UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Region 1
5 Post Office Square, Suite 100
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August 15, 2014

Bruce Thompson
Industri-plex Superfund Site OU2 Project Coordinator
demaximis, inc
200 Day Hill Road, Suite 200
Windsor, CT 06095

Re: Industri-plex OU2: EPA conditional approval revised 100% Remedial Design for Lower South Pond (LSP) sediments adjacent to West Hide Pile (WHP), July 31, 2014

Dear Bruce:

EPA has completed its review of the revised 100% Remedial Design for the LSP sediments adjacent to the WHP (LSP RD), dated July 31, 2014.

EPA approves the LSP RD, conditioned upon the revised attached Preliminary Remediation Goal (PRG) Summary for benzene in sediments of 1,290 ug/kg (1.29 mg/kg) being applied as the benzene cleanup standard in the LSP and replacing the prior recommended PRG for benzene in sediments of 1,472 ug/kg. In addition, next week EPA will release a public notice announcing the draft Explanation of Significant Difference (ESD) associated with this revised benzene sediment PRG and cleanup standard of 1,290 ug/kg in the LSP for public comment. The final ESD will document the additional work of dredging benzene contaminated sediment in the LSP exceeding the 1,290 ug/kg PRG, disposing the dredged sediment off-site, and restoring all disturbed areas as an expansion of the 2006 Record of Decision (ROD). Pursuant to the SOW Section V.B.4, EPA conditionally approves LSP RD consistent with this letter, which must be attached to the final LSP RD.

If you should have any questions regarding this letter or attached comments, please contact me at 617.918.1323.

Sincerely,

Joseph F. LeMay, P.E.
Remedial Project Manager
Office of Site Remediation & Restoration

cc: Bob Cianciarulo, EPA
David Peterson, EPA
Robert Ford, EPA-ORD
Jennifer McWeeney, MassDEP
Paul Dombrowski, AECOM
Gordon Bullard, TLA
Randy Cooper, Monsanto
Charles Elmendorf, Astra Zeneca
Linda Raymond, ASC

SDMS Doc ID 564613

PRG Summary
Explanation of Significant Differences (ESD)
Industri-Plex Superfund Site, Operable Unit 2
REVISED AUGUST 11, 2014

Background

This summary provides information to evaluate existing data on benzene toxicity in freshwater sediments and to support the development of a site-specific Preliminary Remediation Goal (PRG) for the sediments in Lower South Pond (LSP) in the vicinity of the West Hide Pile on the Industri-Plex Site, Operable Unit 2 (OU-2), in Woburn, Massachusetts.

Habitat, Receptors and Complete Exposure Pathways

Lower South Pond is a shallow aquatic habitat. Recent site activities during the OU-2 Pre-Design Investigations have focused on characterization of groundwater migration in the vicinity of the West Hide Pile, adjacent to Lower South Pond, and the evaluation of the extent of potential aquatic impacts. The area of interest is located between the East and West Hide Piles in Lower South Pond. The data collected in sediments in as part of the pre-design investigation in 2011 and in subsequent samples have indicated concentrations of benzene in sediments up to 380,000 ug/kg. Benzene was detected in sediment samples collected in shallow cores (0-6 inches) in the surface sediments, in particular along the shore with the West Hide Pile. There have not been any detections of benzene in surface water samples along the shore of the West Hide Pile. Therefore, it is assumed that the surface water exposure pathway of fish and aquatic invertebrates exposed to benzene is likely to be minor. Based on the presence of benzene detected in sediment samples, the primary receptors are those exposed directly to sediments, and those that may be exposed by feeding on organisms in the sediment. The highest exposures are likely to occur to benthic organisms that are exposed to high concentrations of benzene in pore water. These organisms include benthic invertebrates and possibly amphibians that burrow in sediments. Incidental ingestion by sediment-feeding organisms such as fish is also a potential exposure pathway, but exposures would be lower than those of the benthic organisms.

Benzene toxicity

For non-polar organic chemicals, including benzene, properties such as water solubility, sorption to sediment particles, and toxicity are proportional to hydrophobicity, which is expressed as the octanol-water partition coefficient (K_{ow}). Hydrocarbons are lost from buried sediment layers mainly by dissolution or dispersion in water percolating through sediment layers, or by microbial degradation. In sediment porewater (in solution), benzene is more bioavailable and toxic to sediment-dwelling organisms than when adsorbed to sediment particles. Bioaccumulation of hydrocarbons sorbed to sediments by direct contact with external body surfaces or following ingestion of the particles is thought to involve an intermediate step in which the chemicals desorb from the particle into the water and then are absorbed into an organism (Di Toro et al., 1991; 2000; Hansen et al., 2003).

Hydrocarbons associated with sediment particles must partition from the sediment particles into solution before they can move across biological membranes and be taken up by the organism. For low molecular weight hydrocarbons like benzene ($\log K_{ow} = 2.13$) with high solubility, sufficient levels in the porewater allow rapid bioaccumulation across external permeable membranes or across the gut of organisms when sediment and porewater are ingested.

Generally, the best approach for estimating the toxicity of low molecular weight hydrocarbons in sediments to benthic organisms is to estimate the hydrocarbon concentration in sediment porewater and then compare the estimated concentration to water quality criteria for the hydrocarbon as described in USEPA Guidance (Hansen et al., 2003). The dissolved phase of hydrocarbons in sediment porewater can be estimated based on equilibrium partitioning theory (EqP) as described by Hansen et al. (2003). Assumptions and limitations of these calculations are well-documented. The fundamental assumption for this method is that the derived sediment benchmark, based on toxicity of benzene to surface water organisms, is protective of benthic organisms exposed to similar porewater concentrations.

There are a limited number of studies of water column invertebrates, frogs and fish sensitivity to benzene that have led to development of water quality benchmarks. In general these data are available in the ECOTOX database (http://www.epa.gov/ecotox). There have never been enough data on benzene toxicity for EPA to calculate a National Ambient Water Quality Criteria (NAWQC) value for benzene. Several sources have used various methods and assumptions to develop water quality benchmarks based on available surface water toxicity data.

Using the EqP approach, water quality benchmark values can be used to derive sediment screening values through equilibrium partitioning.

A sediment benchmark was calculated using the recommended Canadian Water Quality Guideline (surface water value of 370 ug/L), which was based on leopard frog toxicity (CCME, 1999). This Canadian water quality guideline for benzene was derived from a 9-day study of the early life stages of the leopard frog, which was the most sensitive organism represented in the toxicity dataset. The final chronic value was derived by multiplying the endpoint from this study (LC50 = 3.7 mg/L) by a safety factor of 0.1.

The sediment benchmark for benzene was then determined from the Final Chronic Value (FCV), K_{ow}, K_{oc}, and the fraction of organic carbon in sediment (f_{oc}). Site-specific sampling data were collected from Lower South Pond during pre-design investigation in 2011 and 2012 in the vicinity of the West Hide Pile (Table 1). From these data a site-specific TOC was calculated as 3.5% organic carbon (geometric mean, since concentration range is greater than an order of magnitude). This mean TOC value included samples up to 5 ft below the surface. If the data are calculated for shallow sediments only (1 to 2 ft depth), the resulting geometric mean is similar (3.8%).

The Log organic carbon-to-water partitioning coefficient (Log K_{oc}) is related to Log K_{ow} for each hydrocarbon by the following equation (Di Toro et al., 1991):

Log Koc = 0.00028 + 0.938Log Kow

Using the K_{ow} values benzene (log K_{ow} = 2.13), the Log K_{oc} from the above equation for benzene is equal to 1.998 and K_{oc} is 99.59.

A Sediment Benchmark is then calculated from the equation:

Sediment Benchmark (mg/kg $_{sediment}$) = K_{oc} x FCV (mg/L) x foc (0.035) Where foc

is the assumed site-specific fraction of organic carbon, at 3.5%.

For benzene in sediment, the calculated sediment benchmark is:

Sediment Benchmark (mg/kg $_{oc}$) = 99.59 x 370 ug/L x 0.001 mg/ug = 36.8 mg/kg $_{oc}$

or assuming 3.5% organic carbon, the benchmark is 1.290 mg/kg $_{sediment}$ (36.8 mg/kg $_{oc}$ * 0.035 kg $_{oc}$/kg $_{sediment}$).

Converting this result to ug/kg sediment, results in a recommended PRG for benzene of **1,290 ug/kg**.

References

Canadian Council of Ministers of the Environment (CCME). 1999. Canadian water quality guidelines for the protection of aquatic life: Benzene. In: Canadian environmental quality, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

Di Toro, D.M., J.A. McGrath, and D.J. Hansen. 2000. Technical basis for narcotic chemicals and polycyclic aromatic hydrocarbon criteria. I. Water and tissue. *Environ. Toxicol. Chem*. 19:1951-1970.

Di Toro, D.M., C.S. Zarba, D.J. Hansen, W.J. Berry, R.C. Swartz, C.E. Cowan, S.P. Pavlou, H.E. Allen, N.A. Thomas, and P.R. Paquin. 1991. Technical basis for establishing sediment quality criteria for nonionic organic chemicals by using equilibrium partitioning. *Environ. Toxicol. Chem.* 10(12): 1541-1583.

Hansen, D.J., DiToro, D.M., McGrath, J.A., Swartz, R.C., Mount, D.R., Spehar, R.L., Burgess, R.M., Ozretich, R.J., Bell, H.E., Reiley, M.C., and T.K. Linton. 2003. Procedures for the Derivation of Equilibrium Partitioning Sediment Benchmarks (ESBs) for the Protection of Benthic Organisms: PAH Mixtures. United States Environmental Protection Agency Office of Research and Development. Washington, D.C. EPA-600-R-02-013. November.

Table 1. Total Organic Carbon Data for Sediments in Lower South Pond

Sample ID	Sampling round[1]	TOC (%)
PZ-101-SE	2011 PDI Data [2]	1.67
PZ-103-SE	2011 PDI Data [2]	3.64
CS-1 (1')	2012 PDI Followup Data [3]	2.8
CS-1 (4')	2012 PDI Followup Data [3]	0.522
CS-1 (5')	2012 PDI Followup Data [3]	11
CS-2 (1')	2012 PDI Followup Data [3]	4.06
CS-2 (2')	2012 PDI Followup Data [3]	11.6
CS-2 (3')	2012 PDI Followup Data [3]	12.3
CS-2 (4')	2012 PDI Followup Data [3]	1.28

Average	5.4
Geometric Mean	3.5
Median	3.6
Minimum	0.5
Maximum	12.3

Notes:

1) Samples include all data along West Hide Pile, near elevated benzene (PZ-101, PZ-103, CS-1, CS-2) PDI - Pre-Design Investigation

TOC - Total Organic Carbon content measured in sediment samples

2) Haley and Aldrich, 2012. 30% Remedial Design Report, Appendix A

3) Haley and Aldrich, 2012. Sediment: Total Organic Carbon Results, June 2012. Provided via email from Russell Schuck June 26, 2012.