REPORT #
RRTAC OF-4

Chemical Characterization of Various Oil Sands Substrates

CONSERVATION AND RECLAMATION
MANAGEMENT GROUP
Reclamation Research
Technical Advisory Committee

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RRTAC OF-4

Chemical Characterization of Various Oil Sands Substrates

Compiled by

C.B. Powter

Chairman

Reclamation Research Technical Advisory Committee

Prepared for

ALBERTA CONSERVATION AND RECLAMATION MANAGEMENT GROUP
(Reclamation Research Technical Advisory Committee)

1994

Alberta's Reclamation Research Program

Regulating surface disturbances in Alberta is the responsibility of the Conservation and Reclamation Management Group. The Chairman is from Alberta Environmental Protection. The Group oversaw a reclamation research program, established in 1978, to identify the most efficient methods for achieving acceptable reclamation in the province. Funding for the research program was provided by Alberta's Heritage Savings Trust Fund, Land Reclamation Program. Funding ended in March of 1994.

Additional information on the Reclamation Research Program may be obtained by contacting:

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Reclamation Research Technical Advisory Committee
Alberta Environmental Protection
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This report may be cited as:

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DISCLAIMER

This report is intended to provide government and industry staff with up-to-date technical information to assist in the preparation and review of Conservation and Reclamation Approvals, and development of guidelines and operating procedures. This report is also available to the public so that interested individuals similarly have access to the most current information on land reclamation topics.

The opinions, findings, conclusions, and recommendations expressed in this report are those of the authors and do not necessarily reflect the views of government or industry. Mention of trade names or commercial products does not constitute endorsement, or recommendation for use, by government or industry.

REVIEWS

This report was reviewed by RRTAC and the Oil Sands Reclamation Research Program Committee, as well as Mike MacKinnon (Syncrude), John Gulley (Suncor) and Tom Dereniwski (OSLO).

FUNDING

This project was co-funded by the Alberta Heritage Savings Trust Fund, Land Reclamation Program through the Alberta Conservation and Reclamation Management Group and by Syncrude Canada Limited, Suncor Inc. and OSLO.

CHAIRMAN'S SUMMARY

This report is a condensed version of two reports on the chemistry of a variety of oil sands substrates from Syncrude, Suncor, OSLO and SolvEx. The study was conducted by EnviroTest Laboratories for RRTAC, Syncrude, Suncor and OSLO.

Page 2 of the report identifies the source of the various samples. Please note:

- The 11th sample (OSLO OHWE Tailings Sand) was derived from a batch test of the OSLO process. The batch test used Athabasca River water, kerosene and proprietary MIBC compounds. The result was a high water content tailings that more closely resembles extraction tailings at the point of discharge rather than tailings at the disposal area. The higher levels of unrecovered bitumen (and the associated organic chemicals found in this study) reported for this sample could be lower at the tailings site.
- The 12th sample (E401069-01) is the filter cake produced by SOLV-EX Corporation after they have processed oil sands fine tailings.

The data are provided to give readers a snapshot of the chemicals and their concentrations in the substrates. **Readers are cautioned that these data are for one sample only and may not be representative of the material from the sites.** No interpretations of the data are provided; readers may wish to compare them against published criteria. The data were provided to the industry participants for a study of toxicity of the substrates. The data were also used for an RRTAC/industry study by Golder Associates to evaluate the potential risk to wildlife on areas reclaimed using these substrates.

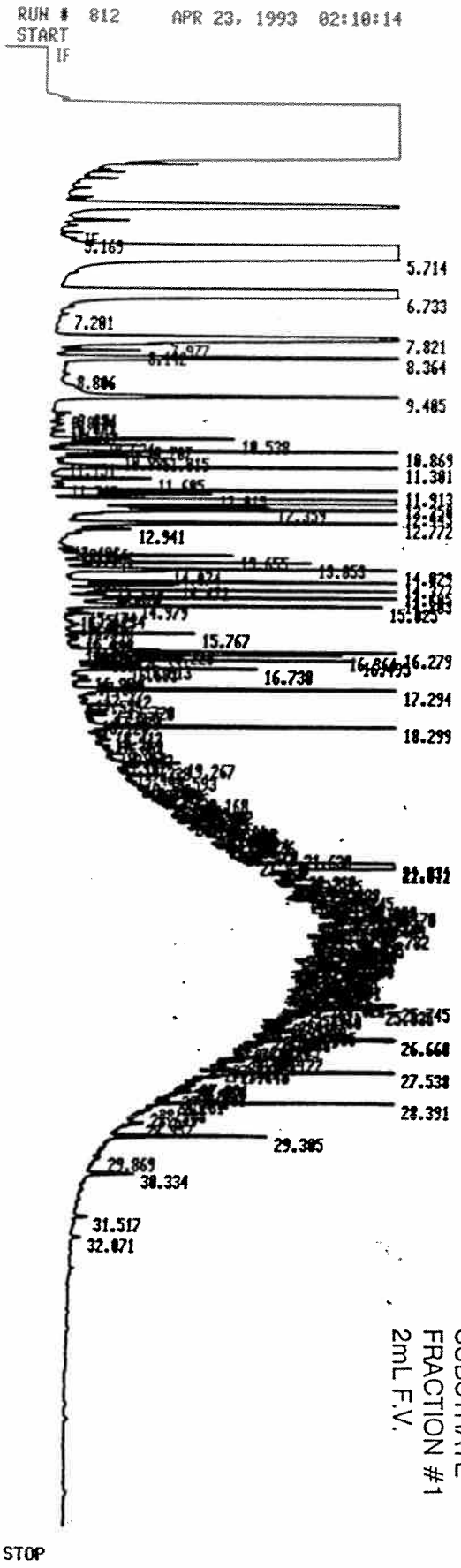
Data are provided for:

- The raw sample;
- Leachate from the raw sample (using the TCLP - Toxicity Characteristic Leaching Procedure of the US Environmental Protection Agency); and
- The leached solid.

Inorganic analytical data are given for the raw sample and the leachate. Organic analytical data (gravimetric and GC/FID) are provided for all three substrates for various fractions (acid, base/neutral) as well as for targeted priority pollutant polyaromatic hydrocarbons (PAH's) and target substituted PAH's. The GC/FID chromatograms were provided in the original data but are not presented here. The chromatograms indicated a wide variety of compounds were present in the samples (see following example).

Some of the samples were also analyzed for non-target organic chemicals. Only those samples where identifiable compounds were quantified are presented.

The entire dataset from the study has been included with the copy of this report in the Alberta Environmental Protection library, 6th Floor, Bramalea Building, 9920 - 108 Street, Edmonton.



E3-02-125-5
SUBSTRATE
FRACTION #1
2mL F.V.

ACKNOWLEDGEMENTS

This work was completed by Enviro-Test Laboratories under contract to Alberta Environment with funding provided from the Alberta Heritage Savings Trust Fund Land Reclamation Program Through the Alberta Land Conservation and Reclamation Council. The Scientific Authority for Alberta Environment for this project was Chris Powter. The project design was provided by Dr. M. MacKinnon of Syncrude Canada Research and Development. Dr. MacKinnon also provided the samples utilized in this study.

E3-02-125 REP. cont'd

OVERVIEW:

Eleven samples were submitted to Enviro-Test Labs for GC/MS characterization. The sample ID's are given below. *

LAB SAMPLE#	CLIENT I.D.	
E3-02-125-1	POND 2	FINE TAILS : FRESH (SUNCOR)
E3-02-125-2	CP1	FINE TAILS : FRESH (SYNCRUDE)
E3-02-125-3	CP3	OVERBURDEN CLAY SHALE (KCa)
E3-02-125-4	CP4	TAILINGS SAND (SYNCRUDE PLANT 5 BEACH)
E3-02-125-5	CP5	TAILINGS SAND (SUNCOR BEACH)
E3-02-125-6	CP6	TAILINGS SAND + FINE TAILS (SYNCRUDE)
E3-02-125-7	CP7	FINE TAILS SYNCRUDE
E3-02-125-8	CP8	FINE TAILS : AIR DRIED
E3-02-125-9	CP9	OIL SAND (SYNCRUDE)
E3-02-125-10	CP10	OIL SAND (SUNCOR)
E3-02-125-11	CP11	TAILINGS SAND (OSLO OHWE)

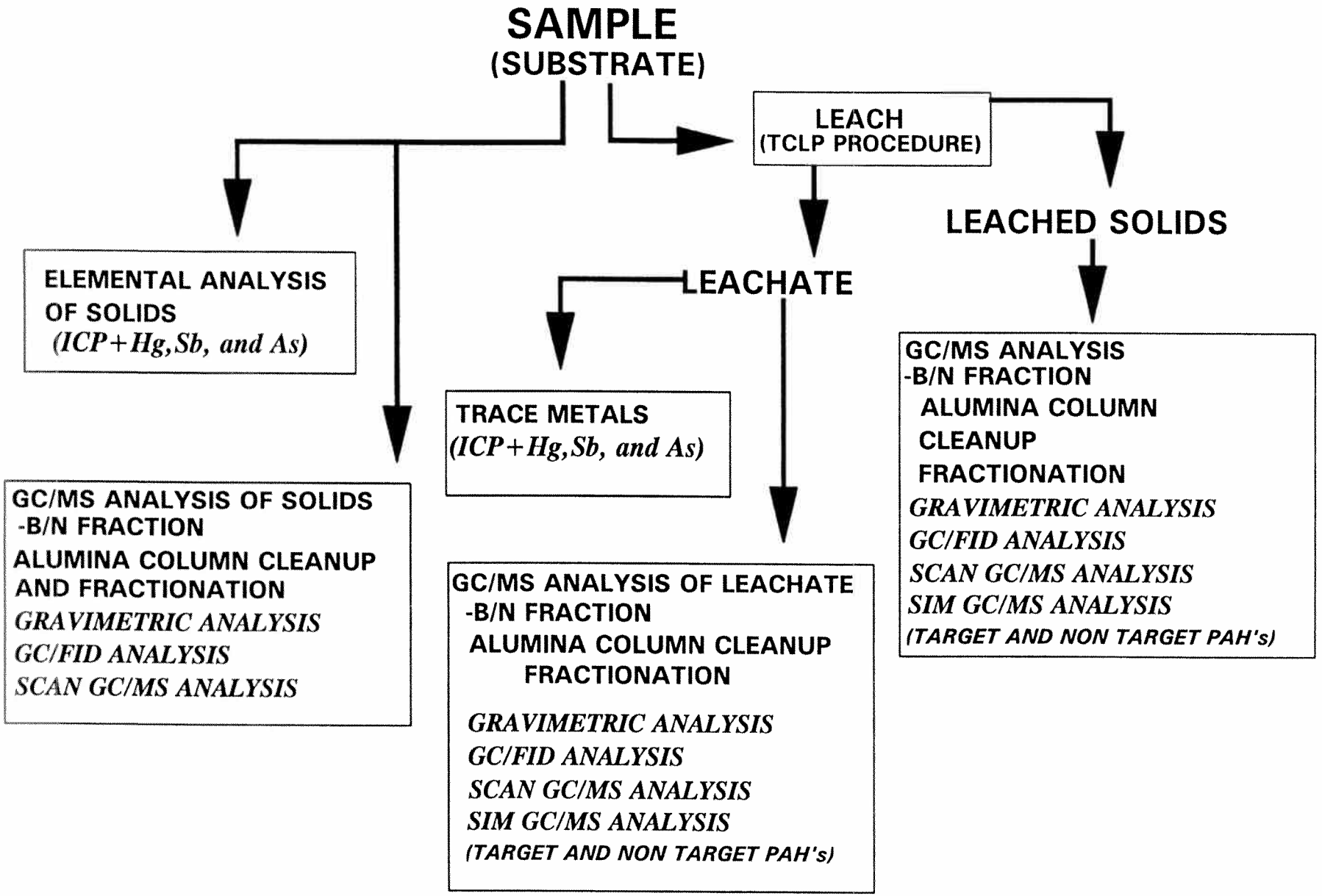
The analytical scheme, as provided by Dr. MacKinnon of Syncrude, is attached.

A. Substrate Samples

Approximately 10 grams of each sample was spiked with a mixture of surrogate compounds and then transferred to glass soxhlet apparatus and extracted with dichloromethane (DCM) for 16 hours. Samples which had a high water content were air dried before extraction. A one gram portion of each sample was weighed into a tray and dried in a oven overnight to determine the percent moisture content. Each extract was then partitioned under basic and then acidic conditions using a modified version of EPA method 3650 to give two extracts. Each acid extract and base-neutral (B/N) extract was reduced to a low final volume using rotary evaporation and nitrogen blowdown techniques. The acid extracts contained the most polar compounds such as phenols, naphthenic acids and other carboxylic acid. These extracts were taken to analysis without further preparation. The base-neutral extracts were further separated into three fractions using alumina fractionation (see Table below).

*Note: The 12th sample, E401069-01 (SOL-EX FILT CAKE), is the filter cake produced by SOLV-EX Corporation after processing of oil sands fine tails.

FIGURE 1: OUTLINE OF ANALYTICAL SCHEME



ELUTION PROFILE OF ALUMINA ADSORBENT

FRACTION	ELUTION SOLVENT	CHEMICAL CLASS REPRESENTED
1	Pentane	Saturates/Olefins and Monoaromatics
2	Benzene	PAH's and Polycyclic Aromatic Sulphur Hydrocarbons
3	Chloroform	PAHN's Heterocyclics

This fractionation is based on increasing polarity of the compounds that will elute in each fraction. Alumina adsorbent was calibrated prior to use by applying a solution of reference compounds to the alumina column. The column was eluted following the elution profile in Table 1. Each fraction was reduced to a known final volume and analyzed by GC/FID. The calibration had to meet criteria for adequate separation and % recovery for the various chemical classes before the samples were run. Each B/N extract went through alumina column fractionation following this same elution order. All fractions were then concentrated to a low final volume and analyzed as per the analytical scheme presented earlier.

B. Leachate Generation

A portion of each sample was sublet to Norwest Labs where a TCLP Leachate extraction was done on samples E3-02-125-4 through E3-02-125-11. The first step in the leachate extraction had each sample ground to pass through a 9.5 mm sieve. A moisture content was done and the equivalent of 50 g dry mass of sample was added to a 1250 mL bottle. The sample was agitated on a rotary extractor for 24 hours with 1000 mL of water with the pH adjusted to 5 or less.

C. Leached Solids / Leachates

Bottles containing the leachate/leached solid were returned to Enviro-Test for further analysis.

The leachate and leached soil were first separated by filtration. Samples with a high oil content caused some problems at this stage. Some oil was retained on the filtration apparatus and could not be reincorporated into the leached solids. This did not affect the leachates.

The leached solids were air dried and extracted and fractionated in the same manner as the original substrates. Each leached solid sample was soxhlet extracted for 16 hours and then reduced to a low final volume and fractionated as discussed earlier for the substrate material. The leachate waters were extracted with dichloromethane first under basic and then acidic conditions giving two extracts per leachate. The base-neutral extracts were fractionated on alumina in the same manner as described above.

D. Inorganic Analysis on Substrates / Leachates

A portion of each sample was sublet to Norwest Labs. Norwest carried out metals analysis on the original substrates and also did a metals scan on the TCLP leachates. The results of the metals analysis are attached. Method references for the inorganic analysis are included with the results from Norwest Labs.

9938-67 Avenue
Edmonton,AB
T6E 0P5

NORWEST LABS

(403) 438-5522 or 1-800-661-7645
(403) 438-0396 fax

DATE 12 MAR 93 11:55
P.O. NO. E3-02-125
W.O. NO. 2 60500

E.T.L. CHEMSPEC
EDMONTON, AB

ALBERTA ENVIRO

Revised Born

SAMPLE		1 E3-02-125-01 POND 2 FINE TAILS	2 E3-02-125-02 CP1 FINE TAILS SYNCRUDE	3 E3-02-125-03 CP3 CLAY SHALE SYNCRUDE	4 E3-02-125-04 CP4 BEACH SAND SYNCRUDE
SOIL HYDRIDE					
ARSENIC	ug/gm	5.35	5.54	15.8	1.07
SELENIUM	ug/gm	0.10	0.09	0.74	<0.02
ANTIMONY	ug/gm	0.06	<0.05	0.06	<0.05
SOIL COLD VAPOR					
MERCURY	ug/gm	0.04	0.05	0.07	0.11
ICP METALS, 3050					
ALUMINUM	ug/gm	2690	3440	10500	433
BARIUM	ug/gm	59.7	77.9	219	8.5
BERYLLIUM	ug/gm	1.5	1.1	1.0	0.1
CADMIUM	ug/gm	<0.3	<0.3	<0.3	<0.3
CALCIUM	ug/gm	3340	2400	8540	450
CHROMIUM	ug/gm	6.8	15.0	5.1	1.4
COPPER	ug/gm	13.5	8.5	25.1	0.7
IRON	ug/gm	18100	13800	23400	2040
LEAD	ug/gm	9	7	10	<2
MAGNESIUM	ug/gm	1680	1730	8060	298
MANGANESE	ug/gm	518	472	117	74.4
MOLYBDENUM	ug/gm	<2	<2	<2	<2
NICKEL	ug/gm	39	23	30	3
PHOSPHORUS	ug/gm	149	162	450	24
POTASSIUM	ug/gm	858	1220	2330	195
SODIUM	ug/gm	1370	1800	5550	154
VANADIUM	ug/gm	75.1	28.9	15.1	3.4
ZINC	ug/gm	41.2	37.5	72.7	8.3
COBALT	ug/gm	12	11	12	2
TCLP LEACH, ICP					
ALUMINUM	mg/L				0.17
BARIUM	mg/L				0.086
BERYLLIUM	mg/L				0.001
BORON	mg/L				0.07
CADMIUM	mg/L				<0.003
CALCIUM	mg/L				10.7

Lab Manager: JA

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EDMONTON, AB

ALBERTA ENVIRO

SAMPLE		1 E3-02-125-01 POND 2 FINE TAILS	2 E3-02-125-02 CP1 FINE TAILS SYNCRUDE	3 E3-02-125-03 CP3 CLAY SHALE SYNCRUDE	4 E3-02-125-04 CP4 BEACH SAND SYNCRUDE
TCLP LEACH, ICP					
CHROMIUM	mg/L				<0.006
COPPER	mg/L				0.01
IRON	mg/L				11.0
LEAD	mg/L				<0.04
MAGNESIUM	mg/L				5.26
MANGANESE	mg/L				0.820
MOLYBDENUM	mg/L				<0.02
NICKEL	mg/L				<0.02
PHOSPHORUS	mg/L				0.2
POTASSIUM	mg/L				<1
VANADIUM	mg/L				0.009
ZINC	mg/L				0.131
ARSENIC	mg/L				<0.05
SELENIUM	mg/L				<0.05
ANTIMONY	mg/L				<0.05
MERCURY	mg/L				<0.05
COBALT	mg/L				<0.01
SILVER	mg/L				<0.05
SILICON	mg/L				0.84
TITANIUM	mg/L				<0.003
THALLIUM	mg/L				<0.1
PHYSICAL					
MOIST.WET WT.	%	71.5	64.8	18.2	10.1
MINOR NUTRIENTS					
BORON	ug/gm	9.4	7.4	7.2	1.0

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SAMPLE		5 E3-02-125-05 CP5 TAILINGS SUNCOR	6 E3-02-125-06 CP6 TAILINGS SAND SYNCRUDE	7 E3-02-125-07 CP7 FINE TAILS SYNCRUDE	8 E3-02-125-08 CP8 FINE TAILS AIR DRIED
SOIL HYDRIDE					
ARSENIC	ug/gm	0.63	1.49	6.85	7.88
SELENIUM	ug/gm	<0.02	<0.02	0.10	0.10
ANTIMONY	ug/gm	<0.05	<0.05	0.05	<0.05
SOIL COLD VAPOR					
MERCURY	ug/gm	0.03	<0.01	0.06	0.11
ICP METALS, 3050					
ALUMINUM	ug/gm	172	911	4350	5890
BARIUM	ug/gm	4.9	17.4	78.2	81.9
BERYLLIUM	ug/gm	<0.1	0.2	1.2	2.3
CADMIUM	ug/gm	<0.3	<0.3	<0.3	<0.3
CALCIUM	ug/gm	559	530	2320	3460
CHROMIUM	ug/gm	<0.5	3.2	18.1	17.6
COPPER	ug/gm	<0.5	2.5	17.5	12.6
IRON	ug/gm	3350	3560	16800	18000
LEAD	ug/gm	<2	<2	9	14
MAGNESIUM	ug/gm	133	392	1770	1890
MANGANESE	ug/gm	56.5	121	581	498
MOLYBDENUM	ug/gm	<2	<2	<2	<2
NICKEL	ug/gm	2	6	27	51
PHOSPHORUS	ug/gm	22	44	181	188
POTASSIUM	ug/gm	110	345	1210	1490
SODIUM	ug/gm	<50	273	1180	1470
VANADIUM	ug/gm	2.8	6.7	30.3	111
ZINC	ug/gm	5.8	12.2	47.1	49.1
COBALT	ug/gm	2	4	13	16
TCLP LEACH, ICP					
ALUMINUM	mg/L	0.10	0.74	1.83	1.38
BARIUM	mg/L	0.015	0.317	0.241	0.447
BERYLLIUM	mg/L	<0.001	0.004	0.010	0.009
BORON	mg/L	<0.03	0.20	0.88	0.72
CADMIUM	mg/L	<0.003	<0.003	<0.003	<0.003

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SAMPLE		5 E3-02-125-05 CP5 TAILINGS SUNCOR	6 E3-02-125-06 CP6 TAILINGS SAND SYNCRUDE	7 E3-02-125-07 CP7 FINE TAILS SYNCRUDE	8 E3-02-125-08 CP8 FINE TAILS AIR DRIED
TCLP LEACH, ICP					
CALCIUM	mg/L	24.0	19.7	94.4	54.6
CHROMIUM	mg/L	<0.006	<0.006	<0.006	<0.006
COPPER	mg/L	<0.01	0.01	<0.01	<0.01
IRON	mg/L	3.06	67.3	102	75.6
LEAD	mg/L	<0.04	<0.04	<0.04	<0.04
MAGNESIUM	mg/L	5.85	9.29	35.6	28.3
MANGANESE	mg/L	0.208	3.61	7.23	6.96
MOLYBDENUM	mg/L	<0.02	<0.02	<0.02	<0.02
NICKEL	mg/L	0.02	0.11	0.62	0.37
PHOSPHORUS	mg/L	0.2	0.8	0.2	0.2
POTASSIUM	mg/L	<1	2	11	7
VANADIUM	mg/L	0.004	0.079	0.083	0.033
ZINC	mg/L	0.027	0.083	0.351	0.342
ARSENIC	mg/L	<0.05	<0.05	<0.05	<0.05
SELENIUM	mg/L	<0.05	<0.05	<0.05	<0.05
ANTIMONY	mg/L	<0.05	<0.05	<0.05	<0.05
MERCURY	mg/L	<0.05	<0.05	<0.05	<0.05
COBALT	mg/L	0.01	0.04	0.32	0.22
SILVER	mg/L	<0.05	<0.05	<0.05	<0.05
SILICON	mg/L	0.39	2.49	6.63	4.33
TITANIUM	mg/L	<0.003	0.005	<0.003	<0.003
THALLIUM	mg/L	<0.1	<0.1	<0.1	<0.1
PHYSICAL					
MOIST.WET WT.	%	0.7	18.6	21.4	28.4
MINOR NUTRIENTS					
BORON	ug/gm	<0.1	2.8	6.8	7.7

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SAMPLE		9 E3-02-125-09 CP9 OIL SAND SYNCRUDE	10 E3-02-125-10 CP10 OIL SAND SUNCOR	11 E3-02-125-11 CP11 1% TAILS OSLO PROCESS
SOIL HYDRIDE				
ARSENIC	ug/gm	1.75	1.55	1.08
SELENIUM	ug/gm	<0.02	<0.02	<0.02
ANTIMONY	ug/gm	<0.05	<0.05	<0.05
SOIL COLD VAPOR				
MERCURY	ug/gm	4.62	0.02	<0.01
ICP METALS, 3050				
ALUMINUM	ug/gm	789	748	302
BARIUM	ug/gm	16.9	18.7	6.2
BERYLLIUM	ug/gm	0.4	0.4	<0.1
CADMIUM	ug/gm	<0.3	<0.3	<0.3
CALCIUM	ug/gm	569	2570	211
CHROMIUM	ug/gm	5.6	2.0	1.0
COPPER	ug/gm	3.4	2.0	<0.5
IRON	ug/gm	4320	7450	1300
LEAD	ug/gm	<2	<2	<2
MAGNESIUM	ug/gm	424	1230	163
MANGANESE	ug/gm	153	217	45.4
MOLYBDENUM	ug/gm	<2	<2	<2
NICKEL	ug/gm	16	15	2
PHOSPHORUS	ug/gm	47	54	20
POTASSIUM	ug/gm	322	267	139
SODIUM	ug/gm	257	207	<50
VANADIUM	ug/gm	22.5	26.2	2.5
ZINC	ug/gm	12.8	10.7	6.0
COBALT	ug/gm	4	4	1
TCLP LEACH, ICP				
ALUMINUM	mg/L	0.43	0.52	0.19
BARIUM	mg/L	0.212	0.254	0.072
BERYLLIUM	mg/L	0.004	0.002	<0.001
BORON	mg/L	0.25	0.19	0.04
CADMIUM	mg/L	<0.003	<0.003	<0.003

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ALBERTA ENVIRO

SAMPLE		9 E3-02-125-09 CP9 OIL SAND SYNCRUDE	10 E3-02-125-10 CP10 OIL SAND SUNCOR	11 E3-02-125-11 CP11 1% TAILS OSLO PROCESS
TCLP LEACH, ICP				
CALCIUM	mg/L	15.4	76.1	7.4
CHROMIUM	mg/L	<0.006	<0.006	<0.006
COPPER	mg/L	<0.01	<0.01	<0.01
IRON	mg/L	67.7	33.4	21.0
LEAD	mg/L	<0.04	<0.04	<0.04
MAGNESIUM	mg/L	8.41	29.7	3.36
MANGANESE	mg/L	3.76	2.06	1.13
MOLYBDENUM	mg/L	<0.02	<0.02	<0.02
NICKEL	mg/L	0.14	0.11	0.04
PHOSPHORUS	mg/L	0.3	0.3	0.5
POTASSIUM	mg/L	2	2	<1
VANADIUM	mg/L	0.062	0.035	0.025
ZINC	mg/L	0.066	0.063	0.029
ARSENIC	mg/L	<0.05	<0.05	<0.05
SELENIUM	mg/L	<0.05	<0.05	<0.05
ANTIMONY	mg/L	<0.05	<0.05	<0.05
MERCURY	mg/L	<0.05	<0.05	<0.05
COBALT	mg/L	0.08	0.06	0.03
SILVER	mg/L	<0.05	<0.05	<0.05
SILICON	mg/L	1.00	1.00	0.83
TITANIUM	mg/L	<0.003	<0.003	<0.003
THALLIUM	mg/L	<0.1	<0.1	<0.1
PHYSICAL				
MOIST.WET WT.	%	4.0	8.8	19.7
MINOR NUTRIENTS				
BORON	ug/gm	3.8	2.9	0.6

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PAGE 1

E.T.L. CHEMSPEC
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CHRIS POWTER
AB ENVIR-94-0124

SOILS AND SEDIMENTS ANALYSIS REPORT

SAMPLE		1
		E401069-01
		SOL-EX FILT CAKE
SOIL HYDRIDE		
ARSENIC	ug/gm	3.07
SELENIUM	ug/gm	0.37
ANTIMONY	ug/gm	0.20
SOIL COLD VAPOR		
MERCURY	ug/gm	0.23
ICP METALS, 3050		
ALUMINUM	ug/gm	2340
BARIUM	ug/gm	157
BERYLLIUM	ug/gm	<0.1
CADMIUM	ug/gm	<0.3
CALCIUM	ug/gm	13200
CHROMIUM	ug/gm	14.0
COPPER	ug/gm	24.0
IRON	ug/gm	2360
LEAD	ug/gm	22
MAGNESIUM	ug/gm	7570
MANGANESE	ug/gm	24.1
MOLYBDENUM	ug/gm	6
NICKEL	ug/gm	11
PHOSPHORUS	ug/gm	68
POTASSIUM	ug/gm	787
SODIUM	ug/gm	501
VANADIUM	ug/gm	32.7
ZINC	ug/gm	35.1
COBALT	ug/gm	1
THALLIUM	ug/gm	<2
TCLP LEACH, ICP		
ANTIMONY	mg/L	<0.20
ALUMINUM	mg/L	0.15
BARIUM	mg/L	0.940
BERYLLIUM	mg/L	<0.001
BORON	mg/L	0.29
CADMIUM	mg/L	<0.003
CALCIUM	mg/L	553
COBALT	mg/L	<0.01

Lab Manager: _____

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lmonton,AB
T6E 0P5

NORWEST LABS

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(403) 438-0396 fax

DATE 22 JAN 94 09:50
P.O. NO. E4-01-069
W.O. NO. 2 74809

E.T.L. CHEMSPEC
EDMONTON, AB

CHRIS POWTER
AB ENVIR-94-0124

SOILS AND SEDIMENTS ANALYSIS REPORT

AMPLE		1
		E401069-01
		SOL-EX FILT CAKE
CLP LEACH, ICP		
CHROMIUM	mg/L	<0.006
COPPER	mg/L	<0.01
IRON	mg/L	0.09
LEAD	mg/L	<0.05
MAGNESIUM	mg/L	362
MANGANESE	mg/L	0.665
MOLYBDENUM	mg/L	<0.02
NICKEL	mg/L	<0.02
PHOSPHORUS	mg/L	0.8
POTASSIUM	mg/L	11
SELENIUM	mg/L	<0.20
SILICON	mg/L	328
TITANIUM	mg/L	0.007
THALLIUM	mg/L	<0.1
VANADIUM	mg/L	0.042
ZINC	mg/L	0.428
SILVER	mg/L	<0.05
ARSENIC	mg/L	<1.00
EACHATE		
MERCURY	mg/L	<0.0005
HYSICAL		
MOIST.WET WT.	%	48.2
MINOR NUTRIENTS		
BORON	ug/gm	0.8

Lab Manager: _____

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DATE 12 MAR 93 11:55
P.O. NO. E3-02-125
W.O. NO. 2 60500

E.T.L. CHEMSPEC
EDMONTON, AB

ALBERTA ENVIRO

The following published METHODS OF ANALYSIS were used:

NWL 6836 ARSENIC
NITRIC/PERCHLORIC DIGEST, ATOMATED HYDRIDE ATOMIC ABSORPTION SPECTROSCOPY

NWL6835 MERCURY
Digestion in a hotblock with sulphuric/ nitric acid & vanadium pentoxide. Analysis by continuous flow cold vapor atomic absorption spectrometry. Ref.Knechtel & Conn, WWTC, Env.Can.

EPA6010 ALUMINUM
ICP Spectroscopy. Ref. EPA 6010 (SW-846)

EPA6010 BARIUM
ICP Spectroscopy. Ref. EPA 6010 (SW-846)

EPA6010 BERYLLIUM
ICP Spectroscopy. Ref. EPA 6010 (SW-846)

EPA6010 CADMIUM
ICP Spectroscopy. Ref. EPA 6010 (SW-846)

EPA6010 CALCIUM
ICP Spectroscopy. Ref. EPA 6010 (SW-846)

EPA6010 CHROMIUM
ICP Spectroscopy. Ref. EPA 6010 (SW-846)

EPA6010 COPPER
ICP Spectroscopy. Ref. EPA 6010 (SW-846)

EPA6010 IRON
ICP Spectroscopy. Ref. EPA 6010 (SW-846)

EPA6010 LEAD
ICP Spectroscopy. Ref. EPA 6010 (SW-846)

EPA6010 MAGNESIUM
ICP Spectroscopy. Ref. EPA 6010 (SW-846)

EPA6010 MANGANESE
ICP Spectroscopy. Ref. EPA 6010 (SW-846)

EPA6010 MOLYBDENUM
ICP Spectroscopy. Ref. EPA 6010 (SW-846)

EPA6010 NICKEL
ICP Spectroscopy. Ref. EPA 6010 (SW-846)

EPA6010 PHOSPHORUS
ICP Spectroscopy. Ref. EPA 6010 (SW-846)

EPA6010 POTASSIUM
ICP Spectroscopy. Ref. EPA 6010 (SW-846)

EPA6010 SODIUM
ICP Spectroscopy. Ref. EPA 6010 (SW-846)

EPA6010 VANADIUM
ICP Spectroscopy. Ref. EPA 6010 (SW-846)

EPA6010 ZINC
ICP Spectroscopy. Ref. EPA 6010 (SW-846)

EPA6010 COBALT
ICP Spectroscopy. Ref. EPA 6010 (SW-846)

CGSB164 LEACHATE
Leachate extraction of 50g sample to 2L pH 5.0 solution(1:20).Extract 24hr. Ref.Cdn.General Stand. Board 164-GP-1MP

EPA 3050 EPA DIGEST 3050
Acid digestion of sediments, soils,and sludges using nitric acid/hydrogen peroxide. Reported on dry weight(mg/kg). Ref. EPA 3050 (SW-846)

MSS 4.6 BORON

Method References:

1. APHA Standard Methods for the Examination of Water and Wastewater, American Public Health Assoc., 17th ed.
2. EPA a. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods SW-846, 3rd ed., US EPA, 1986
b. Methods for Chemical Analysis ofWater and Wastewater, US EPA, 1983
3. MSS Manual on Soil Sampling and Methods of Analysis, Cdn. Soc. of Soil Science, J. A. McKeague, 2nd ed.

* NORWEST SOIL RESEARCH LTD has been accredited by the STANDARDS COUNCIL of CANADA for specific tests registered with the COUNCIL.

Lab Manager: _____

ANALYSIS

A. Gravimetric and GC/FID Analyses

An aliquot of the extract was blown to dryness under nitrogen to determine gravimetrically the amount of extracted material. This gravimetric analysis is based on gravimetric oil and grease methodologies such as Standard Methods 503A. The solvent removal process during this determination will result in the loss of short chained hydrocarbons such as those similar to gasoline and Fuel oil #2.

A portion of each extract was also analyzed by Gas Chromatography with Flame Ionization Detection (GC/FID). The total material detected by the GC/FID was calculated by comparing total peak area for the sample chromatogram to total peak area for an in-house diesel standard. The GC/FID limitations are based on the volatility of the hydrocarbons being analyzed. Material that is heavier than C_{35} hydrocarbons will not be detected by this technique due to the temperature limitation. If a sample has a high gravimetric value and a low GC/FID result; this is an indication that the sample contained mostly heavier hydrocarbons. If the GC/FID value is higher that the gravimetric value then this is an indication that the sample contained lighter hydrocarbons that are lost during the solvent removal step of the gravimetric analysis. Neither of these tests will measure hydrocarbons lighter than C_7.

TABLE 1: TOTAL EXTRACTABLE HYDROCARBONS BY GC/FID

IN SUBSTRATE SAMPLES

LAB SAMPLE #:	CLIENT ID	FRACTION RESULTS µg/g (ppm)				
		ACID	B/N	FR #1	FR #2	FR #3
E3-02-125-01A	POND 2	38	9100	3000	350	60
E3-02-125-02A	CP1	180	2400	2200	510	N.D.
E3-02-125-03A	CP3	N.D.	8.5	3.7	N.D.	N.D.
E3-02-125-04A	CP4 Duplicate 1	N.D.	50	28	N.D.	N.D.
E3-02-125-04B	CP4 Duplicate 2	N.D.	40	52	N.D.	N.D.
E3-02-125-05A	CP5	N.D.	19	21	N.D.	N.D.
E3-02-125-06A	CP6	2.0	210	160	49	12
E3-02-125-07A	CP7	14	4000	1200	420	150
E3-02-125-08A	CP8	44	11,000	7000	1100	250
E3-02-125-09A	CP9 Duplicate 1	25	3600	2300	1100	130
E3-02-125-09B	CP9 Duplicate 2	39	5800	3100	950	120
E3-02-125-10A	CP10	120	2700	3100	1400	60
E3-02-125-11A	CP11	N.D.	290	110	40	N.D.
Detection limit (ppm)		1.0	1.0	1.0	10*	10*

N.D. - Not detected.

* - Detection limits for FR #2 & FR #3 are higher due to high level of co-extractives in the method blank.

TABLE 2: TOTAL EXTRACTABLE HYDROCARBONS BY GC/FID IN LEACHATE SAMPLES

LAB SAMPLE #:	CLIENT ID	FRACTION RESULTS µg/L (ppb)				
		ACID	B/N	FR #1	FR #2	FR #3
E3-02-125-04A	CP4	N.D.	230	N.D.	N.D.	N.D.
E3-02-125-05A	CP5	N.D.	320	13	N.D.	N.D.
E3-02-125-06A	CP6	51	270	N.D.	N.D.	N.D.
E3-02-125-07A	CP7	64	1600	N.D.	N.D.	520
E3-02-125-08A	CP8	530	1800	N.D.	N.D.	1200
E3-02-125-09A	CP9	N.D.	1200	N.D.	N.D.	770
E3-02-125-10A	CP10	92	2900	N.D.	N.D.	470
E3-02-125-11	CP11	N.D.	280	N.D.	N.D.	N.D.
Detection limit (ppb)		10	10	10	10	200*

N.D. - Not detected.

* - The detection limit was raised for FR #3 results due to high level of co-extractives in the method blank.

TABLE 3: TOTAL EXTRACTABLE HYDROCARBONS BY GC/FID IN LEACHED SOLID SAMPLES

LAB SAMPLE #:	CLIENT ID	FRACTION RESULTS µg/g (ppm)				
		ACID	B/N	FR #1	FR #2	FR #3
E3-02-125-04A	CP4	N.D.	62	42	8.0	N.D.
E3-02-125-05A	CP5	N.D.	52	25	23	N.D.
E3-02-125-06A	CP6	17	330	430	100	14
E3-02-125-07A	CP7	80	4000	1500	600	59
E3-02-125-08A	CP8	100	11,000	4200	2300	250
E3-02-125-09A	CP9	97	3100	2100	1300	55
E3-02-125-10A	CP10	56	5500	3800	2300	95
E3-02-125-11	CP11	N.D.	130	84	59	16
Detection limit (ppm)		1.0	1.0	1.0	1.0	1.0

N.D. - Not detected.

E3-02-125 REP. cont'd

TABLE 4: TOTAL EXTRACTABLE HYDROCARBONS BY GRAVIMETRIC ANALYSIS

IN SUBSTRATE SAMPLES

LAB SAMPLE #:	CLIENT ID	FRACTION RESULTS µg/g (ppm)				
		ACID	B/N	FR #1	FR #2	FR #3
E3-02-125-01A	POND 2	560	74,000	26,000	15,000	18,000
E3-02-125-02A	CP1	4200	29,000	12,000	8500	13,000
E3-02-125-03A	CP3	N.D.	N.D.	N.D.	N.D.	N.D.
E3-02-125-04A	CP4 Duplicate 1	N.D.	1300	400	240	520
E3-02-125-04B	CP4 Duplicate 2	200	1700	580	210	590
E3-02-125-05A	CP5	N.D.	900	N.D.	240	340
E3-02-125-06A	CP6	160	5100	1600	730	1300
E3-02-125-07A	CP7	620	43,000	19,000	8300	12,000
E3-02-125-08A	CP8	1300	160,000	59,000	45,000	47,000
E3-02-125-09A	CP9 Duplicate 1	1100	100,000	30,000	30,000	29,000
E3-02-125-09B	CP9 Duplicate 2	2800	100,000	33,000	24,000	32,000
E3-02-125-10A	CP10	8000	120,000	24,000	31,000	42,000
E3-02-125-11A	CP11	180	3600	1000	560	790
Detection limit (ppm)		100	100	100	100	100

N.D. - Not detected.

TABLE 5: TOTAL EXTRACTABLE HYDROCARBONS BY GRAVIMETRIC ANALYSIS IN LEACHATE SAMPLES

LAB SAMPLE #:	CLIENT ID	FRACTION RESULTS µg/L (ppb)				
		ACID	B/N	FR #1	FR #2	FR #3
E3-02-125-04A	CP4	1600	700	600	N.D.	200
E3-02-125-05A	CP5	2900	5000	190	N.D.	940
E3-02-125-06A	CP6	1100	400	N.D.	N.D.	400
E3-02-125-07A	CP7	2700	3400	190	N.D.	3200
E3-02-125-08A	CP8	3400	5500	N.D.	N.D.	4000
E3-02-125-09A	CP9	1100	2400	400	N.D.	2200
E3-02-125-10A	CP10	2000	15,000	200	980	3300
E3-02-125-11	CP11	1200	600	400	N.D.	200
Detection limit (ppb)		100	100	100	100	100

N.D. - Not detected.

* - The detection limit was raised for FR #3 results due to high level of extractables in the method blank.

TABLE 6: TOTAL EXTRACTABLE HYDROCARBONS BY GRAVIMETRIC ANALYSIS IN LEACHED SOLID SAMPLES

LAB SAMPLE #:	CLIENT ID	FRACTION RESULTS µg/g (ppm)				
		ACID	B/N	FR #1	FR #2	FR #3
E3-02-125-04A	CP4	64	2000	580	310	N.D.
E3-02-125-05A	CP5	270	3500	1100	350	620
E3-02-125-06A	CP6	1600	13,000	5500	1500	1400
E3-02-125-07A	CP7	1900	42,000	20,000	7600	9100
E3-02-125-08A	CP8	4900	140,000	59,000	32,000	36,000
E3-02-125-09A	CP9	6600	110,000	33,000	24,000	20,000
E3-02-125-10A	CP10	2400	140,000	38,000	42,000	34,000
E3-02-125-11	CP11	89	4400	1200	680	130
Detection limit (ppm)		100	100	100	100	100

N.D. - Not detected.

TABLE 1: TOTAL EXTRACTABLE HYDROCARBONS BY GC/FID IN SUBSTRATE SAMPLE

LAB SAMPLE #	SAMPLE I.D.	FRACTION RESULTS µg/g (ppm)				
		ACID	B/N	FR #1	FR #2	FR #3
E4-01-069-01A	SOLV-EX Filter Cake	110	12,000*	5,800*	380	130

TOTAL EXTRACTABLE HYDROCARBONS BY GC/FID IN LEACHED SOLID SAMPLE

LAB SAMPLE #	SAMPLE I.D.	FRACTION RESULTS µg/g (ppm)				
		ACID	B/N	FR #1	FR #2	FR #3
E4-01-069-01A	SOLV-EX Filter Cake	80	6,400*	3,300*	300	20
Detection Limit (ppm) -		1.0	1.0	1.0	1.0	1.0

Results reported on a dry weight basis.

* The hydrocarbons in the Base/Neutral and fraction #1 extracts were poorly resolved by GC/FID. The majority of the material came out as an unresolved "hump". The resulting total extractable values are lower than the actual concentrations.

TABLE 2: TOTAL EXTRACTABLE HYDROCARBONS BY GC/FID IN LEACHATE SAMPLE

LAB SAMPLE #	SAMPLE I.D.	FRACTION RESULTS µg/L (ppb)				
		ACID	B/N	FR #1	FR #2	FR #3
E4-01-069-01A	SOLV-EX Filter Cake	130	260	N.D.	N.D.	N.D.
Detection Limit (ppb) -		20	20	20	20	20

N.D. - Not detected, less than detection limit.

TABLE 3: TOTAL EXTRACTABLE HYDROCARBONS BY GRAVIMETRIC ANALYSIS IN SUBSTRATE SAMPLE

LAB SAMPLE #	SAMPLE I.D.	FRACTION RESULTS µg/g (ppm)				
		ACID	B/N	FR #1	FR #2	FR #3
E4-01-069-01A	SOLV-EX Filter Cake	530	24,000	16,000	1,900	290

TOTAL EXTRACTABLE HYDROCARBONS BY GRAVIMETRIC ANALYSIS IN LEACHED SOLID SAMPLE

LAB SAMPLE #	SAMPLE I.D.	FRACTION RESULTS µg/g (ppm)				
		ACID	B/N	FR #1	FR #2	FR #3
E4-01-069-01A	SOLV-EX Filter Cake	470	16,000	12,000	1,800	N.D.
Detection Limit (ppm) -		100	100	100	100	100

N.D. - Not detected, less than detection limit.

Results reported on a dry weight basis.

TABLE 4: TOTAL EXTRACTABLE HYDROCARBONS BY GRAVIMETRIC ANALYSIS IN LEACHATE SAMPLE

LAB SAMPLE #	SAMPLE I.D.	FRACTION RESULTS µg/L (ppb)				
		ACID	B/N	FR #1	FR #2	FR #3
E4-01-069-01A	SOLV-EX Filter Cake	N.D.	N.D.	N.D.	N.D.	N.D.
Detection Limit (ppb) -		1000	1000	1000	1000	1000

N.D. - Not detected, less than detection limit.

B. GC/MS Target PAH Analysis

- EPA Target PAHs

Target EPA PAH analysis was requested for the Fraction #2 extracts for the leachate and leached solid samples. The extracts were analyzed along with a quantitative standard using a gas chromatograph/mass spectrometer (GC/MS) in a selected ion monitoring (SIM) mode. SIM analysis is more sensitive than scan acquisition and was used to achieve the low detection limits quoted. The data was processed using the mass spectrometer's automated software to create hardcopies of the extracted ion profiles for the target compound and to quantitate the target compound. The analyst manually reviewed the data to ensure proper identification and quantitation.

- Target Alkylated PAHs

The same Fraction #2 extracts were reanalysed at twice more to check for all the quoted alkylated PAH's and for all the requested additional compounds. SIM GC/MS analysis was utilized for the analysis of these additional compounds with some modifications from the original target compound analysis. For the analysis of the parent PAHs, a target ion and two confirmation ions for each compound are selected and data collected during the GC/MS analysis. For the alkylated compounds the target ion and one qualifier were selected. Fewer ions were selected due to the number of compounds requested and the spectral differences in the possible isomers. The other difference was that most of alkylated compounds were quantitated against the parent PAH since analytical standards were not available.

C. GC/MS Non-Target Analysis

Based on the GC/FID chromatograms, 26 representative extracts were taken to GC/MS for Non-Target characterization. A portion of each extract was spiked with the deuterated internal standard Anthracene d_{10} and analyzed by GC/MS in the scanning acquisition mode. In this mode, the instrument gives a full mass spectrum for each resolved compound. The mass spectra for all the major components were then generated along with an area % report and a computer generated library search. The spectra were manually interpreted using first principles and matching to hardcopy library spectra, when available. Each compound was assigned a confidence of identification value based on the quality of the mass spectra and the analyst's opinion of the match to hardcopy spectra. These values are fully explained in the table at the end of the Non-Target results. The components identified were semi-quantitated by comparison to the Anthracene d_{10} internal standard.

RESULTS

A. GC/FID & Gravimetric Results

All the base-neutral, acid, and fraction #1, #2 & #3 extracts were screened by GC/FID and gravimetric analysis. The GC/FID and gravimetric results are given in the Tables 1 through 6. The GC/FID chromatograms have all been attached as well.

B. Target GC/MS Results

Target PAH analysis was requested for the Fraction #2 extracts for the Leachates and the Leached solids. The PAHs and Alkylated PAHs that were included in this analysis are listed in the table on the following page. The target ion selected for each compound is also listed in the table. In this report the alkylated compounds are more accurately named by carbon substitution. The results for this analysis are given in the tables following this section.

TARGET PRIORITY POLLUTANT PAH's

	COMPOUND	M/E
1.)	Naphthalene	128
2.)	Acenaphthylene	152
3.)	Acenaphthene	153
4.)	Fluorene	166
5.)	Phenanthrene	178
6.)	Anthracene	178
7.)	Fluoranthene	202
8.)	Pyrene	202
9.)	Benz[a]Anthracene	228
10.)	Chrysene	228
11.)	Benzo[b & k]fluoranthene	252
12.)	Benzo[a]pyrene	252
13.)	Indeno[c,d-1,2,3]pyrene	276
14.)	Dibenzo[a,h]anthracene	278
15.)	Benzo[g,h,i]perylene	276

TARGET SUBSTITUTED PAHs

	COMPOUND	M/E
1.)	Methyl naphthalenes	142
2.)	C_2 Substituted naphthalenes	156
3.)	C_3 Subst'd naphthalenes	170
4.)	C_4 Subst'd naphthalenes	184
5.)	Biphenyl	154
6.)	Methyl biphenyl	168
7.)	C_2 Substituted biphenyl	182
8.)	Methyl acenaphthene	166
9.)	Methyl fluorene	180
10.)	C_2 Substituted fluorene	194
11.)	Methyl phenanthrene/anthracene	192
12.)	C_2 Substituted phenanthrene/anthracene	206
13.)	C_3 Subst'd phenanthrene/anthracene	220
14.)	C_4 Subst'd phenanthrene/anthracene	234
15.)	1-Methyl-7-isopropyl-phenanthrene (Retene)	219
16.)	Dibenzothiophene	184
17.)	Methyl dibenzothiophene	198
18.)	C_2 Substituted dibenzothiophene	212
19.)	C_3 Subst'd dibenzothiophene	226
20.)	C4 Subst'd dibenzothiophene	240
21.)	Methyl pyrene/fluoranthene	216
22.)	Methyl chrysene/benz(a)anthracene	242
23.)	C_2 Substituted chrysene/benz(a)anthracene	266
24.)	Methyl benzo(a)pyrene/benzo(b&k)fluoranthene	266
25.)	C_2 Subst'd benzo(a)pyrene/benzo(b&k)fluoranthene	280

PAHs IN SOLIDS AND LEACHATES

	E3-02-125-1 POND 2 FINE TAILS	E3-02-125-2 CP1 FINE TAILS	E3-02-125-3 CP3 CLAY SHALE
TARGET PRIORITY POLLUTANT PAH's	SUBSTRATE CONC. (µg/g)	SUBSTRATE CONC. (µg/g)	SUBSTRATE CONC. (µg/g)
Naphthalene	N.D.	N.D.	N.D.
Acenaphthylene	N.D.	N.D.	N.D.
Acenaphthene	0.51	1.7	N.D.
Fluorene	0.29	0.19	0.05
Dibenzothiophene	0.47	0.13	0.05
Phenanthrene	1.9	2.1	0.06
Anthracene	N.D.	N.D.	N.D.
Fluoranthene	0.57	0.21	N.D.
Pyrene	0.88	0.58	N.D.
Benzo(a)Anthracene/Chrysene	3.3	2.6	N.D.
Benzo(b&k)fluoranthene	1.0	0.35	N.D.
Benzo(a)pyrene	1.2	0.50	N.D.
Indeno(c,d-123)pyrene	N.D.	N.D.	N.D.
Dibenzo(a,h)anthracene	N.D.	N.D.	N.D.
Benzo(g,h,i)perylene	0.33	0.17	N.D.
TARGET SUBSTITUTED PAH's			
Methyl naphthalenes	N.D.	N.D.	0.04
C_2 Substituted naphthalenes	0.36	0.16	0.39
C_3 Subst'd naphthalenes	4.4	0.54	0.06
C_4 Subst'd naphthalenes	7.0	1.4	N.D.
Biphenyl	N.D.	N.D.	N.D.
Methyl biphenyl	N.D.	N.D.	N.D.
C_2 Substituted biphenyl	N.D.	N.D.	N.D.
Methyl acenaphthene	N.D.	N.D.	N.D.
Methyl fluorene	0.42	0.12	N.D.
C_2 Substituted fluorene	1.5	0.36	N.D.
Methyl phenanthrene/anthracene	12	9.7	0.04
C_2 Substituted phenanthrene/anthracene	26	6.5	0.02
C_3 Subst'd phenanthrene/anthracene	50	8.1	0.03
C_4 Subst'd phenanthrene/anthracene	7.0	1.0	N.D.
1-Methyl-7-isopropyl-phenanthrene (Retene)	N.D.	N.D.	N.D.
Methyl dibenzothiophene	5.8	1.4	0.02
C_2 Substituted dibenzothiophene	22	6.5	0.01
C_3 Subst'd dibenzothiophene	35	8.0	0.05
C_4 Subst'd dibenzothiophene	33	6.4	0.11
Methyl fluoranthene/pyrene	4.2	1.0	N.D.
Methyl benzo(a)anthracene/chrysene	7.0	1.0	N.D.
C_2 Subst'd benzo(a)anthracene/chrysene	7.7	1.7	N.D.
Methyl benzo(b or k)fluoranthene/methyl benzo(a)pyrene	2.0	0.41	N.D.
C_2 Subst'd benzo(b or k)fluoranthene/benzo(a)pyrene	2.9	0.38	N.D.

N.D. - Not detected.
Solid Detection limit - 0.01 ppm for all compounds. Based on sample size and dilution required.
Results reported on a dry sample weight basis.

PAHS IN SOLIDS AND LEACHATES

	E3-02-125-4 CP4 SYNCRUDE BEACH		E3-02-125-5 CP5 SUNCOR BEACH	
TARGET PRIORITY POLLUTANT PAH's	LEACHATE CONC. (µg/L)	SOLID CONC. (µg/g)	LEACHATE CONC. (µg/L)	SOLID CONC. (µg/g)
Naphthalene	0.11	N.D.	0.05	N.D.
Acenaphthylene	N.D.	N.D.	N.D.	N.D.
Acenaphthene	N.D.	N.D.	N.D.	N.D.
Fluorene	N.D.	N.D.	N.D.	N.D.
Dibenzothiophene	N.D.	N.D.	N.D.	N.D.
Phenanthrene	0.05	0.04	0.04	0.02
Anthracene	N.D.	N.D.	N.D.	N.D.
Fluoranthene	N.D.	N.D.	N.D.	N.D.
Pyrene	N.D.	0.01	N.D.	0.04
Benzo(a)Anthracene/Chrysene	N.D.	0.09	N.D.	0.15
Benzo(b&k)fluoranthene	N.D.	0.01	N.D.	0.03
Benzo(a)pyrene	N.D.	0.03	N.D.	N.D.
Indeno(c,d-123)pyrene	N.D.	N.D.	N.D.	N.D.
Dibenzo(a,h)anthracene	N.D.	N.D.	N.D.	N.D.
Benzo(g,h,i)perylene	N.D.	0.01	N.D.	N.D.
TARGET SUBSTITUTED PAH's				
Methyl naphthalenes	0.08	N.D.	N.D.	N.D.
C_2 Substituted naphthalenes	N.D.	N.D.	N.D.	N.D.
C_3 Subst'd naphthalenes	N.D.	N.D.	N.D.	N.D.
C_4 Subst'd naphthalenes	N.D.	0.01	N.D.	N.D.
Biphenyl	N.D.	N.D.	N.D.	0.01
Methyl biphenyl	N.D.	N.D.	N.D.	N.D.
C_2 Substituted biphenyl	N.D.	N.D.	N.D.	N.D.
Methyl acenaphthene	N.D.	N.D.	N.D.	N.D.
Methyl fluorene	N.D.	N.D.	N.D.	N.D.
C_2 Substituted fluorene	N.D.	N.D.	N.D.	N.D.
Methyl phenanthrene/anthracene	N.D.	0.13	N.D.	0.08
C_2 Substituted phenanthrene/anthracene	N.D.	0.14	N.D.	0.12
C_3 Subst'd phenanthrene/anthracene	N.D.	0.07	N.D.	0.11
C_4 Subst'd phenanthrene/anthracene	N.D.	0.06	N.D.	0.23
1-Methyl-7-isopropyl-phenanthrene (Retene) *	N.D.	N.D.	N.D.	N.D.
Methyl dibenzothiophene	N.D.	0.05	N.D.	0.02
C_2 Substituted dibenzothiophene	N.D.	0.11	N.D.	0.07
C_3 Subst'd dibenzothiophene	N.D.	0.15	N.D.	0.19
C_4 Subst'd dibenzothiophene	N.D.	0.34	N.D.	0.52
Methyl fluoranthene/pyrene	N.D.	N.D.	N.D.	0.01
Methyl benzo(a)anthracene/chrysene	N.D.	0.13	N.D.	0.21
C_2 Substituted benzo(a)anthracene/chrysene	N.D.	0.16	N.D.	0.29
Methyl benzo(b or k)fluoranthene/methyl benzo(a)pyrene	N.D.	0.03	N.D.	0.13
C_2 Subst'd benzo(b or k)fluoranthene/benzo(a)pyrene	N.D.	0.06	N.D.	0.07

N.D. - Not detected.
Aqueous Detection limit - 0.04 ppb for all compounds. Based on sample size and dilution required.

Solid Detection limit - 0.01 ppm for all compounds. Based on sample size and dilution required.
Results reported on a dry sample weight basis.

PAHS IN SOLIDS AND LEACHATES

	E3-02-125-6 CP6 SAND + TAILS		E3-02-125-7 CP7 TAILS DRIED	
TARGET PRIORITY POLLUTANT PAH	LEACHATE CONC. (µg/L)	SOLID CONC. (µg/g)	LEACHATE CONC. (µg/L)	SOLID CONC. (µg/g)
Naphthalene	0.06	N.D.	0.05	N.D.
Acenaphthylene	N.D.	N.D.	N.D.	N.D.
Acenaphthene	0.11	0.03	0.07	0.12
Fluorene	0.05	0.05	N.D.	0.09
Dibenzothiophene	N.D.	N.D.	N.D.	N.D.
Phenanthrene	0.76	0.58	0.12	1.4
Anthracene	N.D.	N.D.	N.D.	N.D.
Fluoranthene	0.44	0.06	N.D.	0.24
Pyrene	0.28	0.17	N.D.	0.89
Benzo(a)Anthracene/Chrysene	0.13	0.86	N.D.	3.0
Benzo(b&k)fluoranthene	N.D.	0.14	N.D.	0.44
Benzo(a)pyrene	N.D.	0.17	N.D.	0.18
Indeno(c,d-123)pyrene	N.D.	N.D.	N.D.	N.D.
Dibenzo(a,h)anthracene	N.D.	N.D.	N.D.	N.D.
Benzo(g,h,i)perylene	N.D.	0.05	N.D.	0.20
TARGET SUBSTITUTED PAH's				
Methyl naphthalenes	N.D.	0.01	N.D.	N.D.
C_2 Substituted naphthalenes	N.D.	N.D.	N.D.	N.D.
C_3 Subst'd naphthalenes	N.D.	0.22	N.D.	1.1
C_4 Subst'd naphthalenes	N.D.	0.58	N.D.	4.3
Biphenyl	N.D.	0.01	N.D.	N.D.
Methyl biphenyl	N.D.	0.10	N.D.	0.48
C_2 Substituted biphenyl	N.D.	N.D.	N.D.	N.D.
Methyl acenaphthene	N.D.	N.D.	N.D.	N.D.
Methyl fluorene	N.D.	0.37	N.D.	1.0
C_2 Substituted fluorene	N.D.	0.17	N.D.	0.42
Methyl phenanthrene/anthracene	0.58	3.3	0.22	11
C_2 Substituted phenanthrene/anthracene	N.D.	3.0	N.D.	16
C_3 Subst'd phenanthrene/anthracene	N.D.	2.2	N.D.	13
C_4 Subst'd phenanthrene/anthracene	N.D.	1.6	N.D.	8.9
1-Methyl-7-isopropyl-phenanthrene (Retene)	N.D.	N.D.	N.D.	N.D.
Methyl Dibenzothiophene	N.D.	0.91	N.D.	3.5
C_2 Substituted Dibenzothiophene	N.D.	3.4	N.D.	17
C_3 Subst'd Dibenzothiophene	N.D.	4.0	N.D.	22
C_4 Subst'd dibenzothiophene	N.D.	4.5	N.D.	26
Methyl fluoranthene/pyrene	N.D.	0.09	N.D.	0.59
Methyl benzo(a)anthracene/chrysene	N.D.	1.0	N.D.	4.8
C_2 Subst'd benzo(a)anthracene/chrysene	N.D.	0.18	N.D.	5.9
Methyl benzo(b or k)fluoranthene/methyl benzo(a)pyrene	N.D.	0.30	N.D.	2.2
C_2 Subst'd benzo(b or k)fluoranthene/benzo(a)pyrene	N.D.	0.33	N.D.	0.93

N.D. - Not detected.
Aqueous Detection limit - 0.04 ppb for all compounds. Based on sample size and dilution required.

Solid Detection limit - 0.01 ppm for all compounds. Based on sample size and dilution required.
Results reported on a dry sample weight basis.

PAHS IN SOLIDS AND LEACHATES

	E3-02-125-8 CP8 TAILS DRIED		E3-02-125-9 CP9 OIL SAND SYN.	
TARGET PRIORITY POLLUTANT PAH	LEACHATE CONC. (µg/L)	SOLID CONC. (µg/g)	LEACHATE CONC. (µg/L)	SOLID CONC. (µg/g)
Naphthalene	0.21	N.D.	0.08	N.D.
Acenaphthylene	N.D.	N.D.	N.D.	N.D.
Acenaphthene	0.10	0.52	0.10	0.36
Fluorene	N.D.	0.15	N.D.	0.12
Dibenzothiophene	N.D.	N.D.	N.D.	N.D.
Phenanthrene	0.17	1.8	0.23	4.0
Anthracene	N.D.	N.D.	N.D.	N.D.
Fluoranthene	N.D.	0.59	N. D.	0.44
Pyrene	N.D.	3.0	N.D.	1.5
Benzo(a)Anthracene/Chrysene	N.D.	8.7	N.D.	4.9
Benzo(b&k)fluoranthene	N.D.	1.3	N.D.	0.91
Benzo(a)pyrene	N.D.	0.79	N.D.	0.92
Indeno(c,d-123)pyrene	N.D.	N.D.	N.D.	N.D.
Dibenzo(a,h)anthracene	N.D.	N.D.	N.D.	N.D.
Benzo(g,h,i)perylene	N.D.	N.D.	N.D.	N.D.
TARGET SUBSTITUTED PAH's				
Methyl naphthalenes	0.08	N.D.	N.D.	N.D.
C_2 Substituted naphthalenes	N.D.	0.17	N.D.	N.D.
C_3 Subst'd naphthalenes	N.D.	1.9	N.D.	1.7
C_4 Subst'd naphthalenes	N.D.	5.9	N.D.	5.3
Biphenyl	N.D.	0.11	N.D.	0.10
Methyl biphenyl	N.D.	2.2	N.D.	0.63
C_2 Substituted biphenyl	N.D.	N.D.	N.D.	N.D.
Methyl acenaphthene	N.D.	N.D.	N.D.	N.D.
Methyl fluorene	N.D.	0.59	N.D.	1.8
C_2 Substituted fluorene	N.D.	1.5	N.D.	1.2
Methyl phenanthrene/anthracene	0.15	12	0.33	21
C_2 Substituted phenanthrene/anthracene	N.D.	19	N.D.	20
C_3 Subst'd phenanthrene/anthracene	N.D.	31	N.D.	17
C_4 Subst'd phenanthrene/anthracene	N.D.	25	N.D.	14
1-Methyl-7-isopropyl-phenanthrene (Retene)	N.D.	N.D.	N.D.	N.D.
Methyl dibenzothiophene	N.D.	6.6	N.D.	4.4
C_2 Substituted dibenzothiophene	N.D.	21	N.D.	18
C_3 Subst'd dibenzothiophene	N.D.	46	N.D.	25
C_4 Subst'd dibenzothiophene	N.D.	67	N.D.	36
Methyl fluoranthene/pyrene	N.D.	1.5	N.D.	0.57
Methyl benzo(a)anthracene/chrysene	N.D.	14	N.D.	9.9
C_2 Subst'd benzo(a)anthracene/chrysene	N.D.	18	N.D.	9.5
Methyl benzo(b or k)fluoranthene/methyl benzo(a)pyrene	N.D.	6.0	N.D.	2.4
C_2 Subst'd benzo(b or k)fluoranthene/benzo(a)pyrene	N.D.	4.7	N.D.	1.9

N.D. - Not detected.
Aqueous Detection limit - 0.04 ppb for all compounds. Based on sample size and dilution required.

Solid Detection limit - 0.01 ppm for all compounds. Based on sample size and dilution required.
Results reported on a dry sample weight basis.

PAHS IN SOLIDS AND LEACHATES

	E3-02-125-10 CP10 OIL SAND SUN.		E3-02-125-11 CP11 SAND OSLO	
TARGET PRIORITY POLLUTANT PAH	LEACHATE CONC. (µg/L)	SOLID CONC. (µg/g)	LEACHATE CONC. (µg/L)	SOLID CONC. (µg/g)
Naphthalene	0.05	N.D.	0.12	N.D.
Acenaphthylene	N.D.	N.D.	N.D.	N.D.
Acenaphthene	0.21	1.1	0.20	0.01
Fluorene	N.D.	0.14	0.14	0.03
Dibenzothiophene	N.D.	N.D.	N.D.	N.D.
Phenanthrene	0.14	4.7	0.33	0.24
Anthracene	N.D.	N.D.	N.D.	N.D.
Fluoranthene	N.D.	0.69	0.06	0.02
Pyrene	N.D.	2.0	0.04	0.06
Benzo(a)Anthracene/Chrysene	N.D.	7.0	N.D.	0.23
Benzo(b&k)fluoranthene	N.D.	N.D.	N.D.	0.04
Benzo(a)pyrene	N.D.	0.92	N.D.	N.D.
Indeno(c,d-123)pyrene	N.D.	N.D.	N.D.	N.D.
Dibenzo(a,h)anthracene	N.D.	N.D.	N.D.	N.D.
Benzo(g,h,i)perylene	N.D.	N.D.	N.D.	0.02
TARGET SUBSTITUTED PAH's				
Methyl naphthalenes	N.D.	N.D.	0.24	N.D.
C_2 Substituted naphthalenes	N.D.	0.12	N.D.	0.03
C_3 Subst'd naphthalenes	N.D.	1.5	N.D.	0.19
C_4 Subst'd naphthalenes	N.D.	7.9	N.D.	0.39
Biphenyl	N.D.	N.D.	N.D.	0.02
Methyl biphenyl	N.D.	N.D.	N.D.	0.05
C_2 Substituted biphenyl	N.D.	N.D.	N.D.	N.D.
Methyl acenaphthene	N.D.	N.D.	N.D.	N.D.
Methyl fluorene	N.D.	1.8	N.D.	0.14
C_2 Substituted fluorene	N.D.	1.2	N.D.	0.07
Methyl phenanthrene/anthracene	0.38	35	0.58	1.4
C_2 Substituted phenanthrene/anthracene	N.D.	40	N.D.	1.4
C_3 Subst'd phenanthrene/anthracene	N.D.	40	N.D.	0.97
C_4 Subst'd phenanthrene/anthracene	N.D.	25	N.D.	0.67
1-Methyl-7-isopropyl-phenanthrene (Retene)	N.D.	N.D.	N.D.	N.D.
Methyl dibenzothiophene	N.D.	9.0	N.D.	0.48
C_2 Substituted dibenzothiophene	N.D.	36	N.D.	1.2
C_3 Subst'd dibenzothiophene	N.D.	55	N.D.	1.3
C_4 Subst'd dibenzothiophene	N.D.	10	N.D.	2.0
Methyl fluoranthene/pyrene	N.D.	1.0	N.D.	0.04
Methyl benzo(a)anthracene/chrysene	N.D.	18	N.D.	0.32
C_2 Subst'd benzo(a)anthracene/chrysene	N.D.	13	N.D.	0.45
Methyl benzo(b or k)fluoranthene/methyl benzo(a)pyrene	N.D.	0.03	N.D.	0.13
C_2 Subst'd benzo(b or k)fluoranthene/benzo(a)pyrene	N.D.	2.2	N.D.	0.10

N.D. - Not detected.
Aqueous Detection limit - 0.04 ppb for all compounds. Based on sample size and dilution required.

Solid Detection limit - 0.01 ppm for all compounds. Based on sample size and dilution required.
Results reported on a dry sample weight basis.

TABLE 1: TARGET PAHs IN SOIL AND LEACHATE BY GC/MS/SIM

	E4-01-069-01A Solv-ex filter cake		
TARGET PRIORITY POLLUTANT PAHs	Solid µg/g (ppm)*	Leached solid µg/g (ppm)*	Leachate µg/L (ppb)
Naphthalene	0.064	0.098	N.D.
Acenaphthylene	N.D.	N.D.	N.D.
Acenaphthene	N.D.	N.D.	N.D.
Fluorene	0.026	0.028	N.D.
Dibenzothiophene	0.061	0.061	N.D.
Phenanthrene	0.24	0.23	N.D.
Anthracene	N.D.	N.D.	N.D.
Fluoranthene	0.055	0.040	N.D.
Pyrene	0.14	0.12	N.D.
Benzo(a)Anthracene/Chrysene	0.52	0.49	N.D.
Benzo(b&k)fluoranthene	0.061	0.057	N.D.
Benzo(a)pyrene	N.D.	N.D.	N.D.
Indeno(c,d-123)pyrene	N.D.	N.D.	N.D.
Dibenzo(a,h)anthracene	0.012	0.012	N.D.
Benzo(g,h,i)perylene	0.029	0.025	N.D.
TARGET SUBSTITUTED PAHs			
Methyl naphthalenes	0.22	0.22	N.D.
C_2 Substituted naphthalenes	0.29	0.33	N.D.
C_3 Subst'd naphthalenes	0.48	0.47	N.D.
C_4 Subst'd naphthalenes	0.84	0.74	N.D.
Biphenyl	0.037	0.034	N.D.
Methyl biphenyl	0.039	0.033	N.D.
C_2 Substituted biphenyl	N.D.	N.D.	N.D.
Methyl acenaphthene	0.021	0.018	N.D.
Methyl fluorene	0.092	0.072	N.D.
C_2 Substituted fluorene	0.19	0.19	N.D.
Methyl phenanthrene/anthracene	0.92	0.84	N.D.
C_2 Substituted phenanthrene/anthracene	2.0	1.6	N.D.
C_3 Subst'd phenanthrene/anthracene	2.4	1.9	N.D.
C_4 Subst'd phenanthrene/anthracene	1.6	1.3	N.D.
1-Methyl-7-isopropyl-phenanthrene (Retene)	N.D.	N.D.	N.D.
Methyl dibenzothiophene	0.36	0.35	N.D.
C_2 Substituted dibenzothiophene	0.99	0.88	N.D.
C_3 Subst'd dibenzothiophene	1.2	1.4	N.D.
C_4 Subst'd dibenzothiophene	0.24	0.16	N.D.
Methyl fluoranthene/pyrene	0.15	0.11	N.D.
Methyl benzo(a)anthracene/chrysene	0.49	0.40	N.D.
C_2 Subst'd benzo(a)anthracene/chrysene	0.29	0.23	N.D.
Methyl benzo(b or k)fluoranthene/methyl benzo(a)pyrene	0.13	0.11	N.D.
C_2 Subst'd benzo(b or k)fluoranthene/benzo(a)pyrene	0.11	0.13	N.D.

N.D. - Not detected, less than detection limit.
Solid Detection limit - 0.01 ppm for all compounds. Based on sample size and dilution required.
Leachate Detection Limit - 0.04 ppb for all compounds.
* Results reported on a dry sample weight basis.

C. Non-Target GC/MS Results

The results of the non-target GC/MS characterizations have been attached to this report. A non-target form with comments has been attached to its corresponding chromatogram for all the sample extracts. At the beginning of the results there is a table which explains the confidence of identification values.

The detection limits for the non-target analyses are:
Leachate extracts - 10 ppb - based on extract final volumes and the sample volume.
Substrate extracts - 2 ppm - based on extract final volumes and dry sample weight.

QA/QC

To monitor method and extraction efficiently, surrogate compounds were added to all samples prior to being extracted. Their average recoveries are reported below.

SURROGATE COMPOUND	RECOVERY (%) Water	RECOVERY (%) Soil
Nitrobenzene d_5	78%	35%
2-Fluorobiphenyl	65%	66%
p-Terphenyl d_{14}	61%	120%

Method blanks were extracted and analyzed along with the samples. Method blanks are generated by going through the entire analytical process but substituting organic free water (in place of liquids) or reagent grade sodium sulfate (in place of solids). This type of blank accounts for contamination from solvents or reagents utilized in the analysis. Glassware proofs are also generated during the sample preparation phase of the project. These are generated by rinsing **all** glassware to be utilized in the analysis and combining and concentrating the rinsings. This type of proof will monitor any contribution from trace contamination on the glassware utilized.

Two of the substrate samples were extracted in duplicate (E3-02-125-4 and -9). The results for each duplicate can be found in the gravimetric and GC/FID result tables.

TABLE OF CONFIDENCE OF IDENTIFICATION

NUMBER 1: Very confident, clean spectra, excellent match with library spectra.

NUMBER 2: Some small spectra differences with library match. A good comparison. Reference standard needed for positive identification.

NUMBER 3: Possible compound or very similar to. Spectra is definitely contaminated. Reference standard needed for positive identification.

NUMBER 4: Evidence of possible structure and molecular weight. Compound not identified.

NUMBER 5: Unable to identify.

GC/MS CHARACTERIZATION RESULTS AND THE MATCHING GC/FID CHROMATOGRAMS HAVE BEEN GROUPED IN THE FOLLOWING MANNER.

FRACTION 1 GC/MS CHARACTERIZATION

- SUBSTRATE
- LEACHATE
- LEACHED SOIL

FRACTION 2 GC/MS CHARACTERIZATION

- SUBSTRATE
- LEACHATE
- LEACHED SOIL

FRACTION 3 GC/MS CHARACTERIZATION

- SUBSTRATE
- LEACHATE
- LEACHED SOIL

ACID EXTRACT GC/MS CHARACTERIZATION

- SUBSTRATE
- LEACHATE
- LEACHED SOIL

BASE/NEUTRAL EXTRACT GC/MS CHARACTERIZATION

- SUBSTRATE
- LEACHATE
- LEACHED SOIL

SUMMARY OF IDENTIFICATION BY GC/MS

SAMPLE: CP3 CLAY SHALE SYNCRUDE (SUBSTRATE - FRACTION #1)

LAB SAMPLE #: E3-02-125-03A (SUBSTRATE - FRACTION #1)

CONCENTRATION: Versus Internal Standard

SPECIFIC COMPOUNDS IDENTIFIED

COMPOUND	CONFIDENCE OF IDENTIFICATION	APPROXIMATE CONCENTRATION µg/g (ppm)
4-Hydroxy-4-methyl pentanone	1	110

SUMMARY OF IDENTIFICATION BY GC/MS

SAMPLE: CP6 TAILINGS SAND + FINE TAILS SYNCRUDE) (SUBSTRATE - FRACTION #1)

LAB SAMPLE #: E3-02-125-06A (SUBSTRATE - FRACTION #1)

CONCENTRATION: Versus Internal Standard

SPECIFIC COMPOUNDS IDENTIFIED

COMPOUND	CONFIDENCE OF IDENTIFICATION	APPROXIMATE CONCENTRATION µg/g (ppm)
Aliphatic hydrocarbons		
C_9 hydrocarbons (2 isomers)	1	12
C_{10} hydrocarbons (3 isomers)	1	22
C_{11} hydrocarbons (5 isomers)	1	18
Olefinic hydrocarbons		
C_9 hydrocarbon	1	8.2
C_{10} hydrocarbons (7 isomers)	1	130
C_{11} hydrocarbons (12 isomers)	1	91
C_{12} hydrocarbons (2 isomers)	1	7
C_{13} hydrocarbons (3 isomers)	1	9.2

E3-02-125 REP. cont'd

SUMMARY OF IDENTIFICATION BY GC/MS

SAMPLE: CP6 TAILINGS SAND + FINE TAILS (SYNCRUDE) cont'd (SUBSTRATE - FRACTION #1)

LAB SAMPLE #: E3-02-125-06A (SUBSTRATE - FRACTION #1)

CONCENTRATION: Versus Internal Standard

SPECIFIC COMPOUNDS IDENTIFIED

COMPOUND	CONFIDENCE OF IDENTIFICATION	APPROXIMATE CONCENTRATION µg/g (ppm)
Olefinic hydrocarbons		
C_{14} hydrocarbons (2 isomers)	1	3.6
C_{15} hydrocarbons (2 isomers)	1	6.8

SUMMARY OF IDENTIFICATION BY GC/MS

SAMPLE: CP5 TAILINGS SAND (SUNCOR BEACH) (LEACHATE - FRACTION #1)

LAB SAMPLE #: E3-02-125-05A (LEACHATE - FRACTION #1)

CONCENTRATION: Versus Internal Standard

SPECIFIC COMPOUNDS IDENTIFIED

COMPOUND	CONFIDENCE OF IDENTIFICATION	APPROXIMATE CONCENTRATION µg/L (ppb)
Ethylbenzene	1	9
Xylenes	1	23

These compounds will be poorly quantitated by this technique as they are volatile components.

E3-02-125 REP. cont'd

SUMMARY OF IDENTIFICATION BY GC/MS

SAMPLE: POND 2 FINE TAILS : FRESH (SUNCOR) (SUBSTRATE - FRACTION #2)

LAB SAMPLE #: E3-02-125-01A (SUBSTRATE - FRACTION #2)

CONCENTRATION: Versus Internal Standard

SPECIFIC COMPOUNDS IDENTIFIED

COMPOUND	CONFIDENCE OF IDENTIFICATION	APPROXIMATE CONCENTRATION µg/g (ppm)
C_2 substituted Dibenzothiophene (2 isomers)	1	11
C_2 substituted Phenanthrene/ Anthracene	1	7.8
C_3 substituted Phenanthrene/ Anthracene (2 isomers)	1	14

E3-02-125 REP. cont'd

SUMMARY OF IDENTIFICATION BY GC/MS

SAMPLE: CP1 FINE TAILS : FRESH (SYNCRUDE) (SUBSTRATE - FRACTION #2)

LAB SAMPLE #: E3-02-125-02A (SUBSTRATE - FRACTION #2)

CONCENTRATION: Versus Internal Standard

SPECIFIC COMPOUNDS IDENTIFIED

COMPOUND	CONFIDENCE OF IDENTIFICATION	APPROXIMATE CONCENTRATION µg/g (ppm)
C_5 substituted Fluorene (3 isomers)	1	3.1
Methyl dibenzothiophene (2 isomers)	2	4.4
Methyl phenanthrene/anthracene (3 isomers)	1	7.0
C_2 substituted Dibenzothiophene (4 isomers)	1	7.8
C_2 substituted Phenanthrene/ Anthracene	1	3.5
C_3 substituted Dibenzothiophene (4 isomers)	2	8.5
C_3 substituted Phenanthrene/ Anthracene (2 isomers)	1	5.9

E3-02-125 REP. cont'd

SUMMARY OF IDENTIFICATION BY GC/MS

SAMPLE: CP3 CLAY SHALE SYNCRUDE (SUBSTRATE - FRACTION #2)

LAB SAMPLE #: E3-02-125-03A (SUBSTRATE - FRACTION #2)

CONCENTRATION: Versus Internal Standard

SPECIFIC COMPOUNDS IDENTIFIED

COMPOUND	CONFIDENCE OF IDENTIFICATION	APPROXIMATE CONCENTRATION μg/g (ppm)
Unidentified cyclic (mol wt 170)	4	3.8

E3-02-125 REP. cont'd

SUMMARY OF IDENTIFICATION BY GC/MS

SAMPLE: CP4 TAILINGS SAND (SYNCRUDE PLANT 5 BEACH) (SUBSTRATE - FRACTION #2)

LAB SAMPLE #: E3-02-125-04A (SUBSTRATE - FRACTION #2)

CONCENTRATION: Versus Internal Standard

SPECIFIC COMPOUNDS IDENTIFIED

COMPOUND	CONFIDENCE OF IDENTIFICATION	APPROXIMATE CONCENTRATION µg/g (ppm)
C_{10} Cyclic Olefin (3 isomers)	3	1.3

E3-02-125 REP. cont'd

SUMMARY OF IDENTIFICATION BY GC/MS

SAMPLE: CP5 TAILINGS SAND (SUNCOR BEACH) (SUBSTRATE - FRACTION #2)

LAB SAMPLE #: E3-02-125-05A (SUBSTRATE - FRACTION #2)

CONCENTRATION: Versus Internal Standard

SPECIFIC COMPOUNDS IDENTIFIED

COMPOUND	CONFIDENCE OF IDENTIFICATION	APPROXIMATE CONCENTRATION µg/g (ppm)
C_5 substituted Furan	2	4.0
C_6 substituted Furan	2	2.2
Dibutyl phthalate	2	0.18

E3-02-125 REP. cont'd

SUMMARY OF IDENTIFICATION BY GC/MS

SAMPLE: CP6 TAILINGS SAND + FINE TAILS (SYNCRUDE) (SUBSTRATE - FRACTION #2)

LAB SAMPLE #: E3-02-125-06A (SUBSTRATE - FRACTION #2)

CONCENTRATION: Versus Internal Standard

SPECIFIC COMPOUNDS IDENTIFIED

COMPOUND	CONFIDENCE OF IDENTIFICATION	APPROXIMATE CONCENTRATION µg/g (ppm)
C_5 substituted Furan	2	3.4
Methyl dibenzothiophene	1	0.20
Methyl phenanthrene/anthracene (2 isomers)	1	0.88
C_2 substituted Dibenzothiophene	2	0.63
C_2 substituted Phenanthrene/ Anthracene	1	0.46
C_3 substituted Dibenzothiophene (4 isomers)	2	1.2
C_3 substituted Phenanthrene/ Anthracene (2 isomers)	1	1.2

E3-02-125 REP. cont'd

SUMMARY OF IDENTIFICATION BY GC/MS

SAMPLE: CP7 FINE TAILS SYNCRUDE (SUBSTRATE - FRACTION #2)

LAB SAMPLE #: E3-02-125-07A (SUBSTRATE - FRACTION #2)

CONCENTRATION: Versus Internal Standard

SPECIFIC COMPOUNDS IDENTIFIED

COMPOUND	CONFIDENCE OF IDENTIFICATION	APPROXIMATE CONCENTRATION µg/g (ppm)
C_5 substituted Furan	1	4.1
C_4 substituted Naphthalene (4 isomers)	2	3.4
Methyl fluorene 1	2.4	
C_3 substituted Biphenyl	2	0.51
C_2 substituted Fluorene (3 isomers)	1	5.0
Methyl dibenzothiophene (2 isomers)	2	6.4
Methyl phenanthrene/anthracene (3 isomers)	1	13
C_3 substituted Fluorene (2 isomers)	1	1.9
C_2 substituted Dibenzothiophene (6 isomers)	2	32
C_2 substituted Phenanthrene/ Anthracene (3 isomers)	1	10
C_3 substituted Dibenzothiophene (6 isomers)	2	26
C_3 substituted Phenanthrene/ Anthracene (5 isomers)	1	21
C_4 substituted Dibenzothiophene (5 isomers)	2	3.5
C_4 substituted Phenanthrene/ Anthracene (2 isomers)	2	3.8
Benzo(a)anthracene/Chrysene	2	2.8
C_4 substituted Phenanthrene/ Anthracene (2 isomers)	2	3.0

E3-02-125 REP. cont'd

SUMMARY OF IDENTIFICATION BY GC/MS

SAMPLE: CP8 FINE TAILS AIR DRIED (SUBSTRATE - FRACTION #2)

LAB SAMPLE #: E3-02-125-08A (SUBSTRATE - FRACTION #2)

CONCENTRATION: Versus Internal Standard

SPECIFIC COMPOUNDS IDENTIFIED

COMPOUND	CONFIDENCE OF IDENTIFICATION	APPROXIMATE CONCENTRATION µg/g (ppm)
C_4 substituted Naphthalene	1	5.2
Methyl Phenanthrene/Anthracene	1	11
C_2 substituted Phenanthrene/ Anthracene (2 isomers)	1	13
C_3 substituted Phenanthrene/ Anthracene (2 isomers)	1	21
C_4 substituted Phenanthrene/ Anthracene	1	5.1
C_2 substituted Dibenzothiophene (3 isomers)	1	30
C_3 substituted Dibenzothiophene (4 isomers)	1	33
C_4 substituted Dibenzothiophene (3 isomers)	1	13

E3-02-125 REP. cont'd

SUMMARY OF IDENTIFICATION BY GC/MS

SAMPLE: CP9 OIL SAND SYNCRUDE (SUBSTRATE - FRACTION #2)

LAB SAMPLE #: E3-02-125-09A-D2 (SUBSTRATE - FRACTION #2)

CONCENTRATION: Versus Internal Standard

SPECIFIC COMPOUNDS IDENTIFIED

COMPOUND	CONFIDENCE OF IDENTIFICATION	APPROXIMATE CONCENTRATION µg/g (ppm)
C_4 substituted Naphthalene	1	5.9
Methyl Fluorene	1	3.6
C_2 substituted Fluorene	1	1.1
Phenanthrene/Anthracene	1	0.94
Methyl Phenanthrene/Anthracene (3 isomers)	1	16
C_2 substituted Phenanthrene/ Anthracene (4 isomers)	1	26
C_3 substituted Phenanthrene/ Anthracene (2 isomers)	1	11
Methyl Dibenzothiophene (2 isomers)	1	8.9
C_2 substituted Dibenzothiophene (2 isomers)	1	14
C_3 substituted Dibenzothiophene (4 isomers)	1	18

E3-02-125 REP. cont'd

SUMMARY OF IDENTIFICATION BY GC/MS

SAMPLE: CP10 OIL SAND SUNCOR (SUBSTRATE - FRACTION #2)

LAB SAMPLE #: E3-02-125-10A (SUBSTRATE - FRACTION #2)

CONCENTRATION: Versus Internal Standard

SPECIFIC COMPOUNDS IDENTIFIED

COMPOUND	CONFIDENCE OF IDENTIFICATION	APPROXIMATE CONCENTRATION µg/g (ppm)
Methyl Phenanthrene/Anthracene (2 isomers)	1	29
C_2 substituted Phenanthrene/ Anthracene (2 isomers)	1	26
C_3 substituted Phenanthrene/ Anthracene (2 isomers)	1	24
C_2 substituted Dibenzothiophene (2 isomers)	1	26
C_3 substituted Dibenzothiophene (2 isomers)	1	44

E3-02-125 REP. cont'd

SUMMARY OF IDENTIFICATION BY GC/MS

SAMPLE: CP11 TAILINGS SAND (OSLO OHWE) (SUBSTRATE - FRACTION #2)

LAB SAMPLE #: E3-02-125-11A (SUBSTRATE - FRACTION #2)

CONCENTRATION: Versus Internal Standard

SPECIFIC COMPOUNDS IDENTIFIED

COMPOUND	CONFIDENCE OF IDENTIFICATION	APPROXIMATE CONCENTRATION µg/g (ppm)
C_5 substituted Furan	2	2.1
C_4 substituted Naphthalene (2 isomers)	1	0.32
Methyl fluorene	1	0.29
Phenanthrene	1	0.050
C_2 substituted Fluorene (2 isomers)	1	0.17
Methyl dibenzothiophene (2 isomers)	2	1.0
Methyl phenanthrene/anthracene (2 isomers)	1	1.2
C_3 substituted Fluorene	2	0.036
C_2 substituted Dibenzothiophene (6 isomers)	2	3.3
C_2 substituted Phenanthrene/ Anthracene (3 isomers)	2	1.4
C_3 substituted Dibenzothiophene (3 isomers)	2	1.3
C_3 substituted Phenanthrene/ Anthracene (3 isomers)	1	1.9
C_4 substituted Dibenzothiophene (2 isomers)	2	0.27

E3-02-125 REP. cont'd

SUMMARY OF IDENTIFICATION BY GC/MS

SAMPLE: CP3 CLAY SHALE SYNCRUDE (SUBSTRATE - FRACTION #3)

LAB SAMPLE #: E3-02-125-03A (SUBSTRATE - FRACTION #3)

CONCENTRATION: Versus Internal Standard

SPECIFIC COMPOUNDS IDENTIFIED

COMPOUND	CONFIDENCE OF IDENTIFICATION	APPROXIMATE CONCENTRATION μg/g (ppm)
Nitrogen Compounds		
Unidentified cyclic amine m.w. 145	3	9.3
Unidentified cyclic amine m.w. 161	3	10

E3-02-125 REP. cont'd

SUMMARY OF IDENTIFICATION BY GC/MS

SAMPLE: CP4 TAILINGS SAND (SYNCRUDE PLANT 5 BEACH) (SUBSTRATE - FRACTION #3) **LAB SAMPLE #:** E3-02-125-04A-D2 (SUBSTRATE - FRACTION #3)

CONCENTRATION: Versus Internal Standard

SPECIFIC COMPOUNDS IDENTIFIED

COMPOUND	CONFIDENCE OF IDENTIFICATION	APPROXIMATE CONCENTRATION µg/g (ppm)
Misc. Oxygenated compounds		
Methyl cyclohexenone	1	1.1
Methyl ester; unidentified carboxylic acid	3	3.1
Similar to methyl-isopropyl-oxoheptanoate	3	3.3
Unidentified alcohol/ether	4	11
Long chained diolefinic alcohol	3	6.9

Other components present as unresolved "hump" of material.

E3-02-125 REP. cont'd

SUMMARY OF IDENTIFICATION BY GC/MS

SAMPLE: CP5 TAILINGS SAND SUNCOR (SUBSTRATE - FRACTION #3)

LAB SAMPLE #: E3-02-125-05A (SUBSTRATE - FRACTION #3)

CONCENTRATION: Versus Internal Standard

SPECIFIC COMPOUNDS IDENTIFIED

COMPOUND	CONFIDENCE OF IDENTIFICATION	APPROXIMATE CONCENTRATION µg/g (ppm)
Misc. Oxygenated compounds		
Unidentified alcohol/ether	4	24
Long chained diolefinic alcohol	3	13

Other components present as unresolved "hump" of material.

E3-02-125 REP. cont'd

SUMMARY OF IDENTIFICATION BY GC/MS

SAMPLE: CP6 TAILINGS SAND + FINE TAILS (SYNCRUDE) (SUBSTRATE - FRACTION #3)

LAB SAMPLE #: E3-02-125-06A (SUBSTRATE - FRACTION #3)

CONCENTRATION: Versus Internal Standard

SPECIFIC COMPOUNDS IDENTIFIED

COMPOUND	CONFIDENCE OF IDENTIFICATION	APPROXIMATE CONCENTRATION µg/g (ppm)
Nitrogen Compounds		
Unidentified cyclic amine m.w. 145	3	1.0

Other components present as unresolved "hump" of material.

E3-02-125 REP. cont'd

SUMMARY OF IDENTIFICATION BY GC/MS

SAMPLE: CP7 FINE TAILS SYNCRUDE (SUBSTRATE - FRACTION #3)

LAB SAMPLE #: E3-02-125-07A (SUBSTRATE - FRACTION #3)

CONCENTRATION: Versus Internal Standard

SPECIFIC COMPOUNDS IDENTIFIED

COMPOUND	CONFIDENCE OF IDENTIFICATION	APPROXIMATE CONCENTRATION µg/g (ppm)
Nitrogen Compounds		
Unidentified cyclic amine m.w. 145	3	4.0

Other components present as unresolved "hump" of material.

E3-02-125 REP. cont'd

SUMMARY OF IDENTIFICATION BY GC/MS

SAMPLE: CP9 OIL SAND SYNCRUDE (SUBSTRATE - FRACTION #3)

LAB SAMPLE #: E3-02-125-09A (SUBSTRATE - FRACTION #3)

CONCENTRATION: Versus Internal Standard

SPECIFIC COMPOUNDS IDENTIFIED

COMPOUND	CONFIDENCE OF IDENTIFICATION	APPROXIMATE CONCENTRATION μg/g (ppm)
Nitrogen Compounds		
Unidentified cyclic amine m.w. 145	3	15

Other components present as a very large unresolved "hump" of material.

E3-02-125 REP. cont'd

SUMMARY OF IDENTIFICATION BY GC/MS

SAMPLE: CP4 TAILINGS SAND (SYNCRUDE PLANT 5 BEACH) (LEACHATE - FRACTION #3)

LAB SAMPLE #: E3-02-125-04A (LEACHATE - FRACTION #3)

CONCENTRATION: Versus Internal Standard

SPECIFIC COMPOUNDS IDENTIFIED

COMPOUND	CONFIDENCE OF IDENTIFICATION	APPROXIMATE CONCENTRATION µg/L (ppb)
Misc. Oxygenated compounds		
Long chained diolefinic alcohol (approx. C_{13}; breakthrough from B/N)	3	110
Unidentified cyclic oxygenate	4	170
Nitrogen Compounds		
Unidentified cyclic amine m.w. 145	3	35

E3-02-125 REP. cont'd

SUMMARY OF IDENTIFICATION BY GC/MS

SAMPLE: CP5 TAILINGS SAND (SUNCOR BEACH) (LEACHATE - FRACTION #3)

LAB SAMPLE #: E3-02-125-05A (LEACHATE - FRACTION #3)

CONCENTRATION: Versus Internal Standard

SPECIFIC COMPOUNDS IDENTIFIED

COMPOUND	CONFIDENCE OF IDENTIFICATION	APPROXIMATE CONCENTRATION µg/L (ppb)
Nitrogen Compounds		
Unidentified cyclic amine m.w. 145	3	16

E3-02-125 REP. cont'd

SUMMARY OF IDENTIFICATION BY GC/MS

SAMPLE: CP6 TAILINGS SAND + FINE TAILS (SYNCRUDE) (LEACHATE - FRACTION #3)

LAB SAMPLE #: E3-02-125-06A (LEACHATE - FRACTION #3)

CONCENTRATION: Versus Internal Standard

SPECIFIC COMPOUNDS IDENTIFIED

COMPOUND	CONFIDENCE OF IDENTIFICATION	APPROXIMATE CONCENTRATION µg/L (ppb)
Nitrogen Compounds		
Unidentified cyclic amine m.w. 145	3	46

E3-02-125 REP. cont'd

SUMMARY OF IDENTIFICATION BY GC/MS

SAMPLE: CP7 FINE TAILS SYNCRUDE (LEACHATE - FRACTION #3)

LAB SAMPLE #: E3-02-125-07A (LEACHATE - FRACTION #3)

CONCENTRATION: Versus Internal Standard

SPECIFIC COMPOUNDS IDENTIFIED

COMPOUND	CONFIDENCE OF IDENTIFICATION	APPROXIMATE CONCENTRATION µg/L (ppb)
Misc. Oxygenated compounds		
Long chained diolefinic alcohol (approx. C_{13}; breakthrough from B/N)	4	100
C_8 olefinic alcohol	3	17
Nitrogen Compounds		
Unidentified cyclic amine m.w. 145	3	21

Other components present as a very large unresolved "hump" of material.

E3-02-125 REP. cont'd

SUMMARY OF IDENTIFICATION BY GC/MS

SAMPLE: CP8 FINE TAILS AIR DRIED (LEACHATE - FRACTION #3)

LAB SAMPLE #: E3-02-125-08A (LEACHATE - FRACTION #3)

CONCENTRATION: Versus Internal Standard

SPECIFIC COMPOUNDS IDENTIFIED

COMPOUND	CONFIDENCE OF IDENTIFICATION	APPROXIMATE CONCENTRATION µg/L (ppb)
Misc. Oxygenated compounds		
Unidentified alcohol/ether	4	180
Long chained diolefinic alcohol (approx. C_{13})	3	160
Unidentified cyclic oxygenate	4	73

Other components present as a very large unresolved "hump" of material.

E3-02-125 REP. cont'd

SUMMARY OF IDENTIFICATION BY GC/MS

SAMPLE: CP7 FINE TAILS SYNCRUDE (LEACHATE - ACID)

LAB SAMPLE #: E3-02-125-07A (LEACHATE - ACID)

CONCENTRATION: Versus Internal Standard

SPECIFIC COMPOUNDS IDENTIFIED

COMPOUND	CONFIDENCE OF IDENTIFICATION	APPROXIMATE CONCENTRATION µg/L (ppb)
Long chained carboxylic acid	2	12
Unidentified carboxylic acid	4	11

E3-02-125 REP. cont'd

SUMMARY OF IDENTIFICATION BY GC/MS

SAMPLE: CP8 FINE TAILS AIR DRIED (LEACHATE - ACID)

LAB SAMPLE #: E3-02-125-08A (LEACHATE - ACID)

CONCENTRATION: Versus Internal Standard

SPECIFIC COMPOUNDS IDENTIFIED

COMPOUND	CONFIDENCE OF IDENTIFICATION	APPROXIMATE CONCENTRATION µg/L (ppb)
Unidentified olefinic acid	3	17
Unidentified carboxylic acid	4	19