LABELLA
Associates, D.P.C.
Engineering
Architecture
Environmental
Planning

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July 11, 2014

Todd M. Caffoe
Division of Environmental Remediation
New York State Department of Environmental Conservation
6274 East Avon-Lima Road
Avon, New York 14414

Re: Remedial Investigation Work Plan Amendment – P1 Plume Area
Former Emerson Street Landfill
NYSDEC Site #828023
LaBella Project No. 210173

Dear Mr. Caffoe:

LaBella Associates, D.P.C. ("LaBella") is submitting this letter on behalf of the City of Rochester ("City") to the New York State Department of Environmental Conservation (NYSDEC) to propose an amendment to the approved Remedial Investigation Work Plan (RIWP) dated November 2012 for the Former Emerson Street Landfill, Rochester, New York site (hereinafter referred to as "the Site"). The work addressed by this amendment consists of advancing additional soil borings at an area north of the P-1 plume area and specifically in the area proposed for delisting from the Inactive Hazardous Waste Disposal Site (IHWDS). Figure 1 provides the location of the Site and indicates the approximate area proposed for delisting (actual limits to be determined by testing data). Additional work is warranted due to the identification of Light Non-Aqueous Phase Liquid (LNAPL) identified in the "Delist Well".

Background

The RIWP was submitted in November 2012 and an amendment to the RIWP was submitted on September 30, 2013. The NYSDEC approved the RIWP in a letter dated November 29, 2013. The amendment to the RIWP included additional testing to support a delisting petition for "Parcel 10" (northern portion of 1655 Lexington Avenue). The delisting work included test pits, installing a shallow bedrock well, designated "Delist Well" and collecting soil and groundwater samples. During the Delist Well installation, apparent petroleum related impacts were identified in the fill materials directly on top of bedrock (i.e., odors and staining). The table below summarizes the Delist Well boring/installation and the well construction log is also included in Attachment 1.

Delist Well Details

Depth (feet, BGS)	Comment
24-28	Petroleum Odors, Staining
28	Top of Bedrock (Auger Refusal)
28-31	Rock Socket
31-41	Open Bedrock Hole

BGS – denotes Below Ground Surface

Subsequent to installing the Delist Well, LNAPL that appeared (based on field observations) to be heavier weight petroleum hydrocarbons (e.g., motor oil, fuel oil, hydraulic oil, mineral oil, etc.) was observed within the well during development/sampling. An attempt was made to measure the thickness of LNAPL; however, attempts to estimate the thickness of LNAPL were unsuccessful with an oil/water interface probe due to the LNAPL coating/fouling the probe sensor. A bailer was used to obtain a sample of the LNAPL and the bailer was full of LNAPL at the time of sampling. It should be noted that monitoring wells typically over exaggerate the thickness of LNAPL in the subsurface due to a number of factors such as, geologic setting, water table fluctuations, capillary pressures, etc.

The sample of the LNAPL was collected and submitted to Chemtech Laboratories (Chemtech) for analysis of the following parameters:

- Target Compound List (TCL) and CP-51 List Volatile Organic Compounds (VOCs) using United States Environmental Protection Agency (USEPA) Method 8260;
- Polychlorinated Biphenyls (PCBs) using USEPA Method 8082;
- Resource Conservation and Recovery Act (RCRA) Metals using USEPA Methods 6010 and 7471;
- And Total Petroleum Hydrocarbons (TPHs) using USEPA Method 8015B.

The initial sample of LNAPL was collected on May 20, 2014; however, due to the laboratory analyzing the VOCs and PCBs out of hold time, a second sample for VOCs and PCBs was collected on June 18, 2014 and reanalyzed by the laboratory. The results of the testing for these samples are summarized in a table in Attachment 2. As shown, PCBs and VOCs were not detected above the reported laboratory detection limits, with the exception of four VOCs which were below the reported laboratory detection limits but reported as estimated values. Specifically, the following VOCs were detected: chlorobenzene (0.120 ppm), isopropylbenzene (0.170 ppm), m,p-xylene (0.160 ppm), and methylcyclohexane (0.220 ppm); however, the chlorinated VOCs tetrachloroethene, trichloroethene, dichloroethene and vinyl chloride were not detected. Furthermore, the concentrations of VOCs reported are relatively low. In addition to VOCs, two metals were also detected (chromium and lead); however, the concentrations detected were less than 1 milligram per kilogram (mg/Kg). A copy of the laboratory report is included in Attachment 2.

The laboratory report for the TPH analysis did not match the material to any standard reference (e.g., motor oil, fuel oil, etc.) and the laboratory did not provide a concentration. A copy of the laboratory report for the TPH testing is included in Attachment 2.

Based on the field observations and the laboratory testing results of the LNAPL, the LNAPL appears to be petroleum related (possibly highly weathered and thus not comparable to a reference standard) and does not contain PCBs, VOCs (with any appreciable concentration) or significant metals concentrations. As such, it appears the LNAPL is non-hazardous; however, evaluating the extent of LNAPL in this area appears warranted.

It should be noted that the additional delisting data collected (test pits, soil samples, etc.) will be provided in a separate delisting petition subsequent to addressing the LNAPL identified in the Delist Well.

Proposed Amendment

The additional investigation activities will be completed to accomplish the following objectives:

1) Evaluate the approximate vertical extent of LNAPL in the vicinity of the Delist Well (i.e., limited to overburden/fill material or extending into shallow bedrock).
2) Evaluate the approximate lateral/aerial extent of LNAPL.
3) Preliminarily evaluate the total and recoverable LNAPL in the Delist Well.

To accomplish these objectives, the following tasks are proposed:

1) Baildown/recharge testing of the Delist Well and collection of a groundwater sample.
2) Advance additional soil borings.

As with the previous RI fieldwork, a flexible, field-based investigation approach (dynamic investigation) will be utilized to minimize work (soil borings) that is not directly supportive of evaluating the extent of LNAPL. Additional borings (and potentially shallow bedrock wells) may be added to the program in the event LNAPL extends beyond currently proposed testing locations. The following details the tasks that will be completed as part of this amendment:

Task 1 Bail down test of existing Delist Well and Groundwater Sampling

As noted previously, petroleum impacts were noted in the overburden/fill materials prior to advancing the Delist Well into the shallow bedrock. As such, it is uncertain if the NAPL in the Delist Well is associated with LNAPL limited to the overburden/fill or within the shallow bedrock. As such, a bail down test will be used to remove free product from the Delist Well and determine if LNAPL re-enters the well. In the event that LNAPL recharges, the thickness and depth to free product in the well as the well recovers will be measured. Specifically the following work will be implemented:

1) Initially the depth to LNAPL will be measured with an oil/water interface probe and then the current thickness of LNAPL in the Delist Well will be estimated (prior to bailing). The thickness will be evaluated by a bailer. It should be noted, that initial attempts to estimate the thickness of LNAPL were unsuccessful with an oil/water interface probe due to the LNAPL coating/fouling the probe sensor. As such, a bailer will be lowered in the well and allowed to fill and then removed and the thickness of LNAPL in the bailer measured.
2) Subsequent to estimating the pre-baildown LNAPL thickness, the well will be bailed dry and/or until only a limited amount of product is present (less than an inch). The removed LNAPL will be containerized in 55-gallon drums and stored at the Site until characterized for disposal.
3) Subsequent to removing the LNAPL, the recharge of the LNAPL will be monitored by the oil/water interface probe and as necessary confirmation with a bailer. The groundwater and LNAPL recharge (if any) will be monitored as summarized in the table below:

Time From Ceasing Bailing	Measurement Intervals
0-15 minutes	1 per minute
15-30 minutes	1 per 5 minutes
30 – 2 hrs	1 per 15 minutes
2 hrs – 4 hrs	1 per 30 minutes
4 hrs - TBD (see below)	TBD (see below)

The extent of monitoring and intervals after 4 hours will depend on the amount the LNAPL recharges at the time of work. At a minimum, measurements will be collected every 1 hour until recharge is within 90% of initial measurement or 8 hrs has passed. In the event the well does not recharge to 90% within 8 hrs, the well will be monitored daily for a period of 5 days to confirm extent of recharge and then weekly for 2 weeks.

The LNAPL recharge information will be utilized with additional data collected (Tasks below) in order to preliminarily evaluate the recoverable LNAPL.

Subsequent to the LNAPL recharge testing, a sample of the groundwater in the Delist Well will be collected as proposed in the NYSDEC approved RIWP (Section 5.0).

Task 2 Soil Borings and Soil Sampling

Five soil borings are proposed to initially evaluate the extent of LNAPL in proximity to the Delist Well. The locations of the soil borings are shown on Figure 2 attached. As shown, one soil boring is proposed in close proximity to the Delist Well in order to further assess and sample soil/fill materials on top of bedrock. In addition, four additional soil borings are proposed approximately 40 ft. from the Delist well in the northeast, northwest, southeast and southwest directions. However, in the event that LNAPL is apparent in the initial borings, additional borings will be advanced further from the Delist Well (additional 40 ft.). For example, in the event the initial boring to the southeast encounters LNAPL, an additional soil boring will be advanced further to the southeast. The final locations will depend on accessibility and proximity to other work in the area. Figure 2 illustrates the proposed soil boring approach.

The advancement and sampling of the soil borings will be completed in accordance with Section 5.0, Task 2 of the approved RIWP, which include continuous soil sampling until refusal, containerization of Investigation Derived Waste, decontamination procedures, etc. Since the impacts appear to be limited to petroleum related LNAPL, visual observations will be utilized to determine if LNAPL is present. In addition, a select number of soil samples will be submitted for TPH testing via NYSDOH Method 310.13 to evaluate the extent of LNAPL impacts, if any in the overburden/fill on top of bedrock. This amendment includes submitting up to four soil sample for TPH. The TPH testing will also be utilized to provide estimated volumes of LNAPL in the subsurface.

The results of the above testing will be utilized to evaluate the extent and volume of LNAPL present. The evaluation of LNAPL volume will be completed based on “USEPA 510-R-96-001 Methods for Evaluating Recoverability of Free Product,” September 1996. Specifically, the TPH soil sampling data and baildown recovery testing will be used with the USEPA guidance procedures for evaluating recoverable free product. Excerpts from the USEPA guidance are included in Attachment 3 for reference.

In the event that LNAPL recovers in the Delist Well and it appears that LNAPL is present in the shallow bedrock, some of the soil borings proposed in Task 2 above may be advanced into the shallow bedrock to assess extent of LNAPL in the shallow bedrock zone. In this event NYSDEC will be contacted prior to proceeding.

Health and Safety and Community Air Monitoring

All fieldwork will be completed in accordance with the previously approved Health and Safety Plan and Community Air Monitoring Program as described in the NYSDEC approved RI Work Plan.

If you have any questions, please do not hesitate to contact me at (585) 295-6611.

Sincerely,

LABELLA ASSOCIATES, P.C.

Daniel P. Noll, P.E.
Project Manager

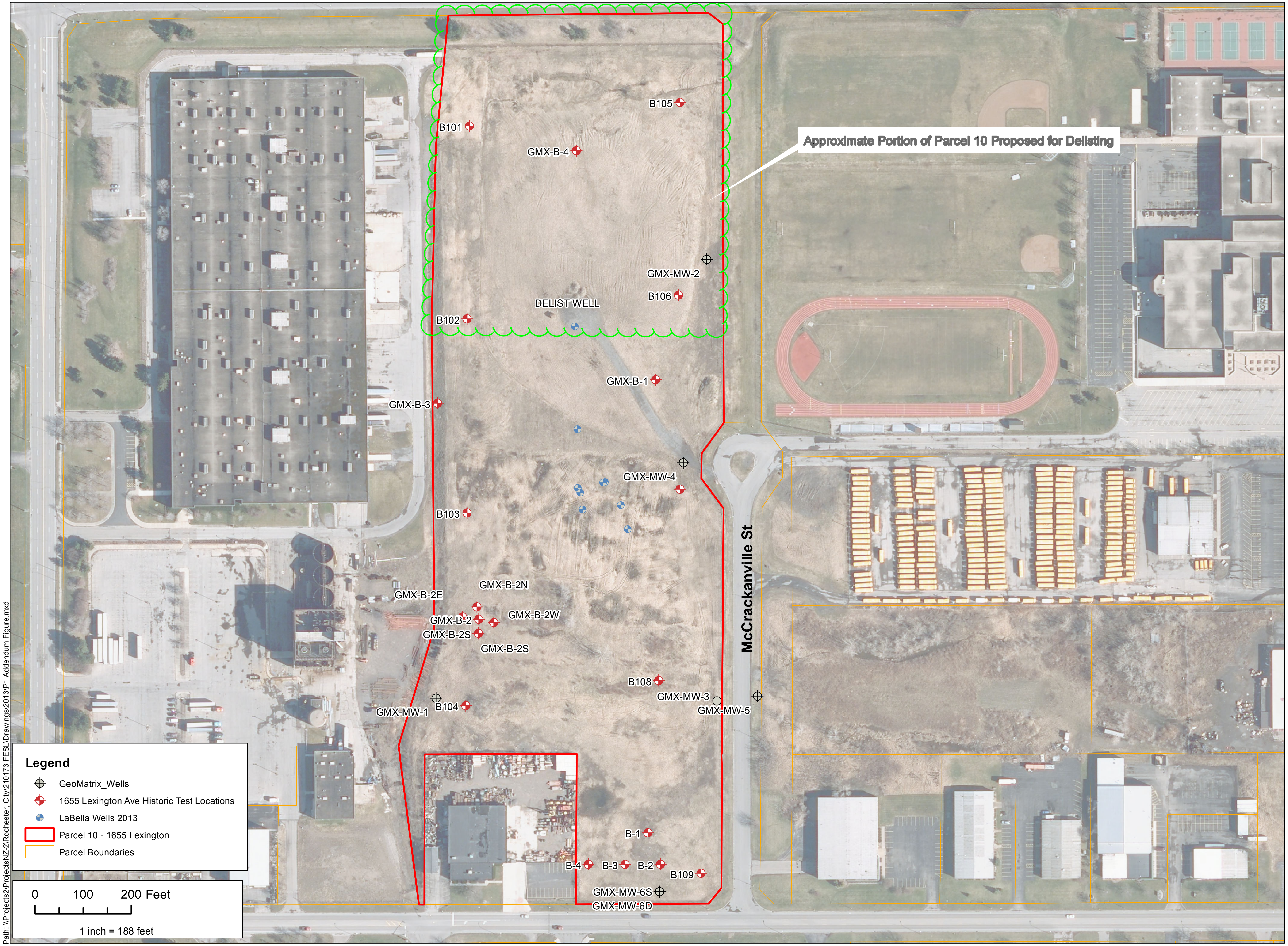
DPN/dk

cc: Joseph Biondolillo – City of Rochester

Attachment 1: Delist Well Construction Log
Attachment 2: Analytical Summary Table and Laboratory Reports
Attachment 3: Excerpts from "USEPA 510-R-96-001 Methods for Evaluating Recoverability of Free Product," September 1996

\\Projects2\ProjectsNZ-2\Rochester, City\210173 FESL\P-1 Investigation (Data, Logs, etc.)\P-1 WP\P-1 Work Plan Amendments\P-1 Workplan Revised.doc

Figures



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FORMER EMERSON STREET LANDFILL

CITY OF ROCHESTER

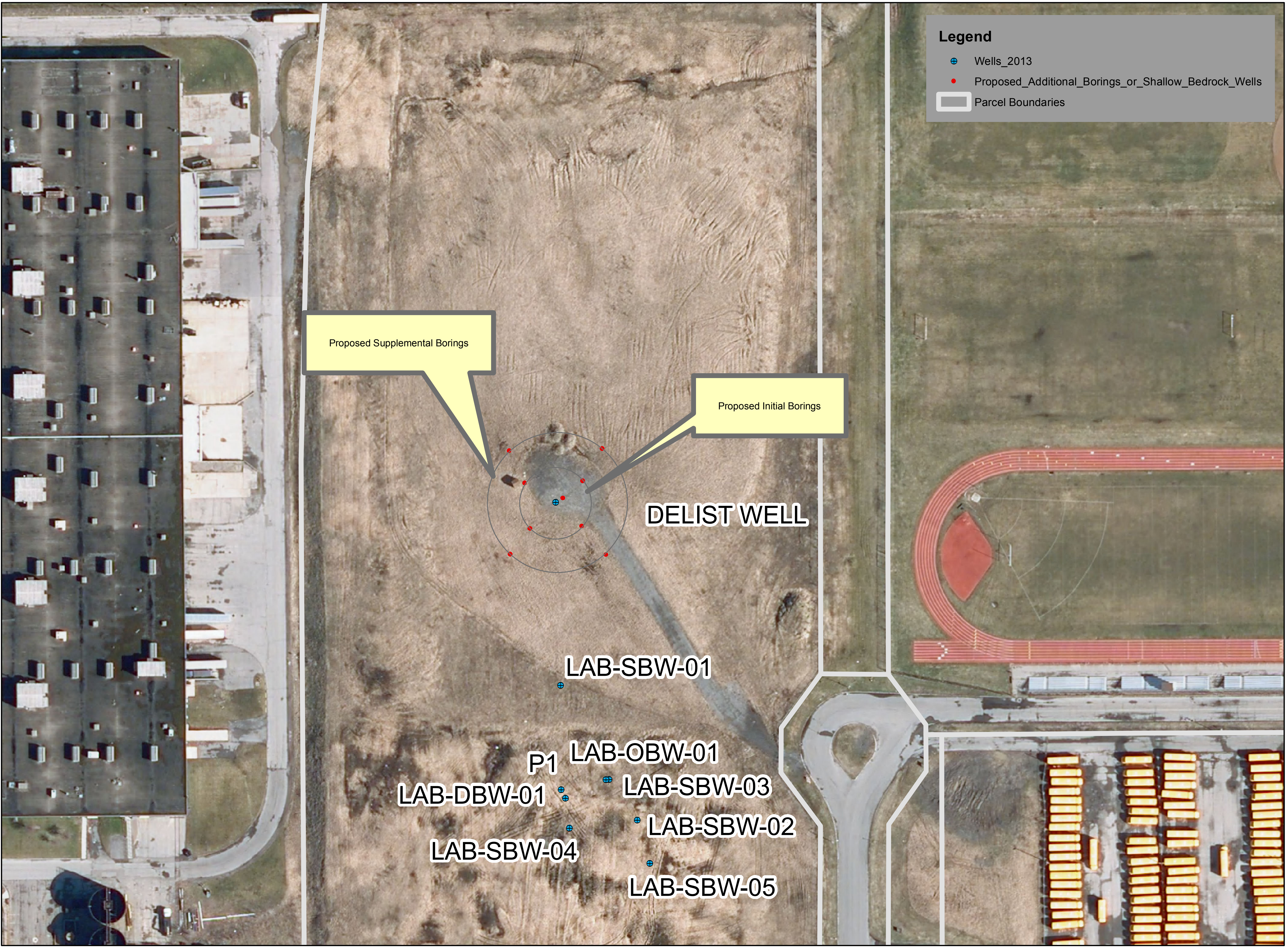
REMEDIAL INVESTIGATION WORK PLAN: P-1 PLUME AREA AMMENDMENT

N
W
E
S

0
80
160
320
Feet
1 inch = 188 feet

210173

FIGURE 1



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P-1 WORK PLAN AMENDMENT
1655 LEXINGTON AVENUE
ROCHESTER, NEW YORK

CITY OF ROCHESTER

Supplemental Borings and Monitoring Wells Delisting Area

N
W E
S

0 55 110 Feet

1 inch = 107 feet

210173

FIGURE 2

Attachment 1
Delist Well Construction Log

LABELLA Associates, P.C.
300 STATE STREET, ROCHESTER, NEW YORK
ENVIRONMENTAL ENGINEERING CONSULTANTS

PROJECT
P-1 Remedial Investigation (Delist Area)
Former Emerson Street Landfill
1655 Lexington Avenue, Rochester, NY

BORING: Delist Well
SHEET 1 OF 1
JOB # 210173
CHKD. BY:

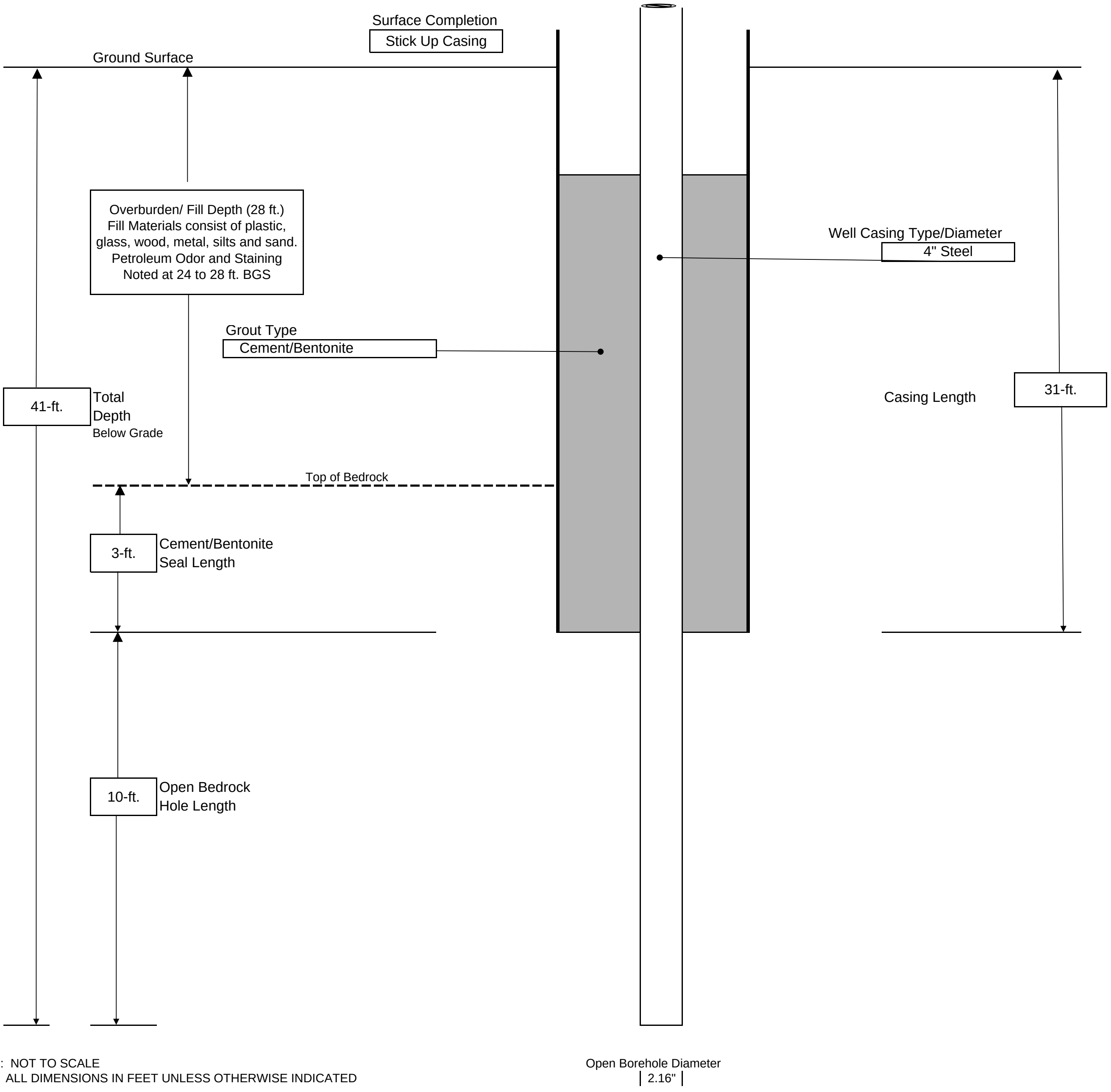
CONTRACTOR: Nothagle Drilling
DRILLER: Kevin Bush
LABELLA REPRESENTATIVE: J. Jaskowiak

BORING LOCATION: Northing: 1159006.14 Easting: 1390182.43
GROUND SURFACE ELEVATION: 548.46 feet DATUM:
START DATE: 3/6/14 END DATE: 3/6/14

TYPE OF DRILL RIG: CME75
AUGER SIZE AND TYPE: 4 1/4 HSAs
OVERBURDEN SAMPLING METHOD: Direct-Push
ROCK DRILLING METHOD: NX Core

WATER LEVEL DATA

DATE	TIME	WATER	CASING	REMARKS



Overburden/ Fill Depth (28 ft.)
Fill Materials consist of plastic, glass, wood, metal, silts and sand. Petroleum Odor and Staining Noted at 24 to 28 ft. BGS

NOTE: NOT TO SCALE
ALL DIMENSIONS IN FEET UNLESS OTHERWISE INDICATED

GENERAL NOTES:
1) STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL
2) WATER LEVEL READINGS HAVE BEEN MADE AT TIMES AND UNDER CONDITIONS STATED, FLUCTUATIONS OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.

Attachment 2
Laboratory Summary Table and Analytical Reports

Former Emerson Street Landfill
P-1 Remedial Investigation

Delist Well Analytical Data Summary Table

All units in Micrograms per Kilogram or about Parts per Billion (PPB)

	DELIST WELL			
Sample Date	**5/20/2014**		**6/18/2014**	
Detected VOCs				
Chlorobenzene	ND		120	J
Isopropylbenzene	ND		170	J
m/p-Xylene	100	J	160	J
Methylcyclohexane	ND		220	J
TOTAL Detected VOCs	100		670	
PCBs				
Aroclor-1016	500	U	500	U
Aroclor-1221	500	U	500	U
Aroclor-1232	500	U	500	U
Aroclor-1242	500	U	500	U
Aroclor-1248	500	U	500	U
Aroclor-1254	500	U	500	U
Aroclor-1260	500	U	500	U
Aroclor-1262	NA		500	U
Aroclor-1268	NA		500	U
Metals				
Arsenic	844	U	NA	
Barium	4220	U	NA	
Cadmium	253	U	NA	
Chromium	725		NA	
Lead	314	J	NA	
Mercury	10	U	NA	
Selenium	844	U	NA	
Silver	422	U	NA	

Legend:

U - Indicates the compound was analyzed for as part of the standard list but not detected, with the detection limit shown as the value.
ND - Indicates not detected
J - Indicates an estimated value.
D = Indicates the the reported concentration was from a diluted sample due to initial detection being above the calibrated range.
NA- Not applicable
NL - Indicates there is not a current Part 703 Groundwater Standard Listed for this Compounds
Total VOCs - denotes summation of all detected compounds (i.e., constituents below the detection limits are assumed to be zero).

\\Projects2\ProjectsNZ-2\Rochester, City\210173 FESL\P-1 Investigation (Data, Logs, etc.)\P-1 WP\P-1 Work Plan Amendments\Delist well data.xls

CHEMTECH 284 Sheffield Street, Mountainside, NJ 07092 Phone: 908 789 8900 Fax: 908 789 8922

DATA FOR

VOLATILE ORGANICS

GC SEMI-VOLATILES

PROJECT NAME : FORMER EMERSON STREET LANDFILL

LABELLA ASSOCIATES P.C.
300 State Street
Suite 201
Rochester, NY - 14614
Phone No: 585-295-6253

ORDER ID : **F2807**
ATTENTION : **Dan Noll**

ACCREDITED IN ACCORDANCE WITH nelac

DoD ELAP

CHEMTECH 284 Sheffield Street, Mountainside, NJ 07092 Phone: 908 789 8900 Fax: 908 789 8922

Date : 06/20/2014

Dear Dan Noll,

1 soil samples for the **Former Emerson Street Landfill** project were received on **06/19/2014.** The analytical fax results for those samples requested for an expedited turn around time may be seen in this report. Please contact me if you have any questions or concerns regarding this report.

Regards,

Reginald St-Juste

908-728-3147

Reginald@chemtech.net

CHEMTECH
CHAIN OF CUSTODY RECORD

284 Sheffield Street, Mountainside, NJ 07092
(908) 789-8900 Fax (908) 789-8922
www.chemtech.net

Chemtech Project Number F2807
COC Number

CLIENT INFORMATION

Report to be sent to
COMPANY: Labella Associates DPC
ADDRESS: 300 State Street Suite 201
CITY: Rochester STATE: NY ZIP: 14614
ATTENTION: Dan Noll
PHONE: 585-295-6611 FAX:

PROJECT INFORMATION

PROJECT NAME: FESL
PROJECT #: 210173 LOCATION:
PROJECT MANAGER: Dan Noll
E-MAIL: dnoll@LabellaPC.com
PHONE: 585-295-6611 FAX:

BILLING INFORMATION

BILL TO: SAME PO#
ADDRESS:
CITY: STATE: ZIP:
ATTENTION:
PHONE:

DATA TURNAROUND INFORMATION

FAX:__________ DAYS*
HARD COPY:__________ DAYS*
EDD__________ DAYS*
* TO BE APPROVED BY CHEMTECH
STANDARD TURNAROUND TIME IS 10 BUSINESS DAYS

DATA DELIVERABLE INFORMATION

☐ RESEULTS ONLY
☐ RESULTS * QC
☐ New Jersey REDUCED
☐ New Jersey CLP
☒ EDD FORMAT EQUIS
☐ USEPA CLP
☒ New York State ASP "B"
☐ New York State ASP "A"
☐ Other__________

ANALYSIS

1 PCB
2 VOC's
3
4
5
6
7
8
9

CHEMTECH SAMPLE ID	PROJECT SAMPLE IDENTIFICATION	SAMPLE MATRIX	SAMPLE TYPE COMP	SAMPLE TYPE GRAB	SAMPLE COLLECTION DATE	SAMPLE COLLECTION TIME	# of Bottles	PRESERVATIVES 1	2	3	4	5	6	7	8	9	COMMENTS <-- Specify Preservatives A-HCl B-HNO4 C-H2SO13 D-NaOH E-ICE F-OTHER	
1.	DELIST WELL	Product		X				X	X									
2.																		
3.																		
4.																		
5.																		
6.																		
7.																		
8.																		
9.																		
10.																		

SAMPLE CUSTODY MUST BE DOCUMENTED BELOW EACH TIME SAMPLES CHANGE PROSSESSION INCLUDING COURIER DELIVERY

RELINQUISHED BY SAMPLER 1.	DATE/TIME 6/16/2014 12:30	RECEIVED BY 1.
RELINQUISHED BY 2.	DATE/TIME	RECEIVED BY 2.
RELINQUISHED BY 3. UPS	DATE/TIME 1015 6-19-14	RECEIVED FOR LAB BY 3.

Conditions of bottles or collers at receipt: [✓ COMPLIANT] NON COMPLIANT COOLER TEMP 6°C
MeOH extraction requires an additional 4oz. Jar for percent solid
Comments: VOC's = TCL & CP-51 Plus TIC's

Page_____ of_____

CLIENT: Hand Delivered [✓ Overnight]
CHEMTECH: Picked Up

Shipment Complete
☒ YES ☐ NO

10/18/2004

WHITE - CHEMTECH COPYFOR RETURN TO CLIENT **YELLOW** - CHEMTECH COPY **PINK** - SAMPLER COPY #

Report of Analysis

Client:	LaBella Associates P.C.			Date Collected:	06/18/14	
Project:	Former Emerson Street Landfill			Date Received:	06/19/14	
Client Sample ID:	DELIST-WELL			SDG No.:	F2807	
Lab Sample ID:	F2807-01			Matrix:	SOIL	
Analytical Method:	SW8082A			% Moisture:	0	Decanted:
Sample Wt/Vol:	1.03	Units:	g	Final Vol:	10000	uL
Soil Aliquot Vol:			uL	Test:	PCB	
Extraction Type:				Injection Volume :		
GPC Factor :	1.0	PH :				

File ID/Qc Batch:	Dilution:	Prep Date	Date Analyzed	Prep Batch ID
PO015228.D	1	06/19/14	06/20/14	PB77300

CAS Number	Parameter	Conc.	Qualifier	MDL	LOD	LOQ / CRQL	Units
TARGETS							
12674-11-2	Aroclor-1016	500	U	97	97	500	ug/kg
11104-28-2	Aroclor-1221	500	U	97	97	500	ug/kg
11141-16-5	Aroclor-1232	500	U	97	97	500	ug/kg
53469-21-9	Aroclor-1242	500	U	97	97	500	ug/kg
12672-29-6	Aroclor-1248	500	U	97	97	500	ug/kg
11097-69-1	Aroclor-1254	500	U	43.4	97	500	ug/kg
37324-23-5	Aroclor-1262	500	U	97	97	500	ug/kg
11100-14-4	Aroclor-1268	500	U	97	97	500	ug/kg
11096-82-5	Aroclor-1260	500	U	97	97	500	ug/kg
SURROGATES							
877-09-8	Tetrachloro-m-xylene	13.9		10 - 166		69%	SPK: 20
2051-24-3	Decachlorobiphenyl	15.8		60 - 125		79%	SPK: 20

U = Not Detected
LOQ = Limit of Quantitation
MDL = Method Detection Limit
LOD = Limit of Detection
E = Value Exceeds Calibration Range
P = Indicates >25% difference for detected concentrations between the two GC columns
Q = indicates LCS control criteria did not meet requirements

J = Estimated Value
B = Analyte Found in Associated Method Blank
N = Presumptive Evidence of a Compound
* = Values outside of QC limits
D = Dilution
S = Indicates estimated value where valid five-point calibration was not performed prior to analyte detection in sample.

Report of Analysis

Client:	LaBella Associates P.C.			Date Collected:	06/18/14	
Project:	Former Emerson Street Landfill			Date Received:	06/19/14	
Client Sample ID:	DELIST-WELL			SDG No.:	F2807	
Lab Sample ID:	F2807-01			Matrix:	SOIL	
Analytical Method:	SW8260			% Moisture:	0	
Sample Wt/Vol:	5	Units:	g	Final Vol:	10000	uL
Soil Aliquot Vol:	100		uL	Test:	VOCMS Group1	
GC Column:	RXI-624	ID :	0.25	Level :	MED	

File ID/Qc Batch:	Dilution:	Prep Date	Date Analyzed	Prep Batch ID
VR013772.D	1		06/19/14	VR061914

CAS Number	Parameter	Conc.	Qualifier	MDL	LOD	LOQ / CRQL	Units
TARGETS							
75-71-8	Dichlorodifluoromethane	500	U	50	50	500	ug/Kg
74-87-3	Chloromethane	500	U	50	50	500	ug/Kg
75-01-4	Vinyl Chloride	500	U	50	50	500	ug/Kg
74-83-9	Bromomethane	500	U	100	100	500	ug/Kg
75-00-3	Chloroethane	500	U	50	50	500	ug/Kg
75-69-4	Trichlorofluoromethane	500	U	50	50	500	ug/Kg
76-13-1	1,1,2-Trichlorotrifluoroethane	500	U	50	50	500	ug/Kg
75-35-4	1,1-Dichloroethene	500	U	50	50	500	ug/Kg
67-64-1	Acetone	2500	U	250	250	2500	ug/Kg
75-15-0	Carbon Disulfide	500	U	50	50	500	ug/Kg
1634-04-4	Methyl tert-butyl Ether	500	U	50	50	500	ug/Kg
79-20-9	Methyl Acetate	500	U	100	100	500	ug/Kg
75-09-2	Methylene Chloride	500	U	50	50	500	ug/Kg
156-60-5	trans-1,2-Dichloroethene	500	U	50	50	500	ug/Kg
75-34-3	1,1-Dichloroethane	500	U	50	50	500	ug/Kg
110-82-7	Cyclohexane	500	U	50	50	500	ug/Kg
78-93-3	2-Butanone	2500	U	310	750	2500	ug/Kg
56-23-5	Carbon Tetrachloride	500	U	50	50	500	ug/Kg
156-59-2	cis-1,2-Dichloroethene	500	U	50	50	500	ug/Kg
74-97-5	Bromochloromethane	500	U	50	50	500	ug/Kg
67-66-3	Chloroform	500	U	50	50	500	ug/Kg
71-55-6	1,1,1-Trichloroethane	500	U	50	50	500	ug/Kg
108-87-2	Methylcyclohexane	220	J	50	50	500	ug/Kg
71-43-2	Benzene	500	U	38	50	500	ug/Kg
107-06-2	1,2-Dichloroethane	500	U	50	50	500	ug/Kg
79-01-6	Trichloroethene	500	U	50	50	500	ug/Kg
78-87-5	1,2-Dichloropropane	500	U	26	50	500	ug/Kg
75-27-4	Bromodichloromethane	500	U	50	50	500	ug/Kg
108-10-1	4-Methyl-2-Pentanone	2500	U	250	250	2500	ug/Kg
108-88-3	Toluene	500	U	50	50	500	ug/Kg
10061-02-6	t-1,3-Dichloropropene	500	U	50	50	500	ug/Kg

Report of Analysis

Client:	LaBella Associates P.C.	Date Collected:	06/18/14
Project:	Former Emerson Street Landfill	Date Received:	06/19/14
Client Sample ID:	DELIST-WELL	SDG No.:	F2807
Lab Sample ID:	F2807-01	Matrix:	SOIL
Analytical Method:	SW8260	% Moisture:	0
Sample Wt/Vol:	5 Units: g	Final Vol:	10000 uL
Soil Aliquot Vol:	100 uL	Test:	VOCMS Group1
GC Column:	RXI-624 ID : 0.25	Level :	MED

File ID/Qc Batch:	Dilution:	Prep Date	Date Analyzed	Prep Batch ID
VR013772.D	1		06/19/14	VR061914

CAS Number	Parameter	Conc.	Qualifier	MDL	LOD	LOQ / CRQL	Units
10061-01-5	cis-1,3-Dichloropropene	500	U	50	50	500	ug/Kg
79-00-5	1,1,2-Trichloroethane	500	U	90	100	500	ug/Kg
591-78-6	2-Hexanone	2500	U	250	250	2500	ug/Kg
124-48-1	Dibromochloromethane	500	U	50	50	500	ug/Kg
106-93-4	1,2-Dibromoethane	500	U	50	50	500	ug/Kg
127-18-4	Tetrachloroethene	500	U	50	50	500	ug/Kg
108-90-7	Chlorobenzene	120	J	50	50	500	ug/Kg
100-41-4	Ethyl Benzene	500	U	50	50	500	ug/Kg
179601-23-1	m/p-Xylenes	160	J	72	100	1000	ug/Kg
95-47-6	o-Xylene	500	U	50	50	500	ug/Kg
100-42-5	Styrene	500	U	45	50	500	ug/Kg
75-25-2	Bromoform	500	U	74	150	500	ug/Kg
98-82-8	Isopropylbenzene	170	J	48	50	500	ug/Kg
79-34-5	1,1,2,2-Tetrachloroethane	500	U	46	50	500	ug/Kg
103-65-1	n-propylbenzene	500	U	36	50	500	ug/Kg
108-67-8	1,3,5-Trimethylbenzene	500	U	45	50	500	ug/Kg
98-06-6	tert-Butylbenzene	500	U	50	50	500	ug/Kg
95-63-6	1,2,4-Trimethylbenzene	500	U	50	50	500	ug/Kg
135-98-8	sec-Butylbenzene	500	U	50	50	500	ug/Kg
99-87-6	p-Isopropyltoluene	500	U	29	50	500	ug/Kg
541-73-1	1,3-Dichlorobenzene	500	U	37	50	500	ug/Kg
106-46-7	1,4-Dichlorobenzene	500	U	41	50	500	ug/Kg
104-51-8	n-Butylbenzene	500	U	46	50	500	ug/Kg
95-50-1	1,2-Dichlorobenzene	500	U	50	50	500	ug/Kg
96-12-8	1,2-Dibromo-3-Chloropropane	500	U	87	500	500	ug/Kg
120-82-1	1,2,4-Trichlorobenzene	500	U	50	50	500	ug/Kg
91-20-3	Naphthalene	500	U	45	50	500	ug/Kg
87-61-6	1,2,3-Trichlorobenzene	500	U	50	100	500	ug/Kg
123-91-1	1,4-Dioxane	10000	U	10000	10000	10000	ug/Kg
SURROGATES							
17060-07-0	1,2-Dichloroethane-d4	49.7		56 - 120		99%	SPK: 50
1868-53-7	Dibromofluoromethane	44.1		57 - 135		88%	SPK: 50

Report of Analysis

Client:	LaBella Associates P.C.	Date Collected:	06/18/14
Project:	Former Emerson Street Landfill	Date Received:	06/19/14
Client Sample ID:	DELIST-WELL	SDG No.:	F2807
Lab Sample ID:	F2807-01	Matrix:	SOIL
Analytical Method:	SW8260	% Moisture:	0
Sample Wt/Vol:	5 Units: g	Final Vol:	10000 uL
Soil Aliquot Vol:	100 uL	Test:	VOCMS Group1
GC Column:	RXI-624 ID : 0.25	Level :	MED

File ID/Qc Batch:	Dilution:	Prep Date	Date Analyzed	Prep Batch ID
VR013772.D	1		06/19/14	VR061914

CAS Number	Parameter	Conc.	Qualifier	MDL	LOD	LOQ / CRQL	Units
2037-26-5	Toluene-d8	48.5		67 - 123		97%	SPK: 50
460-00-4	4-Bromofluorobenzene	54.5		33 - 141		109%	SPK: 50
INTERNAL STANDARDS							
363-72-4	Pentafluorobenzene	1053750	7.47				
540-36-3	1,4-Difluorobenzene	1844630	8.42				
3114-55-4	Chlorobenzene-d5	1617920	11.27				
3855-82-1	1,4-Dichlorobenzene-d4	603969	13.22				

U = Not Detected
LOQ = Limit of Quantitation
MDL = Method Detection Limit
LOD = Limit of Detection
E = Value Exceeds Calibration Range
Q = indicates LCS control criteria did not meet requirements

J = Estimated Value
B = Analyte Found in Associated Method Blank
N = Presumptive Evidence of a Compound
* = Values outside of QC limits
D = Dilution

CHEMTECH 284 Sheffield Street, Mountainside, NJ 07092 Phone: 908 789 8900 Fax: 908 789 8922

DATA FOR

VOLATILE ORGANICS

GC SEMI-VOLATILES

METALS

PROJECT NAME : FORMER EMERSON STREET LANDFILL

LABELLA ASSOCIATES P.C.
300 State Street
Suite 201
Rochester, NY - 14614
Phone No: 585-295-6253

ORDER ID : **F2753**
ATTENTION : **Dan Noll**

ACCREDITED IN ACCORDANCE WITH nelac

DoD ELAP

CHEMTECH 284 Sheffield Street, Mountainside, NJ 07092 Phone: 908 789 8900 Fax: 908 789 8922

Date : 06/17/2014

Dear Dan Noll,

2 soil samples for the **Former Emerson Street Landfill** project were received on **05/24/2014.** The analytical fax results for those samples requested for an expedited turn around time may be seen in this report. Please contact me if you have any questions or concerns regarding this report.

The invoice for this workorder is also attached to the e-mail.

Regards,

Reginald St-Juste

908-728-3147

Reginald@chemtech.net

CHEMTECH
CHAIN OF CUSTODY RECORD

284 Sheffield Street, Mountainside, NJ 07092
(908) 789-8900 Fax (908) 789-8922
www.chemtech.net

CHEMTECH PROJECT NO.
QUOTE NO. F2753
COC Number 028394

CLIENT INFORMATION

REPORT TO BE SENT TO:
COMPANY: LaBella Associates D.P.C.
ADDRESS: 300 State St. Suite 201
CITY: Rochester STATE: NY ZIP: 14614
ATTENTION: Dan Noll
PHONE: FAX:

CLIENT PROJECT INFORMATION

PROJECT NAME: FESL
PROJECT NO.: LOCATION:
PROJECT MANAGER:
e-mail: dnoll@labellapc.com
PHONE: 585-295-6611 FAX:

CLIENT BILLING INFORMATION

BILL TO: PO#:
ADDRESS: 300 State St. Suite 201
CITY: Rochester STATE: NY ZIP: 14614
ATTENTION: Michelle Clausen PHONE:

DATA TURNAROUND INFORMATION

FAX: ______ DAYS *
HARD COPY: ______ DAYS *
EDD: ______ DAYS *
PREAPPROVED TAT: ☐ YES ☐ NO
* STANDARD TURNAROUND TIME IS 10 BUSINESS DAYS

DATA DELIVERABLE INFORMATION

☐ LEVEL 1: Results only ☐ Others______
☐ LEVEL 2: Results + QC
☐ LEVEL 3: Results (plus results raw data) + QC
☐ LEVEL 4: Results + QC (all raw data)
☐ EDD Format: ______

ANALYSIS

1. TCL + CP-51 VOC
2. Alkalinity / Ferr. Iron / TDS
3. Sulfide
4. Tot. Hard / Mercury / TAL Metals
5. TOC / nitrate / Nitrite
6. Methane
7. RCRA Metals
8. PCBs
9. TPH (Fingerprint)

CHEMTECH SAMPLE ID	PROJECT SAMPLE IDENTIFICATION	SAMPLE MATRIX	SAMPLE TYPE COMP	SAMPLE TYPE GRAB	SAMPLE COLLECTION DATE	SAMPLE COLLECTION TIME	# OF BOTTLES	1	2	3	4	5	6	7	8	9	COMMENTS ← Specify Preservatives A-HCl B-HNO_3 C-H_2SO_4 D-NaOH E-ICE F-Other
							PRESERVATIVES	A		D	B	C	A				
1.	LBA-DBW-1	GW		X	5/21/14	1013	8	X	X	X	X	X	X				
2.	GMX-MW-3	GW		X	5/21/14	1327	8	X	X	X	X	X	X				
3.	LBA-SBW-2	GW		X	5/21/14	1501	8	X	X	X	X	X	X				
4.	Delist Well	Unknown		X	5/20/14	1000	3	X NO PRESERV						X	X	X	
5.																	
6.																	
7.																	
8.																	
9.																	
10.																	

SAMPLE CUSTODY MUST BE DOCUMENTED BELOW EACH TIME SAMPLES CHANGE POSSESSION INCLUDING COURIER DELIVERY

RELINQUISHED BY	DATE/TIME	RECEIVED BY
RELINQUISHED BY SAMPLER: 1.	5/21/14 PM	1. [redacted]
RELINQUISHED BY: 2.	DATE/TIME:	RECEIVED BY: 2.
RELINQUISHED BY: 3. FedEx	5/22/14 925	RECEIVED FOR LAB BY: 3.

Conditions of bottles or coolers at receipt: ☑ Compliant ☐ Non Compliant Cooler Temp. 4°
MeOH extraction requires an additional 4 oz jar for percent solid.
Comments:
Ice in Cooler?: ✓

Page 1 of 1

SHIPPED VIA: CLIENT: ☐ HAND DELIVERED ☐ OVERNIGHT
CHEMTECH: ☐ PICKED UP ☐ OVERNIGHT

Shipment Complete: ☒ YES ☐ NO

Revision 8/2007

WHITE - CHEMTECH COPY FOR RETURN TO CLIENT YELLOW - CHEMTECH COPY PINK - SAMPLER COPY

Report of Analysis

Client:	LaBella Associates P.C.	Date Collected:	05/20/14
Project:	Former Emerson Street Landfill	Date Received:	05/24/14
Client Sample ID:	DELIST-WELL	SDG No.:	F2753
Lab Sample ID:	F2753-02	Matrix:	SOIL
Level (low/med):	low	% Solid:	100

Cas	Parameter	Conc.	Qua.	DF	MDL	LOD	LOQ / CRQL	Units	Prep Date	Date Ana.	Ana Met.
7440-38-2	Arsenic	0.844	U	1	0.278	0.422	0.844	mg/Kg	06/17/14	06/17/14	SW6010
7440-39-3	Barium	4.22	U	1	0.338	2.11	4.22	mg/Kg	06/17/14	06/17/14	SW6010
7440-43-9	Cadmium	0.253	U	1	0.051	0.127	0.253	mg/Kg	06/17/14	06/17/14	SW6010
7440-47-3	Chromium	0.725		1	0.11	0.211	0.422	mg/Kg	06/17/14	06/17/14	SW6010
7439-92-1	Lead	0.314	J	1	0.101	0.253	0.506	mg/Kg	06/17/14	06/17/14	SW6010
7439-97-6	Mercury	0.01	U	1	0.005	0.005	0.01	mg/Kg	06/13/14	06/17/14	SW7471A
7782-49-2	Selenium	0.844	U	1	0.346	0.422	0.844	mg/Kg	06/17/14	06/17/14	SW6010
7440-22-4	Silver	0.422	U	1	0.127	0.211	0.422	mg/Kg	06/17/14	06/17/14	SW6010

Color Before:	Brown	Clarity Before:		Texture:	Medium
Color After:	Yellow	Clarity After:		Artifacts:	No

Comments: METALS RCRA

U = Not Detected
LOQ = Limit of Quantitation
MDL = Method Detection Limit
LOD = Limit of Detection
D = Dilution
Q = indicates LCS control criteria did not meet requirements

J = Estimated Value
B = Analyte Found in Associated Method Blank
* = indicates the duplicate analysis is not within control limits.
E = Indicates the reported value is estimated because of the presence of interference.
OR = Over Range
N =Spiked sample recovery not within control limits

Report of Analysis

Client:	LaBella Associates P.C.		Date Collected:	05/20/14	
Project:	Former Emerson Street Landfill		Date Received:	05/24/14	
Client Sample ID:	DELIST-WELL		SDG No.:	F2753	
Lab Sample ID:	F2753-02		Matrix:	SOIL	
Analytical Method:	SW8082A		% Moisture:	0	Decanted:
Sample Wt/Vol:	1.02 Units:	g	Final Vol:	10000	uL
Soil Aliquot Vol:		uL	Test:	PCB	
Extraction Type:			Injection Volume :		
GPC Factor :	1.0	PH :			

File ID/Qc Batch:	Dilution:	Prep Date	Date Analyzed	Prep Batch ID
PO015159.D	1	06/16/14	06/16/14	PB77228

CAS Number	Parameter	Conc.	Qualifier	MDL	LOD	LOQ / CRQL	Units
TARGETS							
12674-11-2	Aroclor-1016	500	U	97.9	97.9	500	ug/kg
11104-28-2	Aroclor-1221	500	U	97.9	97.9	500	ug/kg
11141-16-5	Aroclor-1232	500	U	97.9	97.9	500	ug/kg
53469-21-9	Aroclor-1242	500	U	97.9	97.9	500	ug/kg
12672-29-6	Aroclor-1248	500	U	97.9	97.9	500	ug/kg
11097-69-1	Aroclor-1254	500	U	43.8	97.9	500	ug/kg
11096-82-5	Aroclor-1260	500	U	97.9	97.9	500	ug/kg
SURROGATES							
877-09-8	Tetrachloro-m-xylene	13.5		10 - 166		67%	SPK: 20
2051-24-3	Decachlorobiphenyl	14.8		60 - 125		74%	SPK: 20

U = Not Detected
LOQ = Limit of Quantitation
MDL = Method Detection Limit
LOD = Limit of Detection
E = Value Exceeds Calibration Range
P = Indicates >25% difference for detected concentrations between the two GC columns
Q = indicates LCS control criteria did not meet requirements

J = Estimated Value
B = Analyte Found in Associated Method Blank
N = Presumptive Evidence of a Compound
* = Values outside of QC limits
D = Dilution
S = Indicates estimated value where valid five-point calibration was not performed prior to analyte detection in sample.

Report of Analysis

Client:	LaBella Associates P.C.	Date Collected:	05/20/14
Project:	Former Emerson Street Landfill	Date Received:	05/24/14
Client Sample ID:	DELIST-WELL	SDG No.:	F2753
Lab Sample ID:	F2753-02	Matrix:	SOIL
Analytical Method:	SW8260	% Moisture:	0
Sample Wt/Vol:	5 Units: g	Final Vol:	10000 uL
Soil Aliquot Vol:	100 uL	Test:	VOCMS Group1
GC Column:	RXI-624 ID : 0.25	Level :	MED

File ID/Qc Batch:	Dilution:	Prep Date	Date Analyzed	Prep Batch ID
VR013721.D	1		06/17/14	VR061714

CAS Number	Parameter	Conc.	Qualifier	MDL	LOD	LOQ / CRQL	Units
TARGETS							
75-71-8	Dichlorodifluoromethane	50	U	50	50	500	ug/Kg
74-87-3	Chloromethane	50	U	50	50	500	ug/Kg
75-01-4	Vinyl Chloride	50	U	50	50	500	ug/Kg
74-83-9	Bromomethane	100	U	100	100	500	ug/Kg
75-00-3	Chloroethane	50	U	50	50	500	ug/Kg
75-69-4	Trichlorofluoromethane	50	U	50	50	500	ug/Kg
76-13-1	1,1,2-Trichlorotrifluoroethane	50	U	50	50	500	ug/Kg
75-35-4	1,1-Dichloroethene	50	U	50	50	500	ug/Kg
67-64-1	Acetone	250	U	250	250	2500	ug/Kg
75-15-0	Carbon Disulfide	50	U	50	50	500	ug/Kg
1634-04-4	Methyl tert-butyl Ether	50	U	50	50	500	ug/Kg
79-20-9	Methyl Acetate	100	U	100	100	500	ug/Kg
75-09-2	Methylene Chloride	50	U	50	50	500	ug/Kg
156-60-5	trans-1,2-Dichloroethene	50	U	50	50	500	ug/Kg
75-34-3	1,1-Dichloroethane	50	U	50	50	500	ug/Kg
110-82-7	Cyclohexane	50	U	50	50	500	ug/Kg
78-93-3	2-Butanone	750	U	310	750	2500	ug/Kg
56-23-5	Carbon Tetrachloride	50	U	50	50	500	ug/Kg
156-59-2	cis-1,2-Dichloroethene	50	U	50	50	500	ug/Kg
74-97-5	Bromochloromethane	50	U	50	50	500	ug/Kg
67-66-3	Chloroform	50	U	50	50	500	ug/Kg
71-55-6	1,1,1-Trichloroethane	50	U	50	50	500	ug/Kg
108-87-2	Methylcyclohexane	50	U	50	50	500	ug/Kg
71-43-2	Benzene	50	U	38	50	500	ug/Kg
107-06-2	1,2-Dichloroethane	50	U	50	50	500	ug/Kg
79-01-6	Trichloroethene	50	U	50	50	500	ug/Kg
78-87-5	1,2-Dichloropropane	50	U	26	50	500	ug/Kg
75-27-4	Bromodichloromethane	50	U	50	50	500	ug/Kg
108-10-1	4-Methyl-2-Pentanone	250	U	250	250	2500	ug/Kg
108-88-3	Toluene	50	U	50	50	500	ug/Kg
10061-02-6	t-1,3-Dichloropropene	50	U	50	50	500	ug/Kg

Report of Analysis

Client:	LaBella Associates P.C.			Date Collected:	05/20/14
Project:	Former Emerson Street Landfill			Date Received:	05/24/14
Client Sample ID:	DELIST-WELL			SDG No.:	F2753
Lab Sample ID:	F2753-02			Matrix:	SOIL
Analytical Method:	SW8260			% Moisture:	0
Sample Wt/Vol:	5	Units:	g	Final Vol:	10000 uL
Soil Aliquot Vol:	100		uL	Test:	VOCMS Group1
GC Column:	RXI-624	ID :	0.25	Level :	MED

File ID/Qc Batch:	Dilution:	Prep Date	Date Analyzed	Prep Batch ID
VR013721.D	1		06/17/14	VR061714

CAS Number	Parameter	Conc.	Qualifier	MDL	LOD	LOQ / CRQL	Units
10061-01-5	cis-1,3-Dichloropropene	50	U	50	50	500	ug/Kg
79-00-5	1,1,2-Trichloroethane	100	U	90	100	500	ug/Kg
591-78-6	2-Hexanone	250	U	250	250	2500	ug/Kg
124-48-1	Dibromochloromethane	50	U	50	50	500	ug/Kg
106-93-4	1,2-Dibromoethane	50	U	50	50	500	ug/Kg
127-18-4	Tetrachloroethene	50	U	50	50	500	ug/Kg
108-90-7	Chlorobenzene	50	U	50	50	500	ug/Kg
100-41-4	Ethyl Benzene	50	U	50	50	500	ug/Kg
179601-23-1	m/p-Xylenes	100	J	72	100	1000	ug/Kg
95-47-6	o-Xylene	50	U	50	50	500	ug/Kg
100-42-5	Styrene	50	U	45	50	500	ug/Kg
75-25-2	Bromoform	150	U	74	150	500	ug/Kg
98-82-8	Isopropylbenzene	50	U	48	50	500	ug/Kg
79-34-5	1,1,2,2-Tetrachloroethane	50	U	46	50	500	ug/Kg
103-65-1	n-propylbenzene	50	U	36	50	500	ug/Kg
108-67-8	1,3,5-Trimethylbenzene	50	U	45	50	500	ug/Kg
98-06-6	tert-Butylbenzene	50	U	50	50	500	ug/Kg
95-63-6	1,2,4-Trimethylbenzene	50	U	50	50	500	ug/Kg
135-98-8	sec-Butylbenzene	50	U	50	50	500	ug/Kg
99-87-6	p-Isopropyltoluene	50	U	29	50	500	ug/Kg
541-73-1	1,3-Dichlorobenzene	50	U	37	50	500	ug/Kg
106-46-7	1,4-Dichlorobenzene	50	U	41	50	500	ug/Kg
104-51-8	n-Butylbenzene	50	U	46	50	500	ug/Kg
95-50-1	1,2-Dichlorobenzene	50	U	50	50	500	ug/Kg
96-12-8	1,2-Dibromo-3-Chloropropane	500	U	87	500	500	ug/Kg
120-82-1	1,2,4-Trichlorobenzene	50	U	50	50	500	ug/Kg
91-20-3	Naphthalene	50	U	45	50	500	ug/Kg
87-61-6	1,2,3-Trichlorobenzene	100	U	50	100	500	ug/Kg
123-91-1	1,4-Dioxane	10000	U	10000	10000	10000	ug/Kg
SURROGATES							
17060-07-0	1,2-Dichloroethane-d4	49.7		56 - 120		99%	SPK: 50
1868-53-7	Dibromofluoromethane	43.7		57 - 135		87%	SPK: 50

Report of Analysis

Client:	LaBella Associates P.C.	Date Collected:	05/20/14
Project:	Former Emerson Street Landfill	Date Received:	05/24/14
Client Sample ID:	DELIST-WELL	SDG No.:	F2753
Lab Sample ID:	F2753-02	Matrix:	SOIL
Analytical Method:	SW8260	% Moisture:	0
Sample Wt/Vol:	5 Units: g	Final Vol:	10000 uL
Soil Aliquot Vol:	100 uL	Test:	VOCMS Group1
GC Column:	RXI-624 ID : 0.25	Level :	MED

File ID/Qc Batch:	Dilution:	Prep Date	Date Analyzed	Prep Batch ID
VR013721.D	1		06/17/14	VR061714

CAS Number	Parameter	Conc.	Qualifier	MDL	LOD	LOQ / CRQL	Units
2037-26-5	Toluene-d8	48.6		67 - 123		97%	SPK: 50
460-00-4	4-Bromofluorobenzene	52.4		33 - 141		105%	SPK: 50
INTERNAL STANDARDS							
363-72-4	Pentafluorobenzene	1198580	7.47				
540-36-3	1,4-Difluorobenzene	2052410	8.42				
3114-55-4	Chlorobenzene-d5	1749440	11.27				
3855-82-1	1,4-Dichlorobenzene-d4	678158	13.22				

U = Not Detected
LOQ = Limit of Quantitation
MDL = Method Detection Limit
LOD = Limit of Detection
E = Value Exceeds Calibration Range
Q = indicates LCS control criteria did not meet requirements

J = Estimated Value
B = Analyte Found in Associated Method Blank
N = Presumptive Evidence of a Compound
* = Values outside of QC limits
D = Dilution

CHEMTECH 284 Sheffield Street, Mountainside, New Jersey 07092 Phone : 908 789 8900 Fax : 908

DATA PACKAGE

FINGER PRINT

PROJECT NAME : FORMER EMERSON STREET LANDFILL

LABELLA ASSOCIATES P.C.
300 State Street
Suite 201
Rochester, NY - 14614
Phone No: 585-295-6253

ORDER ID : F2453
ATTENTION : Dan Noll

DoD ELAP

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Cover Page

Order ID : F2453

Project ID : Former Emerson Street Landfill

Client : LaBella Associates P.C.

Lab Sample Number	Client Sample Number
F2453-01	LBA-SBW-5
F2453-02	DUP-2
F2453-03	LBA-SBW-3
F2453-04	F2453-03MS
F2453-05	F2453-03MSD
F2453-06	DELIST-WELL

I certify that the data package is in compliance with the terms and conditions of the contract,both technically and for completeness, for other than the conditions detailed above. Release of the data contained in this hard copy data package has been authorized by the laboratory manager or his designee, as verified by the following signature.

Signature :

REVIEWED
By kalpana at 9:49 pm, Jun 06, 2014

Date: 6/6/2014

NYDOH CERTIFICATION NO - 11376

NJDEP CERTIFICATION NO - 20012

CASE NARRATIVE

LaBella Associates P.C.
Project Name: Former Emerson Street Landfill
Project # N/A
Chemtech Project # F2453
Test Name: Finger Print

A. Number of Samples and Date of Receipt:
6 Water samples were received on 05/24/2014.

B. Parameters:
According to the Chain of Custody document, the following analysis were requested: Alkalinity, Ferrous Iron, Fingerprint, Gases, Hardness, Total, Mercury, Metals ICP-TAL, METALS-TAL, Nitrate+Nitrite, Sulfide, TDS, TOC and VOCMS Group1. This data package contains results for Finger Print.

C. Analytical Techniques:
The analyses were performed on instrument FID_C. The column is RXI-1MS which is 20 meters, 0.18mm ID, 0.18 um df, catalog 10224.The finger was based on method 8015.

D. QA/ QC Samples:
The Holding Times were met for all analysis.
The Blank analysis did not indicate the presence of lab contamination.

I certify that the data package is in compliance with the terms and conditions of the contract, both technically and for completeness, for other than the conditions detailed above. The laboratory manager or his designee, as verified by the following signature has authorized release of the data contained in this hard copy data package.

Signature

REVIEWED
By kalpana at 9:50 pm, Jun 06, 2014

APPENDIX A

QA REVIEW GENERAL DOCUMENTATION

Project #: F2453

	Completed
For thorough review, the report must have the following:	
GENERAL:	
Are all original paperwork present (chain of custody, record of communication,airbill, sample management lab chronicle, login page)	✓
Check chain-of-custody for proper relinquish/return of samples	✓
Is the chain of custody signed and complete	✓
Check internal chain-of-custody for proper relinquish/return of samples /sample extracts	✓
Collect information for each project id from server. Were all requirements followed	✓
COVER PAGE:	
Do numbers of samples correspond to the number of samples in the Chain of Custody on login page	✓
Do lab numbers and client Ids on cover page agree with the Chain of Custody	✓
CHAIN OF CUSTODY:	
Do requested analyses on Chain of Custody agree with form I results	✓
Do requested analyses on Chain of Custody agree with the log-in page	✓
Were the correct method log-in for analysis according to the Analytical Request and Chain of Castody	✓
Were the samples received within hold time	✓
Were any problems found with the samples at arrival recorded in the Sample Management Laboratory Chronicle	✓
ANALYTICAL:	
Was method requirement followed?	✓
Was client requirement followed?	✓
Does the case narrative summarize all QC failure?	✓
All runlogs and manual integration are reviewed for requirements	✓
All manual calculations and /or hand notations verified	✓

1st Level QA Review Signature: PARVATHY NAIR **Date:** 06/06/2014

2nd Level QA Review Signature: **Date:**

REVIEWED
By kalpana at 9:49 pm, Jun 06, 2014

DATA REPORTING QUALIFIERS- ORGANIC

For reporting results, the following “ Results Qualifiers” are used:

Value	If the result is a value greater than or equal to the detection limit, report the value
U	Indicates the compound was analyzed for but was not detected. Report the minimum detection limit for the sample with the U, i.e. “10 U”. This is not necessarily the instrument detection limit attainable for this particular sample based on any concentration or dilution that may have been required.
ND	Indicates the analyte was analyzed for, but not detected
J	Indicates an estimated value**.** This flag is used: (1) When estimating a concentration for a tentatively identified compound (library search hits, where a 1:1 response is assumed.) (2) When the mass spectral data indicated the identification, however the result was less than the specified detection limit greater than zero. If the detection limit was 10ug/L and a concentration of 3 ug/L was calculated report as 3 J. This is flag is used when similar situation arise on any organic parameter i.e. Pest, PCB and others.
B	Indicates the analyte was found in the blank as well as the sample report as “12 B”.
E	Indicates the analyte ‘s concentration exceeds the calibrated range of the instrument for that specific analysis.
D	This flag identifies all compounds identified in an analysis at a secondary dilution factor.
P	This flag is used for Pesticide/PCB target analyte when there is >25% difference for detected concentrations between the two GC columns. The lower of the two values is reported on Form 1 and flagged with a “P”.
N	This flag indicates presumptive evidence of a compound. This is only used for tentatively identified compounds (TICs), where the identification is based on a mass spectral library search. It applies to all TIC results. For generic characterization of a TIC, such as chlorinated hydrocarbon, the flag is not used.
A	This flag indicates that a Tentatively Identified Compound is a suspected aldol-condensation product.
Q	Indicates the LCS did not meet the control limits requirements

CHEMTECH PROJECT NUMBER: F2453 MATRIX: Water

METHOD: 8015B

		NA	NO	YES
1.	Blank Contamination - If yes, list compounds and concentrations in each blank:		✓	
				✓
2	Digestion Holding Time Met			✓
	If not met, list number of days exceeded for each sample:			

ADDITIONAL COMMENTS:

REVIEWED

By kalpana at 9:49 pm, Jun 06, 2014

QA REVIEW

Date

CHEMTECH

FINGERPRINT DATA

CHEMTECH

FINGERPRINT
QC DATA

TABULATED ANALYTICAL REPORT
QUALITATIVE GC FINGERPRINT

MATRIX: Water
DATE EXTRACTED: 06/02/14
LAB FILE: FC011317.D

ANALYSIS DATE : 06/03/14

LAB ID	FUEL TYPE
METHOD BLANK (PB76886BL)	ND

COMMENTS:

A=GASOLINE
B=UNKNOWN FUEL OIL
C= #2 FUEL OIL
D= #4 FUEL OIL
G= #5 FUEL OIL
H= #6 FUEL OIL
N = JET FUEL STANDARD
F=KEROSENE
CT= COAL TAR
PT= PAINT THINNER

K= 30 W LUBRICATING OIL
L= 40 W LUBRICATING OIL
M= 50 W LUBRICATING OIL
ND = NOT DETECTED (CONC)
MS= MINERAL SPIRITS
O= HYDRAULIC OIL
E= NO CALIBRATED STANDARDS DETECTED
CS= CLIENT STANDARDS

CHEMTECH

FINGERPRINT SAMPLE DATA

TABULATED ANALYTICAL REPORT
QUALITATIVE GC FINGERPRINT 8015

CLIENT: LaBella Associates P.C.
CLIENT PROJECT : Former Emerson Street Landfill
REPORT DATE 06/03/14
PROJECT RECEIVED DATE : 05/24/14
ANALYSIS DATE 06/03/14
EXT. DATE: 06/02/14
MATRIX: Water
LAB PROJECT: F2453

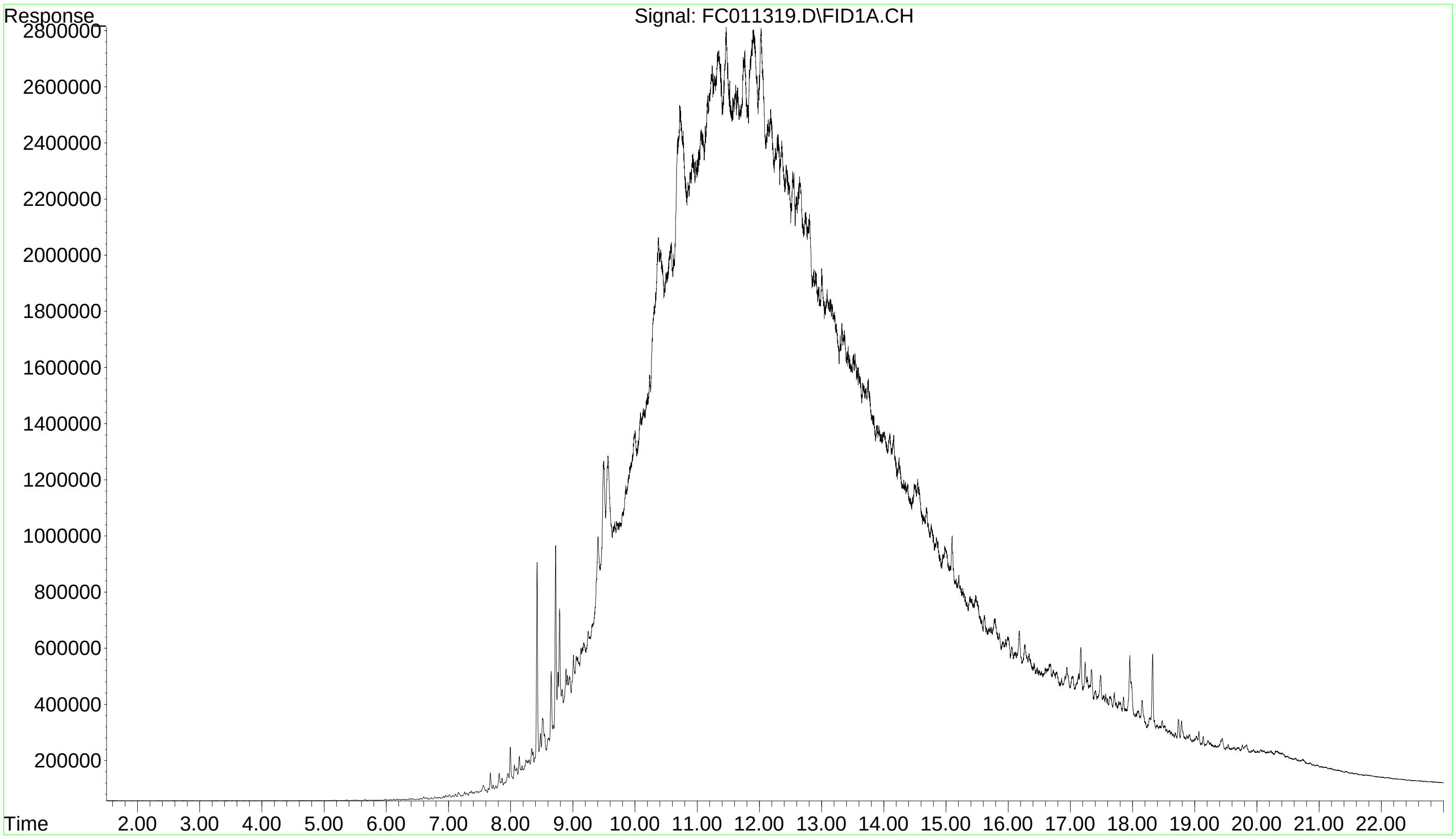
CLIENT ID	FILE ID	LAB ID	FUEL TYPE
DELIST-WELL	FC011319.D	F2453-06	E

COMMENTS:

A= GASOLINE
B= UNKNOWN FUEL OIL
C= #2 FUEL OIL
D= #4 FUEL OIL
G= #5 FUEL OIL
H= #6 FUEL OIL
N = JET FUEL STANDARD
F=KEROSENE
CT= COAL TAR
PT= PAINT THINNER

K= 30 W LUBRICATING OIL
L= 40 W LUBRICATING OIL
M= 50 W LUBRICATING OIL
ND = NOT DETECTED (CONC)
MS= MINERAL SPIRITS
O= HYDRAULIC OIL
E= NO CALIBRATED STANDARDS DETECTED
CS= CLIENT STANDARDS

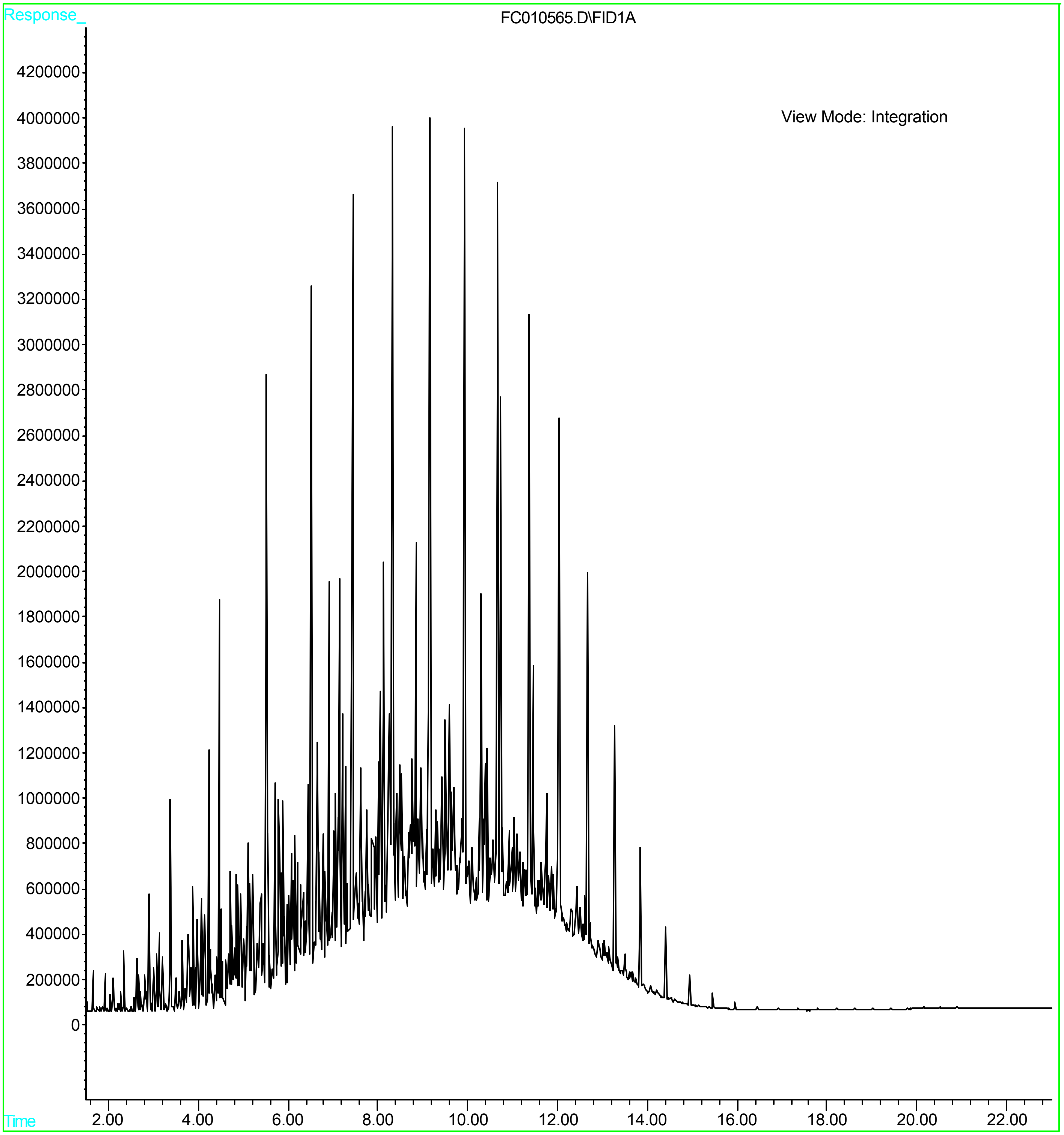
```
File        :P:\HPCHEM1\FID_C\Data\FC060214\FC011319.D
Operator    : JJ
Acquired    : 03 Jun 2014   8:03     using AcqMethod 8015C.M
Instrument :    FID C
Sample Name: F2453-06
Misc Info   :
Vial Number: 33
```



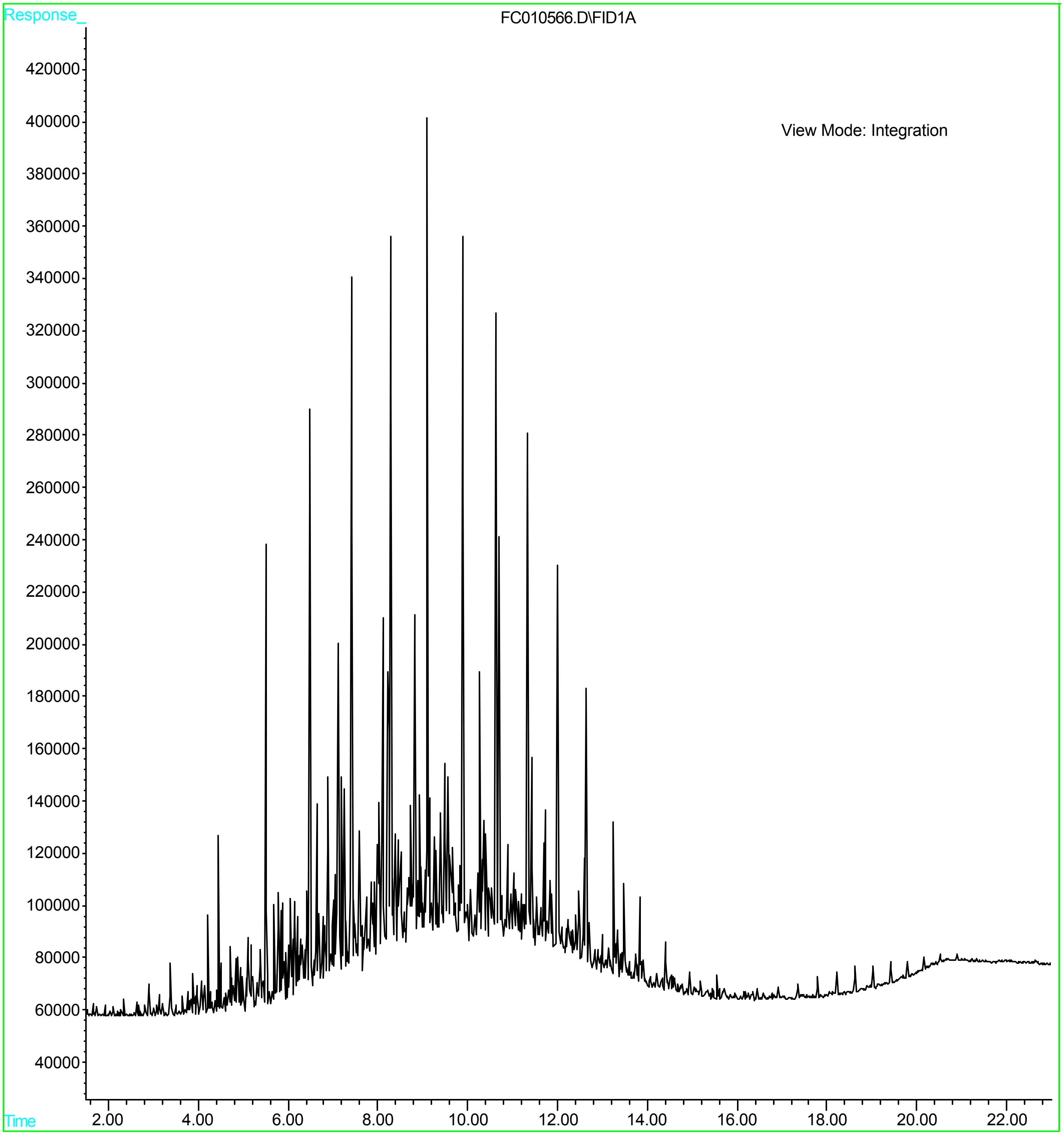
CHEMTECH

FINGERPRINT CALIBRATION DATA

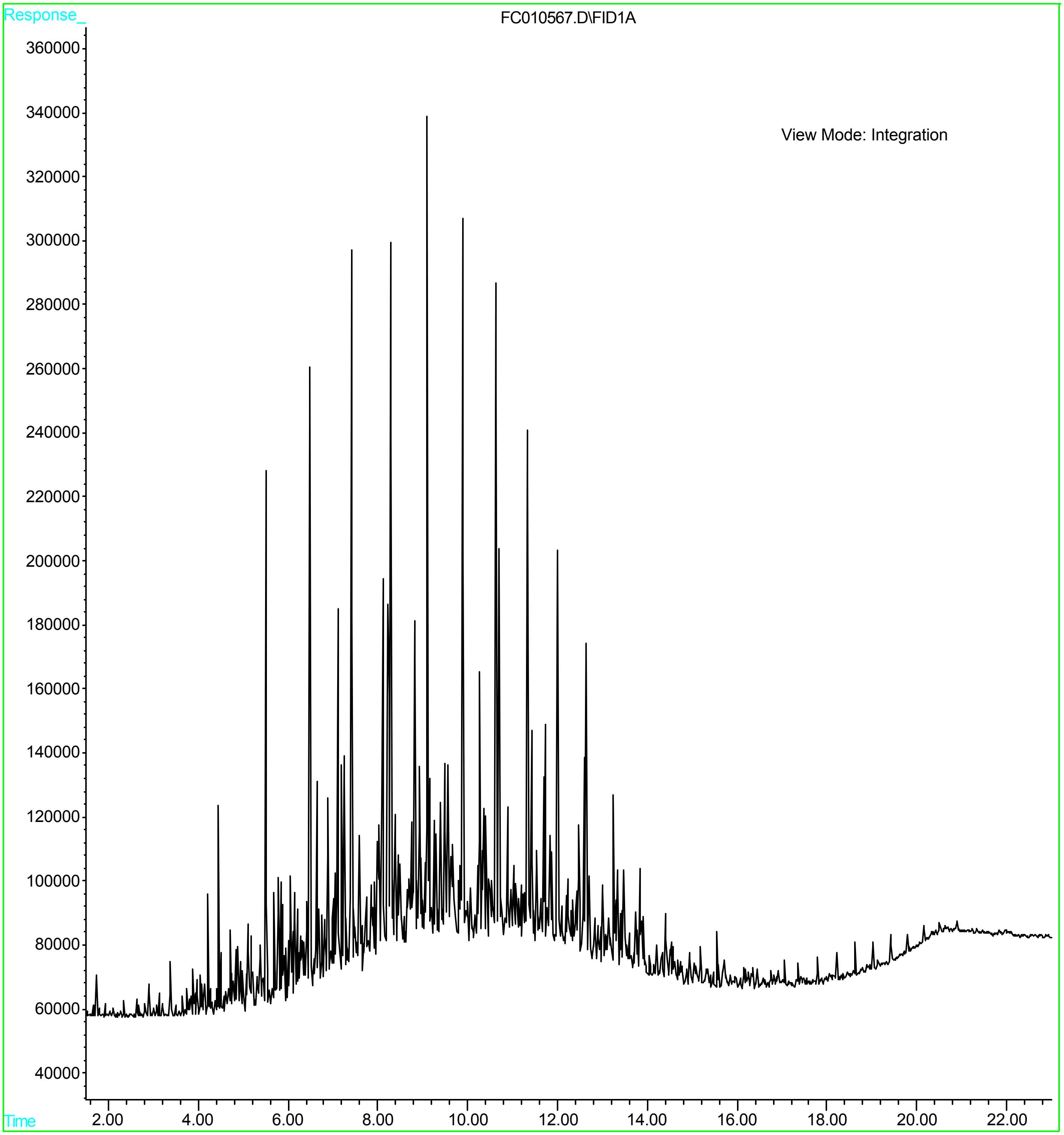
```
File       : P:\HPCHEM1\FID_C\DATA\FC043014\FC010565.D
Operator   : JJ
Acquired   : 4-29-2014 16:56:00  using AcqMethod 8015C.M
Instrument :   FID_C
Sample Name: #2 FUEL OIL STD
Misc Info  :
Vial Number: 3
```



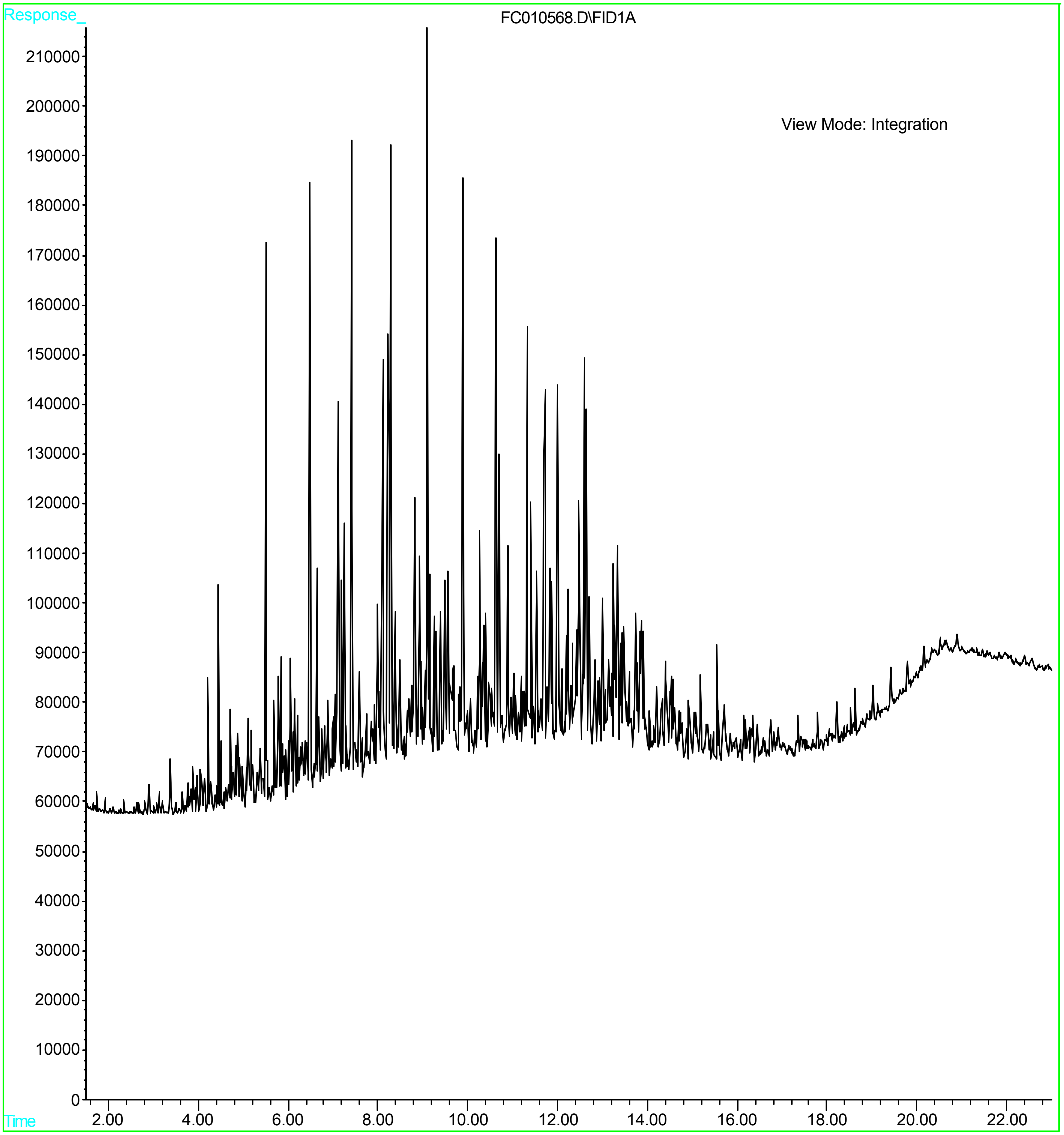
```
File       : P:\HPCHEM1\FID_C\DATA\FC043014\FC010566.D
Operator   : JJ
Acquired   : 4-29-2014 17:31:55  using AcqMethod 8015C.M
Instrument :   FID_C
Sample Name: #4 FUEL OIL STD
Misc Info  :
Vial Number: 4
```



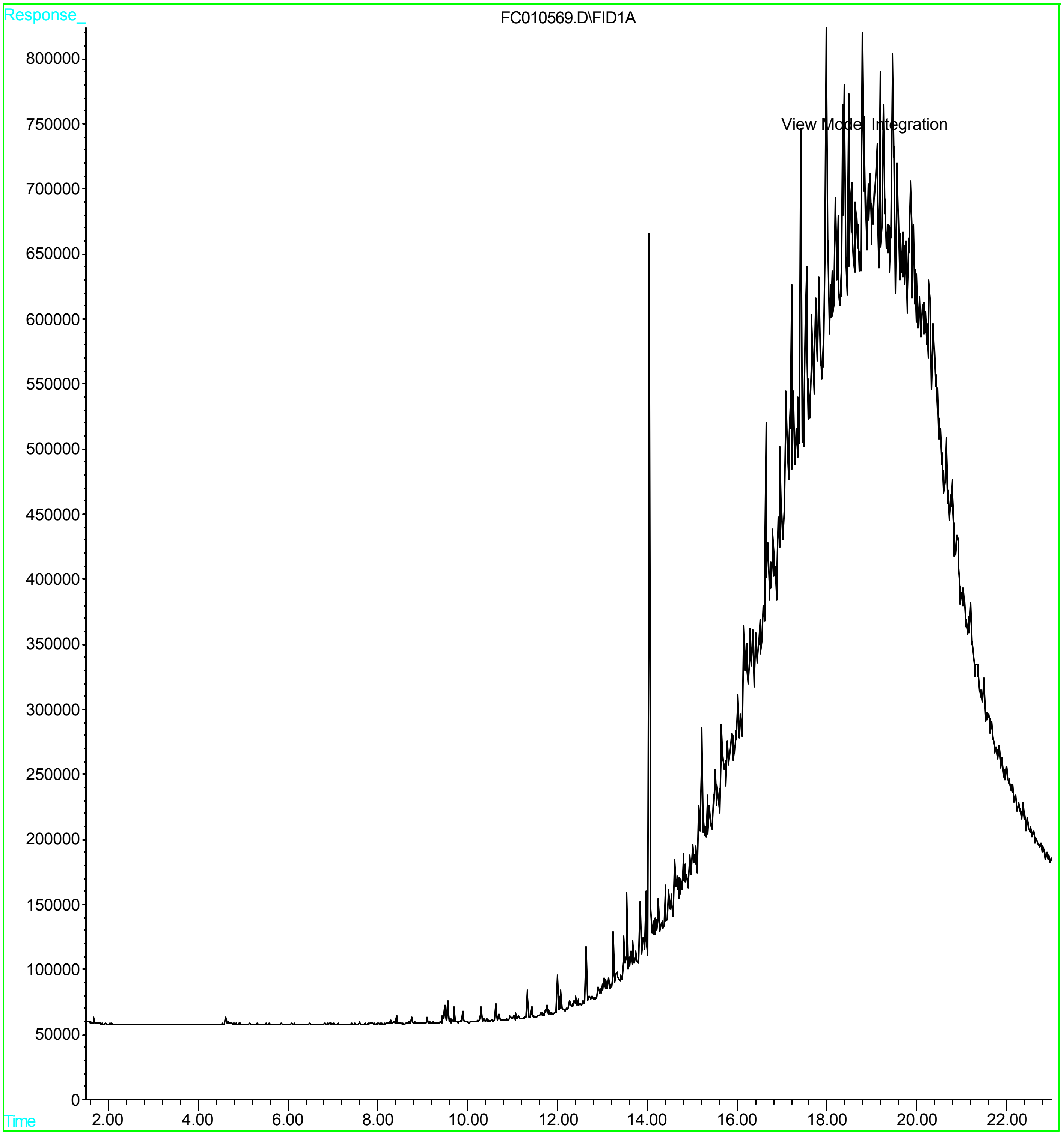
```
File       : P:\HPCHEM1\FID_C\DATA\FC043014\FC010567.D
Operator   : JJ
Acquired   : 4-29-2014 18:07:33  using AcqMethod 8015C.M
Instrument :   FID_C
Sample Name: #5 FUEL OIL STD
Misc Info  :
Vial Number: 5
```



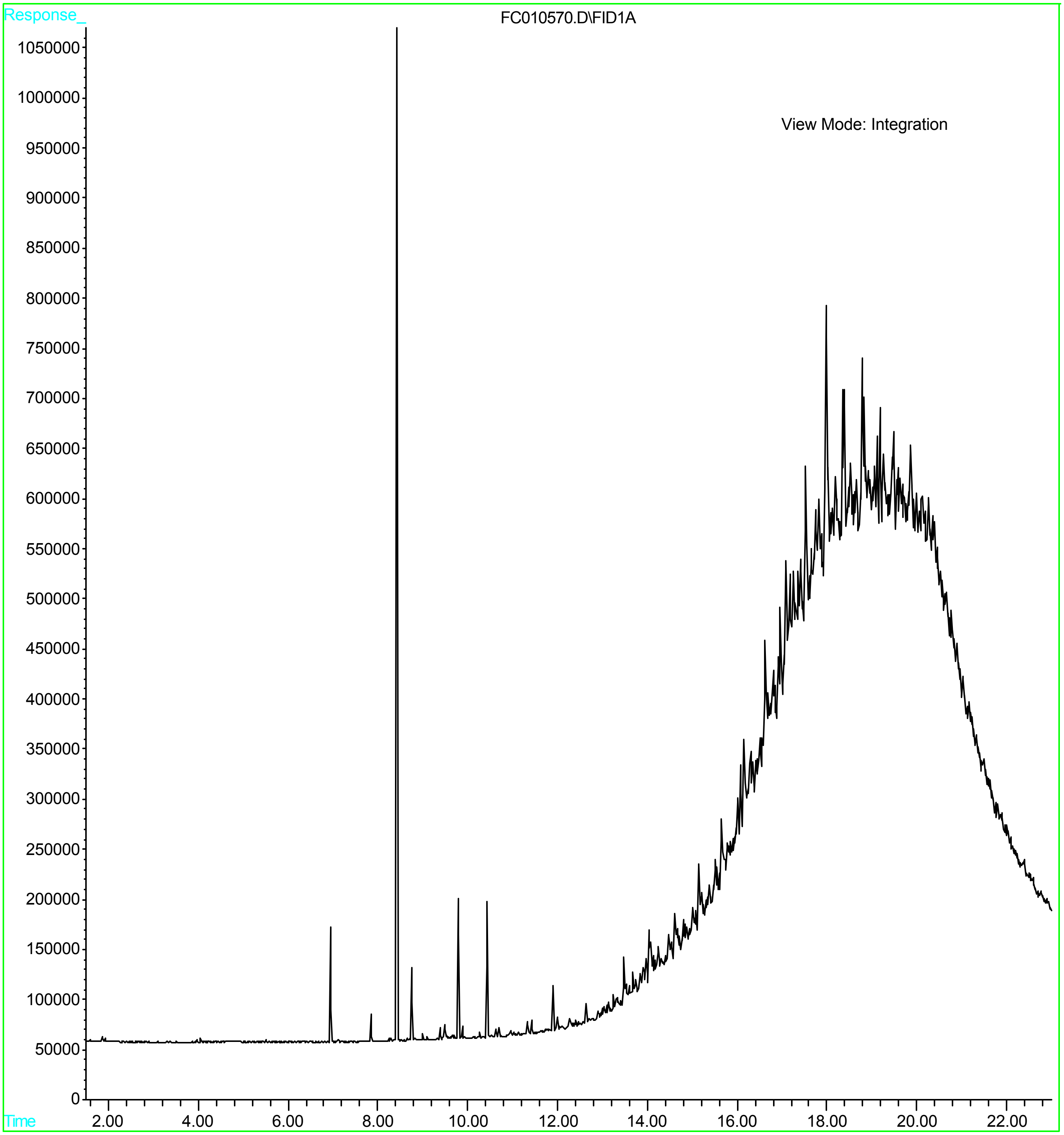
```
File       : P:\HPCHEM1\FID_C\DATA\FC043014\FC010568.D
Operator   : JJ
Acquired   : 4-29-2014 18:43:21  using AcqMethod 8015C.M
Instrument :   FID_C
Sample Name: #6 FUEL OIL STD
Misc Info  :
Vial Number: 6
```



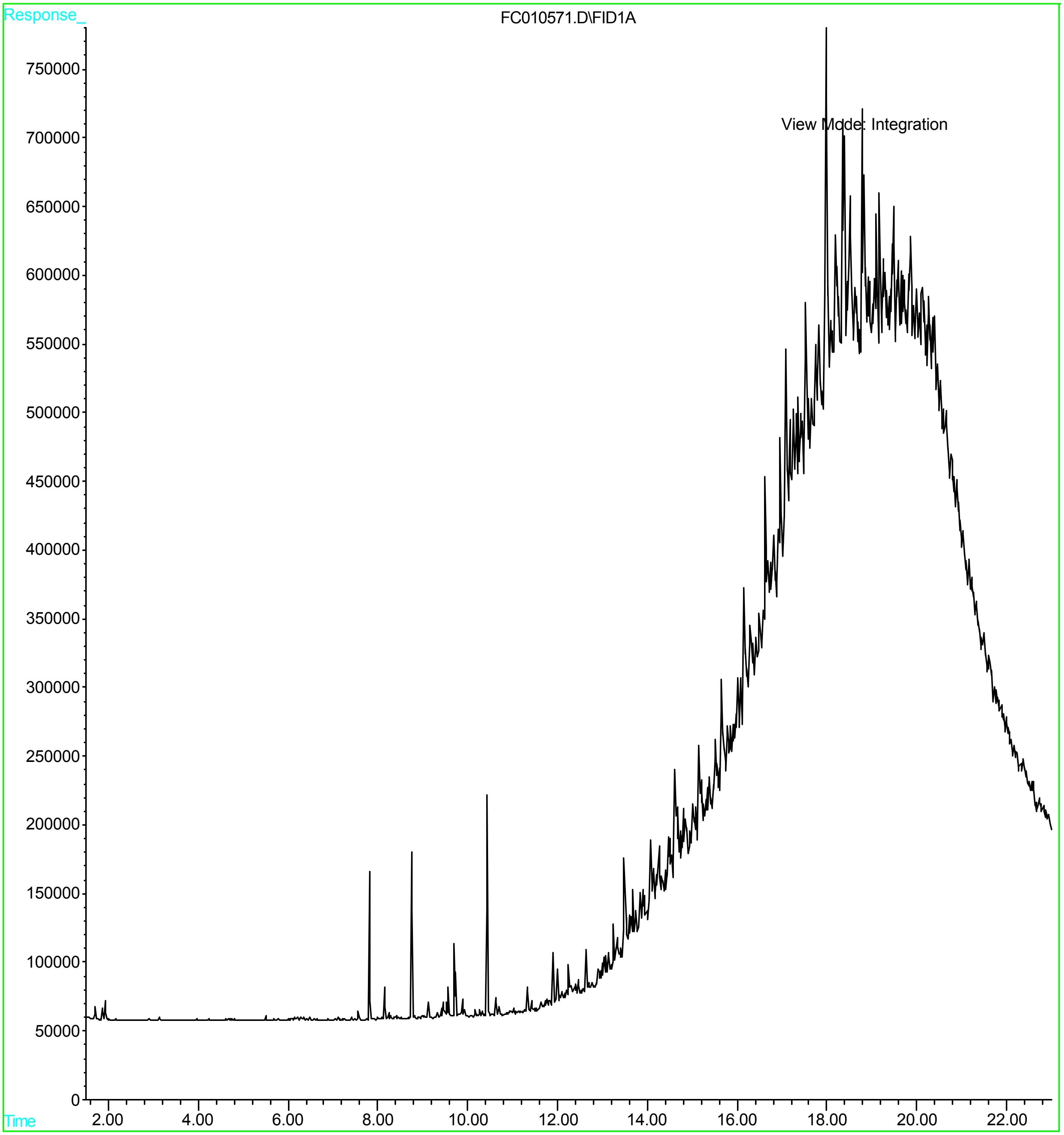
```
File       : P:\HPCHEM1\FID_C\DATA\FC043014\FC010569.D
Operator   : JJ
Acquired   : 4-29-2014 19:18:49  using AcqMethod 8015C.M
Instrument :   FID_C
Sample Name: MOTOR OIL 30
Misc Info  :
Vial Number: 7
```



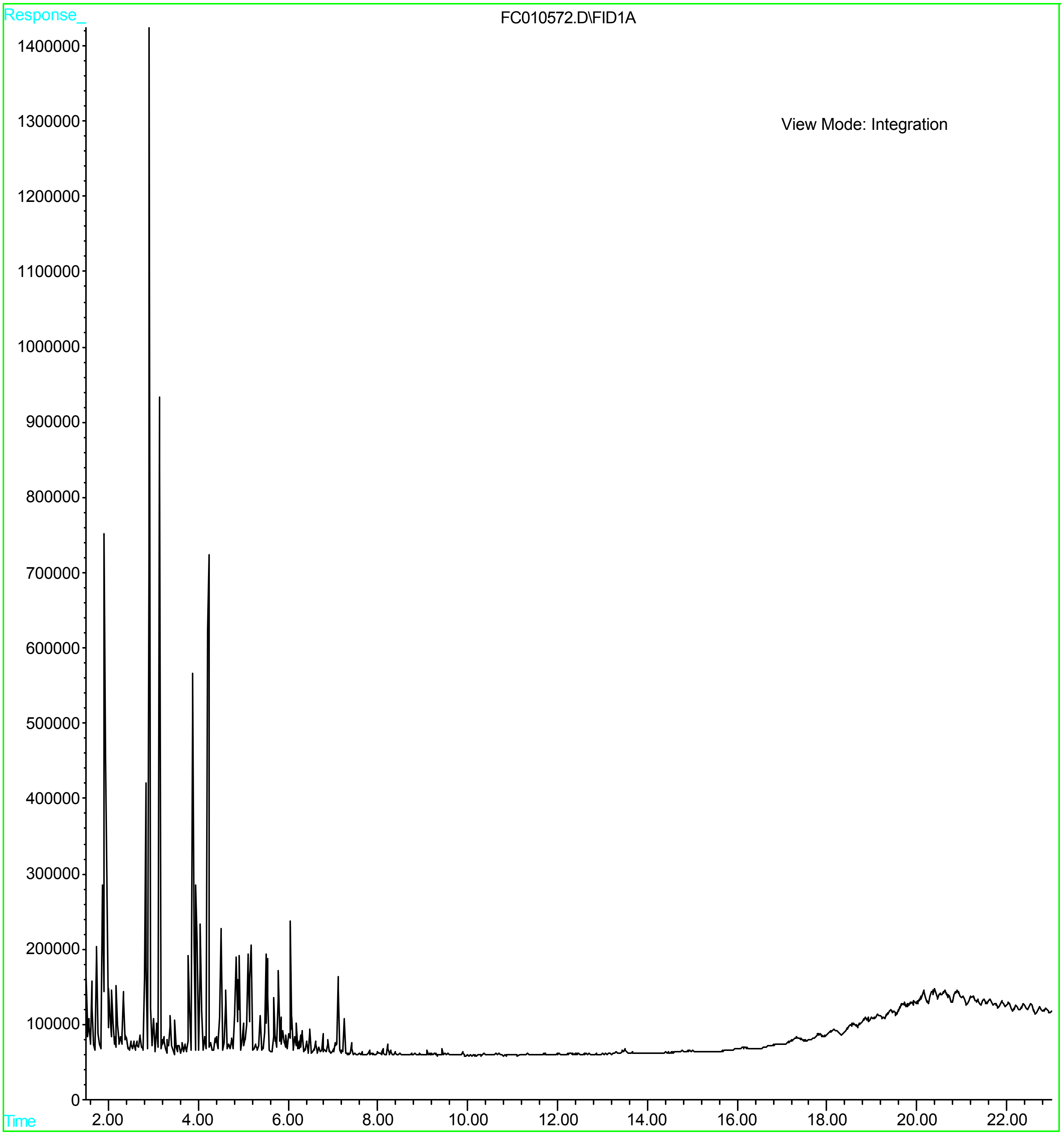
```
File        : P:\HPCHEM1\FID_C\DATA\FC043014\FC010570.D
Operator    : JJ
Acquired    : 4-29-2014 19:54:17  using AcqMethod 8015C.M
Instrument  :    FID_C
Sample Name: MOTOR OIL 40
Misc Info   :
Vial Number: 8
```



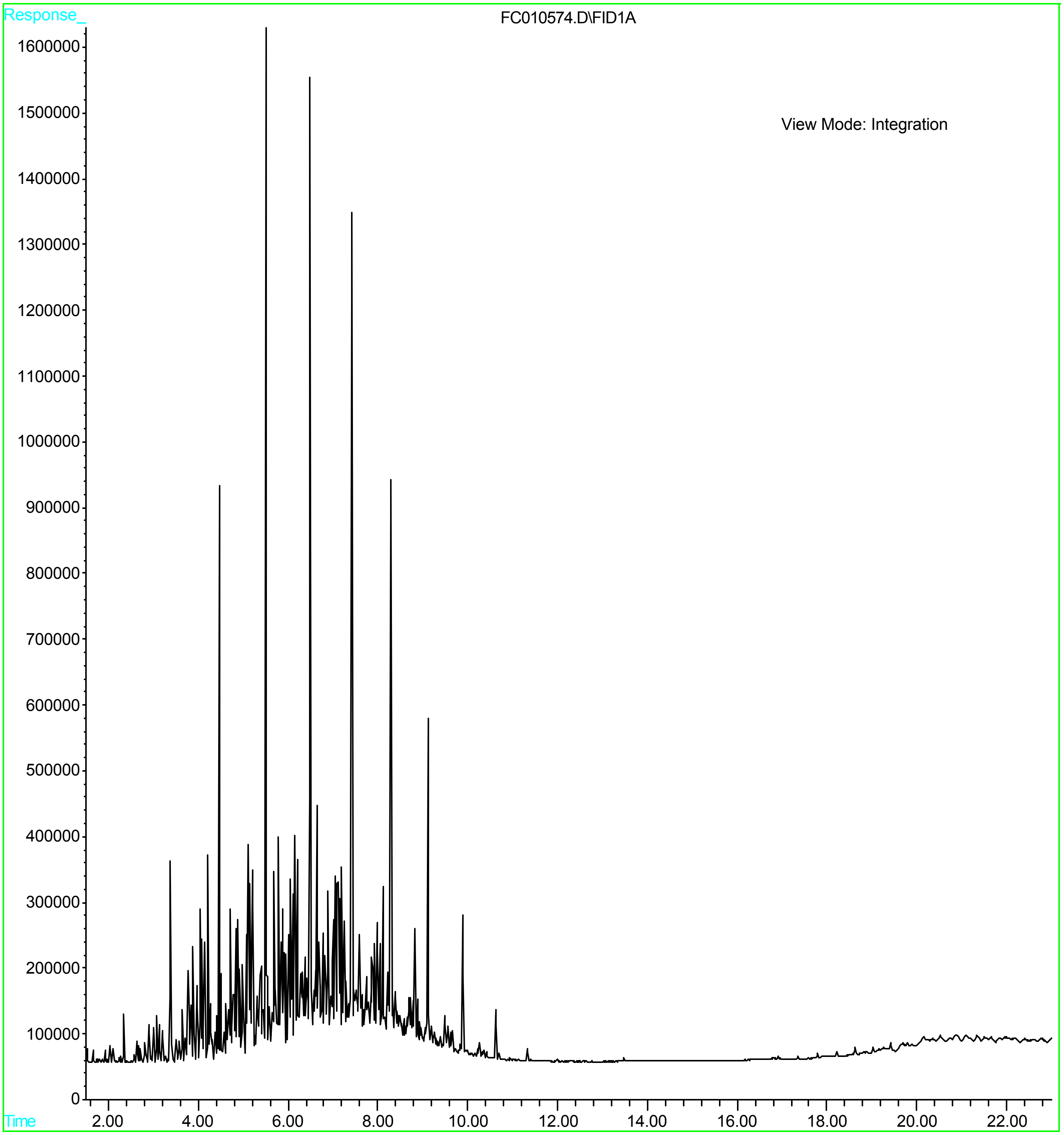
```
File       : P:\HPCHEM1\FID_C\DATA\FC043014\FC010571.D
Operator   : JJ
Acquired   : 4-29-2014 20:29:30  using AcqMethod 8015C.M
Instrument :   FID_C
Sample Name: MOTOR OIL 50
Misc Info  :
Vial Number: 9
```



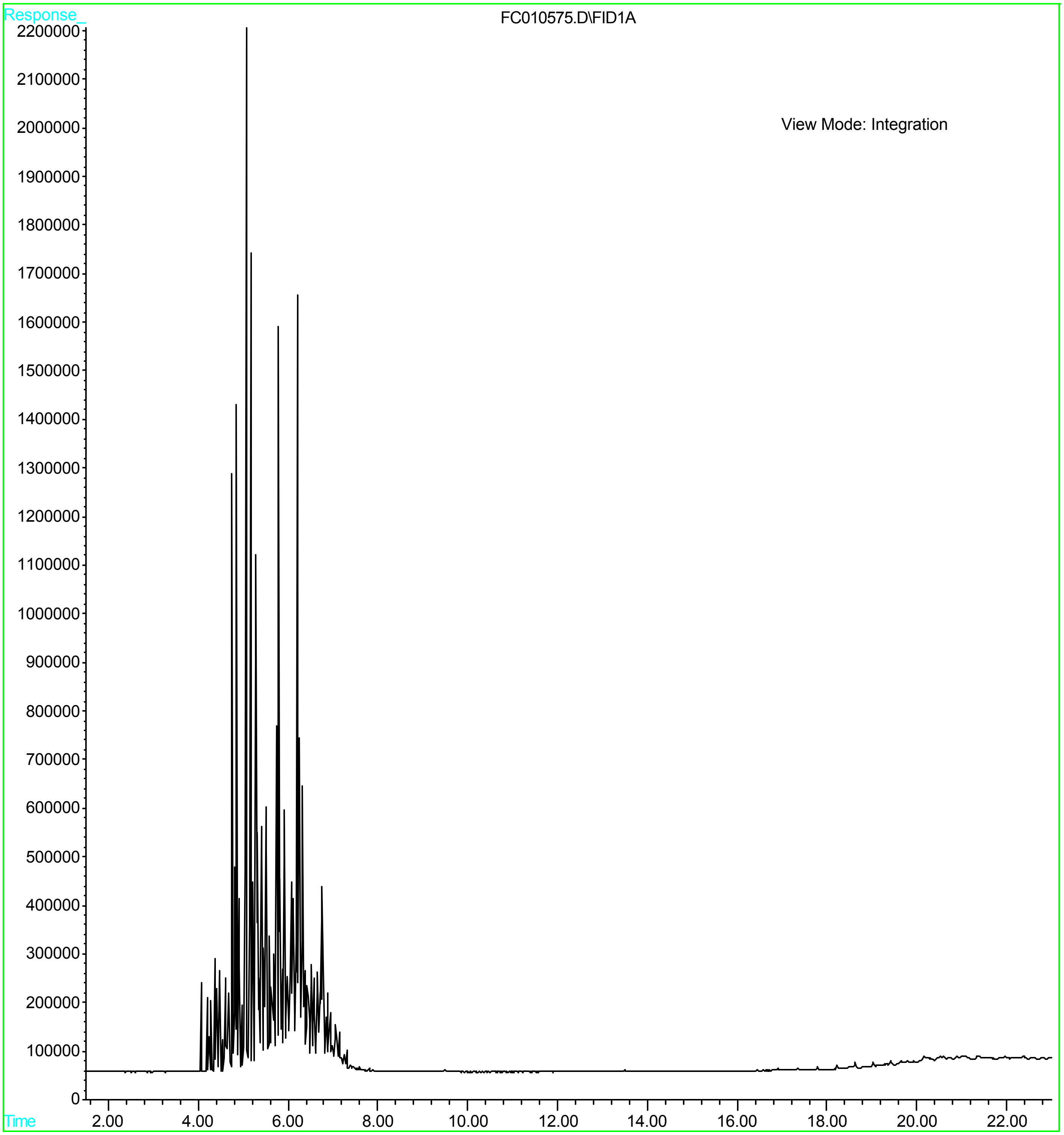
```
File       : P:\HPCHEM1\FID_C\DATA\FC043014\FC010572.D
Operator   : JJ
Acquired   : 4-29-2014 21:04:52  using AcqMethod 8015C.M
Instrument :   FID_C
Sample Name: UNLEADED GASOLINE
Misc Info  :
Vial Number: 10
```



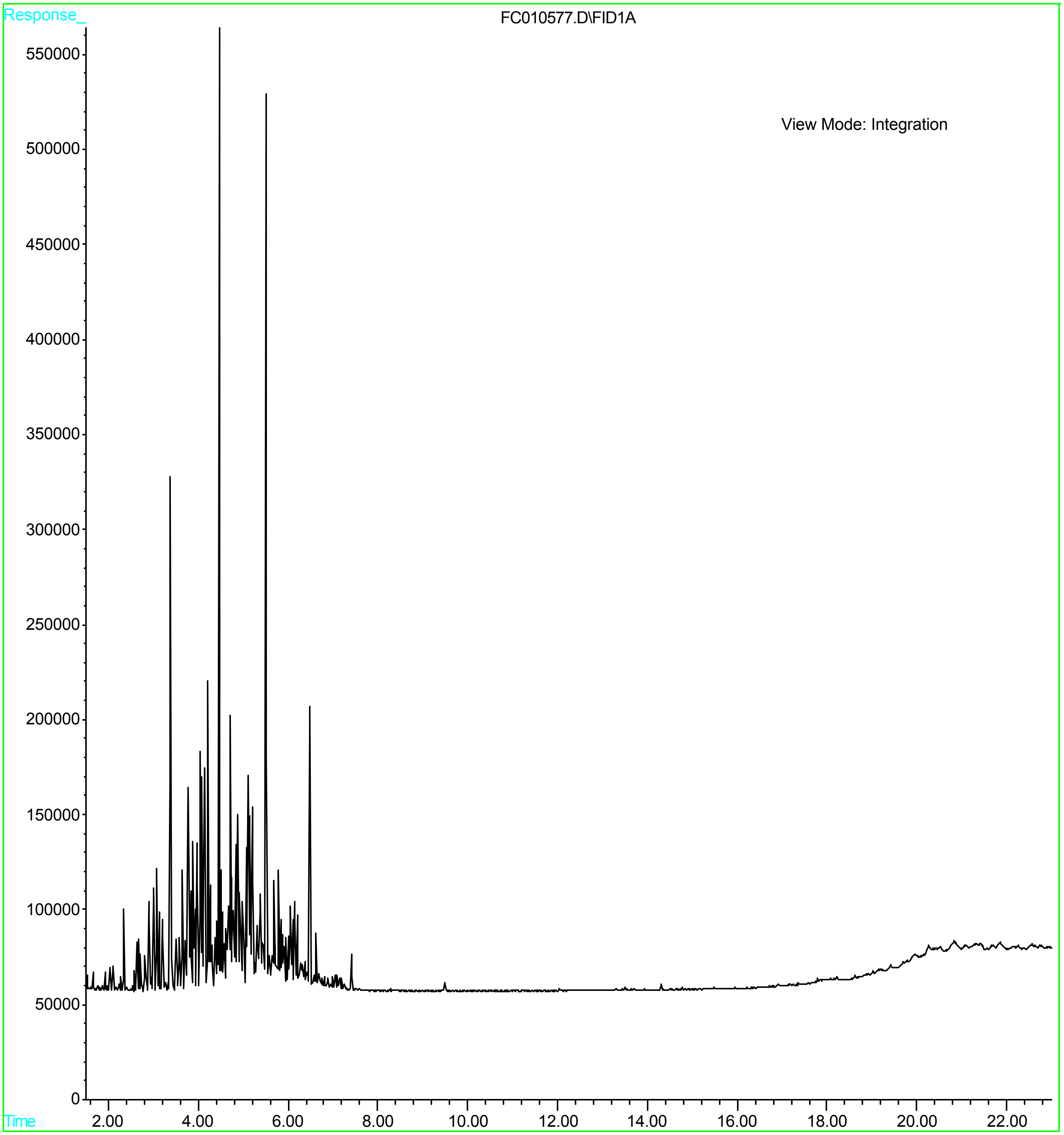
```
File       : P:\HPCHEM1\FID_C\DATA\FC043014\FC010574.D
Operator   : JJ
Acquired   : 4-29-2014 22:15:01  using AcqMethod 8015C.M
Instrument :   FID_C
Sample Name: JET FUEL
Misc Info  :
Vial Number: 12
```



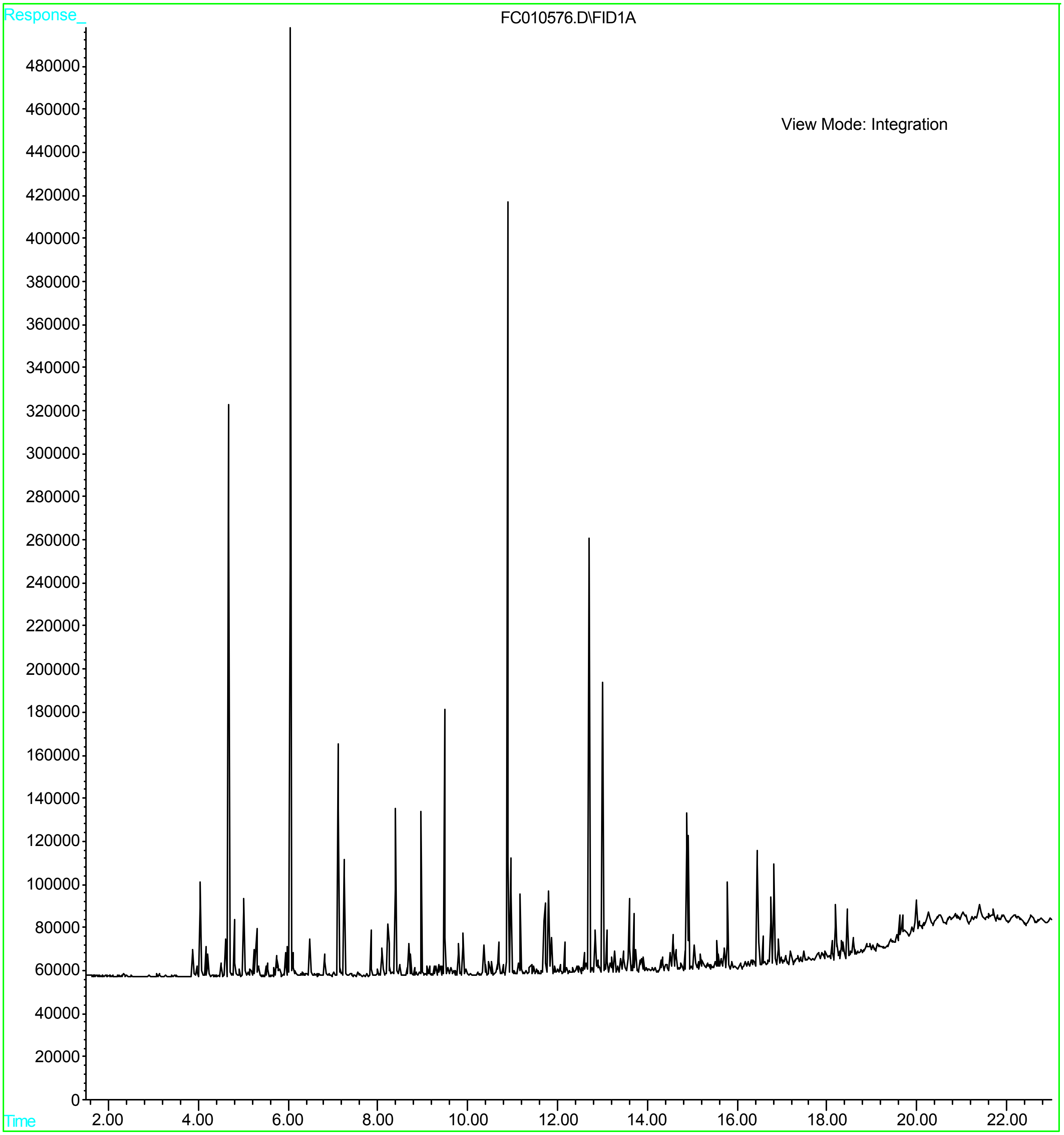
```
File       : P:\HPCHEM1\FID_C\DATA\FC043014\FC010575.D
Operator   : JJ
Acquired   : 4-29-2014 22:49:58  using AcqMethod 8015C.M
Instrument :    FID_C
Sample Name: MINERAL SPIRIT
Misc Info  :
Vial Number: 13
```



```
File       : P:\HPCHEM1\FID_C\DATA\FC043014\FC010577.D
Operator   : JJ
Acquired   : 4-29-2014 23:59:44  using AcqMethod 8015C.M
Instrument :   FID_C
Sample Name: PAINT THINNER
Misc Info  :
Vial Number: 15
```

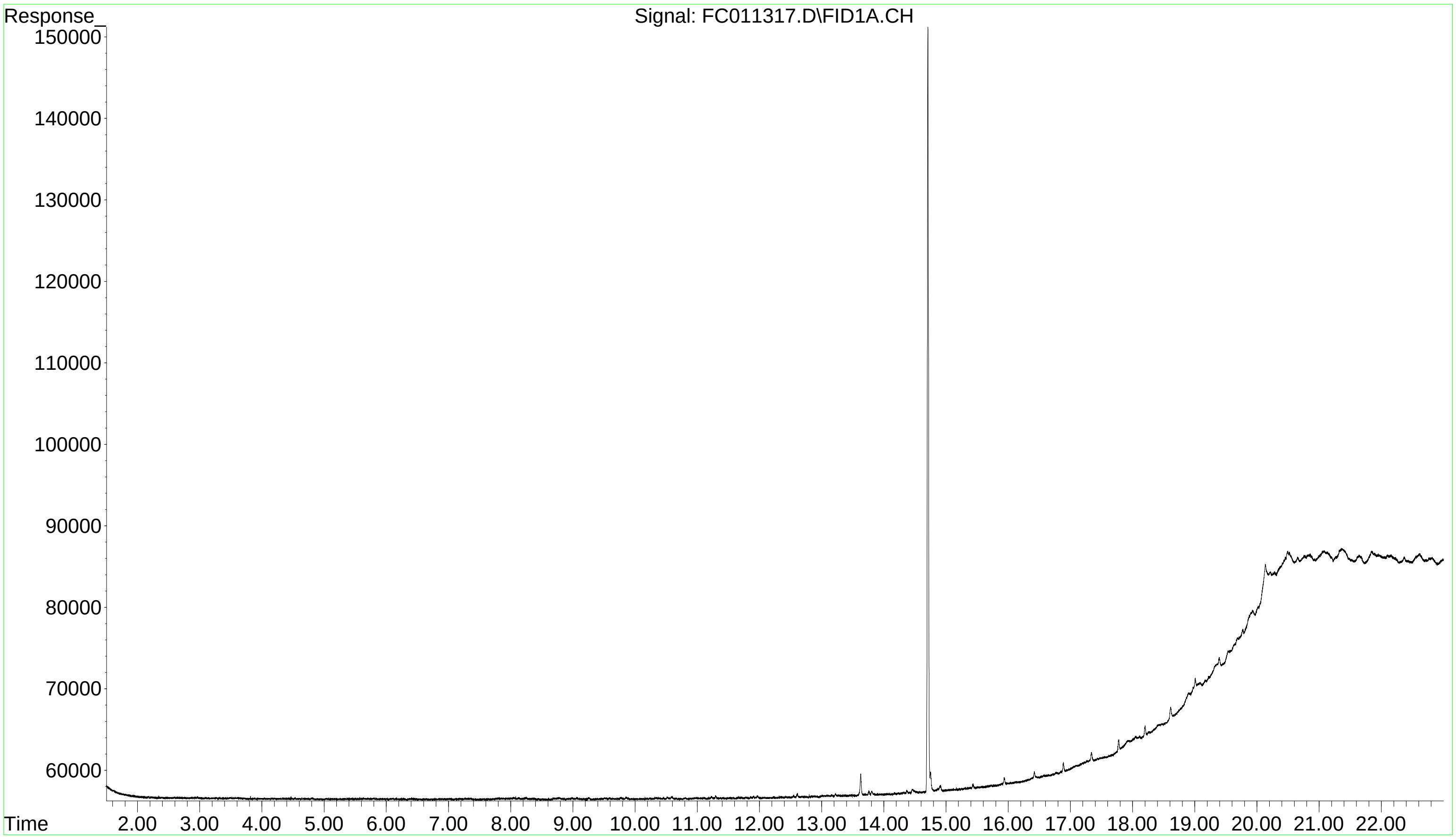


```
File       : P:\HPCHEM1\FID_C\DATA\FC043014\FC010576.D
Operator   : JJ
Acquired   : 4-29-2014 23:24:58  using AcqMethod 8015C.M
Instrument :   FID_C
Sample Name: COAL TAR
Misc Info  :
Vial Number: 14
```



FINGERPRINT RAW QC DATA

```
File        :P:\HPCHEM1\FID_C\Data\FC060214\FC011317.D
Operator    : JJ
Acquired    : 03 Jun 2014   6:49     using AcqMethod 8015C.M
Instrument :    FID C
Sample Name: PB76886BL
Misc Info   :
Vial Number: 31
```



FINGERPRINT MISCELLANEOUS DATA

CHEMTECH **EXTRACTION LOGPAGE**

PR76886

SOP ID: M 3510C·3580A·Extraction·920·07

Matrix : Water

Clean Up SOP #: N/A

Batch# PB76886

Extraction Date : 06/02/14

Extraction Time : 9:35

Review By :

Weigh By: N/A **Extraction By:** **Filter By:** **Concentration By:**

Balance check: N/A **Weight 1:** (2) 2 **Weight 2:** (2) 2

Method of Extraction

☐ Seperatory Funne ☐ Continious Liquid/Liquid ☐ Sonication ☑ Waste Dilution ☐ Soxhlet

Standared Name	MLS USED	Concentration ug/mL	STD REF. # FROM LOG
Spike	1.0ML	20 PPM	PP8029
Surrogate	1.0ML	20 PPM	PP8228

6/02

Chemical Used	ML/SAMPLE USED	Lot Number
Methylene Chloride		E1811
Baked Na2SO4		EP1483

6/02

Extraction Conformance/Non-Conformance Comments:

Extraction End Time: 14:00 Oily Matrix

KD Bath Temperature: — **C**

Envap Temperature: — **C**

Received Date: 6/2/14

Received By:

Delivered Date: 06/02/14

Delivered By:

Delivered Time: 14:05

Analysis Group: QM, HP

Extraction Group: , ZQ, TP, MM, UA, RP, BP, JP

CHEMTECH **EXTRACTION LOGPAGE** **PrepBatch ID** **PB76886**

Analytical Method: 8015 B **Extraction Date:** 06/02/2014-09:33 **Concentration Date:** 06/02/14

Lab Sample ID	Client Sample ID	Test	g / [✓ mL]	PH	Surr/Spike By:		Final Vol.(mL)	Comments	Prep Pos
					Added By	Verified By			
PB76886BL	PB76886BL	Fingerprint	1.0	NA	MM	H	10		
PB76886BS	PB76886BS	Fingerprint	1.0	|	↓	|	10		
F2453-06	DELIST-WELL	Fingerprint	1.0	|	↓	|	10	Oily Matrix	

6/02

* **Extracts relinquished on the same date as received.**

CHEMTECH **EXTRACTION LOGPAGE** **PrepBatch ID : PB76886**

Analytical Method: 2 **Extraction Date:** 06/02/2014-09:33 **Concentration Date:** ___/___/___

Lab Sample ID	Client Sample ID	Test	g / [✓ mL]	PH	Surr/Spike By:		Final Vol.(mL)	Comments	Prep Pos.
		2	2		Added By	Verified By			
PB76886BL	PB76886BL	Fingerprint	1.0	N/A	Muteen	RajeshParikh	10		
PB76886BS	PB76886BS	Fingerprint	1.0	N/A	Muteen	RajeshParikh	10		
F2453-06	DELIST-WELL	Fingerprint	1.0	N/A	Muteen	RajeshParikh	10		
F2453-06MSD	DELIST-WELLMSD	Fingerprint	1.0	N/A	Muteen	RajeshParikh	10		

2 6/02

2 6/02

* **Extracts relinquished on the same date as received.**

CHEMTECH **Instrument ID: FID_C**

284 Sheffield Street, Mountainside NJ 07092 (908) 789-8900

Daily Analysis Runlog For Sequence/QCBatch ID #FC043014

STD. NAME	STD REF.#	STD. NAME	STD REF.#
Review By	jung	Review On	5/5/2014 12:49:50 PM
Tune/Reschk	N/A	Initial Calibration Stds	
CCC	N/A	SubDirectory	FC043014
Internal Standard/PEM	N/A	HP Acquire Method	8015C
ICV/I.BLK	N/A	HP Processing Method	N/A

Sr#	SampleId	Data File Name	Comment	Status
1	MECL2	FC010563.D		Ok
2	MECL2	FC010564.D		Ok
3	#2 FUEL OIL STD	FC010565.D	P1935	Ok
4	#4 FUEL OIL STD	FC010566.D	P1805	Ok
5	#5 FUEL OIL STD	FC010567.D	P1804	Ok
6	#6 FUEL OIL STD	FC010568.D	P1831	Ok
7	MOTOR OIL 30	FC010569.D	P3872	Ok
8	MOTOR OIL 40	FC010570.D	P3870	Ok
9	MOTOR OIL 50	FC010571.D	P3868	Ok
10	UNLEADED GASOLINE	FC010572.D	P1801	Ok
11	KEROSENE	FC010573.D	P1809	Ok
12	JET FUEL	FC010574.D	P3339	Ok
13	MINERAL SPIRIT	FC010575.D	P1808	Ok
14	COAL TAR	FC010576.D	P4421	Ok
15	PAINT THINNER	FC010577.D	P4420	Ok
16	MECL2	FC010578.D		Ok
17	PB76267BL	FC010579.D		Ok
18	PB76267BS	FC010580.D		Ok
19	PB76267BSD	FC010581.D		Ok
20	F2135-01	FC010582.D	needs DL for better comparision	Not Ok
21	F2135-02	FC010583.D	needs DL for better comparision	Not Ok

CHEMTECH	**Instrument ID: FID_C**

284 Sheffield Street, Mountainside NJ 07092 (908) 789-8900

Daily Analysis Runlog For Sequence/QCBatch ID #FC043014

STD. NAME	**STD REF.#**	**STD. NAME**	**STD REF.#**
Review By	jung	Review On	5/5/2014 12:49:50 PM
Tune/Reschk	N/A	Initial Calibration Stds	
CCC	N/A	SubDirectory	FC043014
Internal Standard/PEM	N/A	HP Acquire Method	8015C
ICV/I.BLK	N/A	HP Processing Method	N/A

Sr#	**SampleId**	**Data File Name**	**Comment**	**Status**
22	F2135-01DL 100X	FC010584.D		Ok
23	F2135-02DL 100X	FC010585.D		Ok

CHEMTECH

Instrument ID: FID_C

284 Sheffield Street, Mountainside NJ 07092 (908) 789-8900

Daily Analysis Runlog For Sequence/QCBatch ID #FC060214

STD. NAME	**STD REF.#**	**STD. NAME**	**STD REF.#**
Review By	ugo	Review On	6/3/2014 11:09:34 AM
Tune/Reschk	N/A	Initial Calibration Stds	PP7968,PP8204,PP8205,PP8206,PP8207
CCC	PP8204	SubDirectory	FC060214
Internal Standard/PEM	N/A	HP Acquire Method	8015C
ICV/I.BLK	PP8208,PP8030	HP Processing Method	FC053114

Sr#	**SampleId**	**Data File Name**	**Comment**	**Status**
1	MECL2	FC011289.D		Ok
2	I.BLK	FC011290.D		Ok
3	50 PPM TRPH STD	FC011291.D		Ok
4	RT MARKER	FC011292.D		Ok
5	F2445-08	FC011293.D		Ok
6	F2445-10	FC011294.D		Ok
7	F2445-13	FC011295.D	20x	Ok,M
8	F2467-08	FC011296.D	20x	Ok,M
9	F2467-09	FC011297.D		Ok
10	F2465-01	FC011298.D	20x	Ok,M
11	F2465-02	FC011299.D	50x	Ok
12	F2465-03	FC011300.D	50x	Ok
13	F2465-04	FC011301.D	20x	Ok,M
14	F2465-06	FC011302.D	20x	Ok,M
15	I.BLK	FC011303.D		Ok
16	50 PPM TRPH STD	FC011304.D		Ok
17	F2465-12	FC011305.D	2x	Ok,M
18	F2465-13	FC011306.D	2x	Ok,M
19	F2465-16	FC011307.D		Ok
20	F2465-18	FC011308.D	2x	Ok,M
21	PB76858BL	FC011309.D		Ok

CHEMTECH	**Instrument ID: FID_C**

284 Sheffield Street, Mountainside NJ 07092 (908) 789-8900

Daily Analysis Runlog For Sequence/QCBatch ID #FC060214

STD. NAME	**STD REF.#**	**STD. NAME**	**STD REF.#**
Review By	ugo	Review On	6/3/2014 11:09:34 AM
Tune/Reschk	N/A	Initial Calibration Stds	PP7968,PP8204,PP8205,PP8206,PP8207
CCC	PP8204	SubDirectory	FC060214
Internal Standard/PEM	N/A	HP Acquire Method	8015C
ICV/I.BLK	PP8208,PP8030	HP Processing Method	FC053114

Sr#	**SampleId**	**Data File Name**	**Comment**	**Status**
22	PB76858BS	FC011310.D		Ok
23	F2482-01	FC011311.D	10x, needs 50x	Dilution
24	F2482-02	FC011312.D	5x	Ok
25	F2482-03	FC011313.D	5x	Ok,M
26	F2482-04	FC011314.D	10x, needs 50x	Dilution
27	I.BLK	FC011315.D		Ok
28	50 PPM TRPH STD	FC011316.D		Ok
29	PB76886BL	FC011317.D	fingerprint batch	Ok
30	PB76886BS	FC011318.D	fingerprint batch	Ok
31	F2453-06	FC011319.D	fingerprint batch	Ok
32	F2453-06	FC011320.D	10x, DL not needed.	Not Ok
33	F2482-05	FC011321.D	10x, needs 50x	Dilution

SHIPPING DOCUMENTS

CHEMTECH

CHAIN OF CUSTODY RECORD

284 Sheffield Street, Mountainside, NJ 07092
(908) 789-8900 Fax (908) 789-8922
www.chemtech.net

CHEMTECH PROJECT NO.
QUOTE NO. F2453
COC Number 028395

CLIENT INFORMATION

REPORT TO BE SENT TO:
COMPANY: LaBella Associates, DPC
ADDRESS: 300 State St. Suite 201
CITY: Rochester STATE: NY ZIP: 14614
ATTENTION: Dan Noll
PHONE: FAX:

CLIENT PROJECT INFORMATION

PROJECT NAME: FESL
PROJECT NO: LOCATION:
PROJECT MANAGER: Dan Noll
e-mail: dnoll@labellapc.com
PHONE: FAX:

CLIENT BILLING INFORMATION

BILL TO: LaBella Associates PO#:
ADDRESS: 300 State St. Suite 201
CITY: Rochester STATE: NY ZIP: 14614
ATTENTION: Michelle Clausen PHONE:

DATA TURNAROUND INFORMATION

FAX: DAYS *
HARD COPY: DAYS *
EDD: DAYS *
PREAPPROVED TAT: ☐ YES ☐ NO
* STANDARD TURNAROUND TIME IS 10 BUSINESS DAYS

DATA DELIVERABLE INFORMATION

☐ LEVEL 1: Results only ☐ Others
☐ LEVEL 2: Results + QC
☐ LEVEL 3: Results (plus results raw data) + QC
☐ LEVEL 4: Results + QC (all raw data)
☐ EDD Format:

ANALYSIS

1 TCL + CP-51 VOC
2 Alkalinity / Fer. Iron / TDS
3 Sulfide
4 Tot. Hard / Mercury / TAL Metals
5 TOC / Nitrate / Nitrite
6 Methane
7
8
9

CHEMTECH SAMPLE ID	PROJECT SAMPLE IDENTIFICATION	SAMPLE MATRIX	SAMPLE TYPE COMP	SAMPLE TYPE GRAB	SAMPLE COLLECTION DATE	SAMPLE COLLECTION TIME	# OF BOTTLES	PRESERVATIVES 1	2	3	4	5	6	7	8	9	COMMENTS ← Specify Preservatives A – HCl B – HNO_3 C – H_2SO_4 D – NaOH E – ICE F – Other
								A		D	B	C	A				
1	LBA-SBW-5	GW		X	5/23			X	X	X	X	X	X				
2.	Dupe 2	GW		X	[redacted]	—		X	X	X	X	X	X				
3.	LBA-SBW-3	GW		X	5/23			X	X	X	X	X	X				
4.	MS	GW		X	5/23			X	X	X	X	X	X				
5.	MSD	GW		X	5/23			X	X	X	X	X	X				
6.																	
7																	
8.																	
9.																	
10.																	

SAMPLE CUSTODY MUST BE DOCUMENTED BELOW EACH TIME SAMPLES CHANGE POSSESSION INCLUDING COURIER DELIVERY

RELINQUISHED BY	DATE/TIME	RECEIVED BY
RELINQUISHED BY SAMPLER: 1.	5/23 8PM	RECEIVED BY: 1. Fedex
RELINQUISHED BY: 2. Fedex	5/24/14 1030AM	RECEIVED BY: 2. Amit Patel
RELINQUISHED BY: 3.	DATE/TIME:	RECEIVED FOR LAB BY: 3.

Conditions of bottles or coolers at receipt: ☑ Compliant ☐ Non Compliant
Cooler Temp. 4°C
MeOH extraction requires an additional 4 oz jar for percent solid.
Ice in Cooler?: yes
Comments:

Page ______ of ______

SHIPPED VIA: CLIENT: ☐ HAND DELIVERED ☐ OVERNIGHT
CHEMTECH: ☐ PICKED UP ☑ OVERNIGHT

Shipment Complete: ☑ YES ☐ NO

FedEx Express NEW

FedEx Tracking Number 8055 7023 0263

Form ID No. 0200

1 From

Date 5/23/14 [redacted]

Sender's Name Steven Rife Phone 585 755-9244

Company LaBella Associates DPC

Address 300 State St Suite 201 Dept./Floor/Suite/Room

City Rochester State NY ZIP 14614

2 Your Internal Billing Reference

3 To

Recipient's Name Chemtech Laboratories Phone 908 789-8900

Company

Address 284 Sheffield St. Dept./Floor/Suite/Room

We cannot deliver to P.O. boxes or P.O. ZIP codes.

☐ HOLD Weekday
FedEx location address REQUIRED. NOT available for FedEx First Overnight.

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Address

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City Mountainside State NJ ZIP 07092

Deepak Parman 5/24/14 10:30 Am

8055 7023 0263

4 Express Package Service * To most locations. For p

NOTE: Service order has changed. Please select carefully.

Next Business Day

☐ FedEx First Overnight
Earliest next business morning delivery to select locations. Friday shipments will be delivered on Monday unless SATURDAY Delivery is selected

☒ FedEx Priority Overnight
Next business morning.* Friday shipments will be delivered on Monday unless SATURDAY Delivery is selected.

☐ FedEx Standard Overnight
Next business afternoon.* Saturday Delivery NOT available.

2 or 3 Business Day

☐ FedEx 2Day A.M.
Second business morning.* Saturday Delivery NOT avail

☐ FedEx 2Day
Second business afternoon will be delivered on Monday Delivery is selected.

☐ FedEx Express Sa

5 Packagin

☐ FedEx Envelo

6 Special Ha

☒ SATURDAY De
NOT available for Fo

☐ No Signature R
Package may be left w obtaining a signature fo

Does this shipmen
One bo

☒ No ☐ Yes As per a Shipper'

Dangerous goods (including dry ic or placed in a FedEx Express Drop

7 Payment *Bill to*

☒ Sender Acct. No. in Section 1 will be billed. ☐ ☐

[redacted]

Total Packages 2 Total V

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300 STATE ST STE 201

ROCHESTER, NY 146141098
UNITED STATES US

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284 SHEFFIELD ST

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INV:
PO:

1 of 2

TRK# 0200 8055 7023

fedex.com 1.800.GoFedEx 1.800

Align Upper End of FedEx Pouch Here

Reginald St-Juste

From: Rife, Steven <SRife@LaBellaPC.com>
Sent: Tuesday, May 27, 2014 3:41 PM
To: Reginald@chemtech.net
Subject: RE: Samples received over the week end

Reggie,

Thanks for the help.

Sorry for the inconvenience of some missing details with this project, I was pulled on it with next to no advance notice, and thus had to do a lot of organizing on the fly.

I appreciate your cooperation.

Steve

Steven Rife
LaBella Associates, D.P.C.
Direct: 585-402-7004 | Cell: 585-755-9244

From: Reginald St-Juste [mailto:Reginald@chemtech.net]
Sent: Tuesday, May 27, 2014 3:36 PM
To: Rife, Steven
Subject: Samples received over the week end

Steven as discussed over the phone,

The MS and MSD sample is out of LBA-SBW-3, also there was no time on the COC. I pulled out the time from the bottles.

Regards,
Reginald St-Juste
Project Manager
Tel. 908 728 3147
Email: Reginald@chemtech.net

284 Sheffield Street,
Mountainside, New Jersey 07092
Phone: (908) 789 8900
Fax: (908) 789 8922

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Reginald St-Juste

From: Rife, Steven <SRife@LaBellaPC.com>
Sent: Friday, May 23, 2014 4:27 PM
To: Reginald@chemtech.net; Steven@chemtech.net
Cc: Noll, Dan; Kaveney, Danielle

Reginald,

Please find attached the COC's that will be accompanying the samples arriving tomorrow morning. I will be sending them within the hour.

As discussed earlier on the phone with Danielle, 48-hour hold time samples (Ferr. Iron, Nitrate, Nitrite) will be included with this shipment. If a staff member could perform the analysis at a point in time this weekend, we would be very appreciative.

Also I will include the three samples from the previous chain that I forgot to include with the last shipment **("Delist Well", 3 Amber jars, red caps)**

Sorry for any inconvenience, and thanks for your help.

Best,

Steven Rife
Project Geologist
Direct: 585-402-7004 | Cell: 585-755-9244
srife@labellapc.com

LABELLA ASSOCIATES, D.P.C.
300 State Street, Rochester, NY 14614
Office: 585-454-6110
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Laboratory Certification

State	License No.
New Jersey	20012
New York	11376
Connecticut	PH-0649
Florida	E87935
Louisiana	5035
Maryland	296
Massachusetts	M-NJ503
Pennsylvania	68-548
Rhode Island	LAO00259
Virginia	460220
Texas	T10470448-10-1

Other :

DOD ELAP Certified (L-A-B Accredited), ISO/IEC 17025	L2219
Soil Permit	P330-11-00012
CLP Inorganic Contract	EPW09038
CLP Organic Contract	EPW11030

QA Control Code: A2070148

CHEMTECH

LOGIN REPORT/SAMPLE TRANSFER

Order ID:	F2453 LABE01	**Order Date:**	5/27/2014	**Project Mgr:**	Reginald
Client Name:	LaBella Associates P.C.	**Project Name:**	Former Emerson Street Landfill	**Report Type:**	NYS ASP B
Client Contact:	Dan Noll	**Rec DateTime**	5/24/2014 10:30:00 AM	**EDD:**	NYSDEC EDD V-3
Invoice Name:	LaBella Associates P.C.	**Purchase Order:**	210173	**Hard Copy Date:**	
Invoice Contact:	Dan Noll	**Login Tech:**	Nikul	**Date Signoff:**	5/27/2014 3:21:34 PM

LAB ID	CLIENT ID	MATRIX	SAMPLE DATE	SAMPLE TIME	QTY	TEST	TEST GROUP	METHOD	COMMENT		FAX DATE	Due Dates
F2453-01	LBA-SBW-5	Water	5/23/2014	8:20	8							
						VOCMS Group1		8260-Low		10 Bus.	6/6/2014	6/6/201
F2453-02	DUP-2	Water	5/23/2014	0:00	8							
						VOCMS Group1		8260-Low		10 Bus.	6/6/2014	6/6/201
F2453-03	LBA-SBW-3	Water	5/23/2014	10:20	7							
						VOCMS Group1		8260-Low		10 Bus.	6/6/2014	6/6/201
F2453-04	F2453-03MS	Water	5/23/2014	10:20	7							
						VOCMS Group1		8260-Low		10 Bus.	6/6/2014	6/6/201
F2453-05	F2453-03MSD	Water	5/23/2014	10:20	7							
						VOCMS Group1		8260-Low		10 Bus.	6/6/2014	6/6/201

CHEMTECH

LOGIN REPORT/SAMPLE TRANSFER

Order ID:	F2453	LABE01	**Order Date:**	5/27/2014	**Project Mgr:**	Reginald
Client Name:	LaBella Associates P.C.		**Project Name:**	Former Emerson Street Landfill	**Report Type:**	NYS ASP B
Client Contact:	Dan Noll		**Rec DateTime**	5/24/2014 10:30:00 AM	**EDD:**	NYSDEC EDD V-3
Invoice Name:	LaBella Associates P.C.		**Purchase Order:**	210173	**Hard Copy Date:**	
Invoice Contact:	Dan Noll		**Login Tech:**	Nikul	**Date Signoff:**	5/27/2014 3:21:34 PM

LAB ID	CLIENT ID	MATRIX	SAMPLE DATE	SAMPLE TIME	QTY	TEST	TEST GROUP	METHOD	COMMENT	FAX DATE	Due Dates

SAMPLE CONDITION RECORD

Are samples submitted with a chain of custody?	Yes
Are the number of samples the same as stated on the chain of custody?	Yes
Are bottle caps tight and securely in place?	Yes
Were all containers intact when received?	Yes
Were samples submitted in an ice chest?	Yes
Were samples received cold?	Yes
Were samples within the holding time for the requested test(s)?	Yes
Is the volume of sample submitted sufficient for the requested test(s)?	Yes
Are all samples for volatile organic analyses free of headspace?	Yes

+ Gases

ORDER COMMENT

NY. VOC Group 1 = VOC-TCL + CP51. Gases = Methane only. ("Delist Well", 3 Amber jars for FingerPrint. Sample are oil.

Relinquished By: RU

Date / Time: 5/28/14 3:22pm

Received By:

Date / Time: 5/28/14 322

Storage Area: VOA Refridgerator Room

Attachment 3

Excerpts from “USEPA 510-R-96-001 Methods for Evaluating Recoverability of Free Product,” September 1996

CHAPTER IV

METHODS FOR EVALUATING RECOVERABILITY OF FREE PRODUCT

CHAPTER IV

METHODS FOR EVALUATING RECOVERABILITY OF FREE PRODUCT

The primary objectives of a free product recovery system are to recover as much free product as possible, as quickly as possible, and with as little expense as possible. In order to design an effective and efficient free product recovery system, you need to answer several questions: “What is the areal and vertical extent of the free product?”, “How much free product has accumulated?”, “How much of the total volume is recoverable?”, and “How quickly can the free product be recovered?”. The answers to each of these questions relate to the recoverability of free product from the subsurface.

Intuitively, the most effective locations for free product recovery devices are those places where the accumulations are the greatest. Early tasks, therefore, include locating those areas where free product accumulations are the greatest and delineating the areal extent of the free product plume (or pools). Knowledge of the areal extent is also necessary to assess whether or not hydraulic containment is required. This information can be obtained from excavations and test pits, soil borings, and monitoring wells or well points.

The volume of free product present at a site should be estimated in order to help evaluate progress during the recovery phase. One of the ways to establish this estimate is to determine the hydrocarbon concentrations in soil and hydrocarbon thickness in wells. Methods used to estimate free product volumes are based on theoretical models, simplified correlations between hydrocarbon thickness in wells, and specific oil volumes. The reliability of volume estimates is typically low, with accuracy within an order of magnitude. Because of the uncertainty, we suggest that more than one method should be used for volume estimation.

The recoverability of free product from the subsurface environment is dependent upon several factors: The physical and chemical properties of the separate phase petroleum hydrocarbons, the transport properties of the geologic media, and the capabilities of engineered recovery systems. The physical and chemical properties of the petroleum hydrocarbons determine how the free product will primarily exist in the subsurface; whether as a vapor, a liquid, or dissolved in groundwater. These properties also affect how fast the free product will move and where in relation to the water table it will accumulate. Properties of the geologic media influence the rate and direction in which the free product will move. Engineered systems are designed for use within discrete operating ranges, and no one recovery system will be optimally suited for all hydrocarbon release sites. It is also important to realize that only a portion of the total volume of the release will be recoverable. Even under ideal conditions a significant proportion of the free product will remain in the subsurface as immobile residue.

Finally, the rate at which free product can be collected in wells or trenches will influence decisions on the types and number of wells, the type of collection equipment used, and the sizing of the treatment system and/or separators. Recovery rates can be estimated from the results of specialized pumping tests, the projection of initial recovery rates, and the use of theoretical models. As recovery progresses product thicknesses and saturation levels decrease, which affects recovery rates. Other factors, such as fluctuating water table elevations, can also affect recovery rates. As a result, the uncertainty associated with estimates of long-term recovery rates is high.

The relevant properties of petroleum hydrocarbons and geologic media that govern the behavior of free product in the subsurface have been discussed in detail in Chapter III. Engineered free product recovery systems are described in Chapter V. The remainder of this chapter presents methods for: delineating the areal and vertical extent of free product, estimating the volume of free product at a release site, and estimating free product recovery rates. Theoretical models used to estimate hydrocarbon volumes and recoverability are discussed only briefly.

Areal And Vertical Extent Of Free Product

The areal and vertical extent of free product must be delineated before a free product recovery system can be designed. First, the areal extent is defined by determining the free product thicknesses at available observation points. Second, using these data an isopach (thickness contour) map is developed. Locations where free product thicknesses are greatest are usually the best locations for installation of free product recovery equipment. There are several common methods used to identify locations and thicknesses of free product in the subsurface. Used either alone or in combination with one another, these methods include:

- Observation/measurement of free product in excavations or test pits.

- Observation/measurement or analysis of hydrocarbons in soil samples collected from borings.
- In situ measurements using a variety of geophysical and direct push techniques.
- Measurement of hydrocarbon thicknesses in wells.
- Observations of hydrocarbon seepage in springs or surface water bodies.

At a given site, not all the above methods may be applicable or cost effective, and they each have limitations. Excavations may provide information about free product thickness through measurement of either the thickness of floating product or the thickness of hydrocarbon-saturated soil. In either case, such measurements may not be indicative of the true free product thickness in the soil. For example, the water level in the excavation may not be representative of the ambient water table elevation. Measurements of the thickness of saturated soil should be conducted immediately after the excavation has been dug so that the soil does not have time to drain. Excavations are also generally limited to depths of 20 feet or less.

The process of collecting soil samples results in some degree of disturbance of the sample. For instance, the degree of compaction (which may affect saturation) can change especially if the samples are collected with a split-spoon sampler. The sample collection location relative to the water table and capillary fringe can also affect the degree of saturation and subsequent determination of free product thickness. Various *in situ* methods may be employed to overcome the problems associated with disturbed samples. However, some of the *in situ* methods are geophysical techniques that collect indirect data; that is the response of subsurface materials to an induced stress (*e.g.*, friction) or energy (*e.g.*, electricity, radiation) is measured and the resulting signal is correlated with a particular soil type or characteristic. Their applicability depends to a large degree upon site-specific conditions. The resolution of surface techniques generally diminishes with increasing depth. Borehole techniques require pre-existing wells or boreholes. Direct push techniques enable continuous subsurface data to be collected as well as provide the opportunity to collect samples of both soil and groundwater. The “Soil Borings” section of this chapter provides a limited discussion of direct push methods; a detailed discussion is beyond the scope of this manual. For additional information, please refer to OUST’s soon-to-be published manual on Expedited Site Assessment Methods and Equipment for Underground Storage Tank Sites, which is anticipated to be available in the late fall of 1996.

Although the thickness of a layer of free product in a monitor well can be measured with high accuracy and precision, the measured thickness is usually larger (sometimes by a factor of as much as 4) than the thickness that exists in the surrounding soil. The reasons behind the limitations of monitor wells in providing accurate information on the thickness of free product in the soil are discussed in greater detail later in this chapter.

In most instances where free product appears in a spring or surface water body, its presence is indicated only as a mulit-colored sheen. Rarely is it possible to measure either the thickness of the free product or the rate of flow. However, its presence may provide insight into migration pathways, which can aide in the design of the free product recovery system.

In developing an approach to free product delineation, consideration of each method should lead to the optimal strategy in terms of cost, time, and impact to existing operations at the site. Exhibit IV-1 provides a summary of the features of each of the above methods.

Strategy For Delineation Of Free Product

The strategy for delineating the extent of free product should involve the following steps:

- Estimate duration and volume of release.
- Evaluate potential to reach water table.
- Select methods for identifying locations of free product (*e.g.*, excavation, soil borings, *in situ* techniques, seepage observations, wells).
- Evaluate probable direction of groundwater flow and free product migration.
- Collect samples, make observations, and install wells/well points, moving outward until areal extent is delineated.

Estimation of the duration and volume of a release is initially based on review of inventory and other records in addition to interviews with site personnel. This information may not be credible or available for many sites.

Exhibit IV-1

Features of Methods for Delineating Extent of Free Product

Method of Data Collection	Data Analysis Method	Data Quality & Reproducibility	Correlation to Actual Free Product Thickness	Maximum Practical Depth	Minimum Free Product Thickness
Free Product Thickness in Excavations	direct measurement/ observation	highly variable, but generally low	poor-fair, qualitative (present or absent, much or little)	shallow, less than 20 feet	sheen
Soil Samples					
Chemical Analysis (lab or field methods)	indirect measurement	generally high quality, good reproducibility	good, quantitative	limited only by sample collection method	1 % of saturation of sample; depends on soil type
Direct Observation	direct measurement	highly variable	variable, depends on soil type	limited only by sample collection method	0.01 feet
In Situ Measurement					
Surface Geophysical	indirect measurement	highly variable, depends on method and conditions	variable	up to 100 feet	min. detectable thickness increases with depth
Borehole Geophysical & Direct Push	direct or indirect measurement (depends on method)	generally high, depends on method and conditions	good, quantitative	limited only by the depth of the boring	typically less than 1 foot
Free Product Thickness in Wells	direct measurement	high, very reproducible	poor, qualitative (requires extrapolation)	limited only by depth of well	0.01 feet
Seepage in springs and surface waters	direct measurement/ observation	low	poor, qualitative (present or absent, much or little)	not applicable	sheen

Initial remedial activities often provide direct observations of the depth to water and the presence (or absence) of free product at the water table. Knowledge of the depth to water table is useful in selecting the method of defining the locations of free product. For example, in areas with very shallow water tables (less than 8 feet), test pits excavated by backhoe may be the most cost effective approach to determining the extent of free product. If the geologic materials are coarse-grained sands or gravels, the test pits may also be used as temporary free product recovery trenches.

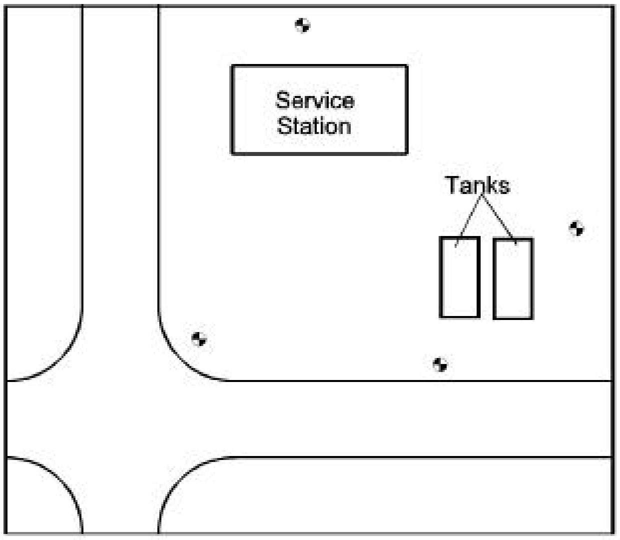
Indirect techniques to identify probable areas of free product may also be useful in focusing the free product investigation. However, these methods (*e.g.*, soil gas surveys, surface geophysical surveys) can be expensive, and the results can be difficult to equate with free product presence. One technique that holds some promise is soil gas monitoring for H_2S, which is associated with anaerobic conditions that may occur with the degradation of free or residual product in the soil (Robbins *et al.*, 1995).

The location of sampling or observation points should be focused in areas in the direction (*i.e.*, downgradient) that groundwater and free product are flowing. This direction may be inferred from the topography and location of surface water bodies (*e.g.*, streams, ponds). In shallow water table aquifers unaffected by pumping, the water table tends to be a subdued reflection of the topography (*i.e.*, groundwater flows from topographically high areas to topographically low areas). This general principle is useful in locating wells to define the direction of groundwater flow. Either traditional wells or well points may be used as locations to measure groundwater elevations. Well points, which are generally less expensive than traditional monitoring wells, can be installed with direct-push equipment during the initial site assessment phase. A minimum of three observation points (well points and/or wells) is required to define the groundwater flow direction. In addition, it is generally recommended that an additional observation point be installed upgradient of the suspected release area. These points must not all be located in the same line. If three points are used, they should be situated in an array that is approximately an equilateral triangle. If four (or more) points are used, they should be arranged in an approximately rectangular array as indicated in Exhibit IV-2. In all cases, whether monitoring wells or well points are installed, the well head or top of casing should be surveyed to establish the elevation.

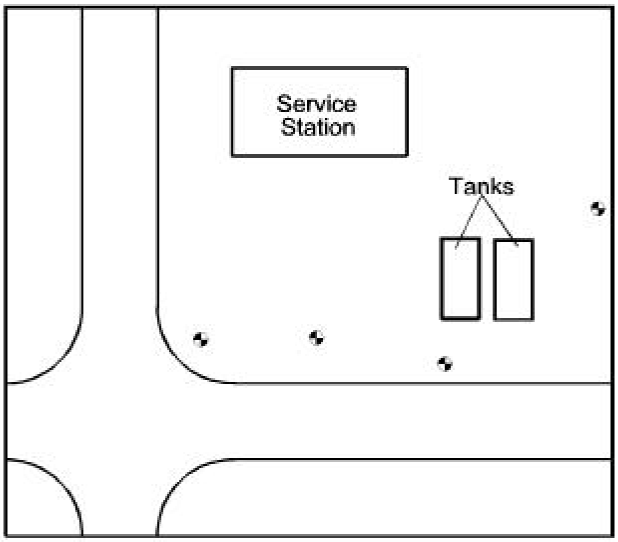
With the groundwater flow direction reliably established, additional sampling points, observation points, or wells/well points can be sited. Well installation and sampling activities generally proceed outward and downgradient from the source area. The areal extent of the plume is adequately delineated when

Exhibit IV-2

Sample Locations Of Wells/Well Points For Determining Groundwater Flow Direction



(a) Good spread, sensitive to any flow direction



(b) Poor spread, not sensitive to gradient or flow in SE-NW direction

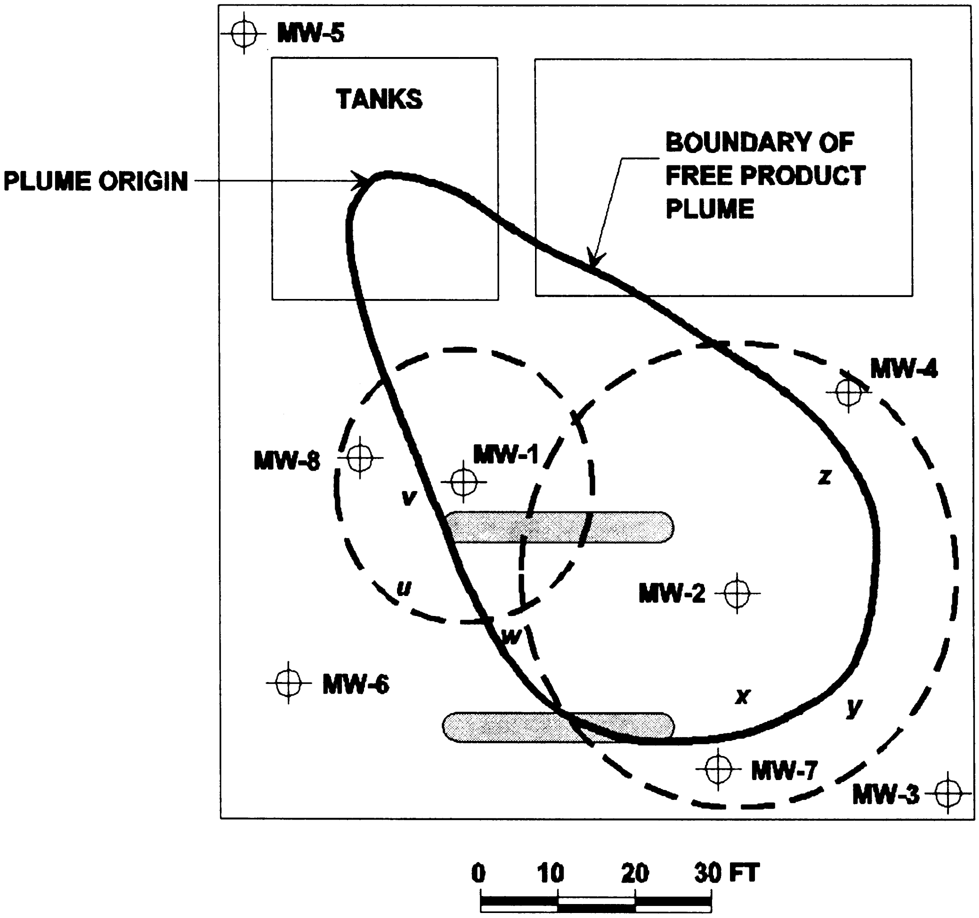
the plume is encircled by a number of observation points (and/or wells/well points) that do not indicate the presence of free product (*i.e.*, no free product is present in the well). The precision of the areal definition of the free product plume depends upon the number of observation points and distances separating the observation points both inside and outside the boundary of the plume. Although the precise number of observation points must be determined on a site-by-site basis, a sufficient number of observation points should be installed to ensure that no part of the plume is migrating in an unexpected direction. It is also important to realize how soil permeability and retention capacity affect the thickness and extent of the free product plume. For a given volume of free product released into a permeable soil (*e.g.*, sand, gravel), the plume will tend to be flat and relatively broad in extent. The same volume of free product if released into less permeable soil (*e.g*, silt, very fine sand), will form a thicker plume (especially near the point of release) and the spread will not be as broad. The decrease in plume thickness near the plume boundary is more rapid in tight formations than in permeable formations. The consequence of this is that in tight formations the distance separating inside and outside wells should be less than in permeable formations or the extent of the free product plume is likely to be overestimated.

By its nature, plume delineation is largely a trial-and-error process; the location of each additional observation point is selected based on results of the preceding ones. Because it is not practicable to install an infinite number of observation points, there needs to be a logical and systematic method which can improve plume delineation. First, we will make the assumption that the plume boundary is located half-way between two suitably positioned—one inside the plume and one outside the plume—observation points. For regular-shaped plumes (*e.g.*, circular or elliptical) the accuracy of the delineated plume area will be about ± 40 percent of the actual area. Second, we will introduce a few guidelines for suitably positioning observation points.

The well locations depicted in Exhibit IV-3 are intended to illustrate key points of the following discussion; they are not intended to be interpreted as examples of "ideal" well placement. In general, observation points that are situated within the plume boundaries can be considered to be either interior (*e.g.*, MW-2) or perimeter (*e.g.*, MW-1). For perimeter observation points, the distance between observation points located inside and outside of the free product plume should be less than 40 percent of the distance from the inside observation point to the plume origin. For example, the dashed circle around MW-1 has a radius of 16 feet, which is 40 percent of the distance (40 feet) from MW-1 to the plume origin. Well MW-8 is located within this radius and the mid-point between the two wells (marked as point "v") is relatively close to the actual plume boundary. Error in the estimated boundary increases with distance beyond this radius. For example,

Exhibit IV-3

Placement Of Observation Points For Delineation Of Free Product Plume



well MW-6 is considerably outside the 16 foot radius and the midpoint (point “u”) significantly overestimates the plume boundary. For interior observation points, these conditions are reversed. Well MW-2 is an internal observation point, which lies 70 feet from the plume origin. The dashed circle around MW-2 has a radius of 28 feet (40 percent of 70 feet). Note that wells either on this radius (MW-4) or inside (MW-7), result in an underestimation of the plume boundary (points “x” and “z”, respectively). The midpoint (point “y”) between wells MW-1 and MW-3 (just slightly outside the 28 foot radius) is reasonably close to the actual plume boundary. If the observation point is too far outside the radius, then the extent of the plume will be overestimated. For both interior and perimeter wells, interpolation accuracy is improved if a straight line between the two observation points intersects the plume boundary at a right angle. Significant deviation from 90° results in increasing error in estimation of the plume boundary. As may be expected, there are exceptions to these guidelines. For instance, the midpoint (point “w”) between MW-2 and MW-6 is reasonably close to the actual plume boundary despite the fact that a line drawn between the two wells intersects the boundary at an angle significantly different from 90°. In spite of the uncertainty in this process, a line beginning at the plume origin drawn so that it connects points v-w-x-y-z and returning to the origin is a reasonable approximation of the actual plume boundary. The approximation could be improved by adding additional observation points to fill in the gaps: Near point “w”, between MW-3 and MW-4, and between MW-1 and MW-4.

Exhibit IV-4 shows alternative observation point spacing for free product plumes of various sizes and shapes. In reviewing a free product recovery plan, the adequacy of the delineation of the free product plume is one of the first technical factors to be checked. If the extent of the plume is not defined in all directions from the source area (plume origin), then more site characterization is required. This deficiency frequently occurs when the free product plume is not defined beyond the site property boundary.

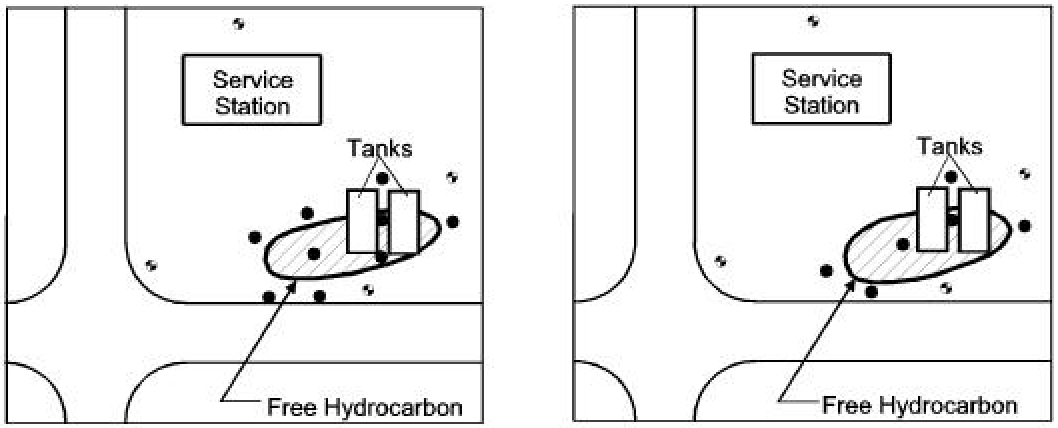
Excavations And Test Pits

Excavation of tanks or pipelines is commonly performed soon after a hydrocarbon release has been confirmed or suspected. These excavations provide for direct observation of the areal and vertical distribution of hydrocarbons. Such observations, if noted and located on a sketch map, can be used to partially identify the extent of free product. However, where the water table is below the maximum depth of the excavation equipment, the extent of lateral spreading at the water table won’t be defined.

For those sites where the water table is very shallow (*i.e.*, less than 8 feet), excavation of test pits can be a quick and cost effective approach to delineating

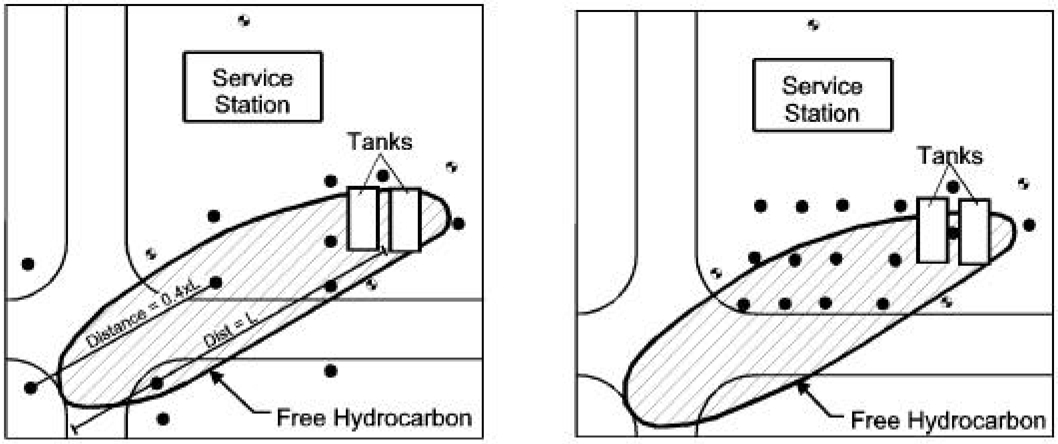
Exhibit IV-4

Delineation Of Free Hydrocarbon Plume Extent Using Soil Borings Or Probes And Monitoring Wells



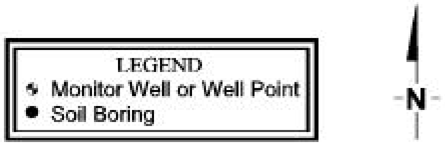
(a) Small plume, well defined in all directions, distance between soil borings about 20 feet

(b) Small plume, not delineated in NW direction



(c) Large plume, defined in all directions, with borings spread at reasonable locations

(d) Large plume, not delineated offsite-unacceptable



the extent of free product. Direct observations of the geologic media and potential preferential permeable pathways or barriers can also be obtained from test pits. The practicality of using of test pits diminishes with depth. Entry into test pits greater than 4 feet requires shoring, a trench box, or sloping of the sides of the excavation to protect workers from cave-in. Such measures although necessary, can be expensive and time consuming to construct or install. In some cases observations can be made from the surface without actually entering the excavation, but visual inspection of deep test pits from the surface is more difficult and less reliable than in shallow test pits. Also, excavated materials, if contaminated, will have to be handled appropriately (*e.g.*, treatment/disposal) which can add to the expense of the investigation.

Soil Borings

The three-dimensional distribution of liquid hydrocarbons can best be determined through a systematic program of soil sampling and free product thickness measurements. These observations may be collected through the use of traditional soil boring and sampling equipment or direct push (DP) technologies. Traditional soil boring techniques include augers (both drill rig-operated hollow-stem and solid stem as well as hand augers) and other rotary drilling methods. Core samples collected by auger rigs are typically obtained using split-spoons and shelby tubes. Direct push technologies, which are also known as “direct drive” and “soil probe” technologies, also include cone penetrometer (CPT) and relatively simple, mechanically assisted push samplers (*e.g.*, impact hammers, hydraulic presses).

DP systems drive, push, and/or vibrate small-diameter steel rods into the ground. These rods may be fitted with specialized tools to collect subsurface samples and data either continuously or over discrete intervals. A wide variety of sampling tools is available for collecting samples of solids (soil), liquids (free product and groundwater) and gas (soil vapor). CPT cones are specially designed to collect continuous lithologic data as the tools are pushed at a constant rate into the subsurface. The presence of free product can be detected using laser induced fluorescence (LIF) technology or other *in situ* analytical screening methods.

DP technologies are generally suitable to depths of up to 100 feet under ideal conditions (*i.e.*, unconsolidated soils free of coarse gravels and cobbles), but at most sites the depth range is between 20 and 60 feet. Deeper penetration typically requires rotary (air or mud) drilling methods.   Manual techniques are generally only practical to depths between 0 and 15 feet. None of the DP technologies is applicable for sites overlying bedrock, large cobbles or boulders, or cemented sedimentary rock. Under such circumstances, even augers may not be suitable, in which case rotary drilling/coring techniques may be required.

Direct push techniques offer the following advantages relative to standard soil boring methods:

- Ability to collect samples rapidly and obtain a large number of samples.
- Capability to collect samples of soil, liquid, and gas.
- Little or no generation of soil cuttings.
- Deployment vehicles are more mobile and require less overhead clearance than drill rigs.
- Lower cost per sample in most settings.

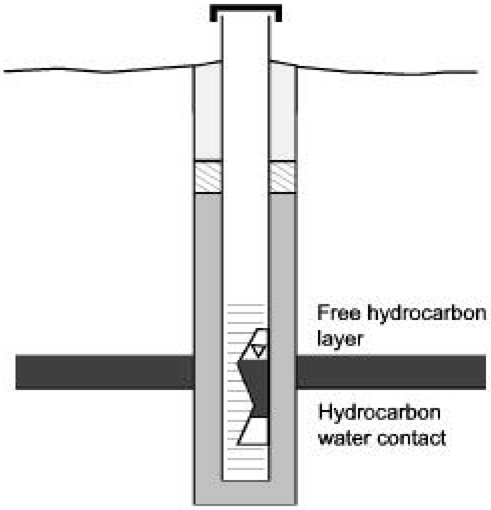
At sites where the use of DP technologies is appropriate, characterization of the subsurface can be more comprehensive than is typically achieved using traditional methods. Where free product recovery (or other remedial alternatives) is required, a more efficient and cost-effective system can be designed for sites that are better characterized. The additional expense of a site characterization conducted using DP technologies can be recovered (possibly many times over) in savings achieved during the remediation phase. However, because the size of the DP borehole is small, installation of free product recovery wells usually must be accomplished with traditional drilling rigs.

Monitor Wells

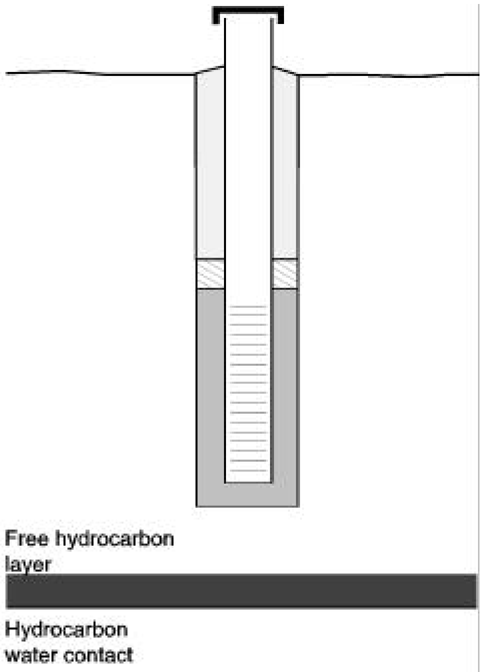
Properly installed and constructed monitor wells can be used both to delineate the extent of free product and monitor temporal changes in free product accumulations. However, it is also important to realize that monitor wells are subject to significant limitations in their ability to provide accurate measurements of the thickness of free product in the surrounding soil. Free product can accumulate in a well only if the well is open (*i.e.*, screened) across the zone of free product (Exhibit IV-5a). A well screened above the water table will generally be dry (Exhibit IV-5b). A well screened below the zone of free product will collect water but no free product (Exhibit IV-5c). Within a well with a properly positioned screen, the thickness of free product typically fluctuates in response to changes in water table elevation. With each rise (or fall) in water table elevation, the measured thickness of free product also changes, resulting in a different calculation of “actual” thickness in the soil (Durnford, *et al.*, 1991). Where a free product recovery plan relies on wells for free product delineation, the reviewer should check the construction diagram of each well and verify that the open (screened) interval of each well straddles the water table. Where wells are initially installed with short screens (*i.e.*, 5 feet or less), changes in the water table

Exhibit IV-5

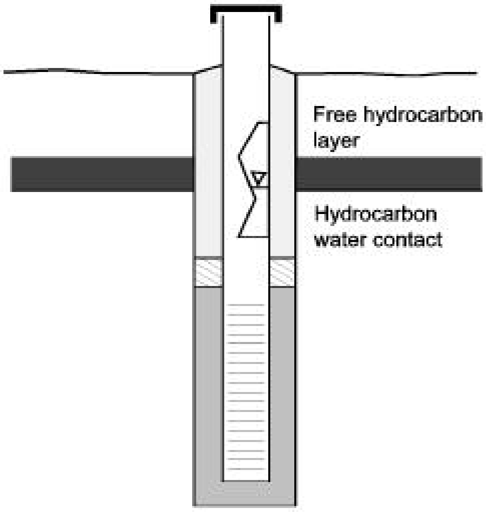
Monitoring Well Installations And Their Ability To Detect Free Product



(a) Properly installed well for monitoring free product accumulation



(b) Well is dry



(c) Well contains only water

Source: API, 1996. A Guide to the Assessment and Remediation of Petroleum Releases, 3rd edition. API Publication 1628, Washington, DC. Reprinted courtesy of the American Petroleum Institute.

elevation may result in a dry well (declining water table) or in a well that is screened below the zone of free product (rising water table). Even in properly constructed wells, the absence of free product may not necessarily indicate that petroleum hydrocarbons (including free product and residual and trapped fractions) are not present in the soil. Similarly to the observation that water may take days or weeks to enter some monitor wells constructed in clayey soil, free product may not initially appear in monitor wells. Such a condition indicates that the relative permeability with respect to free product is very low, hence the mobility of the free product is also low. This may also result in a lower calculated volume of free product.

Monitor wells may be installed by any of several methods. (See Driscol, 1986, and Aller *et al.,* 1989, for detailed descriptions of modern well drilling methods.) For unconsolidated media, hollow-stem augers are used most commonly. The well casing and screen are inserted through the opening in the auger. Depending on the stability of the well bore, the sand pack, sealing, and grout can be placed as the augers are retracted or after the augers have been removed. After the monitor well has been constructed, it should be developed by surging or pumping until water is free of turbidity. The development of new wells in very fine grained materials may not be practical because of its slow recharge rate. For a well with a slow recharge rate, development involves dewatering the well and allowing it to recover for one or more cycles. The development of the monitor well will tend to pull in free product and overcome capillary barriers as a result of the smearing of fine-grained material on the well bore. Without adequate development, free product may accumulate very slowly in the monitor wells (over a period of months). In these cases, initial estimates of the extent of free product may be understated. Product may also enter slowly, or not at all, if the wrong sized sand (filter) pack has been installed. The sand (filter) pack must be four to six times coarser than the aquifer material (Hampton and Heuvelhorst, 1990). The rate of product entry and recovery in wells can be improved by using hydrophobic filter packs (Hampton, 1993).

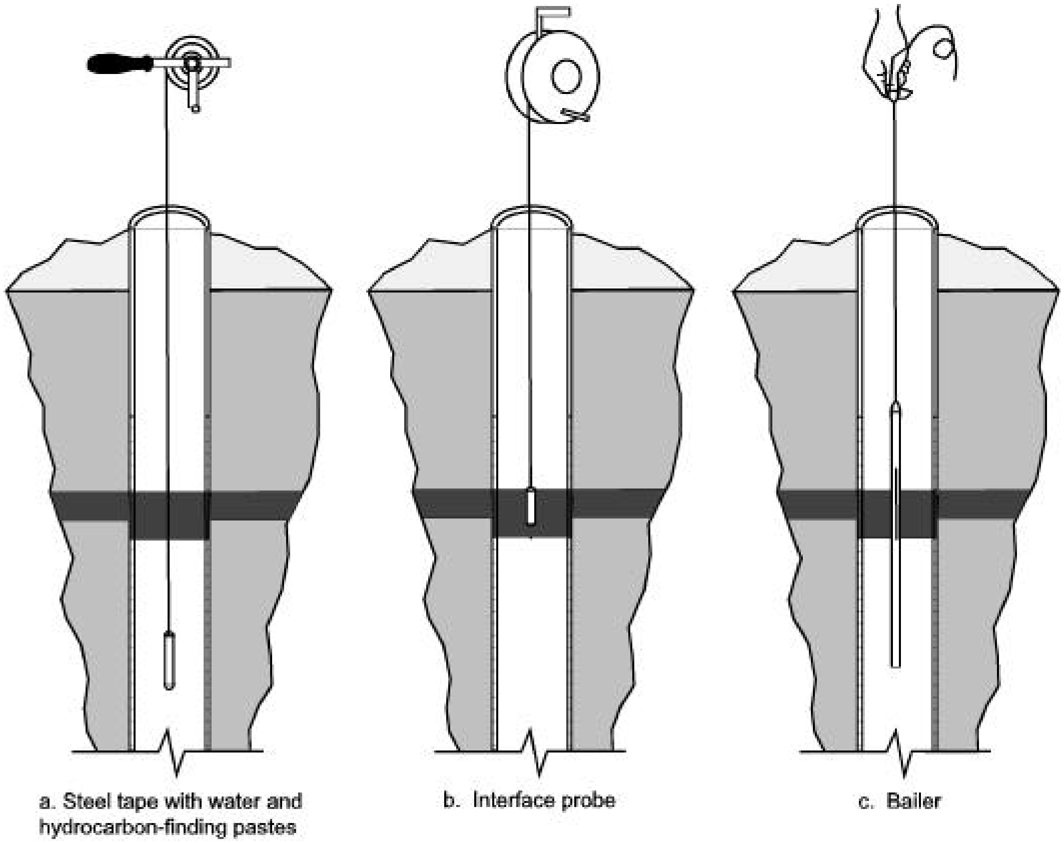
The presence of free product at a well is indicated by the accumulation of a measurable thickness of hydrocarbons in it. Three following methods (see Exhibit IV-6) are commonly used to measure free product thickness in a well:

- Steel tape and paste
- Interface probe, and
- Bailer.

The pastes used with the steel tape are sensitive to hydrocarbons and water. Commercially available interface probes sense the presence of both oil and water. The first two methods are accurate to within about 0.01 foot and are

Exhibit IV-6

Methods For Measuring Accumulations Of Free Liquid Hydrocarbons In A Well



a. Steel tape with water and hydrocarbon-finding pastes

b. Interface probe

c. Bailer

Source: API, 1996. A Guide to the Assessment and Remediation of Petroleum Releases, 3rd edition. API Publication 1628, Washington, DC. Reprinted courtesy of the American Petroleum Institute.

convenient for determining the elevation of the air/free product and oil/water interfaces. Whenever possible measurements should be taken using either steel tape and paste or an interface probe. A bailer is a transparent cylinder with a check valve at its base. The bailer method can significantly under- or over-estimate the thickness of free product in the well and should not be used for determining the elevations of air/free product and free product/water interfaces. Disposable bailers, which are commonly dedicated to monitoring wells containing free product, typically collect an unrealistically small product thickness because of the small size of the intake holes. The use of bailers should be limited to verification of the presence of free product in a well or collection of a sample of it. Bailers can be used to remove liquids from monitoring wells during bail-down tests that are designed to determine the rate of free product recovery into wells.

Volume Estimation

Knowledge of the volume of hydrocarbons in the subsurface is useful for evaluating the performance of a free product recovery system in terms of both total volume recovered and time required for recovery. In some instances the original release volume may be unknown but can be estimated by calculating the volume of free product present in the subsurface. Several methods can be used to estimate hydrocarbon volumes. These include:

! Compilation of historical information on release events and from inventory records.

! Soil sampling and analysis for total petroleum hydrocarbons.

! Correlation of the thickness of free product measured in monitoring wells to total volume of free product.

! Evaluation and projection (extrapolation) of free product recovery data.

The first two approaches yield estimates of total hydrocarbons--residual and free--present in the subsurface. The last two methods--product thickness measured in monitor wells and recovery data--provide estimates of the volume of free product. None of these four methods are entirely precise in most settings because of limited and uncertain data. Even where substantial data are available and several estimation methods used, volume estimates with an uncertainty of minus 50 percent to plus 100 percent are the best that can be expected.

Exhibit IV-7 presents a brief summary of the salient points of each of these four methods.

The relative mass present as free and residual liquid hydrocarbons is large compared to the mass of dissolved or vapor phase hydrocarbons in most subsurface settings. Residual hydrocarbons may represent as much as 50 to 80 percent of the total volume that was originally released. Recoverable free product typically represents 20 to 50 percent of the total. The ratio of free product to residual liquid hydrocarbons tends to decrease with time as plume migration and other processes occur that trap free hydrocarbons (*e.g.*, rising or falling water table). The relative permeability (and mobility) of the free product decreases as more of the free product is recovered and the level of liquid hydrocarbon saturation decreases. When the saturation approaches the residual saturation of the geologic medium, free product will stop flowing readily into monitor/recovery wells. At this point, the recovery well or recovery system should be switched to operate intermittently or possibly turned off altogether. Small quantities of liquid hydrocarbons may continue to slowly drain into wells, but the rates of drainage are usually not sufficient to justify continuous operation of the recovery system.

Volume Estimates Based On Release History

Historical records of release events and hydrocarbon inventories can be used to estimate the total amount of hydrocarbons lost. When accurate inventory or release data are available, the amount lost is likely to be greater than the amount in the subsurface as a result of volatilization and biodegradation. The reliability of historical data ranges widely, but generally, the older the information, the less reliable it is. Furthermore, historical data generally cannot be used to characterize phase distribution in the subsurface.

Even though volume estimates based on release and inventory data may have limited reliability, these estimates are useful in at least two important ways. First, the volume estimate based on historical data can be compared with volume estimates obtained with other approaches to provide a check on the other methods. Second, historical information on when releases began can provide a basis for initial estimates of the extent of free product migration that can be used to assist in locating sampling points and wells for site characterization.

Exhibit IV-7
Methods For Volume Estimation

Method	**Approach & Results**	**Advantages**	**Disadvantages**
Release History	Review inventory records to determine volume(s) and date(s) of release(s).	Relatively simple and statistically accurate if accurate historical data are available.	Data rarely accurate given numerous potential error sources (*e.g.*, measurement technique, volume changes due to temperature)
TPH Concentration in Soil Samples[1]	Convert TPH concentrations in soil samples to saturations and integrate these values over the area of contamination.	Data are relatively easy to collect; several methods are available for data integration.	Calculations required are relatively complicated; requires a lot of data to reduce uncertainty associated with calculated volume; results may differ among various methods for data integration; TPH analysis may not be representative of actual petroleum hydrocarbon saturations.
Product Thickness in Wells	Measure the thickness of the accumulated layer of free product in all monitoring wells.	Free product thickness measurements in monitor wells are routinely collected on a regular basis; the thickness of the free product layer in the monitor well can be measured quite accurately; several methods are available for data analysis.	Product thickness in wells usually exaggerates the thickness in the aquifer--this effect is more pronounced in finer-grained geologic materials; none of the methods that correlate product thicknesses measured in wells to actual product thickness in the soil are reliable either in the field or in the laboratory.
Extrapolation of Recovery Data	Sum the cumulative product recovery volume and an estimate of the residual volume.	Recovery data are routinely collected.	Works best during later stages of recovery; many factors can bias recovery (*e.g.*, smearing); requires two types of data.

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[1] The U.S. Air Force is currently working on an alternative method of using TPH values based on examination of TPH fractions. EPA will release information on this process after peer review has been completed.

Volume Estimates Based On Soil Samples

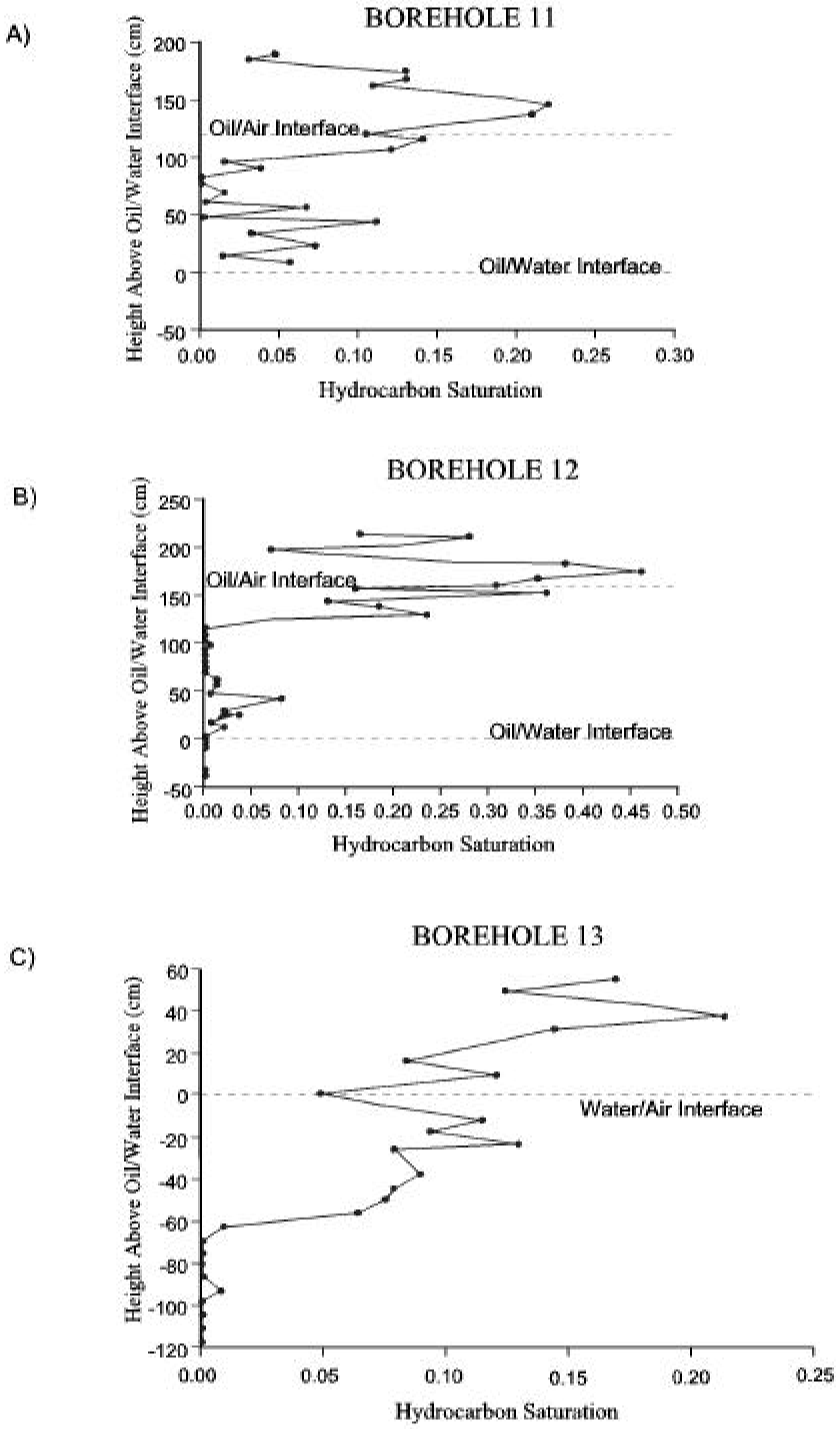
Estimation of the volume of free product in the subsurface based on soil sample data first requires the collection of soil samples and their subsequent analysis for hydrocarbon content. Hydrocarbon content in soil samples can be measured by a variety of standard laboratory methods. These methods include solvent extraction, solvent extraction with distillation, and centrifuging (Cohen and Mercer, 1993; Cohen *et al.*, 1992). The total petroleum hydrocarbons (TPH) analysis commonly used in site assessments is based on solvent extraction. For sites where sufficient TPH data are available, volumes of hydrocarbons in the unsaturated and saturated zones can be estimated. One limitation of TPH data is that it does not distinguish between individual petroleum hydrocarbons or between petroleum hydrocarbons and other non-petroleum organic matter that may be present in the soil sample.

The estimation of hydrocarbon volumes based on soil sample data is subject to significant uncertainty because of the sparseness of the data and the often extreme variability in hydrocarbon concentration within the soil. Exhibit IV-8 shows how variable hydrocarbon saturation can be within the same boring and between three different borings at a typical site. The detail shown in Exhibit IV-8 is much greater than that obtained during most site characterization investigations, but even with this amount of detail at one or more boring, there is still tremendous uncertainty about concentrations in the soil between the borings.

The procedure for estimating liquid hydrocarbon volumes from TPH data involves two calculation steps: (Step 1) TPH results are converted to saturation values at each point, and (Step 2) the volume of liquid hydrocarbons is determined by integrating point saturation data over the volume of subsurface where hydrocarbons are present. The conversion calculation (Step 1) is straightforward and is illustrated in Exhibit IV-9. Integration of the total hydrocarbon volume (Step 2) can be accomplished using standard interpolation and integration techniques. As a simple example, TPH (saturation) results are plotted at their collection locations on a site map. Contours of equal saturation are drawn on the map. The area and volume represented by each contour level is then calculated. Integration is merely the summation of the individual volumes. There are a number of more sophisticated techniques, including computer software, but discussion of these is beyond the scope of this manual. It is also important to recognize that interpolation and integration methods yield only approximations of what is actually present in the field and different methods using the same data set can result in volume estimates that range from minus 30 percent to plus 50 percent. In general, as the number of data points increases the error associated with the method decreases.

Exhibit IV-8

Measured Hydrocarbon Saturation Profiles At Three Boreholes Showing Variability Due To Vertical Heterogeneity



Source: From Huntley, et. al., 1992

Exhibit IV-9

Calculation Procedure To Convert TPH Data From Soil Samples To Hydrocarbon Saturations

TPH analysis results for soil samples may be converted to hydrocarbon saturation by the following equation:

$$S_o = TPH \times \frac{(1 - f)\, r_{gr} \times 10^{-6} \frac{kg}{mg}}{f \;\, r_o}$$

where:

S_o = total hydrocarbon saturation (dimensionless)

TPH = total petroleum hydrocarbon concentration in mg/kg

r_{gr} = grain density (typically 2.65 g/cm^3)

f = porosity (dimensionless)

r_o = density of the hydrocarbon, liquid (g/cm^3).

This equation applies to both the unsaturated and saturated zones.

The amount of free hydrocarbon present can be calculated if residual hydrocarbon saturation is known or estimated. Usually residual saturations are not known or measured, but literature values (*e.g.*, Mercer and Cohen, 1990) can be used as estimates. The free hydrocarbon saturation is given by:

$$S_{of} = S_o - S_r$$

where:

S_{of} = free hydrocarbon saturation

S_r = residual hydrocarbon saturation.

Volume Estimates Based On Product Thickness In Wells

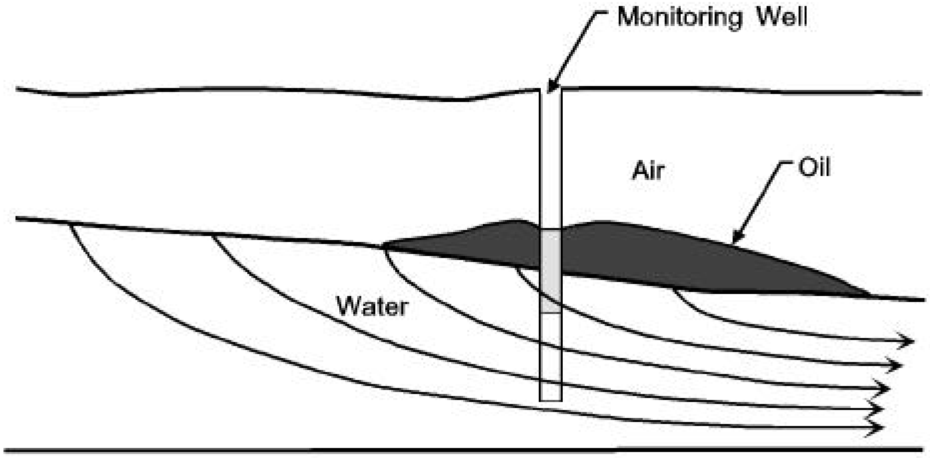
The limitations of monitor wells in providing representative measurements of free product thickness in the adjacent soil are well documented. Fluctuations in the water table can result in large differences in measured hydrocarbon thickness even though the in situ volumes are not significantly changed. Increases in hydrocarbon thickness are commonly observed with declining water tables. API (1989) attributes the thickness increase to drainage from the unsaturated zone. As the water table falls, hydrocarbons previously trapped as a residual phase can become remobilized and enter into wells. Kemblowski and Chiang (1990) relate the changes to preferential fluid flow through the well (Exhibit IV-10).

Many investigators have tried to develop methods to explain how small amounts of mobile hydrocarbons can lead to exaggerated thicknesses of hydrocarbons measured in wells. Hampton and Miller (1988) and Ballestero *et al.*, (1994) provide comprehensive reviews of the methods used to estimate the thickness of free product in the adjacent soil from measurement in monitor wells. A comparison of the predictability of these alternative methods indicates an order of magnitude accuracy of the predicted versus the measured free product thickness among the methods. These investigations can be grouped into two primary approaches: (1) Derivation of empirically-based correlations--typically based on fluid density differences, grainsize of the geologic media, or height of the water capillary fringe, and (2) development of models based on idealized capillary pressure-saturation curves. In spite of the intense attention that has been focused on developing a correlation between free product thickness measured in wells and volume of free product in the soil, none of the available methods has been particularly reliable when tested either in the field (Durnford *et al.*, 1991; Huntley *et al*., 1992; and Ballestero *et al*., 1994) or even in the laboratory (Hampton and Miller, 1988). Durnford *et al*., (1991) summarize the limitations of the methods developed to relate the free product thickness measured in monitor wells to the volume of free product in the soil as follows:

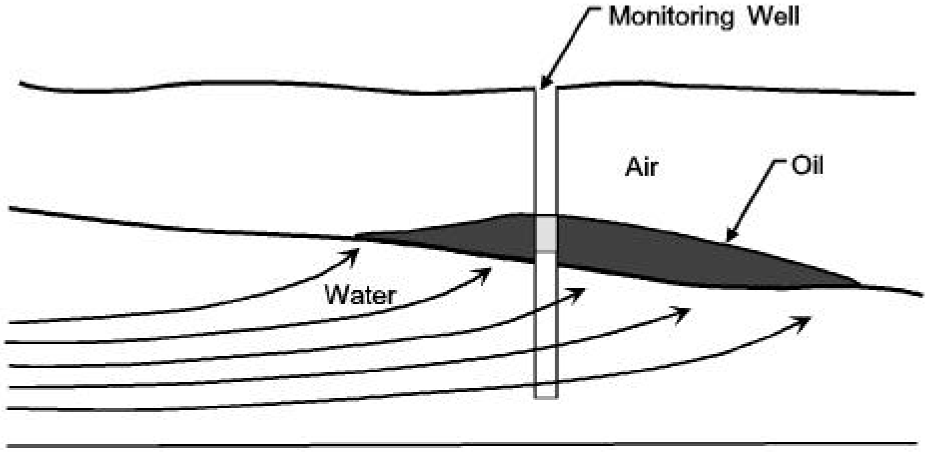
- Free product thicknesses observed in monitoring wells change over time as the water table fluctuates. Each different measured thickness of free product results in a different calculation of free product in the aquifer, even if the actual volume of free product (including residual and trapped) hasn't changed.

Exhibit IV-10

Effects Of Falling Or Rising Water Table On Hydrocarbon Thicknesses Measured In Wells



(a) Hydrocarbon thickness increase for falling water table



(b) Hydrocarbon thickness decrease for rising water table

Source: Kemblowski and Chiang, 1990

- None of the estimation methods accounts for residual and trapped petroleum hydrocarbons--a portion of these fractions can be returned to the free product fraction as the water table moves up or down.

- Methods that are based on measurement of soil and fluid properties require measurements (*e.g*., curves of capillary pressure vs water saturation) that are difficult to obtain in the field, and laboratory-derived measurements may not accurately represent field conditions.

- None of the methods account for spatial variability (heterogeneity) of aquifer parameters. The movement of free product is strongly dependent upon aquifer heterogeneities, which are rarely represented adequately by "average" properties.

Despite the drawbacks with these volume estimation methods, they are frequently used in practice. To illustrate how some of these methods are used, we present a comparison of seven methods reported in Ballestero *et al*., (1994). The seven different approaches can be grouped into the following four categories:

- Correlation based on the density of the liquid hydrocarbon (de Pastrovich *et al.*, 1979);

- Correlation based on properties of the geologic medium (Hall, *et al.*, 1984);

- Correlation based on the height of the water capillary fringe (Blake and Hall, 1984; Ballestero *et al*., 1994; and Schiegg, 1985); and

- Models based on idealized capillary pressure relationships for homogeneous porous media (Farr *et al.*, 1990; and Lenhard and Parker, 1990).

Exhibit IV-11 summarizes the results of calculations for each of the different methods listed above using data from laboratory experiments reported by Abdul *et al*., (1989), with additional parameter values acquired (where

Exhibit IV-11

Comparison Of Seven Alternative Methods For Correlation Of Product Thickness Measured In A Monitor Well To Actual Thickness In The Soil

Calculated Results (Hydrocarbon Thickness in Soil)

Measured hydrocarbon thickness in the soil (cm)	**de Pastrovich *et al*. (1979)**	**Hall *et al*. (1988)**	**Blake and Hall (1984)**	**Ballestero *et al*. (1994)**	**Schiegg (1985)**	**Farr *et al*. (1990)**	**Lenhard and Parker (1990)**
---	1.1	-6.5	-16	-16	-28	2.3	7.1
1	12	50.5	1.1	1.1	29	24.3	74.3
3	13	55.5	4.4	4.4	34	26.2	80.2
7	13.9	60.5	9.7	9.7	39	28.1	86.1
13	16	71.5	13.4	13.4	50	32.4	99.1

Note: All values in centimeters except those for Farr *et al*. (1990) which are volume in cm^3/cm^2.

This comparison is based on a study published by Ballestero *et al*. (1994) using data published in Abdul *et al*. (1989). Additional data required for the methods of Lenhard and Parker (1990) and Farr *et al*. (1990) were obtained from their respective papers. Note that the results presented above are only applicable for the data specified in this example. The use of different data may alter the relative performance of the methods. Refer to the Appendix for a more complete presentation of the individual equations used in this comparison.

necessary) from the individual papers. A more complete presentation (including the equations, variable descriptions, input data and discussion of the salient features) is included in the Appendix. It is important to realize that the relative performance of these methods is dependent upon the specific experimental conditions. Given another set of data obtained from a different experiment using different soil (with different grainsize, porosity, and residual saturation) and different liquid hydrocarbon, the relative performance may be radically different. To reiterate from the opening paragraph in this section, none of the available methods has been particularly reliable when tested in either the field or the laboratory. For any given site, it is probably not likely that the method that will ultimately yield the closest match to conditions in the field can be chosen *a priori*. However this is not to say that there is no point in using these methods to estimate free product volumes. On the contrary, free product thickness data collected from monitor wells is typically plentiful, easily collected, and is usually accurate. In many instances these data may be all that are available. What is most important is to not rely too heavily on one method over another. The best approach is to use more than one method so that a probable range of volumes can be calculated.

Volume Estimates Based On Extrapolation Of Free Product Recovery Data

The difference between the volume of free product released and the volume recovered equals the volume remaining in the subsurface. Often the volume of the release is not known, but in theory it can be determined if the volume of free product that has been (or is anticipated to be) recovered and the volume remaining (or is anticipated to remain) in the subsurface is known. Knowledge of any of these three volumes is associated with a degree of uncertainty, and it is usually not possible to quantify the error associated with estimates of these volumes. Many factors contribute to this uncertainty. Some of the components of the types of petroleum hydrocarbons typically stored in USTs are volatile and/or soluble, and are therefore not likely to be measured as residual hydrocarbons. Biodegradation may further decrease the amount of hydrocarbons present in the subsurface. As was discussed previously, hydrocarbon saturations in soil borings are highly variable in both the vertical and horizontal directions. Samples with anomalously high or low saturations can bias estimates of total residual hydrocarbons remaining in the subsurface. Also, it is important to recognize that the rate of free product recovery typically exhibits a logarithmic decrease with time. The rate of decrease can be quite variable even on the same site due to heterogeneities in the soil which influence residual saturation and relative permeability. The estimate of product remaining in the subsurface as either free or residual changes constantly with time as recovery progresses. Despite these limitations, this method may offer the best (or only) means for estimating volumes at a particular site. Although this method works best late in the recovery phase (after the cumulative recovery curve levels off), it can be used at any time with the understanding that volume estimates based on early recovery data will be associated with a higher degree of uncertainty. Methods to estimate free product recovery rates are presented in the following sections.

Estimation Of Recovery Rates

An important design consideration for free product recovery is the rate at which liquid hydrocarbons can be collected by pumping or skimming techniques. The rate of recovery will depend on the design of the recovery system, the type(s) and distribution of free product in the subsurface, and the hydrogeological conditions. Expected recovery rates are used to size the free product storage tanks and oil/water separators, and, to a lesser degree, to select and size recovery equipment and treatment equipment. Not only is it important to estimate the initial recovery rates but also to predict how the recovery rates will change with time after recovery starts. Estimates of recovery rates can be obtained from field tests (*e.g.*, bail down tests, pumping tests) or from multiphase flow analysis. Usually, recovery rates of free product decline after startup because wells and trenches are located in areas where the volumes of free product are highest. In some settings where wells or trenches pull free product from some distance, recovery rates may increase for a significant duration before declining.

Bail Down Test And Pumping Tests

A bail down test involves removing the free product from a well by bailing and measuring the thickness of and depth to free product in the well as it recovers. These tests have been used to estimate free product thickness by some investigators (Hughes *et al.*, 1988; Wagner *et al.*, 1989; and Gruszczenski, 1987) with limited success. These tests can easily provide estimates of initial recovery rates for a skimming type operation (see Exhibit IV-12, Method 1). In order for the results of a bail down test to be applicable, the free product recharge rate should be slow relative to the rate of groundwater recharge. Where free product recharges the well in less than a few minutes, it is difficult to accurately monitor recovery rates (Hampton, 1993).

For systems where free product will be collected by active pumping of groundwater and product, a pumping test can be used to estimate initial free product recovery rates (see Exhibit IV-12, Method 2). Pumping tests (or aquifer tests) are usually performed to determine groundwater flow properties such as hydraulic conductivity and transmissivity. Estimates of free product recovery rates can be obtained by collecting additional data in conjunction with a standard (groundwater) pumping test or by conducting a specialized pumping test or pilot test.

Exhibit IV-12

Sample Calculations For Estimating Initial Free Product Recovery Rates

Method 1. Bail down testing (Applicable to skimming-type recovery systems).

Inside Diameter of Well Screen = 4 inches
Radius = 2 inches
= 0.166 foot

1. Maximum thickness from table. = 1.15 feet

2. 80% x maximum thickness recovery.
   (0.8 x 1.15) = 0.92 foot

3 Time corresponding to 80% of recovery interpolated from table.
   3 hours 24 min = 204 min

4. Compute gallons per foot of oil thickness in well screen.
   π x (well radius in ft)^2 x (conversion factor ingal/ft^3) = gal/ft
   π x (0.166)^2 ft^2 x 7.48 gal/ft^3 = 0.65 gal/ft

5. Compute average recovery rate to 80% recovery.
   0.65 gal/ft x 0.92 ft/204 min = 0.003 gal/min = 4.2 gal/day

Field Data

Recovery Time		Free Product Thickness (ft)
2	min	0.01
4	min	0.03
10	min	0.12
30	min	0.30
1	hour	0.51
2	hours	0.85
4	hours	0.95
8	hours	0.98
24	hours	1.15
48	hours	1.10

Method 2. Constant rate pump test (Applicable to free product recovery with water level depression).

Pumping Rate = 10 gal/min

1. Compute average hydrocarbon recovery rate from table for 24 hours.

   52.1 gal/24 hours = 2.17 gal/hour
   = 0.0361 gal/min

2. Compute

Field Data

Time Since Pumping Started		Cumulative Hydrocarbons Collected
10	min	0.0 gal
20	min	0.3 gal
40	min	0.8 gal
1	hour	2.5 gal
2	hours	5.8 gal
4	hours	14.6 gal
8	hours	23.8 gal
24	hours	52.1 gal

$$\text{Hydrocarbon Recovery Ratio} = \frac{\text{Hydrocarbon Recovery Rate}}{\text{Total Pumping Rate}}$$

$$\frac{0.0361 \text{ gal/min}}{10 \text{ gal/min}} = 0.00361 = 0.361\%$$

A standard pumping test involves pumping groundwater at a constant rate and monitoring changes in groundwater elevations in the pumping and nearby wells during the test. If free product is present in the vicinity of the well, the pumped fluid will contain both free product and groundwater. The ratio of free product recovered to total fluid recovered can be determined at different times during the test by collecting samples of pumped fluid. These samples may show considerable variability, so as many samples as practicable should be collected during the test. Where the ratios of recovered product to total fluid are more than a few percent, simple volume measurements of the separated liquids may be used to determine the recovery ratio (see Exhibit IV-13). Usually the recovery ratio of free product to total fluid is less than a few percent, in which case the ratio may be determined by a standard TPH or oil and grease analytical method.

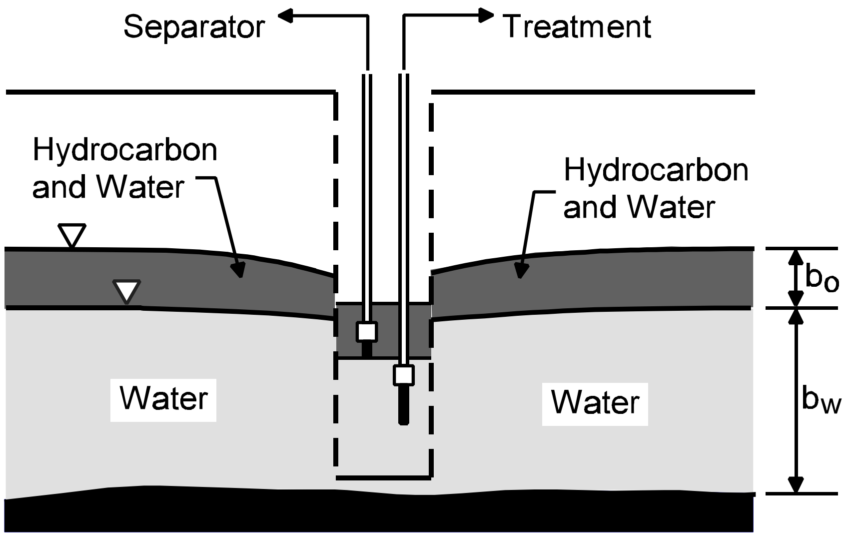
Estimates of free product recovery rates can also be obtained from pilot tests or records of free product pumping that may have been performed as an interim or emergency removal action. Information from pilot tests or prior free product recovery systems provide the best estimates of expected free product recovery rates because the duration and rates of pumping are usually much greater than those of bail down or pump tests.

Multiphase Flow Analysis

The theory of multiphase flow in porous media has been widely used in petroleum reservoir engineering for over 50 years. During the past decade, these same theories have been applied to analysis for environmental applications. Because multiphase flow theory results in complex non-linear partial differential equations, few simple solutions to practical problems are available. One such solution is presented in the preceding section (see Exhibit IV-13). Commonly, the governing equations are solved by a variety of sophisticated numerical techniques using computer models.

Exhibit IV-13

Computational Procedure For Determining Ratio Of Free Product Recovery To Total Fluid Recovered From A Single Recovery Well



Basic Equations:

Mobility of Water $= \dfrac{k\,k_{rw}\,r_w\,g}{m_w}$

Transmissivity of Water, T_w $= \dfrac{b_w\,k\,r_w\,g}{m_w}$

Mobility of Free Product $= \dfrac{k\,k_{ro}\,r_o\,g}{m_o}$

Transmissivity of Free Product, T_o $= \dfrac{b_o\,k\,\overline{k_{ro}}\,r_o\,g}{m_o}$

where:

k is the intrinsic permeability (L^2)
k_{rw} is the relative permeability of water (dimensionless)
k_{ro} is the relative permeability of free product (dimensionless)
$\overline{k_{ro}}$ is the average relative permeability of free product layer (dimensionless)
r_w is the density of water (ML^{-3})

r_o is the density of free product (ML^{-3})
g is the gravitational constant (LT^{-2})
m_w is the viscosity of water ($ML^{-1}T^{-1}$)
m_o is the viscosity of free product ($ML^{-1}T^{-1}$)
b_o is the thickness of free product layer (L)
b_w is the thickness of aquifer below free product layer (L)

Assumed: Water transmissivity of free product layer is negligible

Exhibit IV-13 (continued)

Computational Procedure For Determining Ratio Of Free Product Recovery To Total Fluid Recovered From A Single Recovery Well

General Equation:

$$\text{Ratio} \left(\frac{\text{Free Product Recovery Rate}}{\text{Total Fluid Recovery Rate}} \right) = \frac{Q_o}{Q_o + Q_w} = \frac{T_o}{T_o + T_w}$$

$$= \frac{b_o \overline{k_{ro}}\, r_o / m_o}{b_o \overline{k_{ro}}\, r_o / m_o \quad + \quad b_w r_w / m_o}$$

where:

Q is volumetric flowrate of free product (o) or groundwater (w)

Assumed: Same hydraulic gradients exist in free product layer and groundwater

EXAMPLE:

A 2-foot-thick hydrocarbon layer has an average hydrocarbon saturation of 0.5, a viscosity of 4 centipoise, a density of 0.9 g/cm^3. The average relative permeability for a free product saturation of 0.5 is assumed to be 0.25. The pumping well is screened across the hydrocarbon layer to the base of the aquifer which has a saturated thickness of 20 feet including the hydrocarbon layer.

$$\frac{Q_o}{Q_o + Q_w} = \frac{T_o}{T_o + T_w} = \frac{2\,ft \times 0.25 \times 0.9\,g/ml/4cp}{2\,ft \times 0.25 \times 0.9\,g/ml/4cp \;+\; 18\,ft \times 1g/ml/1cp}$$

$$= \frac{0.1125}{0.1125 + 18} = 0.0062$$

For a total fluid production rate ($Q_o + Q_w$) of 2 gallons per minute, determining free product recovery rate, Q_o.

Q_o = Ratio x ($Q_o + Q_w$) = 0.0062 x 2 gpm = 0.0124 gpm

Calculations Of Initial Free Product To Total Fluid Recovery Ratio. A straightforward calculation based on the relative mobility of free product and water can be used to determine the ratio of free product to total fluid production under pumping conditions in a single well. This procedure is described and illustrated in Exhibit IV-13, which shows that for thin hydrocarbon layers and moderately high viscosities, the recovery of free product will be a small portion of the total fluid production in the well.

Use Of Computer Models. In theory, computer models based on multiphase flow concepts can be used to predict free product recovery rates. Selection of a model for a particular site must be made carefully because all models are not appropriate for all sites. Factors to be considered include; complexity of site geology, availability of input data, and special features of the site (*e.g.*, pumping wells, fluctuating water table). Some of the numerous multiphase flow models that have been developed include:

- Simplified models simulating downward migration of liquid hydrocarbons through the unsaturated zone, radial transport of a hydrocarbon lens in the watertable, and radial migration of hydrocarbons to a recovery well (El-Kadi, 1992; El-Kadi, 1994; Weaver *et al*., 1994; and Charbeneau and Chiang, 1995).
- Complex numerical models (finite-difference and finite-element) of immiscible multiphase flow in porous media in cross-section or three-dimensional (Faust *et al*, 1989; Kaluarachchi and Parker, 1989; Katyal *et al*., 1991).
- Complex numerical models of areal hydrocarbon migration in unconfined aquifers simplified from 3-D to 2-D (Kaluarachchi *et al*., 1990).

Despite the seemingly wide variety of models that are available, in practice the usability of models for reliable prediction of free product recovery rates is limited for a variety of reasons. Many of the models require data that are not measurable in the field (*e.g.*, relative permeability-capillary pressure relations). Mishra *et al*. (1989) present one solution to this problem; they developed a model to estimate relative permeability-capillary pressure relations from grain-size curves, which can be developed relatively easily from soil samples. The problem is that each soil sample would yield a different grain-size curve, and hence, different relative permeability-capillary pressure curves. As even subtle heterogeneities can radically influence the movement of free product in the subsurface, no single curve is likely to be adequate to characterize the entire site. Collection of a sufficiently large number of samples may be prohibitive. Assumptions such as vertical equilibrium and vertical uniformity, which are usually required by the simpler two-dimensional models, are not generally applicable.

More often than not model simulations are very accurate only over the period for which field data are available. Models are calibrated given a set of field data (*e.g.*, water table elevations, volume of product recovered) collected over a specified period of time. Model parameters are then adjusted so that the simulated results as closely as possible match the field data. As more field data are collected, model parameters are adjusted so that the simulation results once again closely match the field data. This process is typically repeated every time additional data are available. Often the final set of model parameters is quite dissimilar from the initial set. If the initial parameters are used over the entire simulation period, then the match is usually best during the early stages and worsens as the simulation progresses. Conversely, if the final parameters are used to simulate the behavior measured in the field, the match is typically poor during the initial stages, but improves as simulation time progresses up to the point in time that the latest data are available. It is reasonable to expect that the simulation results would begin to worsen as the simulation continued to progress into the future.

Appropriate use of models generally requires that they be used by persons experienced in the use of models. As the complexity of the site and the selected model both increase, so must the sophisitication of both the modeler and the computer. Adequately trained modelers command relatively high hourly billing rates. A single simulation using a complex, multi-phase model may take 24 hours or more to run even on today's fastest desk top computers. Often clients are billed for computer time as part of the overall cost for computer modeling. Between the labor rates and the computer usage rates, several simulations of even a small site can result in a large invoice.

Because of limited reliability and expense of use, multiphase computer models are seldom used to estimate recovery rates for a free product recovery plan. For sites with large spills or large volumes of free product in the subsurface, the expense and effort associated with these models may be warranted if it can help significantly reduce the cost of recovery or improve the effectiveness of free product recovery. Where models have been used to design free product recovery systems, the analysis is likely to contain significant uncertainty that should be explicitly addressed in the model description.

Recoverability Of Free Product

Chapter IV has presented several methods for evaluating the volume and recoverability of free product. This section presents a discussion limited to those factors that are most relevant to the recovery of the principal types of petroleum products typically stored in USTs (*i.e.*, gasolines, middle distillates, and heavy fuel oils).

It has been established that the thickness of free product measured in wells usually exceeds the thickness that is present in the surrounding soil. Volume estimates based strictly on measured thickness in wells are erroneous and are often significantly greater than the volume of product that was released. Many methods have been developed to correlate the measured thickness to volume in the soil, but none of the available methods is reliable at all sites. Different methods applied to the same site may yield radically different volume estimates. It is, therefore, important not to rely on the estimate of any single method. Comparison of several estimates may provide a reasonable range for the estimated volume. This range may span an order of magnitude.

The steps involved in estimating the volume of free product in the subsurface include measurements of thicknesses in wells, borings, and excavations; determination of the direction(s) of groundwater flow and free product migration; and estimation of the retention capacity of the soil. Once the probable extent and realistic thicknesses of the free product plume (or pool) have been determined, a variety of techniques are available to calculate the total volume of the release. Under the most favorable conditions, only a fraction of the total release will be recoverable. Recoverable volumes typically range from 20 to 50 percent of the total release. Factors that influence the recoverable percentage include water table fluctuations (which can create a "smear zone"), depth to water table, and soil properties (*e.g.*, heterogeneity, pore size, layering).

The initial rates of product recovery are best estimated from bail down tests and pumping tests. Knowledge of the expected recovery rates are important in sizing components of the treatment process. Often the recovery of product declines significantly from initial rates, especially for wells located where free product volume is highest. Various computer models can, in theory, be used to predict future rates of free product recovery. However, these models are expensive to use and have limited reliability.

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