



3855 North Ocoee Street, Suite 200, Cleveland, TN 37312
(423) 336-4000 FAX (423) 336-4166

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Andrew Smith, P.E., LHG
UST/Technical Services Unit Supervisor
Ecology's Toxics Cleanup Program
Southwest Regional Office
Department of Ecology
PO Box 47775
Olympia, WA 98504-7775

Subject Sampling Comparison Evaluation
 Agreed Order No. DE 97TCS121
 Frederickson Industrial Park Site, Pierce County, WA

Dear Mr. Smith:

Pursuant to your approval of the sampling comparison between Low Flow and Passive Diffusion Bag (PDB) techniques dated August 4, 2015, the Addendum to Appendix A Sampling and Analysis Plan (SAP) for the Compliance Monitoring Work Plan is enclosed. The Addendum specifically covers groundwater compliance monitoring using passive diffusion bag (PDB) samplers. The objective of this addendum is to add PDB sampling procedures to the SAP. A memorandum prepared by Geosyntec Consultants for Olin Corporation and Mallinckrodt US Holdings LLC that describes the rationale used to select deployment depths for PDB sampling of groundwater monitoring wells is also enclosed.

Please let me know if you have questions regarding the information presented herein.

Sincerely,

OLIN CORPORATION

A handwritten signature in black ink, appearing to read "Julie Irwin", written in a cursive style.

Julie Irwin
Environmental Specialist II

Enclosure

OLIN CORPORATION

cc: Karen Burke (Mallinckrodt US Holdings LLC)
James Bet (Boeing)
James Cashwell (Olin Corporation)
Jim Deitsch (Geosyntec Consultants)
Dave Parkinson (Geosyntec Consultants)

Addendum to
APPENDIX A SAMPLING AND ANALYSIS PLAN
for the
COMPLIANCE MONITORING WORK PLAN
FREDERICKSON INDUSTRIAL PARK
PIERCE COUNTY, WASHINGTON

1.0 Introduction

This addendum to the Fredrickson Industrial Park (Site) Compliance Monitoring Work Plan (CMWP) was prepared by Geosyntec Consultants (Geosyntec) at the request of Olin Corporation and Mallinckrodt US Holdings LLC (the Companies). This addendum specifically covers groundwater compliance monitoring using passive diffusion bag (PDB) samplers. The objective of this addendum is to add PDB sampling procedures to the Sampling and Analysis Plan (SAP).

Procedures and protocols outlined herein will be performed in accordance with the existing Quality Assurance Project Plan (QAPP), in particular discussion of parameters to be analyzed, detection and quantitation limits, analytical techniques and procedures, and quality assurance and quality control procedures.

In addition to groundwater monitoring activities described in the SAP, this Addendum includes the following activities:

- Procedures for comparison sampling of wells using both PDBs and low flow groundwater sampling techniques;
- Groundwater sampling of wells in monitoring network using PDB samplers.

Sampling procedures and protocols for the above referenced sampling activities are presented in the following sections.

The following groundwater purging/sampling activities will be conducted in accordance with the Updated Health & Safety Plan.

2.0 PDB/Low Flow Sampling Comparison

2.1 Summary of Procedures

A comparison of PDB and Low-flow sampling techniques for groundwater sampling collection will be completed. The objective of the comparative sampling effort is to demonstrate that groundwater sampling for carbon tetrachloride (CTC) via PDBs is a

suitable alternative to the low flow sampling technique currently employed at the Site. A PDB sampler is a low-density polyethylene bag filled with deionized water, which acts as a semi-permeable membrane and is suspended in a well to passively collect groundwater samples. This approach involves sample collection using both low flow and PDBs in a subset of wells that cover the range of CTC concentrations observed at the Site. Table 1 outlines the monitoring wells for the comparison. The comparison will cover two consecutive sampling events. Ecology approved this sampling approach in an email dated 8/4/2015. Note: The sampling procedures contained in this section should only be implemented for the sampling comparison effort.

2.2 General Sampling Protocols

The following general sampling protocols will be employed during sampling throughout this program:

- Sampling instruments and equipment will be cleaned in accordance with the protocol presented in Section 6.0 of the SAP prior to sampling at each monitoring well location.
- Where applicable and practical, the field activities will proceed from “clean” monitoring wells (i.e. low CTC concentration wells upgradient and downgradient) to relatively “impacted” monitoring wells.
- A new pair of disposable gloves will be used at each monitoring well location.
- Sampling generated waste such as gloves, paper towels, etc., will be collected and contained for proper disposal.
- Following sample collection, pre-preserved sample vials will be labeled, logged on a chain-of-custody, placed into a cooler with ice, and transported to the analytical laboratory for chemical analysis of carbon tetrachloride (CTC) by EPA Method 8260.
- Samples will be iced to 4°C in laboratory supplied coolers after collection and labeling. The sample bottles will be surrounded by bags of ice to ensure proper temperature is achieved and maintained during transport. Appropriate padding will be placed in each cooler then sealed with packing tape.
- Samples will remain under control of the Companies’ Site Representative(s) until relinquished to the laboratory or commercial courier under a chain-of-custody (see QAPP, Appendix B of the CMWP).
- A typical PDB sampler consists of a semi-permeable low density polyethylene (LDPE) membrane between 12 and 24 inches long. PDB samplers are patented, and therefore must be obtained from an authorized distributor. The tube is closed at both ends and contains laboratory grade deionized water that is free of VOCs.

The diameter of a PDB sampler used in a 2-inch diameter well may vary but is typically 1.2-1.5 inches.

- Empty, used PDBs will be managed appropriately as Investigation Derived Waste.
- When PDB samplers are retrieved, they should be visually inspected and observations recorded in the field book, including deposits or coatings. Samplers that have a heavy build-up of organic coating or a tear in the membrane should be rejected.

Additional protocols specific to the sampling methods are presented in the following sections.

2.3 Hydraulic Monitoring

Hydraulic monitoring will be conducted with an electronic battery-operated water level indicator. The equipment used during the hydraulic monitoring activities will be cleaned between monitoring well locations in accordance with protocols outlined in Section 6.0 of the SAP.

- The water level in monitoring wells will be measured with respect to the reference point (top of north side of inner riser pipe) to the nearest 0.01 ft. using an electronic battery-operated water level indicator.
- The water level will be measured following removal of a previously deployed PDB and prior to low-flow purging.
- Water level monitoring will occur at 3-5 minute intervals during low-flow purging, as with other field parameters.
- Final water level measurement will occur after the analytical sample has been collected and labeled and prior to deployment of a new PDB for wells included in the sampling comparison.
- Total well depth measurements will be taken after low-flow sample collection in order to avoid disturbing sediment in the well prior to sample collection. For wells included in the side-by-side comparison this should occur prior to deployment of a new PDB.

Hydraulic monitoring data will be recorded on a standard field sheet and/or field notebook.

2.4 Monitoring Well Sampling

2.4.1 General

Designated monitoring wells will be sampled using both the PDBs followed by low-flow purging (see Table 1). The remaining wells will be sampled only by the low-flow sampling technique as described in the SAP.

2.4.2 Well Purging Sampling Procedures – PDB Sampling Technique

- PDB deployment will be conducted as follows:
 - The PDB samplers will be suspended within each monitoring well on a dedicated metal line with a tether at the top and bottom of each PDB and a weight attached to the base of the metal line. The dedicated metal lines, tethers, and weights are custom assembled by the laboratory to place the PDBs at the specified depths in each well. The amount of weight placed at the bottom of the line is based on the total depth of the well, the depth of the water column, and the number of PDBs in a well. PDBs are typically set at depth(s) consistent with the middle of the well screen interval or in the middle of the wetted screen. Each PDB will be suspended at the same depth as historical low-flow sampling depths. Following deployment, the PDBs will be left to equilibrate with the surrounding water for a minimum 14-day time period.
 - Trip blank PDBs will travel with each batch of PDBs as they are shipped from the laboratory and installed in the wells. The trip blank PDBs will remain in the cooler until the PDBs are installed in the wells. Once installation is complete, the trip blank PDB bag will be emptied into VOA containers preserved with hydrochloric acid and submitted for CTC analysis by EPA Method 8260.
- PDB retrieval and sample collection will be conducted as follows:
 - The PDB sampler will be retrieved from a well by pulling up the metal line attached to the PDB. The PDB is detached from the line and the water inside the PDB is immediately transferred to the laboratory-supplied, preserved, 40-milliliter vials, using care to minimize spillage. The water may be transferred from the PDB by cutting a small slit in the top of the PDB or by using a straw to transfer the water to the vials; other techniques may be used in addition to those described.

2.4.3 Well Purging Sampling Procedures –Comparison Sampling

- Immediately after the PDB is removed from each designated well included in the sample comparison, the low flow sampling method will be used to collect field parameters and a groundwater sample per the sampling procedures described in the SAP.

- The wells that are not included in the sampling comparison will only be sampled by the low-flow sampling technique as described in the SAP.
- Field duplicates, field rinsate blanks, trip blanks and MS/MSD samples will be collected concurrently with field samples at the frequency specified in the QAPP.
 - A second trip blank will be used during the sampling event and will consist of a standard trip blank vial (or VOA) that travels with the cooler as wells are sampled. This trip blank will also be submitted for CTC analysis by EPA Method 8260.
 - Field rinsate blanks will be collected by pouring documented analyte-free water over the pump saving the water into the appropriate sample bottle.
- Following sampling, a new, laboratory-filled PDB will be installed in the well until the next sampling event.

Table 1
Frederickson Site

**Proposed Wells for
Low Flow and PDB Side-by-Side Comparison**

Well	Screen Length (ft.)	Results (Spring 2014/Fall 2014) (µg/L)	Low Flow	PDB
11-BL	10	0.97/0.95	X	
11-CL	10	5.4/4.4	X	
BMW-18 ¹	30	5.5/4.8	X	X
BMW-3 ²	30	0.28/0.39	X	
HLA-1 ¹	10.0	5.0/4.6	X	X
MW-1 ¹	10	1.8/1.4	X	X
MW-4	10	0.82/0.66	X	
MW-7	10	2.3/ND	X	
P2-I ¹	5	0.72/ND	X	X
P2-S ¹	10	0.76/ND	X	X
MW-13 ¹	10	2.3/1.9	X	X

Notes:

1 The wells selected for sampling comparison cover the range of CTC concentrations observed at the Site

2 Consistent with the Cleanup Action Plan, we have requested that BMW-3 be removed from further sampling given that CTC concentrations have consistently been below the cleanup level.

3.0 PDB Sampling

3.1 Summary of Procedures

Upon Ecology's approval for the use of the PDB sampling technique at the Site, the following procedures will be implemented. Note: the use of the low-flow sampling techniques as described in Appendix A of the CMWP should be retained as an alternate sampling methodology for the Site.

3.2 General Sampling Protocols

The general sampling protocols described above in Section 2.2 will be employed during sampling throughout this program.

3.3 Hydraulic Monitoring

Hydraulic monitoring while using the PDB sampling technique only will be conducted using the following procedure:

- The water level will be measured after removal of a previously deployed PDB.
- Sounding of the bottom of the monitoring well will occur after sample collection prior to deployment of a new PDB in order to avoid stirring up of sediment in the well prior to collecting the analytical sample.

Hydraulic monitoring data will be recorded on a standard field sheet and/or field notebook.

3.4 Monitoring Well Sampling

3.4.1 General

All wells will be sampled using the PDB sampling technique.

3.4.2 Well Sampling Procedures

All monitoring wells will be sampled in accordance with procedures described above in Section 2.4.2. Field duplicates, trip blanks and MS/MSD samples will be collected concurrently with field samples at the frequency specified in the QAPP. A second trip blank will be used during the sampling event and will consist of a standard trip blank vial (or VOA) that travels with the cooler as wells are sampled. This trip blank will also be submitted for CTC analysis by EPA Method 8260. Following sampling, a new, laboratory-filled PDB will be installed in the well until the next sampling event.

Memorandum

Date: March 29, 2016
To: Julie Irwin – Olin Corporation
Karen Burke – Mallinckrodt US Holdings LLC
From: Dave Parkinson and James Deitsch, Geosyntec Consultants
Subject: Passive Diffusion Sampling Depth Analysis, Frederickson, WA

Olin Corporation and Mallinckrodt US Holdings LLC (the Companies) are required to monitor carbon tetrachloride (CTC) in groundwater at and downgradient of the Frederickson Industrial Park in Frederickson, Washington (the Site). The monitoring wells, schedule, and reporting requirements are provided in the Compliance Monitoring Work Plan (CMWP) for the Site.

This memorandum has been prepared by Geosyntec Consultants for the Companies to describe the rationale used to select deployment depths for Passive Diffusion Bag (PDB) sampling of groundwater monitoring wells.

EXISTING GROUNDWATER MONITORING APPROACH

The current groundwater sampling protocol is described in the Sampling and Analysis Plan (SAP) of the CMWP, and relies on a low-flow sampling approach to minimize stress and disturbance of the formation being sampled.

Eight of the eleven monitoring wells selected in the CMWP for compliance monitoring have 10-foot screen intervals, one well (P-2I) has a 5-foot screen, and the remaining two wells (BMW-3 and BMW-18) have 30-foot screen intervals. For wells with screen intervals of 10 feet or less, current low-flow procedures described in the SAP set the pump inlet, or tube inlet, at mid-screen depth. For BMW-3 and BMW-18, low-flow sampling is performed using dedicated pumps installed 5 feet above the bottom of the screen interval. The screen intervals for all of the 10 foot screens have always been entirely submerged during monitoring. The two monitoring wells with 30 foot screens (BMW-3 and BMW-18) do have the upper several feet of screen exposed above groundwater level, but still have fifteen feet or more of screen interval submerged during the lowest groundwater levels.

RATIONALE FOR PROPOSED PDB SAMPLING DEPTHS

The primary objective in selecting PDB installation depths is to maximize the likelihood that the PDB sample results will be representative of groundwater conditions and be consistent with the historical data collected through the low-flow sampling approach. We recommend that the midpoint of the 18” PDBs be placed at the midpoint of the screen interval for wells with screen intervals of 10 feet or less based on our evaluation of Site conditions, historical sampling approaches, and well construction. We recommend that the midpoint of the 18” PDBs be placed 5 feet above the bottom of the screen interval for BMW-3 and BMW-18. The rationale for these recommendations is provided below.

The screen interval depths for monitoring wells at the Site with five- or ten-foot screens were guided by vertical aquifer sampling (VAS) of several target wells during drilling and installation. Three of these wells are part of the CMWP monitoring network (P-2I, MW-7 and MW-13). The screened intervals for these three wells were installed such that the mid-points of the screens corresponded to the depths at which the highest CTC concentrations were observed in each boring. The Department of Ecology reviewed the results and provided concurrence on screen interval depths for the cluster wells (P-1 and P-2)¹. P-2S and P-2I are part of the compliance monitoring network. Thus, for these wells, the PDBs would be set at the depths where peak CTC concentrations are anticipated to occur.

The CMWP Quality Assurance Project Plan (QAPP) provides protocols for low-flow sampling methods that include establishment of sampling depths at mid-screen. Historical data collection (up to 25 years) has occurred at the mid-screen depths for wells with screen intervals of 10 feet or less, or 5 feet from the bottom of the screen interval for BMW-3 and BMW-18, which have the dedicated pumps. For BMW-3 and BMW-18, concentration data records for samples collected 5 feet from the bottom of the screen interval date back 23 and 27 years, respectively.

The relatively thick and coarse grained nature of the formation (sand and gravel) at the screen interval in the wells with screen intervals of 10 feet or less further supports using mid-screen depth for sampling. There are no thin, confined, stratigraphic horizons that could control depth and flow of groundwater¹, thus vertical concentration variability over the screen interval is expected to be minimal and the sample result representative of aquifer conditions. The length of the PDBs (15% of the total screened length for the 10-foot screens and 30% for the 5-foot screen) is considered sufficient to incorporate the same formation variability that low flow sampling captured. Placement of PDBs consistent with historical low-flow sampling depths provides the best

¹ Conestoga Rovers, RI/FS Task 8 Groundwater Investigation Update, March 27, 2001.

opportunity for PDB sampling data to be consistent with the historical data record and facilitate remedy performance evaluation.

SUMMARY AND RECOMMENDATIONS

It is recommended that PDBs be deployed at mid-screen in wells with screen intervals of 10 feet or less for the following reasons:

- Monitoring well screen intervals were installed at depths where the highest concentration of CTC was observed using VAS analyses with Agency concurrence; and,
- The proposed PDB sampling depths are most likely to achieve consistency with the historical data record and facilitate remedy performance evaluation given known site-specific hydrogeologic characteristics.

For BMW-3 and BMW-18, it is recommended that the PDBs be deployed 5 feet from the base of the screen, with this depth being confirmed when pulling the dedicated pumps. Similar to the other wells in the compliance network, the proposed installation depth provides the best opportunity for the PDB sample results to be consistent with historical data record and representative of aquifer conditions.

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