Environmental Resources Management

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12 January 2006

Mr. Todd Slater
Manager, Environmental Technologies and Remedial Procurement
Health, Environment and Safety
Arkema Inc.
900 First Avenue
King of Prussia, Pennsylvania 19406-0936

Subject: Work Plan for Evaluation of Dense Non-Aqueous Phase Liquid Monochlorobenzene
Arkema Inc. Portland Facility

Dear Todd:

ERM-West, Inc. (ERM) has prepared this Work Plan to detail the scope of a focused evaluation of the extent of dense non-aqueous phase (DNAPL) monochlorobenzene (MCB) in shallow and shallow-intermediate zone groundwater at the Arkema Inc. (Arkema) facility in Portland, Oregon (the "site"). The purpose of this evaluation is to better define the magnitude and extent of MCB DNAPL in the area downgradient (north) of the air sparging/soil vapor extraction (AS/SVE) system and confirm the absence of DNAPL in the area surrounding the AS/SVE system.

PROJECT BACKGROUND

The Arkema Inc. (Arkema), formerly ATOFINA Chemicals, Inc. (ATOFINA), property is a former chemical manufacturing facility located adjacent to the Willamette River in the northwest industrial area of Portland, Oregon. MCB was used at the site as a raw material in the DDT manufacturing process. MCB and DDT have impacted ground water and soil within the former DDT manufacturing area. An AS/SVE system was installed in the shallow zone aquifer in December 2004 to treat the MCB DNAPL. A performance evaluation of the AS/SVE system performed in December 2005 indicates that the silt layer that separates the shallow and shallow-intermediate zone groundwater in the area downgradient of the AS/SVE system extends to the west beneath portions of the AS/SVE system. Moreover, the MCB DNAPL perched on the silt at the base of the shallow aquifer may extend from the area

beneath the AS/SVE system to the northeast where it was possibly observed in the borings for monitoring wells MWA-8i, MWA-17si, and MWA-13. Although the December 2005 investigation provided a better assessment of the horizontal extent of the MCB DNAPL, additional investigation is needed to fully delineate the extent of the MCB DNAPL. A revised estimate of the horizontal extent of the MCB DNAPL based on the results of the December 2005 investigation is shown on Figure 1.

TECHNICAL APPROACH

This evaluation includes assessing DNAPL occurrence and thickness at points within and around the margin of the known and suspected DNAPL impacted area. The goal of this effort is to define the aerial extent, thickness, and mass of DNAPL in the shallow and shallow-intermediate water-bearing zones. This technical approach is designed to provide the data needed to assess remedial alternatives for the MCB DNAPL.

SCOPE OF WORK

The scope of this work will include the collection of soil samples from 39 boring locations using a direct-push drilling rig. At each boring an 8-foot soil core will be collected from the bottom of the shallow zone as two, 4-foot length soil cores. Each sample will be visually inspected for DNAPL (use dye as appropriate), vapor concentrations will be measured from various locations in each sample core using a photo-ionization detector (PID), and an estimate of the thickness and percent pore space of the DNAPL will be made for each soil core. Select samples will be collected for laboratory analyses of volatile organic compounds (VOCs). The boring locations are shown on Figure 2.

The samples will be collected from three general areas; the area downgradient from the AS/SVE system, the area immediately outside of the inferred DNAPL extent in the vicinity of the AS/SVE system, and the area immediately downgradient of the former manufacturing process residue trench.

For the borings situated in the area of implied DNAPL presence downgradient of the current AS/SVE system (Figure 1), the borings in the middle of the grid nearest the known DNAPL area will be advanced

first and the outer borings will be advanced until the lateral extent of the DNAPL is defined. Boring locations and depths may be modified and additional boring locations may be added to this evaluation based upon conditions encountered in the field.

Soil Boring Procedures

The soil boring at each of the 39 boring locations will be advanced using a direct-push drilling rig and dual-tube sampling equipment having the ability to performed discreet depth sampling. The dual tube sampling tool is being used because: (1) it allows each boring to be continuously cased to prevent potential cross contamination between water-bearing zones, (2) it allows the hole to be fully grouted from the bottom up, and (3) it allows a solid tip to be advanced to the target depth to minimize the amount of investigation-derived waste generated. The soil boring will be advanced as follows:

- The outer tube of the direct-push sampler with a solid point installed in the bottom will be advanced to the target depth for the particular sample. The target depth for each boring based on the depth at which the silt was encountered at previous nearby borings is indicated in Table 1.

- The outer rods will be filled with potable water to prevent sand heave, the solid tip at the bottom of the outer tube will be removed and the soil sampler will be advanced inside the outer tube.

- The soil sampler and outer tube will be advanced together for 4 feet to collect the soil core.

- The soil sampler will be removed leaving the outer tube in place to keep the hole open. Additional water may be added to prevent sand heave from locking the soil sampler inside the outer tube.

- The soil sampler will then be opened and examined. If the soil sample indicates that the shallow zone boundary silt has been reached, then the boring can be abandoned. If the sample does not include the boundary silt or DNAPL conditions indicative of the shallow zone boundary silt, the soil sampler will be advanced 6 inches and the additional sample will be evaluated. If the silt is not observed in the second sample, additional samples will be collected in 6-inch increments until the boundary silt is encountered.

All soil cores will be logged for soil lithology using USCS soil designations and will be screened at least every 6 inches using a PID by placing a small aliquot of soil in a clean polyethylene bag, breaking the sample up to promote volatilization, and then monitoring the headspace in the bag. Any visual evidence of sheen or DNAPL will be noted and any sample without conclusive visual DNAPL will be screened with an oil miscible organic dye such as Sudan IV or Oil Red O. The approximate thickness of any DNAPL deposit will be measured, and an estimate will be made of the volume of pore space occupied by the DNAPL.

All borings will be abandoned with bentonite grout mixed to appropriate weight injected through the outer probe casing from the bottom of the hole to at least the top of the water table. The boring may then be backfilled with bentonite chips to 1 foot below ground surface. All chips must be hydrated for at least 1 hour prior to repair of the surface with asphalt or concrete as appropriate.

Sample Collection Procedures

The mass of MCB in the soil is a key factor in determining the feasibility of various remedial technologies, and the cost of the remediation. To calibrate our DNAPL field observations and to determine the mass of MCB sorbed to the soil in high concentration non-DNAPL impacted areas two soil samples from borings with no visual evidence of DNAPL will be collected and analyzed for VOCs. The two laboratory samples will be collected from the bottom 0.5 inch of soil above the silt from borings in which no visual evidence of DNAPL or sheen is confirmed with a dye test.

To obtain the most representative sample of the soil conditions just above the shallow zone boundary silt, the samples will be collected from the bottom 0.5 inch of soil using SW-846 Method 5035A. The high concentration method for 5035A using methanol for field preservation should be used for the soil collection. The steps for performing this sampling method are as follow:

- Obtain pre-prepared soil sampling vials and jars from the laboratory. Each sample bottle set will include a 2-ounce jar for collecting a bulk sample for bulk density analysis, and two, 40-milliliter (ml) vials with Teflon septa and a pre-measured and pre-weighed 10 ml of laboratory grade methanol. The methanol filled vials will be used for the VOC extraction.

- The soil sample will be collected from the soil core using a soil sampling syringe to extract a plug of soil from the zone to be sampled and extruded directly into the sample vial. Each of the two 40-ml vials with methanol should be filled with as close to 10 grams of soil as possible.

- The 2-ounce jar will be packed with soil representative of the soil matrix added to the 40-ml vials. This soil does not need to be from the highly contaminated zone as it will only be used for dry bulk density analysis so long as it is representative of the lithology.

All samples will be immediately packed with ice and prevented from freezing. Pick up of the samples by laboratory courier will be arranged for the end of each day on which the samples are collected. The samples will be analyzed by North Creek Analytical of Beaverton, Oregon, an Oregon-certified laboratory, for VOCs by SW-849 8260B on a standard 2-week turnaround time.

Decontamination

All drilling and sampling gear will be decontaminated between each boring. The drilling rod and sampler will be rinsed with a hot water pressure washer, scrubbed with a Liquinox or Alconox solution, and then rinsed with the hot water pressure washer. Any reusable sampling tools will be scrubbed with an Alconox solution, rinsed in potable water, sprayed with isopropanol or methanol, and then rinsed again with potable water.

Investigation-Derived Waste

All investigation-derived wastes including soil cuttings and decontamination water will be contained in drums and labeled as instructed by the site manager. ERM will provide a log of the drums to the site manager at the completion of the investigation.

REPORTING

Data from this investigation will be presented in tables and figures to be evaluated by ERM and Arkema. ERM will prepare a comprehensive summary report, presenting the results of this work and data evaluation, as well as the previous direct-push investigation performed in December

2005. The report will be submitted to the Oregon Department of Environmental Quality following Arkema review and approval.

PROJECT SCHEDULE

ERM will begin this field work the week of 16 January 2006 and it is anticipated that the field work will require approximately 14 days. Sample results will be available 2 weeks following sample submittal. A draft report will be submitted to Arkema approximately 3 weeks following completion of the field work.

Thank you for the continued opportunity to work with Arkema. If you have questions about the attached work plan or cost estimate, or require additional information, please contact me or Dave Edwards at (425) 462-8591.

Sincerely,

Erik C. Ipsen, P.E.
Project Manager

David P. Edwards, P.G.
Principal

cc: Larry Patterson/Arkema Inc.
Chris Bailey/ERM-West, Inc.
Matt McClincy / Oregon DEQ

ECI/DPE/clb/dwb/P06-0148
Attachment

Figures

Project No. 0022725.60
Date: 12/16/05
Drawn By: Johnet Estrada
CAD File: s:\0022725\60\0022725560-06.dwg

No. 2 DOCK

WAREHOUSE No. 3

LOADING DOCK

OLD CAUSTIC TANK FARM

PROCESS

FORMER ACID PLANT

FORMER CONTROL HOUSE

WAREHOUSE No. 2

CELL LIQUOR STORAGE

MWA-2, MWA-8i, MWA-13d, MWA-17si, MIP-2, MWA-3, MWA-21b, MWA-9i, MWA-4, MWA-10i, MWA-6r, MWA-16i, MWA-18, MWA-14i, MWA-5, MIP-16, AS-3, AS-4, MIP-14, NMP-5D, MIP-15, NMP-3D, NMP-2D, NMP-6D, MIP/INT-12, MIP-19, AS-8, AS-6, GP-8, AS-7, AS-5, GP-21, GP-7, NMP-1D, GP-20, GP-17, MIP-13, MIP/INT-10, NMP-4D, AS-12, MIP-8, GP-10, MIP/INT-11, MIP/INT-7, GP-9, AS-1, AS-2, MIP/INT-9, AS-9, AS-10, AS-11, MIP-6, GP-19, GP-14, GP-13, MWA-15r, MIP/INT-4, GP-11, MIP/INT-5, AS-17, MIP-17, AS-14, AS-15, AS-16, AS-13, MIP-18, MIP-3, GP-23, GP-15, GP-16, GP-18, GP-12, MWA-11i, AS-19, AS-20, MIP-1, AS-21, AS-18, GP-24

LEGEND

- Monitoring Well, Shallow Zone
- Monitoring Well, Intermediate Zone
- Monitoring Well, Lower Portion Shallow Zone
- Monitoring Well, Deep Zone
- DNAPL Delineation Boring – Intermediate Zone
- CPT/MIP Boring
- Direct–Push Sample Location
- Air Sparge Well
- MPR Manufacturing Process Residue

Green symbol indicates residual DNAPL was detected in soil.

NOTE: A number of buildings and structures shown on this figure have been demolished and/or removed.

Approximate Extent of Residual DNAPL in the Shallow Groundwater Zone: Dashed Where Inferred

TRUE NORTH

PLANT NORTH

0 60

FEET

Figure 1

Extent of DNAPL in Shallow Zone Groundwater

Arkema Inc.

Portland, Oregon

ERM 12/05

Project No. 0022725.60
Date: 01/11/06
Drawn By: F. Lee
CAD File: s:\0022725\60\0022725560-07.dwg

No. 2 DOCK
WAREHOUSE No. 3
OLD CAUSTIC TANK FARM
WAREHOUSE No. 2
CELL LIQUOR STORAGE
FORMER ACID PLANT
FORMER CONTROL HOUSE
PROCESS
LOADING DOCK
FORMER MPR POND AND TRENCH
FORMER MCB RECOVERY UNIT

GP-57 GP-58 GP-59 GP-60 GP-61 GP-62 MIP-2 MWA-3 MWA-21b MWA-2 MWA-13d MWA-8i MWA-17si MWA-9i GP-56 MWA-4 MWA-10i GP-49 GP-52 GP-50 GP-51 GP-53 GP-54 GP-55 MWA-6r MWA-16i MWA-18
MIP-16 AS-4 MIP-14 GP-43 GP-44 GP-45 GP-46 AS-3 GP-48 GP-42 GP-47 GP-41 NMP-5D MIP-15 NMP-3D NMP-2D NMP-6D AS-8 GP-38 GP-39 GP-40 MIP/INT-12 GP-22 MIP-19 AS-6 GP-8 AS-7 AS-5 GP-37 GP-21 GP-7 NMP-1D GP-20 MIP-13 MIP/INT-10 AS-12 NMP-4D GP-10 MIP-8 MIP/INT-11 MIP/INT-7 GP-9 AS-1 AS-2 MIP/INT-9 GP-14 GP-25 GP-36 AS-9 AS-10 GP-33 GP-35 GP-34 AS-11 MIP-6 GP-19 GP-13 MWA-15r MIP/INT-4 GP-11 MIP/INT-5 AS-16 AS-17 MIP-17 GP-26 AS-14 AS-15 AS-13 MIP-18 MIP-3 GP-23 GP-15 GP-16 GP-18 GP-32 GP-12 MWA-11i AS-20 AS-21 AS-19 MIP-1 GP-27 GP-24 AS-18 GP-31 GP-30 GP-28 GP-29 MWA-14i MWA-5

LEGEND

- Monitoring Well, Shallow Zone
- Monitoring Well, Intermediate Zone
- Monitoring Well, Lower Portion Shallow Zone
- Monitoring Well, Deep Zone
- DNAPL Delineation Boring – Intermediate Zone
- CPT/MIP Boring
- Direct–Push Sample Location
- Air Sparge Well
- MPR Manufacturing Process Residue

Green symbol indicates residual DNAPL was detected in soil.

NOTE: A number of buildings and structures shown on this figure have been demolished and/or removed.

- Approximate Extent of Residual DNAPL in the Shallow Groundwater Zone: Dashed Where Inferred
- Proposed Direct–Push Sample Locations

TRUE NORTH
PLANT NORTH
0 60
FEET

Figure 2
Proposed Direct-Push Sample Location
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Portland, Oregon
ERM 01/06

Table

Table 1

Target Sample Intervals
Arkema Inc.
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Boring	Target Sample Interval [a] *ft-bgs*
GP-22	28-36
GP-25	31-39[b]
GP-26	23.5-31.5
GP-27	22-30
GP-28	22-30
GP-29	22-30
GP-30	21-29
GP-31	20-28
GP-32	22-30
GP-33	25-33
GP-34	26-34
GP-35	26.5-34.5
GP-36	29.5-37.5
GP-37	27-35
GP-38	27-35
GP-39	27-35
GP-40	27-35
GP-41	28-36
GP-42	28-36
GP-43	28-36
GP-44	28-36
GP-45	28-36
GP-46	28-36
GP-47	28-36
GP-48	28-36
GP-49	30-38
GP-50	30-38
GP-51	30-38
GP-52	30-38
GP-53	30-38
GP-54	30-38
GP-55	30-38
GP-56	30-38
GP-57	30-38
GP-58	30-38
GP-59	30-38
GP-60	30-38
GP-61	30-38
GP-62	30-38

Notes
ft-bgs = Feet below ground surface

a = Sample intervals based upon depth at which DNAPL or boundary silt were encountered in adjacent previous borings. These depths may be adjusted as field conditions require.

b = Depth from top of Warehouse 3 foundation.