Using HRSC to Refine LNAPL CSMs & Remedial Designs at Kentucky UST Facilities

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Commonwealth of Kentucky
Department for Environmental Protection
Division of Waste Management
Underground Storage Tank (UST) Branch

WHAT IS HRSC?

High-Resolution Site Characterization

For the purpose of this discussion, HRSC refers to intrusive environmental site-characterization tools.

These HRSC tools are designed to efficiently collect real-time, site-specific physical & chemical environmental data.

HRSC tools ***should not*** *be considered a replacement for "traditional" site-characterization tools, methods & strategies.*

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THE "SITE INVESTIGATION TOOLBOX"

HRSC technologies provide important, data-specific tools bolstering our site-characterization **toolbox**.

HRSC tools should be teamed with "traditional" site-characterization tools to **target** the source-area, monitoring locations, sampling locations, etc.

WHY HRSC IN THE "SI TOOLBOX"?

1. **Reinforce conceptual site model (CSM)**
   - Dense-array of real-time data points
   - Minimize data-gaps
   - Confirm contaminant nature & extent
   - Assess contaminant-mass
   - Characterize site-specific soil-lithology & hydrogeologic characteristics
   - Evaluate geology/lithology influencing mass-transport & plume geometry
2. **Focus remedial-strategy/remedial-design**

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THREE HRSC TECHNOLOGIES

LaserInduced Fluorescence/Ultra-Violet Optical Screening Tool® (LIF/UVOST)

- Overburden high resolution NAPL screening tool

Hydraulic Profiling Tool (HPT)

- Overburden relative-permeability screening-tool

Electronic Conductivity (EC)

- Grain-size & lithology/stratigraphy screening tool

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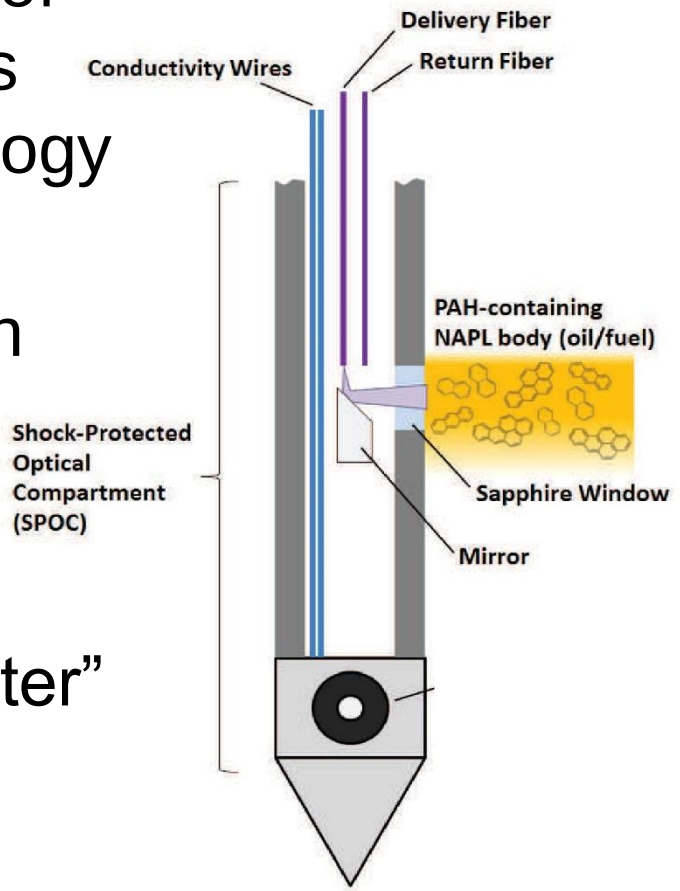
LIF/UVOST

- The UVOST® system measures the laser-induced fluorescence (LIF) of PAHs in petroleum LNAPL as it is advanced via direct-push technology (DPT)
- UVOST® responses are plotted in real-time on a graph of UVOST® signal vs. depth
- UVOST® signal units are a percentage of a “Reference Emitter” (%RE)
- **Target-Data:** Detects petroleum LNAPL in overburden material



Schematic courtesy of Dakota Technologies

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HYDRAULIC PROFILING TOOL (HPT)

Hydraulic Profiling Tool (HPT)

Evaluates the hydraulic behavior of unconsolidated materials by injecting clean water into the subsurface at discrete intervals to measure pressure differences (relative permeability) in overburden stratigraphy.

Target Data

- Pore-pressure profile (relative permeability)
- Hydraulic conductivity ("Effective K") estimation via dissipation test
- Conceptualization of contaminant-flow based on hydrogeology

**Often teamed with an electrical conductivity (EC) probe to interpret and map the subsurface lithology.*

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ELECTRONIC CONDUCTIVITY (EC)

Electronic Conductivity (EC)

- Soil conductivity typically varies with grain size.
- Finer grained soils (silts & clays) tend to produce higher EC signals than sands & gravels.

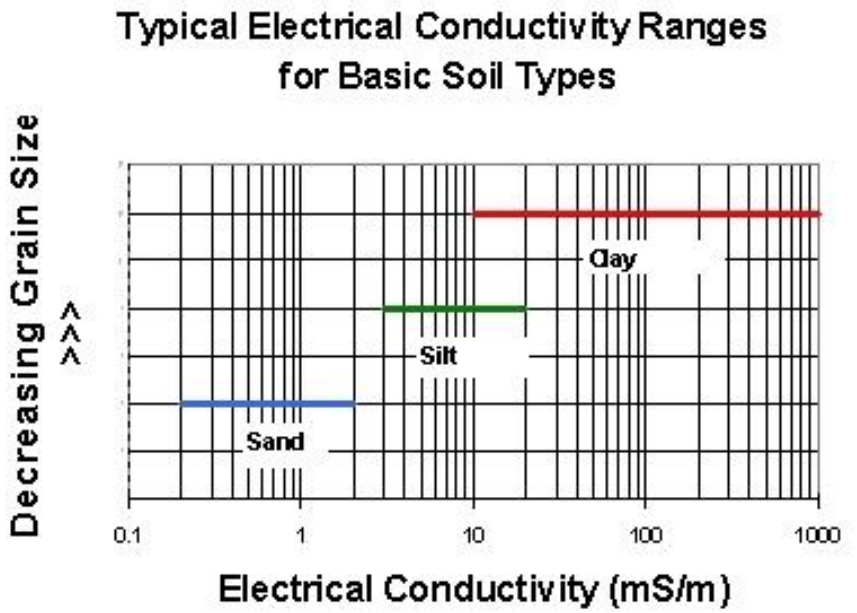

Illustration courtesy of Geoprobe®

Target Data: Correlate EC response with grain-size, lithology, stratigraphy, hydrogeologic properties & plume-geometry

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Case 1 – Parkway Sunoco

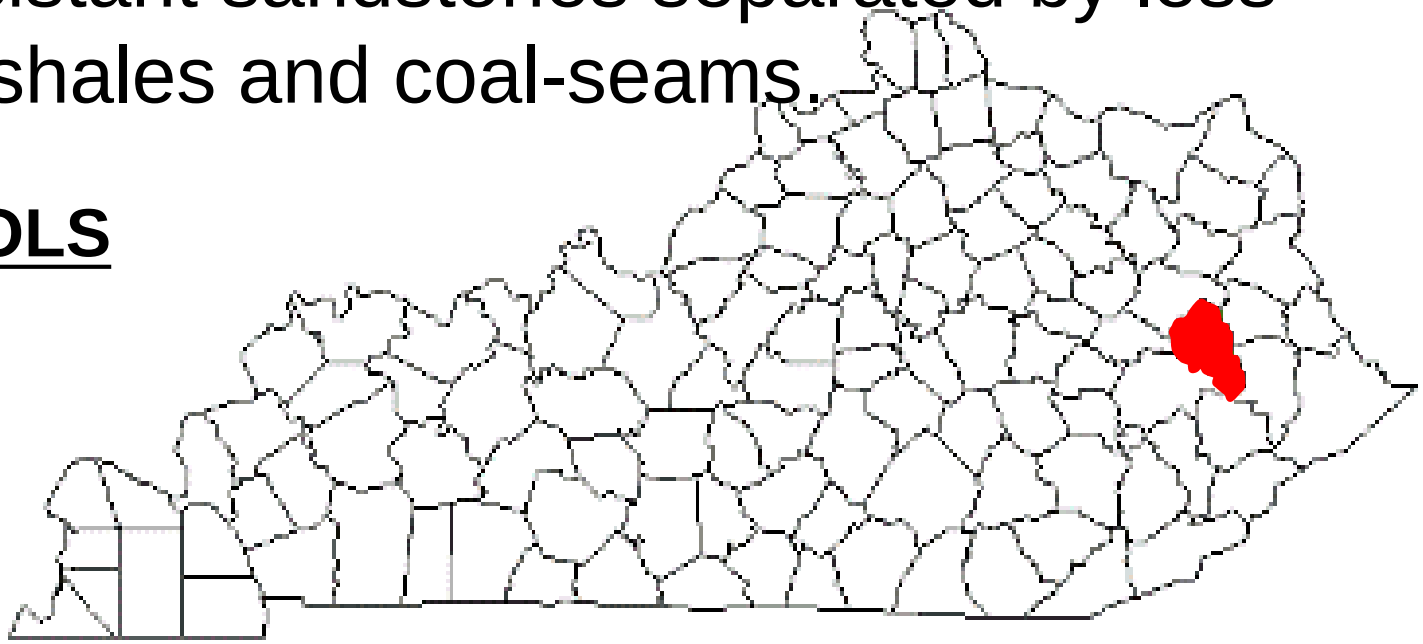
Salyersville, Magoffin County, Kentucky

Geologic Setting

- Eastern Kentucky Coal Field Physiographic Province
- Thick, resistant sandstones separated by less resistant shales and coal-seams.

HRSC Tools

- UVOST
- HPT
- EC



Case 1 – Parkway Sunoco

Site Specifics

- On-Site overburden composed primarily of fill & spoil from local roadwork & coal mining
- Poorly sorted (fill, silty-clay, sandy-clay, sand, gravel)
- Geoprobe® refusal typically ~26 ft bgs
- Water-table & LNAPL elevations range from 13 to 18 ft bgs (groundwater flow south-southwest)

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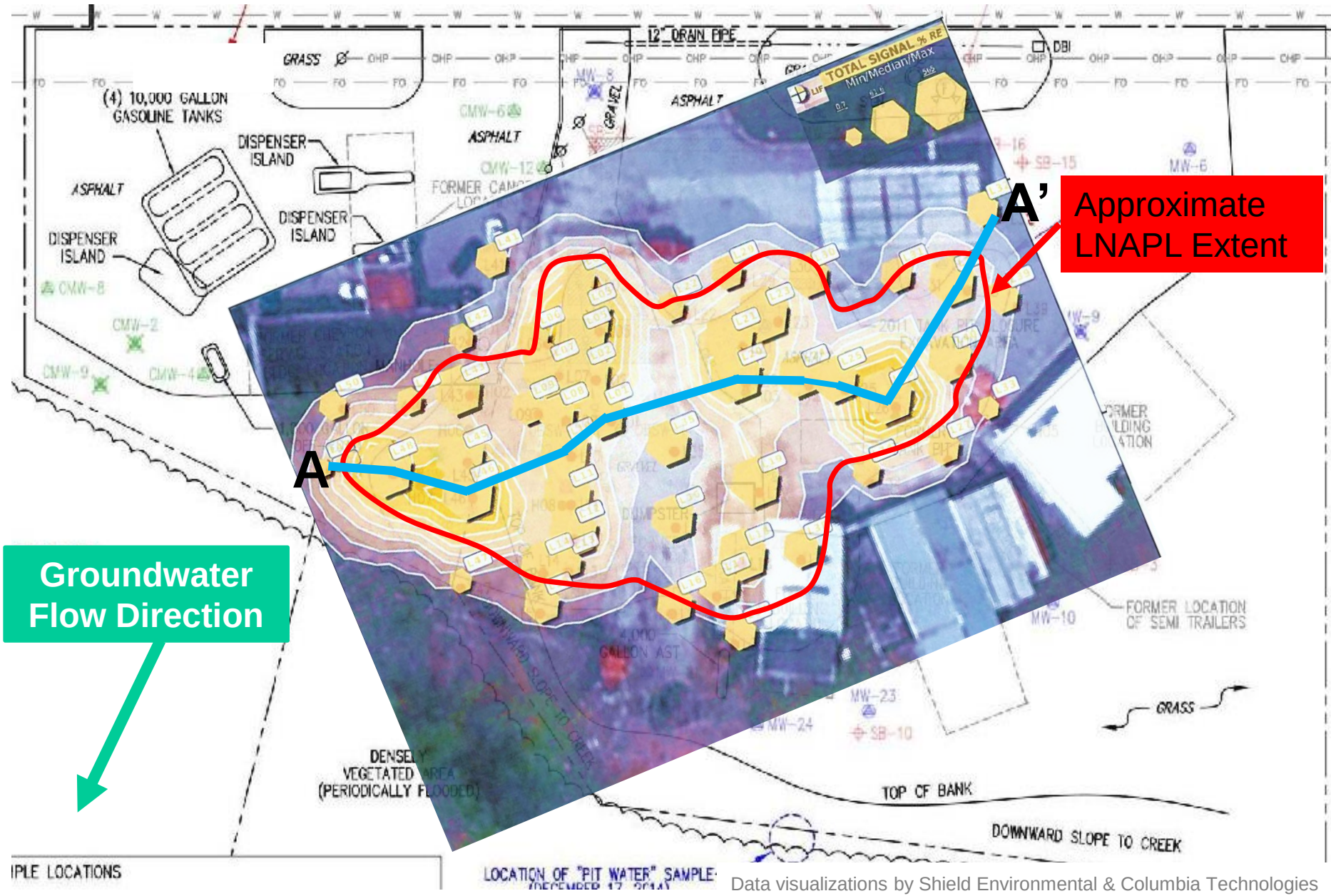
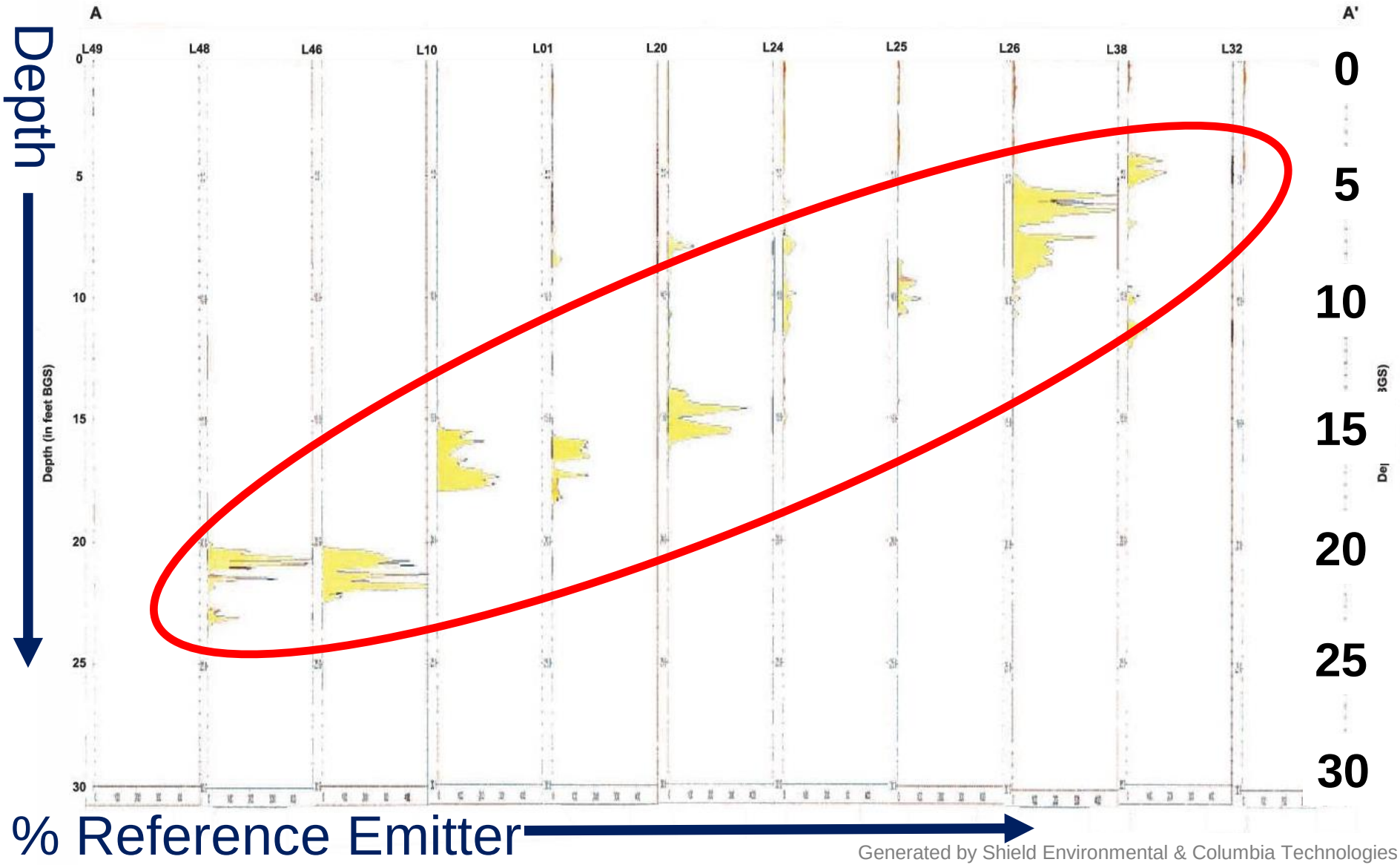
CASE 1 – PARKWAY SUNOCO



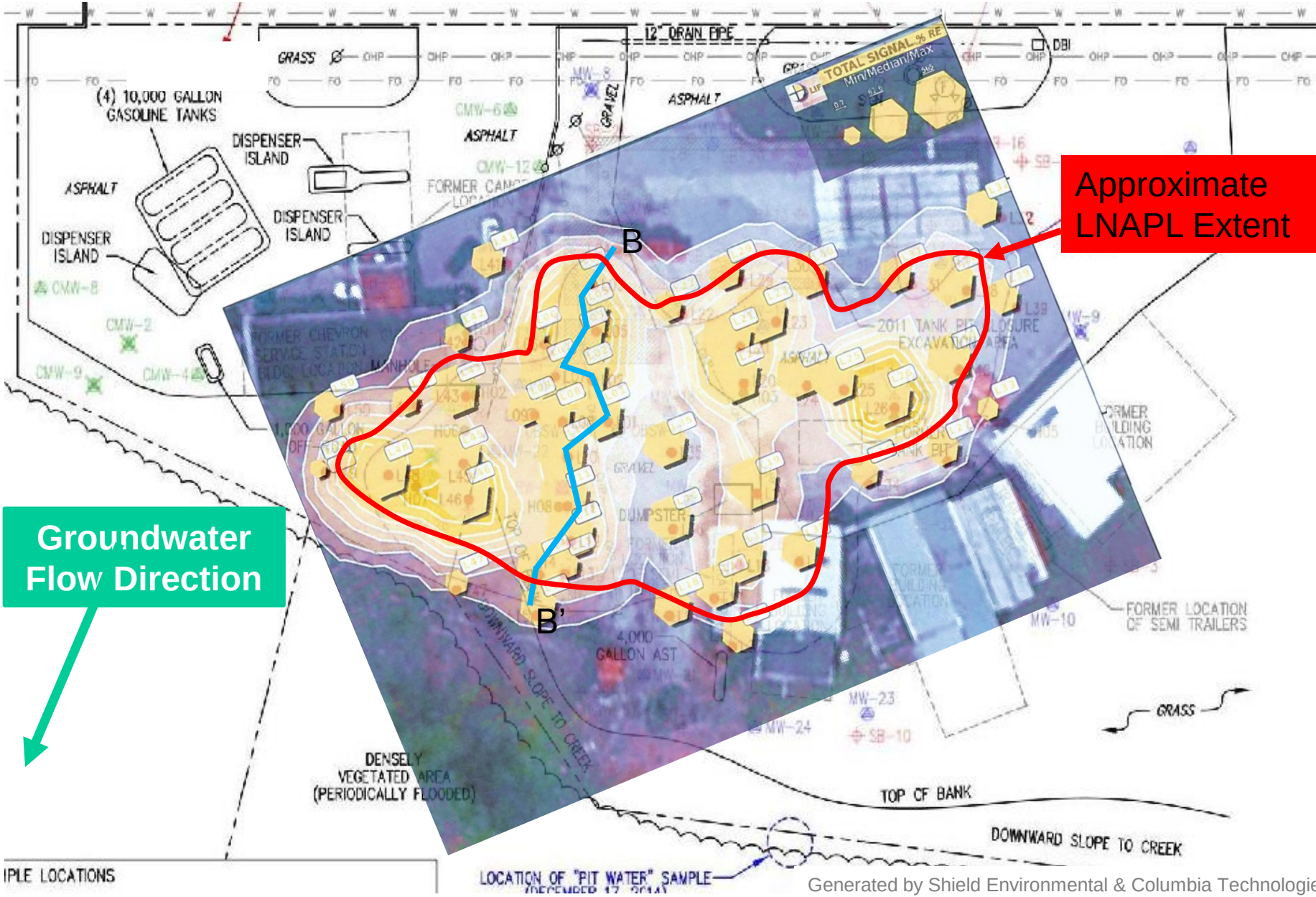
Data visualizations by Shield Environmental & Columbia Technologies

PARKWAY SUNOCO (A - A')

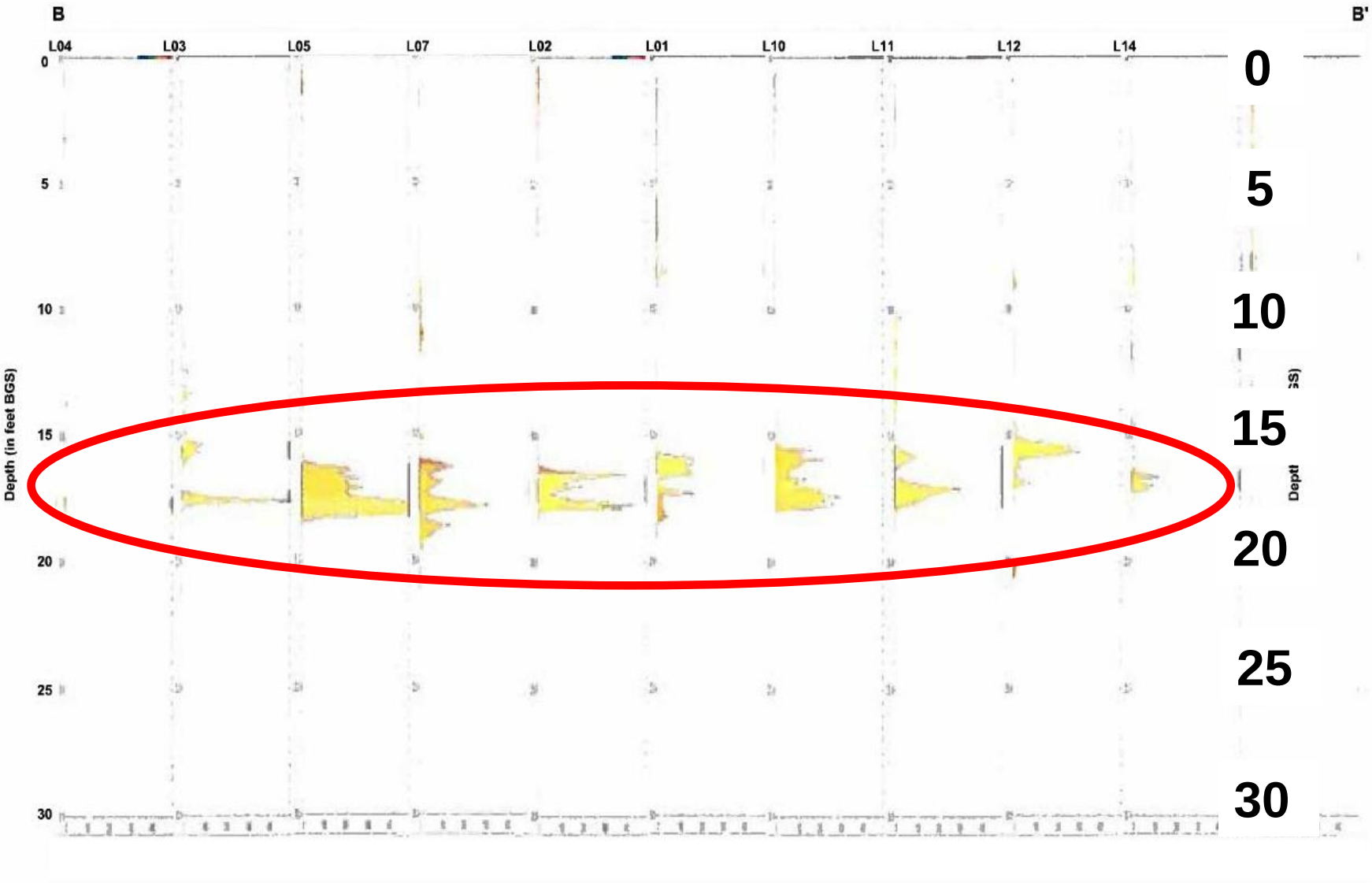


Generated by Shield Environmental & Columbia Technologies

CASE 1 – PARKWAY SUNOCO



Parkway Sunoco (B - B')

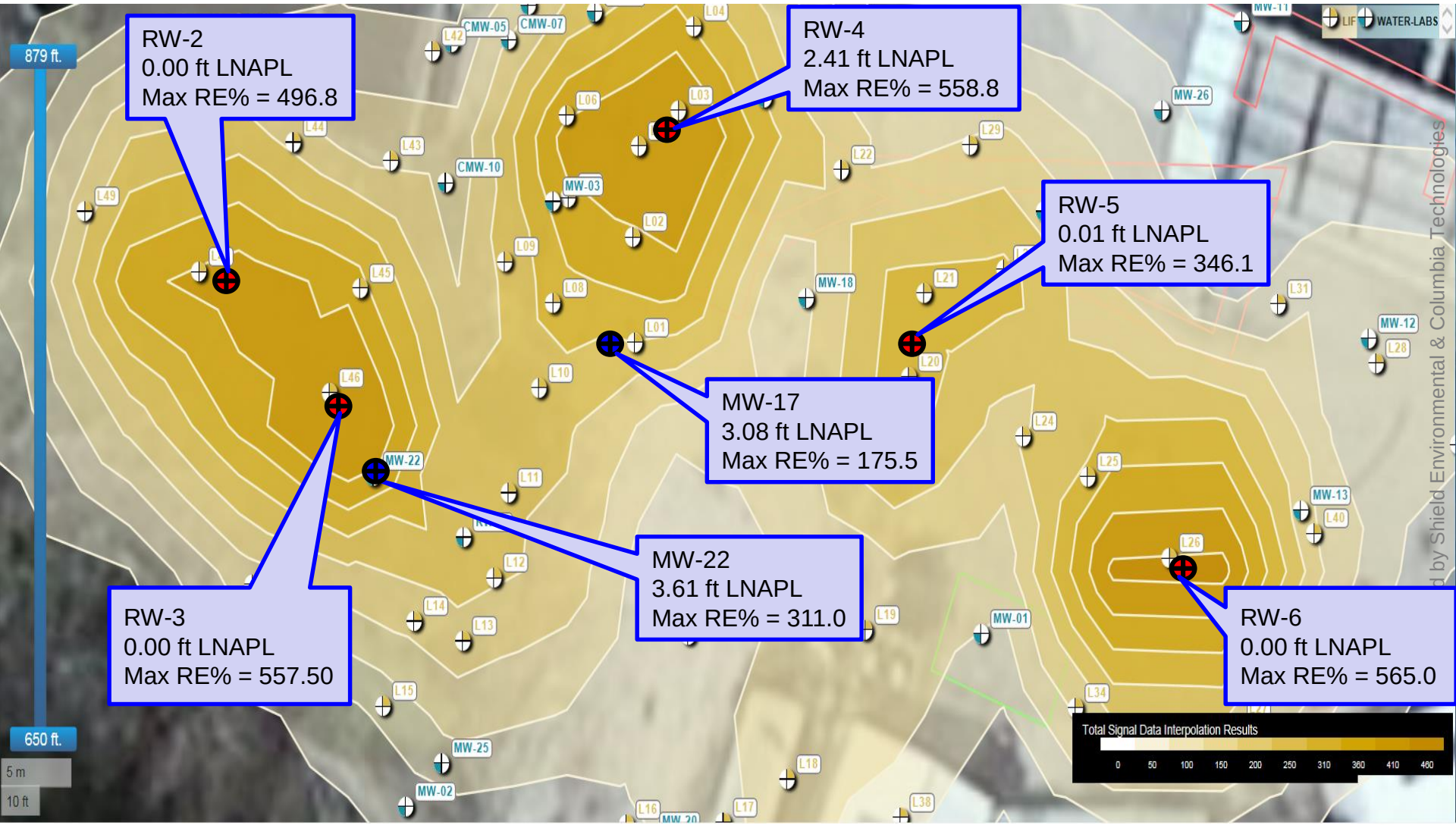


Depth

% Reference Emitter

Generated by Shield Environmental & Columbia Technologies

UVOST & MEASURABLE LNAPL



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LNAPL: Mobile, Migrating & Residual

LNAPL in Wells
Mobile **AND** Migrating

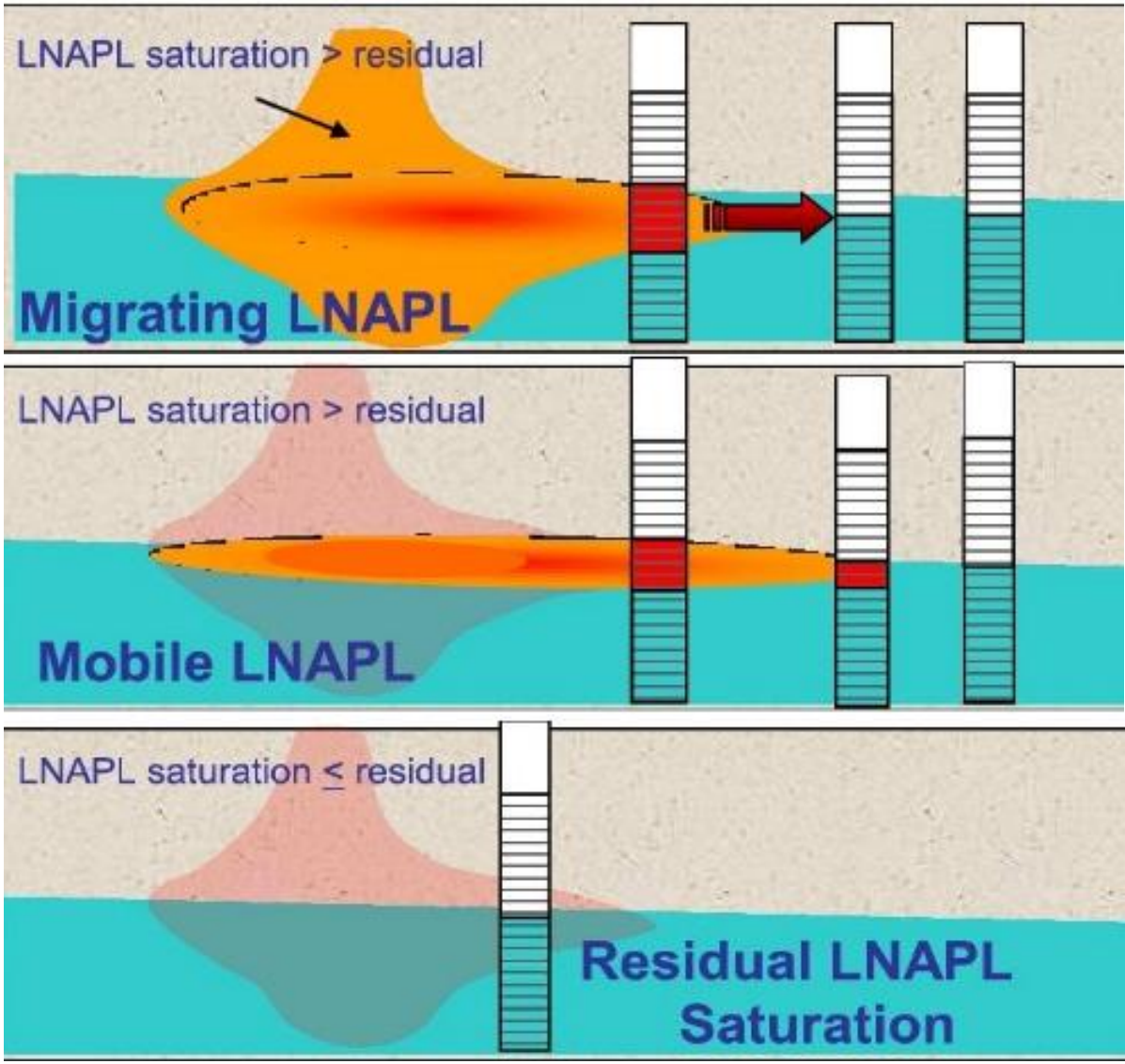
(LNAPL head exceeds formation conditions)

LNAPL in Wells
Mobile **NOT** Migrating

(LNAPL equilibrates with formation conditions)

LNAPL **NOT** measurable in Wells

("ganglia", smear-zones, etc.)



Drawings courtesy of ITRC (Interstate Technology & Regulatory Council). 2009. *Evaluating LNAPL Remedial Technologies for Achieving Project Goals*

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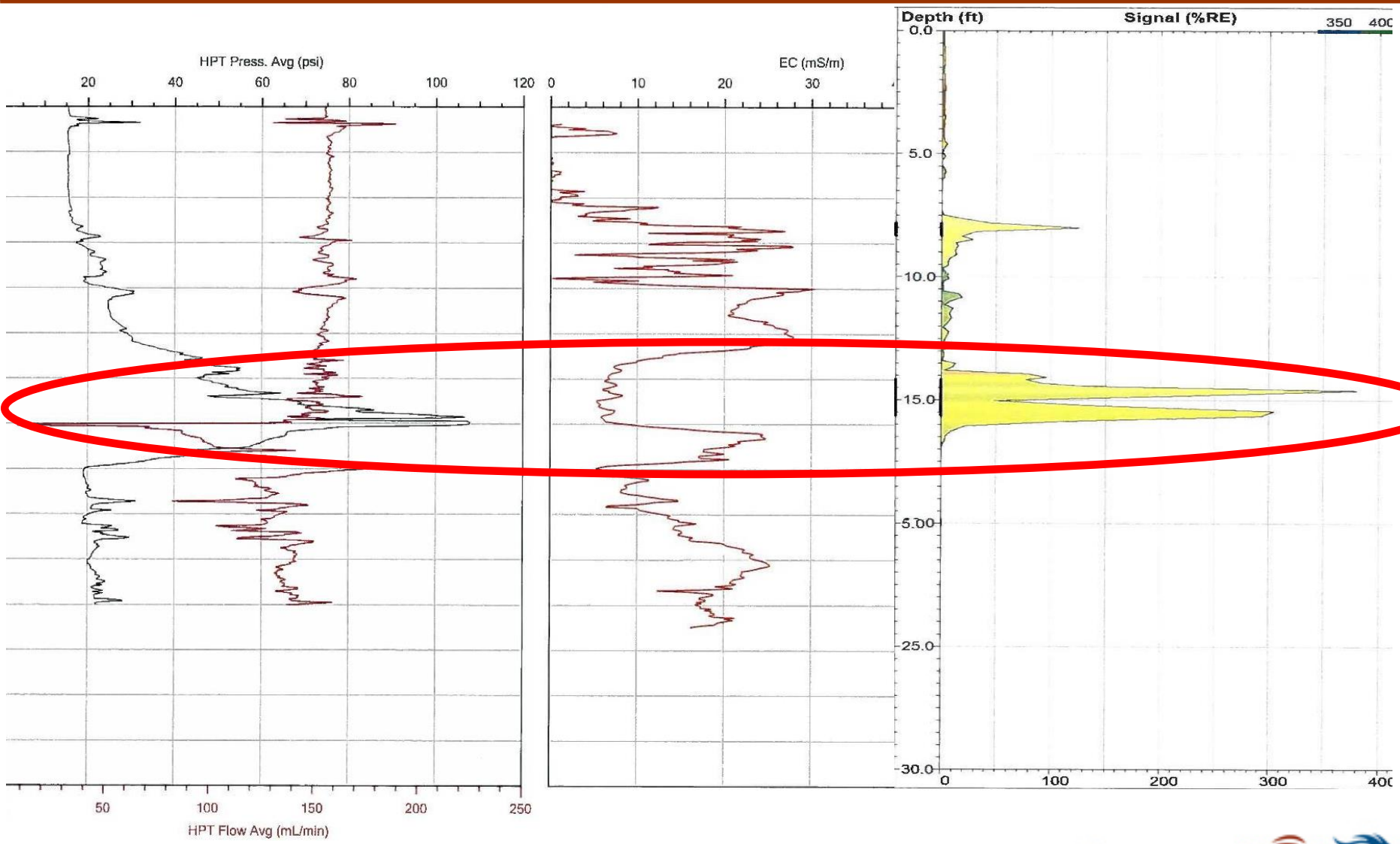
COMBINING UVOST, HPT & EC



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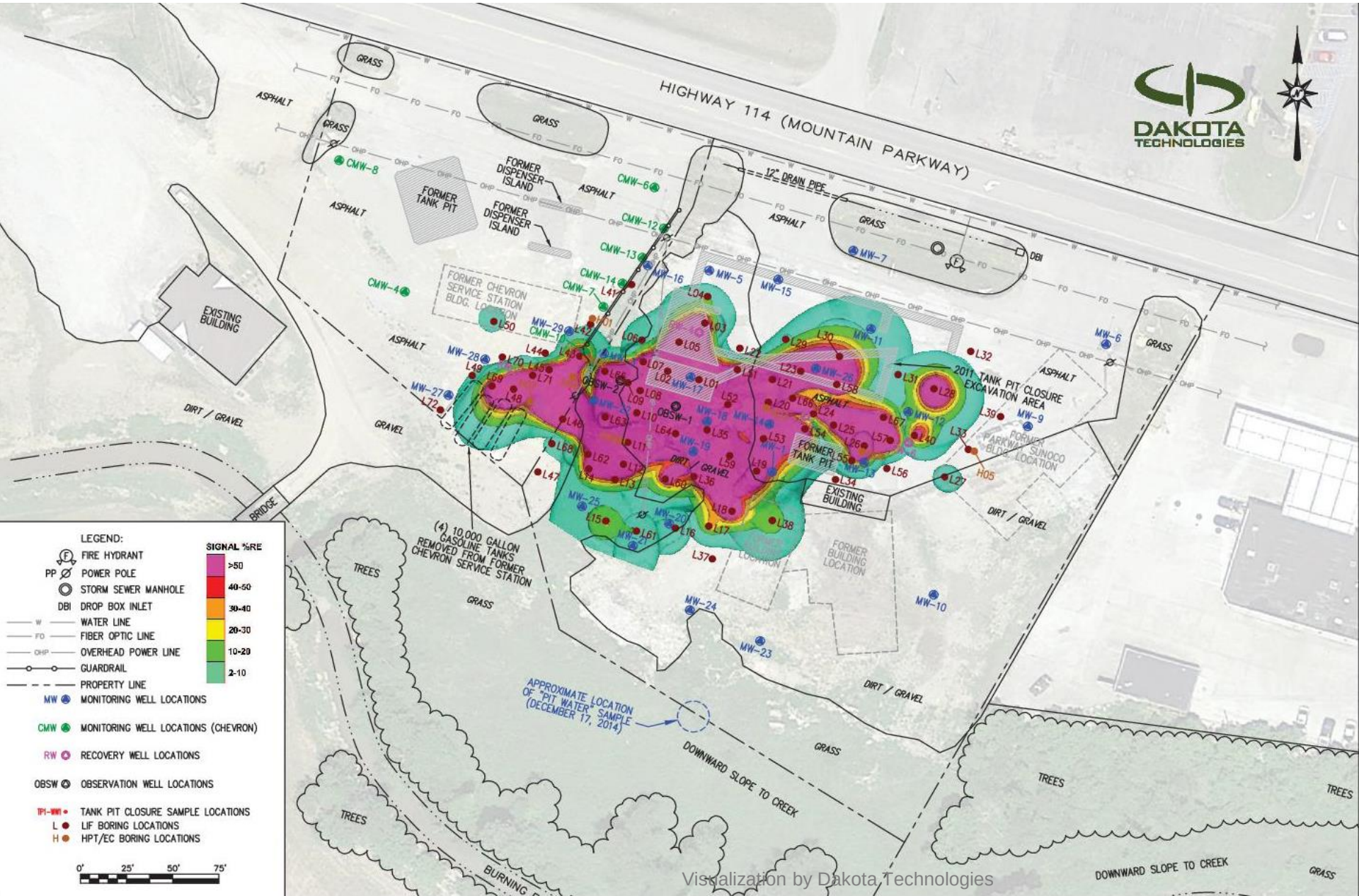
PROPOSED PATH FORWARD REMEDIATION STRATEGIES



Visualization by Dakota Technologies

Case 2 – Sammy's Grocery

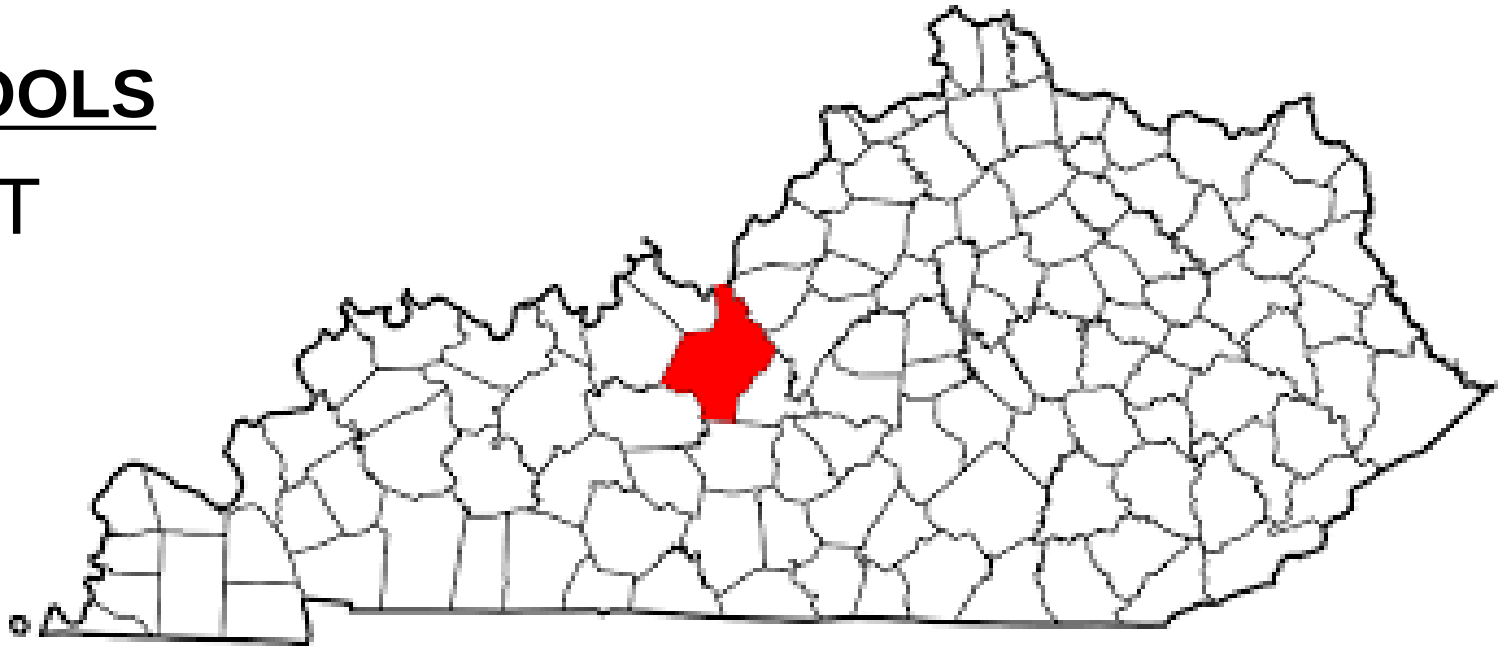
Sonora, Hardin County, Kentucky

Geology

- Mississippian Plateau physiographic province
- Karstic bedrock (Saint Genevieve & St. Louis limestone)

HRSC Tools

- UVOST
- HPT
- EC



Case 2 – Sammy's Grocery

Site Specifics

- Bedrock > 60 ft bgs
- Silty-Clay & Terra Rossa (to ~10 ft bgs)
- Hard/compact sand zones
- Heaving-sands and silt with clay-stringers
- Highly-variable water-table ranging from 8 to 18 ft bgs
- Comingled plumes from multiple tank-pits

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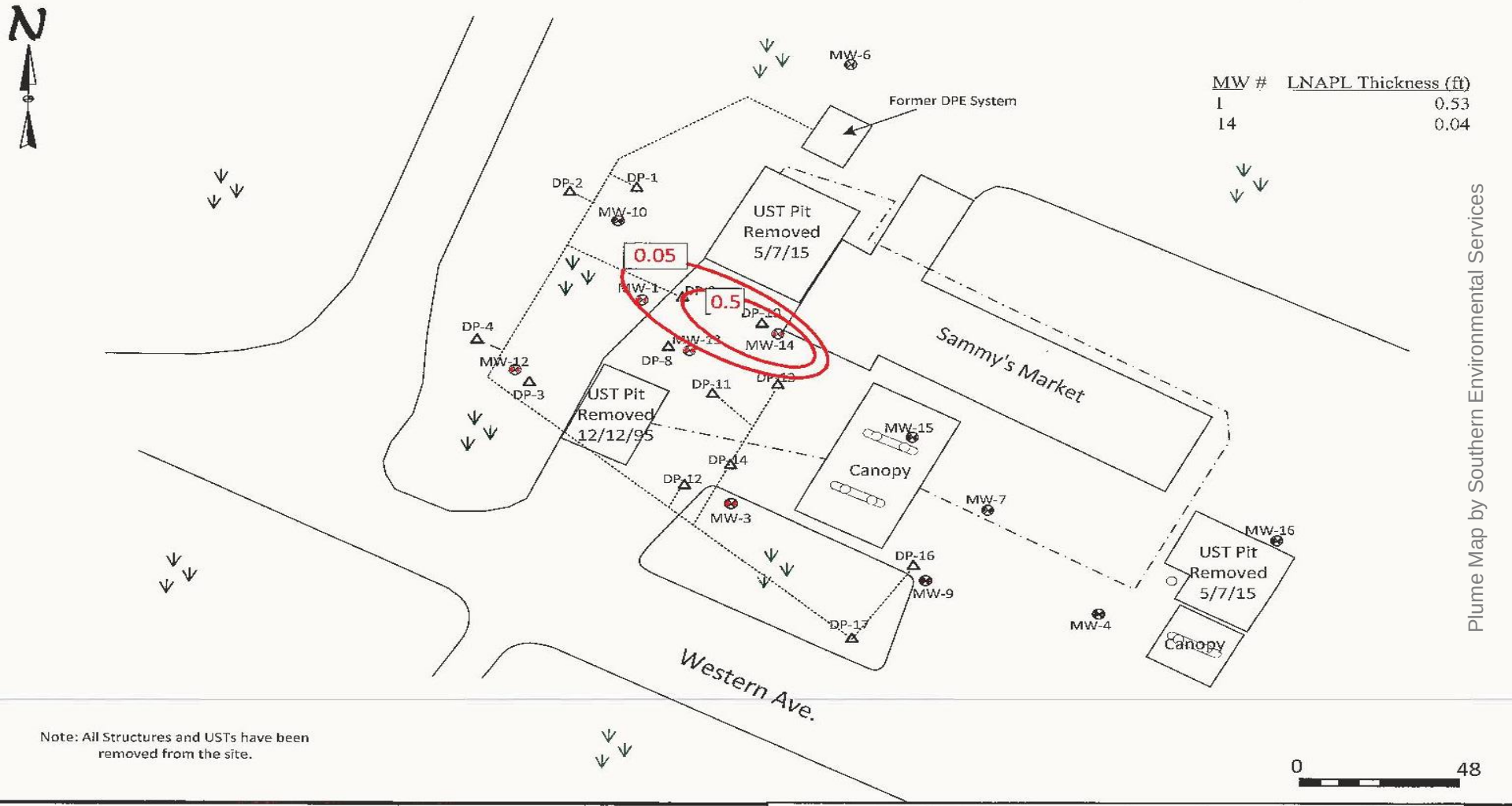
CASE 2 – SAMMY'S GROCERY



SOUTHERN ENVIRONMENTAL SERVICES
(270) 783-8151
4369 LOUISVILLE RD. BOWLING GREEN, KY 42101

Sammy's Market
490 East Western Ave.
Sonora, KY
AI# 1688

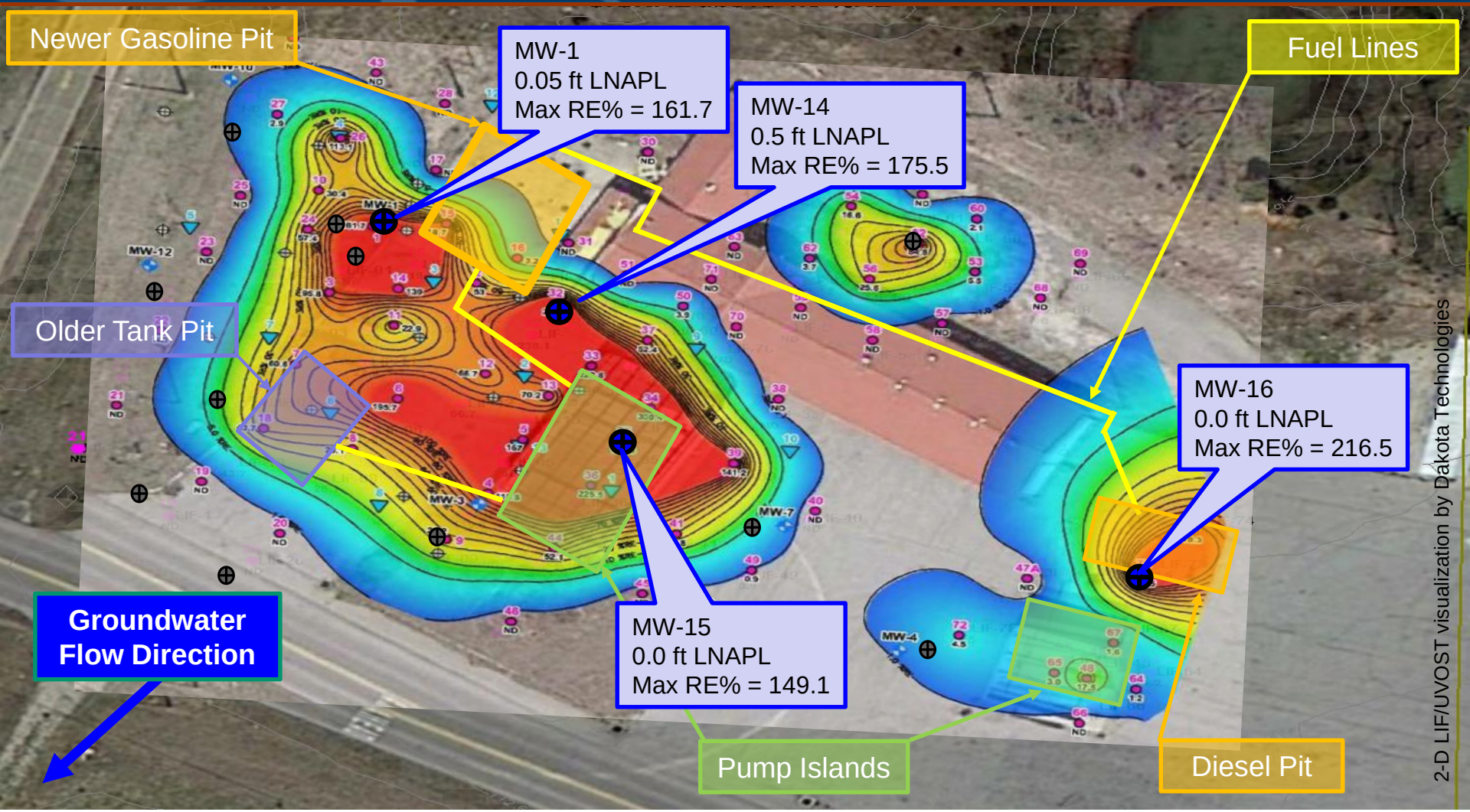
Lat: 37° 31' 15" N
Long: 85° 52' 53" W

DWN BY: BM
Date: 12/5/11

Figure 9, LNAPL Thickness on Groundwater (ppm) – 6/6/18

- Pump Island
- Dispenser
- Grass
- Product Transfer Piping
- System Piping
- Monitrong Well
- Extraction Well
- LNAPL Isocontour

CASE 2 – SAMMY'S GROCERY



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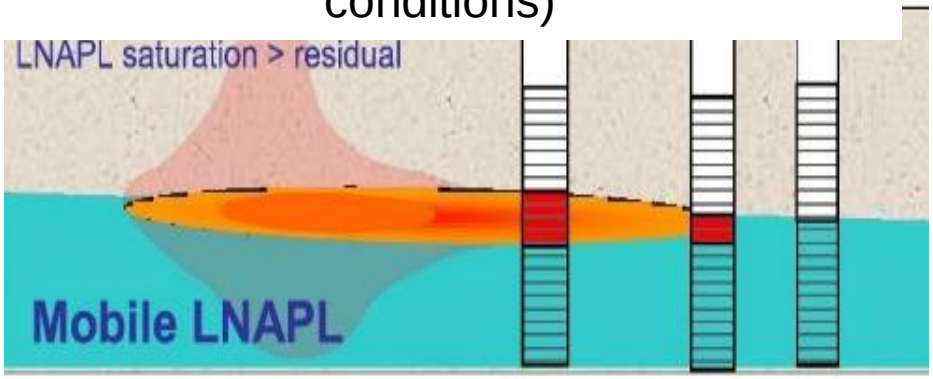
CASE 2 – SAMMY'S GROCERY

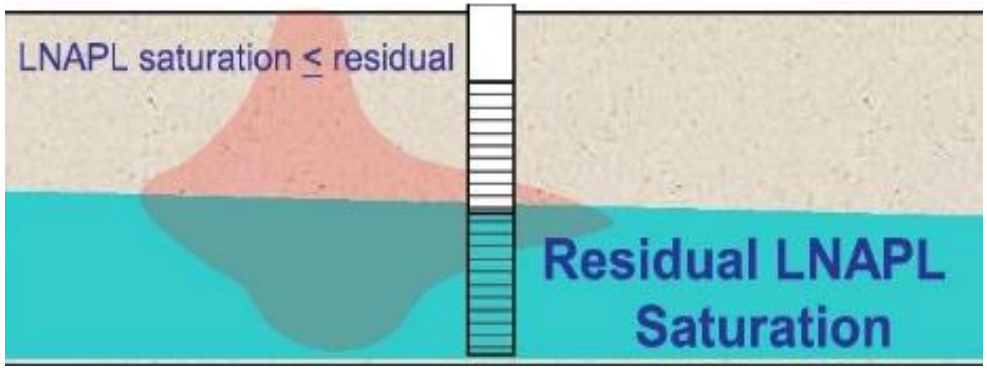
Measurable LNAPL **present** in Wells

(LNAPL equilibrates with formation conditions)

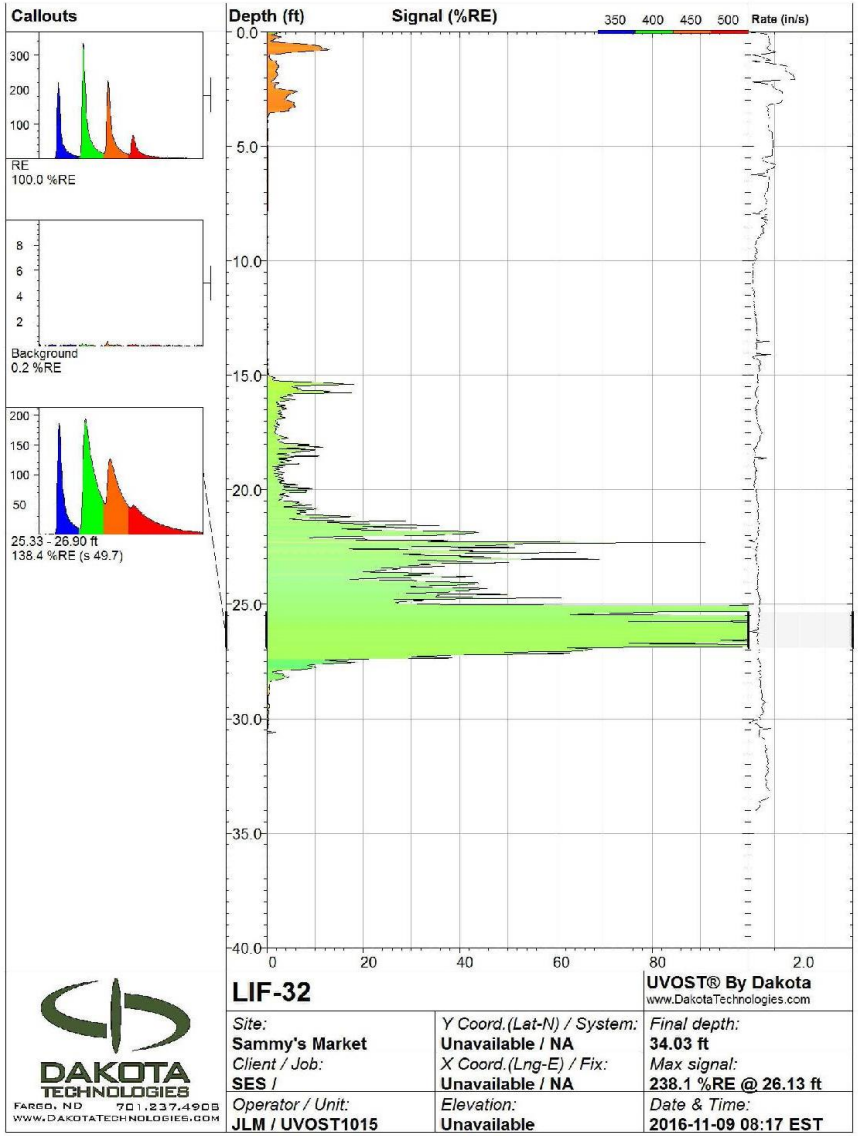


LNAPL **NOT** measurable in Wells

("ganglia", smear-zones, etc.)

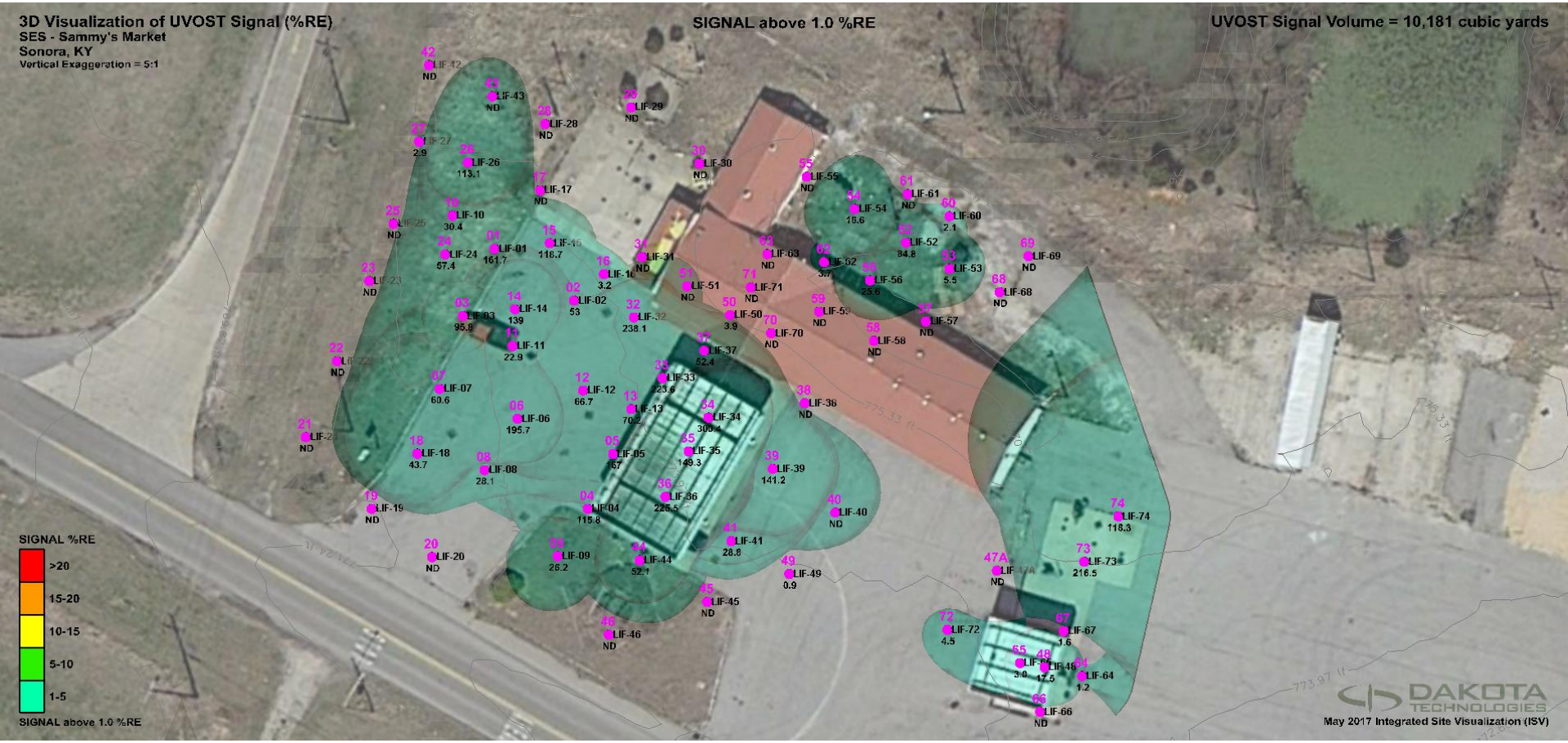


Measurable LNAPL drawing courtesy of ITRC (Interstate Technology & Regulatory Council)



Waveform interpretation by Dakota Technologies

CASE 2 – SAMMY'S GROCERY



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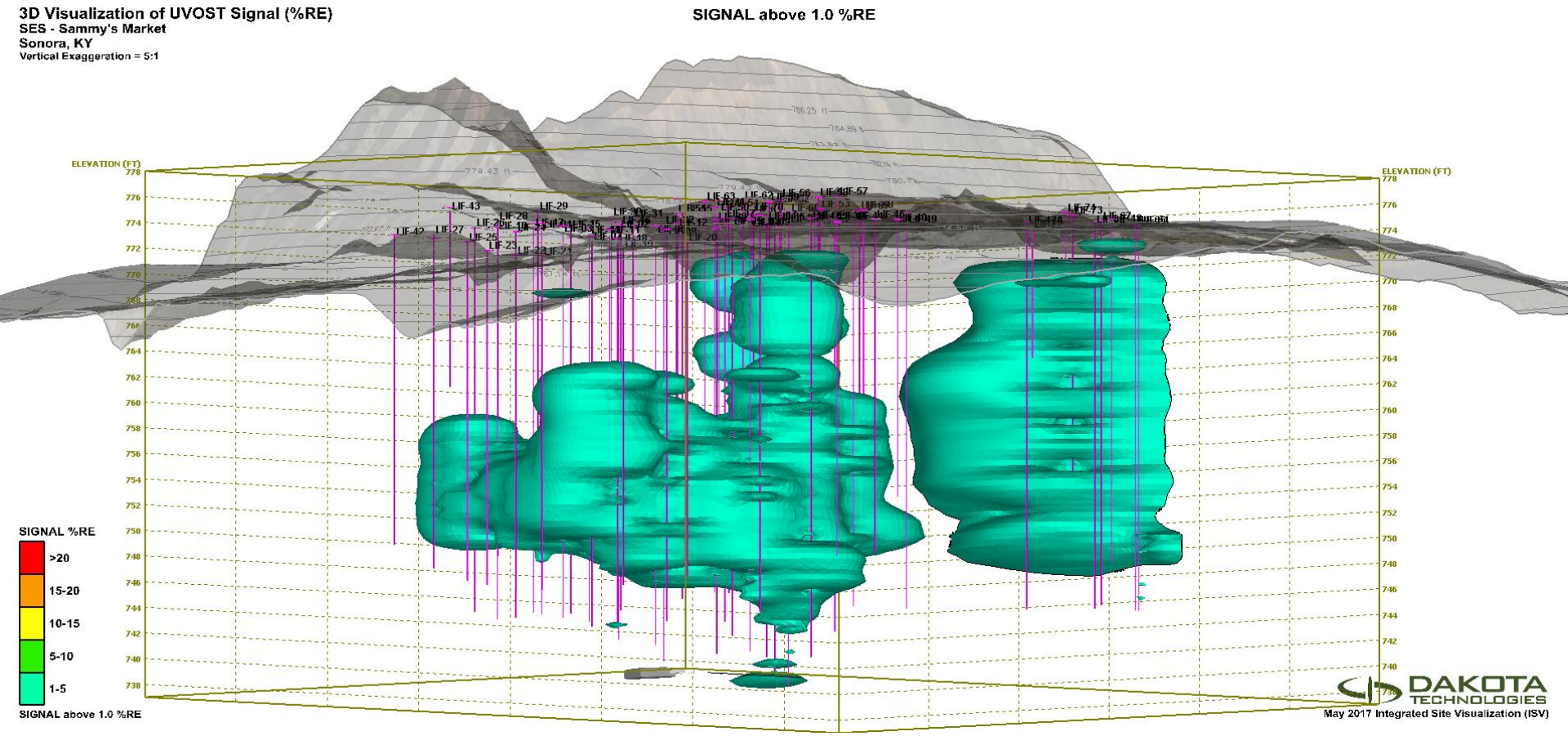

3-D LIF/UVOST visualization by Dakota Technologies

Lessons Learned from the HRSC "Toolbox"

HPT & EC

- Lithologic characterization (overburden)
- Migration pathway characterization
- Development of potential injection strategy
- Facilitate location & design of new monitoring-wells

LIF/UVOST

- At the two case-study sites, LIF/UVOST worked well for characterizing LNAPL plumes.
- Does not necessarily reflect measureable-thickness of LNAPL at monitoring-well.

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LESSONS LEARNED FROM THE HRSC "TOOLBOX"

LIF/UVOST (CONTINUED)

- Does not provide data regarding dissolved-phase or vapor-phase contamination (and does not claim to).
- Potential confirmation sampling issues.
- Differing fuels have differing fluorescing intensities
- Soil matrix (grain size) affects results
- Be hesitant to "cherry-pick" peaks

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ACKNOWLEDGEMENTS

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Thank You!

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KENTUCKY UNDERGROUND STORAGE TANK BRANCH

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