated total aluminum concentrations were likely due to the suspension of sediments, as indicated by the elevated iron and silicon concentrations as well.

Overall, there was no evidence of Windy Camp activities detrimentally affecting the water quality along the shore of Windy Lake near the dock.

6.2.3 Wolverine Lake

Results from the fecal coliform analysis were negative. Fecal coliform counts have been high in waters around this camp in the past, but no evidence of fecal coliform was found along the shore of Wolverine Lake by the dock in July 1999.

The water quality in Wolverine Lake was similar for the nearshore and offshore areas sampled. All metal parameters were well below the Federal criteria for the protection of freshwater aquatic life.

Overall, there was no evidence of Wolverine Camp activities detrimentally affecting the water quality along the shore of Wolverine Lake near the dock.

7. Additional Soil Sampling at Boston Camp

7. ADDITIONAL SOIL SAMPLING AT BOSTON CAMP

A second more thorough assessment of the area downstream/downslope of the settling ponds at Boston Camp was conducted on August 31, 1999. The objective of this survey was to more thoroughly delineate the potentially contaminated area, as two samples collected during the July survey contained high levels of arsenic, chromium, total petroleum hydrocarbons, and salt.

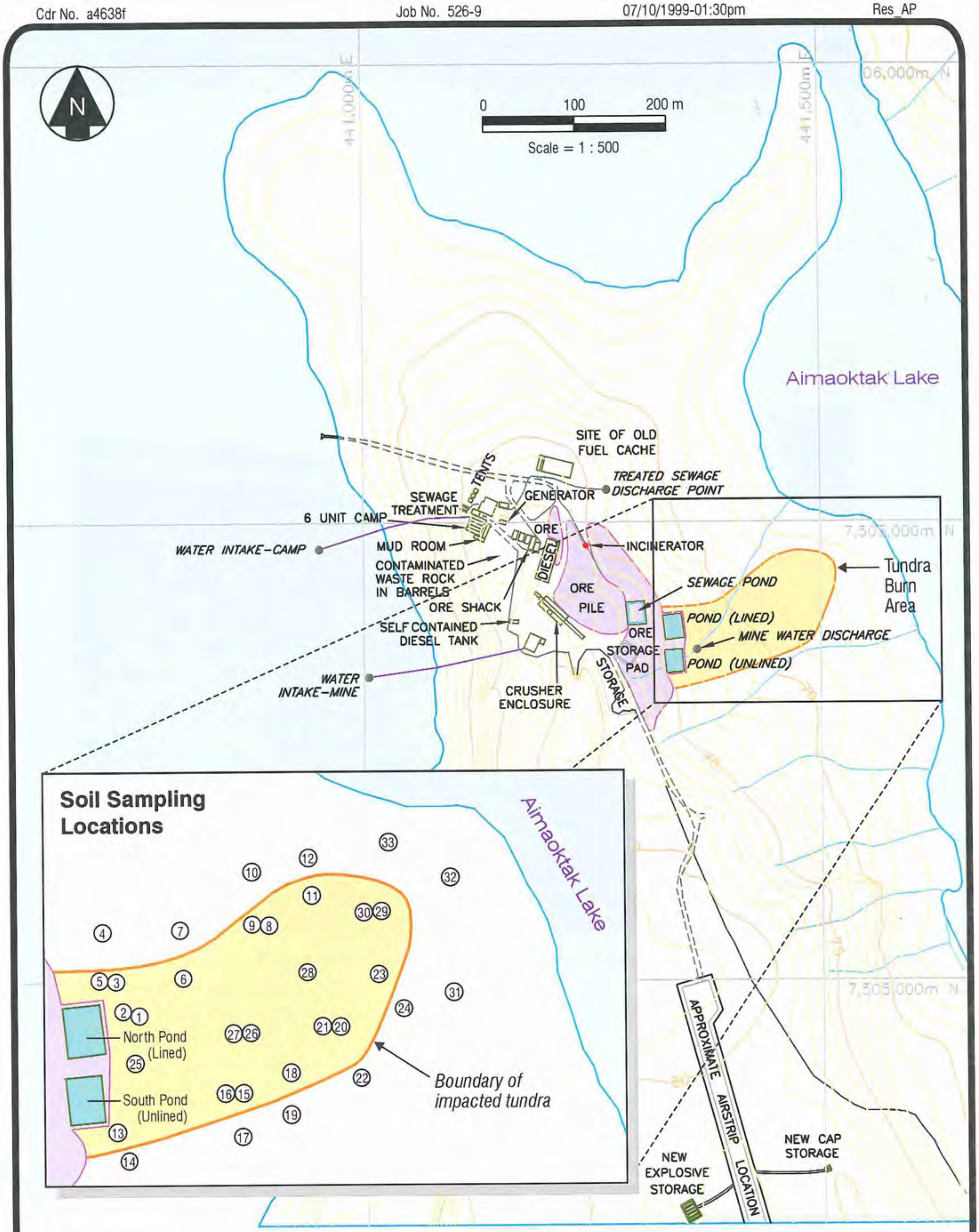
7.1 Methods

A total of 33 soil samples were collected in the vicinity of the visibly impacted tundra (tundra burn), with 12 of the samples being collected outside of the impacted area. Samples were collected from both the surface and subsurface (deeper than 10 cm) in order to determine if contaminants were leaching into the native soils below the tundra vegetation mat.

Figure 7-1 depicts the area downslope of the settling ponds that was surveyed and the location of all samples collected. Plate 7-1 is a photograph of the area, with the boundary depicted in the photograph corresponding with the boundary of the impacted area illustrated in Figure 7-1. Sampling locations 25 and 13 from the August survey corresponded with sites 4 and 5 from the July survey, respectively. A photographic record of all sampling sites is included in Appendix 7-1.

All soil samples were sent to Analytical Service Laboratories in Vancouver for analysis of total metals, salt parameters, and hydrocarbon parameters. The analytical results are provided in Appendix 7-2.

Cdr No. a4638f Job No. 526-9 07/10/1999-01:30pm Res_AP



Location of Tundra Burn Area and Soil Sampling Locations, August 31, 1999

FIGURE 7-1

Plate 7-1 - Tundra burn downslope of settling ponds at Boston Camp, August 31, 1999. The line around the tundra burn corresponds to the shaded area depicted in Figure 7-1.

7.2 Results

Figure 7-2 indicates the tundra burn area, and depicts the areas within the impacted zone that exceed either metal or hydrocarbon criteria. In general, the area between the two ponds and immediately downslope was contaminated with arsenic, chromium, copper, hydrocarbons, and salt. Contamination was continuous throughout the burn extending downslope to sampling location 29. Areas downslope of sampling location 29 (sampling locations 31, 32, and 33) were uncontaminated. The area adjacent to the northern edge of the northern pond was also contaminated with arsenic, chromium, copper, and hydrocarbon concentrations all exceeding industrial criteria (sampling location 3).

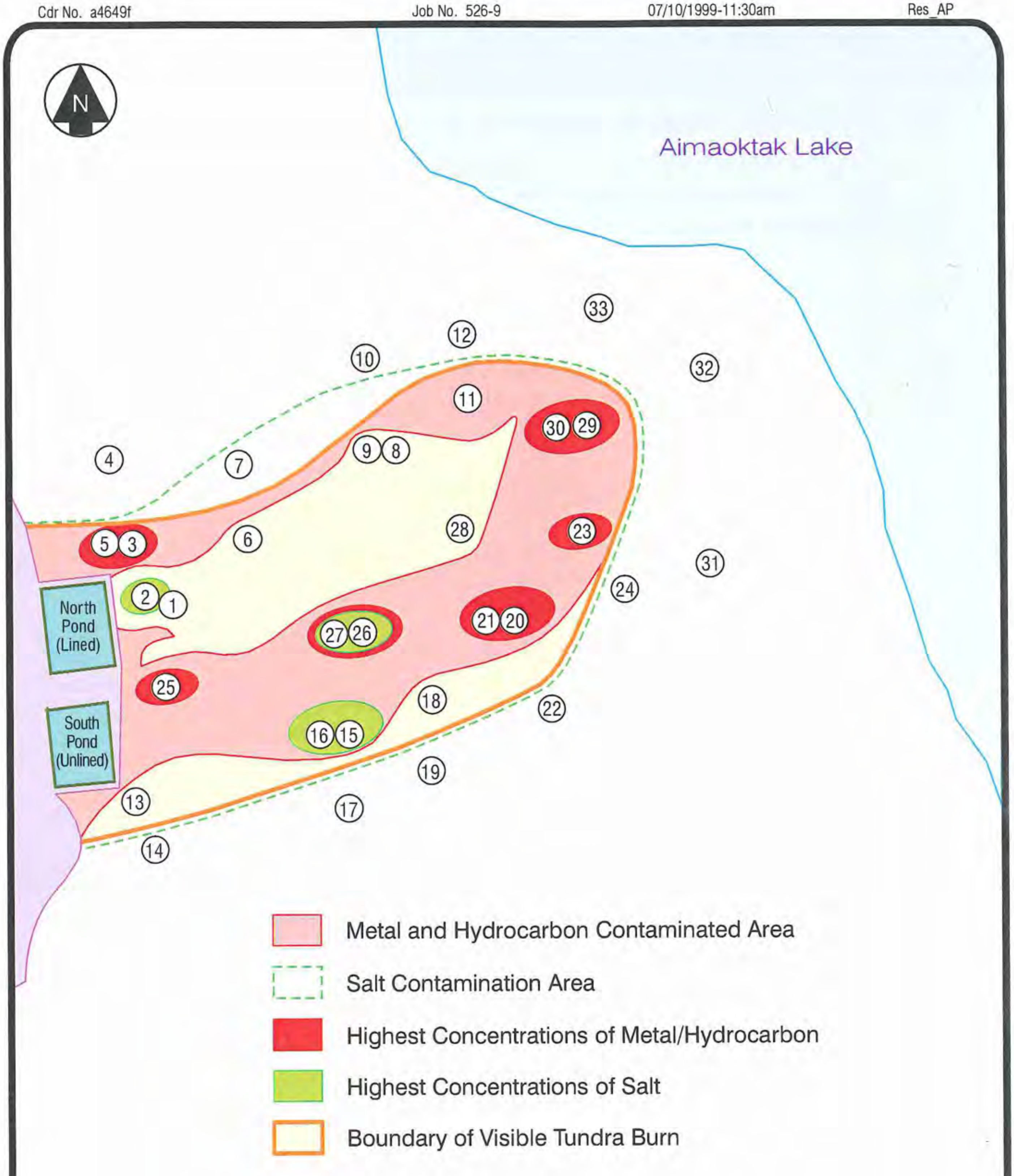
Table 7-1 presents analytical results for those sampling locations where soil criteria were exceeded. The industrial criterion for arsenic levels in soil (26 ppm) was exceeded at sampling locations 3, 15, 23, 25, 26, and 29, with sampling location 29 having the highest concentration at 321 ppm. Arsenic levels were also high (exceeded residential criterion of 19 ppm) at locations 11 and 20. Subsurface samples did not have elevated arsenic levels.

The industrial criterion for chromium levels in soil (87 ppm) was exceeded at sampling locations 3, 20, 23, 25, and 26, with sampling location 3 having the highest concentration at 367 ppm. There was some evidence of subsurface contamination at sampling location 16.

The industrial criterion for soil copper concentrations (100 ppm) was exceeded at sampling locations 3, 20, 25, 26, and 29. Sampling location 29 had the greatest concentration of copper (224 ppm). The residential criterion was exceeded at sampling location 11. There was no evidence of elevated subsurface concentrations.

The industrial criterion for total petroleum hydrocarbons (TPH; 2,500 ppm) was exceeded at sampling locations 3, 20, 25, and 26. The greatest TPH concentration was found at sampling location 25 (8,368 ppm). TPH concentrations were also high (above residential criterion of 500 ppm) at sampling locations 2, 8, 11, 23, and 29.

Cdr No. a4649f Job No. 526-9 07/10/1999-11:30am Res_AP



Areas of Contamination within the Tundra Burn Downslope of Settling Ponds, Boston Camp, August 31, 1999

FIGURE 7-2

BHP

Rescan™

Very high chloride levels (>10,000 mg/dry kg) were found at sampling locations 2, 8, 15, 16 and 26. Chloride levels at sampling locations 15 and 16 were extremely high in both surface and subsurface soils (141,000 and 21,800 ppm, respectively). High levels of chloride (>1,000 mg/dry kg) were found at most sampling locations (surface and subsurface) within the footprint indicated in Figure 7-2.

Table 7-1
Selected Results from Additional Soil Sampling, Boston Camp, August 1999

Parameter	Sampling Locations										Federal Soil Guidelines[1] (ppm)	
(mg/dry kg; ppm)	2	3	8	15	16	20	23	25	26	29	Industrial	Residential
Arsenic	<10	105	10	43	<10	21	89	190	319	321	26	19
Cadmium	<4	<2	<2	<4	<4	<2	<2	<2	<2	<2	27	10
Chromium	33	367	26	14	43	125	169	364	356	13	87	64
Copper	50	115	20	29	30	185	157	143	102	224	100	63
Lead	<100	<50	<50	<100	<100	<50	<50	<50	<50	<50	400	250
Zinc	39	74	53	23	49	128	99	148	148	130	380	200
TPH	335	3,216	522	368	<200	8,040	1,439	8,368	6,189	1,390	2,500	500
Chloride	12,500	2,590	10,100	141,000	21,800	5,400	92	6,750	11,800	2,780		

1: Candian Council of Ministers of the Environment, 1997.

2: Total Petroleum Hydrocarbons, C_8 - C_{31}.

7.3 Recommendations

The source of the contaminants is likely drill cuttings that contain salts which were disposed of in the southern unlined pit in supersack bags (see photograph in Appendix 7-1). TPH contamination from an unknown source has and may still exist.

Regardless of the source, the areas with obvious sedimentary material (light grey in color) should be cleaned up by physically removing the overlying sediment material (using shovels, rakes, and other hand tools) as soon as possible from the tundra and placed into lined barrels or other leak-proof containers. This material is high in arsenic, chromium, and copper, and these metals have largely remained on the surface thus far. Care should be taken to not damage any vegetation still present.

Hydrocarbon contamination has fortunately remained within the surface soils. The entire area could benefit from fertilizer application once the sedimentary material has been physically removed. If the camp is in operation in the future, the outfall hose for the treated sewage could be placed so that it drains over the impacted area. This has met with some success for a tundra burn just north of the one in question.

The salt has unfortunately penetrated into subsurface soils. The worst spot tested was at sampling locations 15 and 16. If no vegetation mat is present, contaminated soil should be removed from this location and replaced with uncontaminated soil of some kind (*e.g.* gravel). If a vegetation mat is present, it should be cut out and retained if possible and placed back over the area after replacing the underlying soil.

Based on the results of these soil contamination assessments, drill cuttings should not be placed in the ponds. The lined pond had gaps in the liner when inspected in July of 1999. The ponds were only designed to filter out suspended sediments from water collected from the underground bulk sampling operation, and were never intended to be used as disposal sites.

References

REFERENCES

Canadian Council of Ministers of the Environment. 1997. *Recommended Canadian Soil Quality Guidelines.*

Canadian Council of Resource and Environmental Ministers. 1987. *Canadian Water Quality Guidelines.* Task Force on Water Quality Guidelines. 679 pp. Including all updates.

Rescan. 1999. *Acid Rock Drainage Characterization - Boston Property Waste Rock.* Rescan™ Environmental Services Ltd. Report prepared for BHP Diamonds Inc.

Appendix 1
Analytical Results from Soil and Water Samples, Hope Bay Belt, July 1998

Rescan™

1988 Triumph Street, Vancouver, B.C., Canada V5L 1K5
analytical
service
laboratories
ltd.
FAX: (604) 253-6700 TEL: (604) 253-4188

CHEMICAL ANALYSIS REPORT

Date:	August 3, 1999
ASL File No.	K7755
Report On:	526-9 Soil Analysis
Report To:	**Rescan Environmental Services** Sixth Floor 1111 West Hastings Street Vancouver, BC V6E 2J3
Attention:	**Ms. Deborah Muggli**
Received:	July 17, 1999

ASL ANALYTICAL SERVICE LABORATORIES LTD.
per:

Frederick Chen, B.Sc. - Manager, Special Projects
Katherine Thomas, B.Sc. - Supervisor, Trace Metals Lab

Specialists in Environmental Chemistry

REMARKS File No. K7755

Additional analyses for Total Petroleum Hydrocarbons (TPH: VH (C6-10) + EPH (C10-18) + EPH (C19-31)) were requested 26 July 1999 for thirteen samples identified as "Sites 8-18" and "Sites 4-5." Please note laboratory subsamples were already taken for other analyses on these particular samples. Since only one container per sample was submitted, some loss of volatile hydrocarbons may have occurred.

RESULTS OF ANALYSIS - Sediment/Soil

File No. K7755

Sample ID		Drum 6	Drum 10	Drum 12	Drum 24	Drum 33
Sample Date		99 07 15	99 07 15	99 07 15	99 07 15	99 07 15
Physical Tests						
Moisture	%	1.4	5.3	9.4	0.7	3.3

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per dry kilogram except where noted.
< = Less than the detection limit indicated.
VPH = Volatile Petroleum Hydrocarbons.
EPH = Extractable Petroleum Hydrocarbons.

RESULTS OF ANALYSIS - Sediment/Soil

File No. K7755

Sample ID		Drum 39	Drum 60	Drum 63	Drum 70	Site 6 East
Sample Date		99 07 15	99 07 15	99 07 15	99 07 15	99 07 15
Physical Tests						
Conductivity	(umhos/cm)	-	-	-	-	29
Moisture	%	2.5	6.3	0.9	2.0	3.2
pH		-	-	-	-	5.58
Dissolved Anions						
Chloride	Cl	-	-	-	-	48
Sulphate	SO4	-	-	-	-	24
Extractable Metals						
Calcium	Ca	-	-	-	-	31.4
Magnesium	Mg	-	-	-	-	10
Potassium	K	-	-	-	-	<20
Sodium Adsorption Ratio (SAR)		-	-	-	-	<0.1
Sodium	Na	-	-	-	-	<20

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per dry kilogram except where noted.
< = Less than the detection limit indicated.
VPH = Volatile Petroleum Hydrocarbons.
EPH = Extractable Petroleum Hydrocarbons.

RESULTS OF ANALYSIS - Sediment/Soil

File No. K7755

Sample ID		Site 6 Centre	Site 7 Middle South	Site 7 Middle	Site 7 North	Site 8
Sample Date		99 07 15	99 07 15	99 07 15	99 07 15	99 07 15
Physical Tests						
Conductivity	(umhos/cm)	28	20	14	15	350
Moisture	%	9.6	14.1	10.8	12.5	71.5
pH		5.87	5.38	5.98	5.62	7.16
Dissolved Anions						
Chloride	Cl	63	26	23	11	3110
Sulphate	SO4	<10	32	29	23	326
Extractable Metals						
Calcium	Ca	11.7	9.1	13.6	8.9	1530
Magnesium	Mg	5	3	4	4	261
Potassium	K	<20	<20	<20	<20	121
Sodium Adsorption Ratio (SAR)		<0.1	<0.1	<0.1	<0.1	0.4
Sodium	Na	<20	<20	<20	<20	206

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per dry kilogram except where noted.
< = Less than the detection limit indicated.
VPH = Volatile Petroleum Hydrocarbons.
EPH = Extractable Petroleum Hydrocarbons.

RESULTS OF ANALYSIS - Sediment/Soil

File No. K7755

Sample ID		Site 9	Site 10	Site 11	Site 12	Site 13
Sample Date		99 07 15	99 07 15	99 07 15	99 07 15	99 07 15
Physical Tests						
Conductivity	(umhos/cm)	205	271	454	313	388
Moisture	%	28.7	23.9	26.8	15.0	22.2
pH		7.87	6.92	7.83	7.72	7.96
Dissolved Anions						
Chloride	Cl	199	634	1530	955	1200
Sulphate	SO4	344	49	47	35	80
Extractable Metals						
Calcium	Ca	416	501	907	629	286
Magnesium	Mg	102	130	146	115	68
Potassium	K	24	55	83	44	23
Sodium Adsorption Ratio (SAR)		<0.1	0.2	0.3	0.2	0.1
Sodium	Na	26	70	106	71	29

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per dry kilogram except where noted.
< = Less than the detection limit indicated.
VPH = Volatile Petroleum Hydrocarbons.
EPH = Extractable Petroleum Hydrocarbons.

RESULTS OF ANALYSIS - Sediment/Soil

File No. K7755

Sample ID		Site 14	Site 15	Site 16	Site 17	Site 18
Sample Date		99 07 15	99 07 15	99 07 15	99 07 15	99 07 15
Physical Tests						
Conductivity	(umhos/cm)	1090	4750	769	726	3460
Moisture	%	17.9	25.2	32.1	25.2	16.6
pH		7.84	7.45	7.69	7.80	7.57
Dissolved Anions						
Chloride	Cl	3440	20900	2960	2530	14200
Sulphate	SO4	807	1740	66	178	396
Extractable Metals						
Calcium	Ca	1260	7540	1440	1270	5630
Magnesium	Mg	292	1570	344	154	875
Potassium	K	223	244	117	197	153
Sodium Adsorption Ratio (SAR)		0.2	0.9	0.6	0.6	0.4
Sodium	Na	119	1090	293	261	412

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per dry kilogram except where noted.
< = Less than the detection limit indicated.
VPH = Volatile Petroleum Hydrocarbons.
EPH = Extractable Petroleum Hydrocarbons.

RESULTS OF ANALYSIS - Sediment/Soil

File No. K7755

Sample ID		Site 4	Site 5	Patch L. Salt Burn	All Terrain Burn	4th Tent From North
Sample Date		99 07 15	99 07 15	99 07 15	99 07 15	99 07 15
Physical Tests						
Conductivity	(umhos/cm)	659	744	419	29	-
Moisture	%	54.4	52.0	21.5	40.2	34.2
pH		7.22	6.96	6.16	6.76	-
Dissolved Anions						
Chloride	Cl	4620	1860	48	40	-
Sulphate	SO4	762	447	1570	66	-
Total Metals						
Antimony	T-Sb	<20	<20	-	-	-
Arsenic	T-As	253	19	-	-	-
Barium	T-Ba	50	43	-	-	-
Beryllium	T-Be	<0.5	<0.5	-	-	-
Cadmium	T-Cd	<0.5	<0.5	-	-	-
Chromium	T-Cr	295	17	-	-	-
Cobalt	T-Co	42	5	-	-	-
Copper	T-Cu	97	22	-	-	-
Lead	T-Pb	<50	<50	-	-	-
Mercury	T-Hg	0.026	0.054	-	-	-
Molybdenum	T-Mo	<4	<4	-	-	-
Nickel	T-Ni	192	15	-	-	-
Selenium	T-Se	0.3	0.2	-	-	-
Silver	T-Ag	5	<2	-	-	-
Tin	T-Sn	<10	<10	-	-	-
Vanadium	T-V	81	12	-	-	-
Zinc	T-Zn	118	9	-	-	-
Extractable Metals						
Calcium	Ca	1780	774	71.8	52.5	-
Magnesium	Mg	334	108	100	28	-
Potassium	K	241	82	52	<20	-
Sodium Adsorption Ratio (SAR)		1.6	0.7	0.2	0.4	-
Sodium	Na	899	259	42	41	-

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per dry kilogram except where noted.
< = Less than the detection limit indicated.
VPH = Volatile Petroleum Hydrocarbons.
EPH = Extractable Petroleum Hydrocarbons.

RESULTS OF ANALYSIS - Sediment/Soil

File No. K7755

Sample ID	7th Tent From North
Sample Date	99 07 15

Physical Tests

Moisture	%	43.2

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per dry kilogram except where noted.
< = Less than the detection limit indicated.
VPH = Volatile Petroleum Hydrocarbons.
EPH = Extractable Petroleum Hydrocarbons.

RESULTS OF ANALYSIS - Sediment/Soil

File No. K7755

Sample ID	Drum 6	Drum 10	Drum 12	Drum 24	Drum 33
Sample Date	99 07 15	99 07 15	99 07 15	99 07 15	99 07 15
Non-halogenated Volatiles					
Benzene	<0.04	<0.04	<0.04	<0.04	<0.04
Ethylbenzene	<0.05	<0.05	<0.05	<0.05	<0.05
Styrene	<0.05	<0.05	<0.05	<0.05	<0.05
Toluene	<0.05	<0.05	<0.05	<0.05	<0.05
meta- & para-Xylene	<0.05	<0.05	0.05	<0.05	<0.05
ortho-Xylene	<0.05	<0.05	0.08	<0.05	<0.05
Volatile Hydrocarbons (VH) C6-10	<100	<100	<100	<100	156
VPH C6-10 (calculated)	<100	<100	<100	<100	156
Extractables					
EPH (C10-18)	4600	1440	629	4720	6230
EPH (C19-31)	16500	701	<200	17600	7300

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per dry kilogram except where noted.
< = Less than the detection limit indicated.
VPH = Volatile Petroleum Hydrocarbons.
EPH = Extractable Petroleum Hydrocarbons.

RESULTS OF ANALYSIS - Sediment/Soil

File No. K7755

Sample ID	Drum 39	Drum 60	Drum 63	Drum 70	Site 6 East
Sample Date	99 07 15	99 07 15	99 07 15	99 07 15	99 07 15
Non-halogenated Volatiles					
Benzene	<0.04	<0.04	<0.04	<0.04	<0.04
Ethylbenzene	<0.05	<0.05	<0.05	<0.05	<0.05
Styrene	<0.05	0.11	<0.05	<0.05	<0.05
Toluene	<0.05	0.05	<0.05	<0.05	<0.05
meta- & para-Xylene	<0.05	1.30	<0.05	<0.05	<0.05
ortho-Xylene	<0.05	3.98	<0.05	<0.05	<0.05
Volatile Hydrocarbons (VH) C6-10	<100	358	<100	<100	<100
VPH C6-10 (calculated)	<100	352	<100	<100	<100
Extractables					
EPH (C10-18)	6070	3790	1780	2160	<200
EPH (C19-31)	8860	<200	30400	21500	<200

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per dry kilogram except where noted.
< = Less than the detection limit indicated.
VPH = Volatile Petroleum Hydrocarbons.
EPH = Extractable Petroleum Hydrocarbons.

RESULTS OF ANALYSIS - Sediment/Soil

File No. K7755

Sample ID	Site 6 Centre	Site 7 Middle South	Site 7 Middle	Site 7 North	Site 8
Sample Date	99 07 15	99 07 15	99 07 15	99 07 15	99 07 15
Non-halogenated Volatiles					
Benzene	<0.04	<0.04	<0.04	<0.04	<0.2
Ethylbenzene	<0.05	<0.05	<0.05	<0.05	<0.2
Styrene	<0.05	<0.05	<0.05	<0.05	<0.2
Toluene	<0.05	<0.05	<0.05	<0.05	<0.2
meta- & para-Xylene	<0.05	<0.05	<0.05	<0.05	<0.2
ortho-Xylene	<0.05	<0.05	<0.05	<0.05	<0.2
Volatile Hydrocarbons (VH) C6-10	<100	<100	<100	<100	<100
VPH C6-10 (calculated)	<100	<100	<100	<100	<100
Extractables					
EPH (C10-18)	219	<200	2210	<200	<200
EPH (C19-31)	<200	<200	29100	<200	1890

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per dry kilogram except where noted.
< = Less than the detection limit indicated.
VPH = Volatile Petroleum Hydrocarbons.
EPH = Extractable Petroleum Hydrocarbons.

RESULTS OF ANALYSIS - Sediment/Soil

File No. K7755

Sample ID	Site 9	Site 10	Site 11	Site 12	Site 13
Sample Date	99 07 15	99 07 15	99 07 15	99 07 15	99 07 15
Non-halogenated Volatiles					
Benzene	<0.04	<0.04	<0.04	<0.04	<0.04
Ethylbenzene	<0.05	<0.05	<0.05	<0.05	<0.05
Styrene	<0.05	<0.05	<0.05	<0.05	<0.05
Toluene	<0.05	<0.05	<0.05	<0.05	<0.05
meta- & para-Xylene	<0.05	<0.05	<0.05	<0.05	<0.05
ortho-Xylene	<0.05	<0.05	<0.05	<0.05	<0.05
Volatile Hydrocarbons (VH) C6-10	<100	<100	<100	<100	<100
VPH C6-10 (calculated)	<100	<100	<100	<100	<100
Extractables					
EPH (C10-18)	1550	<200	475	249	206
EPH (C19-31)	2520	315	2960	1900	520

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per dry kilogram except where noted.
< = Less than the detection limit indicated.
VPH = Volatile Petroleum Hydrocarbons.
EPH = Extractable Petroleum Hydrocarbons.

RESULTS OF ANALYSIS - Sediment/Soil

File No. K7755

Sample ID	Site 14	Site 15	Site 16	Site 17	Site 18
Sample Date	99 07 15	99 07 15	99 07 15	99 07 15	99 07 15
Non-halogenated Volatiles					
Benzene	<0.04	<0.04	<0.04	<0.04	<0.04
Ethylbenzene	<0.05	<0.05	<0.05	<0.05	<0.05
Styrene	<0.05	<0.05	<0.05	<0.05	<0.05
Toluene	<0.05	<0.05	<0.05	<0.05	<0.05
meta- & para-Xylene	<0.05	<0.05	<0.05	<0.05	<0.05
ortho-Xylene	<0.05	<0.05	<0.05	<0.05	<0.05
Volatile Hydrocarbons (VH) C6-10	<100	<100	<100	<100	<100
VPH C6-10 (calculated)	<100	<100	<100	<100	<100
Extractables					
EPH (C10-18)	289	3440	<200	225	730
EPH (C19-31)	3280	3820	1020	1050	2900

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per dry kilogram except where noted.
< = Less than the detection limit indicated.
VPH = Volatile Petroleum Hydrocarbons.
EPH = Extractable Petroleum Hydrocarbons.

RESULTS OF ANALYSIS - Sediment/Soil

File No. K7755

Sample ID	Site 4	Site 5	All Terrain Burn	4th Tent From North	7th Tent From North
Sample Date	99 07 15	99 07 15	99 07 15	99 07 15	99 07 15
Non-halogenated Volatiles					
Benzene	0.29	<0.04	0.06	<0.04	<0.04
Ethylbenzene	<0.1	<0.05	<0.05	<0.05	<0.05
Styrene	<0.1	<0.05	<0.05	<0.05	<0.05
Toluene	<0.1	<0.05	<0.05	<0.05	<0.05
meta- & para-Xylene	<0.1	<0.05	<0.05	<0.05	<0.05
ortho-Xylene	<0.1	<0.05	<0.05	0.16	<0.05
Volatile Hydrocarbons (VH) C6-10	<100	<100	<100	<100	198
VPH C6-10 (calculated)	<100	<100	<100	<100	198
Extractables					
EPH (C10-18)	693	<200	551	12700	15000
EPH (C19-31)	9350	1380	4970	396	856

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per dry kilogram except where noted.
< = Less than the detection limit indicated.
VPH = Volatile Petroleum Hydrocarbons.
EPH = Extractable Petroleum Hydrocarbons.

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

Moisture in Sediment/Soil

This analysis is carried out gravimetrically by drying the sample at 103 C for a minimum of six hours.

Recommended Holding Time:

Sample:	14 days
Reference:	Puget
For more detail see:	ASL "Collection & Sampling Guide"

Conventional Parameters in Sediment/Soil

These analyses are carried out on a leachable basis. The procedure involves mixing the sample with reagent grade water in a one to ten ratio and leaching for several hours. The leachate is filtered and analyzed in accordance with procedures described in "Methods for Chemical Analysis of Water and Wastes" (USEPA), "Manual for the Chemical Analysis of Water, Wastewaters, Sediments and Biological Tissues" (BCMOE), and/or "Standard Methods for the Examination of Water and Wastewater" (APHA). Further details are available on request.

pH in Soil

This analysis is carried out in accordance with procedures described in "Soil Sampling and Methods of Analysis" (CSSS). The procedure involves mixing the air-dried sample with deionized/distilled water. The pH of the solution is then measured using a standard pH probe. A one to two ratio of sediment to water is used for mineral soils and a one to ten ratio is used for highly organic soils.

Leachable Metals in Sediment/Soil

This analysis is carried out using a leaching procedure which involves the gentle tumbling of the sample in a specified leaching solution (typically deionized water) for a specific length of time. The resulting extract is then analysed by atomic absorption spectrophotometry (EPA Method 7000 series) and/or inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

Recommended Holding Time:
Sample/Extract: 6 months (Mercury = 28 days)
Reference: EPA
For more detail see: ASL "Collection & Sampling Guide"

Sodium Absorption Ratio (SAR) in Sediment/Soil

This analysis is adapted from the Sodium Absorption Ratio method outlined in Soil Sampling and Methods of Analysis published by the Canadian Society of Soil Science, 1993. In summary, the equivalent of 10 dry grams of sample is extracted for a 1 hour period using 100 mL of deionized water. The resulting extract is then filtered through a 0.45 micron membrane filter and analysed by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B). The Sodium Absorption Ratio (SAR) is then calculated (in millimoles/Litre) from the Na, Ca and Mg results.

Recommended Holding Time:
Sample/Extract: 6 months
Reference: EPA
For more detail see: ASL "Collection & Sampling Guide"

Metals in Sediment/Soil

This analysis is carried out using procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 Method 3050B or Method 3051, published by the United States Environmental Protection Agency (EPA). The sample is manually homogenized and a representative subsample of the wet material is weighed. The sample is then digested by either hotplate or microwave oven using a 1:1 ratio of nitric acid and hydrochloric acid. Instrumental analysis is by atomic absorption spectrophotometry (EPA Method 7000 series) and/or inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

Method Limitation: This method is not a total digestion technique for most samples. It is a very strong acid digestion that will dissolve almost all elements that could become "environmentally available." By design, elements bound in silicate structures are not normally dissolved by this procedure as they are not usually mobile in the environment.

Recommended Holding Time:
Sample/Extract: 6 months (Mercury = 28 days)
Reference: EPA
For more detail see: ASL "Collection & Sampling Guide"

METHODOLOGY (cont'd)

Volatile Organic Compounds in Sediment/Soil

This analysis is based on United States Environmental Protection Agency Methods 5035, 8260/8021 and British Columbia Ministry of Environment, Lands and Parks Method "Volatile Hydrocarbons in Solids by GC/FID ". The procedure involves a 1:2 extraction of the sediment/soil sample with methanol. Aliquots of the methanol extract are then analyzed by capillary column gas chromatography with mass spectrometric, and/or photo-ionization/flame-ionization detection.

Volatile Petroleum Hydrocarbons (VPH) in Sediment/Soil

Volatile Petroleum Hydrocarbons (VPH) is a calculation defined by British Columbia Ministry of Environment, Lands and Parks (BCMELP) Draft Method "Calculation of Volatile Petroleum Hydrocarbons in Solids or Water", June 1998. The concentrations of specific Monocyclic Aromatic Hydrocarbons (Benzene, Toluene, Ethylbenzene, Xylenes and Styrene) are subtracted from the collective concentration of Volatile Hydrocarbons (VH) that elute between n-hexane (nC6) and n-decane (nC10). Analysis of Volatile Hydrocarbons adheres to all prescribed elements of BCMELP method "Volatile Hydrocarbons in Solid", June 1998.

Extractable Hydrocarbons in Sediment/Soil

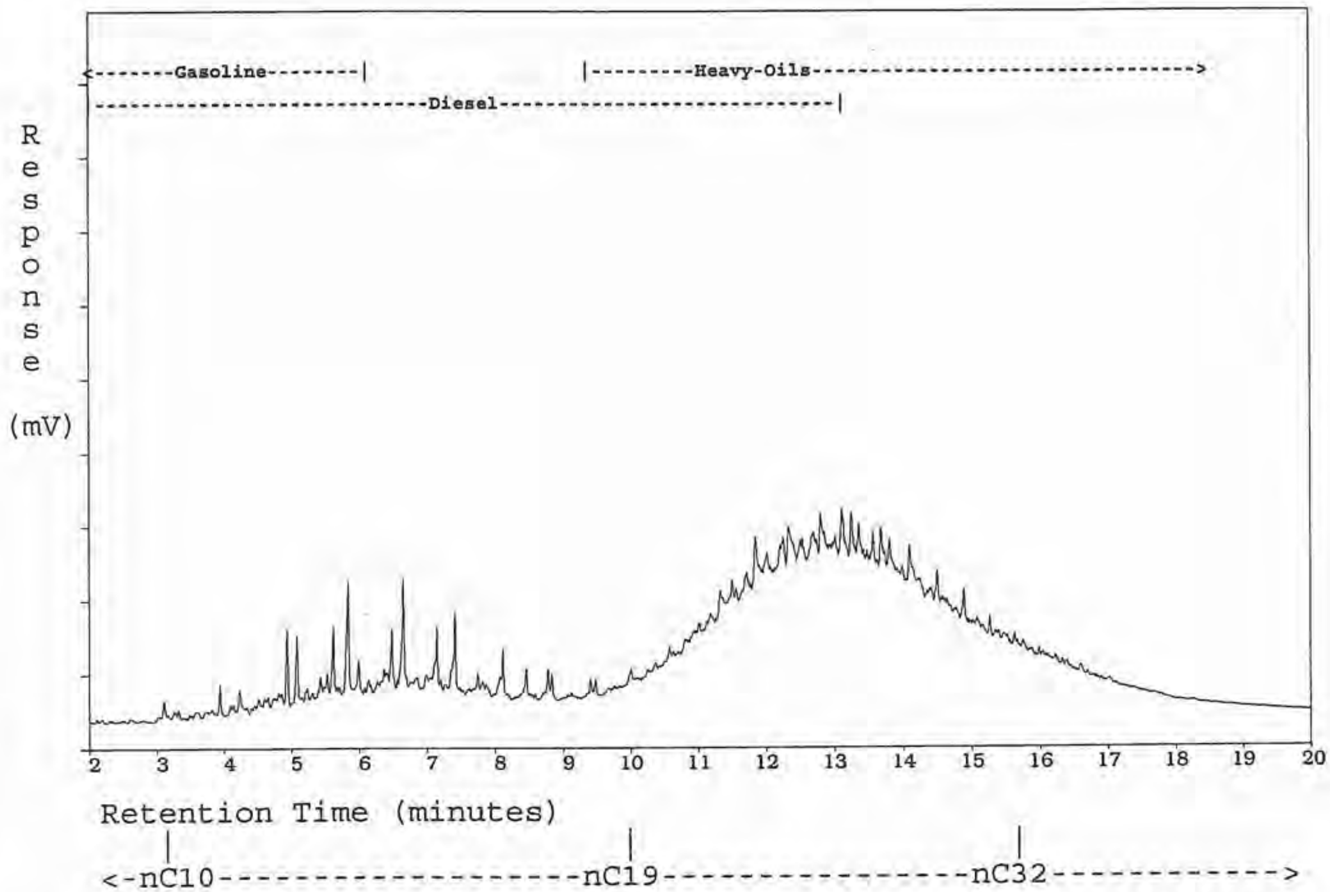
This analysis is carried out using procedures adapted from U.S. EPA Methods 3500/8015 (Publ. # SW-846 3rd ed., Washington, DC 20460) and British Columbia Ministry of Environment, Lands and Parks Method for "Extractable Petroleum Hydrocarbons in Soil by GC/FID" (January 1996) The procedure involves a hexane/acetone solvent extraction followed by analysis of the extract by capillary column gas chromatography with flame ionization detection. Results are not corrected for Polycyclic Aromatic Hydrocarbons (PAHs) for Extractable Petroleum Hydrocarbon (LEPH/HEPH) purposes.

End of Report

HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: Drum 6

File Name: C:\TEH2\JL22\EH3JL22.39R **ASL Sample ID:** K7755-T--1 **Sample acquired:** JUL 23, 1999 00:38:14
Chromatogram Scale: 50.0 millivolts



Sample Amt. (g or mL): 13.8 Dilution: 80.0

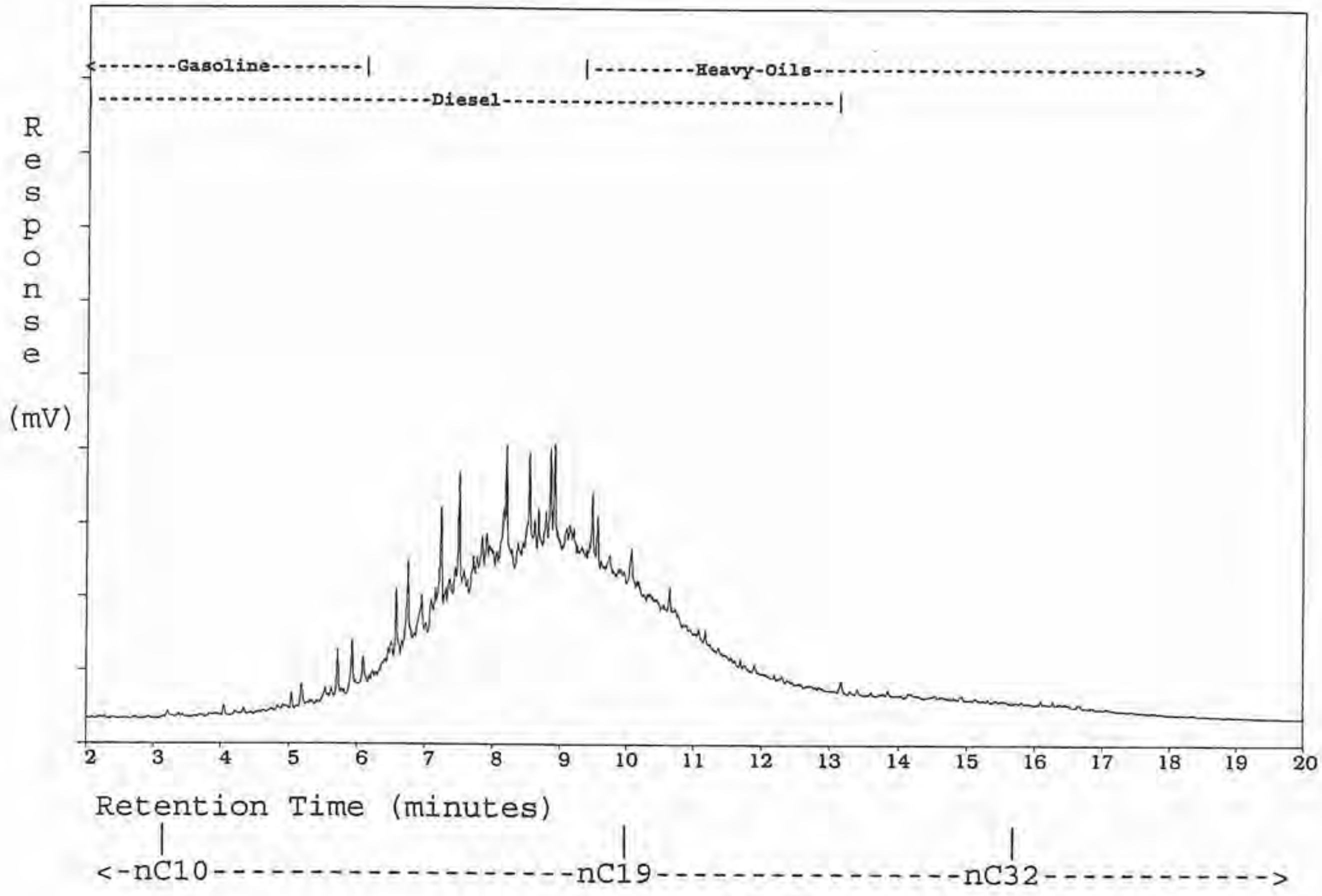
The Hydrocarbon Distribution Report is intended to assist you in characterizing hydrocarbon products that may be present in your sample. The scale at the top of this report represents the approximate hydrocarbon range of common petroleum products. The scale at the bottom of the report shows retention times with the approximate positions of key marker compounds indicated. Comparison of this report with those of reference standards may also assist in characterizing the hydrocarbons present.

Note: This Hydrocarbon Distribution Report was produced using a temperature profile which was implemented on June 21st, 1999. Under these new conditions hydrocarbon compounds elute sooner than before, although characteristic patterns will appear similar. Please exercise caution when comparing this report with reports produced prior to June 21st, 1999. A current library of reference products is available upon request.

HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: Drum 10

File Name: C:\TEH2\JL21\EH3JL21.08R **ASL Sample ID:** K7755-T--2 **Sample acquired:** JUL 21, 1999 15:37:39
Chromatogram Scale: 50.0 millivolts



Sample Amt. (g or mL): 14.2 Dilution: 8.0

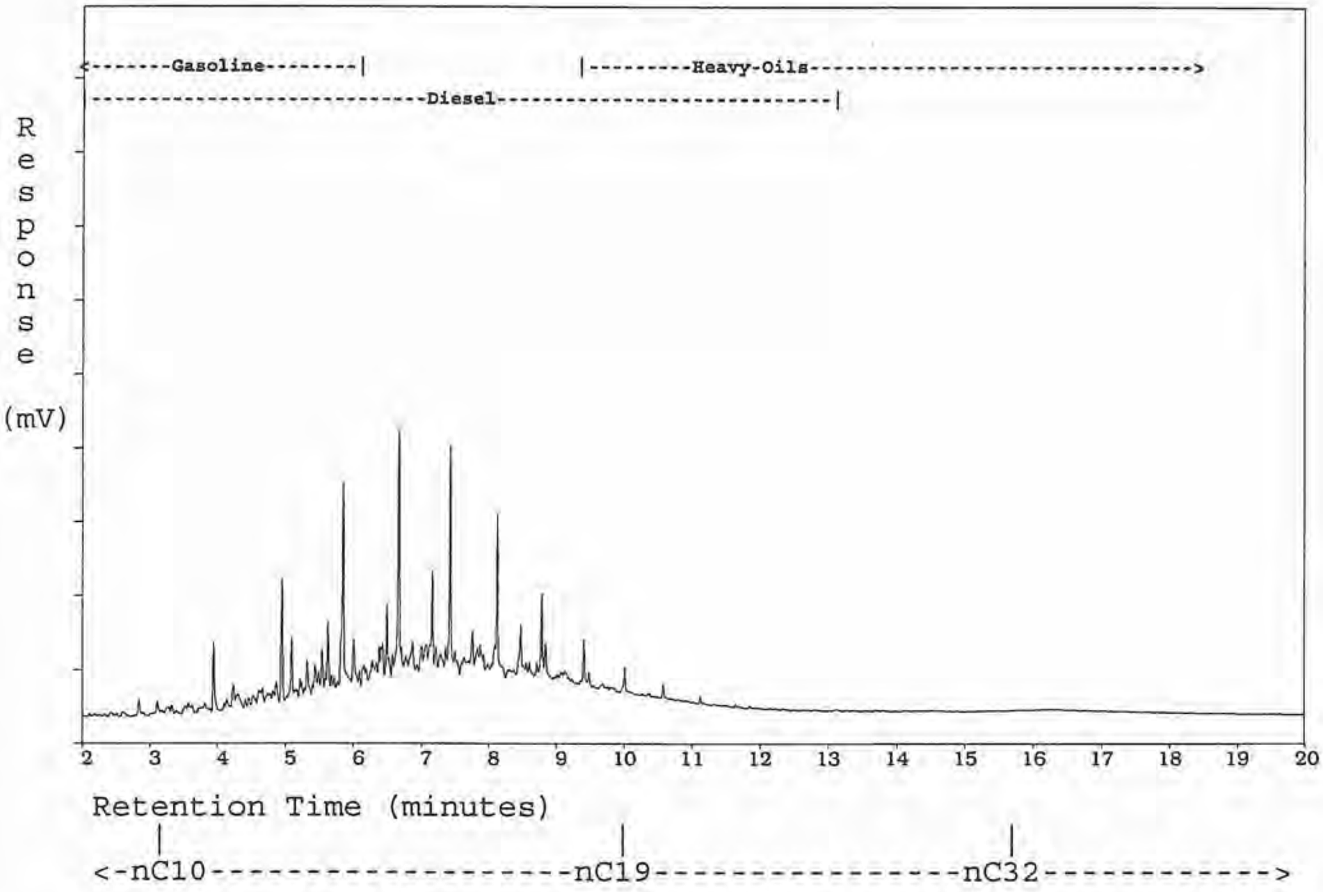
The Hydrocarbon Distribution Report is intended to assist you in characterizing hydrocarbon products that may be present in your sample. The scale at the top of this report represents the approximate hydrocarbon range of common petroleum products. The scale at the bottom of the report shows retention times with the approximate positions of key marker compounds indicated. Comparison of this report with those of reference standards may also assist in characterizing the hydrocarbons present.

Note: This Hydrocarbon Distribution Report was produced using a temperature profile which was implemented on June 21st, 1999. Under these new conditions hydrocarbon compounds elute sooner than before, although characteristic patterns will appear similar. Please exercise caution when comparing this report with reports produced prior to June 21st, 1999. A current library of reference products is available upon request.

HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: Drum 12

File Name: C:\TEH2\JL21\EH3JL21.09R **ASL Sample ID:** K7755-T--3 **Sample acquired:** JUL 21, 1999 16:13:14
Chromatogram Scale: 50.0 millivolts



Sample Amt. (g or mL): 13.5 Dilution: 8.0

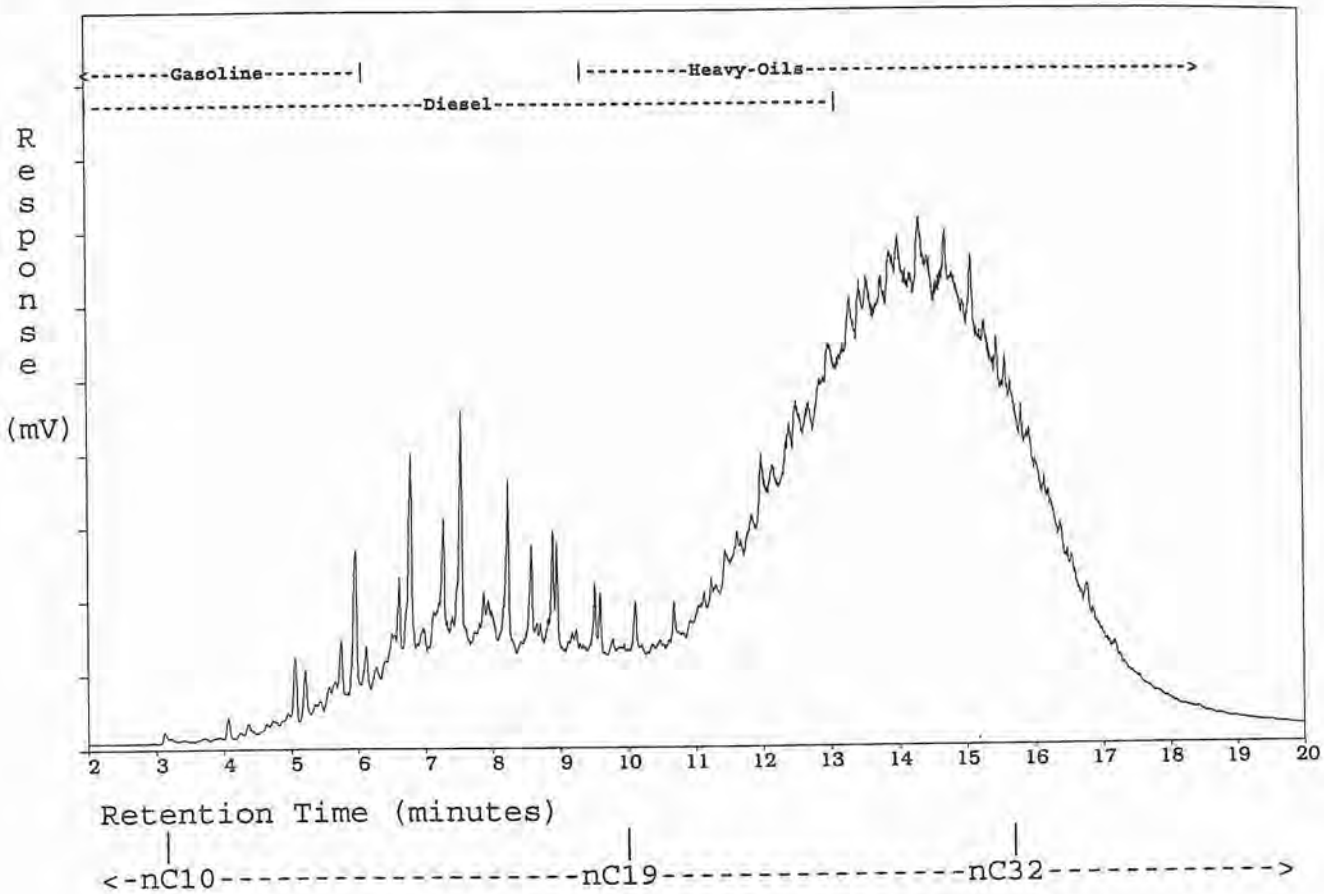
The Hydrocarbon Distribution Report is intended to assist you in characterizing hydrocarbon products that may be present in your sample. The scale at the top of this report represents the approximate hydrocarbon range of common petroleum products. The scale at the bottom of the report shows retention times with the approximate positions of key marker compounds indicated. Comparison of this report with those of reference standards may also assist in characterizing the hydrocarbons present.

Note: This Hydrocarbon Distribution Report was produced using a temperature profile which was implemented on June 21st, 1999. Under these new conditions hydrocarbon compounds elute sooner than before, although characteristic patterns will appear similar. Please exercise caution when comparing this report with reports produced prior to June 21st, 1999. A current library of reference products is available upon request.

HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: Drum 24

File Name: C:\TEH2\JL21\EH3JL21.46R ASL Sample ID: K7755-T--4 Sample acquired: JUL 22, 1999 02:52:18
Chromatogram Scale: 200.0 millivolts



Sample Amt. (g or mL): 14.6 Dilution: 8.0

The Hydrocarbon Distribution Report is intended to assist you in characterizing hydrocarbon products that may be present in your sample. The scale at the top of this report represents the approximate hydrocarbon range of common petroleum products. The scale at the bottom of the report shows retention times with the approximate positions of key marker compounds indicated. Comparison of this report with those of reference standards may also assist in characterizing the hydrocarbons present.

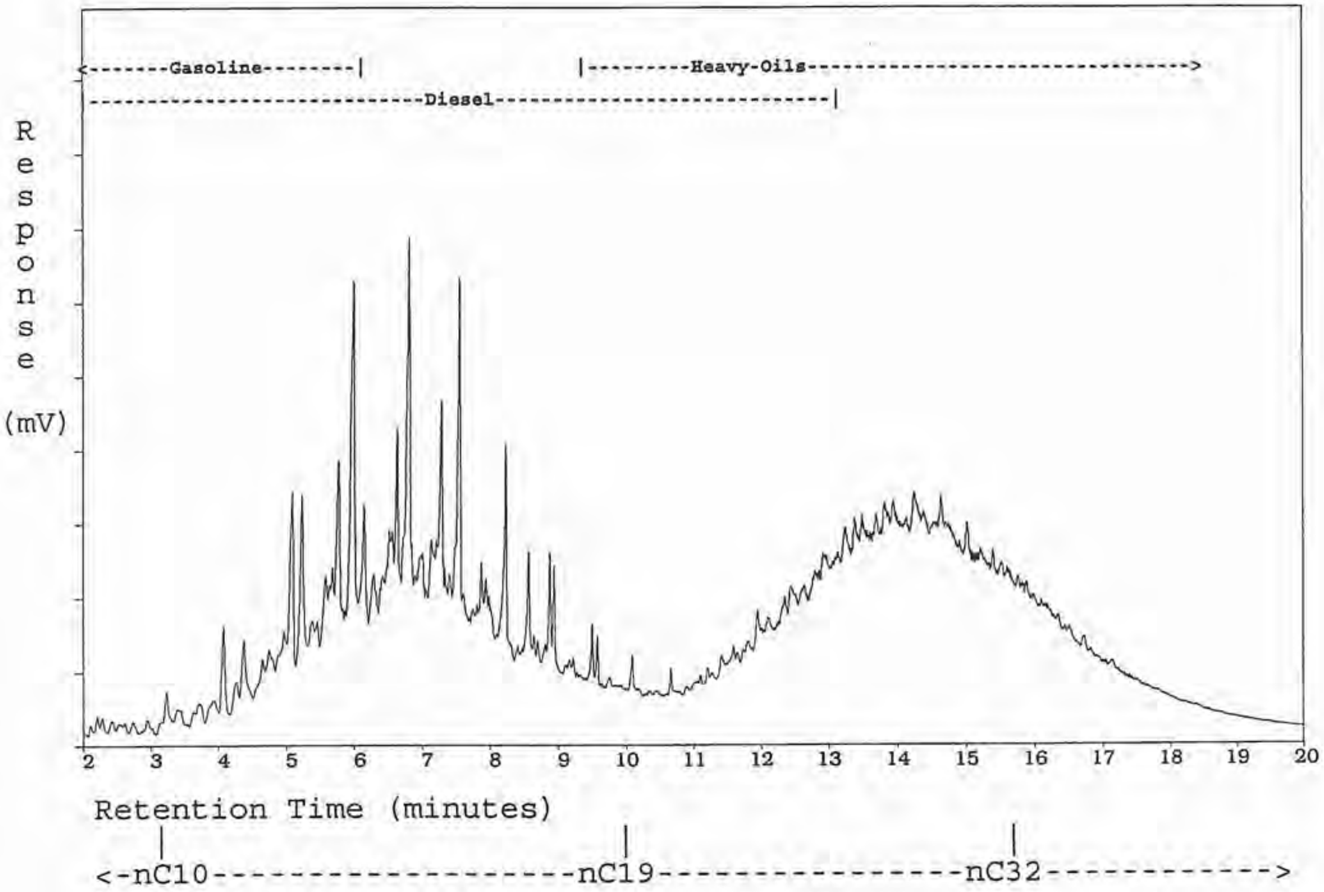
Note: This Hydrocarbon Distribution Report was produced using a temperature profile which was implemented on June 21st, 1999. Under these new conditions hydrocarbon compounds elute sooner than before, although characteristic patterns will appear similar. Please exercise caution when comparing this report with reports produced prior to June 21st, 1999. A current library of reference products is available upon request.

HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: Drum 33

File Name: C:\TEH2\JL21\EH3JL21.10R **ASL Sample ID:** K7755-T--5 **Sample acquired:** JUL 21, 1999 16:13:14

Chromatogram Scale: 200.0 millivolts



Sample Amt. (g or mL): 16.2 Dilution: 8.0

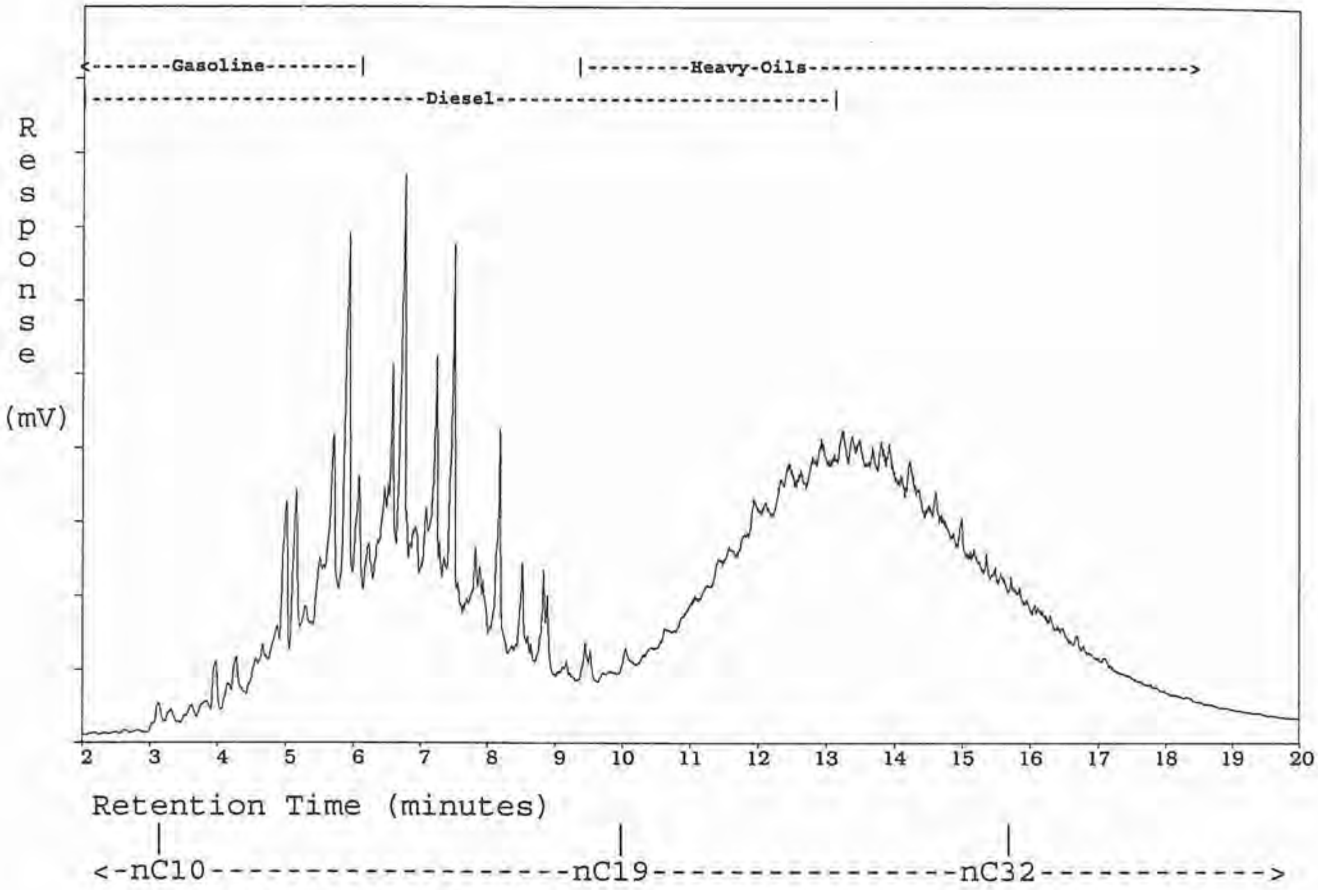
The Hydrocarbon Distribution Report is intended to assist you in characterizing hydrocarbon products that may be present in your sample. The scale at the top of this report represents the approximate hydrocarbon range of common petroleum products. The scale at the bottom of the report shows retention times with the approximate positions of key marker compounds indicated. Comparison of this report with those of reference standards may also assist in characterizing the hydrocarbons present.

Note: This Hydrocarbon Distribution Report was produced using a temperature profile which was implemented on June 21st, 1999. Under these new conditions hydrocarbon compounds elute sooner than before, although characteristic patterns will appear similar. Please exercise caution when comparing this report with reports produced prior to June 21st, 1999. A current library of reference products is available upon request.

HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: Drum 39

File Name: C:\TEH2\JL21\EH3JL21.11R **ASL Sample ID:** K7755-T--6 **Sample acquired:** JUL 21, 1999 16:51:55
Chromatogram Scale: 200.0 millivolts



Sample Amt. (g or mL): 16.2 Dilution: 8.0

The Hydrocarbon Distribution Report is intended to assist you in characterizing hydrocarbon products that may be present in your sample. The scale at the top of this report represents the approximate hydrocarbon range of common petroleum products. The scale at the bottom of the report shows retention times with the approximate positions of key marker compounds indicated. Comparison of this report with those of reference standards may also assist in characterizing the hydrocarbons present.

Note: This Hydrocarbon Distribution Report was produced using a temperature profile which was implemented on June 21st, 1999. Under these new conditions hydrocarbon compounds elute sooner than before, although characteristic patterns will appear similar. Please exercise caution when comparing this report with reports produced prior to June 21st, 1999. A current library of reference products is available upon request.