Soil and Groundwater: Data Acquisition and Interpretation @ LUST Sites

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ITEP

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Environmental Sampling

- **An attempt** to choose and extract a representative portion of a physical system from its surroundings.
- This presentation is a general attempt to point out alternative methods of obtaining soil & ground water samples at LUST sites.
Objectives for sampling activities

- Provide accurate results
- Documentation of activities
- Select location and number of samples to support the intended results
- Provide for proper chain of custody and handling of samples
Sampling events can be designed and conducted to:

- Determine the environmental/human impact of releases from UST facilities
- Determine the facility’s compliance with the provisions and intent of environmental laws
- Evaluate the chemical of concern (COC) & extent of contamination in the soil and/or ground water regime
continued

- Evaluate the effectiveness of remediation technologies in regard to meeting “action levels” or closure performance standards

- Determine the most effective placement of a remediation system there by saving time, money, and practicing sustainable remediation techniques
Types of sampling activities

- Split sampling
- Independent sampling
- Discrete versus Composite
  - Discrete advantages: identifies hot spots or specific area of contamination
  - Composite: physical mixing individual samples, more cost effective
Pre-Sampling Evaluation

Why?
What?
Where?
When?
How?

- Consider sustainable and site best management practices
Confirmed Release & Initial Response Actions

- Facility owner/operator has confirmed a release through facility leak detection system or a release has been detected by other means.
- An initial response has taken place and verification has been made by qualified personnel that the site is safe and immediate threat from the COCs is controlled.
- An attempt has been made to identify the source, quantity, and effected media of concern through a file review and site reconnaissance.
How?
Start with a Sampling & Analysis Plan

- Hard to get contractors to change methods
- Site owners in Indian Country choose the contractors to do the work and remediate the site using their financial assurance mechanism
- In some cases State or Federal funds & contractors are used to assess and remediate a LUST site on tribal land
How do you know you need to sample?

- You can just smell it, see it or even hear it coming out of the ground most of the time
Results - Sources of Release

Dispenser: 32%
Tank: 16%
STP Area: 4%
Others: 1%
Delivery Problems: 16%
Piping: 31%
Dispenser: 32%
Results - Methods of Identification

Visual/Olfactory is most common method of ID

Leak Detection - caught problems 17% of the time

Problems were found at closure 13% of the time
Some techniques that have been tried

Don’t worry bout a thing – every little thing gonna be alright.

Bob Marley

From LDEQ LUST Cleanup presentation 2011
Ex situ Data Collection & Analysis

Grab sample for composite results. Does not tell you much.
Presence/Absence & grain size of disturbed material. This of course is tank backfill material.
Utilize Consistent Techniques

- A reasonably accurate representation of what exists in the subsurface can be constructed by either using data gathered insitu, down hole logging, or exsitu, by visually and physically analyzing the core brought to the surface.

- Try to avoid “hit or miss” methods. A cheap headspace vapor hit may be an expensive analytical miss.
Hot sun, hot metal surface, what kind of reading would you expect from a PID or head space if you took a sample of this core and put into a baggie?
Soil Sampling and Data Collection

Vapor Field
Screening of Subsurface Soil
Baggie Method
Headspace sample technique

Take a sample from here and put into a baggie OR directly insert probe into core and take a sniff. I mean reading.
Another technique inside & later
BAGGIE PROCEDURE

- Unknown volume of soil placed into a sealed baggie and allowed to warm up (somehow)
- Baggie is opened and FID-PID-HNU-OVM probe inserted. Reference gas is not a gasoline COC
- Instrument gathers data for a time, usually when reading stabilizes
### Exhibit VI-1

Summary Table Of Field Methods For Petroleum Hydrocarbon Analysis

<table>
<thead>
<tr>
<th>Test Method</th>
<th>Media&lt;sup&gt;1&lt;/sup&gt;</th>
<th>Analyte</th>
<th>Data Quality Level&lt;sup&gt;2&lt;/sup&gt;</th>
<th>Analysis Time</th>
<th>Cost Per Sample&lt;sup&gt;3&lt;/sup&gt;</th>
<th>Skill Level</th>
<th>Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detector Tubes</td>
<td>✓</td>
<td>&gt;100 specific compounds</td>
<td>1A/1B</td>
<td>5 to 15 min</td>
<td>$8 to $27</td>
<td>Low</td>
<td>High degree of cross-reactivity</td>
</tr>
<tr>
<td>Fiber Optic Chemical Sensors</td>
<td>✓</td>
<td>VOCs and SVOCs ≥ C₆</td>
<td>1A/1B</td>
<td>3 to 5 min</td>
<td>&lt;$1 to $10</td>
<td>Low</td>
<td>Does not measure specific constituents</td>
</tr>
<tr>
<td>Colorimetric Test Kits</td>
<td>✓</td>
<td>Aromatic hydrocarbons</td>
<td>1A/1B</td>
<td>10 to 20 min</td>
<td>$17 to $42</td>
<td>Low-Medium</td>
<td>Colors may be difficult to distinguish</td>
</tr>
<tr>
<td>TOV Methods With FID/PID</td>
<td>✓</td>
<td>Total VOCs</td>
<td>1A/1B</td>
<td>1 to 30 min</td>
<td>&lt;$1 to $10</td>
<td>Low-Medium</td>
<td>Does not measure specific constituents</td>
</tr>
<tr>
<td>Turbidimetric Test Kit</td>
<td>✓</td>
<td>TPH of mid-range hydrocarbons (e.g., diesel fuel)</td>
<td>1B</td>
<td>15 to 20 min (25 per hour)&lt;sup&gt;4&lt;/sup&gt;</td>
<td>$10 to $15</td>
<td>Low-Medium</td>
<td>Not useful for gasoline</td>
</tr>
<tr>
<td>Immunoassay Test kits</td>
<td>✓</td>
<td>TEX/PAHs/TPH</td>
<td>1B</td>
<td>30 to 45 min (5 to 8 per hour)&lt;sup&gt;4&lt;/sup&gt;</td>
<td>$20 to $60</td>
<td>Medium</td>
<td>Cross-reactivity may affect interpretation</td>
</tr>
<tr>
<td>Portable Infrared Detectors</td>
<td>✓</td>
<td>TPH of hydrocarbons C₅ to C₂₅</td>
<td>2</td>
<td>5 to 20 min</td>
<td>$5 to $30</td>
<td>Medium</td>
<td>VOCs are not accurately analyzed</td>
</tr>
<tr>
<td>Field GC</td>
<td>✓</td>
<td>Specific VOCs and SVOCs</td>
<td>2/3</td>
<td>10 to 60 min&lt;sup&gt;5&lt;/sup&gt;</td>
<td>$20 to $70</td>
<td>Medium-High</td>
<td>Requires a skilled technician</td>
</tr>
</tbody>
</table>

<sup>1</sup> Soil (S), Soil-Gas (SG), Water (W)
<sup>2</sup> Data quality levels are discussed in further detail in the following text
<sup>3</sup> Includes estimation of capital costs and disposables -- excludes labor
<sup>4</sup> When run in batches
<sup>5</sup> Longer times result when high quality method preparations are performed
Attempting to control 4 variables sample volume, container volume, time, temp.
Speed is of the Essence

- The less the soil matrix is disturbed until it has been containerized, the better.
- But first the core needs to be screened for concentration and sample zone selected for lab analysis.
- Limit sample exposure to air.
- If using split spoon samples, wrap core in plastic wrap or foil-tightly.
Collected new soil vapor data from sleeved cores

- Used sleeved cores to minimize vapor loss.

Drill-hole OVM method for vapor profile sampling
Step #1: Expose center of core

Step #2: Extract core sample
Step #3: Inject core into prepared vial

Combining the OVM readings vs. laboratory analytical data results in the following graph
Core Description

- From hollow stem auger, hydraulic direct push rig, or split spoon sampler describe and photograph in as much detail as practicable.
- Make a field evaluation of the porosity and permeability. Visible voids of 1 mm are categorized as macroporosity.
- Mesoporosity (1mm-0.01mm) can be qualitatively assessed by using a 3X to 10X hand lens.
Grain Size is important

<table>
<thead>
<tr>
<th>Example</th>
<th>Grain Size:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Coarse Sand</td>
<td>1.0 – 2.0 mm</td>
</tr>
<tr>
<td>Coarse Sand</td>
<td>0.5 – 1.0 mm</td>
</tr>
<tr>
<td>Medium Sand</td>
<td>0.25 – 0.5 mm</td>
</tr>
<tr>
<td>Fine Sand</td>
<td>0.125 – 0.25 mm</td>
</tr>
<tr>
<td>Very Fine Sand</td>
<td>0.0625 – 0.125 mm</td>
</tr>
<tr>
<td>Silt</td>
<td>0.0625 – 0.002 mm</td>
</tr>
<tr>
<td>Clay</td>
<td>&lt; 0.002 mm</td>
</tr>
</tbody>
</table>
Conduct a Sieve Analysis

- When taking a sample for a sieve analysis in order to determine hydraulic conductivity for that particular coring location, it should always be a composite sample.
- Beginning with the capillary fringe and extending down through as much saturated zone as is encountered.
- The more heterogeneous the section, the more important the composting procedure.
Why do all of this? Have you ever seen a Smear Zone?

- The subsurface is very heterogeneous, but that is hard to explain, so we treat it as homogenous because that is the way we like to look at things.
- To further complicate things, nature takes the fuel and smears it all over the place making it harder to find and remediate.
Sampling events can be designed and conducted to:

- Determine the environmental/human impact of releases from UST facilities
- Determine the facility’s compliance with the provisions and intent of environmental laws
- Evaluate the chemical of concern (COC) & extent of contamination in the soil and/or ground water regime
Continued (this one too?)

- Evaluate the effectiveness of remediation technologies in regard to meeting “action levels” or closure performance standards
- Determine the most effective placement of a remediation system thereby saving time, money, and practicing sustainable remediation techniques
Workshop Activity

- Find Base map with monitoring well locations
- Plot Vapor reading ratio thickness for highlighted monitoring wells
- Draw ratio thickness contours using 50 foot contour intervals
- Compare to Oklahoma PSTD drawings and cross sections
<table>
<thead>
<tr>
<th>Well No.</th>
<th>Total OVM Readings</th>
<th>Vertical Feet</th>
<th>Ratio (OVM Total)/(Thickness-ft)</th>
<th># of Data Points</th>
<th>TD</th>
</tr>
</thead>
<tbody>
<tr>
<td>MW-1</td>
<td>2996</td>
<td>18</td>
<td>166</td>
<td>4</td>
<td>20</td>
</tr>
<tr>
<td>MW-2</td>
<td>612</td>
<td>18</td>
<td>34</td>
<td>4</td>
<td>20</td>
</tr>
<tr>
<td>MW-3</td>
<td>280</td>
<td>18</td>
<td>15</td>
<td>4</td>
<td>20</td>
</tr>
<tr>
<td>MW-4</td>
<td>158</td>
<td>13</td>
<td>12</td>
<td>3</td>
<td>15</td>
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<tr>
<td>MW-5</td>
<td>1650</td>
<td>13</td>
<td>127</td>
<td>3</td>
<td>15</td>
</tr>
<tr>
<td>MW-6</td>
<td>190</td>
<td>10</td>
<td>19</td>
<td>3</td>
<td>15</td>
</tr>
<tr>
<td>MW-7</td>
<td>20</td>
<td>13</td>
<td>2</td>
<td>4</td>
<td>15</td>
</tr>
<tr>
<td>MW-8</td>
<td>100</td>
<td>13</td>
<td>8</td>
<td>4</td>
<td>15</td>
</tr>
<tr>
<td>MW-9</td>
<td>1157</td>
<td>13</td>
<td>89</td>
<td>4</td>
<td>15</td>
</tr>
<tr>
<td>MW-10</td>
<td>1942</td>
<td>18</td>
<td>108</td>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td>MW-11</td>
<td>173</td>
<td>18</td>
<td>22</td>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td>MW-12</td>
<td>160</td>
<td>15</td>
<td>11</td>
<td>4</td>
<td>20</td>
</tr>
<tr>
<td>MW-13</td>
<td>600</td>
<td>18</td>
<td>33</td>
<td>4</td>
<td>20</td>
</tr>
<tr>
<td>MW-14</td>
<td>26</td>
<td>15</td>
<td>1</td>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td>MW-15</td>
<td>247</td>
<td>18</td>
<td>14</td>
<td>4</td>
<td>20</td>
</tr>
<tr>
<td>MW-16</td>
<td>1804</td>
<td>18</td>
<td>54.4</td>
<td>4</td>
<td>20</td>
</tr>
<tr>
<td>MW-17</td>
<td>1475</td>
<td>18</td>
<td>82</td>
<td>4</td>
<td>20</td>
</tr>
</tbody>
</table>
Ratio Map
PPM/ft
50' contour

Residential Property

Garage/Service Station - UST-Release Site -

North Washington Aven

MW-2, MW-8

MW-3

Concrete Pavement

Geneva Tank Pk

Water

Concrete Pavement

Gas

Strom

Garage

MW-1

Pump Island

North Washington Rd

OE

MW-4

Drainage

Concrete Pavement

Gas - 2" pipe

Sanitary Drains

Grass Field

MW-9

Concrete Pavement

Former Tank Pk

Former Tank Pk

Former Tank Pk

Former Tank Pk

Former Tank Pk
<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Description of Material</th>
<th>USGS</th>
<th>Depth of OVM sample</th>
<th>OVM PPM</th>
<th>DRILLING AND SAMPLING NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-0.5</td>
<td>Concrete Cover</td>
<td></td>
<td>0'-0.5'</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>0.5-3'</td>
<td>Not Recovered - Post hole dug samples</td>
<td></td>
<td>0.5'-3'</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>3'-4'</td>
<td>Silt Fill - Red-brown, moist, no odor</td>
<td></td>
<td>3'-4.5'</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>4.5-5'</td>
<td>Not Recovered</td>
<td></td>
<td>4.5'-5.5'</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>5'-7.5'</td>
<td>Siltstone - Red-brown, hard, moist, no odor</td>
<td></td>
<td>5'-7.5'</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>7.5-10'</td>
<td>Not Recovered</td>
<td></td>
<td>7.5'-10'</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>10'-13'</td>
<td></td>
<td></td>
<td>10'-13'</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>8'-10'</td>
<td>Siltstone - Red-Brown, hard, moist to very moist, no odor</td>
<td></td>
<td>8'-10'</td>
<td>13'-15'</td>
<td>870</td>
</tr>
<tr>
<td>10'-12.5'</td>
<td>Not Recovered</td>
<td></td>
<td>10'-12.5'</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>12.5-15'</td>
<td>Siltstone - Red-brown, hard, moist to very moist, slight odor</td>
<td></td>
<td>12.5'-15'</td>
<td>15'-17.5'</td>
<td>NS</td>
</tr>
<tr>
<td>15'-19'</td>
<td>Not Recovered</td>
<td></td>
<td>15'-19'</td>
<td>7.5'-20'</td>
<td>600</td>
</tr>
<tr>
<td>19' - 20'</td>
<td>Not Recovered</td>
<td></td>
<td>19' - 20'</td>
<td>NS</td>
<td></td>
</tr>
</tbody>
</table>

T.D. = 20'
Benzene Concentration in GW
A Nice X-Section Example
A Nice Isopach of Vapor concentration
An Example of a Ratio Map of Vapor concentration
Shallow Gamma Ray Scan

WellCAD demo

Feature demonstrated:
Core description with extensive sedimentology description and grain size

Advanced Logic Technology - route de Niederpallen, L-8506 Redange - Tel: +352 23 649 289 - email: sales@alt.lu

<table>
<thead>
<tr>
<th>age</th>
<th>rock units</th>
<th>Gamma Ray (API units)</th>
<th>log depth (m)</th>
<th>driller depth</th>
<th>Core</th>
<th>grain size and sedimentary structure</th>
<th>sedimentary structure</th>
<th>sedimentary qualifier</th>
<th>lithology</th>
<th>lithology description</th>
<th>interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:60</td>
<td>0</td>
<td>20</td>
<td></td>
<td></td>
<td></td>
<td>Pebble</td>
<td>Very coarse sand</td>
<td>Medium sand</td>
<td>Salt</td>
<td>Clast supported conglomerate overlain by carbonates and evaporites</td>
<td>Transgressive marine sh conglomerate overlain by marginal marine to lago carbonates and evaporites</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Clay</td>
<td></td>
<td></td>
<td></td>
<td>Coal, mudstone, conglomerates and variably pebbly sandstones</td>
<td>Fan delta with fringing l swamps</td>
</tr>
</tbody>
</table>

Page 1