

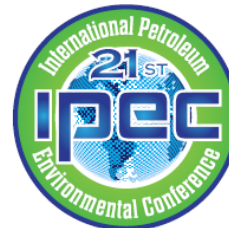
What is TPH?

Making Sense of Names and Acronyms from Around the World

Steve Greason, Speaker
Sitelab Corporation

Technical Session: Legal and Regulatory Issues

Wednesday, October 15th 8:50AM – 9:15 AM



Environmental Issues and Solutions in Exploration,
Production, Refining & Distribution of Petroleum

October 14-16, 2014
Houston, Texas
Marriott Westchase Hotel

List of Common Names

**TPH, PHC, GRO, DRO, VPH, EPH,
ORO, RRO, PRO, TVH, TEH, BTEX,
VOC, SVOC, PAH, HAP, HC, VH, EH,
TRPH, ETPH, O&G ...**

Did I miss any?

T = Total	G = Gasoline
P = Petroleum	D = Diesel
H = Hydrocarbon	C = Compounds
V = Volatile	O = Organics or Oil
E = Extractable	R = Range, Residual or Recoverable

Different Technologies Detect TPH

Gravimetric Methods

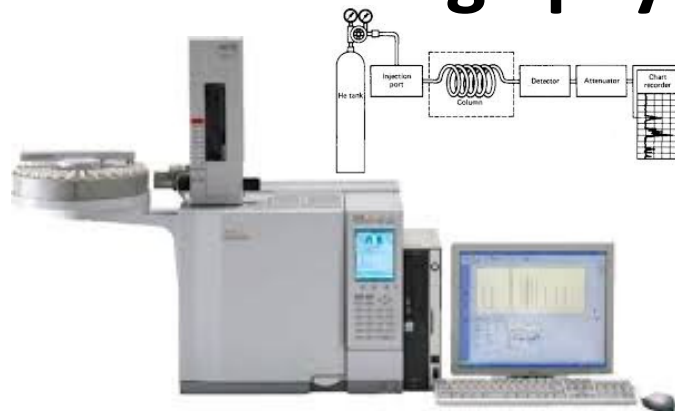


Sample weighed on a scale. Solvent is added to extract oil. Sample is heated to evaporate solvent and then weighed again.

U.S. EPA 9071B - Soil
U.S. EPA 1664 - Water

O&G: Oil and Grease
FOG: Fats, Oils and Grease
HEM: Hexane Extractable Material
SGT: Silica Gel Treated (non-polar)

GC - Gas Chromatography



Sample is extracted in solvent and injected into GC. Compounds separate over time depending on boiling point. FID detector (most common) integrates all the peaks.

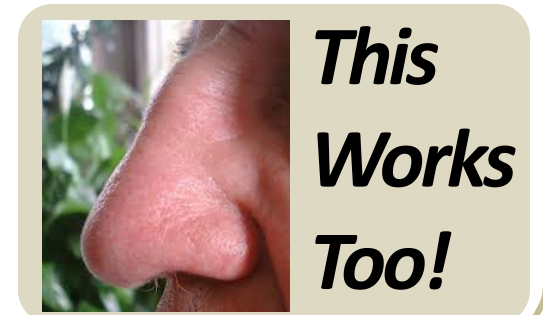
U.S. EPA 8015, 8015B, 8015M, etc.

GRO: Gasoline Range Organics
VPH: Volatile Petroleum Hydrocarbons
EPH: Extractable Petroleum Hydrocarbons
DRO: Diesel Range Organics
ORO, RRO: Oil or Residual Range Organics

Field Methods



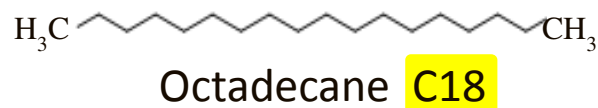
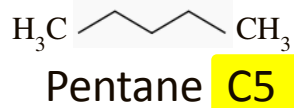
A number of field tools exists using a wide range of different technologies. Accuracy and limitations also vary.



This Works Too!

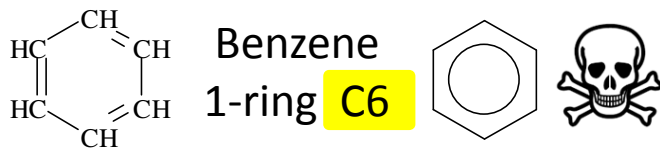
Aliphatic Hydrocarbons

Saturated , Straight Chain Compounds (Alkenes)



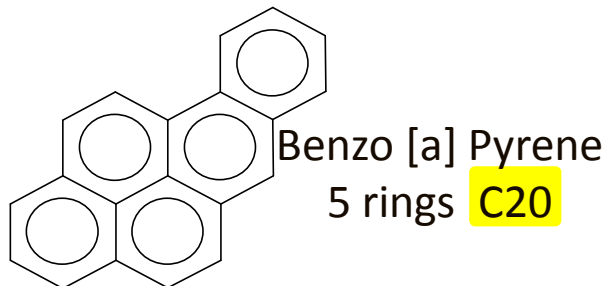
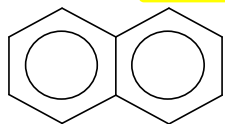
Aromatic Hydrocarbons

Unsaturated , Ring Shaped Compounds (Arenes)



BTEX: Benzene, Toluene, Ethylbenzene and Xylenes

Naphthalene
2-rings **C10**



PAHs: Polynuclear or Polycyclic Aromatic Hydrocarbons
Regulators are concerned with 16 PAHs in C10-C22 range

TPH Fractions

Petroleum contaminants are split into different **Carbon Ranges:**

Volatile Compounds

GRO, VPH, BTEX, VOCs:

C6-C10, C5-C12 or C6-C12

Semi to Non-Volatile Compounds

EPH, EDRO, ETPH, TRPH, SVOCs:

DRO:

C10-C28

C12-C28

ORO or RRO:

C20-C35

C25-C36

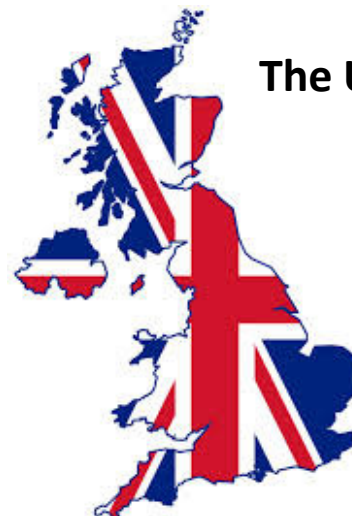
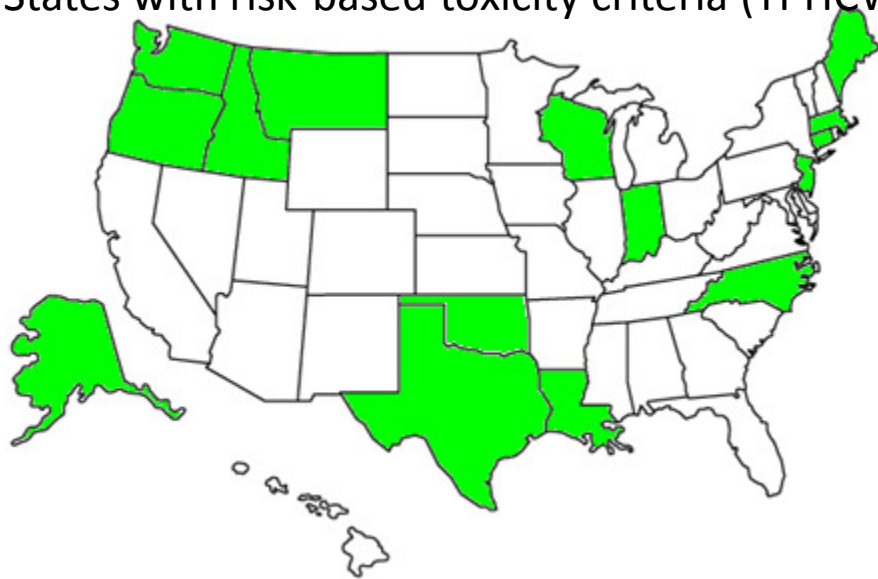
C28-C36



Gasoline mostly contains volatile hydrocarbons vs. Crude Oils contain diesel and oil range hydrocarbons

Some Regulators Require Reporting Aliphatics & Aromatics Separately

States with risk-based toxicity criteria (TPHCWG)



The UK Takes the Cake!

VPH/EPH C5-C44 Suite:

Aliphatic VPH C5-C6

Aliphatic VPH C6-C8

Aliphatic VPH C8-C10

Aliphatic VPH C10-C12

Aromatic VPH C5-C7

Aromatic VPH C7-C8

Aromatic VPH C8-C10

Aliphatic EPH C12-C16

Aliphatic EPH C16-35

Aromatic EPH C10-C12

Aromatic EPH C12-C16

Aromatic EPH C16-C21

Aromatic EPH C21-C35

Aromatic EPH C35-C44



*It's like a big salad...
"You know, it's a
salad, only bigger,
with lots of stuff in it."*

Portable Analyzers using Fluorescence

siteLAB[®] Petroleum Hydrocarbon Solutions



INSTRUMENT SPECIFICATIONS

Weight & Dimensions:	13 lbs (5.9 Kg); 11" x 9" x 8" (28 cm x 23 cm x 21 cm).
Power Requirements:	External power supply, 100-120 VAC, Max. 30 watts.
Operating Temperature:	45°F to 95°F; 7°C to 36°C.
Principle of Operation:	Ultraviolet fluorescence spectrophotometer.
Detector:	Factory-installed photomultiplier tube (PMT).
Lamp:	Mercury vapor lamp included with analyzer (approx 10,000 Hr life expectancy). Replacement/spare lamps are available.
Min. Detection Limits:	Varies depending on Sitalab Calibration Kit used; GRO 0.5 ppm, EDRO 0.1 ppm, PAHs 0.05 ppm and TPH-Oil 0.5 ppm.
Display:	16 x 2 character LCD (3.9" x 0.9"; 9.8 cm x 2.2 cm).
Data Output:	100% ASCII format through a 9-pin RS-232 serial cable at 9600 baud. USB adapter available, Part No. 3100-USB, sold separately.
Software:	Menu driven microprocessor-controlled. CD-ROM with software included for computer connection, Microsoft compatible.
Filter Cylinder:	Accommodates up to eight, 25 mm (1-inch) round optical filters (up to 4 excitation and 4 emission filters).
Cuvettes:	Includes cuvette adapter and two glass cuvettes. Replacement/spare cuvettes are available.
Readout:	Direct concentration (in ppm or ppb) or raw fluorescence.
Calibration:	Multi-point calibration for direct concentration measurement.
Blank:	Reads and subtracts blank using methanol or hexane solvents.
Warranty:	One-year warranty, parts and labor.
Approvals:	CE, UL and C-UL. ISO 9001 manufacturing. Made in USA.

UVF 3100

CONTAMINANTS

Ideal for gasoline, jet fuel, diesel fuel, heating oils, lubricating oils, crude oils, gas condensates, creosote, coal tars, coal ash and many other types of petroleum hydrocarbons.

QUICK RESULTS

Test soil, sediment or water samples in just 5 minutes using Sitalab test kits with solvent extraction.

ACCURACY

Correlates well to regulatory lab GC methods performed by certified laboratories. Ranked highest in U.S. EPA's "TPH in Soil" evaluation study. Publication No. EPA/600/R-01/080

FINGERPRINTING

Test BTEX and PAHs for forensic applications to determine the type or age of petroleum on your site.



Sitalab's UVF-3100A and UVF-3100D models include a field case with all the tools needed to perform tests.

The analyzer is fitted with optical filters sensitive to the gasoline range, diesel and oil range and Target PAH ranges. Sitalab's GRO, EDRO and PAH Calibration Kits provide fast, accurate measurement with quality control.

©2012 Sitalab Corporation All Rights Reserved
UVF-3100 Analyzer Brochure

Visit: site-lab.com Call Toll Free 877-SITELAB or Dial (USA) 978-363-2299
Sitalab Corporation • 86 Coffin Street • West Newbury • MA • 01985 • USA

siteLAB[®] Petroleum Hydrocarbon Solutions



INSTRUMENT SPECIFICATIONS

Weight & Dimensions:	13.9 oz (0.4 Kg); 1.75" x 3.5" x 7.25" (4.5 cm x 8.9 cm x 18.4 cm).
Power Requirements:	Four AAA batteries. Batteries good for approx. 1,000+ readings.
Operating Temperature:	45°F to 95°F; 7°C to 36°C.
Principle of Operation:	Hand-held ultraviolet fluorescence spectrophotometer.
Detector:	Factory-installed photomultiplier sensor.
Lamp:	Light Emitting Diode (LED).
Min. Detection Limits:	Varies depending on Sitalab Calibration Kit used; TPH-Oil 5 ppm, Heavy PAHs 25 ppb.
Display:	16 x 2 character LCD (2.5" x 0.6"; 6 cm x 1.5 cm); ppm or ppb units.
Data Output:	Not available. Record results manually.
Automatic Power Down:	After 3 minutes of inactivity.
Optical Filters:	Includes two sets of factory-installed excitation and emission filters; use Channel A optics for Sitalab applications.
Cuvettes:	Uses disposable 8 mm round glass cuvettes. Cuvettes are included with Sitalab sample extraction kits and calibration kits.
Calibration:	Single-point and blank.
Blank:	Reads and subtracts blank using methanol or hexane solvents.
Response Time:	5 Seconds.
Diagnostics:	Displays percent fluorescence sensitivity of calibration and blank.
Alarms:	Low battery, circuit failure, high blank.
Warranty:	One-year warranty, parts and labor.
Approvals:	CE, UL and C-UL. ISO 9001 manufacturing. Made in USA.

©2012 Sitalab Corporation All Rights Reserved
TD-500D Analyzer Brochure

Visit: site-lab.com Call Toll Free 877-SITELAB or Dial (USA) 978-363-2299
Sitalab Corporation • 86 Coffin Street • West Newbury • MA • 01985 • USA

TD 500D

CONTAMINANTS

Test samples for TPH with heavy fuel oils, waste oils or crude oils. Test for PAHs in old, weathered fuel oils, creosotes, coal tars and coal ash.

QUICK RESULTS

Test soil, sediment or water samples in just 5 minutes using Sitalab test kits with solvent extraction.



ACCURACY

When used with Sitalab Calibration Kits, TPH-Oil results correlate well to EPA's 1644 gravimetric method. PAH results correlate well to EPA's 8270 method as sum of PAH compounds.

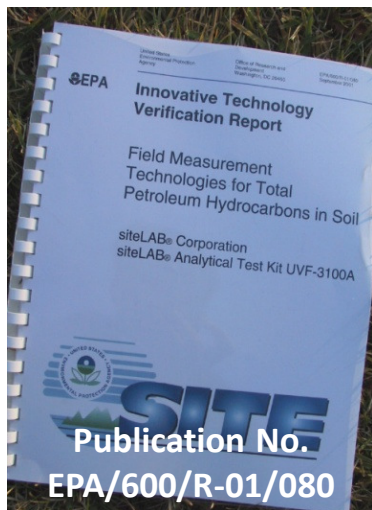


EASY TO USE

The equipment is simple to operate. Sitalab's TD-500D model includes a field case with all the tools needed to perform tests.

Manufactured for Sitalab Corporation by Turner Designs Hydrocarbon Instruments, Inc.

Accuracy is Everything!

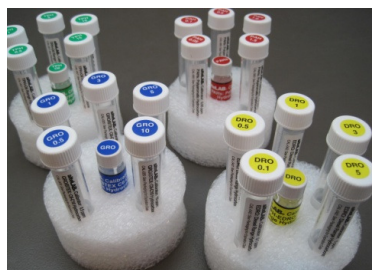


Evaluated by U.S. EPA in 2001

Ranked highest compared to other screening devices for TPH in soil.

Over 200 samples were tested. EPA spent \$800,000 on project.

Results were compared to split samples sent to certified lab for TPH analysis using 8015 by GC-FID.



GRO, EDRO & PAH Calibration Kits

Certified calibration standards are specially formulated to correlate well to laboratory GC methods.

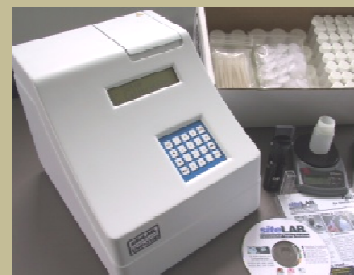


Sample Test Kits

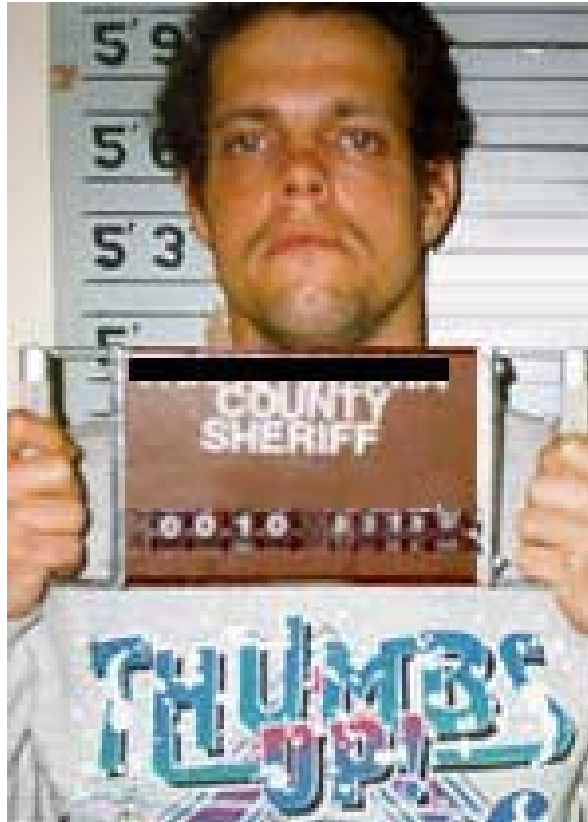
Used to prepare and analyze soil or water using solvent extraction. Results take 5 minutes.

Sitelab's popular UVF-3100D instrument is fitted with 3 sets of optical filters which are sensitive to different hydrocarbon ranges.

Can perform TPH Fingerprinting



Examples Comparing Different Methods



**Regulators require laboratory testing
It's the law!**

Gasoline Range Organics & VPH



Sitelab's GRO calibration kit and the UVF-3100 optics were developed to correlate well to U.S. EPA and State regulatory test methods for volatile petroleum hydrocarbons, like BTEX, and other compounds in the C6-C10 range.



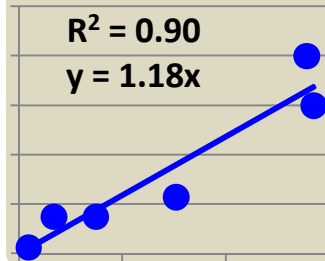
Samples collected from six soil borings were split and sent to a certified lab. The UVF results correlated well to both laboratory methods performed.



Soils from Gasoline Station UST Site, Dracut, Mass Concentrations in ppm units (mg/Kg)

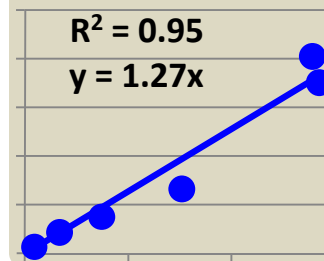
UVF-3100 GRO	Lab GC EPA 8015-GRO	Lab GC Total VPH
176	260	292
666	1,500	886
1,481	1,500	1,526
3,037	2,300	2,665
5,704	6,000	7,025
5,570	8,000	8,103

UVF Accuracy vs. Lab GC GRO



EPA Method 8015-GRO Reports All Hydrocarbons in the C6 to C10 Range

UVF Accuracy vs. Lab GC Total VPH



Mass DEP VPH Method Reports Hydrocarbon Fractions Separately:

- C5-C8 Aliphatic Hydrocarbons
- C8-C12 Aliphatic Hydrocarbons
- C9-C10 Aromatic Hydrocarbons
- + Target BTEX Compounds & MtBE

EPH C11-C22 Aromatic Hydrocarbons

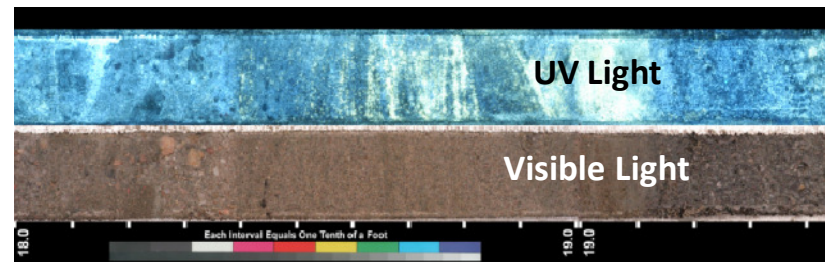
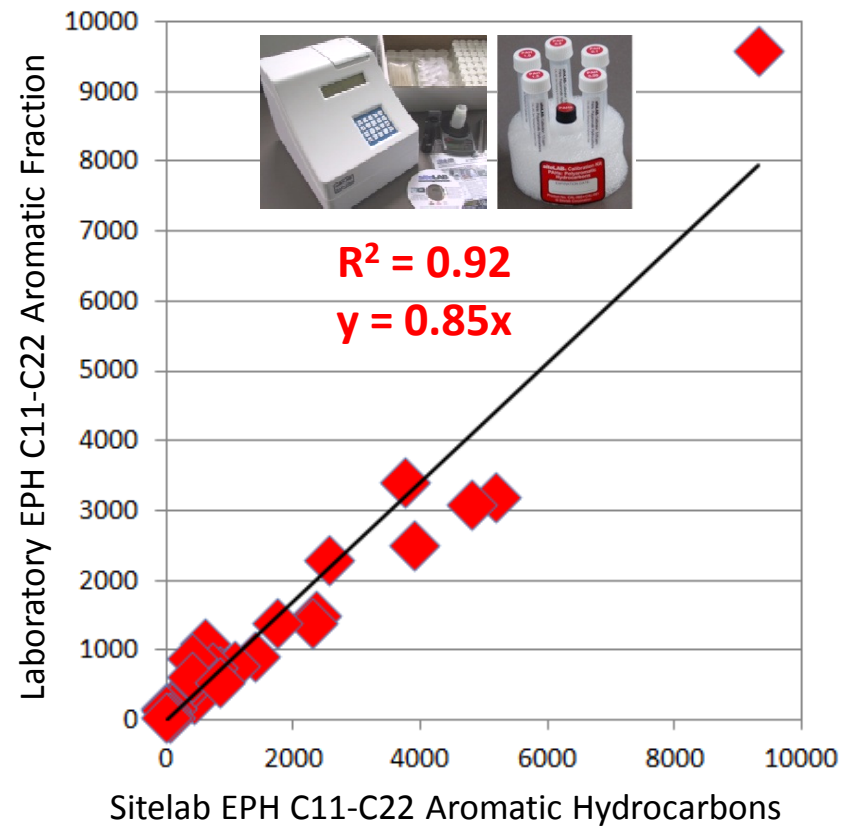
Former Oil Refinery, Kansas:

Site has a huge 100-acre size plume of LNAPL commingled with gasoline, diesel, crude oil and other petroleum products. Sitelab's PAH calibration standard contains same polyaromatic compounds used by laboratory GC methods.



Client uses UVF and LIF together to delineate refinery's contamination

Accuracy vs. Massachusetts DEP EPH Aromatics Concentrations in ppm units (mg/Kg)

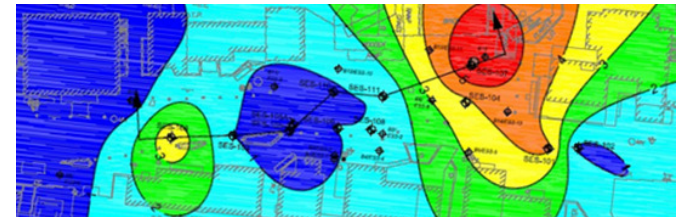


Soil cores were also frozen for physical testing. Centrifuge test measures residual oil saturation

Extended Diesel Range Organics



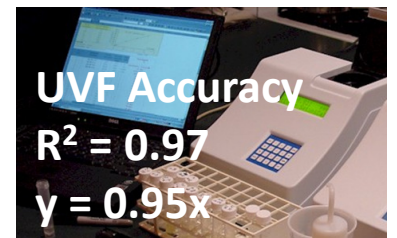
Contaminated Wharf Site, Massachusetts Former Tank Farm with Subsurface Plume of Fuel Oils



Consultant uses Sitelab data to map the extent of contamination

Concentrations in ppm units (mg/Kg)

C9-C18 Aliphatics	C19-C36 Aliphatics	C11-C22 Aromatics	Sum of 16 PAHs	Lab GC Total EPH	UVF-3100 EDRO
67	78	96	ND	241	350
270	57	140	11	478	390
1,600	120	750	21	2,491	1,300
1,600	170	650	45	2,465	1,750
1,700	150	630	49	2,529	2,450
3,200	280	1,700	72	5,252	3,500
2,700	220	1,100	83	4,103	5,050
3,600	290	1,700	102	5,692	6,872
8,800	750	2,400	220	12,170	12,800
12,000	1,100	3,400	182	16,682	16,420





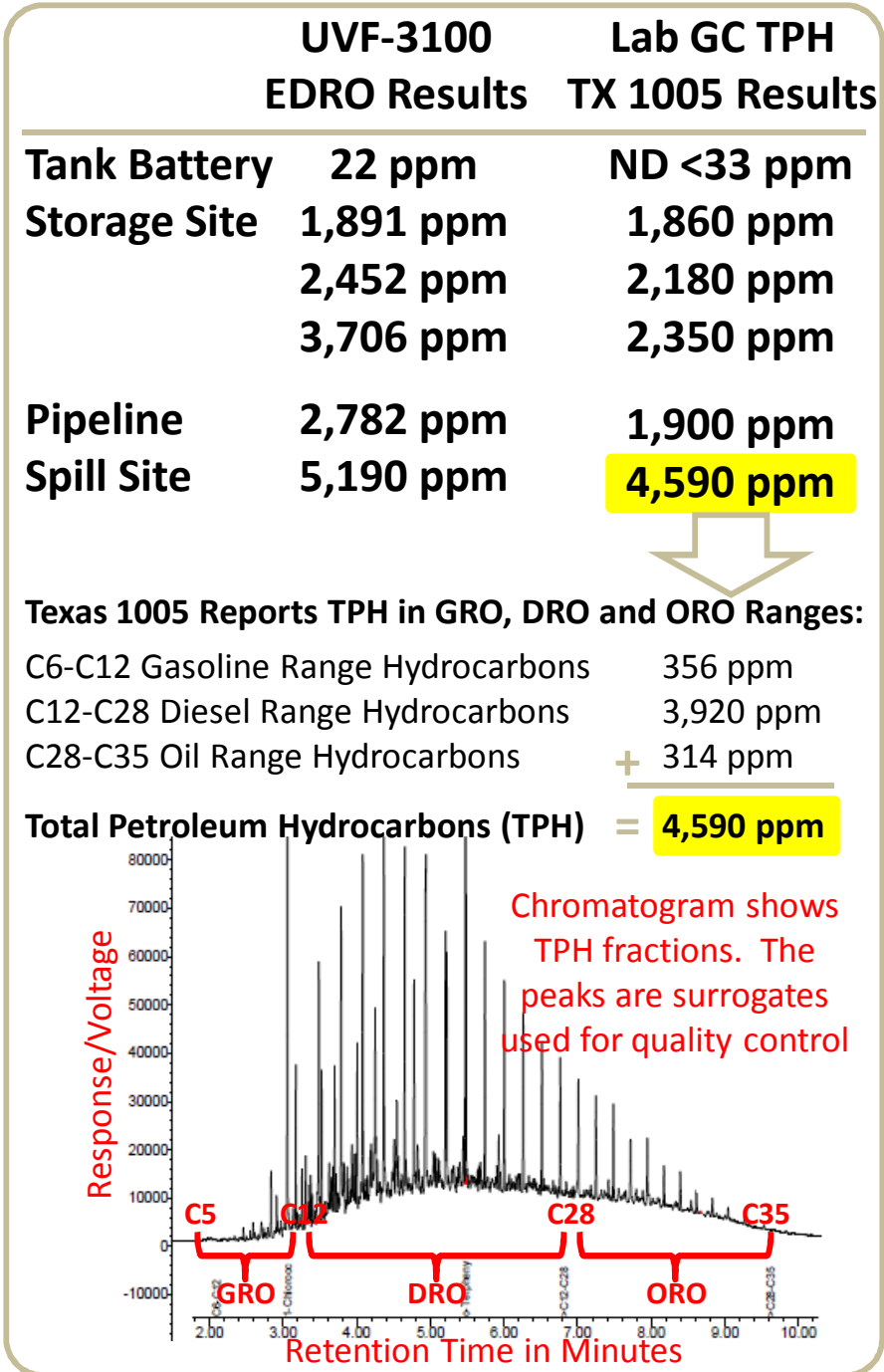
Texas Crude Oil Sites

Sunset Well Service, Inc. - West Texas

Environmental contractor uses their UVF-3100D analyzer (pictured below) to help excavate and remediate soils contaminated by produced water and crude oil. When samples are sent to a certified laboratory for confirmation analysis, the field results correlate well. Laboratories in Texas test TPH using the TX 1005 GC-FID Method.




Sitelab's EDRO calibration kit is used to measure hydrocarbons in the C10 to C36 range.



Canada Crude Oil Sites

The Canadian Council of Ministers of the Environment requires laboratories to use the CCME's Petroleum Hydrocarbon (PHC) Method. GC-FID instrumentation is used to report VPH and EPH hydrocarbon fractions.



Soil and water samples are prepared in solvent using Sitelab extraction test kits. Methanol is used for soil. Hexane is used for water.

Heavy Crude Oil in Soil at Landfill Disposal Site, Alberta Concentrations in ppm units (mg/Kg)

	Lab GC Hydrocarbon Fractions			UVF-3100 EDRO Results	C10 - C34 F2+F3 Fractions	C10 - C50 F2+F3+F4 Fractions
	F2 EPH C10-C16	F3 EPH C16-C34	F4 EPH C34-C50			
Sample 1	153	2,280	1,320	2,500	2,433	3,753
Sample 2	236	2,640	1,270	2,900	2,876	4,146
Sample 3	303	3,560	1,400	3,750	3,863	5,263



 **Results Closer**

Bitumen in Produced Water at SAGD Plant, Kearl Oil Sands Concentrations in ppb units (ug/L)

	Lab GC Hydrocarbon Fractions			UVF-3100 EDRO Results	C10 - C34 F2+F3 Fractions	C10 - C50 F2+F3+F4 Fractions
	F2 EPH C10-C16	F3 EPH C16-C34	F4 EPH C34-C50			
Sample 1	102	1,370	492	1,733	1,472	1,964
Sample 2	137	2,150	904	3,250	2,287	3,191
Sample 3	532	5,540	1,610	10,000	6,072	7,682



 **Results Closer**




Safic Technologies, Ltd. - Port Harcourt

A pilot study was conducted testing soil samples collected from a pipeline spill. Split samples were sent to Sitelab for EDRO analysis and results were the same. Samples were also sent to a Nigerian lab and a highly reputable lab in the United States for confirmation.


Sample 1 also tested for TPH by Gravimetric


American Lab = 44,100 ppm
Method 9071B: Oil & Grease

Sitelab TPH-Oil = 44,750 ppm
Uses same optics as EDRO. UVF-3100 produces results about three times higher.



TPH-Oil **EDRO**
*CAL-057 CAL-042
*For C10-C50 Range

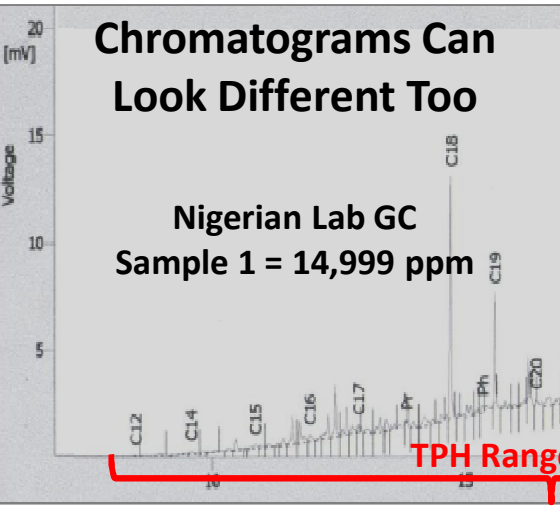


	Soil Sample 1	Soil Sample 2
Customer EDRO	15,150 ppm	7,160 ppm
EDRO at Sitelab	15,430 ppm	7,800 ppm
Nigerian Lab GC-FID Using EPA 8015M: C9-C40	14,999 ppm	6,829 ppm
American Lab GC-FID Using EPA 8015M: C10-C36	46,000 ppm	13,000 ppm
		
American Lab GC-FID	24,800 ppm	10,200 ppm

Samples Retested!

Lower/better results... Labs don't always get it right!

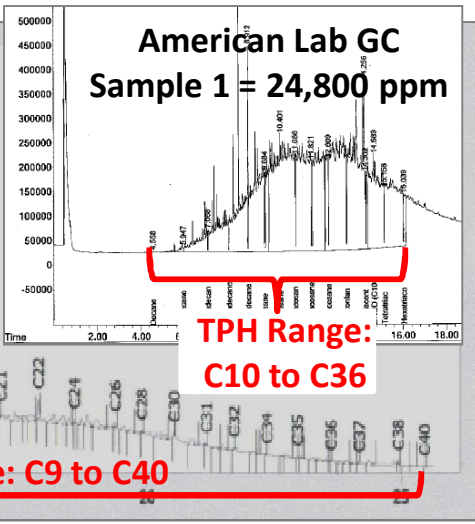
Chromatograms Can Look Different Too



Nigerian Lab GC
Sample 1 = 14,999 ppm

TPH Range: C9 to C40

American Lab GC
Sample 1 = 24,800 ppm



TPH Range: C10 to C36



Environmental consultant uses Sitelab to test soils collected from borings to delineate a large plume of jet fuel below ground. TPH is used to calculate the total mass of NAPL.

Split samples were sent to a certified laboratory for confirmation analysis using the Massachusetts DEP's VPH/EPH method.



Sitelab's UVF-3100 analyzer has optical filters sensitive to GRO and EDRO range hydrocarbons

Jet Fuel Contaminated Soils, Westover Air Force Base Concentrations in ppm units (mg/Kg)

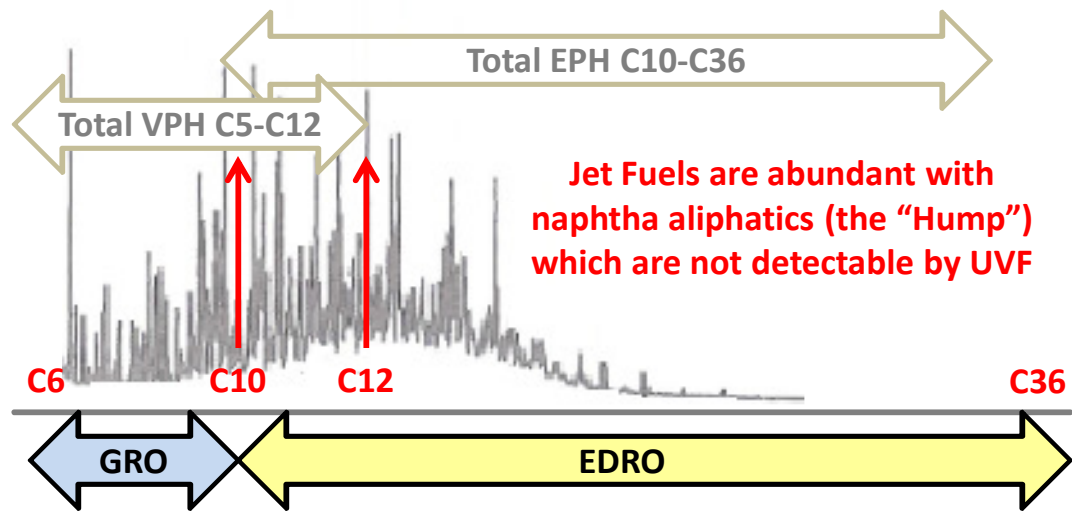
	UVF-3100 GRO Results	Lab GC Total VPH Results	UVF-3100 EDRO Results	Lab GC Total EPH Results	Sitelab UVF GRO+EDRO = TPH	Lab GC VPH+EPH = TPH
Soil 1	6	8	1	ND	7	8
Soil 2	4,760	1,100	680	4,400	5,440	5,500
Soil 3	6,270	4,200	700	5,000	6,970	9,200
Soil 4	7,800	6,500	950	6,700	8,747	13,200
Soil 5	9,760	3,900	1,175	7,000	10,938	10,900
Soil 6	16,380	6,000	1,800	12,000	18,180	18,000

UVF is Higher

UVF is Lower

But TPH is Accurate

Jet Fuel Chromatogram Showing C10 to C12 "Hump"



UVF detects higher GRO vs. VPH due to C10 break point

PAHs in Asphalt



ESITC – France

New regulations across Europe are requiring laboratory analysis for PAH content in asphalt. Researchers at ESITC's lab are using the TD-500D analyzer to monitor PAH levels in new and reclaimed/recycled asphalt.

In this study, samples were ground down to different particle sizes and sent to four certified laboratories for comparison. In France, they use EPA Method 8270 for PAH analysis.

Sum of 16 PAH Compounds Reported by Four Laboratories Exhibiting Wide Range of Concentrations



<u>Sample 1</u>	<u>Granular Size</u>			<u>TD-500D Result</u>
	<u>10 mm</u>	<u>0.5 mm</u>	<u>2 mm</u>	
LAB 1: ESITC	600	270	349	356 ppm
LAB 2	340	424	426	
LAB 3	555	367	356	
LAB 4	246	282	220	
<u>Sample 2</u>				<u>TD-500D Result</u>
LAB 1: ESITC	290	129	182	228 ppm
LAB 2	172	212	243	
LAB 3	215	195	162	
LAB 4	109	141	84	
<u>Sample 3</u>				<u>TD-500D Result</u>
LAB 1: ESITC	1,685	1,347	1,531	1,177 ppm
LAB 2	1,310	1,231	1,773	
LAB 3	2,033	747	1,967	
LAB 4	729	958	1,139	

Concentrations above shown in ppm units (mg/Kg)



Proficiency Evaluation Study Testing Water Samples vs. 83 Laboratories

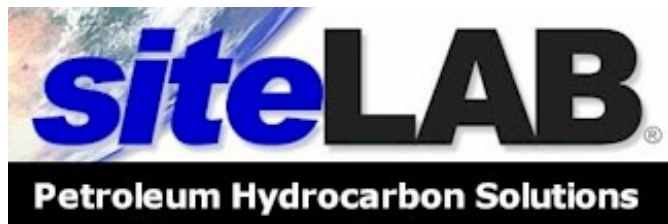
Gasoline Concentration <hr/> 3.47 mg/L	Acceptance Limit <hr/> 1.34 mg/L to 6.11 mg/L	UVF-3100 GRO Result <hr/> 3.33 mg/L	Laboratory Mean Result <hr/> 3.60 mg/L	Lab GC-GRO Methods Used EPA 8015 California LUFT EPA 8015B Iowa OA-1 EPA 8015M Maine 4.2.17 EPA 8020 NWTPH-GX EPA 8260B
Diesel Fuel Concentration <hr/> 3.62 ppm	Acceptance Limit <hr/> 0.90 mg/L to 4.66 mg/L	UVF-3100 EDRO Result <hr/> 3.78 mg/L	Laboratory Mean Result <hr/> 2.60 mg/L	Lab GC-DRO Methods Used EPA 8015 California LUFT EPA 8015B Connecticut ETPH EPA 8015M Maine 4.2.25 Florida PRO NWTPH-DX Iowa OA-2 Oklahoma DRO

Pretty Easy To Pass!

Laboratories must pass these “blind” tests to be certified thru the National Environmental Laboratory Accreditation Program (NELAP) or similar programs several times a year. This study conducted by ERA, Inc.

End of Presentation

Thank you



Visit: site-lab.com
Call: 978-363-2299