# Groundwater Monitoring Plan

## Former Kop-Flex Facility
## Hanover, Maryland
## Voluntary Cleanup Program Site #31

June 2, 2015

**Project No.** E0003705/25

# GROUNDWATER MONITORING PLAN

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## Voluntary Cleanup Program Site #31

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## Client

Emerson Electric Co.
8000 West Florissant Avenue
St. Louis, MO 63136

## Consultant

WSP USA Corp.
11190 Sunrise Valley Drive
Suite 300
Reston, VA 20191
Tel: (703) 709-6500

## WSP Contacts

R. Eric Johnson
Eric.johnson@wspgroup.com

Steve Kretschman, P.E.
Steve.kretschman@wspgroup.com

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# 1 Introduction

This Groundwater Monitoring Plan (GWMP) for the former Kop-Flex Voluntary Cleanup Program (VCP) site in Hanover, Maryland, was prepared by WSP USA Corp. as part of the Response Action Plan (RAP) for the site. The plan was developed following the guidelines presented in the U.S. Environmental Protection Agency (EPA) guidance document titled "*Guidance for Monitoring at Hazardous Waste Sites: Framework for Monitoring Plan Development and Implementation"* USEPA 2004 and other applicable USEPA and Maryland Department of the Environment (MDE) technical guidance and procedures.

All field activities performed as part of the groundwater monitoring program will be conducted in accordance with the current version of the Health and Safety Plan (HASP) for the site (WSP 2013). Any information relevant to the planned monitoring activities that has not been provided in the previous submittals to MDE is included in this GWMP.

# 2 Site Background

## 2.1 Site Description

The former Kop-Flex site is located at 7565 Harmans Road in Hanover, Anne Arundel County, Maryland. The facility occupies an approximately 25-acre parcel and consists of two buildings – an approximately 220,000-square-foot former manufacturing and office building and an approximately 20,000-square-foot former forge building near the eastern property boundary. The property is bordered to the north by a Verizon Communications maintenance facility; to the east by the Williams-Scotsman facility followed by railroad tracks; to the south by the Williams-Scotsman facility followed by Maryland State Route 100; and to the west by undeveloped land along Stony Run, a tributary of the Patapsco River, followed by Harmans Road and a residential area.

The elevation of the site varies from approximately 108 feet mean sea level (ft msl) along the drainage channel and flood plain for Stony Run to 130 ft msl in the southeast corner of the property. The closest surface water body is Stony Run, which crosses the northwestern portion of the site. This stream flows northward and eventually discharges into the Patapsco River, which is located 7 miles from the site. In addition to this stream, several small pond areas have been identified and mapped in the vicinity of the site.

## 2.2 Geology and Hydrogeology

The site lies within the Atlantic Coastal Plain physiographic province. In Anne Arundel County, Maryland, this province is characterized by alternating layers of predominately sand and clay sediments of Cretaceous age. Based on regional hydrogeologic cross-sections for these sedimentary deposits, the inter-layered sequence of sand and clay units dips gently to both the south and east from the north part of the county. In Anne Arundel County, the Coastal Plain deposits range in thickness from a few tens of feet along the northwestern boundary with Howard County to as much as 2,500 feet in southeastern Anne Arundel County (Vroblesky and Fleck, 1991). The complexly stratified deposits comprising the Atlantic Coastal Plain form an inter-layered sequence of aquifers and confining beds. The upper-most water-bearing unit is typically represented by an unconfined surficial aquifer consisting of Quarternary alluvium and terrace deposits, which is underlain by several confined aquifers that include the Patuxent, lower and upper Patapsco, and Magothy. These aquifers may be considered unconfined over their outcrop areas and confined in the direction down-dip from the outcrop and subcrop areas, although the confining units may thin and be regionally discontinuous.

An evaluation of borehole lithologic data obtained from field investigations indicates the coastal plain deposits at the site comprise a complexly inter-bedded sequence of predominately coarse-grained (sand with gravel and fines) and fine-grained (silt and clay) units. Given the spatial and vertical heterogeneity typical of the Atlantic Coastal Plan deposits, the unconsolidated materials have been grouped into three gross stratigraphic units, which are generically termed "upper," "middle," and "lower" (Figure 1). The Upper Stratigraphic Unit is comprised primarily of sand, with variable fines content, to gravelly sand along with occasional discontinuous silt and clay lenses of variable extent and thickness. This upper sandy unit appears to be thickest in the eastern portion of the site and thins to the west. The Upper Stratigraphic Unit is underlain by the Middle Stratigraphic Unit, which is characterized by zones of coarse-grained (sand to clayey sand) and fine-grained (silty to sandy clay to clayey to sandy silt to finely inter-laminated sand and clay) sediments exhibiting variable thickness and noticeable lateral and vertical heterogeneity. From northwest to southeast across the site, the lithologic characteristics of this unit transition from a thick (20 to 30-foot) sand interval bounded above and below by silt and clay deposits to an area of inter-bedded and inter-fingering coarse and fine-grained deposits underneath the eastern portion of the manufacturing building to an very thick (approximately 65 feet) sequence of predominately silt and clay deposits in the southern-most portion of the site. A locally continuous layer of hard, dense silty clay to clayey silt sediments layer exits at a depth of approximately 60 feet at the site. The Lower Stratigraphic Unit consists primarily of sand and gravelly sand deposits with occasional discontinuous layers of inter-mixed clay and silt sediments of variable thickness. Based on evaluation of the lithologic data, the top of this unit occurs at depths ranging from approximately 50 feet below ground surface (bgs) in the northwest portion of the site to approximately 100 feet bgs near the southeastern corner of the property.

Based on the textural variation of the three stratigraphic units and their associated permeability, the predominately coarse-grained sediments comprising the upper and lower units and the thick sand interval within the middle unit represent the primary zones for groundwater flow at the site. The unconsolidated deposits of the upper and middle units at depths ranging from approximately 45 feet in the north to 60+ feet in the south constitute the shallow water-bearing zone, or Surficial Aquifer, within the hydrogeologic system. The lower unit is inferred to be upper portion of the Lower Patapsco Aquifer. Hard silt and clay deposits of the Middle Stratigraphic Unit form a leaky aquitard (Patapsco Confining Unit) that hydraulically separates the Surficial and Lower Patapsco aquifers. Overall, flow paths within the fine-grained deposits of the Middle Stratigraphic Unit are complex and involve predominately vertical (downward) movement of groundwater.

For the Surficial Aquifer, groundwater occurs under an unconfined condition in the coarse-grained deposits of the Upper Stratigraphic Unit. Given the presence of appreciable clayey deposits in the shallow subsurface in the northern and western portions of the site, groundwater within the sand lenses and thick sand layer within the Middle Stratigraphic Unit occurs under a partially, or semi-, confined condition. Flow within the Surficial Aquifer is in a west to northwest direction toward Stony Run (Figure 2). Groundwater discharge within the upper-most sand units and deeper (partially confined) sand deposits is believed to provide base flow to Stony Run. Groundwater in the Lower Patapsco Aquifer also occurs under semi-confined conditions. Based on water level data from site monitoring wells, the direction of groundwater flow in the Lower Patapsco Aquifer is to the south-southeast, which is consistent with published studies of the Coastal Plain Aquifer System in Anne Arundel County, Maryland (Figure 3). The significant head differences in monitoring wells completed at depths of less than and greater than 60 feet bgs indicate that the hard silt and clay layer serves as an aquitard, between the Surficial and Lower Patapsco aquifers in the hydrostratigraphic sequence. However, spatial variations in the lithology and thickness of the sediments comprising the aquitard and associated sedimentary structures within the fine-grained deposits may provide mechanisms for the vertical leakage of groundwater to the Lower Patapsco sand deposits.

## 2.3 Groundwater Quality

### 2.3.1 Surficial Aquifer

The chemicals of concern (COCs) in the Surficial Aquifer consist of chlorinated volatile organic compounds (VOCs), primarily the following:

- 1,1,1-trichloroethane (TCA)
- degradation products of 1,1,1-TCA such as 1,1-dichloroethene (1,1-DCE) and 1,1-dichloroethane (DCA),
- chlorinated ethenes such as trichloroethene (TCE) and tetrachloroethene (PCE)
- 1,4-dioxane

In general, the highest VOC levels in shallow groundwater are found in the identified source areas in the southwest portion of the manufacturing building and to the east of the manufacturing building and decrease in the direction of groundwater flow. VOC impacts in shallow groundwater extend from the vicinity of wells MW-02, MW-11, MW-12 and MW-16, which are located to the east of the manufacturing building, to the area west of the manufacturing building at MW-18 and MW-39. Although VOCs were detected in wells near the eastern property boundary (MW-04, MW-08, and MW-20), the concentrations are substantially lower than VOC concentrations found in wells located in close proximity to the source area to the immediate east of the building.

VOC's associated with the source area east of the building have migrated westward (downgradient) below the manufacturing building and commingled with constituents associated with the source area below the southwest portion of the building. Figure 4 depicts the total VOC distribution in the Surficial Aquifer at the site. In the area west of the manufacturing building, VOC concentrations are higher in samples collected from the shallow wells screened in the upper clayey deposits than in samples collected from slightly deeper wells completed in the underlying sand unit (MW-14, MW-18 and MW-39). Neither of the site-related COCs have been detected in samples from shallow well MW-03 northwest of the manufacturing building. Based on evaluation of the sampling data, no site-related VOCs are migrating offsite in the shallow portion of the groundwater system.

### 2.3.2 Lower Patapsco Aquifer

The COCs in the Lower Patapsco Aquifer are consistent with those identified in the shallow water-bearing zone: 1,1,1-TCA and its degradation products, chlorinated ethenes, and 1,4-dioxane. An iso-concentration map showing the total VOC distribution in the deeper aquifer is shown in Figure 5. Overall, VOC impacts in deeper groundwater extend from the identified source area to the east of the manufacturing building to the south-southeast (downgradient) beyond the Kop-Flex property boundary. As indicated in the plume map, total VOC concentrations greater than 500 micrograms per liter (µg/l) are present at well MW-17D, which is located immediately south of the source area, and in samples from downgradient wells MW-1D (onsite) and MW-24D (offsite). Wells MW-19, MW-23D, and MW-27D are located hydraulically upgradient of the area where VOCs enter the Lower Patapsco Aquifer at the site. Trace to non-detect levels of site-related VOCs are present in samples collected from MW-19 and MW-27D. Well MW-23D, which is locate approximately 350 feet north of the eastern source area, contains low levels of site-related VOCs such as 1,1-DCE and 1,4-dioxane. Although these VOCs are consistent with the identified site COCs, the presence of these compounds some distance upgradient of the highest concentrations are believed to reflect the influence of transient migration pathways different from those in the hydrogeologic system.

# 3 Groundwater Monitoring Program

## 3.1 Cleanup Criteria for Chemicals of Concern

The cleanup criteria for all site-related COCs, except for 1,4-dioxane, are equivalent to the promulgated MDE groundwater quality standards, and are listed below.

- 1,1,1-TCA – 200 µg/l
- 1,1-DCE – 7 µg/l
- 1,2-DCA – 5 µg/l
- 1,1-DCA – 90 µg/l
- Chloroethane – 3.6 µg/l
- *cis*-1,2-DCE – 70 µg/l
- TCE – 5 µg/l
- PCE – 5 µg/
- Vinyl chloride – 2 µg/l

These values correspond to the standards for Type I and II aquifers, and maximum contaminant levels (MCLs) and secondary MCLs developed by USEPA under the Safe Drinking Water Act. Based on the site hydrogeologic and hydrogeochemical data, both the Surficial and Lower Patapsco aquifer meet the definitions of a Type I aquifer provided in the document *Cleanup Standards for Soil and Groundwater, Interim Final Guidance (Update No. 2.1)* (MDE 2008).

At present, no groundwater quality standard has been promulgated for 1,4-dioxane. Using the current default exposure factors developed by USEPA and a target cancer risk of 1E-5, the calculated risk-based criterion for 1,4-dioxane is 7.8 µg/l. Given the depth to groundwater and planned implementation of groundwater use restrictions on the property, the direct ingestion exposure pathway for 1,4-dioxane would be incomplete for potential onsite receptors. Based on the incomplete groundwater exposure pathway, an alternate groundwater quality standard would be applicable for the site. In addition, for any groundwater discharged to Stony Run with detectable concentrations of 1,4-dioxane, the surface water levels of this compound would rapidly decrease in response to mixing with flow from upstream areas south of the site. Given these conditions, an alternate, property-specific cleanup criterion of 15 µg/l, or approximately 2x the calculated risk-based level of 7.8 µg/l, has been proposed for the site.

## 3.2 Abandonment of Existing Wells

Based on the development plan for the property, monitoring wells situated within the planned footprint of the new buildings and truck dock areas will need to be abandoned to facilitate the future construction activities. In addition, WSP plans to decommission wells within the loading dock area, except for the MW-16/MW-16D well pair, due to health and safety (H&S) hazards associated with working in an area with a high volume of truck traffic, and selected wells situated in other portions of the property.

The utility plan for the property development will necessitate the relocation of wells MW-05-31 and MW-38-28. The relocation of these monitoring points will involve the abandonment of the existing wells and installation of similarly designed and constructed replacement wells (MW-05R and MW-38R) in the immediately surrounding area. Each replacement well would be installed a minimum distance of 10 feet from any subsurface utility lines.

Figure 6 shows the locations of the existing monitoring wells to be abandoned at the site, together with an overlay of the planned property development. All wells will be decommissioned in accordance with the applicable Maryland well construction regulations. Additional information concerning the well abandonment procedures is provided in Section 4.

## 3.3 Monitoring Network

### 3.3.1 Groundwater Level Measurements for Assessing Hydraulic Containment

#### 3.3.1.1 Surficial Aquifer

Water level data will be collected from the remaining monitoring wells and piezometers at the site. These data will be augmented by measurements at the extraction wells. Table 1 lists the wells and piezometers to be included in the water level monitoring network for the Surficial Aquifer. The locations of these monitoring points are shown in Figure 7. In addition, three new wells – MW-43, MW-44, and MW-45 – will be installed cross and downgradient of the extraction well system near the inferred limits of the VOC plume in the Surficial Aquifer. (Information on the installation of these proposed wells is provided in Section 4.) Water level measurements from the new wells will be used to evaluate hydraulic containment of affected groundwater extending west of the building area. Groundwater elevations calculated from the depth to water measurements will be contoured using geostatistical methods to determine aquifer drawdown and assess capture effectiveness in response to withdrawals from the extraction wells.

The water level data for the extraction wells RW-1S, RW-2S, and RW-3S will be used to approximate aquifer drawdown during remedial pumping and check for declines in the specific capacity for each well during system operation. The specific capacity of a pumping well is the yield per unit drawdown, and is calculated using the following relationship (Heath 1987):

$$\text{Specific capacity} = \text{pumping rate/drawdown} = Q/S_w$$

where Q is the pumping rate and $S_w$ is the drawdown. Significant reductions in the recovery well specific capacity may indicate possible encrustation, clogging, or fouling of the screen and/or sand filter pack, and the need to perform maintenance activities to rehabilitate the well.

#### 3.3.1.2 Lower Patapsco Aquifer

Water level data will be collected from all of the remaining deep monitoring wells and offsite well MW-24D on the Williams-Scotsman property. These data will be augmented by measurements at extraction wells RW-1D and RW-2D installed within the area of VOC plume. Table 1 lists the monitoring wells to be included in the water level monitoring network for the Lower Patapsco Aquifer. The locations of these monitoring points are shown in Figure 8. In addition to the existing wells, two new monitoring wells (MW-40D and MW-41D) will be installed near the southern property boundary. (Information on the installation of this proposed monitoring well is provided in Section 4.) Water level measurements from these new wells will be used to evaluate hydraulic containment of the affected groundwater extending to off-property areas.

Groundwater elevations determined for the wells will be contoured using geostatistical methods to determine aquifer drawdown and assess capture effectiveness in response to extraction well pumping. Additionally, the water level elevations for well MW-41D will be compared with MW-21D to determine the presence of vertical hydraulic gradients in response to pumping from the extraction wells along the southern property boundary.

As with the shallow extraction wells, the water level data for deep extraction wells RW-1D and RW-2D will be used to approximate aquifer drawdown during remedial pumping and check for declines in the specific capacity for each well during system operation. Significant reductions in the recovery well specific capacity may indicate possible encrustation, clogging, or fouling of the screen and/or sand filter pack, and the need to perform maintenance activities to rehabilitate the well.

### 3.3.2 Groundwater Monitoring for Assessing Remedy Effectiveness

#### 3.3.2.1 Surficial Aquifer

The three shallow extraction wells (RW-1S, RW-2S, and RW-3S), along with selected existing wells (MW-03, MW-04, MW-05R, MW-09, MW-16, MW-38R and MW-39) and new wells MW-42, MW-43 and MW-44, will be used to monitor and evaluate the performance of the hydraulic containment system for the Surficial Aquifer. Figure 9 indicates the wells comprising the groundwater quality monitoring network with respect to the inferred area of VOC-impacted groundwater underneath and west of the former manufacturing building. A summary of pertinent construction information for the existing monitoring points is presented in Table 2. In this table, the selected wells are grouped into those monitoring for hydraulic containment of the VOC-affected groundwater and for mass removal from the impacted aquifer.

#### 3.3.2.2 Lower Patapsco Aquifer

Deep extraction wells RW-1D and RW-2D, together with eight monitoring wells (including new wells MW-40D and MW-41D), will be used to collect groundwater quality samples from the Lower Patapsco Aquifer to evaluate the performance of the hydraulic containment system. The locations of the wells comprising the groundwater quality monitoring network in the deep aquifer with respect to the inferred VOC plume are shown in Figure 10. Well construction information for the existing monitoring points is provided in Table 3. In this table, the selected wells are grouped into those for monitoring hydraulic containment of the VOC-affected groundwater and mass removal of the impacted aquifer.

## 3.4 Monitoring Frequency

### 3.4.1 Groundwater Levels

#### 3.4.1.1 Base-line Monitoring Event

A synoptic round of depth to water measurements will be gathered from the wells and piezometers comprising the water level monitoring network in each aquifer no more than 48 hours before the start of pumping from the extraction wells in the respective water-bearing zone. The water levels in the monitoring wells and piezometers will be manually measured using an electronic water level indicator. Groundwater level elevations will be determined from the field measurements and survey information for each well and piezometer. The elevation data will be contoured using geostatistical methods (kriging) to characterize the static, or non-pumping, groundwater surface at the site. These data will also be used to determine the drawdown in the pieziometric surfaces in both aquifers in response to groundwater withdrawals during system operation.

#### 3.4.1.2 Remedial System Start-up and Initial Operation

During the initial week of startup, the monitoring wells and piezometers included in the water level monitoring networks for each aquifer comprise two groups with respect to the measurement frequency. The first group will consist of monitoring points located in the vicinity of groundwater extraction wells. During the first week of extraction from each aquifer, water level measurements will be obtained hourly for the first 8 hours of pumping then every 8 hours for the rest of the first day and daily for the next 6 days from the wells and piezometers listed below.

| Surficial Aquifer | Lower Patapsco Aquifer |
|---|---|
| MW-05R | MW-1D |
| MW-18 | MW-16D |
| MW-38R | MW-22D |
| MW-42 | MW-24D |
| MW-43 | MW-40D |
| MW-44 | MW-41D |
| OW-1 | |

Water level measurements will be collected twice per day from the rest of the wells and piezometers, which represents the second group of monitoring points. The depth to water will be manually measured using an electronic water level indicator. These data, along with measurements from the recovery wells, will be examined to evaluate aquifer hydraulic response during system operation and the significance of any hydraulic head fluctuations. Given the selected pumping rates, it is believed the hydraulic head distribution should begin approaching an initial steady-state condition one to two days after start-up in the Surficial Aquifer and less than seven days for the Lower Patapsco Aquifer. The water level data will provide an early indication of the response to pumping from the extraction well networks.

During the second week of pumping, synoptic rounds of water level measurements will be collected every two days from all wells and piezometers then weekly for the next four weeks. Manual depth to water measurements will be made at the monitoring points using an electronic water level indicator. These data will be used to monitor further changes in the hydraulic head distribution in both aquifers under remedial pumping conditions, particularly in areas distant from the extraction points to evaluate containment of the VOC plumes. The actual time for adjusting the measurement frequency from daily to weekly may be modified based on a review of any trends and variability in the water level data.

#### 3.4.1.3 Long-Term Water Level Monitoring

After the start-up period, water levels in the wells and piezometers in both aquifers will be measured quarterly for the remainder of the first year of pumping. Assuming no unexpected findings or conditions with respect to the hydraulic response within the aquifer system, the water level monitoring frequency will be reduced to semi-annual for the remainder of the systems' operation. The water levels in all monitoring wells and piezometers will be measured by hand using an electronic water level indicator.

During full-scale system operation, the following conditions may warrant more frequent collection of water level data from all or a sub-set of the monitoring wells and piezometers within a particular aquifer (Cohen et al. 1994).

- adjustment in the withdrawal rate from one or more extraction wells
- extraneous factors that may affect flow pathways in the aquifer system

These factors would typically be associated with changes in the magnitude of water sources and sinks to each aquifer, such as significantly increased precipitation recharge (Surficial Aquifer) or leakage (Lower Patapsco Aquifer) or groundwater pumping from new municipal or commercial/industrial water-supply wells in the area. Any modification in the monitoring frequency will be made on a case-by-case basis in light of the presumed importance of the source/sink on the water balance and flow dynamics.

## 3.4.2 Groundwater Quality Monitoring

### 3.4.2.1 Baseline Groundwater Sampling Event

One round of groundwater samples will be collected from the monitoring wells listed in Tables 2 and 3 to characterize the baseline hydrogeochemistry of the Surficial and Lower Patapsco aquifers, respectively. Baseline sampling will be completed less than four weeks before the start of groundwater withdrawals from the aquifer system to gather data on the pre-pumping hydrogeochemical conditions at the site. These data will be evaluated with sampling data obtained during operation of the hydraulic containment systems to evaluate capture of the VOC-impacted groundwater and removal of contaminant mass from the aquifers.

### 3.4.2.2 Long-Term Groundwater Monitoring

Long-term groundwater quality sampling will be performed to monitor changes in VOC concentrations in the Surficial and Lower Patapsco aquifers during operation of the hydraulic containments system. The proposed sampling frequency for monitoring points in the Surficial and Lower Patapsco aquifers are also provided in Tables 2 and 3, respectively.

For the extraction wells in both containment systems, groundwater samples will initially be collected on a quarterly basis. The monitoring frequency for these wells will be reduced to semi-annual following one year of continuous pumping. The sampling data will be used to monitor changes in VOC concentrations, and corresponding mass removal, in the well discharge.

Groundwater samples collected from the following monitoring wells, which are located in the western portion of the site, will be used to evaluate VOC concentrations in the Surficial Aquifer during operation of the hydraulic containment system.

- MW-03
- MW-05R
- MW-18
- MW-38R
- MW-39
- MW-42
- MW-43
- MW-44

Wells MW-05R, MW-18, MW-38R, MW-39, MW-42, and MW-43 will be sampled on a semi-annual basis. The other wells – MW-03 and MW-44 – are located unaffected portions of the Surficial Aquifer downgradient or cross-gradient of the VOC plume. The groundwater samples will be collected from these wells on an annual basis. The remaining monitoring points for the Surficial Aquifer consist of three wells (MW-04, MW-09, and MW-16) that occur within the inferred limits of the VOC plume in the area east (hydraulically upgradient) of the extraction well system. Semi-annual groundwater samples will be collected from these monitoring wells to evaluate changes in COC concentrations in response to groundwater withdrawals from the extraction wells.

For the Lower Patapsco Aquifer, groundwater samples from the monitoring wells listed below will be used to assess VOC concentrations in response to groundwater withdrawals from the deep extraction wells.

- MW-1D
- MW-21D
- MW-22D

- MW-24D
- MW-40D

Samples will be collected from these wells semi-annually. Monitoring wells MW-16D and MW-23D are situated within the VOC plume in the area hydraulically upgradient of the extraction wells. These wells will also be sampled semi-annually to evaluate changes in COC concentrations in response to groundwater pumping. Groundwater samples will be collected on an annual basis from well MW-27D located upgradient of the inferred extent of VOC impacts in the aquifer, and MW-41D, which will be screened at depth below the recovery wells in the lower portion of the aquifer. The collection of samples from “background” well MW-27D will be used to monitor the hydrogeochemistry of groundwater flowing on to the site from off-property areas to the north. Water quality results for MW-41D samples will be evaluated, together with the hydraulic head data, to ensure site-related VOCs are not migrating in deeper portions of the Lower Patapsco Aquifer and by-passing the partially penetrating extraction well system.

## 3.5 Field Methods and Sampling Procedures

### 3.5.1 Water Level Measurements

Field measurements of the depth to standing water in monitoring wells and piezometers will be obtained at the frequency described in Section 3.3.1 with an electronic water level indicator. During groundwater sampling events, measurements will be made of the static water and well depth to determine the height of the water column in the well and identify potential siltation problems inside the well casing. All measurements for a given water level monitoring event will be taken within a 10-hour work period to minimize potential discrepancies due to transient head fluctuations. All field measurements will be recorded in a bound field notebook.

### 3.5.2 Groundwater Sampling and Analysis

#### 3.5.2.1 Recovery Well Sampling Procedure

Groundwater samples will be collected from pumping wells via the sampling port in the well head vault (see Appendix A of the RAP). The valve will be opened to deliver a smooth, thin stream of water, which has a flow low enough to permit filling of the sample bottles without turning the valve down. After purging a small amount of water from the sampling port, a groundwater sample will be collected for laboratory analysis.

#### 3.5.2.2 Monitoring Well Sampling Procedure

Groundwater samples will be collected from the monitoring wells using either the low flow purge and sample method, or a passive sampling method (HydraSleeve). The HydraSleeve is one of several passive sampling technologies demonstrated to be capable of collecting representative groundwater samples for analysis of chlorinated VOCs and 1,4-dioxane (Parker and Clark 2002, Montgomery Watson Harza 2002, Parsons Corporation 2005, and ITRC 2006). Final selection of the sampling method will be based on the results of the field performance study, which will be conducted during the baseline monitoring event.

Information concerning the passive (HydraSleeve) sampling procedure is provided in Section 5.2.2. If the low flow method is selected for collection of the groundwater samples, a description of the field sampling procedure will be provided in a subsequent submittal to MDE. All field information related to the sampling activities will be documented in a bound field notebook.

#### 3.5.2.3 Analytical Methods

The groundwater samples and associated field quality control (QC) samples will be submitted to the Pace Analytical Services, Inc. laboratory in Huntersville, North Carolina (Maryland certification number 322) for chemical analysis. All samples will be analyzed for VOCs using USEPA SW-846 Test Method 8260B and 1,4-dioxane using modified USEPA Method 8260B with selective ion monitoring (SIM). The proposed quantitation limits (QL) for the target compounds listed under USEPA Method 8260B are provided in Appendix A. For 1,4-dioxane analysis using SIM, the reporting limit is 2 µg/l and the method detection limit is 1.9 µg/l.

### 3.5.3 Field Quality Assurance/Quality Control (QA/QC) Procedures

The field QA/QC procedures to be used for the groundwater monitoring activities will be consistent with the protocols described WSP Field Standard Operating Procedure (SOP) #3 – Sample Packaging and Shipping Procedure, and Field SOP #4 – Sample Collection and Quality Assurance Procedure (Appendix B). These SOPs include standards and guidance for sample identification numbers, sample custody, shipping of samples to the laboratory, and collection of field and QC samples. Additional information concerning on the collection of field QC samples during the monitoring activities is provided in the following sections.

#### 3.5.3.1 Trip Blanks

Trip blanks are samples used to identify possible sample contamination originating from sample transport, shipping, or site conditions. Each trip blank will consist of two or three preserved 40-milliliter glass vials with Teflon®-lined septum caps that are filled with organic-free water. They will be stored with the field samples and returned to the laboratory for VOC analysis. One trip blank will accompany each cooler containing samples to be analyzed for VOCs. Trip blanks will be labeled, documented, and handled in the same manner as other field samples. Trip blanks will be analyzed for VOCs only.

#### 3.5.3.2 Equipment Blanks

If the low flow purge method is used for sample collection, one equipment rinsate blank will be collected each day that sampling activities are conducted at the site. These samples will be used as a QC check of the decontamination procedures for sampling devices. Equipment blanks will be prepared after the equipment has been used and decontaminated in the field. Equipment blanks will be prepared by filling or rinsing the cleaned equipment with analyte-free water and collecting the rinsate in the appropriate sample containers. Equipment blanks will be submitted blind to the laboratory and analyzed for all the analytes for which the environmental samples are being analyzed. Equipment blanks will be labeled, documented, and handled in the same manner as other field samples.

#### 3.5.3.3 Matrix Spike/Matrix Spike Duplicate (MS/MSD) Samples

An MS/MSD sample will be collected for every 20 samples collected and analyzed as a further QC check. The specific sample location that will be used for the MS/MSD sample will be chosen by WSP field personnel. MS/MSD samples will be labeled and documented as such and handled in the same manner as other field samples. Results from the MS/MSD samples will determine analytical accuracy and precision. The purpose of the spike samples is to monitor any possible matrix effects on specific samples collected from the site.

#### 3.5.3.4 Field Duplicates

Duplicate samples will be collected to allow for determination of analytical precision. One duplicate sample will be collected for every 20 samples from the same matrix and submitted blind to the laboratory for analysis.

## 3.6 Groundwater Monitoring Optimization

Optimization of the monitoring networks for both the Surficial and Lower Patapsco aquifers will be assessed every 2-3 years to determine whether reductions in sampling frequency and/or changes in the number and locations of monitoring points can be implemented while still assuring attainment of the monitoring objectives. The optimization evaluation will use the Monitoring and Remediation Optimization System (MAROS) software package, developed by Groundwater Services, Inc., to perform qualitative, temporal, and spatial-statistical analyses of the groundwater sampling data from the monitoring wells (USEPA 2004). Parametric and non-parametric methods will be utilized to assess the statistical significance of temporal trends in COC concentrations. The results of the temporal-trend analyses will then be evaluated by the MAROS program to develop recommendations for optimal sampling frequency at each monitoring point using a modified Cost Effective Sampling algorithm. In addition, a spatial statistical algorithm will also be used to assess the relative “value” of the groundwater sampling data being collected from the well network, and identify optimal locations of monitoring points. Formal decision logic may also be used to help evaluate the data and formulate recommendations for modifying the monitoring program.

# 4 Monitoring Well and Piezometer Abandonment

A total of 21 groundwater wells and piezometers will be abandoned in accordance with the applicable requirements in the following regulations:

- Maryland Code 26 04.04.34 – Well Abandonment and Sealing Standards – General
- Maryland Code 26 04.04.35 – Well Sealing Materials
- Maryland Code 26 04.04.36 – Well Sealing Procedures

As indicated in Figure 6, the majority of the wells designated for abandonment are screened in the unconfined Surficial Aquifer. Five wells (MW-2D-138, MW-17D-97, MW-19-56, MW-26D-105, and TW-2-145) are screened in the confined Lower Patapsco Aquifer. All well abandonment activities will be conducted by a Maryland-licensed well driller.

The abandonment procedure for the wells and piezometers screened in each hydrogeologic unit are described below.

- Measure the depth to water and total well depth using a water level indicator or weighted tape, and check for the presence of any obstructions inside the well casing. If an obstruction is encountered, WSP will assess the nature and approximate depth of the obstruction and its potential effect on abandoning the well in place.
- Remove the concrete pad and flush-mount or above-grade protective cover and cut the well casing so the top is 0.5-1 foot below grade.
- Backfill the polyvinyl chloride (PVC) well casing with a bentonite-cement grout emplaced from the bottom of the well to the surface using the tremie method.
- After plugging the well, backfill the hole to existing grade with clean soil material obtained from the property.

For wells located in future paved and warehouse areas, the backfilled holes will be covered at the surface with a layer of asphalt patch to match the existing grade. Any wells located in future unpaved (grassy) areas will be seeded following placement of the clean soil fill.

After completing the field activities, a completed Water Well Abandonment Sealing Report will be prepared for each well and submitted to MDE.

# 5 Monitoring Well Installation

## 5.1 General

Three new shallow monitoring wells (MW-42, MW-43 and MW-44) and two new deep monitoring wells (MW-40D and MW-41D) will be installed as part of the groundwater monitoring network for the groundwater response action at the former Kop-Flex site. The new shallow wells will be installed near the inferred lateral and downgradient boundaries of the VOC plume in the Surficial Aquifer, as shown in Figures 7 and 9, and will be used to obtain groundwater level and quality data to assess the effectiveness of the extraction well system. Well MW-40D will be located near the inferred western boundary of the deeper VOC (Figures 8 and 10), and will be used to gather groundwater level and water quality data to evaluate hydraulic containment of the chlorinated VOCs in the Lower Patapsco Aquifer. The other deep monitoring well (MW-41D) will be screened in the lower portion of the aquifer within the plume area to assess vertical head gradients and VOC concentrations in the groundwater system.

In addition, monitoring wells MW-05R and MW-38R will be installed within the upper, predominately fine-grained portion of the Surficial Aquifer in the western portion of the site (Figures 7 and 9). These wells will replace existing wells MW-05 and MW-38, which are located in areas of future underground utility lines on the property, and will be used to obtain water level and water quality data to assess the effectiveness of the extraction well system.

All drilling and installation activities will be performed by a driller licensed in Maryland.

## 5.2 Monitoring Well Installation

### 5.2.1 Surficial Aquifer Wells

The boreholes for the new monitoring wells will be installed using the roto-sonic drilling method. The MW-05R, MW-38R, and MW-42 borings will be completed to a depth of approximately 25-30 feet bgs, and MW-43 and MW-44 to depths of 35 feet bgs and 40 feet bgs. During borehole advancement, cores of the unconsolidated deposits will be collected and logged in the field. Lithologic descriptions and other pertinent observations will be included in boring logs prepared after completion of the drilling activities.

Based on the site hydrogeologic data, monitoring well MW-42 and the replacement wells will be installed in the predominately fine grained deposits immediately overlying the thick sand unit. Monitoring wells MW-43 and MW-44 will be completed in the upper portion of the predominately sand to clayey sand materials at a slightly greater depth (approximately 40 feet bgs). The actual depths may vary slightly depending upon the lithologic conditions encountered during completion of the respective well boreholes. Each well will be constructed of 2-inch inside diameter (ID), threaded, Schedule 40 polyvinyl chloride (PVC) casing. The screen for well MW-05R, MW-38R, and MW-42 will be 10 feet long and consist of 0.010-inch machined horizontal slots; the MW-43 and MW-44 screens will also be 10 feet in length but with a slot size of 0.020 inches. A filter pack of clean quartz sand appropriate for the designated slot size will be placed down the annular space to a minimum depth of 2 feet above the top of the screen. A 3-foot-thick bentonite seal will be placed above the sand filter pack, and the remainder of the annular space will be filled to approximately 1-foot bgs with a cement-bentonite grout mixture. The piezometers will be completed at grade with a traffic-rated, protective steel cover set in a high strength concrete pad and fitted with a locking, expansion-grip well cap. Well construction information will be recorded in a field notebook, and as-built diagrams included with the boring log.

All drill cuttings and drilling water generated during the installation activities will be contained in Department of Transportation (DOT)-compliant 55-gallon steel drums. The drums will be labeled and moved to a staging area on the property at the end of each work day for subsequent management and disposal.

The newly installed monitoring wells will be developed by extracting groundwater from the casing using a suitable pump.  All water will be contained in DOT-compliant 55-gallon steel drums. Turbidity, pH, temperature and specific conductivity will be periodically monitored during the development process to ensure that water representative of the screened potion of the aquifer is entering the piezometer.  Development will continue until the discharge is relatively free of fine suspended sediments.

### 5.2.2 Lower Patapsco Aquifer Monitoring Wells

Two deep, double-cased monitoring wells (MW-40D and MW-41D) will be installed in the Lower Patapsco Aquifer to gather hydrologic and hydrogeochemical data for assessing the performance of the hydraulic containment system.  The borehole for well MW-40S will be installed to an approximate depth of 115 feet bgs using the roto-sonic drilling method.  The well MW-41D borehole will be completed to approximately 165 feet bgs using the same drilling method.  The proposed borehole depths are based on the recovery well construction details and groundwater quality data obtained from other deep monitoring wells in this portion of the site.

A continuous core of the unconsolidated Coastal Plain deposits will be collected from the ground surface to borehole termination depth, and logged in the field by the WSP site geologist.  Lithologic descriptions and other pertinent observations will be included in a boring log prepared after completion of the drilling activities.  Upon encountering the confining unit at an approximate depth of 60 feet bgs, a 7-inch diameter outer steel casing will be advanced a few feet into the clayey layer and sealed in place using a cement-bentonite grout mixture.  The actual depth for setting of the outer steel casing will be dependent on the lithology encountered during the drilling activities.  After allowing sufficient time for setting of the grout seal, the borehole will be advanced through the confining layer and into the underlying confined Lower Patapsco Aquifer.  In this aquifer unit, depth-discrete groundwater samples will be collected at approximately 10-foot intervals over the depth of approximately 90 feet to 150 feet bgs.  Each sample will be obtained after purging sufficient water from the sampling tool to ensure the collection of groundwater representative of the aquifer. Grab water samples will be collected for both field screening for 1,1-DCE using a colorimetric tube procedure and submittal to a local analytical laboratory – Phase Separation Sciences in Baltimore, Maryland – for VOC analysis.  A maximum of three groundwater samples will be collected from the MW-40D well borehole and five samples from the MW-41D borehole.

Each monitoring well will be constructed of 2.5-inch ID, threaded, Schedule 80 PVC casing with a 10-foot long screen consisting of 0.020-inch machined horizontal slots.  A filter pack of clean quartz sand appropriate for the designated slot size will be placed down the annular space to a minimum depth of 2 feet above the top of the screen.  A 3-foot-thick bentonite seal will be placed above the sand filter pack, and the remainder of the annular space will be filled to approximately 1-foot bgs with a cement-bentonite grout mixture.  The well will be completed at grade with a traffic-rated, protective steel cover set in a high strength concrete pad and fitted with a locking, expansion-grip well cap.  Well construction information will be recorded in a field notebook, and an as-built diagram included with the boring log.  A construction schematic for this double-cased monitoring well is provided in Figure 11.

All drill cuttings and drilling water generated during the installation activities will be contained in DOT-compliant 55-gallon steel drums.  The drums will be labeled and moved to a staging area on the property at the end of each work day for subsequent management and disposal.

The newly installed wells will be developed by extracting groundwater from the casing using a suitably-sized submersible pump.  All well discharge will be contained in DOT-compliant 55-gallon drums. Turbidity, pH, temperature and specific conductivity will be periodically monitored during the development process to ensure that water representative of the aquifer is entering the well screen.  Development will continue until the discharge is relatively free of fine suspended sediments.

## 5.3 Surveying

After completing the installation activities, the location and elevation of the ground surface and measuring point at the top of the PVC casing will be determined for the new monitoring wells. The location coordinates and elevations will be determined by a surveyor licensed in the state of Maryland, and will be consistent with standard technical practices. All horizontal locations will reference the North American Datum of 1983 for reference; vertical elevations will be referenced to the North American Vertical Datum of 1998.

## 5.4 Management of Investigation-Derived Media

Investigation-derived media (IDM) generated during the installation of the monitoring wells for the proposed response action monitoring activities will include the following:

- drill cuttings
- solid-containing drilling water
- purge water from depth-discrete groundwater sampling
- groundwater from well development
- miscellaneous solid materials that come in contact with potentially contaminated soil or groundwater (e.g., personal protective equipment, plastic, tubing, etc.)

As discussed in Section 5.2 above, all IDM will be containerized in DOT-compliant, open or closed-top, 55-gallon steel drums. These materials will be segregated into two groups, with one consisting of potentially VOC-contaminated material and the other comprising potentially non-impacted media. All drummed materials will be moved to a covered and paved staging area at the site and labeled as “non-hazardous pending analysis”.

Composite samples will be collected of the drill cuttings and drilling water from the well installation activities, and analyzed for the applicable analytical parameters to determine the appropriate management of these materials. In addition, samples of the development water from both shallow and deep wells will be collected for waste characterization analysis. Laboratory analytical results for the groundwater samples will be used to characterize the sample purge water from the MW-40D and MW-41D boreholes. Characterization of the miscellaneous solid materials will be consistent with the associated environmental media. All IDM will be managed in accordance with applicable state and federal regulations.

# 6 Passive Sampler Field Demonstration Study

## 6.1 Study Approach

Previous groundwater monitoring events at the former Kop-Flex site have utilized standard purge or low flow purging methods to collect samples for VOC analysis. Over the past decade, a significant research effort has been focused on understanding the applicability and use of passive, or no-purge, sampling technologies for the collection of groundwater quality samples from monitoring wells. These sampling methods include the HydraSleeve sampler, which is a grab-sampling device that collects an “instantaneous” groundwater sample without the purging or mixing of liquid within the water column of the well. Salient technical findings concerning the potential applicability of HydraSleeve samplers for the collection of groundwater quality data at the Kop-Flex site include the following (ITRC 2007).

- Capability of obtaining groundwater samples for most chemical parameters because method involves the collection of a time-specific grab sample and is not reliant on diffusive processes in the well.
- Sampler is easy to deploy and recover, and is disposable, thereby eliminating the need for the field decontamination of sampling equipment and collection of regular equipment rinsate blanks.
- Ability to obtain representative groundwater samples from both low and high yield monitoring wells.
- Sample collection method results in the minimal displacement of water inside the well casing.

Since the research findings support the use of HydraSleeve samplers for the COCs and hydrogeologic conditions at the former Kop-Flex site, WSP recommends the use of this sampling technology for the long-term groundwater monitoring activities. A field demonstration test will be conducted to confirm the applicability of the HydraSleeve sampler in obtaining representative groundwater samples from the Surficial and Lower Patapsco aquifers. The field test will be completed approximately two months before the baseline groundwater sampling event to allow sufficient time for finalizing the sample collection procedure and obtaining regulatory approval.

Since the initiation of groundwater remedial actions in 2002-2003, semi-annual monitoring has been implemented to assess groundwater quality at the site. Over the past four years, additional surficial and deep aquifer wells have been incorporated into the site monitoring program. With the completion of the 2014 monitoring activities, the number of sampling events will be greater than 20 for Surficial Aquifer wells, and between 6 and 10 for the majority of the wells in the Lower Patapsco Aquifer.

A review of the historical sampling data for both the Surficial and Lower Patapsco aquifer through 2013 shows minor temporal variability in COC concentrations in the affected portion of the aquifer. (The 2014 sampling results are excluded because of possible transient effects on VOC mass distribution resulting from the April-May aquifer test activities.) As shown in Figures 12 and 13, these variations are most prevalent in the upper-most hydrogeologic unit, which probably reflect the influence by changes in precipitation recharge and associated groundwater surface fluctuations, and the status of active remedial measures in different portions of the site. Given the ongoing monitoring activities, sufficient groundwater sampling data is available to characterize the hydrogeochemical conditions in the VOC-affected portions of the aquifer system. Therefore, the sampler demonstration test will involve the comparison of groundwater quality data obtained using the HydraSleeve sampler with the historical monitoring results.

## 6.2 HydraSleeve Field Demonstration Test

### 6.2.1 Sampling Locations

The HydraSleeve sampler will be deployed in 6 of the 11 monitoring wells in the groundwater quality monitoring network for the Surficial Aquifer, and 5 of the 9 wells in the Lower Patapsco Aquifer monitoring network. The selected monitoring points are listed below and identified in Figures 14 and 15.

| Surficial Aquifer | Lower Patapsco Aquifer |
|---|---|
| MW-03 | MW-1D |
| MW-04 | MW-16D |
| MW-05R | MW-21D |
| MW-09 | MW-23D |
| MW-16 | MW-24D |
| MW-18 | |

Sampling locations for the field demonstration test were selected to include wells that were (1) screened in relatively low and high permeability aquifer materials and (2) will have data for a minimum of six monitoring events by June 2015. For the Surficial Aquifer, four of the proposed HydraSleeve sampler test locations (MW-04, MW-05R, MW09, and MW-16) are located within the inferred limits of the VOC plume, with the two remaining wells (MW-03 and MW-18) situated hydraulically downgradient of the area of VOC affected groundwater. All of the Lower Patapsco Aquifer wells selected for the test are situated within the know VOC plume area.

### 6.2.2 Sampling Activities

#### 6.2.2.1 General

The approach for the HydraSleeve field demonstration test will involve sampler deployment in the selected monitoring wells in both aquifers at the same time. WSP will set all of the passive samplers over a one to two-day field period. Given the range in permeability of the aquifer materials screened by the test wells, the samplers will remain in place for a minimum of two weeks to allow for the re-stabilization of analyte concentrations in the wells. After reaching the equilibration period, the HydraSleeve samplers will be removed from the selected monitoring points and samples collected for laboratory analysis.

The following section provides a description of the procedure for obtaining the groundwater samples using this passive sampling technology. Detailed information on the deployment and sample collection and recovery using the HydraSleeve is included in Appendix C.

#### 6.2.2.2 HydraSleeve Sampling Procedure

Initially, the depth to water and total depth will be measured for the selected wells prior to deployment of the HydraSeleeve samplers. These field measurements will be reviewed, along with the well construction information, to determine the target depths for placing the passive samplers.

Construction details and lithologic descriptions of the aquifer materials within the screen intervals were reviewed for the monitoring wells selected for deployment of the passive samplers. Based on this information, a single HydraSleeve sampler will be placed down all of the wells to collect groundwater samples for the field demonstration test. Single HydraSleeve samplers will be set so as to target sample collection over the 2.5 to 5-foot portion of the screen in communication with the more permeable (i.e., coarser) aquifer materials. The proposed depth intervals for setting the samplers in the test wells are provided in Table 4.

The 2.5-foot long HydraSleeve sampler will be attached to a weighted, nylon suspension tether and set at the pre-determined depth within the screen interval. The placement of the HydraSleeve will involve first lowering the sampler to the bottom of the well and very slowly raising the sampler so the valve/opening is at the prescribed depth – termed “bottom-up deployment”. The suspension line will then be secured at the well head to ensure the sampler remains at the designated depth during the two-week re-stabilization period. Following equilibration, the groundwater sample will be collected by continuously pulling upward on the HydraSleeve until full. The HydraSleeve will be carefully removed from the well, and the sample immediately collected in the appropriate containers to minimize the diffusive loss of VOCs through the polyethylene wall of the sampler. The procedures for sample labeling, custody and shipping will follow the requirements specified in the WSPs Field SOPs (Appendix B). The groundwater samples will be analyzed for VOCs using USEPA SW-846 Test Method 8260B and 1,4-dioxane using modified USEPA Method 8260B with SIM.

### 6.2.3 Field QC Sample Collection

In addition to a trip blank, the QC samples for assessing the data quality during the HydraSleeve field demonstration test will consist of a field duplicate and equipment blank. The equipment blank will be used as a control sample and to identify potential biases for any target compounds. This sample will be collected by filling one, un-used sampler with deionized or distilled water, and then transferring water to the necessary sample containers in the same manner as a groundwater sample.

## 6.3 Data Evaluation and Sampling Method Recommendation

The data evaluation will utilize both qualitative and quantitative assessment of the comparability of the groundwater quality data obtained using the passive sampling method and conventional (standard and low-flow purging) methods. Quantitative evaluation of the demonstration test data will primarily involve the analysis of well-specific data plots and comparing the HydraSleeve sampler data with historical results. Statistical values (e.g., mean, standard deviation, median, etc.) may be calculated for the historical sampling data to assist in characterizing VOC concentrations at a given monitoring point. The passive sampler data will be reviewed in light of the “logical filters” outlined in Parson (2005) before conducting the comparison evaluation. These filters will concern the potential exclusion of data points based on the presence of non-detected values for site-related COCs and the quality of the reported laboratory results after completing a data quality assurance review.

The evaluation of the field demonstration test results will be used to conclude whether the HydraSleeve sampler provides groundwater samples representative of hydrogeochemical conditions in the aquifer at the proposed monitoring points. It should be noted that differences in VOC concentrations between the passive sampling method and historical samples collected using conventional methods may not necessarily indicate the HydraSleeve sampler does not adequately monitor the ambient groundwater quality. The low-flow sampling method will be the default sampling technology in the event the HydraSleeve sampler is deemed inappropriate for the long-term monitoring program. A summary of the field demonstration test results and sampling method recommendation will be forwarded to MDE for review and approval before conducting the base line groundwater monitoring event.

If the HydraSleeve is deemed a suitable sample collection method, one sampler will be used in all wells during future groundwater sampling events. For these monitoring points, the HydraSleeve sampler will be placed at the approximate mid-point of the screen interval.

# 7 Evaluation and Reporting of Monitoring Data

## 7.1 Data Tabulation

The analytical results for each groundwater sample collected during a particular monitoring event will be presented in tabular format, along with the sampling date and any associated data qualifiers. Non-detect results will be represented using the quantitation limit for the compound and the “U” data qualifier. Additionally, historical data tables, which include COC concentrations for all or selected monitoring points, will be prepared and updated in conjunction with the preparation of the data tables.

## 7.2 Data Evaluation

A systematic analysis of the hydraulic capture and containment of the VOC plume will be conducted using both the water level and groundwater quality data. The overall groundwater capture evaluation will be similar to the process described in the U.S. EPA guidance document *A Systematic Approach for the Evaluation of Capture Zones at Pump and Treat Systems* (USEPA 2008). This evaluation approach will include preparing groundwater surface and drawdown contour maps and well pair hydrographs to determine horizontal and vertical gradients, and concentration versus time plots for wells located cross-gradient and downgradient of the extraction well systems. The groundwater surface contours will be compared to predicted values from the remedial pumping flow simulations to assess the accuracy of the analytical model results.

The groundwater monitoring results will also be evaluated to assess the performance of the remedial system with respect to the removal of mass from the impacted aquifers. Data analysis will include the preparation of temporal concentration plots for wells situated within the pre-remediation plume boundaries at the site. Statistical methods, such as non-parametric trend analysis (Mann-Kendall and Mann-Whitney tests), may be used to assess the significance of temporal trends in the COC concentrations in groundwater.

## 7.3 Reporting of Monitoring Data

The water level data and groundwater sampling results will be included as part of the Operation, Maintenance and Monitoring (OM&M) reports for the hydraulic containment systems. The information provided in the OM&M reports will include a discussion of the monitoring activities, event-specific and historical data tables, and interpretation of the water level and groundwater quality data in terms of the groundwater remedial objectives and cleanup criteria. The OM&M reports will also include electronic copies of the certified laboratory analytical reports for all groundwater sampling events conducted during the reporting period.

# 8 References

Interstate Technology and Regulatory Council (ITRC). 2007. Protocol for Use of Five Passive Samplers to Sample for a Variety of Contaminants in Groundwater, DSP-5, 88 p.

Montgomery Watson Harza, Inc.  2002.  Point Source Bailer Demonstration Report, Former Mather Air Force Base, Mather, California.

Parker, L.V., and C.H. Clarke. 2002. Study of Five Discrete Interval-Type Groundwater Sampling Devices; U.S. Army Corps of Engineers, Technical Report ERDC/CRREL TR-02-12, 38 p.

Parsons Corporation. 2005. Results Report for the Demonstration of No-Purge Groundwater Sampling Devices at the Former McClellan Air Force Base, California; U.S. Army Corps of Engineers, Air For Center for Environmental Excellence and Air Force Real Property Agency.

U.S. Environmental Protection Agency (USEPA).  2004.  Demonstration of Two Long-Term Groundwater Monitoring Optimization Approaches; Office of Solid Waste and Emergency Response, EPA 542-R-04-001a, 47 p.

U.S. Environmental Protection Agency (USEPA).  2008.  A Systematic Approach for the Evaluation of Capture Zones at Pump and Treat Systems.

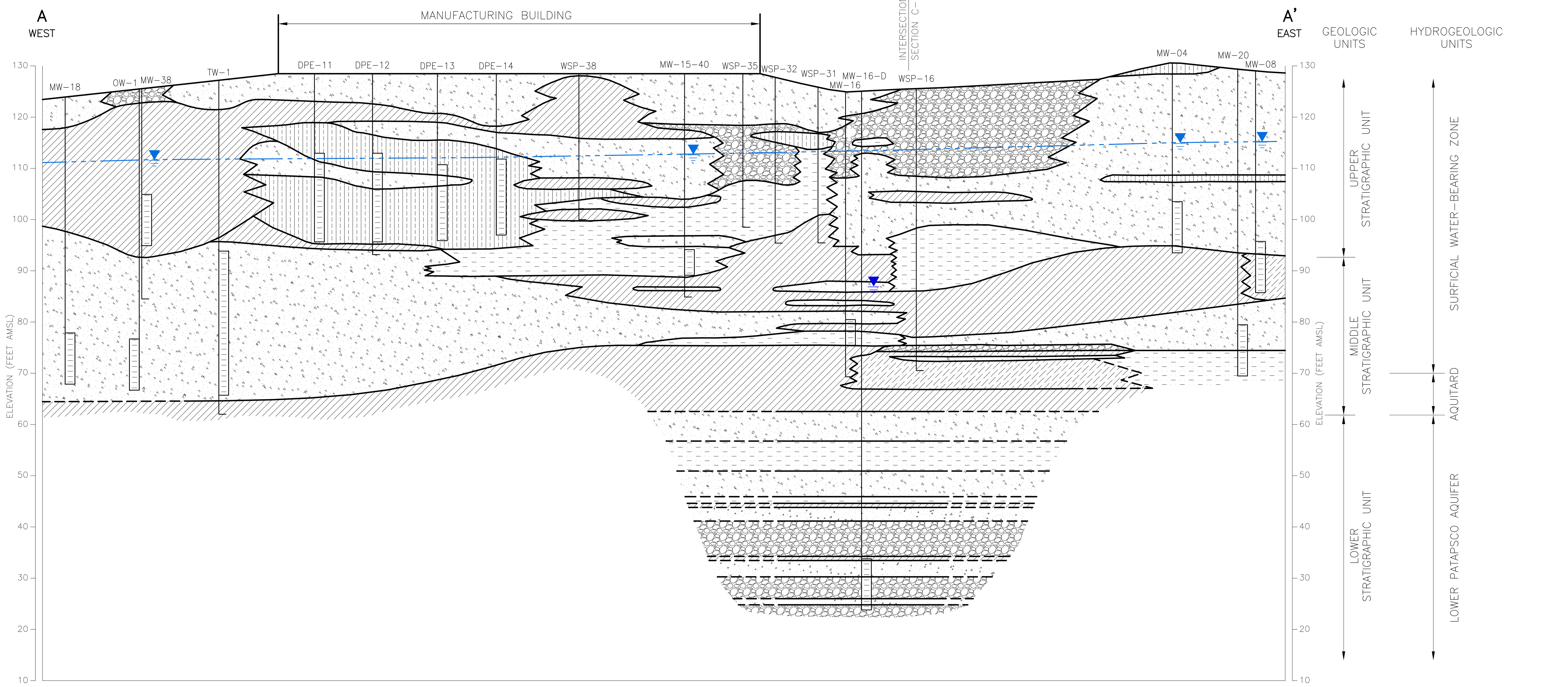
Vroblesky, D.A. and W.B. Fleck.  1991.  Hydrogeologic Framework of the Coastal Plain of Maryland, Delaware, and the District of Columbia, U.S. Geological Survey Professional Paper 1404-E, 41 p.

WSP USA (WSP).  2013.  Health and Safety Plan, Kop-Flex, Inc. VCP Site, Hanover, Maryland (Version 3.0), 52 p.

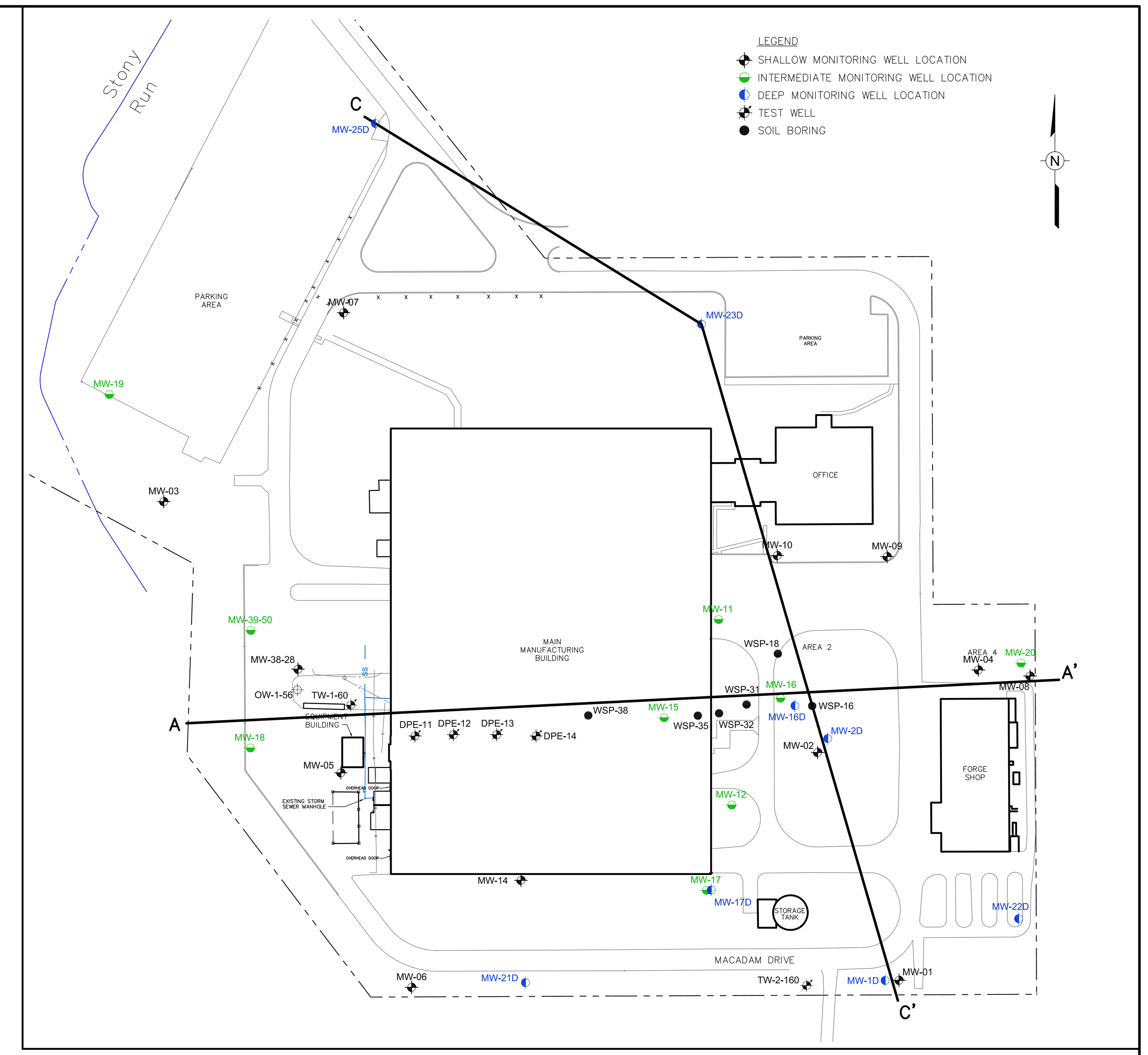
# 9 Acronyms

| | |
|---|---|
| bgs | below ground surface |
| COCs | chemicals of concern |
| DCA | 1,1-dichloroethane |
| DCE | 1,1-dichloroethene |
| DOT | Department of Transportation |
| GWMP | Groundwater Monitoring Plan |
| H&S | health and safety |
| HASP | Health and Safety Plan |
| ID | inside diameter |
| IDM | Investigation-derived media |
| MAROS | Monitoring and Remediation Optimization System |
| MCLs | maximum contaminant levels |
| MDE | Maryland Department of the Environment |
| msl | mean sea level |
| OM&M | Operation, Maintenance and Monitoring |
| PCE | tetrachloroethene |
| PVC | polyvinyl chloride |
| QA/QC | Quality Assurance/Quality Control |
| QL | quantitation limits |
| RAP | Groundwater Response Action Plan |
| SIM | selective ion monitoring |
| SOP | Standard Operating Procedure |
| TCA | 1,1,1-trichloroethane |
| TCE | trichloroethene |
| USEPA | U.S. Environmental Protection Agency |
| VCP | Voluntary Cleanup Program |
| VOCs | volatile organic compounds |

# Figures




FENCE DIAGRAM A–A'




FENCE DIAGRAM LOCATIONS
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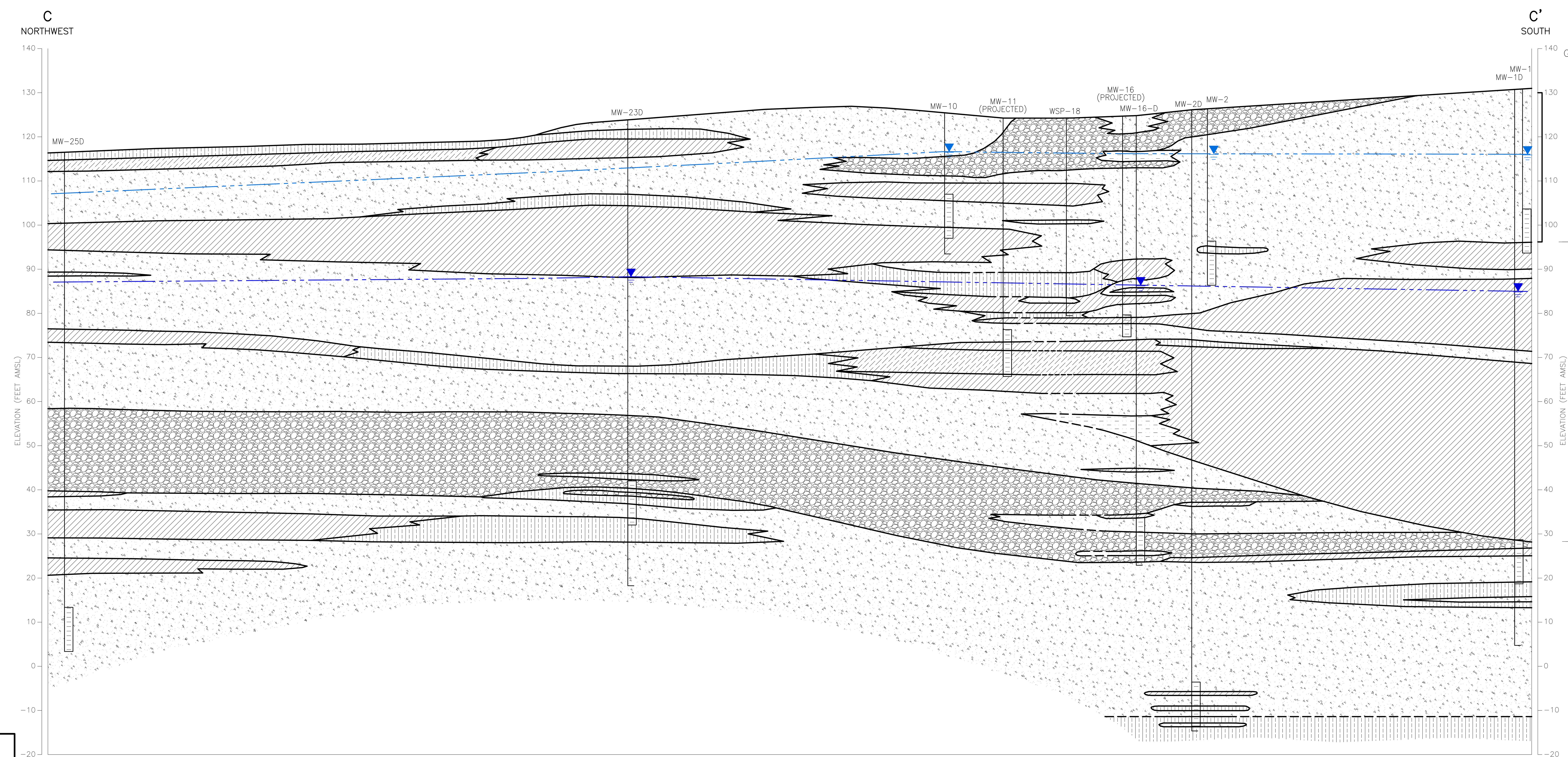


FENCE DIAGRAM C–C'

LEGEND

- GRAVELLY SAND
- SAND – SILTY SAND – CLAYEY SAND
- INTERLAYERED SAND AND CLAY
- CLAYEY TO SANDY SILT
- SANDY TO GRAVELLY CLAY
- SILTY CLAY TO CLAY
- BOREHOLE
- SCREEN
- BOTTOM OF BOREHOLE
- WATER LEVEL IN SHALLOW MONITORING WELL
- WATER LEVEL IN DEEP MONITORING WELL
- SHALLOW ZONE GROUNDWATER SURFACE ELEVATION
- POTENTIOMETRIC SURFACE FOR DEEP GROUNDWATER ZONE

NOTES:
1. GROUNDWATER ELEVATIONS FOR SHALLOW AND INTERMEDIATE WELLS FROM DATA COLLECTED IN JULY 2013.
2. GROUNDWATER ELEVATIONS FOR DEEP WELLS FROM DATA COLLECTED IN SEPTEMBER 2013.

15'
60'
4:1 VERTICAL EXAGGERATION

0 15 30
VERTICAL SCALE IN FEET

0 60 120
HORIZONTAL SCALE IN FEET

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| REV | DESCRIPTION |
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| | |

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CHECKED MCR
APPROVED
10/10/14





SEAL
DATE

# HYDROGEOLOGIC FENCE DIAGRAMS

FORMER KOPFLEX FACILITY
HANOVER, MARYLAND
PREPARED FOR
EMERSON

WSP
WSP USA Corp.
11190 Sunrise Valley Drive, Suite 300
Reston, Virginia 20191
(703) 709-6500
www.wspgroup.com/usa

FIGURE 1

Drawing Number
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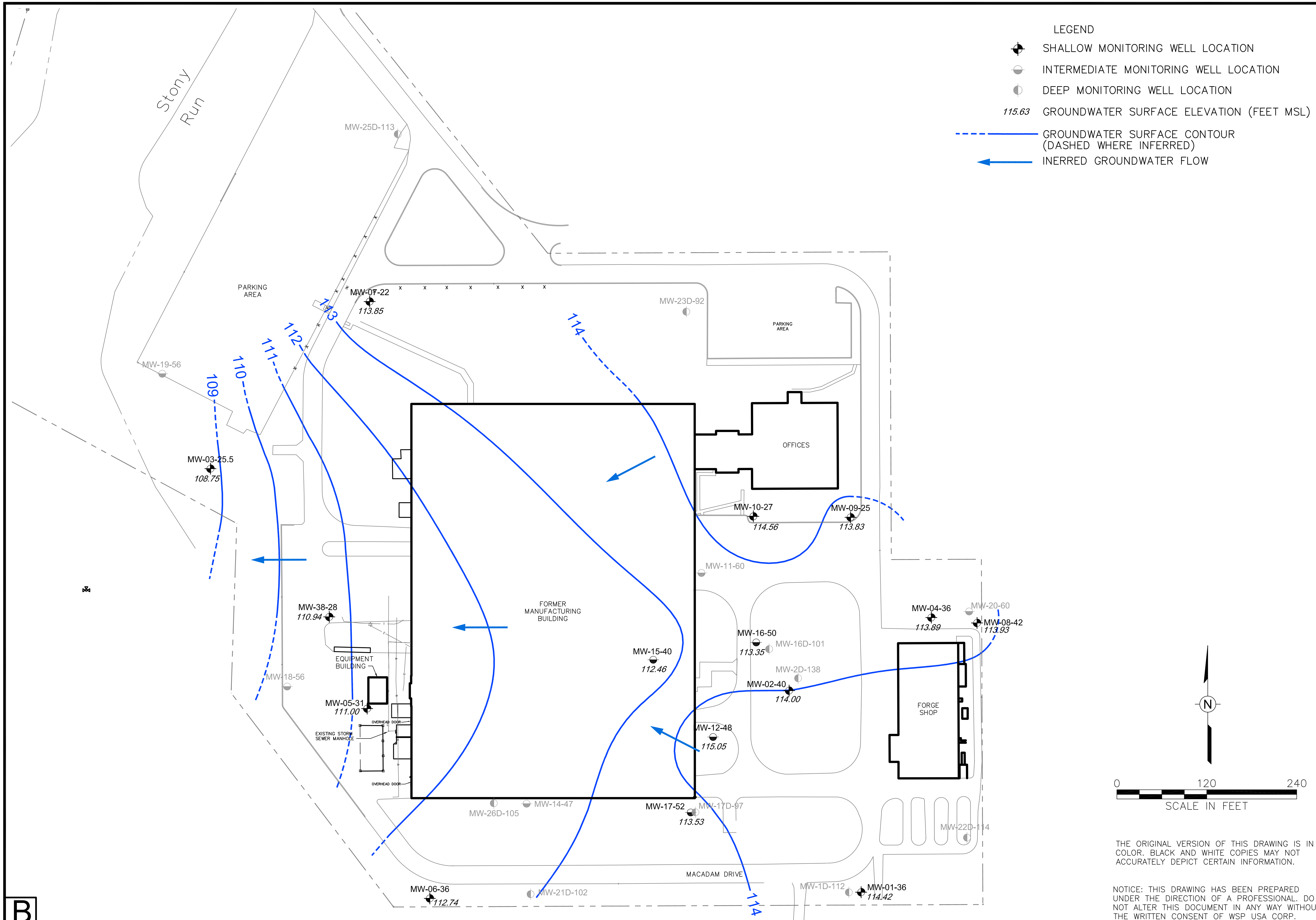


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Checked: RJW 12/22/2014
Approved:
DWG Name: 00003705-192

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Figure 2

GROUNDWATER SURFACE CONTOUR MAP
SURFICIAL AQUIFER
DECEMBER 2014


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WSP USA Corp.
11190 Sunrise Valley Drive, Suite 300
Reston, Virginia 20191
(703) 709-6500
www.wspgroup.com/usa

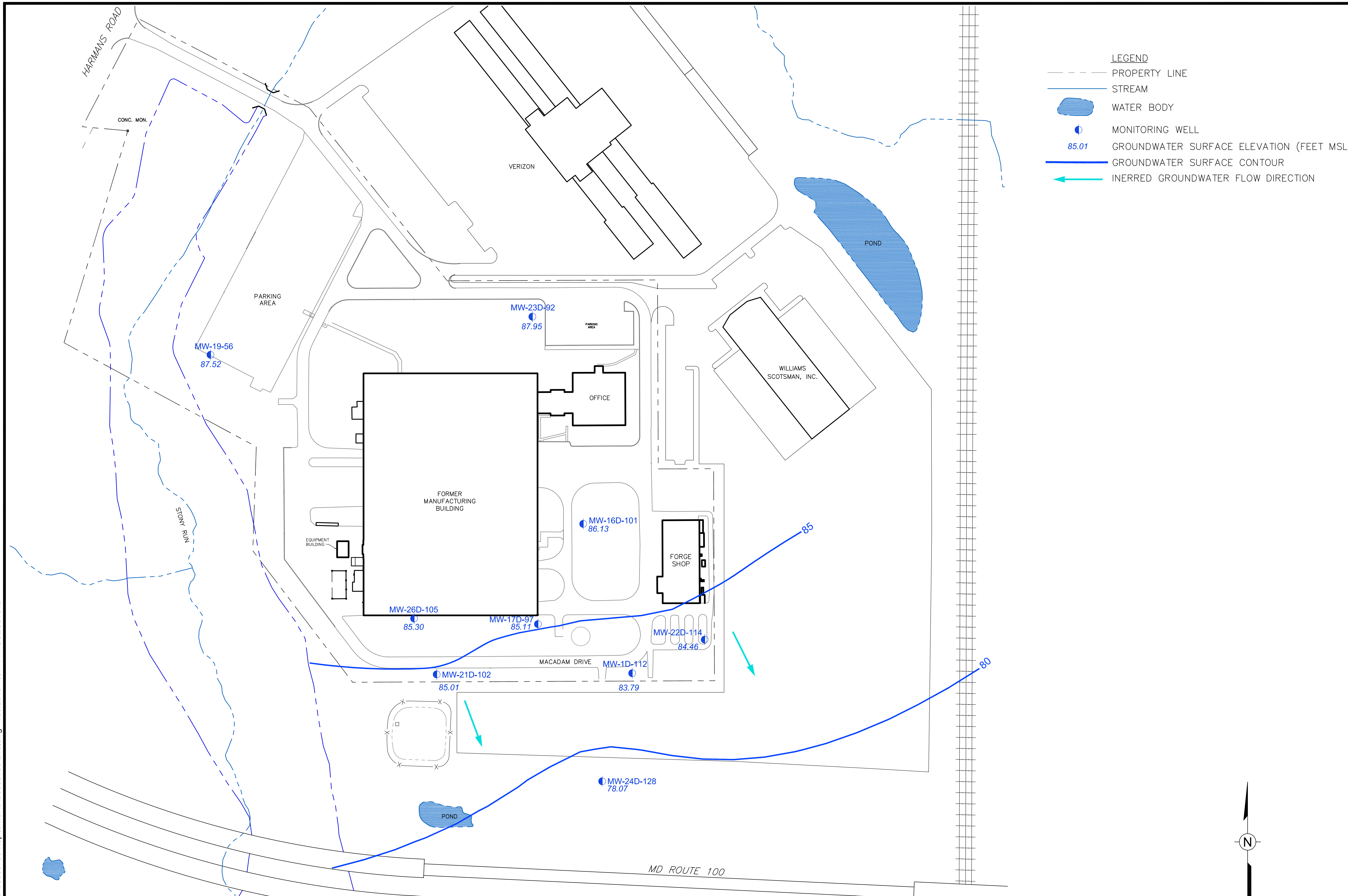


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Figure 3

POTENTIOMETRIC CONTOUR SURFACE MAP
LOWER PATAPSCO AQUIFER
DECEMBER 2014

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11190 Sunrise Valley Drive, Suite 300
Reston, Virginia 20191
(703) 709-6500
www.wspgroup.com/usa

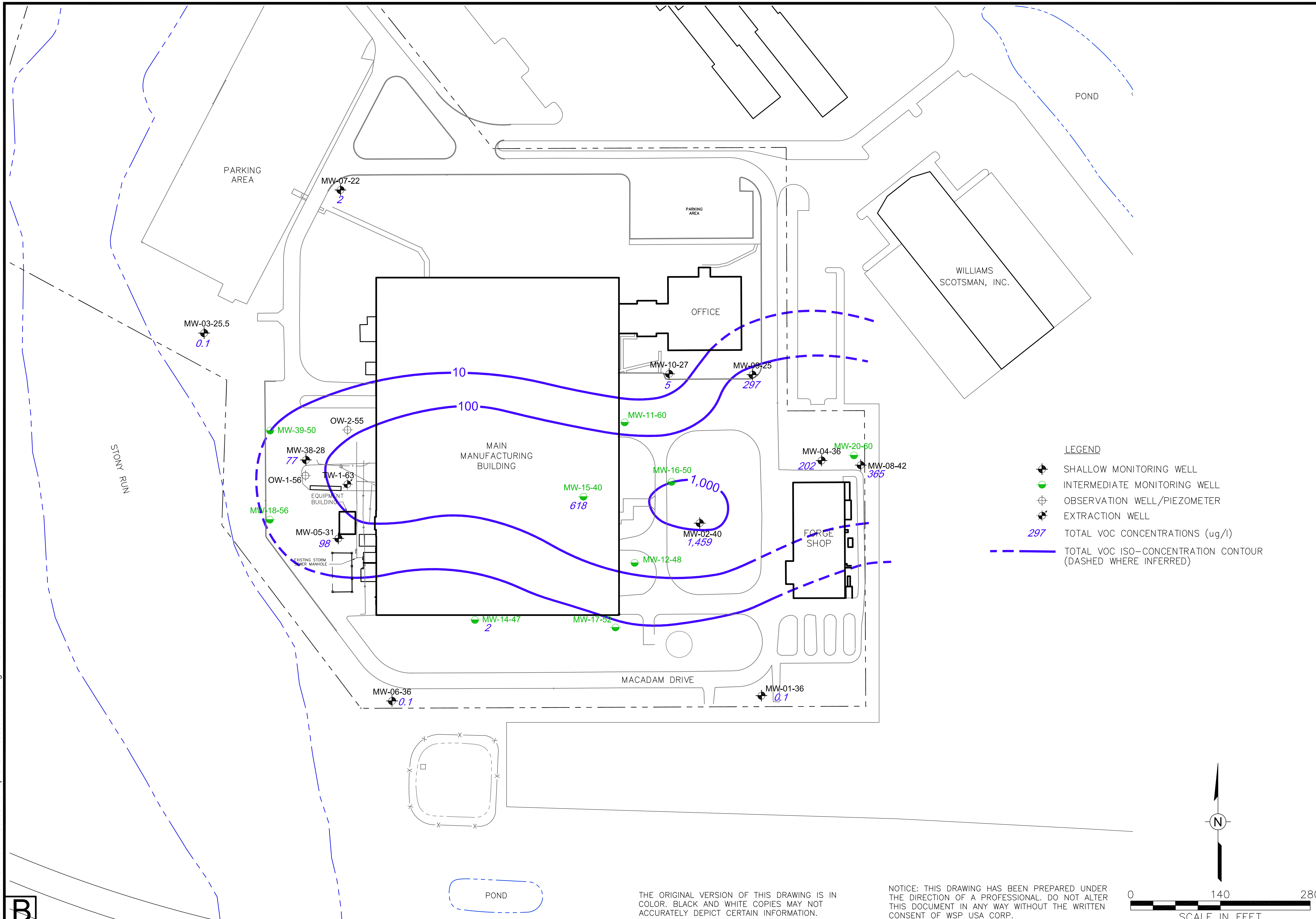


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Figure 4

CURRENT SITE LAYOUT WITH TOTAL VOC CONCENTRATIONS IN SHALLOW GROUNDWATER (DECEMBER 2014)

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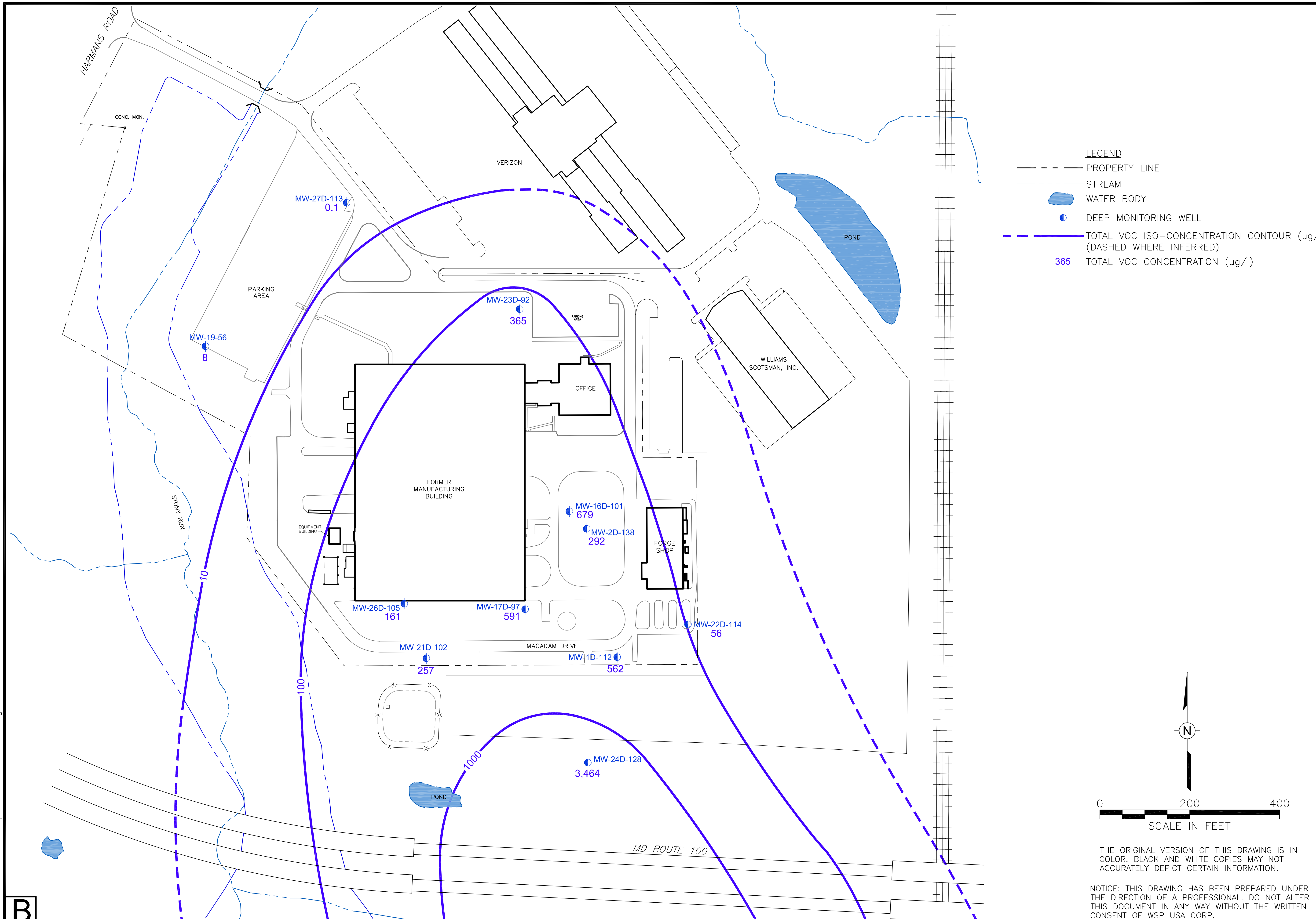


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Figure 5

CURRENT SITE LAYOUT WITH TOTAL VOC CONCENTRATIONS IN LOWER PATAPSCO AQUIFER (DECEMBER 2014)

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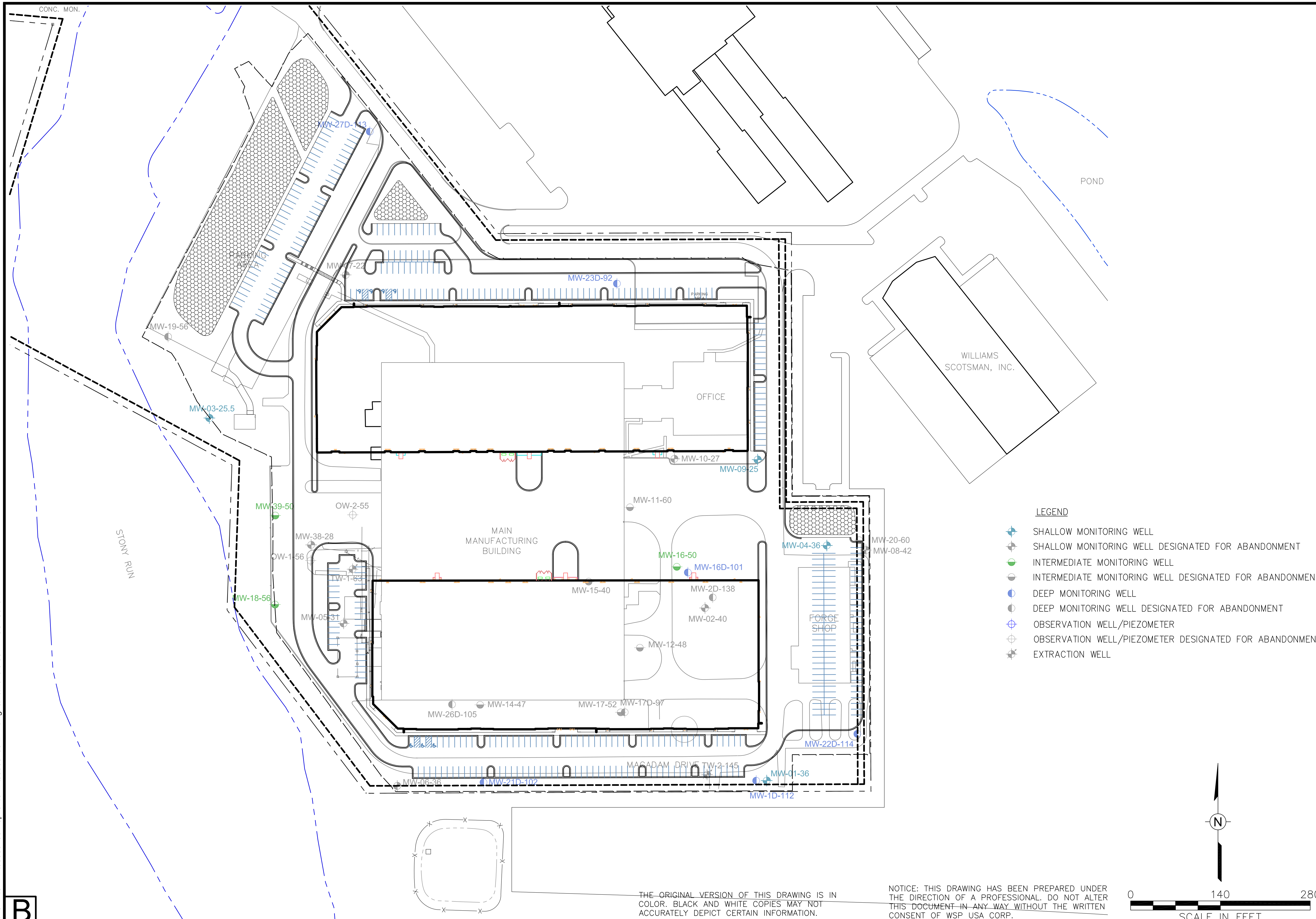


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Figure 6

EXISTING WELLS PLANNED FOR ABANDONMENT

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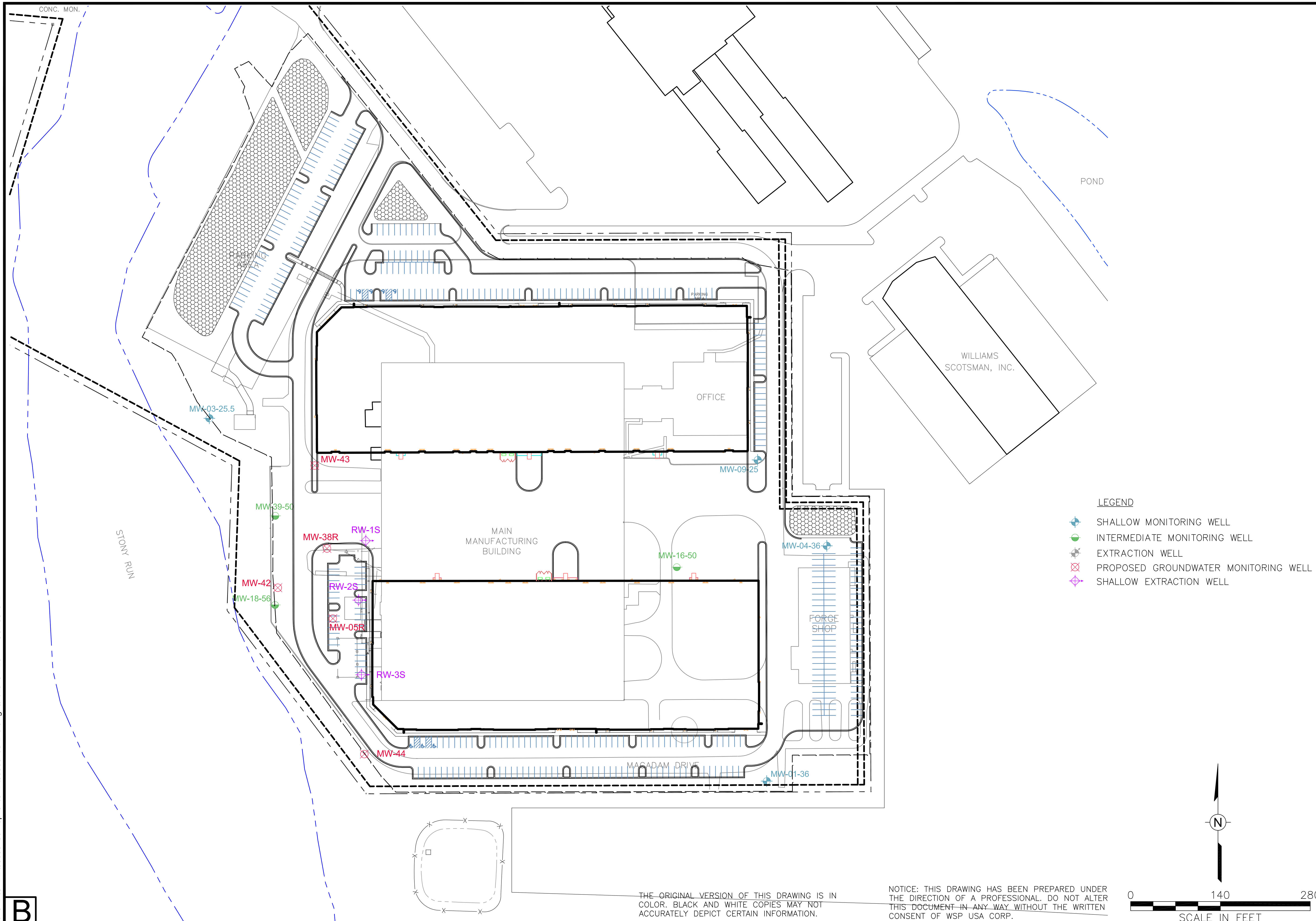


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Figure 7

CURRENT AND FUTURE SITE LAYOUT WITH SURFICIAL AQUIFER WELLS FOR COLLECTION OF WATER LEVEL DATA

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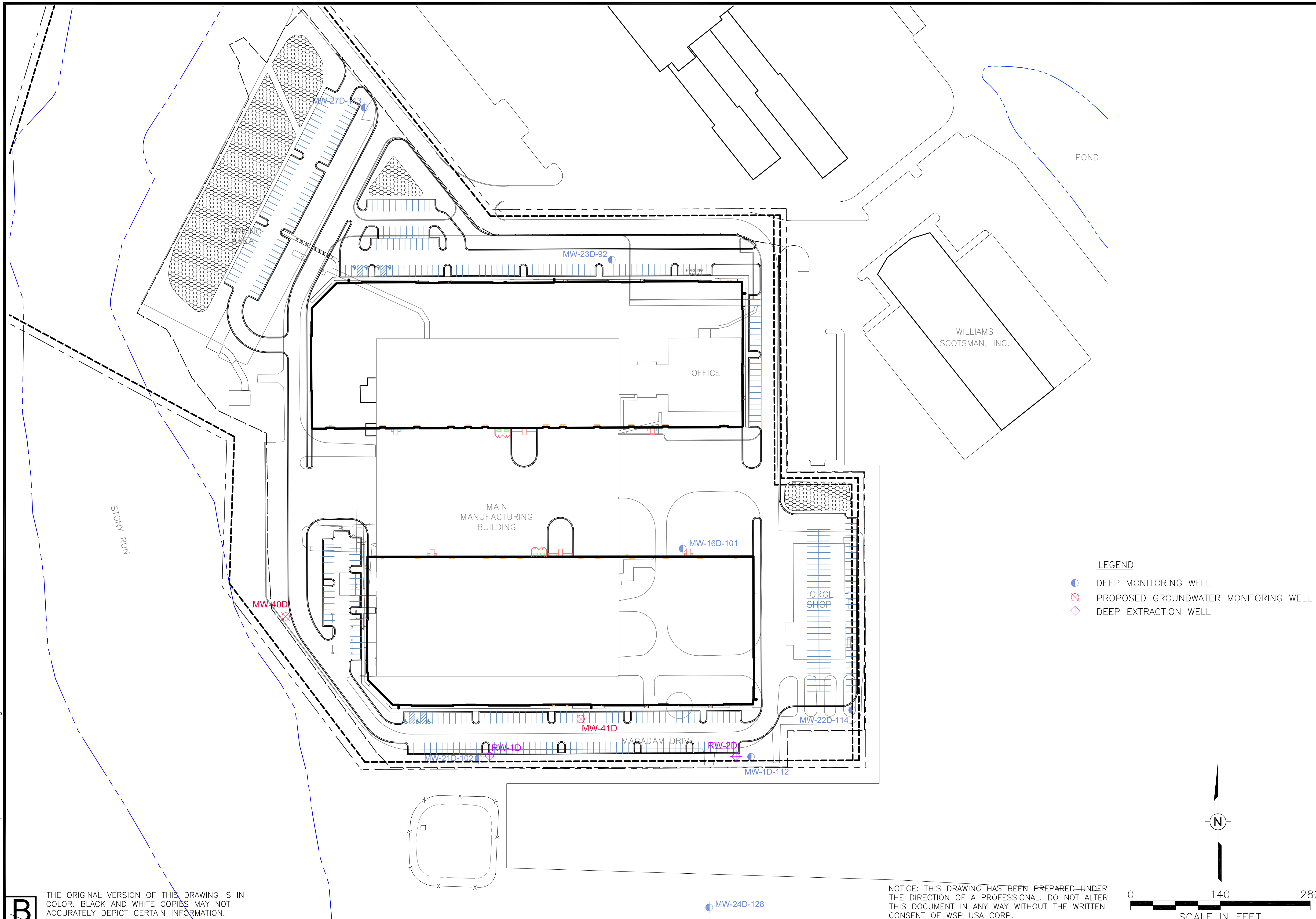


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Figure 8

CURRENT AND FUTURE SITE LAYOUT WITH LOWER PATAPSCO AQUIFER WELLS FOR COLLECTION OF WATER LEVEL DATA

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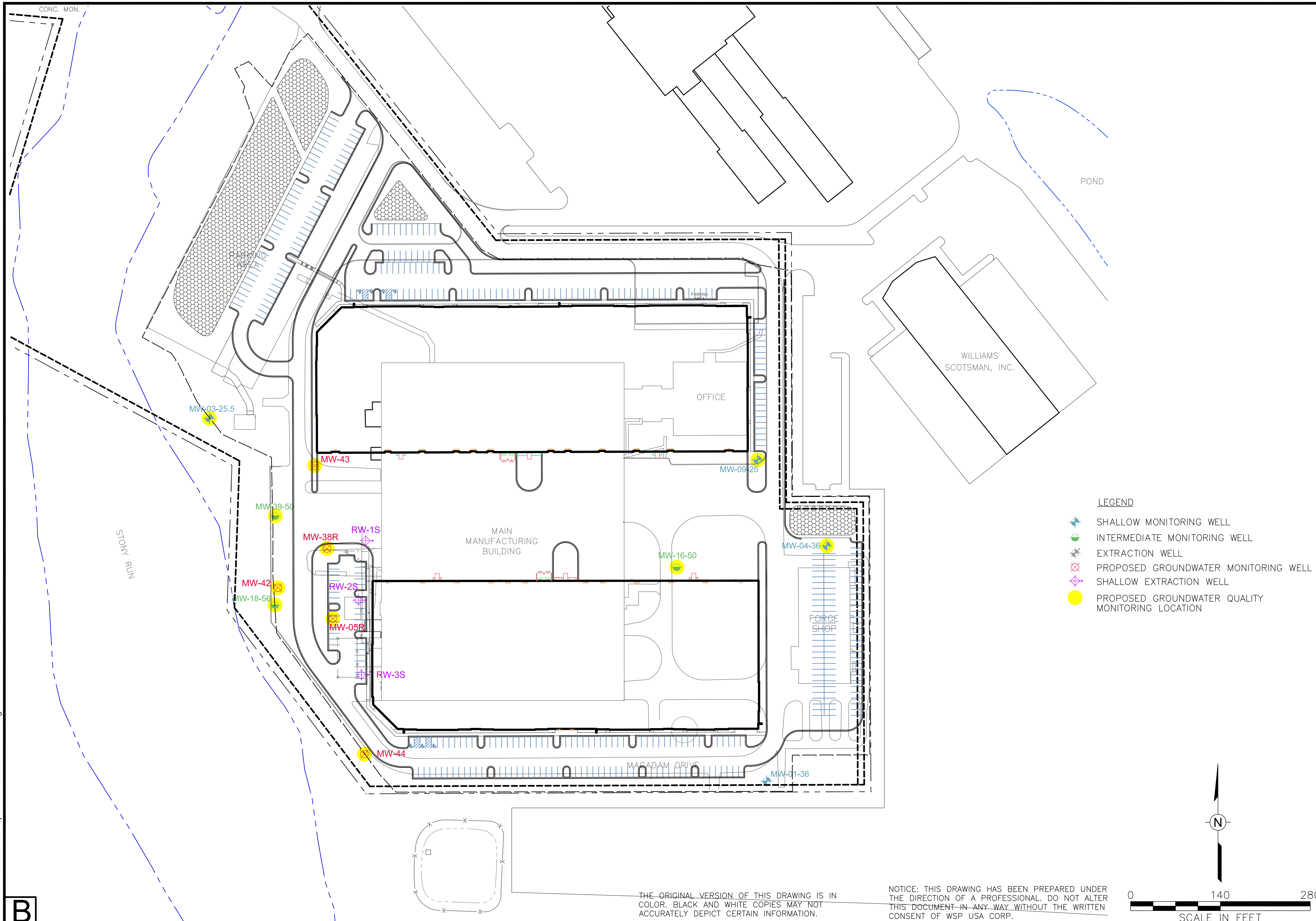


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Figure 9
SURFICIAL AQUIFER GROUNDWATER QUALITY MONITORING POINTS

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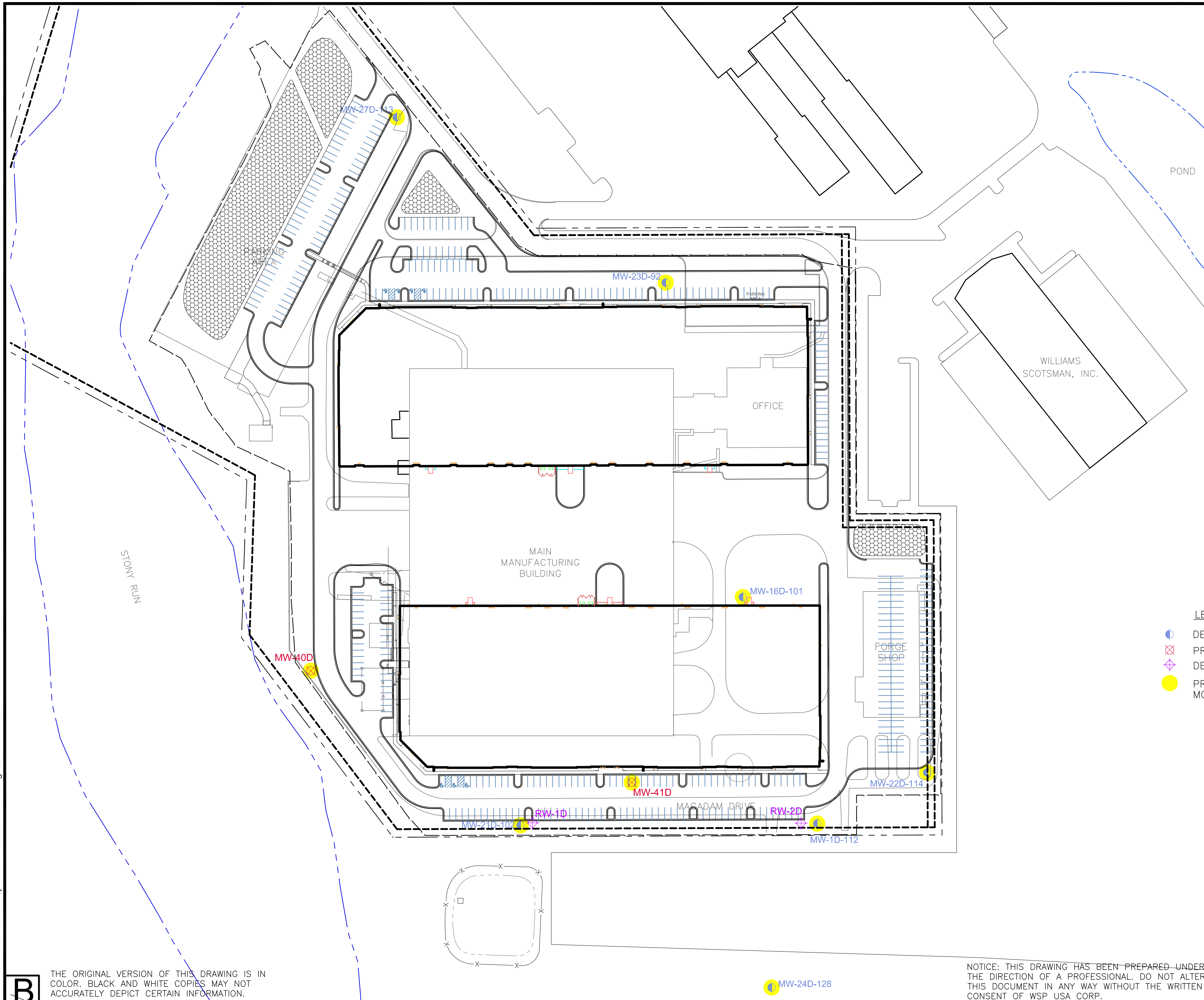


LEGEND

- DEEP MONITORING WELL
- PROPOSED GROUNDWATER MONITORING WELL
- DEEP EXTRACTION WELL
- PROPOSED GROUNDWATER QUALITY MONITORING LOCATION

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Figure 10

LOWER PATAPSCO
GROUNDWATER QUALITY MONITORING POINTS

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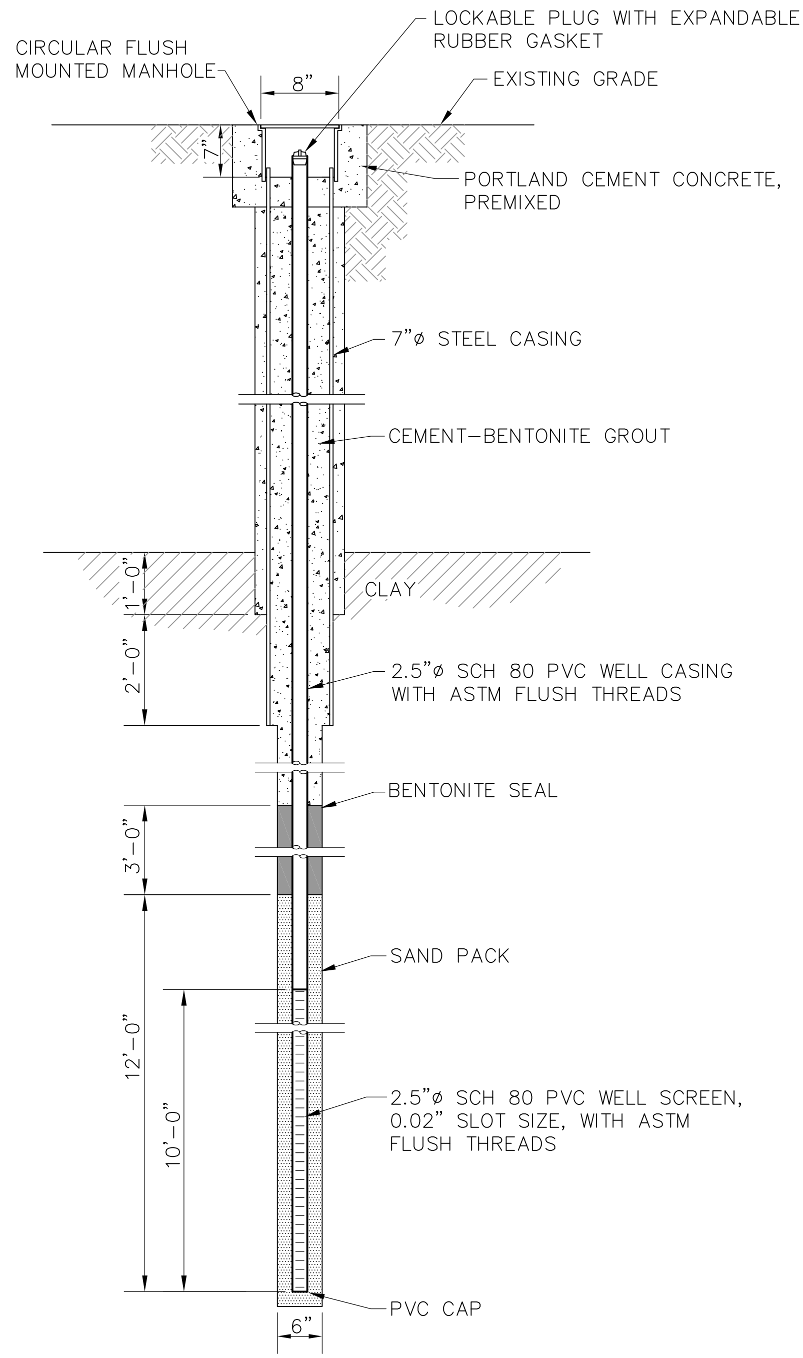


NOTE: PROPOSED WELL WILL BE INSTALLED USING THE ROTO–SONIC DRILLING METHOD.



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Figure 11

CONSTRUCTION FOR PROPOSED DEEP MONITORING WELLS

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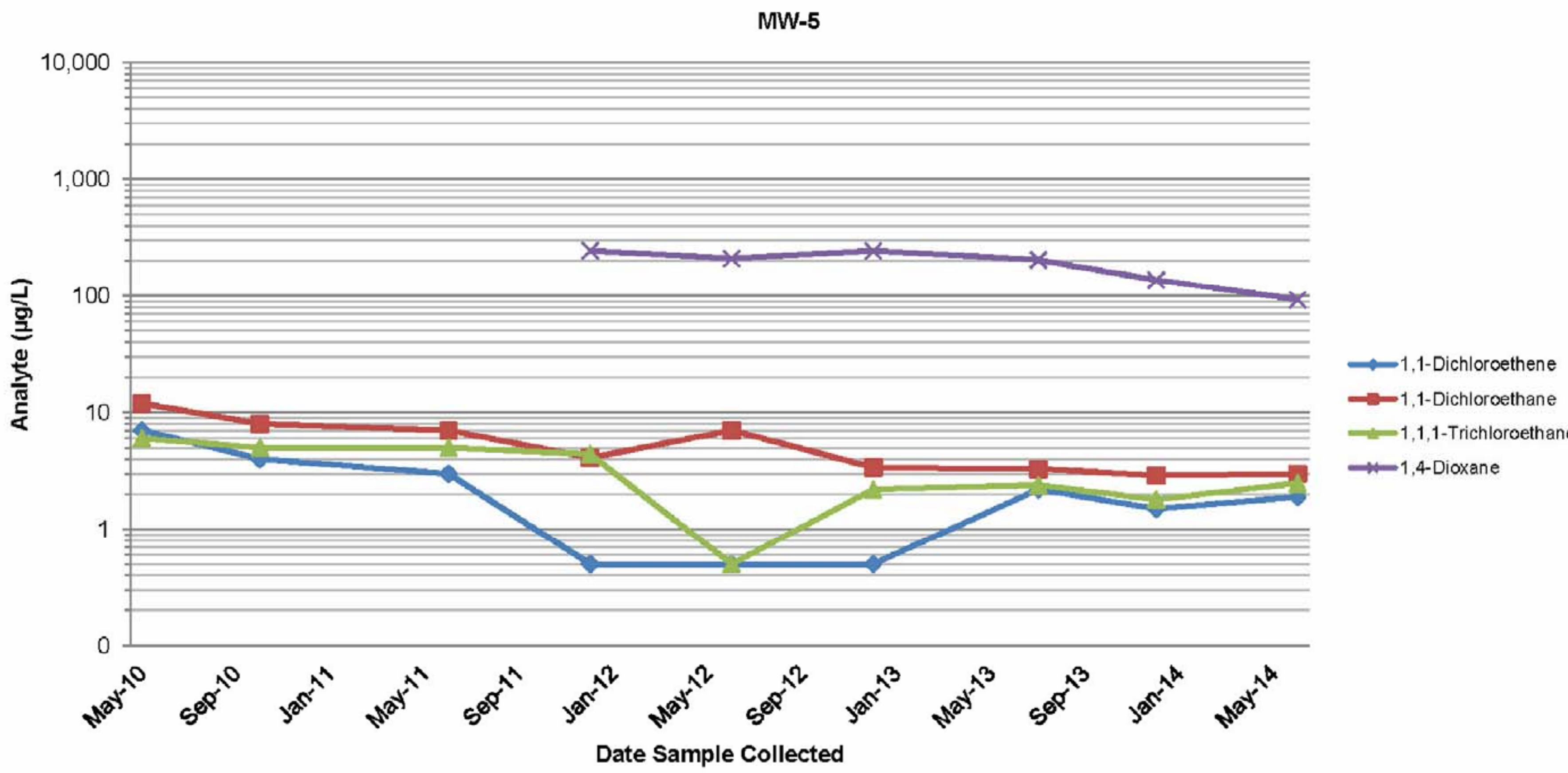


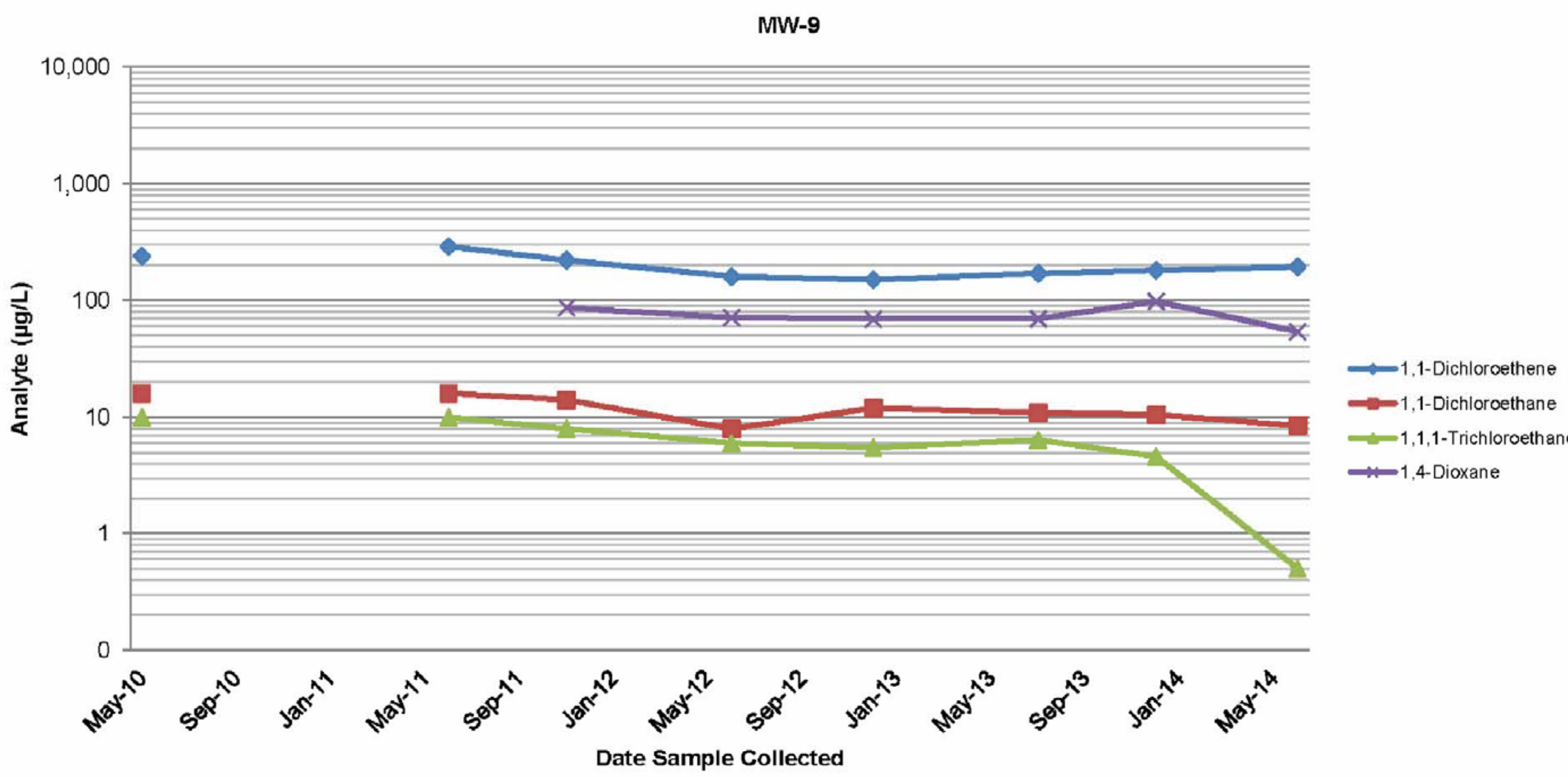


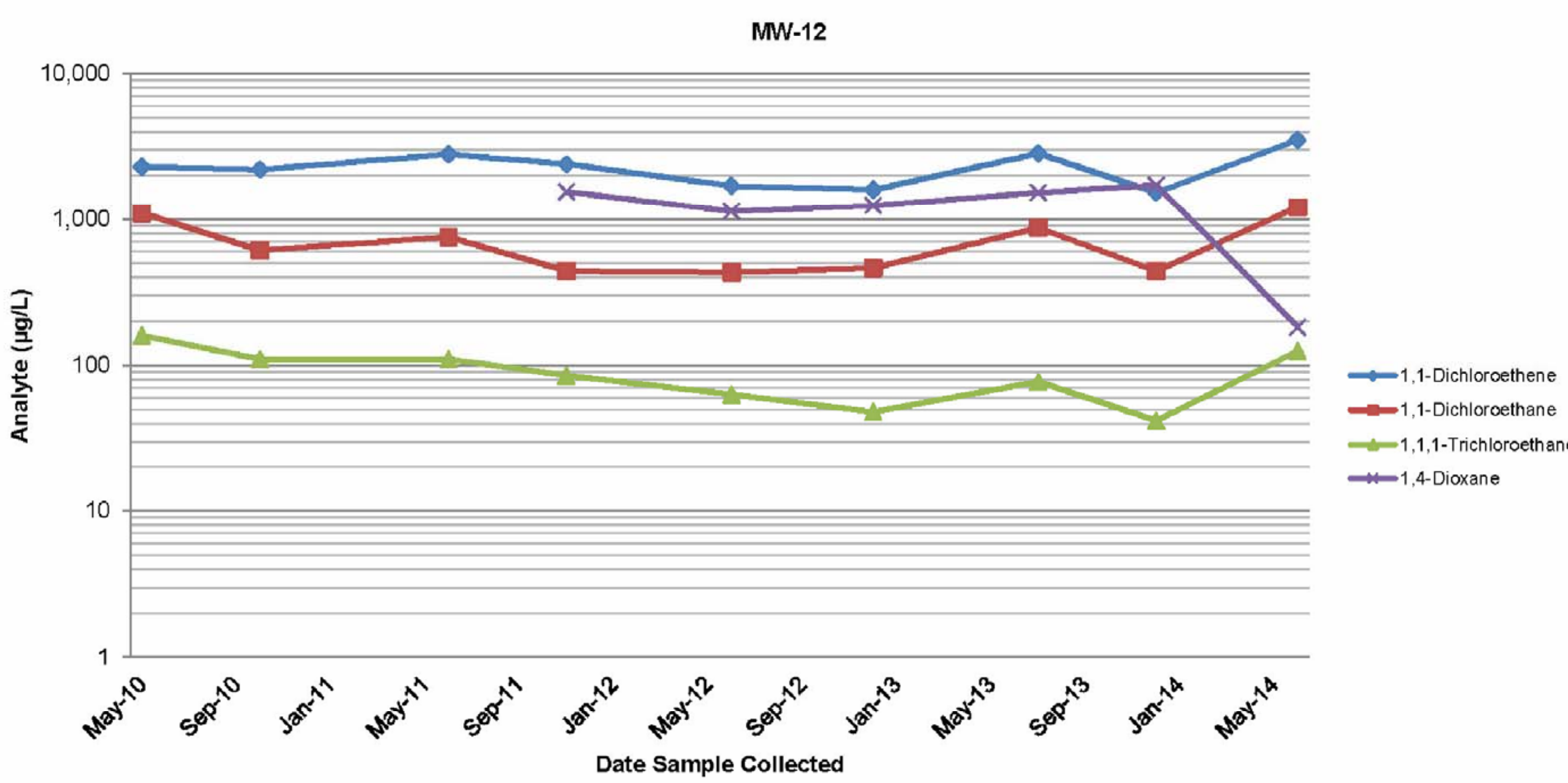


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Figure 12

CONCENTRATIONS OF SITE-RELATED COCs IN SURFICIAL AQUIFER GROUNDWATER SAMPLES (2010-2014)

FORMER KOPFLEX FACILITY
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| | |
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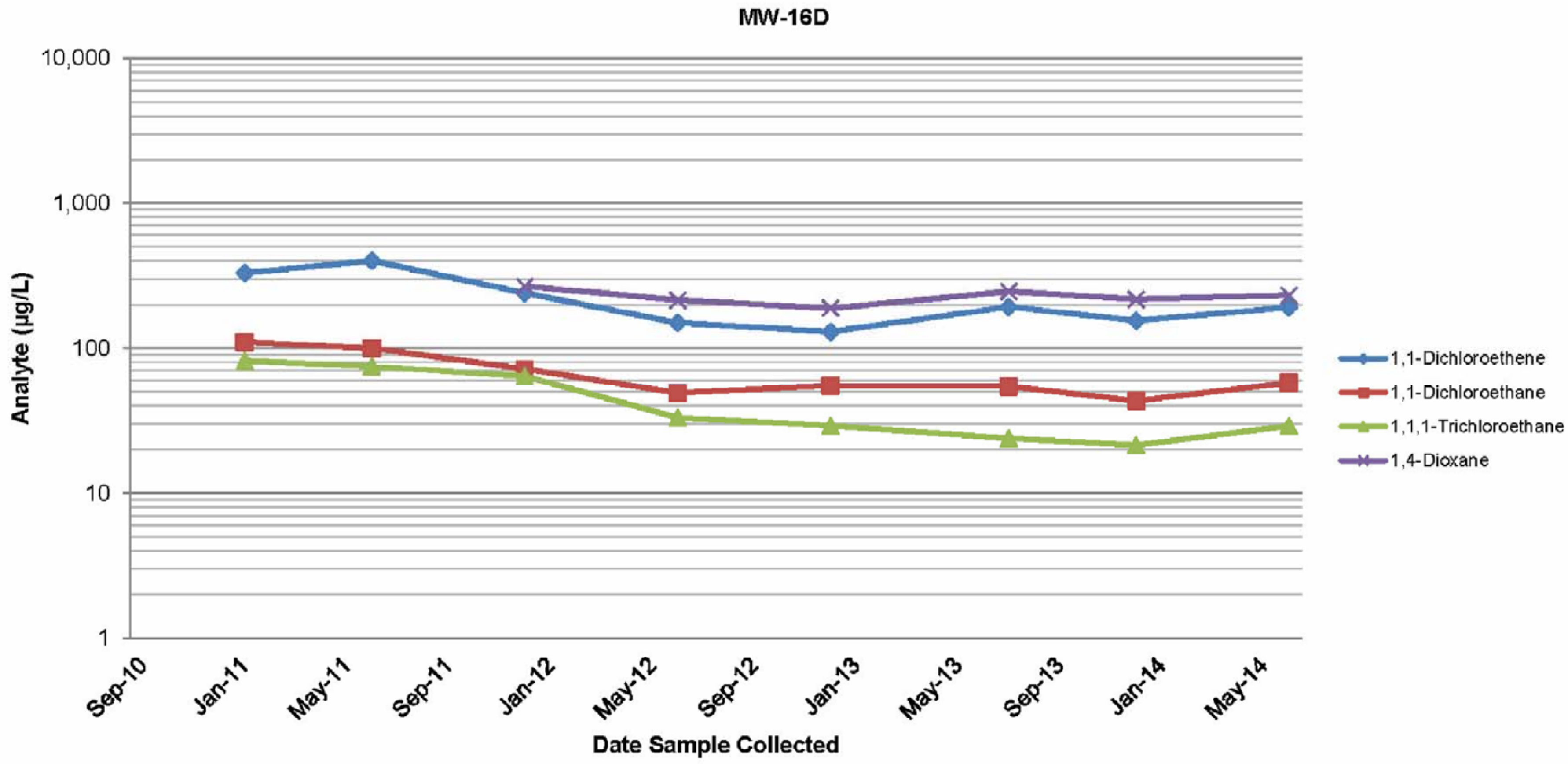


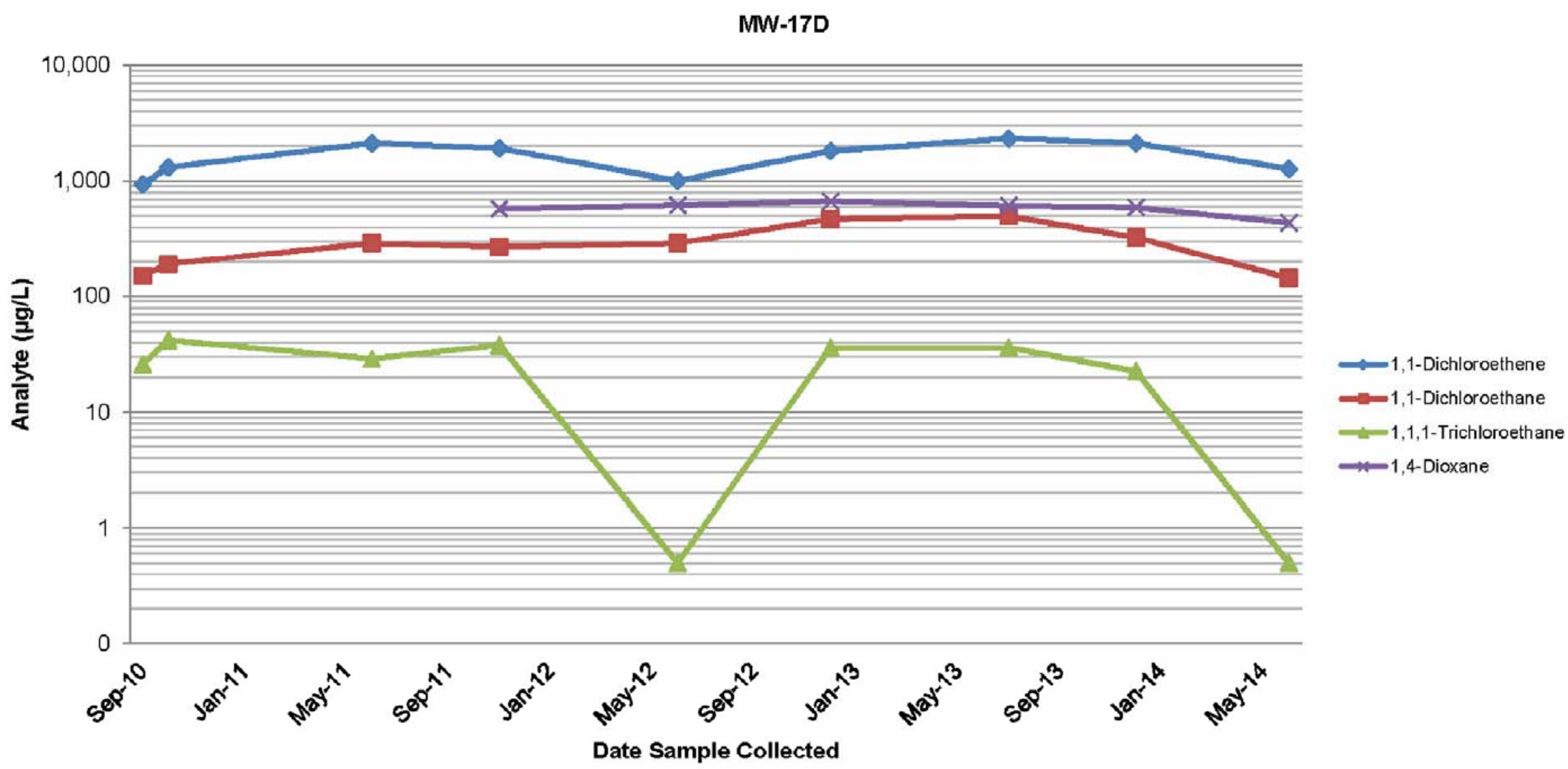


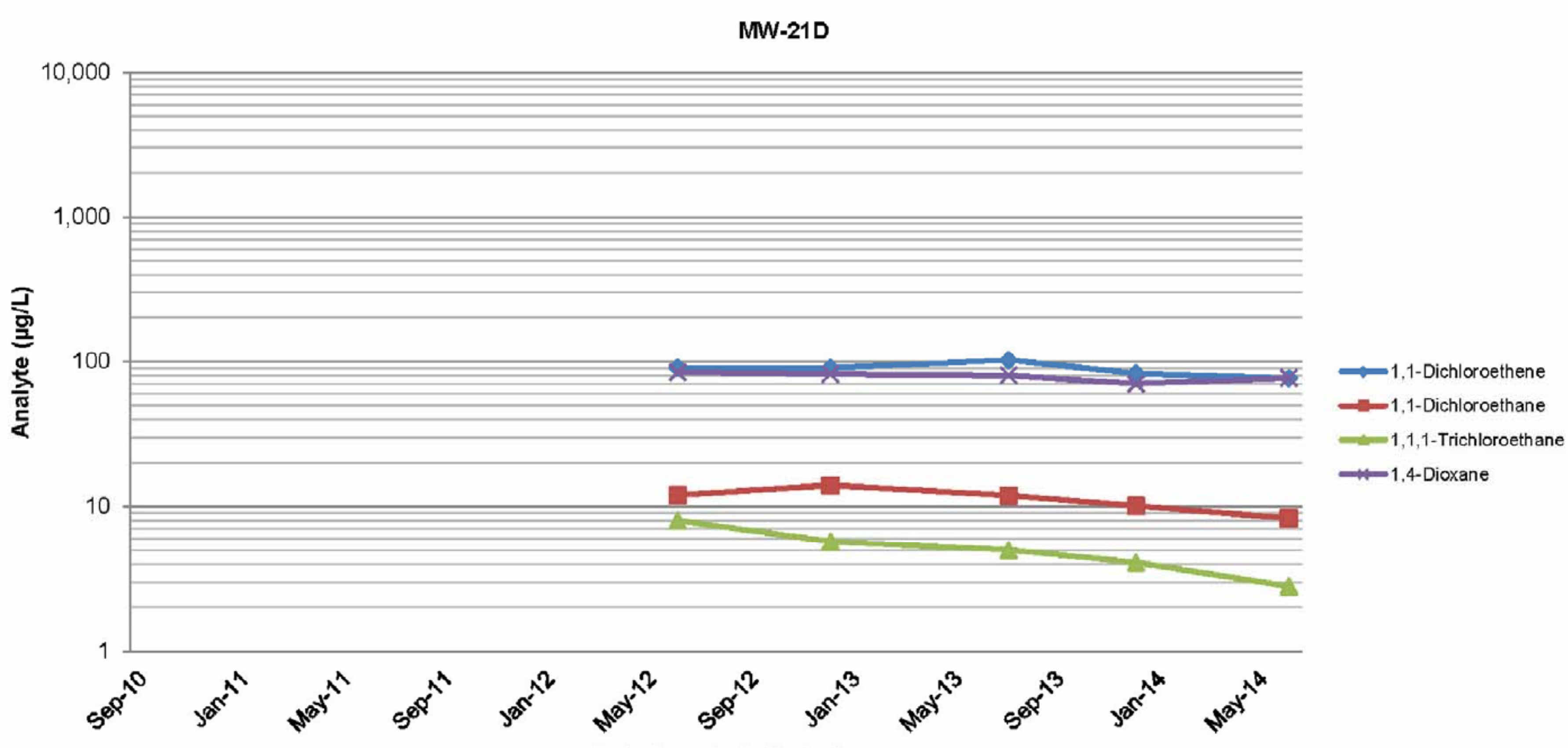


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Figure 13

CONCENTRATIONS OF SITE–RELATED COCs IN LOWER PATAPSCO AQUIFER GROUNDWATER SAMPLES (2010–2014)

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DWG Name: 00003705–188

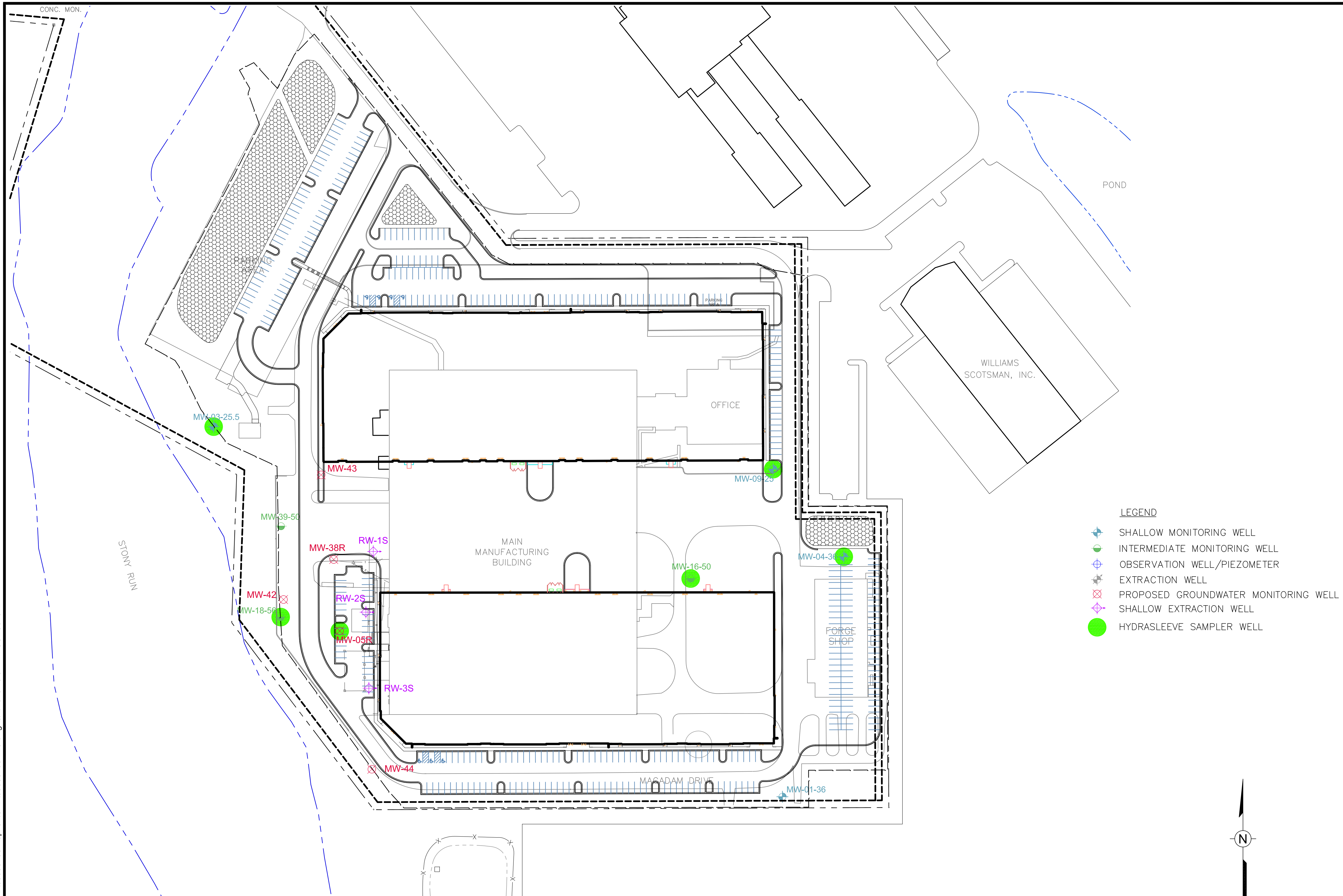


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Figure 14

SURFICIAL AQUIFER WELLS FOR HYDRASLEEVE DEPLOYMENT DURING FIELD DEMONSTRATION TEST

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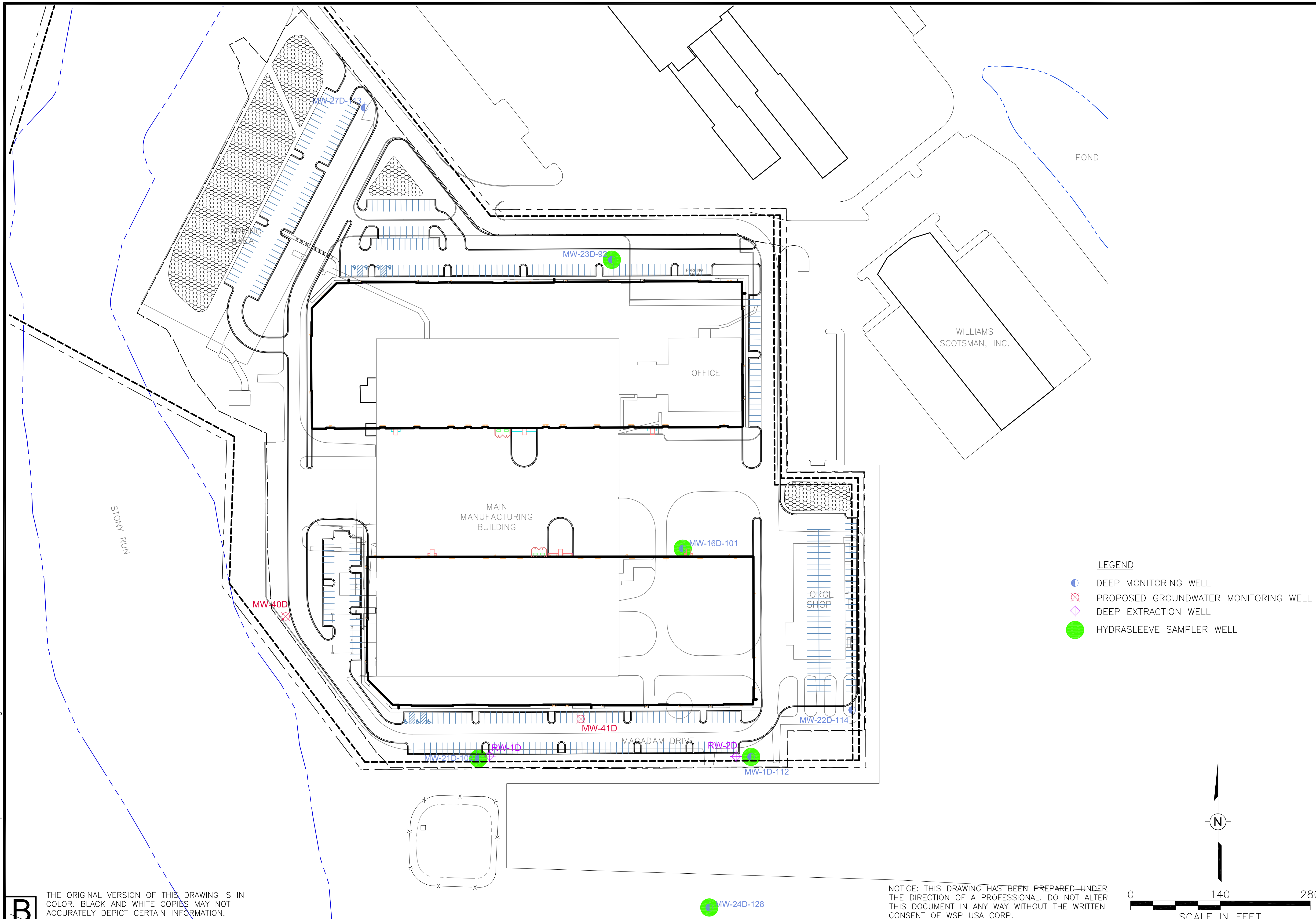


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Figure 15

LOWER PATAPSCO AQUIFER WELLS FOR HYDRASLEEVE DEPLOYMENT DURING FIELD DEMONSTRATION TEST


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# Tables

**Table 1**

**Groundwater Level Monitoring Networks**
**for Hydraulic Containment Systems**
**Former Kop-Flex Facility**
**Hanover, Maryland (a)**

| Surficial Aquifer | | |
|---|---|---|
| MW-01 | MW-09 | MW-39 |
| MW-03 | MW-16 | MW-42 (b) |
| MW-04 | MW-18 | MW-43 (b) |
| MW-05R | MW-38R | MW-44 (b) |
| **Lower Patapsco Aquifer** | | |
| MW-1D | MW-22D | MW-27D |
| MW-16D | MW-23D | MW-40D (b) |
| MW-21D | MW-24D | MW-41D (b) |

a/ Monitoring networks do not include groundwater extraction wells.

b/ Monitoring well to be installed as part of the response action.

**Table 2**

**Groundwater Quality Monitoring Network**
**Surficial Aquifer**
**Former Kop-Flex Facility**
**Hanover, Maryland**

| Well ID | Well Depth (feet bgs) | Screen Interval (feet MSL) | | Sampling Rationale | Sampling Frequency |
|---|---|---|---|---|---|
| **Monitoring Wells** | | | | | |
| MW-03 | 25.5 | 89.2 - 99.2 | | Monitor COC concentrations downgradient of plume boundary | Annual |
| MW-04 | 36 | 89.4 - 99.4 | | Monitor COC concentrations upgradient of source area | Semi-annual |
| MW-05R | 31 | 94.8 - 104.8 | | Monitor COC concentrations in plume area west of the main building | Semi-annual |
| MW-09 | 25 | 100.1 - 110.1 | | Assess COC concentrations in vicinity of source area | Semi-annual |
| MW-16 | 50 | 73.8 - 83.8 | | Assess COC concentrations in vicinity of source area | Semi-annual |
| MW-18 | 56 | 66.5 - 76.5 | | Assess downgradient extent of COC plume in lower sand unit | Semi-annual |
| MW-38R | 28 | 95.1 - 105.1 | | Assess downgradient extent of COC plume in upper clayey unit | Semi-annual |
| MW-39 | 50 | 71.2 - 81.2 | | Assess downgradient extent of COC plume in lower sand unit | Semi-annual |
| MW-42 (a) | 25 | 97 - 107 | | Assess downgradient extent of COC plume in upper clayey unit | Semi-annual |
| MW-43 (a) | 40 | 82 - 92 | | Monitor COC concentrations north of extraction well system | Semi-annual |
| MW-44 (a) | 40 | 85 - 95 | | Monitor COC concentrations south of extraction well system | Annual |
| **Recovery Wells** | | | | | |
| RW-1S | 60 (b) | 62 - 97 | (c) | Monitor COC concentrations in extracted groundwater | Quarterly (d) |
| RW-2S | 60 (b) | 64.5 - 99.5 | (c) | Monitor COC concentrations in extracted groundwater | Quarterly (d) |
| RW-3S | 60 (b) | 65 - 100 | (c) | Monitor COC concentrations in extracted groundwater | Quarterly (d) |

a/ Well depth and screen interval based on inferred geology; actual depths will be dependent on actual subsurface conditions.
b/ Depth from remedial system design; actual completion depth may vary based on subsurface conditions.
c/ Screen interval based on approximate ground surface elevation for proposed location and screen length of 35 feet.
d/ Sampling frequency to be decreased to semi-annual after one year of system operation.

**Table 3**

**Groundwater Quality Monitoring Network**
**Lower Patapsco Aquifer**
**Former Kop-Flex Facility**
**Hanover, Maryland**

| Well ID | Well Depth (feet bgs) | Screen Interval (feet MSL) | | Sampling Rationale | Sampling Frequency |
|---|---|---|---|---|---|
| **Monitoring Wells** | | | | | |
| MW-1D | 112 | 17.1 - 27.7 | | Assess COC concentrations downgradient of source area | Semi-annual |
| MW-16D | 101 | 22.3 - 32.5 | | Assess COC concentrations in the vicinity of source area | Semi-annual |
| MW-21D | 102 | 21 - 31 | | Assess COC concentrations downgradient of source area | Semi-annual |
| MW-22D | 114 | 14.3 - 24.3 | | Monitor COC concentrations near the eastern plume boundary | Semi-annual |
| MW-23D | 92 | 30.1 - 40.1 | | Assess COC concentrations north of the source area | Semi-annual |
| MW-24D | 128 | 0.7 - 10.7 | | Monitor COC concentrations in off-property portion of the plume | Semi-annual |
| MW-27D | 113 | 2.6 - 12.6 | | Monitor background groundwater quality | Annual |
| MW-40D (a) | 115 (b) | 9 - 19 | (b) | Monitor COC concentrations near the western plume boundary | Semi-annual |
| MW-41D (a) | 160 (b) | (-36) - (-26) | (b) | Monitor COC concentrations in portion of the aquifer below the recovery wells | Annual |
| **Recovery Wells** | | | | | |
| RW-1D | 140 (c) | (-17) - 23 | (d) | Monitor COC concentrations in extracted groundwater | Quarterly (e) |
| RW-2D | 140 (c) | (-12) - 28 | (d) | Monitor COC concentrations in extracted groundwater | Quarterly (e) |

a/ New monitoring well to be installed as part of the response action.
b/ Well depth and screen interval based on approximate ground surface elevation for proposed location and screen length of 10 feet.
c/ Depth from remedial system design; actual completion depth may vary based on subsurface conditions.
d/ Screen interval based on approximate ground surface elevation for proposed location and screen length of 40 feet.
e/ Sampling frequency to be decreased to semi-annual after one year of system operation.

# Table 4

## Monitoring Wells for HydraSleeve
## Field Demonstration Test
## Former Kop-Flex Facility
## Hanover, Maryland

| Test Well | Screen Interval (feet bgs) | | HydraSleeve Deployment Depth (feet bgs) (b) | Approximate HydraSleeve Sampling Depth (feet bgs) (c) |
|---|---|---|---|---|
| **Surficial Aquifer** | | | | |
| MW-03 | 15.5 - 25.5 | | 22 | 18.2 - 22 |
| MW-04 | 26 - 36 | | 33 | 29.2 - 33 |
| MW-05R | 20 - 30 | (d) | 27 | 23.2 - 27 |
| MW-09 | 14 - 24 | | 21 | 17.2 - 21 |
| MW-16 | 40 - 50 | | 47 | 43.2 - 47 |
| MW-18 | 46 - 56 | | 53 | 49.2 - 53 |
| **Lower Patapsco Aquifer** | | | | |
| MW-1D | 102 - 112 | | 109 | 105.2 - 109 |
| MW-16D | 91 - 101 | | 97 | 93.2 - 97 |
| MW-21D | 92 - 102 | | 99 | 95.2 - 99 |
| MW-23D | 82 - 92 | | 86 | 82.2 - 86 |
| MW-24D | 118 - 128 | | 123 | 119.2 - 123 |

a/ bgs = below ground surface
b/ Depth for the top of the HydraSleeve sampler.
c/ Sample interval equivalent to approximately 1.5x the length of a 2.5-foot long sampler.
d/ Replacement well for existing well MW-05; screen interval is approximate.

# Appendix A – Quantitation Limits for VOC Analytical Method

# Profile List

## PASI Charlotte Laboratory

**Client** 92-WSP **Profile Number** 4362 **Line Item** 1

| Line Item | Acode | Cmp List | Cmp | Analyte | CAS No. | PQL | MDL | Units | Sig Figs |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1664 W92 | 1664 W92 | og | Oil and Grease | | 5 | 1.1 | mg/L | E |
| | 1664 WH92 | 1664 WH92 | tph | Total Petroleum Hydrocarbons | | 5 | 5 | mg/L | E |
| | 2540D W | 2540D W | tssw | Total Suspended Solids | | 2.5 | 2.5 | mg/L | E |
| | 6010 W | 6010 W | Al | Aluminum | 7429-90-5 | 100 | 50 | ug/L | E |
| | | | Cu | Copper | 7440-50-8 | 5 | 2.5 | ug/L | E |
| | | | Fe | Iron | 7439-89-6 | 50 | 25 | ug/L | E |
| | | | Pb | Lead | 7439-92-1 | 5 | 2.5 | ug/L | E |
| | | | Mn | Manganese | 7439-96-5 | 5 | 2.5 | ug/L | E |
| | | | Ni | Nickel | 7440-02-0 | 5 | 2.5 | ug/L | E |
| | | | thrd | Hardness, Total (SM 2340B) | | 662 | 662 | ug/L | E |
| | | | Zn | Zinc | 7440-66-6 | 10 | 5 | ug/L | E |
| | 6010 WD | 6010 WD | Al | Aluminum | 7429-90-5 | 100 | 25 | ug/L | E |
| | | | Cu | Copper | 7440-50-8 | 5 | 0.3 | ug/L | E |
| | | | Fe | Iron | 7439-89-6 | 50 | 14 | ug/L | E |
| | | | Pb | Lead | 7439-92-1 | 5 | 4 | ug/L | E |
| | | | Mn | Manganese | 7439-96-5 | 5 | 0.3 | ug/L | E |
| | | | Ni | Nickel | 7440-02-0 | 5 | 1.7 | ug/L | E |
| | | | Zn | Zinc | 7440-66-6 | 10 | 0.4 | ug/L | E |
| | 8260 WLL | 8260 WLL | acet | Acetone | 67-64-1 | 25 | 10 | ug/L | E |
| | | | benz | Benzene | 71-43-2 | 1 | 0.25 | ug/L | E |
| | | | brob | Bromobenzene | 108-86-1 | 1 | 0.3 | ug/L | E |
| | | | bcoo | Bromochloromethane | 74-97-5 | 1 | 0.17 | ug/L | E |
| | | | brod | Bromodichloromethane | 75-27-4 | 1 | 0.18 | ug/L | E |
| | | | brof | Bromoform | 75-25-2 | 1 | 0.26 | ug/L | E |
| | | | broe | Bromomethane | 74-83-9 | 2 | 0.29 | ug/L | E |
| | | | 2but | 2-Butanone (MEK) | 78-93-3 | 5 | 0.96 | ug/L | E |
| | | | cate | Carbon tetrachloride | 56-23-5 | 1 | 0.25 | ug/L | E |
| | | | chlb | Chlorobenzene | 108-90-7 | 1 | 0.23 | ug/L | E |
| | | | choe | Chloroethane | 75-00-3 | 1 | 0.54 | ug/L | E |
| | | | chof | Chloroform | 67-66-3 | 1 | 0.14 | ug/L | E |
| | | | chom | Chloromethane | 74-87-3 | 1 | 0.11 | ug/L | E |
| | | | 2clb | 2-Chlorotoluene | 95-49-8 | 1 | 0.35 | ug/L | E |
| | | | 4clb | 4-Chlorotoluene | 106-43-4 | 1 | 0.31 | ug/L | E |
| | | | 12dc | 1,2-Dibromo-3-chloropropane | 96-12-8 | 2 | 2 | ug/L | E |
| | | | dibm | Dibromochloromethane | 124-48-1 | 1 | 0.21 | ug/L | E |
| | | | 12do | 1,2-Dibromoethane (EDB) | 106-93-4 | 1 | 0.27 | ug/L | E |
| | | | dimm | Dibromomethane | 74-95-3 | 1 | 0.21 | ug/L | E |
| | | | 12db | 1,2-Dichlorobenzene | 95-50-1 | 1 | 0.3 | ug/L | E |
| | | | 13dc | 1,3-Dichlorobenzene | 541-73-1 | 1 | 0.24 | ug/L | E |
| | | | 14db | 1,4-Dichlorobenzene | 106-46-7 | 1 | 0.33 | ug/L | E |
| | | | difm | Dichlorodifluoromethane | 75-71-8 | 1 | 0.21 | ug/L | E |
| | | | 11da | 1,1-Dichloroethane | 75-34-3 | 1 | 0.32 | ug/L | E |
| | | | 12de | 1,2-Dichloroethane | 107-06-2 | 1 | 0.12 | ug/L | E |
| | | | 11dd | 1,1-Dichloroethene | 75-35-4 | 1 | 0.56 | ug/L | E |
| | | | c12d | cis-1,2-Dichloroethene | 156-59-2 | 1 | 0.19 | ug/L | E |
| | | | t12d | trans-1,2-Dichloroethene | 156-60-5 | 1 | 0.49 | ug/L | E |
| | | | 12dp | 1,2-Dichloropropane | 78-87-5 | 1 | 0.27 | ug/L | E |

# Profile List

## PASI Charlotte Laboratory

**Client** 92-WSP **Profile Number** 4362 **Line Item** 1

| Line Item | Acode | Cmp List | Cmp | Analyte | CAS No. | PQL | MDL | Units | Sig Figs |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 8260 WLL | 8260 WLL | 13dp | 1,3-Dichloropropane | 142-28-9 | 1 | 0.28 | ug/L | E |
| | | | 22dp | 2,2-Dichloropropane | 594-20-7 | 1 | 0.13 | ug/L | E |
| | | | 11dp | 1,1-Dichloropropene | 563-58-6 | 1 | 0.49 | ug/L | E |
| | | | c13d | cis-1,3-Dichloropropene | 10061-01-5 | 1 | 0.13 | ug/L | E |
| | | | t13d | trans-1,3-Dichloropropene | 10061-02-6 | 1 | 0.26 | ug/L | E |
| | | | diie | Diisopropyl ether | 108-20-3 | 1 | 0.12 | ug/L | E |
| | | | 14dx | 1,4-Dioxane (p-Dioxane) | 123-91-1 | 150 | 78.36 | ug/L | E |
| | | | eben | Ethylbenzene | 100-41-4 | 1 | 0.3 | ug/L | E |
| | | | h13b | Hexachloro-1,3-butadiene | 87-68-3 | 1 | 0.71 | ug/L | E |
| | | | 2hex | 2-Hexanone | 591-78-6 | 5 | 0.46 | ug/L | E |
| | | | pcpi | p-Isopropyltoluene | 99-87-6 | 1 | 0.31 | ug/L | E |
| | | | mech | Methylene Chloride | 75-09-2 | 2 | 0.97 | ug/L | E |
| | | | mibk | 4-Methyl-2-pentanone (MIBK) | 108-10-1 | 5 | 0.33 | ug/L | E |
| | | | metb | Methyl-tert-butyl ether | 1634-04-4 | 1 | 0.21 | ug/L | E |
| | | | naph | Naphthalene | 91-20-3 | 1 | 0.24 | ug/L | E |
| | | | styr | Styrene | 100-42-5 | 1 | 0.26 | ug/L | E |
| | | | 11tc | 1,1,1,2-Tetrachloroethane | 630-20-6 | 1 | 0.33 | ug/L | E |
| | | | 11te | 1,1,2,2-Tetrachloroethane | 79-34-5 | 1 | 0.4 | ug/L | E |
| | | | tece | Tetrachloroethene | 127-18-4 | 1 | 0.46 | ug/L | E |
| | | | tolu | Toluene | 108-88-3 | 1 | 0.26 | ug/L | E |
| | | | 12tb | 1,2,3-Trichlorobenzene | 87-61-6 | 1 | 0.33 | ug/L | E |
| | | | 12b4 | 1,2,4-Trichlorobenzene | 120-82-1 | 1 | 0.35 | ug/L | E |
| | | | 11t1 | 1,1,1-Trichloroethane | 71-55-6 | 1 | 0.48 | ug/L | E |
| | | | 11t2 | 1,1,2-Trichloroethane | 79-00-5 | 1 | 0.29 | ug/L | E |
| | | | trce | Trichloroethene | 79-01-6 | 1 | 0.47 | ug/L | E |
| | | | trcf | Trichlorofluoromethane | 75-69-4 | 1 | 0.2 | ug/L | E |
| | | | 12tp | 1,2,3-Trichloropropane | 96-18-4 | 1 | 0.41 | ug/L | E |
| | | | vace | Vinyl acetate | 108-05-4 | 2 | 0.35 | ug/L | E |
| | | | vcrd | Vinyl chloride | 75-01-4 | 1 | 0.62 | ug/L | E |
| | | | txyl | Xylene (Total) | 1330-20-7 | 2 | 0.66 | ug/L | E |
| | | | mpxy | m&p-Xylene | 179601-23-1 | 2 | 0.66 | ug/L | E |
| | | | oxyl | o-Xylene | 95-47-6 | 1 | 0.23 | ug/L | E |
| | 8260 WSIM | 8260 WSIM | 14dx | 1,4-Dioxane (p-Dioxane) | 123-91-1 | 2 | 1.9 | ug/L | E |

*The MDLs listed are not instrument specific.

*Signficant Figures:

Numeric Value - The actual number of significant figures

E (EPA) - Numbers less than 10 have 2 significant figures and numbers greater than or equal to 10 have 3 significant figures

M (Metals) - Numbers less than 100 have 2 significant figures and numbers greater than or equal to 100 have 3 significant figures

O (Organics) - Numbers less than 1 have 1 significant figure, numbers less than 100 but not less than 1 have 2 significant figures, and numbers greater than or equal to 100 have 3 significant figures.

# Appendix B – WSP Standard Field Operating Procedures

# FIELD STANDARD OPERATING PROCEDURE #1
# Note Taking and Field Book Entries Procedure

The field book is a record of the day's activities that serves as a reference for future reporting and analyses. The field book is also a legal record for projects that may become involved in litigation. It is of the utmost importance that your notes be complete and comprehensive. The user is advised to read the entire standard operating procedure (SOP) and review the site health and safety plan (HASP) before beginning any onsite activities.

## 1.1 Acronyms and Abbreviations

| | |
|---|---|
| HASP | health and safety plan |
| IDW | investigation-derived waste |
| SOP | standard operating procedure |

## 1.2 Materials

- Permanently-bound waterproof field book (e.g., Rite-in-the-Rain® #550, or equivalent)
- Black or blue ballpoint pen (waterproof ink recommended; do not use felt-tip pens)

## 1.3 Preconditions and Background

This SOP has been prepared as part of the WSP USA Corp. Environmental Quality Management Plan and is designed to provide detailed procedures for common field practices. Compliance with the methods presented in this document is mandatory for all field personnel and will ensure that the tasks are performed in safe and consistent manner, are in accordance with federal and state guidance, and are technically defensible.

This SOP is written for the sole use of WSP employees and will be revised periodically to reflect updates to WSP policies, work practices, and the applicable state and/or federal guidance. WSP employees must verify that this document is the most recent version of the WSP SOPs. WSP employees are also strongly advised to review relevant state and/or federal guidance, which may stipulate program-specific procedures, in advance of task implementation.

The purpose of the field book is to provide a log of all of field events and conditions. The notes must include sufficient detail (i.e., who, what, when, where, why, and how) to enable others to reconstruct the day's activities for analysis, reporting, or litigation. It is important to be objective, factual, and thorough. Language must be free of personal comments or terminology that might prove inappropriate. Additional data logs or worksheets, such as low flow groundwater sampling sheets, may be used as a supplement; however, under no circumstances should the data sheets be used as a substitute for the daily record of events to be recorded in the field book.

The field book forms the foundation upon which most of the project work (reports, subsequent work plans, etc.) will be based. It is critical that field book chain of custody is maintained at all times.

## 1.4 Set-Up Procedures

The first step in setting up a new field book is to add the information necessary for you to identify the field book in the future and for others to return the book to WSP, should it be lost. On the first page of the field book (or, for some field books, the inside cover), place a "Return for Reward" notice. Include the following information:

- An "If Found – Return for Reward" notice in bold letters
- Our company name
- Our company address (usually the office where the project is being managed)
- Our company phone number

Reserve the second page of the field book for project-specific information, such as:

- The project name and number
- The project manager's name
- The site telephone number, address, and onsite contact (if appropriate)
- The names and telephone numbers for all key (onsite) personnel
- The emergency telephone numbers including the police, fire, and ambulance (found in the HASP)

Business cards from individuals who visit the site, (including the person in charge of the field book) can be affixed to the inside back cover.

## 1.5 Field Book Entries

Start each day on a new page. Include the following information in the header of the first page (and all subsequent pages):

- The date
- The project name
- The page number (often pre-printed in Rite-in-the-Rain® style field books)

Precede field book entries by the time entered along the left margin of the page using a 24-hour or military clock (e.g., 1330 for 1:30 PM). The first entry of the day must include your and your subcontractor's arrival time at the site, a description of the planned activities, key onsite personnel (including subcontractors), and the weather forecast. The first entry must also detail the tailgate review of the site-specific HASP with the onsite personnel. Be sure that field book entries are LEGIBLE and contain factual, accurate, and inclusive documentation of project field activities. <u>Do not leave blank lines between field book entries.</u> If a mistake is made in an entry, cross out the mistake <u>with a single line</u> and place your initials the end of the line. Any acronyms written in the field book (including your initials) must be spelled out prior to the first use. Record your initials and date at the bottom of each page.

Subsequent log entries must document the day's activities in sequence and must be completed throughout the day as events occur (i.e., do not wait until the end of the work day to complete the notes); should out of sequence notes need to be entered, please identify using a footnote or by clearly indicating "Late Entry." Notes must be descriptive and provide location information or diagrams (if appropriate) of the work area or sample locations. Note any changes in the weather and document all deviations from the work plan. Arrival and departure times of all personnel, and operational periods of standby, decontamination, and specific activities must be recorded.

List all field equipment used (e.g., photoionization detector, water testing equipment, personal protective equipment, etc.) and equipment calibration activities, and record field measurements, including distances, monitoring and testing instrument readings. Include the following information in entries describing sampling activities:

- The equipment and materials used by subcontractors, if appropriate (e.g., drill rig type, boring sizes, well casing materials, etc.)
- The sample media and analyses to be performed

- The sampling procedures (e.g., split-spoon sampling, hand trowel, low flow, etc.)
- The equipment used to obtain the sample (e.g., bailers, pump types, geochemical monitoring equipment, etc.)
- The sizes and types of containers, preservation (if any), and any resulting reactions
- The sample identification (especially for duplicate samples)
- The sample collection time
- The shipping and handling procedures, including chain-of-custody, air bill, and seal numbers
- If supplemental data recording logs (digital or hard copy), such as low flow groundwater sheets, the above information must be entered in the field book and the supplemental records cross-referenced.

For most sampling activities, the log entries must also include:

- The decontamination and disposal procedures for all equipment, samples, and protective clothing
- An inventory of the investigation-derived waste (IDW) materials generated during the site activities
- A description of the IDW labeling procedures and the onsite staging information

Maintain a sequential log if the sample locations and areas of interest are photographed (strongly recommended). The photographic log must include:

- The date and time of the photograph
- The sequential number of the photograph (e.g., photograph-1, photograph-2, etc.)
- The general direction faced when the photograph was made
- A description of the subject in the image

## 1.6 Closing Notes

The last entry of the day must include a brief wrap up of the work accomplished, a description of how the site is being secured, and a description of any near hits, accidents, and incidents that occurred during the day's work. Draw a line through the remainder of the page from the row of text diagonally through any blank lines and initial at the end of the diagonal line.

# FIELD STANDARD OPERATING PROCEDURE #3
# Sample Packaging and Shipment Procedure

Shipping samples is a basic but important component of field work. Nearly all of the WSP activities include the collection of environmental samples. Proper packing and preservation of those samples is critical to ensuring the integrity of WSP's work product. The user is advised to read the entire standard operating procedure (SOP) and review the site health and safety plan (HASP) before beginning any onsite activities. In accordance with the HASP, proper personal protective equipment (PPE) must be selected and used appropriately.

## 3.1 Acronyms and Abbreviations

| | |
|---|---|
| CFR | Code of Federal Regulations |
| DOT | U.S. Department of Transportation |
| IATA | International Air Transport Association |
| HASP | health and safety plan |
| PPE | personal protective equipment |
| SOP | standard operating procedure |

## 3.2 Materials

- Suitable shipping container (e.g., plastic cooler or lab-supplied styrofoam-insulated cooler)
- Chain-of-custody forms
- Custody seals
- WSP mailing labels
- Tape (Strapping, clear packing, or duct tape)
- Heavy-duty zipper-style plastic bags
- Knife or scissors
- Permanent marker
- PPE
- Large plastic garbage bag
- Wet ice (as necessary)
- Bubble wrap or other packing material
- Universal sorbent materials
- Sample container custody seals (if required)
- Shipping form (with account number)

## 3.3 Preconditions and Background

This SOP has been prepared as part of the WSP USA Corp. Environmental Quality Management Plan and is designed to provide detailed procedures for common field practices. Compliance with the methods presented in this document is mandatory for all field personnel and will ensure that the tasks are performed in safe and consistent manner, are in accordance with federal and state guidance, and are technically defensible.

This SOP is written for the sole use of WSP employees and will be revised periodically to reflect updates to WSP policies, work practices, and the applicable state and/or federal guidance. WSP employees must verify that this document is the most recent version of the WSP SOPs. WSP employees are also strongly advised to review relevant state and/or federal guidance, which may stipulate program-specific procedures, in advance of task implementation.

This SOP is designed to provide the user with a general outline for shipping samples and assumes the user is familiar with basic field procedures, such as recording field notes (SOP 1), sample collection and quality assurance procedures (SOP 4), and investigation derived waste management procedures (SOP 5), and has a current certificate for WSP's U.S. Department of Transportation (DOT) Hazardous Materials training.

> **NOTE: WSP employees shipping samples regulated as hazardous materials or exempt hazardous materials by air must have International Air Transport Association (IATA) training. IATA training is a separate training required in addition to DOT hazardous materials training for such shipments. Most WSP employees do not have IATA training and therefore, anyone who needs to ship by air MUST consult with a WSP IATA-trained compliance professional. The remainder of Section 3.3 covers shipments regulated by DOT only.**

Environmental samples can meet the definition of DOT hazardous materials when shipped by air, ground, or rail from a project site to the laboratory. As such, field staff must work with their assigned WSP compliance professional to determine whether the sample shipment is subject to any specific requirements (e.g., packaging, marking, labeling, and documentation) under the DOT hazardous materials regulations.

Title 49 Code of Federal Regulations (CFR) Section 171.8 defines a "hazardous material" as a substance which has been determined by the Secretary of Transportation to be capable of posing an unreasonable risk to health, safety, and property when transported in commerce, and which has been so designated. DOT hazardous materials are listed in the hazardous materials table at 49 CFR 172.101.

In most cases, WSP is collecting environmental samples in order to determine whether any hazardous chemicals are present in the sampled media. Therefore, we would not have the appropriate information to make a hazardous materials classification for the samples prior to shipment. 49 CFR 172.101(c)(11) allows the use of a tentative classification where the shipper is uncertain of the material's hazard class. Where WSP does not know the physical characteristics of the samples, a non-hazardous material classification may be made. Non-hazardous materials are not subject to the DOT hazardous materials regulations.

There are certain cases where the characteristics and hazard class of the samples are known (e.g., samples of free product, samples preserved with a hazardous material [TerraCore® samplers]). Contact your assigned WSP compliance professional or an internal DOT contact for guidance on shipment of these materials.

## 3.4 Sample Shipment Procedures

The two major concerns in shipping samples are incidental breakage during shipment and complying with applicable DOT and courier requirements for hazardous materials shipments.

> **NOTE: Many couriers, including Federal Express and UPS, have requirements that WSP register with them before shipping hazard materials. In most cases, it is the sampling location, not the WSP office address, which needs to be registered. Therefore, each project will likely have unique requirements. Please contact your WSP compliance**

**professional to determine whether or not you will be required to register for your shipment.**

Protecting the samples from incidental breakage can be achieved using "common sense." Pack all samples in a manner that will not allow them to freely move about in the cooler or shipping container. Do not allow glass surfaces to contact each other. When possible, repack the sample containers in the same materials that they were originally received in from the laboratory. Cushion each sample container with plastic bubble wrap, styrofoam, or other nonreactive cushioning material. A more detailed procedure for packing environmental samples is presented below.

### 3.4.1 Non-Hazardous Material Environmental Samples

The first step in preparing your samples for shipment is securing an appropriate shipping container. In most cases, the analytical laboratory will supply an insulated cooler for the bottle shipment, which can be used to return the samples once they have been collected. Be sure that the container is sufficiently large to contain both your samples, cushioning material, and enough wet ice to maintain the samples at the preservation temperature (usually 4° Celsius). Do not use lunch-box sized coolers or soft-sided coolers, which do not offer sufficient insulation or protection from damage.

Place universal sorbent materials (e.g., sorbent pads, Pig-brand absorbent blankets) in the bottom of the shipping container. The amount of sorbent material must be sufficient to absorb any condensation from the wet ice and a reasonable volume of water from melted wet ice (if a bag were to rupture) or a damaged (aqueous) sample container. If using a plastic cooler with a drain, securely tape the inside of the drain plug with duct tape or other material to ensure that no water leaks from the cooler during shipment.

The next step is to line the shipping container with a large, heavy-duty plastic garbage bag. Place 2 to 4 inches of bubble wrap or other appropriate packing material inside the heavy-duty plastic bag in the bottom of the shipping container to form a cushion for the sample containers. Place the samples on the packing materials with sufficient space to allow for the addition of more bubble wrap or other packing material between the sample containers. Place large or heavy sample containers on the bottom of the cooler with lighter samples placed on top to minimize the potential for breakage. Place all sample containers in the shipping container right-side up. Do not overfill the cooler with samples; leave sufficient room for the wet ice if the samples are to be preserved during transit.

Place wet ice to be used for sample preservation inside two sealed heavy-duty zipper-style plastic bags (1 gallon-sized, or less). Place the bags of ice on top of or between the samples. Place as much ice as possible into the cooler to ensure the samples arrive at the lab at the required preservation temperature, even if the shipment is delayed. Fill any remaining space with bubble wrap or other packing material to limit the airspace and minimize the in-transit melting. Securely close and seal, with tape, the top of the heavy-duty plastic bag. Place the original, white top copy chain-of-custody form into a heavy-duty zipper-style plastic bag, affix the bag to the shipping container's inside lid, and then close the shipping container. Sample shipment preparations are complete if using a laboratory courier.

If sending the sample shipment through a commercial shipping vendor, place two signed and dated chain-of-custody seals on alternate sides of the shipping container lid so that it cannot be opened without breaking the seals. Securely fasten the top of the shipping container shut with clear packing tape; carefully tape over the custody seals to prevent damage during shipping. Once the shipping container is sealed, shake test the shipping container to make sure that there are no loose sample containers. If loose sample containers are detected, open the shipping container, repack the sample containers, and reseal the shipping container.

Using clear tape, affix a mailing label with WSP's return address to the top of the shipping container. Ship environmental samples to the contracted analytical laboratory using an appropriate delivery schedule. If applicable, check the appropriate box on the airbill for Saturday delivery (you need to verify with the laboratory that someone will be at the lab on a Saturday to receive the sample shipment). Declare the value of samples on the shipping form for insurance purposes, if applicable, and be sure to include the project billable number on the shipping form's internal billing reference section. When shipping samples to a lab, identify a declared value equal to the carrier's default value ($100); additional fees will be charged based on a higher value declared. Our preferred carrier, FedEx, will only reimburse for the actual value of the cooler and its contents if a sample shipment is lost; they will not reimburse for the cost of having to re-collect the samples. [Please note: if you are shipping something other than samples, such as field equipment, declare the replacement value of the contents.]

Record the tracking numbers from the shipping company forms (i.e., the airbill number) in the field book and on the chain-of-custody form and retain a copy of the shipping airbill. On the expected delivery date, confirm sample receipt by contacting the laboratory or tracking the package using the tracking number; provide this confirmation information to the WSP project manager.

### 3.4.2 Hazardous Materials Samples

WSP personnel rarely ship hazardous materials due to DOT shipping requirements. If you find that your samples could be considered a DOT hazardous material, first coordinate with the assigned WSP compliance professional and project manager to make a hazardous material classification and, if necessary, establish the necessary protocols and to receive the appropriate training/certification. **Do not ship hazardous materials samples without first consulting a WSP compliance professional.**

# FIELD STANDARD OPERATING PROCEDURE #4
# Sample Collection and Quality Assurance Procedure

The purpose of this procedure is to assure that sample volumes and preservatives are sufficient for analytical services required under U.S. Environmental Protection Agency (EPA) or other agency approved protocols. This operating procedure describes the ways and means of selecting the appropriate sampling containers for environmental sampling. The user is advised to read the entire standard operating procedure (SOP) and review the site health and safety plan (HASP) before beginning any onsite activities. In accordance with the HASP, proper personal protective equipment (PPE) must be selected and used appropriately.

## 4.1 Acronyms and Abbreviations

| | |
|---|---|
| ºC | degrees Celsius |
| COC | chain-of–custody [form] |
| DI | deionized water |
| DOT | U.S. Department of Transportation |
| EDD | electronic data deliverable |
| EPA | U.S. Environmental Protection Agency |
| HASP | health and safety plan |
| MS/MSD | matrix spike and matrix spike duplicate |
| MSA | Master Service Agreement |
| PPE | personal protective equipment |
| QA | quality assurance |
| QA/QC | quality assurance/quality control |
| QAPP | Quality Assurance Project Plan |
| SOP | standard operating procedure |
| VOCs | volatile organic compounds |

## 4.2 Materials

- Field book
- Indelible (waterproof) markers or pens
- PPE
- Sample containers
- Sample labels
- Clear tape
- Deionized (DI) water
- Cleaned or dedicated sampling equipment

## 4.3 Preconditions and Background

This SOP has been prepared as part of the WSP USA Corp. Environmental Quality Management Plan and is designed to provide detailed procedures for common field practices. Compliance with the methods presented in this document is mandatory for all field personnel and will ensure that the tasks are performed in safe and consistent manner, are in accordance with federal and state guidance, and are technically defensible.

This SOP is written for the sole use of WSP employees and will be revised periodically to reflect updates to WSP policies, work practices, and the applicable state and/or federal guidance. WSP employees must verify that this document is the most recent version of the WSP SOPs. WSP employees are also strongly advised to review relevant state and/or federal guidance, which may stipulate program-specific procedures, in advance of task implementation.

This SOP is designed to provide the user with a general outline for collecting environmental and quality assurance samples and assumes the user is familiar with basic field procedures, such as recording field notes (SOP 1), sample shipment procedures (SOP 3), investigation derived waste management procedures (SOP 5), and equipment decontamination (SOP 6). This SOP does not cover investigation planning, nor does it cover the analysis of the analytical results. These topics are more appropriately addressed in a site-specific work plan or a dedicated quality assurance project plan.

## 4.4 Sample Identification Procedures

Information on the sample labels must contain the site/project name, project/task number, unique alpha-numeric sample identification (ID) number, sample date, time of collection using the military or 24-hour clock system (e.g., 0000 to 2400 hours), analytical parameters, preservative, and sampling personnel. WSP personnel are advised to use pre-printed waterproof mailing labels (e.g., Avery® 5xxx Waterproof Address Labels) for all sample identification. WSP templates for the labels are available in each office.

The sample identification number must, unless otherwise approved by your project manager or specified in your site-specific work plan, follow the WSP naming protocol. This protocol was developed to aid in determining the type of sample collected (e.g., soil, groundwater, vapor, etc.), the sample location, and, where appropriate, the sample depth. The protocol was also designed to ensure consistency across the company.

Construct sample IDs in the following format:

SB-10A (4-6)

Where, in this example:

SB = the first two or three characters will define the sample type (see list of approved prefixes below); in this case, a soil boring

10A = the next two or three alpha-numeric digits (separated by a dash from the sample type identifier) indicate the location of the boring on the site; in this case, boring number 10A

(4-6) = the depth the sample was collected, with the first number (including decimals, if necessary) indicating the top of the sample interval and the second number indicating the bottom of the sample interval; not all sample types will include depth information.

Additional label information may be added after the last character of the sample ID (e.g., sample date, underground storage tank number, area of concern number, “Area” number, Client Identifier, etc.). Separate any additional information from the required portion of the sample name by dash(es).

| Sample Prefix | Permitted Use |
|---|---|
| AA - | Ambient outdoor air samples |
| CC - | Concrete core/chip sample |
| CS - | Confirmation/verification soil samples collected from an excavation |
| HA - | Soil samples collected with a hand auger |
| IAB - | Indoor air samples – basement |
| IAC - | Indoor air samples – crawl space |
| IAF - | Indoor air samples – first floor |
| MW - | Soil samples collected from a monitoring well borehole or a groundwater sample collected from a monitoring well |
| PZ - | Groundwater samples collected from a piezometer |
| SB - | Soil samples collected from boreholes that will not be converted to monitoring wells |
| SED - | Sediment samples |
| SG - | Soil gas samples other than sub-slab samples (e.g., samples collected from temporary or permanent PVC sample points or stainless steel screen implants) |
| SL - | Sludge samples |
| SS - | Surface soil samples collected using hand tools (e.g., trowel, spoon, etc.) and typically at depths less than 2 feet below ground surface |
| SSV - | Sub-slab vapor samples |
| SW - | Surface water samples |
| TC - | Tree core samples |
| TP - | Soil samples collected from a test pit |
| WC - | Waste characterization samples |
| WP - | Wipe samples |

## 4.5 Sample Containers, Preservatives, and Holding Times

The first step in sample collection is to verify that the analytical laboratory has provided the correct number and type of sample containers and each contains the appropriate preservatives for the proposed project (i.e., check against the sampling plan requirements outlined in the site-specific Quality Assurance Project Plan [QAPP]). Inspect all containers and lids for flaws (cracks, chips, etc.) before use. Do not use any container with visible defects or discoloration. Report any discrepancies, or non-receipt, of specific types of sample containers to the team leader or project manager immediately. Make arrangements with the laboratory to immediately ship missing or additional sampling containers.

Take special effort to prevent cross contamination and contamination of the environment when collecting samples. Protect equipment, sample containers and supplies from accidental contamination. Wear a clean pair of new, disposable gloves each time a different sample is collected and don the gloves immediately prior to sampling. The gloves must not come in contact with the medium being sampled and must be changed any time during sample collection when their cleanliness is compromised. Sample collection must follow all appropriate SOPs and state and federal regulations, or guidance, for the collection of environmental samples; the recommended order of sample collection is:

- Geochemical measurements (e.g., temperature, pH, specific conductance)

- Volatile organic compounds (VOCs)
- Extractable organics, petroleum hydrocarbons, aggregate organics, and oil and grease
- Total metals
- Dissolved metals
- Inorganic non-metallic and physical and aggregate properties
- Microbiological samples
- Radionuclides

Collected samples that require thermal preservation must be immediately (within 15 minutes) placed in a cooler with wet ice and maintained at a preservation temperature of 4° Celsius (C).

## 4.6 Field Quality Assurance/Quality Control Samples

Field quality assurance/quality control (QA/QC) samples include equipment blanks, trip blanks, duplicates, and split samples. The project manager or QAPP must specify the type and frequency of QA/QC sample collection. The QA/QC sample identification number must, unless otherwise approved by your project manager or specified in your site-specific work plan, follow the WSP naming protocol as discussed in the sections below. QA/QC samples must be clearly identified on WSP's copy of the COC form and in the field book. Failure to properly collect and submit required QA/QC samples can result in invalidation of an entire sampling event.

Collect, preserve, transport and document split samples using the same protocols as the related samples.

### 4.6.1 Equipment Blanks

Equipment blanks are used to document contamination attributable to using non-dedicated equipment. Collect equipment blanks in the field at a rate of one per type of equipment per day, unless otherwise specified. If the site-specific work plan or QAPP indicates that an equipment blank is to be collected from dedicated sampling equipment, collect the equipment blank in the field before sampling begins. If field decontamination of sampling equipment is required, prepare the equipment blanks after the equipment has been used and field-decontaminated at least once. Prepare equipment blanks by filling or rinsing the pre-cleaned equipment with laboratory provided analyte-free water and collecting the rinsate in the appropriate sample containers. The samples must be labeled, preserved, and filtered (if required) in the same manner as the environmental samples. Record the type of sampling equipment used to prepare the blank. Have the equipment blanks analyzed for all the analytes for which the environmental samples are being analyzed, unless otherwise specified. Decontamination of the equipment following equipment blank procurement is not required. If laboratory-grade DI water is unavailable, store-grade distilled water can be used to prepare these blanks. If store-grade distilled water is used, be sure to record the source and lot number in the field book. Designate equipment blanks using "EB", followed by the date, and in the order of equipment blanks collected that day. For example, the first equipment blank collected on July 4, 2013, would be designated EB070413-1.

### 4.6.2 Trip Blanks

Trip blanks are used to document VOC contamination attributable to shipping and field handling procedures. Trip blanks are only required when analyzing samples for VOCs. Trip blank(s) will be prepared at the laboratory and will be sent to the facility along with sample containers. Never open trip blank sample bottles, but label them in the field and return them to the laboratory in the same shipping container in which the trip blank sample bottles arrived at the site. Keep the trip blank sample bottles in the same shipping container used to ship and store VOC sample bottles during the sampling event. To minimize the number of trip blanks needed per shipment, if possible, ship all of the VOC samples in the same shipping container with the trip blank. If laboratory-provided trip blanks are not available, DI water, or store-grade distilled water and clean, empty VOC sample bottles can be used to prepare additional trip blanks. If store-grade distilled water is used, be sure to record the source and lot number in the field book. Identify trip blanks using “TB”, followed by the date. For example, the trip blank shipped with a cooler of samples on July 4, 2013, would be designated TB070413-1. If a second trip blank is needed on that same day, the designation would be TB070413-2.

### 4.6.3 Temperature Blank

Temperature blanks are used to determine if proper sample thermal preservation has been maintained by measuring the temperature of the sample container upon arrival at the laboratory. A temperature blank should be included in each sample cooler used to ship and store the sample bottles during the sampling event. If laboratory-provided temperature blanks are not available, fill a clean, unpreserved sample bottle with potable, DI, or store-grade distilled water and identify the bottle as a temperature blank.

### 4.6.4 Duplicates

Duplicates are useful for measuring the variability and documenting the precision of the sampling process. Unless more stringent project requirements are in place, collect duplicate samples at least at a rate of 1 per 20 samples collected. Under no circumstances can equipment or trip blanks be used as duplicates. Sample locations where sufficient sample volume is available and where expected contamination is present should be selected for sample duplication.

Collect each duplicate sample at the same time, from the same sample aliquot and in the same order as the corresponding field environmental sample. When collecting aqueous duplicate samples, alternately fill sample bottle sets (i.e., the actual sample bottle and the bottle to be used for the duplicate) with aqueous samples from the same sampling device. If the sampling device does not hold enough volume to fill the sample containers, fill the first container with equal portions of the sample, and pour the remaining sample into the next sample containers. Obtain additional sample volume and pour the first portion into the last sample container, and pour the remaining portions into the first containers. Continue with these steps until all containers have been filled.

Duplicate samples will be assigned arbitrary sample ID and a false collection time so that they are not identified as duplicates by the laboratory (i.e., submit the samples blind to the lab). The blind duplicate sample "location designation" will be left up to the project manager; however, in no case will "Dup" be allowed to appear in the sample name. Have the duplicate samples analyzed for the same analytes as the original sample. Be sure to record the duplicate sample ID, the false time, and the actual time of collection in the field notebook. The duplicate should also be indicated on WSP’s carbon copy of the chain-of-custody.

### 4.6.5 Matrix Spike and Matrix Spike Duplicates

Matrix spike and matrix spike duplicate samples, known as MS/MSD samples, are used to determine the bias (accuracy) and precision of a method for a specific sample matrix. Many of WSPs projects require the collection of MS/MSD samples; however, laboratory generated MS/MSD samples are sufficient for some projects. As required by your QAPP or site-specific work plan, collect MS/MSD samples at the required ratio; if the sampling ratio is not specified by your QAPP or site-specific work plan, collect MS/MSD samples at a rate of 1 for every 20 samples. Clearly convey the MS/MSD identity to the laboratory by adding “MS" or "MSD” after the sample name (e.g., MW-01MS) or in the comments section of the chain-of-custody. Under no circumstances can equipment or trip blanks be used as MS/MSD samples.

### 4.6.6 Split Samples

Split samples may be collected as a means of determining compliance or as an added measure of quality control. Unlike duplicate samples that measure the variability of both the sample collection and laboratory procedures, split samples measure only the variability between laboratories. Therefore, the laboratory samples must be subsamples of the same parent sample and every attempt must be made to ensure sample homogeneity. Collect aqueous split samples in the same manner as a duplicate sample.

Collecting split samples of soils, sediments, wastes, and sludge is not recommended because the homogenization necessary for a true split sample in these matrices is not possible.

Spilt samples should have the same sample location (e.g., MW-01, SB-03 (4-6), but differentiated from each other by inserting the laboratory analyzing or the agency/consultant collecting the sample after the sample location (e.g., MW-01-WSP and MW-01-EPA).

## 4.7 Custody Documentation

Sample custody protocols are used to demonstrate that the samples and sample containers were handled and transferred in such a manner as to eliminate possible tampering. Legal chain of custody (COC) begins when the pre-cleaned sample containers are dispatched to the field from the laboratory and continues through the sample analysis and eventual disposal. Maintaining custody requires that samples must be in the actual possession or view of a person who is authorized to handle the samples (e.g., sample collector, laboratory technician), secured by the same person to prevent tampering, or stored in a designated secure area.

It is a good idea to limit, to the extent possible, the number of individuals who physically handle the samples. Samples must be placed in locked storage (e.g., locked vehicle, locked storeroom, etc.) at all times when not in the possession or view of authorized personnel. Do not leave samples in unoccupied motel or hotel rooms or other areas where access cannot be controlled by the person(s) responsible for custody without first securing samples and shipping or storage containers with tamper-indicating evidence tape or custody seals

The COC form is used to trace sample possession from the time of collection to receipt at the laboratory. Although laboratories commonly supply their own COC form, it is recommended that WSP's COC be used to ensure that all necessary data are recorded. At a minimum, the COC needs to have a unique COC number, accompany all the samples, and include the following information:

- Project number, name, and location
- Sampler's printed name(s) and signature(s)
- Sample identification number
- Date and time (military time) of collection
- Sample matrix
- Total number of containers per sample
- Parameters requested for analysis including number of containers per analyte
- Remarks (e.g., irreducible headspace, field filtered sample, expected concentration range, specific turn-around time requested, etc.)
- Signatures of all persons involved in the chain of possession in chronological order
- Requested turn-around-time
- Name and location of analytical laboratory
- Custody seal numbers
- Shipping courier name and tracking information
- Internal temperature of shipping container upon shipment to laboratory, as needed
- Internal temperature of shipping container upon delivery to laboratory

- WSP contact information

Affix tamper-indicating evidence tape or seals to all storage and shipping container closures when transferring or shipping sample container kits or samples to an off-property party. Place the seal so that the closure cannot be opened without breaking the seal. Record the time, calendar date and signatures of responsible personnel affixing and breaking all seals for each sample container and shipping container. Affix new seals every time a seal is broken until continuation of evidentiary custody is no longer required.

# FIELD STANDARD OPERATING PROCEDURE #5
# Investigation Derived Waste Management Procedure

The purpose of this standard operating procedure (SOP) is to provide instructions for handling, storing, and managing Investigation Derived Waste (IDW) pending disposal. All IDW, which includes (but is not limited to) soil cuttings, development water, purge water, drilling fluids, decontamination fluids, personal protective equipment (PPE), and sampling equipment, must be managed in compliance with applicable or relevant and appropriate requirements. The user is advised to read the entire SOP and review the site health and safety plan (HASP) before beginning any onsite activities. In accordance with the HASP, proper personal protective equipment (PPE) must be selected and used appropriately.

## 5.1 Acronyms and Abbreviations

| | |
|---|---|
| DOT | U.S. Department of Transportation |
| EPA | U.S. Environmental Protection Agency |
| HASP | health and safety plan |
| IDW | investigation derived waste |
| PCB | polychlorinated biphenyl |
| PPE | personal protective equipment |
| RCRA | Resource Conservation and Recovery Act |
| SOP | standard operating procedure |
| TSCA | Toxic Substances Control Act |

## 5.2 Materials

- Non-hazardous waste, hazardous waste, and/or polychlorinated biphenyl (PCB) labels
- Investigation derived waste (IDW) log (figure 1)
- Permanent ink marking pen, paint, stick/pen
- Sampling equipment (refer to sampling SOPs)
- Impermeable covers (e.g., tarps), as needed
- Duct tape, rope, or other material to secure tarp
- Copy of the waste manifest or bills of lading

## 5.3 Preconditions and Background

This SOP has been prepared as part of the WSP USA Corp. Environmental Quality Management Plan and is designed to provide detailed procedures for common field practices. Compliance with the methods presented in this document is mandatory for all field personnel and will ensure that the tasks are performed in safe and consistent manner, are in accordance with federal and state guidance, and are technically defensible.

This SOP is written for the sole use of WSP employees and will be revised periodically to reflect updates to WSP policies, work practices, and the applicable state and/or federal guidance. WSP employees must verify that this document is the most recent version of the WSP SOPs. WSP employees are also strongly advised to review relevant state and/or federal guidance, which may stipulate program-specific procedures, in advance of task implementation.

This SOP is designed to provide the user with a general outline for handling, storing, and managing IDW pending disposal and assumes the user holds a current U.S. Department of Transportation (DOT) training and Resource Conservation and Recovery training (if required) certificates and is familiar with basic field procedures, such as recording field notes (SOP 1), sample shipment procedures (SOP 3), sample collection and quality assurance procedures (SOP 4), and equipment decontamination (SOP 6). The SOP does not cover investigation planning, DOT regulations, nor does it cover the evaluation of the analytical results. **Consult and involve WSP's compliance professionals during all phases of IDW management and disposal.**

## 5.4 IDW General Procedures

Nearly all intrusive field activities performed at WSP will generate solid or liquid wastes. Examples include:

| Solid Wastes | Liquid Wastes |
|---|---|
| ■ Soil Cuttings | ■ Decontamination water |
| ■ Drilling mud | ■ Development water |
| ■ Plastic sheeting | ■ Drilling fluids |
| ■ Spent carbon or filters (e.g., bag filters) | ■ Purge water |
| ■ PPE (e.g., Tyvek, gloves, respirator cartridges, etc.) | ■ Soap or wash solutions |
| ■ Disposable or dedicated sampling equipment (e.g,, bailers, hose, clamps, buckets, cartridge filters, etc.) | ■ Reagents (e.g,, hexane, nitric acid, methanol, etc.) |
| ■ Field analytical waste (HACH kits, Chlor-n-Soil kits, etc.) | |

The specific procedures for dealing with these materials after the field activities have been completed will vary depending on whether the materials are considered non-hazardous, Resource Conservation and Recovery Act (RCRA) hazardous (characteristic or listed wastes), or contain PCBs at concentrations above 50 milligrams per kilogram (i.e., PCB wastes regulated under the Toxic Substances Control Act [TSCA]). The characterization of the wastes to be generated is ideally determined in conjunction with a WSP compliance professional before the field event occurs, based on previously generated data; however, in some cases, particularly for new sites, the status of the wastes may not be known. In these cases, handle IDW as hazardous waste until the status can be verified. Field personnel must consult their assigned WSP compliance professionals for assistance in proper waste characterization.

***It is important to note that information contained in this SOP is based on federal regulations and interpretive guidance provided by the U.S. Environmental Protection Agency (EPA) and other federal regulatory sources; therefore, information provided in this SOP may be superseded by state or local-specific statutes or regulations. Field personnel must discuss the handling procedures with the project manager and assigned WSP compliance professional before mobilizing to the field.***

### 5.4.1 Waste Minimization

Select investigation methods and techniques that will minimize the amount of wastes generated during field activities, particularly if the IDW is hazardous. Examples include using direct-push methods instead of hollow stem augers (to minimize soil cuttings) during a soil investigation, if appropriate, and limiting contact with the materials to reduce the amount of PPE required. Minimizing the amount of waste generated will reduce handling requirements and overall project costs, and is consistent with WSP's corporate goals for sustainability.

### 5.4.2 Hazardous Waste Generator Status

The hazardous waste generator requirements that pertain to a site depend on how much hazardous waste is generated at a site in a calendar month. In coordination with your assigned WSP compliance professional, determine the site's hazardous waste generator status (conditionally exempt, small, or large quantity generator) before site work begins and inform the site contact and/or client representative of the quantity of hazardous waste that will be generated as a result of its activities.

The following table provides a summary of requirements for each class of hazardous waste generator: Conditionally Exempt Small Quantity Generators (CESQGs), Small Quantity Generators (SQGs), and Large Quantity Generators (LQGs). Note that this is provided for guidance purposes only and should not substitute for close coordination with your assigned WSP compliance professional for all IDW-related activities.

| | **CESQGs** | **SQGs** | **LQGs** |
|---|---|---|---|
| **Quantity Limits** | ≤100 kg/month<br>≤1 kg/month of acute hazardous waste<br>≤100 kg/month of acute spill residue or soil<br>§§261.5(a) and (e) | Between 100 - 1,000 kg/month<br>§262.34(d) | ≥1,000 kg/month<br>>1 kg/month of acute hazardous waste<br>>100 kg/month of acute spill residue or soil<br>Part 262 and §261.5(e) |
| **EPA ID Number** | Not required<br>§261.5 | Required<br>§262.12 | Required<br>§262.12 |
| **On-Site Accumulation Quantity** | ≤1,000 kg<br>≤1 kg acute<br>≤100 kg of acute spill residue or soil<br>§§261.5(f)(2) and (g)(2) | ≤6,000 kg<br>§262.34(d)(1) | No limit |
| **Accumulation Time Limits** | None<br>§261.5 | ≤180 days or<br>≤270 days (if greater than 200 miles)<br>§§262.34(d)(2) and (3) | ≤90 days<br>§262.34(a) |

| | CESQGs | SQGs | LQGs |
|---|---|---|---|
| **Storage Requirements** | None §261.5 | Basic requirements with technical standards for tanks or containers §§262.34(d)(2) and (3) | Full compliance for management of tanks, containers, drip pads, or containment buildings §262.34(a) |
| **Sent To:** | State approved or RCRA permitted/interim status facility §§261.5(f)(3) and (g)(3) | RCRA permitted/interim status facility §262.20(b) | RCRA permitted/interim status facility §262.20(b) |
| **Manifest** | Not required §261.5 | Required §262.20 | Required §262.20 |
| **Biennial Report** | Not required §261.5 | Not required §262.44 | Required §262.41 |
| **Personnel Training** | Not required §261.5 | Basic training required §262.34(d)(5)(iii) | Required §262.34(a)(4) |
| **Contingency Plan** | Not required §261.5 | Basic plan §262.34(d)(5)(i) | Full plan required §262.34(a)(4) |
| **Emergency Procedures** | Not required §261.5 | Required §262.34(d)(5)(iv) | Full plan required §262.34(a)(4) |
| **DOT Transport Requirements** | Yes (if required by DOT) | Yes §§262.30-262.33 | Yes §§262.30-262.33 |

## 5.5 Onsite IDW Management Procedures

Onsite handling procedures typically involve containerization of the IDW for offsite disposal at a regulated facility (RCRA hazardous waste, TSCA PCB waste, or certain non-hazardous wastes) or, in the case of certain non-hazardous wastes, onsite disposal. The procedures for each type of waste are presented below.

### 5.5.1 Hazardous Waste Management

If site data or generator knowledge indicates that the IDW is determined to be RCRA hazardous, the following procedures will apply:

- Place IDW in DOT-authorized containers (e.g., 55-gallon drum, roll-off container, or temporary storage tank). Before placing IDW in the containers, ensure that they are in good condition and will not leak.
- Containers must remain closed except when adding, sampling, or inspecting the material. The containers cannot be used as a work surface once waste is put in the container.
- Mark the container with an appropriate waterproof, self-adhesive RCRA hazardous waste label. The label must include the accumulation start date, a description of the contents of the container (e.g., soil cuttings, purge water, etc.), the EPA identification number, the generator name (the client or the facility, never WSP), and the

hazardous waste codes, if known. Field personnel must consult the assigned WSP compliance professional for help in properly completing the labels.

- The IDW containers must be properly closed, wiped clean, and stored in a secure onsite location (facility hazardous waste storage area if one exists) to limit access. At a minimum, place the drums on an impermeable surface (if available) in an area of limited access. If stored outside, cover the containers with a secured tarp at the end of each field day until the containers are picked up for disposal.
- Complete the IDW Logs (Figure 1) before leaving the site. Present one copy of the log to the site contact and the original to the project manager.
- Ensure that weekly inspections are conducted and the proper inspection forms for documentation are completed during the entire time the waste is stored onsite.

If the IDW is presumed to be hazardous and sampling is required to confirm its classification, it must be labeled "Hazardous Waste-Pending Analysis" and sampled for the parameters specified by the project regulatory specialist or project manager before leaving the site (see sampling SOPs). Treatment, storage, and disposal facilities will usually specify the required analysis for waste profiles (see below).

### 5.5.2 Polychlorinated Biphenyl Waste Management

If information exists to classify the IDW as TSCA-regulated PCB-containing IDW, the following procedures must be implemented:

- Place the PCB-containing IDW in DOT-authorized containers (55-gallon drum, roll-off container, or temporary storage tank).
- Containers must remain closed except when adding, sampling, or inspecting the material. The containers cannot be used as a work surface once waste is put in the container.
- Mark the container with an appropriate waterproof, self-adhesive yellow label with the words "Caution Contains PCBs", the "removed from service" date (the accumulation start date), and a description of the contents of the container (e.g., soil cuttings). Complete the label with the name and phone number of the WSP field personnel to contact in the event of an accident or spill. Field personnel must consult the assigned WSP compliance professional for help in properly completing the labels.
- The IDW containers must be properly closed, wiped clean, and stored in a secure PCB storage area onsite. If a PCB storage area is not available, construct a temporary PCB storage area. Cover the containers with a secured tarp at the end of each field day until the drums are picked up for disposal. Place one yellow 6" x 6" "Caution Contains PCBs" label on the outside of the tarp, and note the "Removed from service date" on the label.
- Inspect the area and the containers for leaks once every 30 days in accordance with 40 Code of Federal Regulations 761.65(c)(5) during the entire period the waste is stored onsite.
- Complete the IDW Logs (Figure 1) before leaving the site. Present one copy of the log to the site contact and the original to the project manager.

### 5.5.3 Onsite Non-Hazardous Waste Management

If information exists to classify the IDW as non-hazardous waste, the following procedures must be implemented only after being discussed and approved by the project manager and assigned WSP compliance professional:

- Soil can be spread around the borehole or other onsite location (with the approval of the client and in accordance with any applicable regulatory requirements), placed back in the boring or excavated test pit, or containerized and disposed of offsite.

- Groundwater and decontamination fluids can be poured onto the ground next to well to allow infiltration, or discharged to either the publically-owned treatment works or onsite wastewater treatment plant with approval of the client.
- PPE can be double bagged and deposited in the site dumpster with approval of the client and facility personnel or containerized and disposed of offsite.

If the IDW is containerized and is classified as non-hazardous, the following procedures will apply:

- Place the non-hazardous IDW in DOT-authorized containers (55-gallon drum, roll-off container, or temporary storage tank).
- Containers must remain closed except when adding, sampling, or inspecting the material. The containers cannot be used as a work surface once waste is put in the container.
- Mark the container with an appropriate waterproof, self-adhesive non-hazardous waste label. The label must include a description of the contents of the container (e.g., soil cuttings, purge water, etc.) and the generator (the client or the facility, never WSP). Field personnel must consult the assigned WSP compliance professional for help in properly completing the labels.
- Complete the IDW Logs (Figure 1) before leaving the site. Present one copy of the log to the site contact and the original to the project manager.
- The IDW containers must be properly closed, wiped clean, and stored in a secure onsite location.

## 5.6 Post-Field IDW Management Activities

It is important to follow-up on the management of the IDW once the field personnel have returned from the field. RCRA Hazardous and TSCA-regulated PCB-containing wastes have time limits and periodic inspection requirements to remain in compliance with state and federal regulations. The general post-field activities are listed below.

### 5.6.1 Waste Classification and Waste Profiles

Waste classifications and waste profiles must be reviewed and approved by WSP's project manager, WSP compliance professional, and the client before field work begins. Waste profiles are generated based on new or existing site data (i.e., soil and groundwater results) and generator knowledge, although some disposal facilities may require additional composite or grab samples for characterization of the waste. WSP's compliance professionals must be consulted to verify that proper waste classifications have been identified. Waste profiles for the same waste stream are generally valid for one year; ensure that no additional sampling is required to update existing waste profiles before conducting field activities.

### 5.6.2 Waste Disposal Oversight

Although exceptions may apply, generally, disposal of RCRA hazardous must be completed within **90 days** of the accumulation start date. If the facility is a small quantity generator, up to **180 days** is allowed for shipment. Disposal of TSCA-regulated PCB-containing IDW must generally be completed within 30 days of the "removal of service" date. WSP's compliance professionals must be consulted to determine if any exemptions apply.

Before the IDW is removed, the waste disposal subcontractor must provide WSP with a copy of the waste profile and printed manifest for review and approval. Your assigned WSP compliance professional must review and approve these documents. <u>WSP must have written authorization from the client on file to act **on behalf of (never "as an agent of")** the client for waste disposal (handled on a site-by-site basis)</u>.

- The transport driver will present you with a pre-printed manifest that has been reviewed and approved by WSP. Review and verify that all information is complete and correct and that the total estimated weight of the material is written on the manifest. (Note: Manifests for PCB wastes must be completed in accordance with TSCA regulations. 40 CFR 761.207 requires that the weight of the PCBs be in kilograms and the date removed from service be on the manifest.) Remember, only a DOT-trained WSP employee is allowed to review and sign the manifest.
- Sign the manifest “On behalf of [insert client name].”  Do not us “as an agent of.”
- Ensure that all containers are properly labeled and transferred to the transporting vehicle; ensure that the vehicle is properly placarded.
- Once the IDW has been removed from the site, the IDW log must be marked “Removed,” placed in the project file, and a copy must be forwarded to WSP’s DOT compliance manager.

The manifest, certificate of disposal, IDW log, and inspection reports must be maintained on file for at least 3 years.

# Investigation Derived Waste Log

Date:______________

Site Information

Site Name: ________________________________ Site EPA ID #:___________________________

Site Contact: _______________________________ Site Address: ___________________________

Contact Telephone No: ________________________

Waste Identification:

Type of Waste Generated (check one of the following):

☐ Soil Cuttings ☐ PPE ☐ Decontamination Water

☐ Groundwater ☐ Storm Water ☐ Drilling Fluids

☐ Other (Describe):___________________________________________________________

Field Activities that Generated the Waste:

☐ Soil Borings ☐ Well Sampling ☐ Well Installation

☐ Decon ☐ Excavation ☐ Pumping Tests

☐ Other (Describe): ___________________________________________________________

Generation Date:_______________________ ***90-Day Deadline***: __________________________

Quantity of Waste Generated and Container Type:

________________________________________________________________________________

________________________________________________________________________________

Storage Location:_________________________________________________________________

Waste Identification (Check One of the Following):

☐ Non Hazardous Waste (pending analysis)

☐ Non Hazardous Waste (based on site information or generator knowledge)

☐ Hazardous Waste (pending analysis)

☐ Hazardous Waste (based on site information or generator knowledge)

If generator knowledge or site information was used for identification, explain: ____________________

________________________________________________________________________________

________________________________________________________________________________

Type of Label Applied to Container: ☐ Non Haz ☐ Hazardous ☐ PCB ☐ Used Oil

WSP Information (Note: One copy to site contact - the original in project file)

Personnel/Contact:________________________________ Project No.: _____________________

Telephone:______________________________________

# FIELD STANDARD OPERATING PROCEDURE #7
# Water Quality Monitoring Equipment Procedure

The procedures outlined in this Standard Operating Procedure (SOP) are designed to ensure that water quality monitoring equipment is calibrated and used properly. This SOP addresses the short-term or discrete-measurement use of portable water quality monitoring equipment for the collection of physical, chemical, or biological field measurements. Common field parameters include temperature, pH, specific conductance (SC), turbidity, oxidation-reduction potential (ORP), and dissolved oxygen (DO). The user is advised to read the entire SOP and review the site health and safety plan (HASP) before beginning any onsite activities. In accordance with the HASP, proper personal protective equipment (PPE) must be selected and used appropriately.

## 7.1 Acronyms and Abbreviations

| | |
|---|---|
| DI | deionized water |
| DO | dissolved oxygen |
| $^{o}$F | degrees Fahrenheit |
| HASP | health and safety plan |
| IDW | investigation derived waste |
| mg/l | milligrams per liter |
| mV | millivolts |
| NTU | nephelometric turbidity units |
| ORP | oxidation-reduction potential |
| PPE | personal protective equipment |
| QAPP | quality assurance project plan |
| SC | specific conductance |
| SDS | Safety Data Sheets |
| SOP | standard operating procedure |
| SU | standard units |
| µS/cm | microsiemens per centimeter |

## 7.2 Materials

- Field book
- PPE
- Water quality meter
- Display/logger
- Communication cables
- Calibration cup or beaker
- Standard solutions, as appropriate

- Deionized water (DI) or distilled water
- Decontamination supplies

## 7.3 Preconditions and Background

This SOP has been prepared as part of the WSP USA Corp. Environmental Quality Management Plan and is designed to provide detailed procedures for common field practices. Compliance with the methods presented in this document is mandatory for all field personnel and will ensure that the tasks are performed in a safe and consistent manner, are in accordance with federal and state guidance, and are technically defensible.

This SOP is written for the sole use of WSP employees and will be revised periodically to reflect updates to WSP policies, work practices, and the applicable state and/or federal guidance. WSP employees must verify that this document is the most recent version of the WSP SOPs. WSP employees are also strongly advised to review relevant state and/or federal guidance, which may stipulate program-specific procedures, in advance of task implementation.

This SOP is designed to provide the user with a general outline for preparing water quality monitoring equipment for use and assumes the user is familiar with basic field procedures, such as recording field notes (SOP 1), investigation derived waste (IDW) management procedures (SOP 5), equipment decontamination (SOP 6), groundwater sampling (SOP 11), and surface water sampling (SOP 12). This SOP does not cover the selection of water quality monitoring equipment, nor does it cover water quality monitoring equipment-specific instructions. These topics require a significant amount of planning and are more appropriately addressed in a project-specific work plan. Be sure to review the project-specific work plan or Quality Assurance Project Plan (QAPP) and any applicable state and federal guidelines or calibration procedures. The sampler should be familiar with the use and calibration of all sampling and monitoring equipment. All sampling references must be available for consultation in the field, including:

- WSP's SOPs
- Applicable state and federal guidelines or sampling procedures
- Manufacturer's manuals
- Project-specific work plan, HASP, and QAPP

## 7.4 General Equipment Handling and Management Procedures

Generally, WSP uses multi-parameter water quality meters bundled in a single housing unit (a sonde). These types of units offer a single, convenient device that is capable of measuring most or all of the parameters monitored during a typical sampling event. Individual parameter water quality meters are available and, in some cases, offer a higher degree of accuracy, although the difficulty in deploying multiple meters for most tasks relegates them to specialty use.

***Field personnel must consult their assigned WSP compliance professionals for assistance in proper use, storage, and disposal of all calibration standard solutions.***

The manufacturer's recommendations and instructions vary from one instrument to the next; however, all types of water quality monitoring equipment share common handling and management procedures designed to ensure the integrity of the measurements collected. Based on these procedures, the user should:

- Transport the water quality monitoring equipment in a padded case that is designed to protect the equipment; airtight cases need to be vented if using sensors that have flexible or semi-permeable membranes.
- Follow the manufacturer's instructions for assembly, operation, calibration, and maintenance specific to your equipment. The manufacturer's instructions should be followed explicitly in order to obtain accurate results.

- Follow the manufacturer's instructions for assembly, operation, calibration, and maintenance specific to your equipment. The manufacturer's instructions should be followed explicitly in order to obtain accurate results.
- Keep either the sensor guard or transportation/calibration cup installed to avoid damaging the sensors. Some sensors require a small amount of water in the transportation/calibration cup; follow the manufacturer's recommendations.
- Ensure that all equipment is in proper working condition, not damaged, and that batteries are properly charged before using the equipment for field testing measurements.
- Instruments may be sensitive to static electricity.
- Record manufacturer name and model number for each instrument used in the field book.
- Calibrate the instrument in the field, as close to the time of use as possible, and repeat at the frequency suggested by the manufacturer.
- Protect the instrument from direct sunlight, precipitation, and extremely hot or cold temperatures (e.g., do not store in vehicle).
- Store cables only after they are clean, dry, and neatly coiled – do not bend or crimp cables.
- Attach any provided storage caps. Protect cables from abrasion or unnecessary tension when in use.
- Unless otherwise instructed by the manufacturer, decontaminate water quality monitoring equipment with non-phosphate detergent solution using a small, nonabrasive brush, cotton swab or cloth, followed by a thorough DI water rinse.

## 7.5 Calibration Procedures

Water quality monitoring equipment must be inspected and the sensors calibrated before use. Consult the manufacturer's guidelines before beginning the calibration process and contact the manufacturer's technical support if problems or questions arise.

Conduct the following procedures to ensure proper testing and calibration and record observations in the field book:

- Inspect the sensors to be sure that they are clean, installed properly and are not damaged before calibrating and using a water quality monitoring equipment in the field.
- Complete field calibration in an area sheltered from wind, dust, and temperature/sunlight fluctuations such as inside a room or vehicle in which the ambient temperature of the standards is maintained at a temperature >40 degrees Fahrenheit ($^{o}$F) and < 100°F.
- Purchase appropriate, prepared standard solutions in accordance with the project-specific work plan or QAPP. Do not mix or dilute standards in the field. Allow water quality monitoring equipment to warm up for at least 10 minutes after being turned on, or for the specified time period recommended by the manufacturer.
- Record the brand, concentration, lot numbers and expiration dates of standard solutions in the field book.
- Handle standard solutions in a manner that prevents their dilution or contamination. Do not use expired standard solutions. Do not reuse standard solutions or pour solutions back into the bottle; ensure that proper chain-of-custody has been followed for standard solutions stored at a site.
- Ensure that the water quality monitoring equipment has been set to display or record the appropriate measurement unit, as available.
- Allow standard solutions to equilibrate to the temperature of the sample source, to the degree possible or as specified in the manufacturer's guidance.

- Unless otherwise instructed by the manufacturer, use the calibration cup that comes with the instrument for calibration.
- Use the recommended volume of standard solution when filling the calibration cup (e.g., the standard solution must cover the temperature sensor, as most sensors require temperature compensation).
- Be careful not to over tighten the calibration cup; many calibration cups have vents that allow their equilibration with ambient pressure.
- Rinse sensors thoroughly three times with DI water after use of each standard solution, followed by three rinses with the next standard solution to be used.
- Wait for readings to stabilize (approximately 30 seconds under normal conditions) before adjusting and saving the calibration point.
- Do not override a calibration error message without troubleshooting and correcting the cause of the error. For example, check the fluid level and check for air bubbles in the sensor. Record calibration end points and readings in the field book.
- Calibration frequency is dependent upon project specifications, instrument performance, and manufacturer's recommendations; repeat the calibration procedures as directed.
- Document the time, date, and calibration status for each instrument.
- If calibration fails to meet criteria, follow the manufacturer's instructions for corrective action to adjust instrument performance and note any indication of a substandard calibration.
- If the instrument does not start up, check out, or calibrate properly, the instrument should not be used.

### 7.5.1 Specific Conductance

SC, or conductivity, measures the ability of water to conduct an electric current. It is generally reported in microsiemens per centimeter (µS/cm) or millisiemens per centimeter. Natural waters, including groundwater, commonly exhibit specific conductance well below 1 µS/cm. Total dissolved solid concentrations may be approximated from specific conductance data; high readings (greater than 500 µS/cm) may indicate contamination, especially if the readings are elevated compared to background. Alternatively, elevated specific conductance may indicate inadequate well development, grout contamination, or an inadequate grout seal.

When calibrating for specific conductance:

- If not specified in the project-specific work plan, choose a SC standard solution recommended by the instrument manufacturer; otherwise, select a standard that is close in conductivity to that of the environmental water being sampled.
- The presence of air bubbles in conductivity electrodes will cause erroneous readings and incorrect calibration. Transmission lines, alternating-current electrical outlets and radio-frequency noise sources may cause interference; check with the instrument manufacturer's specifications for troubleshooting procedures.

### 7.5.2 Dissolved Oxygen

DO is used to assess the water quality with respect to certain metals (the amount of oxygen can control the valence state of metals) and, more typically, biological activity. Concentrations of DO in uncontaminated groundwater generally range from 1 to 4 milligrams per liter (mg/l). Erratic or elevated (greater than 4 milligrams per liter) DO readings may reflect sampling procedures that are causing excessive agitation and aeration of the water column which may affect sample results (i.e., oxidation or volatilization of dissolved compounds). Elevated DO readings may also indicate equipment maintenance issues. DO readings are sensitive to atmospheric interference and must be measured with a flow-through cell for *ex situ* measurements (i.e., those measured outside of the well itself). Select the type of DO sensor for the multi-parameter water quality meter in accordance with the project-specific work plan (i.e., the polarographic [or Clark cell] sensor or the luminescent [optical] sensor). Further discussion focuses on the more common polarographic sensor.

- Check the DO membrane for bubbles, wrinkles or tears. If necessary, install a new membrane and replace worn or stretched O-rings. Manufacturer guidance generally specifies membrane replacement should be completed at least 3 to 4 hours before use,
- Most manufacturers recommend that the sensor be allowed to equilibrate to the temperature of the water-vapor-saturated air for at least 15 minutes before calibration,
- Fill the calibration cup with less than 1/8 inch of water, or as recommended by the manufacturer.
- Remove any water droplets from the sensor without wiping the membrane. Water droplets on the sensor can cause a temperature compensation error in the DO calibration.
- Do not submerge or wet the sensor when loosely attaching the calibration cup.
- Enter the barometric pressure and wait for readings to stabilize before adjusting and saving the calibration point.

### 7.5.3 pH

pH is a measure of the effective concentration (or activity) of hydrogen ions and is expressed as the negative base-10 logarithm of the hydrogen-ion activity in moles per liter. Natural (uncontaminated) waters typically exhibit a pH ranging from 5 to 9 Standard Units (SU). Deviation of pH from background may indicate the presence of groundwater contamination or well construction problems.

Typically, a two-point calibration is used for pH (i.e., a zero-point and span calibration[s]):

- If not specified in the project-specific work plan, select a 7 SU buffer (zero-point) plus a second pH buffer (4 SU or 10 SU) that brackets the range of expected pH.
- If applicable, calibrate the conductivity and DO sensors before calibrating the pH sensor. This helps prevent cross-contamination of the conductivity sensor from pH buffer solutions (pH buffers have much higher conductivities than most environmental waters).
- Allow time for the pH and temperature sensors to equilibrate to the temperature of the buffer and stabilize before adjusting and saving the calibration point. Record the temperature reading and use the chart provided by the buffer manufacturer to determine the true pH of the buffer at that temperature and adjust the calibration reading to that value.
- Repeat the calibration process with the second buffer.

### 7.5.4 Oxidation-Reduction Potential

ORP is a numerical index of the intensity of the oxidizing or reducing conditions within an aqueous solution. Oxidizing conditions are indicated by positive potentials and reducing conditions are indicated by negative potentials; these values are frequently used when evaluating the biodegradation capacity of a system. Generally, negative potentials and low DO (less than 1 mg/l) are measured concurrently. ORP measurements are generally expressed in millivolts (mV). The ORP of natural (uncontaminated) waters typically ranges from +500 to -100 mV. ORP and reduction potential (Eh) are not equivalent. Follow the manufacturer's instructions to calculate Eh. ORP readings are sensitive to atmospheric interference and must be measured with a flow-through cell; ORP may not be an appropriate stabilization parameter for some groundwater conditions. Avoid touching the sensors during calibration and measurement as calibration can be affected by static electricity.

A one-point calibration, at a known temperature, is used to calibrate the ORP sensor:

- Fill the calibration cup with enough standard solution (i.e., ZoBell's solution) to completely cover the temperature and ORP sensors.
- Allow time for the ORP and temperature sensors to equilibrate to the temperature of the buffer and stabilize before adjusting and saving the calibration point. Record the temperature reading and use the chart provided by the manufacturer to determine the true ORP of the solution at that temperature and adjust the calibration reading to that value.

### 7.5.5 Turbidity

Turbidity is the presence of suspended mineral and organic particles in a water sample. Turbid water may indicate inadequate well construction, development or improper sampling procedures, such as purging at an excessive rate that exceeds the well yield. Purging and sampling in a manner that produces low-turbidity water is particularly important when analyzing for total metals and other hydrophobic compounds, such as polychlorinated biphenyls, which may exhibit artificially elevated concentrations in high-turbidity samples due to their adsorption to colloidal material. Generally, the turbidity of *in situ* groundwater is very low (at or below 10 nephelometric turbidity units, NTUs); however, some groundwater zones may have natural turbidity higher than 10 NTUs.

Standard turbidity solutions are not necessarily interchangeable. Serious calibration errors can result from using inappropriate standards. Use only those standard turbidity solutions that are prescribed for the sensor by the instrument manufacturer.

Turbidity consists of a zero-point calibration and a span calibration(s):

- Fill the calibration cup to the reference line with DI or a zero-point standard.
- Allow time for the turbidity sensors to stabilize before adjusting and saving the calibration point. Record the temperature reading and use the chart provided by the buffer manufacturer to determine the true turbidity of the buffer and adjust the calibration reading to that value.
- Repeat the calibration process with the standard span calibration standard(s).

## 7.6 Equipment Use Procedures

Following calibration, use the monitoring equipment to complete the field measurement procedures directed in the project-specific work plan or QAPP.

- Charge instrument batteries per the manufacturer's instructions, as necessary.
- Ensure that instrument is warmed up and the measured value(s) on the water quality monitoring equipment are equilibrated (i.e., readings are representative of the solution, not ambient air) before recording in the field book.
- Biological growth or debris in the water can foul sensors; as possible, avoid inserting the sonde in areas that will result in having to stop and clean algae, sediment, or debris from the sensors (e.g., do not place on bottom of a well or streambed).
- If continuous monitoring is required, follow the manufacturer's instructions for performing continuous data logging events.

Monitoring should be performed at regular intervals as specified in the work plan, QAPP, and/or HASP. Record all measurements in the field book or on field forms and note any conditions that may affect the quality of the data (e.g., changes in weather or background conditions).

### 7.6.1 Groundwater

Field parameters are generally measured *ex situ* during well purging and development to provide an indication of when water representative of the formation is entering the well. Field parameters are typically recorded after each well volume is purged or at a periodic interval until stability criteria have been met. Field parameters may be measured *in situ* during purging by deploying a multi-parameter water quality meter downhole or lowered into a well or piezometer and collected at various depths (i.e., depth profile). Follow the instructions detailed in SOP 11 (Groundwater Sampling Procedures) for groundwater purging and sampling procedures.

#### 7.6.1.1 Flow-through Cell Operation

A flow-through cell is used to minimize potential alteration of the water during contact with the air. A flow-through cell must be used when measuring DO or ORP under *ex situ* conditions.

- Inspect the integrity of the flow-through cell and O-rings.
- Connect the discharge tubing to the bottom of the flow-through cell using properly-sized tubing and fittings. Connect the effluent tubing to the top of the flow-through cell and secure the end of the tubing into the designated groundwater purge container.
- Shield the flow-through cell from direct sunlight to minimize changes in the temperature.
- Do not record any measurements until all the air from the flow-through cell and the effluent tubing has been displaced and the sensors have equilibrated. The presence of air bubbles in the flow-through cell will result in highly biased readings. Do not collect groundwater samples for laboratory analysis from the groundwater in the flow-through cell.

### 7.6.2 Surface Water

Surface water quality measurements commonly are monitored within a cross section of the surface water body to help determine the level of stratification or mixing (if the water body is moving). Typically a multi-parameter water quality meter is lowered through the water column to collect the data *in situ*. A multi-parameter water quality meter may be paired with a pressure transducer or graduated cable to record water quality changes with depth (i.e., depth profile). If strong currents exist, it may be necessary to attach the instruments to a weighted rope. After recording multiple measurements, as possible, return to the original measurement location to confirm the initial measurement; repeat as necessary. Follow the instructions detailed in SOP 12 (Surface Water Sampling Procedures) for surface water sampling procedures.

## 7.7 Closing Notes

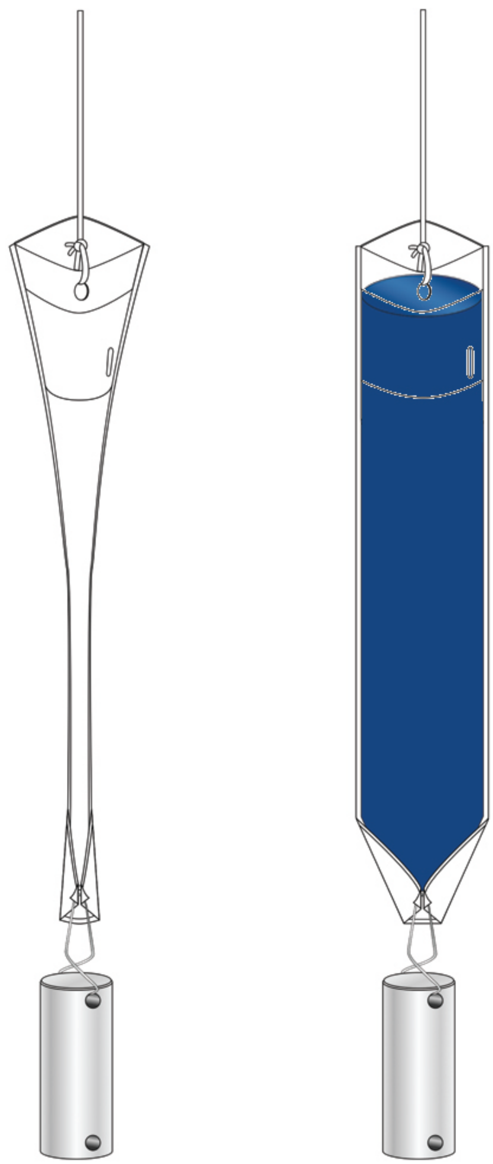
Once field activities are complete, secure the site in accordance with the project-specific work plan. Decontaminate all equipment prior to departure and properly manage all PPE and IDW in conformance with applicable regulations.

# Appendix C – HydraSleeve Standard Operating Procedure

HYDRASleeve™

Simple by Design US Patent No. 6,481,300; No. 6,837,120 others pending

# Standard Operating Procedure:
# Sampling Ground Water with a HydraSleeve



This Guide should be used in addition to field manuals appropriate to sampling device (i.e., HydraSleeve or Super Sleeve).

Find the appropriate field manual on the HydraSleeve website at http://www.hydrasleeve.com.

For more information about the HydraSleeve, or if you have questions, contact:
GeoInsight, 2007 Glass Road, Las Cruces, NM 88005, 1-800-996-2225, info@hydrasleeve.com.



## Table of Contents

## Introduction

The HydraSleeve is classified as a no-purge (passive) grab sampling device, meaning that it is used to collect ground-water samples directly from the screened interval of a well without having to purge the well prior to sample collection. When it is used as described in this Standard Operating Procedure (SOP), the HydraSleeve causes no drawdown in the well (until the sample is withdrawn from the water column) and only minimal disturbance of the water column, because it has a very thin cross section and it displaces very little water (<100 ml) during deployment in the well. The HydraSleeve collects a sample from within the screen only, and it excludes water from any other part of the water column in the well through the use of a self-sealing check valve at the top of the sampler. It is a single-use (disposable) sampler that is not intended for reuse, so there are no decontamination requirements for the sampler itself.

The use of no-purge sampling as a means of collecting representative ground-water samples depends on the natural movement of ground water (under ambient hydraulic head) from the formation adjacent to the well screen through the screen. Robin and Gillham (1987) demonstrated the existence of a dynamic equilibrium between the water in a formation and the water in a well screen installed in that formation, which results in formation-quality water being available in the well screen for sampling at all times. No-purge sampling devices like the HydraSleeve collect this formation-quality water as the sample, under undisturbed (non-pumping) natural flow conditions. Samples collected in this manner generally provide more conservative (i.e., higher concentration) values than samples collected using well-volume purging, and values equivalent to samples collected using low-flow purging and sampling (Parsons, 2005).

## Applications of the HydraSleeve

The HydraSleeve can be used to collect representative samples of ground water for all analytes (volatile organic compounds [VOCs], semi-volatile organic compounds [SVOCs], common metals, trace metals, major cations and anions, dissolved gases, total dissolved solids, radionuclides, pesticides, PCBs, explosive compounds, and all other analytical parameters). Designs are available to collect samples from wells from 1" inside diameter and larger. The HydraSleeve can collect samples from wells of any yield, but it is especially well-suited to collecting samples from low-yield wells, where other sampling methods can't be used reliably because their use results in dewatering of the well screen and alteration of sample chemistry (McAlary and Barker, 1987).

The HydraSleeve can collect samples from wells of any depth, and it can be used for single-event sampling or long-term ground-water monitoring programs. Because of its thin cross section and flexible construction, it can be used in narrow, constricted or damaged wells where rigid sampling devices may not fit. Using multiple HydraSleeves deployed in series along a single suspension line or tether, it is also possible to conduct in-well vertical profiling in wells in which contaminant concentrations are thought to be stratified.

As with all groundwater sampling devices, HydraSleeves should not be used to collect groundwater samples from wells in which separate (non-aqueous) phase hydrocarbons (i.e., gasoline, diesel fuel or jet fuel) are present because of the possibility of incorporating some of the separate-phase hydrocarbon into the sample.

## Description of the HydraSleeve

The HydraSleeve (Figure 1) consists of the following basic components:

- A suspension line or tether (A.), attached to the spring clip or directly to the top of the sleeve to deploy the device into and recover the device from the well. Tethers with depth indicators marked in 1-foot intervals are available from the manufacturer.
- A long, flexible, 4-mil thick lay-flat polyethylene sample sleeve (C.) sealed at the bottom (this is the sample chamber), which comes in different sizes, as discussed below with a self-sealing reed-type flexible polyethylene check valve built into the top of the sleeve (B.) to prevent water from entering or exiting the sampler except during sample acquisition.
- A reusable stainless-steel weight with clip (D.), which is attached to the bottom of the sleeve to carry it down the well to its intended depth in the water column. Bottom weights available from the manufacturer are 0.75” OD and are available in three sizes: 5 oz. (2.5” long); 8 oz. (4” long); and 16 oz. (8” long). In lieu of a bottom weight, an optional top weight may be attached to the top of the HydraSleeve to carry it to depth and to compress it at the bottom of the well (not shown in Figure 1);
- A discharge tube that is used to puncture the HydraSleeve after it is recovered from the well so the sample can be decanted into sample bottles (not shown).
- Just above the self-sealing check valve at the top of the sleeve are two holes which provide attachment points for the spring clip and/or suspension line or tether. At the bottom of the sample sleeve are two holes which provide attachment points for the weight clip and weight.

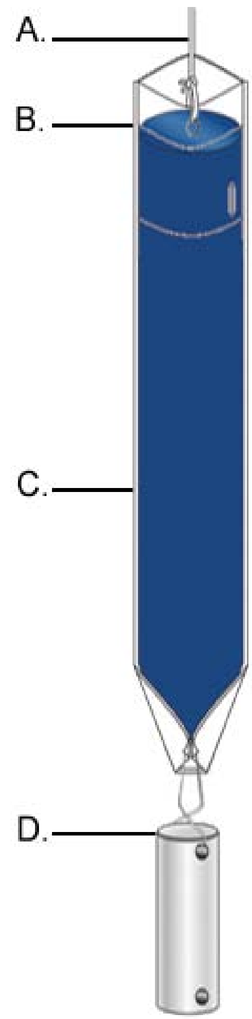


Figure 1. HydraSleeve components.

> **Note:** The sample sleeve and the discharge tube are designed for one-time use and are disposable. The spring clip, weight and weight clip may be reused after thorough cleaning. Suspension cord is generally disposed after one use although, if it is dedicated to the well, it may be reused at the discretion of the sampling personnel.

## Selecting the HydraSleeve Size to Meet Site-Specific Sampling Objectives

It is important to understand that each HydraSleeve is able to collect a finite volume of sample because, after the HydraSleeve is deployed, you only get one chance to collect an undisturbed sample. Thus, the volume of sample required to meet your site-specific sampling and analytical requirements will dictate the size of HydraSleeve you need to meet these requirements.

The volume of sample collected by the HydraSleeve varies with the diameter and length of the HydraSleeve. Dimensions and volumes of available HydraSleeve models are detailed in Table 1.

**Table 1. Dimensions and volumes of HydraSleeve models.**

| Diameter | Volume | Length | Lay-Flat Width | Filled Dia. |
|---|---|---|---|---|
| *2-Inch HydraSleeves* | | | | |
| Standard 625-ml HydraSleeve | 625 ml | < 30” | 2.5” | 1.4” |
| Standard 1-Liter HydraSleeve | 1 Liter | 38” | 3” | 1.9” |
| 1-Liter HydraSleeve SS | 1 Liter | 36” | 3” | 1.9” |
| 2-Liter HydraSleeve SS | 2 Liters | 60” | 3” | 1.9” |
| *4-Inch HydraSleeves* | | | | |
| Standard 1.6-Liter HydraSleeve | 1.6 Liters | 30” | 3.8” | 2.3” |
| Custom 2-Liter HydraSleeve | 2 Liters | 36” | 4” | 2.7” |

HydraSleeves can be custom-fabricated by the manufacturer in varying diameters and lengths to meet specific volume requirements. HydraSleeves can also be deployed in series (i.e., multiple HydraSleeves attached to one tether) to collect additional sample to meet specific volume requirements, as described below.

If you have questions regarding the availability of sufficient volume of sample to satisfy laboratory requirements for analysis, it is recommended that you contact the laboratory to discuss the minimum volumes needed for each suite of analytes. Laboratories often require only 10% to 25% of the volume they specify to complete analysis for specific suites of analytes, so they can often work with much smaller sample volumes that can easily be supplied by a HydraSleeve.

# HydraSleeve Deployment

## Information Required Before Deploying a HydraSleeve

Before installing a HydraSleeve in any well, you will need to know the following:

- The inside diameter of the well
- The length of the well screen
- The water level in the well
- The position of the well screen in the well
- The total depth of the well

The inside diameter of the well is used to determine the appropriate HydraSleeve diameter for use in the well. The other information is used to determine the proper placement of the HydraSleeve in the well to collect a representative sample from the screen (see HydraSleeve Placement, below), and to determine the appropriate length of tether to attach to the HydraSleeve to deploy it at the appropriate position in the well.

Most of this information (with the exception of the water level) should be available from the well log; if not, it will have to be collected by some other means. The inside diameter of the well can be measured at the top of the well casing, and the total depth of the well can be measured by sounding the bottom of the well with a weighted tape. The position and length of the well screen may have to be determined using a down-hole camera if a well log is not available. The water level in the well can be measured using any commonly available water-level gauge.

## HydraSleeve Placement

The HydraSleeve is designed to collect a sample directly from the well screen, and it fills by pulling it up through the screen a distance equivalent to 1 to 1.5 times its length. This upward motion causes the top check valve to open, which allows the device to fill. To optimize sample recovery, it is recommended that the HydraSleeve be placed in the well so that the bottom weight rests on the bottom of the well and the top of the HydraSleeve is as close to the bottom of the well screen as possible. This should allow the sampler to fill before the top of the device reaches the top of the screen as it is pulled up through the water column, and ensure that only water from the screen is collected as the sample. In short-screen wells, or wells with a short water column, it may be necessary to use a top-weight on the HydraSleeve to compress it in the bottom of the well so that, when it is recovered, it has room to fill before it reaches the top of the screen.

**Example**

2" ID PVC well, 50' total depth, 10' screen at the bottom of the well, with water level above the screen (the entire screen contains water).

*Correct Placement (figure 2):* Using a standard HydraSleeve for a 2" well (2.6" flat width/1.5" filled OD x 30" long, 650 ml volume), deploy the sampler so the weight (an 8 oz., 4"-long weight with a 2"-long clip) rests at the bottom of the well. The top of the sleeve is thus set at about 36" above the bottom of the well. When the sampler is recovered, it will be pulled upward approximately 30" to 45" before it is filled; therefore, it is full (and the top check valve closes) at approximately 66" (5 ½ feet) to 81" (6 ¾ feet) above the bottom of the well, which is well before the sampler reaches the top of the screen. In this example, only water from the screen is collected as a sample.

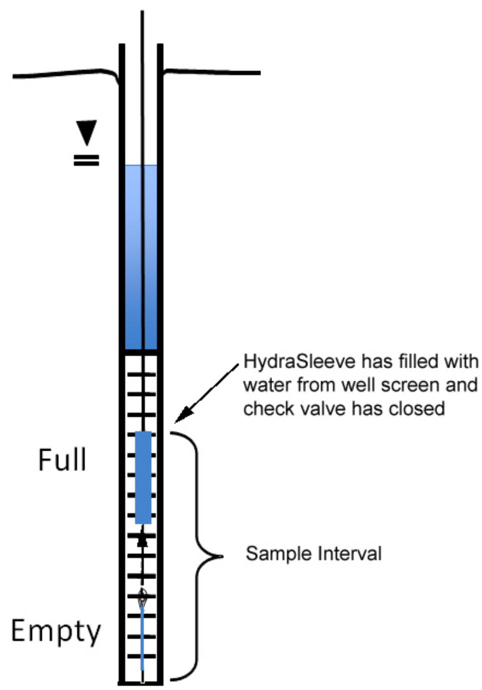



Figure 2. Correct placement of HydraSleeve.

*Incorrect Placement (figure 3):* If the well screen in this example was only 5' long, and the HydraSleeve was placed as above, it would not fill before the top of the device reached the top of the well screen, so the sample would include water from above the screen, which may not have the same chemistry.

*The solution?* Deploy the HydraSleeve with a top weight, so that it is collapsed to within 6" to 9" of the bottom of the well. When the HydraSleeve is recovered, it will fill within 39" (3 ¼ feet) to 54" (4 ½ feet) above the bottom of the well, or just before the sampler reaches the top of the screen, so it collects only water from the screen as the sample.

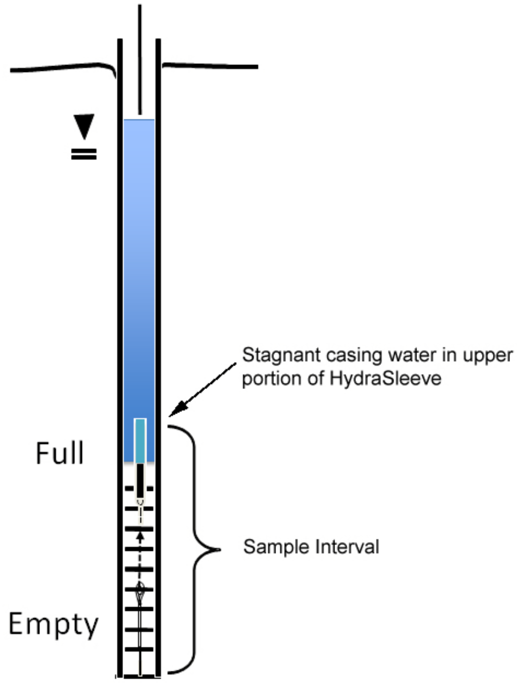



Figure 3. Incorrect placement of HydraSleeve.

This example illustrates one of many types of HydraSleeve placements. More complex placements are discussed in a later section.

## Procedures for Sampling with the HydraSleeve

Collecting a ground-water sample with a HydraSleeve is a simple one-person operation.

**Note:** Before deploying the HydraSleeve in the well, collect the depth-to-water measurement that you will use to determine the preferred position of the HydraSleeve in the well. This measurement may also be used with measurements from other wells to create a ground-water contour map. If necessary, also measure the depth to the bottom of the well to verify actual well depth to confirm your decision on placement of the HydraSleeve in the water column.

Measure the correct amount of tether needed to suspend the HydraSleeve in the well so that the weight will rest on the bottom of the well (or at your preferred position in the well). Make sure to account for the need to leave a few feet of tether at the top of the well to allow recovery of the sleeve

**Note:** Always wear sterile gloves when handling and discharging the HydraSleeve.

### I. Assembling the HydraSleeve

1. Remove the HydraSleeve from its packaging, unfold it, and hold it by its top.
2. Crimp the top of the HydraSleeve by folding the hard polyethylene reinforcing strips at the holes.
3. Attach the spring clip to the holes to ensure that the top will remain open until the sampler is retrieved.
4. Attach the tether to the spring clip by tying a knot in the tether.

**Note:** Alternatively, attach the tether to one (NOT both) of the holes at the top of the Hydrasleeve by tying a knot in the tether.

5. Fold the flaps with the two holes at the bottom of the HydraSleeve together and slide the weight clip through the holes.
6. Attach a weight to the bottom of the weight clip to ensure that the HydraSleeve will descend to the bottom of the well.

## II. Deploying the HydraSleeve

1. Using the tether, carefully lower the HydraSleeve to the bottom of the well, or to your preferred depth in the water column

   During installation, hydrostatic pressure in the water column will keep the self-sealing check valve at the top of the HydraSleeve closed, and ensure that it retains its flat, empty profile for an indefinite period prior to recovery.

> **Note:** Make sure that it is not pulled upward at any time during its descent. If the HydraSleeve is pulled upward at a rate greater than 0.5'/second at any time prior to recovery, the top check valve will open and water will enter the HydraSleeve prematurely.

2. Secure the tether at the top of the well by placing the well cap on the top of the well casing and over the tether.

> **Note:** Alternatively, you can tie the tether to a hook on the bottom of the well cap (you will need to leave a few inches of slack in the line to avoid pulling the sampler up as the cap is removed at the next sampling event).

## III. Equilibrating the Well

The equilibration time is the time it takes for conditions in the water column (primarily flow dynamics and contaminant distribution) to restabilize after vertical mixing occurs (caused by installation of a sampling device in the well).

- Situation: The HydraSleeve is deployed for the first time or for only one time in a well

  The HydraSleeve is very thin in cross section and displaces very little water (<100 ml) during deployment so, unlike most other sampling devices, it does not disturb the water column to the point at which long equilibration times are necessary to ensure recovery of a representative sample.

  In most cases, the HydraSleeve can be recovered immediately (with no equilibration time) or within a few hours. In regulatory jurisdictions that impose specific requirements for equilibration times prior to recovery of no-purge sampling devices, these requirements should be followed.

- Situation: The HydraSleeve is being deployed for recovery during a future sampling event

  In periodic (i.e., quarterly or semi-annual) sampling programs, the sampler for the current sampling event can be recovered and a new sampler (for the next sampling event) deployed immediately thereafter, so the new sampler remains in the well until the next sampling event.

Thus, a long equilibration time is ensured and, at the next sampling event, the sampler can be recovered immediately. This means that separate mobilizations, to deploy and then to recover the sampler, are not required. HydraSleeves can be left in a well for an indefinite period of time without concern.

## IV. HydraSleeve Recovery and Sample Collection

1. Hold on to the tether while removing the well cap.

2. Secure the tether at the top of the well while maintaining tension on the tether (but without pulling the tether upwards)

3. Measure the water level in the well.

4. In one smooth motion, pull the tether up between 30” to 45” (36” to 54” for the longer HydraSleeve) at a rate of about 1’ per second (or faster).

   The motion will open the top check valve and allow the HydraSleeve to fill (it should fill in about 1 to 1.5 times the length of the HydraSleeve). This is analogous to coring the water column in the well from the bottom up.

   When the HydraSleeve is full, the top check valve will close. You should begin to feel the weight of the HydraSleeve on the tether and it will begin to displace water. The closed check valve prevents loss of sample and entry of water from zones above the well screen as the HydraSleeve is recovered.

5. Continue pulling the tether upward until the HydraSleeve is at the top of the well.

6. Decant and discard the small volume of water trapped in the Hydrasleeve above the check valve by turning the sleeve over.

## V. Sample Collection

**Note:** Sample collection should be done immediately after the HydraSleeve has been brought to the surface to preserve sample integrity.

1. Remove the discharge tube from its sleeve.

2. Hold the HydraSleeve at the check valve.

3. Puncture the HydraSleeve just below the check valve with the pointed end of the discharge tube

4. Discharge water from the HydraSleeve into your sample containers.

Control the discharge from the HydraSleeve by either raising the bottom of the sleeve, by squeezing it like a tube of toothpaste, or both.

5. Continue filling sample containers until all are full.

## Measurement of Field Indicator Parameters

Field indicator parameter measurement is generally done during well purging and sampling to confirm when parameters are stable and sampling can begin. Because no-purge sampling does not require purging, field indicator parameter measurement is not necessary for the purpose of confirming when purging is complete.

If field indicator parameter measurement is required to meet a specific non-purging regulatory requirement, it can be done by taking measurements from water within a HydraSleeve that is not used for collecting a sample to submit for laboratory analysis (i.e., a second HydraSleeve installed in conjunction with the primary sample collection HydraSleeve [see Multiple Sampler Deployment below]).

## Alternate Deployment Strategies

**Deployment in Wells with Limited Water Columns**

For wells in which only a limited water column exists to be sampled, the HydraSleeve can be deployed with an optional top weight instead of a bottom weight, which collapses the HydraSleeve to a very short (approximately 6” to 9”) length, and allows the HydraSleeve to fill in a water column only 36” to 45” in height.

**Multiple Sampler Deployment**

Multiple sampler deployment in a single well screen can accomplish two purposes:

- It can collect additional sample volume to satisfy site or laboratory-specific sample volume requirements.
- It can accommodate the need for collecting field indicator parameter measurements.
- It can be used to collect samples from multiple intervals in the screen to allow identification of possible contaminant stratification.

It is possible to use up to 3 standard 30" HydraSleeves deployed in series along a single tether to collect samples from a 10' long well screen without collecting water from the interval above the screen.

The samplers must be attached to the tether at both the top and bottom of the sleeve. Attach the tether at the top with a stainless-steel clip (available from the manufacturer). Attach the tether at the bottom using a cable tie. The samplers must be attached as follows (figure 4):

- The first (attached to the tether as described above, with the weight at the bottom) at the bottom of the screen
- The second attached immediately above the first
- The third (attached the same as the second) immediately above the second

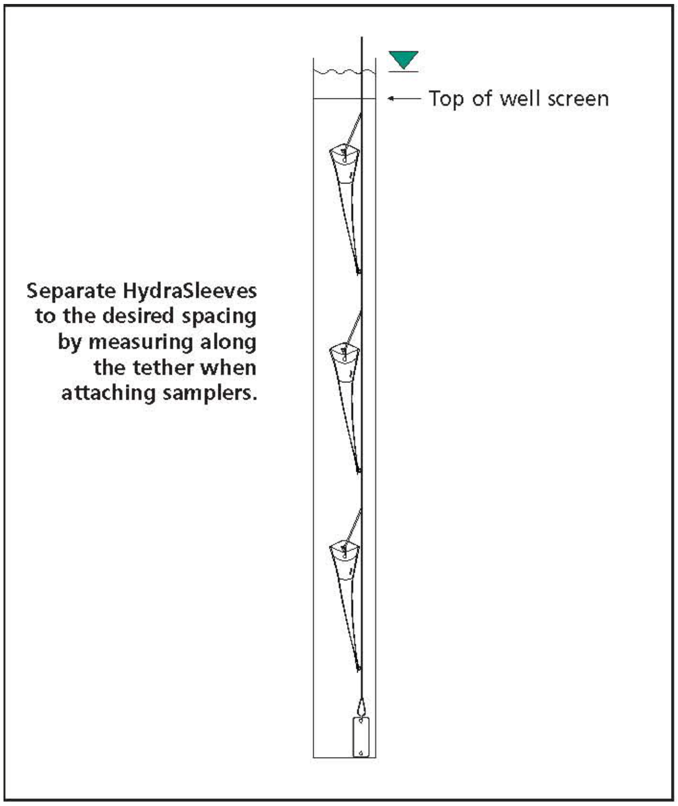



Figure 4. Multiple HydraSleeve deployment.

Alternately, the first sampler can be attached to the tether as described above, a second attached to the bottom of the first using a short length of tether (in place of the weight), and the third attached to the bottom of the second in the same manner, with the weight attached to the bottom of the third sampler (figure 5).

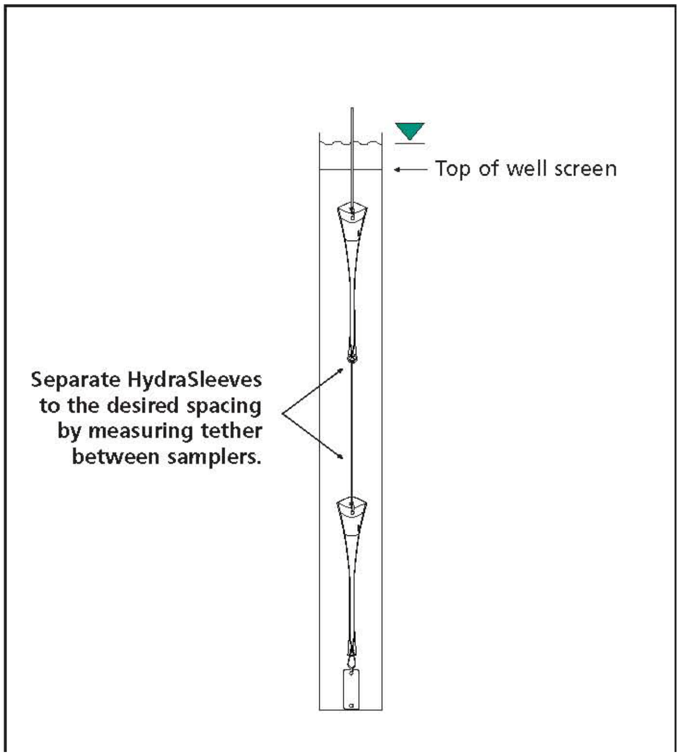



Figure 5. Alternative method for deploying multiple HydraSleeves.

In either case, when attaching multiple HydraSleeves in series, more weight may be required to hold the samplers in place in the well than would be required with a single sampler.  Recovery of multiple samplers and collection of samples is done in the same manner as for single sampler deployments.

## Post-Sampling Activities

The recovered HydraSleeve and the sample discharge tubing should be disposed as per the solid waste management plan for the site. To prepare for the next sampling event, a new HydraSleeve can be deployed in the well (as described previously) and left in the well until the next sampling event, at which time it can be recovered.

The weight and weight clip can be reused on this sampler after they have been thoroughly cleaned as per the site equipment decontamination plan. The tether may be dedicated to the well and reused or discarded at the discretion of sampling personnel.

## References

McAlary, T. A. and J. F. Barker, 1987, Volatilization Losses of Organics During Ground-Water Sampling From Low-Permeability Materials, Ground-Water Monitoring Review, Vol. 7, No. 4, pp. 63-68

Parsons, 2005, Results Report for the Demonstration of No-Purge Ground-Water Sampling Devices at Former McClellan Air Force Base, California; Contract F44650-99-D-0005, Delivery Order DKO1, U.S. Army Corps of Engineers (Omaha District), U.S. Air Force Center for Environmental Excellence, and U.S. Air Force Real Property Agency

Robin, M. J. L. and R. W. Gillham, 1987, Field Evaluation of Well Purging Procedures, Ground-Water Monitoring Review, Vol. 7, No. 4, pp. 85-93

**WSP**
11190 Sunrise Valley Drive
Suite 300
Reston, VA 20191
Tel: +1 703 709 6500
Fax: +1 703 709 8505
www.wspgroup.com/usa