Residual LNAPL Remediation Using BOS 200® at Budget Rental Car Site in Louisville, Kentucky USA

Background Information

Linebach Funkhouser, Inc. (LFI) personnel performed permanent closure, assessment and corrective action activities on (UST) systems at a former retail petroleum facility located in Louisville approximately one-quarter mile northwest of the Louisville International Airport. Three gasoline/diesel USTs were removed from the subject site in 1997. During the removal of the USTs, a large amount separate phase product was observed leaching into the common tank pit area. Product recovery procedures were immediately initiated to mitigate the contamination concurrent with notifying the appropriate agencies including the Kentucky Department for Environmental Protection (KDEP), Division of Waste Management, Emergency Response Section and the State Fire Marshal’s Office. Following the completion of the removal and initial abatement procedures, several documents including Initial Abatement, Product Recovery and UST Permanent Closure reports were filed with the KDEP, DWM, Underground Storage Tank Branch (USTB) on our client’s behalf. Several assessments were completed to define the horizontal and vertical extent of the separate phase and dissolved petroleum contaminant plumes identified in the shallow groundwater (approximately 6 feet) which included the installation of 16 monitoring wells on and off-site. LFI personnel enrolled our client in the USTB Petroleum Storage Tank Environmental Assurance Fund (PSTEAF) in an effort to recover eligible costs for assessment and remediation. A Corrective Action Plan (CAP) was written for the site in 2001 outlining mechanical methods of remediation utilizing a traditional pump & treat combined with soil/ vapor extraction (SVE) system. The original CAP was approved by the USTB but never implemented.

A subsequent CAP was written for the site with the assistance of AST Environmental, Inc. (AST) that proposed utilizing a “cutting edge” in-situ remediation technology that consisted of a remediation product developed by Remediation Products, Inc. (RPI) of Golden, Colorado known as BOS 200® a Trap & Treat® Bacteria Concentrate combined with a high velocity/high pressure delivery system designed and implemented by AST. This combined successful product/delivery remediation technology was outlined is a subsequent CAP that was submitted and approved by the USTB in June 2011.
Prior to implementation of the subsequent CAP, subsurface impacts consisted of petroleum hydrocarbons in soils, accumulation of light non-aqueous phase liquids (LNAPL) in three monitoring wells MW-3, MW-5 and MW-6, and aqueous phase (dissolved) benzene in groundwater as high as 11 mg/L.

The impacted area immediately surrounding the former tank pit, occupies approximately 7,000 square feet (ft) and had both soil and groundwater impacts.

**Remedial Effort**

In December 2010, Linebach Funkhouser, Inc., (LFI), and AST Environmental, Inc., (AST) teamed to develop a remedial approach to address the LNAPL and dissolved phase petroleum hydrocarbon impacts at the site. Specifically, an injection design was prepared and implemented to address LNAPL and dissolved phase petroleum hydrocarbons in the following monitoring wells:

- MW-1, benzene (0.94 mg/L) and naphthalene (0.8 mg/L)
- MW-2, benzene (0.35 mg/L) and naphthalene (0.6 mg/L)
- MW-3, benzene (11.2 mg/L) and naphthalene (1.4 mg/L) and LNAPL (0.15 ft thickness)
- MW-5, benzene (0.04 mg/L) and naphthalene (0.1 mg/L) and LNAPL (0.05 ft thickness)
- MW-6 LNAPL (0.01 ft thickness) – diesel range
The goal was to inject BOS 200® to remediate the site for removal all the LNAPL and reduce benzene concentration to below 0.005 mg/L in the on-site monitoring wells. The figure below provides the location of the impacted wells.

Full Scale Design and Implementation

As shown below there are five (5) areas associated with six (6) monitoring wells that were impacted with petroleum hydrocarbons. The specific injection design for each of these areas is detailed below. The injection point spacing varied from 5 to 7.5 feet center.

Area A (MW-5 and MW-6 (~1400 sf))
- 25 injection points (on 7.5’ centers)
- 12 injection points injected at 6, 8, 10, 12 & 14 feet below grade surface (bgs)
- 13 injection points injected at 5, 7, 9, 11 & 13 feet bgs
- 25 pound shots at all 125 injections ~ 3125 pounds BOS 200®
- 6.25 gallons Trap & Treat® Bacteria Concentrate
- Approximately 2,500 gallons of city water (~8 gallons per injection)

Area B (MW-4 (~450 sf))
- 8 injection points (on 7.5’ centers)
- 4 injection points injected at 6, 8, 10, 12 & 14 feet bgs
- 4 injection points injected at 5, 7, 9, 11 & 13 feet bgs
- 15 pound shots at all 40 injections ~ 600 pounds BOS 200®
- 1.25 gallons Trap & Treat® Bacteria Concentrate
- Approximately 600 gallons of city water (~8 gallons per injection)

Area C (MW-3 – 11 mg/L (~1200 sf))
- 48 injection points (on 5’ centers)
- 24 injection points injected at 6, 8, 10, 12 & 14 feet bgs
- 24 injection points injected at 5, 7, 9, 11 & 13 feet bgs
- 1st Injection Event
  - 20 pound shots at all 240 injections ~ 4,800 pounds BOS 200®
  - 10 gallons Trap & Treat® Bacteria Concentrate
  - Approximately 1950 gallons of city water (~8 gallons per injection)

Area D (MW-2 - 0.4 mg/L (~1075 sf))
- 19 injection points (on 7.5’ centers)
- 9 injection points injected at 6, 8, 10, 12 & 14 feet bgs
- 10 injection points injected at 5, 7, 9, 11 & 13 feet bgs
- 20 pound shots at all 95 injections ~ 1900 pounds BOS 200®
- 4 gallons Trap & Treat® Bacteria Concentrate
- Approximately 800 gallons of city water (~8 gallons per injection)

Area E (MW-1 - 0.94 mg/L (~2800 sf))
- 50 injection points (on 7.5’ centers)
- 25 injection points injected at 6, 8, 10, 12 & 14 feet bgs
- 25 injection points injected at 5, 7, 9, 11 & 13 feet bgs
- 40 pound shots at all 250 injections ~ 10,000 pounds BOS 200®
- 20 gallons Trap & Treat® Bacteria Concentrate
- Approximately 2,250 gallons of city water (~8 gallons per injection)

On Friday, August 19, 2011, 20,400 lbs of BOS 200® was delivered to the Budget Site. On the morning of August 22, 2011, AST mobilized personnel and equipment to the site and setup for the injection effort to begin that day. The injections were completed in 8 workdays with AST injecting the 20,400 pounds (lbs) in 150 injection points to
approximately 14' below grade surface. AST prepared BOS 200® slurries and injected it into the subsurface through probe rods. The slurry is pumped through the probe rods using a positive displacement diaphragm pump capable of delivering 1,200 pounds per square inch (psi) at 35 gallon per minute (gpm). The injection pressure varied from 200 to 600 psi. The pressure injection scheme created extensive “fracturing or soil lifting” of the soil to create preferential pathways within the fine grain clay which are filled with BOS 200®. The injection effort was completed on 8/31/2011.

The Tables 1 and 2 below provide the results for the LNAPL monitoring and the post-injection analytical. As seen in the table LNAPL monitoring was performed in January, June, July and October 2012. The events demonstrated no presence of LNAPL. Also, groundwater sampling was performed in June, July and October 2012 and the results from this provided Benzene and other contaminants of concern concentrations below the clean-up standards. The benzene goal being 0.005 mg/L. Although, not shown here ethylbenzene, toluene, xylenes and naphthalene concentrations were all below 0.5 ug/L. The post injection monitoring reports from July and October 2012 provide the full list of analytes and all COCs were well below the clean-up goals. The attached Figure 3 provides from the October 2012 monitoring report provides the final results of the groundwater sampling at the site. These results are from the sampling event conducted 12 months following the injection effort.

Based on these results KY-USTB issued a No Further Action (NFA) for the site in December 2012. A copy of the NFA is provide at the end this document.
<table>
<thead>
<tr>
<th>Well ID</th>
<th>LNAPL (ft) Pre-Injection (8/22/11)</th>
<th>LNAPL (ft) Post-Injection (1/3/12)</th>
<th>LNAPL (ft) Post-Injection (6/01/12)</th>
<th>LNAPL (ft) Post-Injection (7/25/12)</th>
<th>LNAPL (ft) Post-Injection (10/11/12)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>MW-1</td>
<td>Not Present</td>
<td>Not Present</td>
<td>Not Present</td>
<td>Not Present</td>
<td>Not Present</td>
<td>The 7/25/12 and 10/11/12 were per KY-USTB directive. The 1/3/12 or 6/01/12 was for performance purposes with no directive.</td>
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<td>MW-2</td>
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<td>Not Present</td>
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<tr>
<td>MW-6</td>
<td>0.01 (Diesel related)</td>
<td>Not Present</td>
<td>Not Present</td>
<td>Not Present</td>
<td>Not Present</td>
<td>See comment above</td>
</tr>
<tr>
<td>Well ID</td>
<td>Pre-Injection Benzene (mg/L) (9/24/09)</td>
<td>Post-Injection Benzene (mg/L) (6/01/12)*</td>
<td>Post-Injection Benzene (mg/L) (7/25/12)**</td>
<td>Post-Injection Benzene (mg/L) (10/11/12)**</td>
<td>Notes</td>
<td></td>
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<tr>
<td>MW-1</td>
<td>0.94</td>
<td>ND</td>
<td>ND**</td>
<td>ND***</td>
<td>The injection effort was performed in September 2011 and the KY USTB only required 2-quarters of sampling to be performed in the 3rd and 4th quarters of 2012. In June 2012 at no cost to KY-USTB samples were collected and sent to a non-commercial lab to run BTEX and naphthalene as performance monitoring. This data was shared with the KY-USTB. In December 2012, KY-USTB issued a No Further Action for the site. See full reports from July and October Sample</td>
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<td>MW-2</td>
<td>0.35</td>
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<tr>
<td>MW-3</td>
<td>11.2</td>
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<td>ND**</td>
<td>ND***</td>
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<tr>
<td>MW-5</td>
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<td>ND</td>
<td>ND**</td>
<td>ND***</td>
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<td>ND**</td>
<td>ND***</td>
<td>See comments above</td>
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</tbody>
</table>

*Performance Monitoring on 6/01/12 – Non-Commercial Laboratory using EPA Method 8260B for VOCs – BTEX and naphthalene
ND Non-detect (<0.0005 mg/L (or <0.5 ug/L) benzene)
ND** - Commercial Lab Non-detect for Benzene – <0.001 mg/L
ND*** - Commercial Lab Non-detect for Benzene – <0.00033 mg/L
December 20, 2012

HUBER'S INC DBA BUDGET CAR AND TRUCK RENTAL
ATTN: JIM GISH OR KENNY HUBBER
4330 CRITTENDEN DRIVE
LOUISVILLE, KY 40209

Re: UST No Further Action Letter
Agency Interest Number (AI #): 47855  UST ID #: 4547056
Budget Rent A Car System Inc
4330 Crittenden Dr
Louisville, KY 40209
Jefferson County
Applicable Regulation(s): 2011 Regulations
UST System(s): Removal Date: 8/13/97
Incident #: B5399
Tank Number: STOR1 - 4,000 gallon; STOR2- 8,000 gallon; STOR3 – 8,000 gallon; STOR 4 - 560 gallon

Dear Mr Gish:

The Underground Storage Tank (UST) Branch has reviewed the site-specific information received to date for the referenced UST facility. The historical data and analyses reviewed by the UST Branch sufficiently demonstrate that the requirements of Kentucky Revised Statutes Chapter 224, Subchapter 60 and 401 Kentucky Administrative Regulations Chapter 42 applicable to corrective action have been satisfied. Therefore, no further action is required, at this time.

The UST Branch has based this determination on information submitted by Linebach Funkhouser, Inc., and reserves all rights to require additional monitoring, testing or other actions necessary to protect public health and the environment if the UST Branch determines there is need for further investigation.

All monitoring wells shall be properly decommissioned in accordance with 401 KAR 6:350 within thirty (30) days from the date of determination that the monitoring well(s) are unsuitable for use as monitoring wells or within thirty (30) days of receiving a no further action letter from the cabinet. If you have monitoring wells that are required for another investigation that is ongoing, then you may contact the UST Branch to apply for a variance to this monitoring well decommissioning requirement.

This letter serves as authorization for eligible applicants to submit a cost estimate on the appropriate worksheet in order to acquire pre-approval of site restoration and well decommissioning costs in accordance with Section 10 of 401 KAR 42:250. If seeking reimbursement, all claims shall be submitted within two (2) years after the date of this letter.
More information, including the UST Branch regulations, outlines, forms and updates, can be found online at http://waste.ky.gov/ust. If you have any questions regarding this letter, please contact Larry Hughes at 502-564-5981, ext. 4019.

Sincerely,

[Signature]

Larry Hughes, PG
UST Branch, CA Section Supervisor

Cc:

Linebach Funkhouser, Inc
114 Fairfax Avenue
Louisville, KY 40207