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VIA ELECTRONIC MAIL

June 2, 2015

Ms. Richelle Hanson
Project Manager
Maryland Department of the Environment
1800 Washington Boulevard, Suite 625
Baltimore, Maryland 21230-1719

Re: Response Action Plan
Former Kop-Flex Facility, Voluntary Cleanup Program Site #31
Hanover, Maryland

Dear Richelle:

On behalf of EMERSUB 16 LLC, WSP USA Corp. is submitting two (2) copies of the Response Action Plan (RAP) for the former Kop-Flex facility, also designated as Voluntary Cleanup Program Site #31, in Hanover, Maryland. The RAP was prepared to address the chemicals of concern in the soil and groundwater on the property and includes supporting plans for the implementation of the remedial alternatives for the impacted media. In addition to the enclosed hard copies, we will also send you an electronic copy of the RAP for your project file.

If you have any questions, please do not hesitate to contact us at 703-709-6500.

Sincerely yours,

Robert E. Johnson

Robert E. Johnson, PhD.
Senior Technical Manager - Environmental

REJ:kjb
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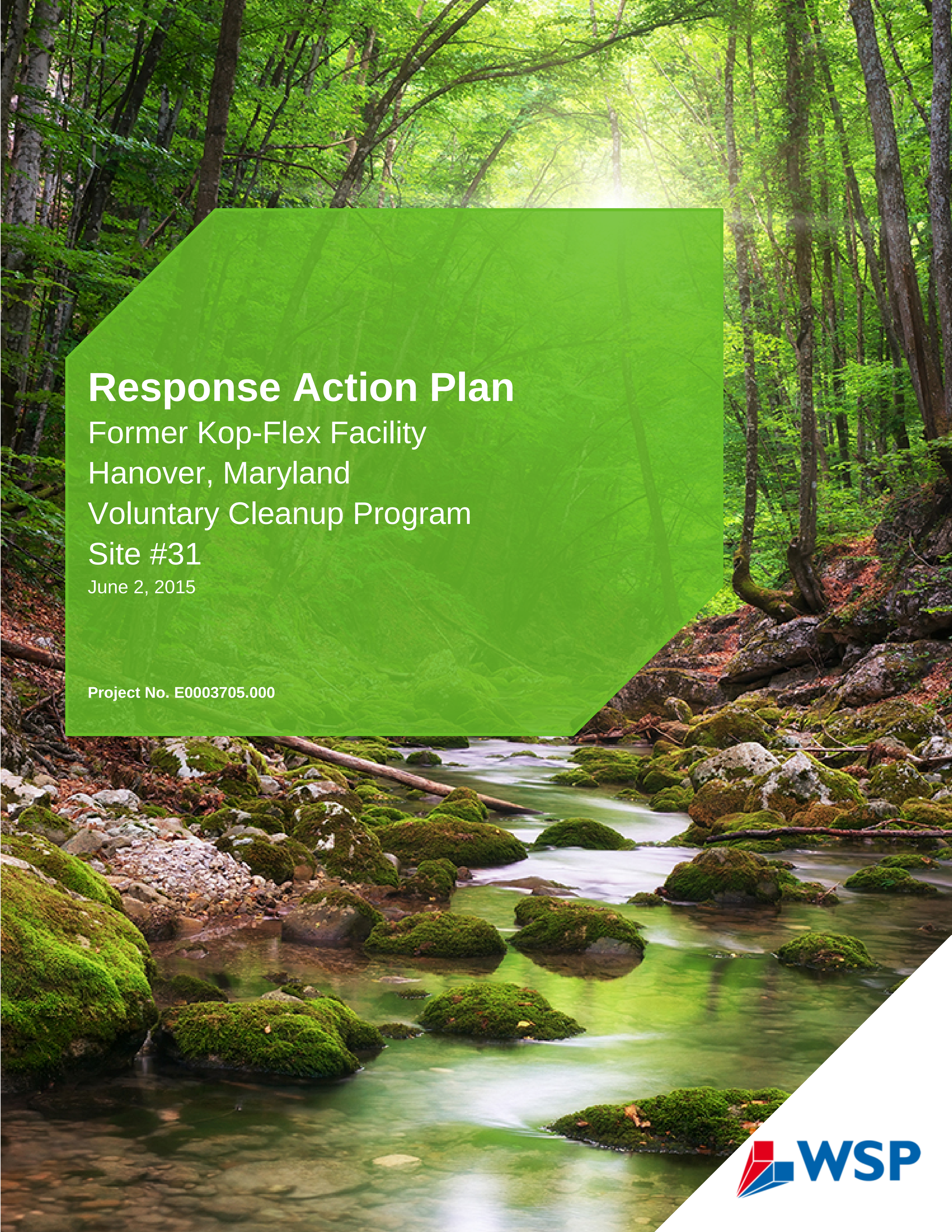
Enclosure

cc\encl: Mr. Erich Weissbart, USEPA Region III
Mr. Stephen Clarke, Emerson Electric Co. (via electronic mail)
Christine Carney, Esquire, Emerson Electric Co. (via electronic mail)
Mr. David Neuman, Trammell Crow Company
Ms. Sheila Harvey, Pillsbury Winthrop Shaw Pittman LLP



Response Action Plan

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

June 2, 2015

Project No. E0003705.000

RESPONSE ACTION PLAN

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

June 2, 2015

Client

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Consultant

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WRITTEN AGREEMENT

Former Kop-Flex Facility, Hanover, Maryland

If the response action plan is approved by the Maryland Department of the Environment, the participant agrees, subject to the withdrawal provisions of Section 7-512 of the Environment Article, to comply with the provisions of the response action plan. Participant understands that if he fails to implement and complete the requirements of the approved plan and schedule, the Maryland Department of the Environment may reach an agreement with the participant to revise the schedule of completion in the approved response action plan or, if an agreement cannot be reached, the Department may withdraw approval of the plan.

Printed Name: Stephen Clarke   Title: President

Signature: Date: June 1, 2015

1 Introduction

WSP USA Corp (WSP) has prepared this Response Action Plan (RAP) on behalf of EMERSUB 16 LLC (EMERSUB 16), for the former Kop-Flex, Inc. (Kop-Flex) Facility located at 7555 and 7565 Harmans Road in Hanover, Maryland. The former Kop-Flex facility is identified as Site #31 under the Maryland Department of the Environment (MDE) Voluntary Cleanup Program (VCP). This RAP pertains to the response action activities to be conducted on the former Kop-Flex property; a separate plan will be prepared and submitted to MDE to address the offsite groundwater impacts.

The RAP describes supplemental remedial actions to be conducted to address risks associated with chlorinated volatile organic compounds (VOCs) and 1,4-dioxane present in the vadose zone soil and groundwater on the former Kop-Flex property. The chlorinated VOCs of concern identified in the soil and groundwater consist primarily of 1,1,1-trichloroethane (TCA) and its degradation products (particularly 1,1-dichloroethane [DCA] and 1,1-dichloroethene [DCE]), with lower concentrations of chlorinated ethenes such as trichloroethene and *cis*-1,2-dichloroethene.

The RAP consists of the following sections:

- Section 2 – Site Overview
- Section 3 – Additional Investigation Results
- Section 4 – Aquifer Testing and Results
- Section 5 – Exposure Assessment
- Section 6 – Cleanup Criteria
- Section 7 – Remedial Alternative Selection for Soil and Groundwater
- Section 8 – Soil Response Action
- Section 9 – Groundwater Response Action
- Section 10 – Permits, Notifications, and Contingencies
- Section 11 – Project Implementation Schedule
- Section 12 – Health & Safety
- Section 13– Waste Management
- Section 14 – Monitoring and Reporting
- Section 15– Administrative Requirements
- Section 16 – Project Completion
- Section 17 – References
- Section 18 - Acronyms

Appendix A of this RAP includes the engineering plans to support the activities to be completed in addressing the VOC-impacted groundwater. Additional plans supporting the proposed response action activities are provided in Appendix E (Soil Management Plan) and Appendix G (Groundwater Monitoring Plan).

2 Site Background

2.1 Site Description

The former Kop-Flex site is located at 7555 and 7565 Harmans Road in Hanover, Anne Arundel County, Maryland (Figure 1). The site occupies a total area of approximately 25 acres and contains 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 (Figure 2). 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 former Kop-Flex 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. Although the site topography is generally flat, the main building and adjacent paved areas sit on a slight topographical rise that was reportedly created during facility construction in 1969. The ground surface gradually slopes to the north and west in the vicinity of former manufacturing and office building.

The closest surface water body is Stony Run, which crosses the northwestern portion of the site. The 100-year flood plain of Stony Run includes a portion of a paved parking area located between this stream and the manufacturing building. Stony Run 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 Site History

The facility was constructed on previously undeveloped land in 1969 by Koppers Company, Inc. The separate forge building was built 10 years later (1979). In 1986, an employee group purchased the company from Koppers and formed Kop-Flex, Inc. (Kop-Flex). In 1996, Emerson Electric acquired Kop-Flex.

Kop-Flex formerly manufactured flexible couplings for the mechanical power transmission industry at the site. The forge building produced precision forging of metal parts and included heat treatment and nitriding capabilities. Universal joints, gear spindles, forgings, and power transmission components were produced at the plant from 1979 to 2012. The facility also provided a repair and maintenance program for the components.

Manufacturing operations at the facility ceased in late 2012. After shutting down production activities, all equipment and machine lines were decommissioned and removed from the facility. At present, the onsite buildings are vacant except for the office building which is occupied by a small number of former plant staff. The office operations will be moved to another location in the Baltimore area in the next few months. In December 2014, Emerson transferred the property to EMERSUB 16 in preparation of selling the property to a third party for future redevelopment.

2.3 Environmental Setting

2.3.1 Geology

The former Kop-Flex 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 ft in southeastern Anne Arundel County (Vroblesky and Fleck 1991).

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 Plain deposits, the unconsolidated materials have been grouped into three gross stratigraphic units, which are generically termed “upper,” “middle,” and “lower” (Figure 3).

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. The upper-most sandy sediments present to a depth of approximately 10 feet below ground surface (bgs) in the building area and eastern portion of the site represent fill material emplaced during construction of the facility. Extensive layers of fine-grained (silt and clay) deposits exist in the shallow subsurface in the northern portion of the site and at a depth of approximately 10 to 20 feet (bgs) in the eastern portion of the building area. This upper sandy unit appears to be thickest in the eastern portion of the former Kop-Flex facility 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 a very thick (approximately 65 feet) sequence of predominately silt and clay deposits in the southern-most portion of the site. Occasional sand zones may be present as isolated lenses or layers within the fine-grained deposits, with the coarser sediments being relatively abundant beneath some areas of the building. The thick sand zone in the northern and western portion of the site occurs between the depths of approximately 30 feet to 60 feet bgs and is underlain by a layer of hard, dense silty clay to clayey silt sediments. A review of the boring logs indicates this fine-grained layer is ubiquitous within the subsurface deposits at the site.

The Lower Stratigraphic Unit is present below the Middle Stratigraphic Unit and consists primarily of sand and gravelly sand deposits with occasional discontinuous layers of inter-mixed clay and silt sediments of variable thickness. Based on correlation of the lithologic data, the top of this unit occurs at depths ranging from approximately 50 feet bgs in the northwest portion of the site to approximately 100 feet bgs near the southeastern corner of the property. Evaluation of the lithologic data indicates the gravelly sand deposits are more spatially extensive than similar lithofacies in the Upper Stratigraphic Unit.

2.3.2 Hydrogeology

The complexly stratified deposits comprising the Atlantic Coastal Plain from Virginia to New Jersey form an inter-layered sequence of aquifers and confining beds (Leahy and Martin 1993). In Anne Arundel County, the upper-most water-bearing unit is typically represented by an unconfined surficial aquifer consisting of Quarternary alluvium and terrace deposits. The thickness of the surficial aquifer is highly variable over the area. The surficial aquifer 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, although locally less permeable materials may exist at the surface. Downdip (southeast) of the outcrop and subcrop areas, the aquifers become confined, although the confining units may thin and be regionally discontinuous.

Given the textural variation of the three main 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 sand deposits present within the upper and middle units at the site constitute the shallow water-bearing zone, or Surficial Aquifer, within the hydrogeologic system. The lower unit is inferred to be upper-most portion of the Lower Patapsco Aquifer. Hard silt and clay deposits of the Middle Stratigraphic Unit that occur at depths ranging from approximately 45 feet in the north to 60+ feet in the south form an aquitard that hydraulically separates the Surficial and Lower Patapsco aquifers. In the southern-most portion of the site, these fine-grained, low permeability deposits are believed to represent the Patapsco Confining Unit. Overall, flow paths within these clayey 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 within the shallow coarse-grained deposits and the fine-grained deposits in the western portion of the site (Figure 3). Given the presence of appreciable clayey deposits in the shallow subsurface in the western portions of the site, groundwater within the sand lenses and thick sand layer within the Middle Stratigraphic Unit occurs locally under a partially, or semi-, confined condition within this portion of the surficial zone at the site. The groundwater surface is encountered at depths ranging from 15 feet to18 feet near the eastern site boundary to less than 10 feet in areas to the north and west of the building. Groundwater flow within the Surficial Aquifer is in a generally west to northwest direction toward Stony Run (Figure 4). Flow within the upper-most sand units and deeper (partially confined) sand deposits provide base flow to Stony Run; however, limited data is available to unequivocally confirm the discharge contribution from the semi-confined sand zone. The consistency in the west to northwest gradient over the entire thickness of the Surficial Aquifer indicates good hydraulic communication between the permeable sand intervals within this hydrogeologic unit.

Groundwater in the Lower Patapsco Aquifer also occurs under semi-confined conditions, with the depth to water in wells screened in this zone ranging from approximately 30 feet in the northwest portion of the site to 45 feet bgs along the southern site boundary. Based on contouring of water level data from site monitoring wells, the direction of groundwater flow in the Lower Patapsco Aquifer is to the south-southeast (Figure 5), which is consistent with published studies of the Coastal Plain Aquifer System in Anne Arundel County, Maryland. In the southern portion of the site, 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 deposits in the lower portion of the Middle Stratigraphic Unit serve as a confining layer, or aquitard, between the overlying Surficial Aquifer and deeper Lower Patapsco Aquifer 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 downward leakage of groundwater to the Lower Patapsco sand deposits.

2.4 Current Site Conditions

2.4.1 Soil

2.4.1.1 Southwest Portion of Former Manufacturing Building (Area of Concern 1)

Soil sampling conducted during the initial site investigation activities detected the presence of chlorinated VOCs and petroleum hydrocarbons in the unsaturated (vadose) zone beneath a former machining area in the southwest portion of the former manufacturing building (Area of Concern [AOC] 1). Evaluation of the sampling results indicated the zone of VOC-affected soil occurred at depths of greater than 7 feet bgs over the area. Based on these findings, a dual-phase extraction (DPE)/soil vapor extraction (SVE) system was installed and operated to recover chlorinated VOC mass present in the vadose zone soils. In conjunction with the remedy implementation, a former concrete well ring, which was identified as a source of VOCs to the subsurface, and the immediately surrounding soil were removed from the area. (The location of the former well ring excavation area is depicted in Figure 6).

During late 2012 and early 2013, supplemental sampling activities were performed in AOC 1 to gather updated soil quality data and assess the effectiveness of the DPE/SVE system. A total of 18 boreholes were completed over the area, with single or multiple soil samples collected for VOC analysis. The locations of soil borings completed as part of the supplemental investigation are shown in Figure 6. Although the SVE system had been successful in recovering contaminant mass, the sampling results indicate the continued presence of elevated VOC concentrations in the subsurface. Based on the sampling data, 1,4-dioxane comprised the majority of the VOC mass at depths of less than 8 to 9 feet below grade, with chlorinated VOCs becoming more prevalent in the deeper portion of the vadose zone.

Given the findings from the supplemental sampling activities, additional source area removal activities were conducted in late 2013 and early 2014 to further reduce VOC mass in the unsaturated soil and reduce the potential for COCs in soil to migrate to indoor air and groundwater. The remedial activities involved the excavation of VOC-containing soils to a depth of 15 feet below the building floor in two rectangular areas, the locations of which are provided in Figure 6. The excavated soil was segregated into stockpiles, characterized, and either transported offsite for disposal (total VOC concentrations greater than 1 milligram per kilogram [mg/kg]) or reused as backfill in the excavations (total VOC concentrations less than 1 milligram per kilogram [mg/kg]). Detailed information concerning the soil removal is provided in the Response Action Completion Report (WSP 2014).

Based on the supplemental soil sampling data, the remaining vadose zone soil beneath the building floor slab in AOC 1 contains low residual levels of site-related VOCs. Unsaturated material to a depth of less than 10 feet below grade (including the recently excavated areas) has total VOC concentrations of less than 3 mg/kg. In the unexcavated areas, the majority of the VOC mass over this depth interval appears to consist of 1,4-dioxane (see tabulated results for borings WSP-84, WSP-88, and WSP-89 in Figure 6). Slightly higher VOC levels (greater than 10 mg/kg) may locally exist in the unexcavated areas at depths below 10 feet below grade (WSP-84 location in Figure 6).

2.4.1.2 Outside Area Near East-Central Portion of Former Manufacturing Building (AOC 2)

Soil and shallow groundwater sampling activities were conducted in the area east of the former manufacturing building between 2006 and 2008, and again in 2012, to further characterize the extent of highly impacted, VOC-containing soil material in this portion of the site. Samples for VOC analysis were collected from approximately 40 borings located both inside and outside of the building (Figure 7). The soil sampling results indicated the presence of VOC-affected soil at depths of greater than 8 feet bgs in the area, and the observed presence of solvent-derived dense non-aqueous phase liquid (DNAPL) at one location immediately adjacent to the east building wall. In addition, concentrations of 1,1,1-TCA indicative of DNAPL were detected in shallow groundwater samples beginning at approximately 8 to 10 feet bgs near the building wall and extending vertically and laterally from this area to the east away from the building along the upper contact of a clay lens in the upper sand unit, and to the west.

Based on evaluation of the sampling data, source area soil removal was conducted in late 2013 to reduce VOC mass in the unsaturated and saturated soils in the area and reduce the potential for COCs to migrate in groundwater. The removal activities involved the excavation of VOC-impacted soils to depths ranging from 18 feet to 23 feet bgs in four shoring cells in the source area. The locations of the shoring cells are shown in Figure 7. The management, characterization, and final disposition of the excavated soil material were similar to the procedures described for the AOC 1 excavation activities. Flowable fill was used to backfill the cells from the terminated depth of the excavations to approximately 15-feet below ground surface to span the interval below the groundwater surface. Additional information concerning the AOC 2 soil removal is provided in the Response Action Completion Report (WSP 2014).

The remaining vadose zone soils to a depth of 8 feet bgs have non-detect to very low concentrations of 1,1,1-TCA and associated degradation compounds. Based on the sampling data, soils with 1,1,1-TCA concentrations above 10 mg/kg are locally present at depths below 8 feet in the area around the excavation cells to the east of the former manufacturing building. For these samples obtained from the deeper vadose zone (8 to 13 feet bgs), the highest 1,1,1-TCA concentration (250 mg/kg) was detected in the sample collected from 8 to 9 feet bgs at the SSI-09 location, with lower levels detected in samples from similar depths at borings SSI-05 (44 mg/kg) and WSP-68 (25 mg/kg) outside the building and WSP-07 (30 mg/kg) inside the building. Given the depth to groundwater is typically less than 13 feet in this portion of the site, the majority of the remaining VOC mass appears to be present in the upper-most portion of the saturated zone (Figure 7).

2.4.2 Groundwater

2.4.2.1 Overview

The initial activities related to understanding the onsite groundwater conditions were conducted between as part of the Phase II assessment (ESC 1999a). These investigation activities included the collection and evaluation of data to characterize the subsurface geology, and the installation and sampling of 13 Surficial Aquifer monitoring wells (MW-1 through MW-12 and MW-14) on the property (Figure 2). The sample results indicated the presence of site-related constituents of concern (COCs), consisting primarily of chlorinated VOCs and petroleum hydrocarbon constituents, in the shallow groundwater system. COC concentrations above the comparative criteria were detected in groundwater samples collected from areas to the east and immediately west of the former manufacturing building.

In addition, limited sampling of extracted groundwater was performed in conjunction with the pilot testing of groundwater remedial technologies in the VOC-impacted areas (ESC 2001a and 2001b). Analytical results for the samples from both tests indicated high total VOC levels in the Surficial Aquifer, with maximum concentrations of greater than 150 milligrams per liter (mg/l).

Based on the pilot test results, a dual phase extraction (DPE)/soil vapor extraction (SVE)system was implemented inside the southwestern portion of the former manufacturing building (AOC 1) and a network of Unterdruck-Verdampfer-Brunnen (UVB), or “vacuum vaporized”, wells were installed to address the VOC-impacted Surficial Aquifer east of the manufacturing building (AOC 2). As part of the remedial activities, a groundwater monitoring program was implemented to evaluate trends in VOC concentrations in the Surficial Aquifer. The monitoring activities included semi-annual sampling of the 13 Surficial Aquifer wells at the site. Table 1 summarizes the historical VOC data obtained during the semi-annual groundwater sampling events from 2009 through 2014.

Several supplemental investigation phases were completed between 2006 and 2013 to further evaluate the horizontal and vertical extent VOCs in the aquifer system (WSP 2013b). These investigations primarily focused on the area east of the main building (AOC 2) and included the following activities related to onsite groundwater:

- groundwater profiling at 14 locations in AOC 2 (2006)
- installation and sampling of five intermediate-depth Surficial Aquifer monitoring wells (MW-15, MW-16, MW-17, MW-18 and MW-20) and eight Lower Patapsco Aquifer wells (MW-1D, MW-2D, MW-16D, MW-17D, MW-19, MW-21D, MW-22D and MW-23D) (2010 – 2012)[1]
- depth-discrete groundwater sampling to further characterize the extent of VOCs in the Surficial Aquifer in AOC 1 and AOC 2, and installation and sampling of one deep monitoring well (MW-26D) in AOC 1 (2012 – 2013)
- installation of an upgradient monitoring well (MW-27D) in the Lower Patapsco Aquifer (2013)

The locations of the monitoring wells installed as part of the supplemental investigations are indicated in Figure 2. Groundwater samples collected from the Surficial Aquifer in AOC 1 and AOC 2, and Lower Patapsco Aquifer in the southern and eastern portions of the site were found to contain elevated concentrations of 1,1,1- TCA, the degradation products 1,1-DCA and 1,1-DCE, and 1,4-dioxane. All new monitoring wells were incorporated into the site-wide, semi-annual groundwater monitoring program to gather additional water quality data for the aquifer system.

During the 2013 response action activities, Emulsified Zero Valent Iron (EZVI) was injected into the shallow groundwater zone in AOC 2 in order to further reduce hot spot VOC concentrations in the saturated soil. The EZVI creates a treatment zone in the shallow groundwater that has the ability to reduce VOCs for an extended period of time via *in situ* abiotic dechlorination. This work is also summarized in the Response Action Completion Report (WSP 2014).

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[1] In addition to the onsite wells, one deep monitoring well (MW-24D) was installed on the adjacent Williams-Scotsman property immediately south of the site.

2.4.2.2 Surficial Aquifer

Discussion of the groundwater quality is based on data from the December 2014 monitoring event, which involved the sampling of 21 shallow (20 to 40 feet bgs) and intermediate (40 to 60 feet bgs) depth wells. The locations of the groundwater monitoring wells are shown on Figure 2. The wells range in depth from 22 feet bgs to 60 feet bgs.

For the Surficial Aquifer, the VOCs of concern are 1,1,1-TCA and its degradation products (e.g., 1,1-DCE and 1,1-DCA), chlorinated ethenes such as trichloroethene and tetrachloroethene, and 1,4-dioxane. The highest VOC levels in shallow groundwater are found in the identified source areas underneath and east of the former 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 former manufacturing building, to the area west of the building in the vicinity of MW-38. Figures 8 depicts the inferred VOC distribution (including 1,4-dioxane) in the upper portion of the Surficial Aquifer at the site.

Well MW-01 is the only Surficial Aquifer monitoring point that is situated upgradient of the source areas and provides background water quality data for this hydrogeologic unit. No site related VOCs have been detected in samples from MW-01. VOC concentrations detected in wells near the eastern property boundary (MW-08 and MW-20) are substantially lower than concentrations in wells located in close proximity to the source area to the immediate east of the former manufacturing building (MW-02, MW-11, MW-12, and MW16).

VOCs associated with the source area immediately east of the former manufacturing building have migrated west (downgradient) and commingled with VOCs associated with the source area below the southwest portion of the building. In the area west of the former manufacturing building, the highest VOC concentrations are found in samples collected from the shallow wells screened in the upper, predominately clayey deposits, with trace to non-detect levels in samples from intermediate-depth wells screened in the underlying sand unit (MW-14, MW-18 and MW-39) (Figures 8 and 9). Typically non-detect levels of site-related VOCs have been found in samples from shallows wells MW-03 and MW-07 northwest of the manufacturing building. Based on evaluation of the sampling data, no site-related VOCs appear to be migrating offsite at levels of concern in the shallow portion of the groundwater system.

2.4.2.3 Lower Patapsco Aquifer

The discussion on groundwater quality for the Lower Patapsco Unit is based sampling data from the 10 deep onsite wells and offsite well MW-24D from the December 2014 monitoring event. The locations of the groundwater monitoring wells are shown on Figure 2. These wells generally range in depth between 90 feet bgs and 130 feet bgs.

The VOCs detected in samples from wells installed in the Lower Patapsco Aquifer are consistent with those identified for 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 inferred total VOC distribution is provided in Figure 10. Overall, VOC impacts in the deep groundwater extend from the identified source area to the east of the manufacturing building to the off-property areas to the south-southeast of the former Kop-Flex facility. As indicated in the VOC plume map, the highest VOC concentrations occur in the vicinity of on-property well MW-17D and off-property well MW-24D, which are located immediately downgradient of the source area. Elevated VOC concentrations were also detected in the samples from well MW-1D along the southern property boundary.

Wells MW-19, MW-23D, and MW-27D are located upgradient of the VOC source areas at the site. Trace to non-detect concentrations of VOCs were detected in samples collected from MW-19 and MW-27D. Well MW-23D, which is located approximately 120 feet north of the former manufacturing building, contained low levels of site-related VOCs, primarily 1,4-dioxane and 1,1-DCE.

2.5 Future Land Use

Although the past land use has been industrial, the property will be sold and redeveloped for commercial use. In December 2014, EMERSUB 16 LLC completed a purchase and sale agreement with TC Harmans Road, LLC, who will redevelop the property and construct commercial warehouses. An overlay of the proposed development plan for property is shown in Figure 2. The planned commercial use of the property was indicated in the new VCP application EMERSUB 16 submitted to MDE on January 30, 2015.

2.6 Response Actions

2.6.1 Soil

Based on the previous investigation and remediation activities, low concentrations of VOCs (primarily 1,4-dioxane) remain in the shallow soil (less than 10 feet bgs) underneath the southwest portion of the former manufacturing building (AOC 1) (see Figure 2). In addition, soil gas may contain VOCs derived from the partitioning of residual contaminant mass in the unsaturated soil and volatilization of constituents from the groundwater surface. The results of the updated site-specific risk assessment demonstrate the soil and soil vapor conditions do not pose any unacceptable human health risk to workers under the current site conditions (WSP 2015). Under the future land use scenario, the calculated risks to workers associated with VOC-containing soil would also be below the target risk values; however, the potential may exist for future risks associated with vapor intrusion into new building structures.

The site response actions for soil will include the implementation of land use and engineering controls to prevent future exposure to soil containing VOCs that remain at the site. Institutional controls will consist of filing a land deed notice restricting the property to non-residential use, and developing and implementing a Soil Management Plan for any intrusive activities performed within the known VOC-affected area. Engineering controls will involve the incorporation of a vapor barrier and vapor collection system in future buildings constructed at the site to prevent VOC-containing vapors from entering the structures.

2.6.2 Groundwater

Information on the groundwater quality at the former Kop-Flex facility has been continually gathered from the sampling of onsite monitoring wells. Evaluation of the historical monitoring data indicates concentrations of chlorinated VOCs and 1,4-dioxane above the applicable groundwater standards in the Surficial Aquifer below the southwest portion of former manufacturing building. The affected area forms a slightly elongate plume of VOC-containing groundwater with the long axis oriented in a generally east-west direction consistent with the overall flow paths in this hydrogeologic unit. Groundwater samples collected from wells along the western (*i.e.*, hydraulically downgradient) property portion of the site show that the surficial VOC plume does not extend to the property boundary. VOC concentrations above the comparative groundwater standards have also been detected in samples from the deeper groundwater zone, which is interpreted to represent the Lower Patapsco Aquifer in the Coastal Plain aquifer system. In this hydrogeologic unit, VOC impacts occur in the southeastern portion of the site and extends southward off the Kop-Flex property.

Hydraulic containment via the pumping of VOC-containing groundwater has been selected as the response action to address the impacted aquifers at the site. An extraction network of shallow pumping wells screened within the Surficial Aquifer and deep wells completed in the Lower Patapsco Aquifer will serve to contain the VOC-affected groundwater to the site. Surficial Aquifer extraction wells will be located in the western portion of the site near the downgradient limit of the shallow VOC plume, and the extraction wells to control VOC migration in the Lower Patapsco Aquifer will be located along the downgradient (south) property boundary. The combined flow from the extraction wells will be treated to remove the site-related contaminants in accordance and the treated effluent will be discharged to Stony Run pursuant to the approved discharge permit. Preliminary (conceptual) engineering drawings of the proposed hydraulic containment systems are provided in Appendix A.

Potable water at the former Kop-Flex site is obtained from the municipal water system; however, there is no restriction on the use of groundwater at the site. Therefore, a restrictive covenant or similar enforceable limitation will be enacted to prohibit the use of groundwater at the site. The groundwater use restriction will be recorded in the county land use records for the property and included Remedial Action Report submitted to MDE.

3 Additional Site Investigations

3.1 Soil Sampling for Proposed Development

In September 2014, thirteen direct-push soil borings were completed to depths of 6 feet bgs in a future loading dock area between two proposed warehouse buildings. Nine boring were installed in the former manufacturing building, one was installed to the west of the building, and three were installed to the east of the building. Soil samples were collected from ten of the thirteen locations and analyzed for VOCs, polycyclic aromatic hydrocarbons, gasoline and diesel range petroleum hydrocarbons, polychlorinated biphenyls, and metals using USEPA-approved test methods. The locations of the shallow soil borings are shown in Figure 11.

Table 2 summarizes the laboratory results for the samples submitted for chemical analysis. The samples contained non-detectable or trace concentrations of site-related VOCs and PAHs. Metal concentrations, except for arsenic in two samples, were below MDE Residential Soil Cleanup Standards. Although two samples had arsenic above the MDE Residential Soil Cleanup Standard, the concentrations were determined to be below the typical MDE bioavailability standard.

3.2 General Hydrogeochemical Parameters

To assess potential hydrogeochemical factors that could influence the treatment process, groundwater samples were collected from selected shallow aquifer wells (MW-05, MW-18, MW-38, and TW-1) in October 2014 and selected deep aquifer wells (MW-1D, MW-2D, MW-16D, MW-17D, MW-21D, and MW-26D) in December 2013. The samples collected from both the shallow and deep wells were analyzed for selected metals (aluminum, copper, iron, lead, manganese, nickel, and zinc) and total hardness (as calcium carbonate) using USEPA-approved test methods. In addition, groundwater samples from Surficial Aquifer wells were analyzed for total petroleum hydrocarbons, and samples from the Lower Patapsco Aquifer wells were tested for total alkalinity. The analytical results for the samples collected from the shallow aquifer and deep aquifer wells are summarized in Tables 3 and 4, respectively. The certified analytical laboratory report for the samples is provided in Appendix B.

3.3 Groundwater Quality Profiling

3.3.1 Overview

As shown in the iso-concentration maps cited in Section 2.4.2, the upgradient extent of VOC-affected groundwater has not been fully delineated in both the Surficial and Lower Patapsco aquifers at the site. Given this data gap, additional field investigations will be conducted to further define the extent of VOC-impacted groundwater to the east of the former Kop-Flex facility in the shallow groundwater and to the north in the deep groundwater. These investigation activities will involve the drilling and groundwater profiling of one shallow borehole (WSP-95) on the adjoining Williams Scotsman, Inc. property and a deep borehole (WSP-96) on the neighboring Verizon property. The proposed locations for the shallow and deep sample boreholes are shown on Figures 8 and 10, respectively. The field and analytical data will be evaluated to determine the appropriate locations for the future installation of permanent groundwater monitoring wells.

3.3.2 Borehole Installation and Depth-Discrete Groundwater Sampling

Each borehole will be advanced using the roto-sonic drilling method, with the shallow borehole (WSP-95) completed to a depth of approximately 60 feet bgs and the deep borehole (WSP-96) extended to approximately 120 feet bgs. The actual borehole depths will be determined in the field based on the lithologic data and the detection of chlorinated VOCs during the field screening of depth-discrete groundwater samples. During borehole installation, continuous, 5-foot-long (WSP-95) and 10-foot long (WSP-96) cores of the unconsolidated geologic materials will be obtained using the drilling method's coring system. The recovered material from each core run will be screened for VOCs at approximately 5-foot intervals using a soil head space procedure and photoionization detector (PID) fitted with an 11.7 electron volt (eV) lamp. The screening process will be compliant with WSP Standard Operating Procedure (SOP) #9. (Copies of applicable field SOPs for the investigation are included in Appendix C.) Field screening results and descriptive information will be recorded by a WSP Geologist in a bound field notebook.

For the shallow boring (WSP-95), groundwater samples will be collected from the predominately sand deposits using a depth-discrete sampling system. Groundwater samples will be collected at approximately 10-foot intervals from a few feet below the water table (approximately 20 feet bgs) to the borehole termination depth, although the vertical interval between successive sampling points will be dictated by the nature and heterogeneity of the unconsolidated deposits. After setting the sampler at the desired sample depth, groundwater will be continuously purged at a low pumping rate to ensure that water representative of aquifer conditions is being collected from the depth interval. During purging, field hydrogeochemical parameters, including temperature, pH, and specific conductance, will be monitored at regular (5-minute) intervals, and the measurements recorded in the field notebook. Once the field parameters have stabilized, groundwater samples will be collected for 1,1-DCE field screening using colorimetric tubes and the Color-Tec procedure, and laboratory analysis. At the deep boring location (WSP-96), the borehole will be advanced through the surficial water-bearing zone and underlying aquitard before commencing the sampling activities. Depth-discrete groundwater samples will be collected at approximately 10-foot intervals beginning at a depth of 5-10 feet below the bottom of the confining unit until termination of the borehole. Each groundwater sample will be collected following stabilization of the field hydrogeochemical parameters during purging and field screened for 1,1-DCE using the Color-Tec procedure. Additionally, a sample will be collected for submittal to an offsite laboratory for chemical analysis. All purge water generated during the sampling activities will be contained in Department of Transportation (DOT)-compliant 55-gallon steel drums and managed in accordance with the procedures described in WSP SOP #5. After completing the sampling activities at a given location, the borehole will be backfilled to a few inches below the paved surface with cement-bentonite grout and then capped with a layer of concrete to match the existing grade.

Each depth-discrete groundwater sample will be submitted to the Phase Separation Science, Inc. laboratory in Baltimore, Maryland and analyzed for VOC and 1,4-dioxane. The groundwater samples for VOC analysis will be analyzed using U.S. EPA SW-846 Test Method 8260B. Samples for 1,4-dioxane analysis will be analyzed using modified U.S. EPA Method 8260B with Selective Ion Monitoring (SIM). Proper quality assurance procedures, including the collection of field quality control (QC) samples, will be implemented in accordance with WSP SOP #4.

3.3.3 Surveying of Sample Locations

A surveyor licensed in the State of Maryland will survey the locations and elevations of the sample boreholes completed during the field investigation activities. The elevation of the ground surface will be surveyed to the nearest 0.01 foot. The horizontal location of the borings will also be determined to the nearest 0.1 foot. Horizontal and vertical data for each location will reference the Maryland State Plane coordinates and the NAVD1988 datum, respectively. The locations will be plotted on a scaled map showing both the former Kop-Flex facility and the surrounding area.

3.3.4 Management of Investigation Derived Media

In addition to the sampler purge water, the following investigation-derived media (IDM) will also be generated during the field investigation activities:

- drill cuttings
- solid-containing drilling water

- decontamination water
- miscellaneous solid materials that come in contact with potentially contaminated soil or groundwater (e.g., personal protective equipment, plastic, tubing, etc.)

All IDM listed will be containerized in DOT-compliant 55-gallon steel drums. The drummed materials will be labeled as “non-hazardous pending analysis”, inventoried and moved to a paved, covered staging area on the property.

During completion of the field activities, composite samples of the solid and liquid IDM will be collected and analyzed to determine the appropriate method for the management of these materials. All IDM will be managed in accordance with state and federal regulations.

4 Aquifer Testing and Results

4.1 Aquifer Testing

4.1.1 Test Design and Performance

Aquifer tests were performed on the Surficial and Lower Patapsco aquifers at the site between April and May 2014. Before initiating any test activities, additional wells and piezometers necessary for conducting the field tests were installed on the former Kop-Flex property. For the Surficial Aquifer, one 4-inch diameter extraction well (TW-1), one shallow monitoring well (MW-38), and three deeper monitoring wells and piezometers (MW-39, OW-1, and OW-2) were installed in early April 2014. The extraction well was screened within the predominately sand deposits present in the lower portion of the Surficial Aquifer (see section A-A' in Figure 3). A deep, double-cased extraction well (TW-2) was installed along the southern property boundary for conducting the pumping test in the Lower Patapsco Aquifer. The locations of the wells and piezometers constructed as part of the test activities are shown in Figure 2. Detailed information on the drilling and installation these additional wells and piezometers (including boring logs) is provided in Appendix D.

The field testing activities were performed in accordance with the Scope of Work for Aquifer Testing, dated March 12, 2014. Aquifer testing was first conducted on the Surficial Aquifer in the area immediately west of the former manufacturing building and then on the Lower Patapsco Aquifer in the southern portion of the site. For each test, field data were gathered during (1) pre-test (background) water level monitoring, (2) step-drawdown test of the groundwater extraction well, and (3) 72-hour constant discharge pumping test. The constant discharge test was designed to record water level changes in the aquifer during and following the cessation of groundwater pumping. The groundwater discharge from both tests was treated and eventually discharged to Stony Run at Outfall 001 in accordance with the facility's National Pollutant Discharge Elimination System (NPDES) Permit MD0069094 and State Discharge Permit No. 07-DP-3442. Water level readings over the duration of the constant discharge test were used to calculate the following aquifer hydraulic parameters: hydraulic conductivity (K), transmissivity (T), storativity (S), and leakage.

4.1.2 Test Results

The following section summarizes the results for the aquifer tests conducted for both the Surficial and Lower Patapsco aquifers at the site. Additional discussion of the test procedures, and data reduction and analysis methods is provided in Appendix D.

4.1.2.1 Surficial Aquifer

For the Surficial Aquifer constant discharge test, a relatively large area of hydraulic influence was created within both the sand unit screened by pumping well TW-1 and the overlying, predominately finer grained silt and clay deposits at the selected pumping rate of 11 gallons per minute (gpm). The noticeable water level displacement in the shallow observation wells (MW-05 and MW-39) indicated good hydraulic communication within the unconsolidated deposits, with and appreciable vertical flow of water from the shallow clayey unit to the deeper sand unit. Based on the specific capacity (yield per unit of well drawdown) of the pumping well and available drawdown, the long term sustainable yield for a well screened in the sand deposits of the Surficial Aquifer is approximately 7 gpm. If the well screen extends into a portion of the overlying silt and clay deposits, then maintaining the groundwater level above the screened interval would result in a smaller maximum available drawdown and corresponding decrease in the long term sustainable yield. For example, an increase in the well screen from 30 feet to 35 feet would cause a reduction in the long term well yield to approximately 4 gpm.

Table 5 summarizes the calculated hydraulic parameters derived from the corrected drawdown and recovery data collected during the constant discharge rate pumping test. Estimated values K and T values for the sand deposits comprising the Surficial Aquifer are consistent with typical published values for these types of unconsolidated materials. The K values for the sandy aquifer materials in the area west of the former manufacturing building ranged from 5.2 feet per day (ft/day) to 15.6 ft/day, with a geometric mean of 9.21 ft/day. Based on a leaky confined flow model, the storativity values for the sand deposits ranged from 7×10^{-4} to 8×10^{-4}.

4.1.2.2 Lower Patapsco Aquifer

A large area of hydraulic influence was also created within the Lower Patapsco Aquifer during the constant discharge test, with the resultant cone of depression around the pumping well forming a slightly ellipsoidal area elongated in a direction perpendicular to flow. Plots of the corrected drawdown *vs.* time data suggest a leaky or semi-confined condition for the aquifer, although an accurate evaluation of this leakage is difficult due to the abnormal hydrologic conditions during the test. The aquifer response during groundwater withdrawal appears to support the existing conceptual hydrogeologic model of the site, which indicated some very limited hydraulic communication across the confining layer that separates the aquifers at a depth of approximately 60 feet bgs. Based on the observed drawdown during both the step and constant rate tests, an extraction well which is designed similar to TW-2 would be able to achieve long term sustainable yields approaching 50 gpm.

Table 6 summarizes the calculated hydraulic parameters derived from the corrected drawdown and recovery data collected during the constant discharge rate pumping test. Based on hydrogeologic information gathered during the installation of the three MW-25 series offsite monitoring wells, the inferred thickness of the Lower Patapsco Aquifer in the site vicinity is estimated to be 80 feet. Aquifer transmissivities obtained from the data analysis show a limited range of values, ranging from a minimum of 1,170 square feet per day (ft^2/day) to a maximum of 1,620 ft^2/day. The geometric mean of the transmissivity values obtained from the test is 1,410 ft^2/day. Based on an inferred thickness for the Lower Patapsco Aquifer of 80 feet, the calculated hydraulic conductivity values for the aquifer materials in the area around TW-2 varied from 14.6 ft/day to 20.3 ft/day, with a geometric mean K of 17.7 ft/day. The estimated geometric mean T and K values are similar with data cited in other hydrogeologic reports for the Coastal Plain deposits in central Maryland.

4.2 Predictive Flow Simulations for Groundwater Containment

4.2.1 Technical Approach

The proposed response action will involve the installation of a groundwater collection and treatment system for hydraulic containment of the dissolved VOC plumes in the Surficial and Lower Patapsco aquifers. The Surficial Aquifer wells will be located in the area west (downgradient) of the former manufacturing building in order to prevent any potential transport of VOCs above the applicable groundwater quality criteria to the Stony Run drainage area. For the deeper Lower Patapsco Aquifer, groundwater withdrawal will be focused along the southern property boundary to minimize further VOC migration to the south.

The technical approach for determining the layout of the groundwater extraction well networks for each aquifer consisted of a two-step process. The initial phase, which was discussed above, involved the completion of pumping tests in each aquifer to evaluate the general effectiveness of groundwater withdrawal from wells as a hydraulic control measure for the VOC plumes. The test results and other hydrogeologic data gathered during previous field investigations were then used to predict the water level drawdown and associated flow pathways in response to remedial pumping in each aquifer using a two-dimensional, analytical steady-state groundwater flow model. Evaluation of the predictive flow simulations was conducted to determine the locations and pumping rates for the groundwater extraction wells to achieve plume containment at the site.

The WinFlow analytical groundwater flow modeling tool was used to simulate groundwater movement within the different units at the site. The WinFlow Solver is part of the non-proprietary computer program AquiferWin32 developed by Environmental Simulations Incorporated (ESI) that simulates two-dimensional steady state and transient groundwater flow. The steady state flow module, which was utilized for determining the extraction well lay-out, simulates flow in a horizontal plane using the analytical functions developed by Lindeburg (1989), and the principle of superposition to evaluate the effects of multiple functions (e.g., pumping wells, recharge, etc.) on the uniform flow field. Both unconfined and confined aquifers can be simulated using the steady state flow module. Homogeneous aquifer hydraulic properties were designated over the model areas, and a constant-head condition specified along the upgradient boundaries of the model area based on the local hydrogeologic data. No sources of water to the groundwater system (e.g., areal recharge to the water table via infiltration of precipitation) were included in the analytical functions. For the Surficial Aquifer flow simulations, Stony Run was modeled as a constant-head line sink, with the surface water elevation approximately 2 feet below the surrounding ground surface elevation. Reverse particle-tracking simulations were performed to trace the horizontal movement of groundwater in the aquifer and simulate the area of groundwater capture for each remedial pumping scenario.

A discussion of the flow simulations used to select the locations and pumping rates for the groundwater extraction well systems is provided in the following sections.

4.2.2 Surficial Aquifer

Model input parameters are based on hydrogeologic data obtained during previous field investigations at the site and are provided in Table 7. Given the good hydraulic communication between the upper clayey and lower sand units, a uniform equivalent horizontal hydraulic conductivity was calculated for the aquifer based on the borehole lithologic data and parameter estimates from the recent aquifer test and slug tests on dual-phase extraction wells conducted in 2002.

Extraction wells were defined within the inferred extent of the VOC plume in the western portion of the site to select potential spacing and pumping rates for the proposed hydraulic containment system. Based on the inferred width of impacted groundwater in the building area, the Surficial Aquifer hydraulic containment system consists of three extraction wells (RW-1S, RW-2S, and RW-3S) located immediately west of the former manufacturing building (Figure 12). Extraction well locations were adjusted slightly during the model runs based on evaluation of the total pumping rate for the well system and percentage of the plume cross-sectional area captured under simulated steady-state flow conditions. The simulated groundwater extraction wells were assigned a diameter of 4 inches, which corresponds to the diameter of the test well used in the 2014 aquifer test. Given the presence of VOCs in both the clayey and sandy units, the extraction wells were modeled with screened intervals within the lower 5 feet of the upper fine-grained layer and fully penetrating the lower coarse-grained deposits. Table 8 summarizes the extraction well construction information input into the groundwater flow model for the remedial pumping scenarios. The extraction well construction information was not varied during the remedial pumping flow simulations.

Groundwater withdrawal was represented as a single stress period with a constant extraction rate at each well. The range of potential pumping rates was based on the long term sustainable well yield determined from the recent aquifer test described in Section 4.1. Withdrawal rates for the stress period were adjusted between model runs by trial and error in light of the presumed range in sustainable well yields for this aquifer. The final simulated pumping rate for each extraction well was determined to be 3 gpm. For the final pumping scenario, the total daily groundwater withdrawal from the Surficial Aquifer extraction wells is 12,960 gallons.

The map depicting the simulated groundwater surface, or water table, during remedial pumping of the Surficial Aquifer extraction wells is shown in Figure 12. The simulated area of groundwater in-flow to the extraction wells is also shown in Figure 12 for this water-bearing zone. Changes in groundwater levels attributed to remedial pumping appear to be relatively small over the area of interest, with drawdown focused in the vicinity of the extraction wells. As indicated by the groundwater surface map, the simulated particle traces also show the convergence of groundwater flow caused by sustained withdrawals from extraction wells clustered in the area west of the main building. The predicted zone of extraction well in-flow indicates good capture of VOC-impacted groundwater underneath and a short distance west of the former manufacturing building (Figure 12). Comparison of the extraction well in-flow area with the inferred VOC distribution in the aquifer indicates the affected groundwater upgradient of the well system is sufficiently captured by the hydraulic containment system operating at the modeled conditions.

4.2.3 Lower Patapsco Aquifer

As with the remedial pumping flow simulations for the shallow groundwater zone, model input parameters for the Lower Patapsco Aquifer are based on hydrogeologic data obtained during previous site investigations and are listed in Table 9. Extraction wells were defined within the inferred extent of the VOC plume on the south portion of the property to select potential spacing and pumping rates for the proposed hydraulic containment system. Based on the inferred extent of impacted groundwater in this portion of the aquifer system, two deep extraction wells (RW-1D and RW-2D) were selected in the model area of interest at the locations shown in Figure 13. Given the probable range in withdrawal rates from this aquifer, the simulated groundwater extraction wells were assigned a diameter of 6 inches. Since the profiling data from previous onsite investigations indicates VOC-impacted groundwater is limited to approximately the upper 40-50 feet of the aquifer thickness, extraction wells could be similar in design to test well TW-2 and only partially penetrate the Lower Patapsco Aquifer. However, the WinFlow modeling program used to determine the well lay-out only allows for the extraction of groundwater from fully penetrating wells. For this flow simulation, the fully-penetrating extraction wells were designed with 50 feet of well screen to simulate the withdrawal of groundwater from the aquifer. Even though the modeled wells may not coincide with the proposed extraction well construction, the predicted well pumping rates should be conservative and more than sufficient to produce the necessary hydraulic containment effect in the aquifer. Table 8 summarizes the extraction well construction information input into the flow model program. The extraction well construction was not varied during the remedial pumping flow simulations.

Extraction rates were adjusted to maximize the capture area overlapping the cross-sectional area of the VOC plume, while minimizing the total groundwater withdrawal rate. Groundwater withdrawal was represented as a single stress period with a constant pumping rate for each well. The upper bound of potential withdrawal rates was based on the long term sustainable well yield determined from the spring 2014 aquifer test. Pumping rates for the stress period were adjusted between model runs by trial and error in light of the presumed range in sustainable well yields for the aquifer. The final simulated pumping rate for the both extraction wells was 35 gpm, with a total groundwater withdrawal from the aquifer of 100,800 gallons per day (gpd).

A site plan depicting the simulated potentiometric surface and area of groundwater in-flow to the extraction wells during remedial pumping is presented in Figure 13. The configuration of the head contours indicates a few feet of drawdown in the area around the extraction wells and the southern property boundary. The simulated particle traces depict the convergence of groundwater flow caused by the sustained withdrawals from the two extraction wells. The predicted zone of extraction well in-flow shows adequate containment of VOC-impacted groundwater in the Lower Patapsco Aquifer on the former Kop-Flex property (Figure 13). Comparison of the extraction well in-flow area with the inferred VOC distribution in the aquifer indicates the affected groundwater upgradient of the well system is sufficiently captured by the hydraulic containment system operating at the modeled conditions. It should be noted the VOC distribution in the Lower Patapsco Aquifer was determined from geostatistical analysis of available groundwater sampling data. Given the spatial distribution of the monitoring points, there is some degree of uncertainty with respect to the exact location of the plume ‘boundary’ in this area, particularly east of the former Kop-Flex property. This uncertainty was taken in consideration when evaluating remedial pumping scenarios to ensure the operation of the proposed extraction well system achieves the desired response action objectives.

5 Exposure Assessment

Potential exposure pathways and the resulting risks were evaluated in detail in a recent site-specific risk assessment (SSRA; WSP 2015). A summary of the potential exposures is discussed below.

5.1 Site Use

The former Kop-Flex facility was used for manufacturing from 1969 to 2012, when the plant closed. A small number of office employees remain on the property; these office functions will be relocated in the next several months.

Current plans involve the redevelopment of the property as a commercial warehouse facility. Two distribution warehouses are planned, with one on the north portion of the site and a second on the south portion and a loading dock area separating the buildings. The planned future use of the site most closely corresponds to Tier 2B (Commercial-Restricted) under the Maryland Voluntary Cleanup Program (VCP).

5.2 Media of Concern

5.2.1 Soil

Historical manufacturing activities and storage of hazardous materials and wastes resulted in releases of COCs (primarily VOCs) to the ground surface or to subsurface soils. Previous remediation activities, including excavation and offsite disposal and dual-phase (water and vapor) extraction, addressed soils with the highest VOC concentrations (generally above 10 mg/kg of total VOCs) located beneath and immediately to the east of the main manufacturing building. The SSRA demonstrated that VOC concentrations currently present in surface and subsurface soils do not exceed non-residential direct contact screening levels. COCs detected above screening levels are arsenic, mercury, and polychlorinated biphenyls.

5.2.2 Groundwater

COCs in soil have migrated to the groundwater system. *In situ* treatment of shallow groundwater has been conducted in the area east of the main building with the highest VOC concentrations. The removal or treatment of unsaturated soil and groundwater with the highest VOC concentrations has reduced potential contaminant flux to and through the groundwater system.

Groundwater on the property is not used as a source of either potable or non-potable water. Institutional controls are planned that would ensure that groundwater is not used onsite in the future.

VOC-containing groundwater has migrated offsite to neighboring properties. In areas with VOC-affected groundwater, an alternative water supply has been provided. A groundwater monitoring program is being implemented to ensure that any changes in groundwater quality are detected.

5.2.3 Soil Vapor and Indoor Air

The existence of impacted soil and shallow groundwater onsite may result in the presence of VOC-containing vapors in soil pore spaces beneath buildings. VOCs were detected in sub-slab soil vapor samples and indoor air samples collected from the current onsite building. Indoor air in the warehouse facilities to be constructed as part of the planned site development, or other future buildings, could potentially be affected by these COCs. A vapor barrier and vapor mitigation system will be installed in the warehouse buildings constructed in the affected areas of the site.

5.3 Potentially Exposed Populations

As indicated above, manufacturing operations have ceased at the site, and a small number of office employees remain on the property into the near future. Current potential receptors include facility office workers, visitors, or trespassers. Visitors and trespassers would generally access the site with much lower frequency and duration, relative to facility office workers. Among the current potential receptors, facility office workers are likely to be present with the highest frequency, resulting in the greatest potential exposure. Actual exposure to COCs in soil is minimized by the presence of the buildings and pavement, which prevent contact with soil over much of the property.

The planned redevelopment to a commercial facility will involve the presence of construction workers on the property, with excavation of soil expected to a maximum depth of up to 4 feet bgs. Over the long term, future uses of the property will be commercial, with the associated presence of commercial facility workers inside or outside of the warehouse buildings. Institutional controls to prevent residential use of the property or use of groundwater as a source of drinking water will be implemented as part of subsequent remedial measures.

Groundwater containing COCs at concentrations above MCLs has migrated off the property, affecting residential wells that use the groundwater from a portion of the aquifer system as a potable water source. Risks to this receptor category have not been evaluated quantitatively, although consumption of water with COCs above MCLs is presumed to result in potential risks. In affected areas, an alternative water source has been provided. A groundwater monitoring program is being implemented so that this exposure pathway can continue to be evaluated.

The following receptors on the property were considered in the SSRA (WSP 2015):

- Current or future facility workers (indoor or outdoor)
- Future construction workers

Additional receptors could potentially be affected by impacted media but are likely to have lesser exposure than the receptors listed above. For example, visitors or trespassers would be expected to have less exposure than facility workers. Utility workers may be on the property to conduct short-term installations or repairs, but would likely be on the property for a shorter duration than construction workers.

5.4 Exposure Pathways for Human Receptors

The presence of COCs in soil and groundwater could result in the following exposure pathways:

- Exposure to COCs in soil through the ingestion, dermal contact, or inhalation routes may affect current or future facility workers and future construction workers.
- Inhalation of COCs originating in soil or groundwater and migrating to indoor air, via vapor intrusion into buildings, may affect current or future facility workers.

Direct contact with soil by facility workers would only be expected to involve soil near the surface. Surface soil (as well as subsurface soil) does not contain VOC concentrations exceeding screening levels for non-residential direct contact. (It should be noted for the SSRA, potential exposure to all affected soil [0-15 feet bgs] was considered as a conservative, worst-case assumption.) Although vapor intrusion could be a complete exposure pathway under current site conditions, this pathway will be eliminated by the implementation of engineering controls as part of the site redevelopment. The anticipated controls include a vapor barrier and vapor mitigation system in future site buildings constructed over VOC-containing soil and groundwater.

Exposure pathways involving onsite groundwater are not complete. Groundwater is not used as a source of potable or non-potable water, and the implementation of institutional controls will ensure no future use of groundwater from onsite water supply wells. The water table occurs at depths of 10 to 15 feet bgs, which is deeper than any foreseeable construction or utility work; therefore, no direct contact with groundwater will occur during these activities.

As previously discussed, groundwater containing site-related COCs has migrated off the property. This results in a potential exposure pathway involving residents who use groundwater for certain portions of the aquifer system as a source of drinking water. However, residents with impacted wells have been provided with an alternative water supply.

The SSRA (WSP 2015) included a quantitative evaluation of human health risks from the soil direct contact pathway for a facility worker or construction worker, and from vapor intrusion for a facility worker. The risks were found to be less than the target levels (hazard index of 1 and cancer risk of 1 x 10^{-5}).

5.5 Ecological Receptors

The closest body of surface water is Stony Run, which crosses the western portion of the site. The 100-year flood plain of Stony Run includes a portion of the parking lot northwest of the main building. Stony Run flows north across Dorsey Road, located approximately 2,000 feet north of the Kop-Flex property, through the Baltimore Commons Business Park and Patapsco State Park before discharging into the Patapsco River, 7 miles to the north. Wetlands (other than areas along Stony Run) are not present on the former Kop-Flex property.

COCs in the shallow groundwater zone could potentially migrate with groundwater flow to the west-northwest and discharge into Stony Run. Another potential transport mechanism that could affect the stream is erosion of surface soil containing COCs. The transport of COCs into Stony Run and its sediments could result in an exposure pathway involving freshwater aquatic organisms such as benthic macro-invertebrates or fish present in the stream. Terrestrial fauna (reptiles, amphibians, birds, and mammals) may also use the stream area as a source of food and water, or habitat, could also potentially be exposed to COCs reaching the stream ecosystem. However, the main COCs present (e.g., chlorinated VOCs) have a low potential for bio-concentration and have not been detected in surface water samples collected from the stream area.

Soil containing COCs is primarily located at depths of greater than 5 feet beneath or to the east of the former manufacturing building. Based on current and planned future development, the property consists mostly of areas covered by buildings, paved parking lots and roadways, and grass or other landscaping. Releases to soil on the property have not occurred in locations that serve as a habitat for terrestrial plants and animals. Given the planned development, the VOC-affected soil will be predominantly beneath buildings and surface pavement. Given the depth to the water table (10-15 feet bgs), exposure to VOC-containing groundwater by ecological receptors does not occur.

The SSRA (WSP 2015) included a screening-level ecological risk assessment. The screening assessment identified no significant ecological risks at the site.

6 Cleanup Criteria

The cleanup criteria for site contaminants of concern (COCs) in groundwater are provided below. As discussed above, soil cleanup has been completed and the risk assessment did not identify any unacceptable risk to current and future site occupants.

6.1 Groundwater

As previously discussed in Section 3, the groundwater COCs consist primarily of chlorinated VOCs and 1,4-dioxane. Using the aquifer designations provided in the MDE Cleanup Standards, both the Surficial and Lower Patapsco units meet the definition of a Type I aquifer in the state of Maryland. Given this classification and non-applicability of any exception described in the aforementioned MDE guidance, the cleanup criteria selected for the VOCs, excluding 1,4-dioxane, are the numeric groundwater standards for Type I/II aquifers (Table 1 of the June 2008 interim final guidance).

The cleanup criterion for 1,4-dioxane, which is not included in the list of VOCs with established groundwater cleanup standards, was determined from an evaluation of calculated risk-based concentrations in groundwater. 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. This value assumes the exposure pathway is from direct ingestion of the chemical via the drinking water source. (Other potential exposure routes for 1,4-dioxane in groundwater [*e.g.*, dermal absorption from bathing or inhalation of volatiles during showering] make a negligible contribution to human health risk.) Given the depth to groundwater and placement of a groundwater use restriction on the property, the direct ingestion exposure pathway would be incomplete for potential onsite receptors. For any groundwater discharged to Stony Run with 1,4-dioxane concentrations greater than 7.8 µg/l, the surface water levels would rapidly decrease in response to mixing with flow from upstream areas south of the site. Based on these conditions, an alternate, property-specific cleanup criterion of 15 µg/l, or approximately 2x the calculated risk-based level, is proposed for the site.

Based on the aquifer designation and MDE risk evaluation, the following numeric cleanup standards are proposed for groundwater at the site.

COC	Proposed Cleanup Standard (µg/l)
Chloroethane	3.6
1,1,1-TCA	200
1,1-DCA	90
1,1-DCE	7
1,2-DCA	5
Tetrachloroethene	5
Trichloroethene	5
cis-1,2-DCE	70
Vinyl Chloride	2
1,4-Dioxane	15

The groundwater response activities described in the RAP will result in the removal and treatment of site-related VOCs present in the aquifer system at the site. The treated water will be discharged to Stony Run in the northwestern portion of the property and, thus returned to the local hydrologic system. In addition to the active remedial measures, institutional controls – groundwater use restriction – will be instituted for the property to mitigate any human health risks associated with exposure to VOC-impacted well water.

7 Response Action for Soil and Groundwater

7.1 Soil Remedial Technology and Selection Rationale

As mentioned in Section 5 and the SSRA (WSP 2015), soil concentrations are below the non-residential cleanup criteria; therefore, no active remediation is required beyond the remedial actions previously completed. Engineering and Institutional Controls will be implemented to maintain the protectiveness of the response action, as discussed in Section 8. Although engineering controls for vapor intrusion are not required based on the risk calculations, the evaluation was specific to the current facility building. For the proposed buildings, the SSRA recommended further evaluation or implementation of engineering controls to prevent vapor intrusion. A soil management plan (Appendix E) was developed for soil excavation activities in areas where VOC-containing soil material may be present in the shallow subsurface.

The objective of the engineering and institutional controls is to reduce the potential risk of exposure to residual contaminants in vadose zone soils through direct contact and vapor intrusion. The soil management procedures will allow for safely conducting soil excavation activities.

7.2 Groundwater Response Action

The proposed groundwater response action is containment of VOC-affected groundwater using groundwater extraction and treatment. The following subsections present the remedial alternatives evaluation and descriptions of the proposed response action, land use controls, and post-remediation requirements.

7.3 Groundwater Response Action Objectives

Groundwater Response Action Objectives (RAOs) were developed to establish goals for protecting human health and the environment. Overall, the goal of the groundwater response action is to prevent potential human and ecological exposure to VOCs present in the aquifer system at the site. Specific RAOs for the remedial actions selected for the VOC-impacted groundwater include:

- controlling potential migration of groundwater with VOCs exceeding applicable human health criteria beyond the Kop-Flex property boundary
- restricting groundwater use on the former Kop-Flex property to prevent potential exposure to VOCs present at concentrations above applicable human health criteria
- reducing concentrations of VOCs in the aquifer system

Mass removal from the groundwater system will be facilitated by the recent excavation of shallow soil containing source-type VOC concentrations, which will serve to reduce further migration of constituents to the saturated zone, and the injection of EZVI into the subsurface to the east of the building where excavation was not practical. The achievement of these remedial action objectives will satisfy the requirements of the MDE VCP for the protection of human health and the environment, and will be consistent with commercial use of the property.

7.3.1 Risk Reduction

Potential exposure pathways for current and future receptors were described in Section 5 of this document and the SSRA (WSP 2015). Since VOC transport in the saturated zone occurs exclusively in the dissolved phase, hydraulic control via withdrawals at groundwater sinks (i.e., pumping wells or collection trenches) can be implemented to contain COCs within the site boundary. The groundwater extraction systems will be located hydraulically downgradient of the source area to control any continued migration of dissolved VOCs in the aquifers.

A monitoring plan will be developed to evaluate the performance and effectiveness of the hydraulic containment systems in controlling the transport of VOC-containing groundwater to downgradient areas.

Although potable water at the former Kop-Flex facility is obtained from the municipal water system, there are no currently identified restrictions on the use of groundwater at the site. As stated previously, a groundwater use restriction will be instituted for the property to mitigate any human health risks associated with exposure to VOC-impacted well water.

7.3.2 Mass Reduction

In addition to reducing human health risks, the remedial activities are designed to achieve the mass reduction RAO. Mass reduction efforts will be optimized by targeting recovery to permeable zones within the known horizontal and vertical extent of the VOC plumes and using proven technologies that remove or destroy the chemicals of concern. Given the source area locations and plume distributions, mass recovery or treatment in the Surficial Aquifer will focus on the area immediately west (hydraulically downgradient) of the former manufacturing building. Recent investigation and monitoring activities have indicated the maximum VOC concentrations in the shallow groundwater zone underneath the building. For the deep groundwater zone, the majority of the VOC mass appears to be present in the southern part of the site and migrating to the south. Mass reduction in this portion of the aquifer system will be optimized by targeting removal of VOC-containing groundwater in the upper 40 feet to 50 feet of the Lower Patapsco Aquifer.

7.4 Groundwater Remedial Alternative Evaluation

Remedial alternatives were evaluated for their ability to meet the groundwater response action objectives, as well as their applicability to site-specific conditions, including access constraints, contaminants, medium, and the area/depth of concern. Alternatives that were considered include containment (permeable reactive barrier and groundwater extraction and treatment) and in situ and ex situ chemical treatments (in situ/ex situ chemical oxidation, biological reduction). The only alternative that was considered feasible was containment through groundwater collection and treatment to remove COCs. All other alternatives were determined to be ineffective with respect to addressing the contaminants and conditions at the site.

Groundwater collection and treatment is designed to prevent migration of groundwater with VOCs exceeding applicable human health criteria beyond the Kop-Flex property boundary through groundwater extraction, and remove the VOC mass from extracted groundwater through treatment prior to discharge to a surface water body. The extraction well placement and water extraction rates (Section 7.4.2.1) are proposed in accordance with the modeled conditions, and will be achieved using the selected submersible pumps (Section 9.2.1). The system's treatment components (Section 9.3) are capable of removing COCs from groundwater in order to meet the groundwater cleanup standards and discharge permit limits. Therefore, this technology is protective of human health and the environment by reducing the mobility, toxicity, and volume of contaminated groundwater at the site.

7.4.1 Groundwater Collection and Treatment

The preliminary layout of the groundwater collection and treatment system is shown in Appendix A, Sheet 2. A groundwater extraction network of three shallow extraction wells (RW-1S through RW-3S), screened within the Surficial Aquifer, and two deep extraction wells (RW-1D and RW-2D), screened in the Lower Patapsco Aquifer, will contain the VOC-affected groundwater to the former Kop-Flex property. The proposed recovery well construction and operation summary is provided in Table 8.

The extraction wells in the Surficial Aquifer will be located across the downgradient, or leading, edge of the shallow plume, and the extraction wells in the Lower Patapsco Aquifer will be located across the downgradient property boundary for the deep plume. The total estimated groundwater flow to achieve the response action objectives is 79 gpm (see Section 4.2). Using a safety factor of 1.2, the system's maximum design flow is 95 gpm.

Extracted groundwater will be piped to a treatment system that includes an transfer pumps, bag filters, synthetic resin system for VOCs and 1,4-dioxane removal, and caustic injection system for pH buffering. Additional treatment equipment, including iron sequestration unit and an ion resin exchange system for metals removal, may be incorporated into the system to maintain treatment equipment performance and/or meet the NPDES permit discharge requirements. Alternate VOCs and 1,4-dioxane treatment equipment, including equalization tanks, air stripper, and advanced oxidation process, may be incorporated into the system in place of the synthetic resin equipment, pending bench-test and pilot test evaluation. As discussed in Section 10.1.1, the site currently operates under State Discharge Permit No. 07-DP-3442 and NPDES Permit No. MD 0069094 for discharges from groundwater remediation activities. The most recent permit was issued on July 1, 2009, and expired on June 30, 2014. No discharge will be performed until the NDPES permit renewal is issued by MDE. The design of this system assumes the discharge permit effluent limits and monitoring requirements (Table 10) in the renewed permit will be consistent with the most recent permit, as well as the groundwater cleanup standards. Based on MDE Air and Radiation Management Administration (ARMA) regulations, no treatment will be required for the off gas generated through the synthetic resin's on-site regeneration process or alternate air stripper (see Section 10.1.3). Therefore, off gas from these operations will be discharged directly to the atmosphere. The treatment system will be located within an equipment building with interconnected wiring and plumbing installations completed by the equipment vendor. Following treatment, the water will be discharged to Stony Run via Outfall 001, in accordance with the recent NPDES permit (Appendix A, Sheet 2). The estimated effluent water concentrations are provided in Table 11.

Sections 7.4.2 and 9 of this report provide a summary of the design rationale, criteria, and calculations that were used to select and size the pumping, conveyance, and treatment equipment that will comprise the proposed hydraulic containment systems.

7.4.2 Rationale for Technology Selection

7.4.2.1 Extraction Well Placement and Flow Rate

The extraction well placement and design flow rates are presented below and based on the aquifer testing and predictive flow simulations presented in Sections 4.1.2 and 4.2. The proposed extraction well locations are shown in Appendix A, Sheet 2, and the flow rates are provided in Appendix A, Table A-1.

In accordance with the flow simulations for the Surficial Aquifer (Section 4.2.2), three shallow extraction wells (RW-1S through RW-3S) will be installed immediately west of the former manufacturing building to prevent the potential transport of VOCs above the applicable groundwater quality criteria to the Stony Run drainage area. Based on the final simulated pumping rate, a sustainable pumping rate of 3 gpm per well (combined flow of 9 gpm), is proposed to provide containment of VOC-impacted groundwater in the Surficial Aquifer.

Two deep extraction wells (RW-1D and RW-2D) will be installed along the southern property boundary to contain the inferred extent of the VOC plume extending offsite to the south-southeast (Section 4.1.2.2). A sustainable pumping rate of 35 gpm per well, with a combined flow rate of 70 gpm, is estimated to provide containment of VOC-impacted groundwater in the Lower Patapsco Aquifer.

7.4.2.2 Mass Loading Rates

Mass loading rate estimates serve as the basis for the treatment system design and required treatment efficiency. The recent groundwater quality data from shallow and deep monitoring wells located within the proposed system's capture area, and the predicted flow rates for each extraction well and the combined flow, were used to estimate dissolved VOC and inorganic mass loading rates for the influent to the treatment system.

Due to variability in the water quality between extraction wells, the influent mass loading was estimated under two scenarios:

- Anticipated Influent Mass Loading Rate: the summation of the mass loading rates from each extraction well, assuming the anticipated concentration and anticipated flow rate (79 gpm).
- Maximum Influent Mass Loading (Worst Case): the maximum anticipated concentration of a constituent from any of the individual extraction wells multiplied by the maximum flow rate (95 gpm).

The mass loading for the treatment system influent was then estimated for each scenario as the concentration multiplied by a flow rate. The estimated mass loading rates are provided in Appendix A, Table A-2.

7.4.2.3 Treatment Requirements

The treated effluent discharge water shall meet the requirements set forth in the NPDES permit at the time of discharge (see Section 10.1.1). The effluent results shall also be consistent with or below the groundwater cleanup standards (Section 6.1). The effluent limits and monitoring requirements for the most recent NPDES permit are provided in Table 10, and the estimated effluent concentrations are provided in Table 11.

7.4.2.4 Site-Specific Conditions Affecting the Design

Site-specific conditions will affect the system configuration and installation of the subsurface piping. As depicted in Appendix A, Sheet 2, subsurface and overhead utilities transect the proposed lay-out for the conveyance piping. Furthermore, the exact location, and in many instances direction, of subsurface utilities are currently unknown. Therefore, all efforts will be made to identify and locate utilities prior to starting construction and care will be taken when excavating above or within the proximity of any utility identified at the site. Well and piping locations may be adjusted during construction of the system to accommodate unanticipated site conditions, and extraction wells will not be installed within 10 feet of any property boundary.

7.5 Proposed Deed Restrictions and Land Use Controls

Given the current soil conditions and results of the updated SSRA, institutional controls will be implemented to limit potential future human exposure to subsurface soils containing residual VOCs. These controls will include restricting the property to commercial use and prohibiting residential use through registration of a deed notice.

As discussed in Section 2.6.2, potable water at the former Kop-Flex property is obtained from the municipal water system; however, there are no currently identified restrictions on the use of groundwater at the site. An institutional control will be enacted on the property to reduce the potential for:

- Use of and exposure to the VOC-impacted groundwater
- Any artificial penetration of the groundwater-bearing unit(s) containing affected groundwater that could result in potential cross-contamination of clean groundwater-bearing units
- Installation of any new groundwater wells on the Property, except those used for investigative or remediation purposes and approved in advance by MDE
- Use of groundwater for any purpose (including drinking and washing) and the release of groundwater to surface water bodies, whether such release is the result of human activities or is naturally occurring
- Use of the property for other than commercial activities

The institutional controls will be included in the Certificate of Completion, to be issued by the VCP once the RAP activities are completed. Additional institutional controls required by the VCP may be included in the COC based on the exposure pathways, site conditions, or quality of implementation or documentation provided.

7.6 Future Property Access

The December 2014 purchase and sale agreement between EMERSUB 16 and TC Harmans Road LLC included an access agreement that will allow access to WSP and its subcontractors for both installation of the groundwater remedial system components and performance of operation, maintenance and monitoring (OM&M) activities. The monitoring activities will include the collection of water level and water quality data from wells and piezometers included in the approved monitoring program. The access requirement specified in the executed purchase and sale agreement will be binding between the parties for the expected operational period for the hydraulic containment systems.

8 Soil Response Action

As mentioned previously, soil cleanup has been completed and the risk assessment did not identify any unacceptable risk to current and future site occupants. The soil response actions will include the implementation of land use and engineering controls to prevent future exposure to soil containing VOCs that remain at the site, as discussed in this Section. The following soil response actions will minimize the risk of exposure to soil containing VOCs that remain at the site.

8.1 Soil Management Plan

The final grading plan and utility plan for the proposed commercial development of the site will be provided at a later date, and will indicate areas of soil removal during development. Low concentrations of VOCs (including 1,4-dioxane) remain in the shallow soil (less than 10 feet bgs) underneath the southwestern portion of the former manufacturing building (AOC 1) (see Figure 2). A soil management plan (Appendix E) was developed that identifies the procedures for safely conducting soil excavation activities in the area where VOC-containing soil material may still be present in the shallow subsurface.

All soil excavation activities in the area of the southwestern portion of the former manufacturing building shall be conducted in a manner that minimizes the exposure of potentially contaminated soil to precipitation and the flow of potentially contaminated storm water runoff to surrounding areas. If excavations are backfilled, clean soil shall be used from an off-site borrow area. Geotextile fabric or composite shall be placed on the bottom and side walls of excavations to serve as a marker and barrier between clean soil/fill and impacted soil. Soil will be disposed of at a properly permitted disposal facility licensed to accept the waste. The procedures described in the plan may be revised, as necessary, to ensure that all soil disturbance activities are conducted in accordance with applicable laws and regulations.

8.2 Engineering Controls

8.2.1 Current and Future Building Floor Slabs

The future development of the property will involve the demolition of the existing manufacturing building and construction of two (north and south) warehouse buildings separated by a truck loading area. In the new building areas, the concrete slab for the existing building will remain in place and the warehouse concrete floor slab will be installed over the current slab. The existing building floor slab will be removed in the proposed loading dock area between the buildings. For this inter-building area, new surface pavement consisting of both concrete and heavy-duty asphalt will be emplaced and serve as the paved surface for the truck loading and unloading activities. The thickness of the new concrete pavement adjacent to the warehouse buildings will be 6 inches. The asphalt will be installed along both sides of the surface drainage gutter running between the buildings and have a thickness of 4.5 inches.

8.2.2 Vapor Mitigation Systems

For the proposed buildings, the SSRA recommended further evaluation or implementation of engineering controls to prevent vapor intrusion. The construction plans for the property will include the implementation of engineering controls to prevent vapor intrusion, including incorporation of a passive vapor mitigation system into the construction of the floor slabs for both the north and south warehouse buildings. The vapor mitigation system will include a vapor collection system consisting of 2-inch diameter slotted or perforated polyvinyl chloride (PVC) pipe laterals spaced evenly within the gravel sub-base under the new floor slab and a vapor barrier consisting of a 20-mil polyethylene sheet placed between the gravel sub-base and new concrete floor slabs. The passive vapor mitigation system will prevent vapor intrusion by collecting any VOC vapors that may potentially accumulate in the gravel sub-base under the polyethylene vapor barrier. The collection system will be connected to 4-inch diameter solid PVC pipe on one side of the building that will be used as an inlet for ambient air and similar piping on the opposite side of the building that will run vertically to above the roofline to vent vapors to the atmosphere. Engineering plans and specifications for the sub-slab vapor venting system in both buildings are provided in Appendix F.

Maintenance requirements for the passive vapor mitigation system to be included with the proposed commercial development will be provided with the final building plans. Inspections for the engineering controls (warehouse building vapor mitigation systems) will be conducted in accordance with the Site Maintenance Plan prepared by the developer. This information will be submitted to MDE following property redevelopment and implementation of the engineering controls.

9 Groundwater Response Action

Extracted groundwater will be transferred from the recovery wells to the equipment building, and power and control wiring will be conveyed from the equipment building to the recovery wells, via parallel lines of below ground piping or conduit. The groundwater collection and treatment system design details and calculations are provided in Appendix A.

9.1 Extraction Wells

The extraction well construction details are provided in Table 8. The extraction well depths and anticipated flow rates are based on the predictive flow simulations for the hydraulic containment system (Section 4.2).

Each shallow extraction well will be constructed of 4-inch diameter, Schedule 40 polyvinyl chloride (PVC) screen and riser. The shallow extraction wells will be installed to a total depth of approximately 60 feet bgs, with 35-foot long screens. The screened intervals will be fully saturated and fully penetrate the lower coarse-grained deposits in the Surficial Aquifer.

Each deep extraction well will be constructed of 6-inch diameter, schedule 80 PVC screen and riser. The deep wells will be installed to a total depth of approximately 140 feet bgs, with 40-foot long screens. The screened intervals will be fully saturated and partially penetrate the upper portion of the Lower Patapsco Aquifer.

Exact well depths will be determined in the field based upon the lithology encountered during drilling. The well screen will be machine-slotted with a slot size of 0.010 inches for the shallow recovery wells and 0.020 inches for the deep recovery wells. The well screens will be surrounded with a high silica content, washed and rounded sand pack. Construction diagrams for the extraction wells and wellhead vaults are shown in Appendix A, Sheet 3.

Each groundwater extraction well borehole will be equipped with a nested 1-inch diameter PVC piezometer that will be used to monitor the groundwater level for the well. Piezometer construction diagrams are also shown in Appendix A, Sheet 3.

9.2 Groundwater Extraction and Conveyance Piping

Groundwater pumping will be used to extract groundwater from the formation. Conveyance piping will transfer the extracted water from the wells to the equipment building, and transfer treated water from the equipment building to the discharge location.

9.2.1 Groundwater Extraction

Groundwater extraction will be performed using submersible pumps capable of overcoming the total dynamic head (TDH) requirement. The dynamic head for each pipe section was calculated using the following Hazen-Williams equation (Lindeburg 2003):

$$\text{Dynamic Head}_{\text{, feet}} = H_{\text{STAT, feet}} + h_{\text{f, feet}} + h_{\text{m, feet}}$$

Where:

$H_{\text{STAT, feet}}$ = static head

$h_{\text{f, feet}}$ = head loss due to friction

$h_{\text{m, feet}}$ = minor losses due to fittings and valves, and

$$h_{f,\ feet} = \frac{10.44 * L_{feet} * V^{1.85}_{gpm}}{C^{1.85} * d^{4.87}_{inches}}$$

Where:

L_{feet} = length of pipe

V_{gpm} = flow

C = Hazen-Williams Coefficient

d_{inches} = diameter of the pipe

The TDH was calculated for pumping from the hydraulically most distant extraction well (RW-2D) on the main header and the hydraulically most distance extraction well on the shallow wells' extension (RW-3S). A safety factor of 1.2 was applied to the anticipated flow rate for each recovery well. According to the TDH calculations provided in Appendix A, Table A-1, the pump in RW-1D will be required to overcome a TDH of 115 feet, and the pump in RW-3S will be required to overcome a TDH of 67 feet.

The Grundfos model SQ05-90 or similar electrical submersible pump has been selected for the shallow extraction well pumps P-1, P-2, and P-3, and the Grundfos model 60S30-5 or similar electrical submersible pump has been selected for the deep extraction well pumps P-4 and P5. These pumps are capable of overcoming the estimated head losses at the shallow and deep wells.

9.2.2 Conveyance Piping

The electrical supply and control wiring conduits will be installed in parallel with the water conveyance piping. The selected materials, sizing, and installation plan are provided below.

9.2.2.1 Materials of Construction

The material of construction for the conveyance piping is based on compatibility with the conveyed media and pipe bedding. Recovered groundwater will be transferred to the equipment building, and treated water transferred from the equipment building, via high density polyethylene (HDPE) conveyance piping. For leak collection and ease of future replacement in the event of pipe degradation or scaling, the untreated groundwater conveyance piping will be installed within a larger diameter HDPE carrier pipe. The electric power supply line and control wiring for operating the submersible pumps will be emplaced inside Schedule 80 PVC electric conduit.

9.2.2.2 Sizing

The electrical conduit will be sized to carry the required number and gauge of power and control wires. Power and control wiring will be installed in separate conduits.

The water conveyance piping is sized to optimize in-pipe water velocities to reduce deposition of solids and minimize the TDH required for conveyance of water from the submersible pumps to the equipment building. Therefore, the conveyance pipe diameters will vary depending upon factors such as hydraulic distance from the equipment building and flow rate over a particular section. The dynamic head calculations and pipe sizes per section are provided in Appendix A, Table A-1, and shown on Sheets 3 and 4.

The protective casing for the water conveyance piping will each be sized at least an inch larger than the inner pipe.

9.2.2.3 Installation

The electrical power and control conduits will be installed in parallel with the water conveyance piping, approximately 18 inches apart in cement-stabilized native soil. The water conveyance piping will be installed at a depth of 3 feet bgs, approximately 6 inches below the frost line in Anne Arundel County, Maryland (Anne Arundel County, 2014). The electrical supply line and control wiring conduits will be installed above the water conveyance piping, at a depth of 2 feet 9 inches bgs. The pipe bedding and compacted backfill will be prepared in accordance with Maryland Department of Transportation State Highway Administration's Technical Requirements Part III (2009). If the soil removed from the trench is not suitable for use in the pipe bedding, clean fill will be brought to the site for use as bedding material. Detector tape stating "Caution: Electrical Line Buried Below" and "Caution: Water Line Buried Below" will be placed above each respective conveyance pipe. A new sub-base that matches any preexisting sub-base will be constructed over the backfill. The trench cuts will be surfaced with new surface material matching the existing surface materials surrounding the trench. Any excavated material not used as backfill will be disposed of offsite in accordance with federal and state regulations.

At pipe junctions, the conveyance piping from an individual extraction well or section of wells will be connected to the main conveyance header. At each extraction well, the conveyance piping will connect with the pumps in each well vault via down-well electrical wiring and discharge hose.

9.2.3 Well Vaults, Pipe Junction Vaults, Valve Vaults, and Cleanouts

The extraction wellheads, pipe junctions, and valve connections will be housed in pre-fabricated steel well vaults. The vaults will be sealed watertight and will be capable of withstanding H-20 traffic loads. The protective casing containing each water pipe will be terminated just inside the entry point of each vault.

The wellhead will be equipped with the following components, as shown in Sheet 3 of Appendix A:

- Backflow preventer
- Ball valve with an electric actuator to regulate flow from the well onsite via a remote control unit and offsite via a Process Logic Control (PLC) system
- Shut off valve
- Vibration dampening clamp attachment on the hydraulic line to absorb shock from vehicular traffic on top of the well vault
- Pressure indicator to monitor for line obstructions indicated by water pressure increases
- Totalizing water flow transmitters to record and transmit the flow rate and total volume of pumped groundwater
- Sample port
- Cleanout port

Iron precipitation or sediment build-up may occur within the water conveyance piping upstream of the treatment system. Therefore, pipe cleanouts will be installed at all water conveyance pipe junctions and changes in direction to allow access for cleaning inside the pipes and fittings.

9.2.4 Backfill Material

The proposed response action requires soil excavation for pipe installation trenches, as well as the installation of extraction well and pipe junction vaults. All excavation and backfill soils will be managed in accordance with the Soil Management Plan (Appendix E). Excavated areas for installation of the response action will be backfilled with native soil. In high-traffic areas, Portland cement will be mixed into the native backfill soil for added stability.

Off-site backfill material is not anticipated during construction of the response action. However, should any off-site fill material be required, a clean fill sampling work plan will be submitted to MDE for approval prior to backfilling activities. Alternatively, an affidavit stating that the imported material has not been contaminated by controlled hazardous substances or oil will be obtained from the vendor and provided to MDE prior to importing the fill.

The source of the backfill material will be documented and provided in the Construction Completion and Implementation Report.

9.3 Treatment Equipment and Discharge

The purpose of the treatment equipment is to treat recovered groundwater to meet the applicable MDE groundwater standards for COCs and effluent limits established in NPDES permit. The effluent limits and monitoring requirements for the recent NPDES permit are provided in Table 10.

The following treatment equipment is included in the design:

- Filtration, for removal of suspended solids
- Synthetic resin (AMBERSORB^{TM} 560) for VOC removal, including 1,4-dioxane
- Caustic injection, for pH buffering

The following alternate or contingency equipment may be incorporated into the treatment system, if required:

- Alternate VOC and 1,4-dioxane removal process equipment, in place of synthetic resin:
  - Equalization tank, for flow equalization and settling of suspended particles
  - Air stripper, for VOC removal
  - Advanced Oxidation Process (with hydrogen peroxide and ozone) for 1,4-dioxane and residual VOC removal
- Ion exchange resin, for metals removal
- Iron sequestering, to reduce formation of iron precipitate
- Liquid-phase granular activated carbon (GAC), for supplemental VOC removal

Additional pre-design testing will be performed to finalize the equipment required to meet the treatment objectives. For example, bench and on-site pilot studies will be performed to select the most appropriate treatment equipment (or combination of equipment) for VOCs and 1,4-dioxane removal (e.g., synthetic resin, air stripping, advanced oxidation). Also, the pre-design studies may include collection of additional geochemical parameters which may impact the treatment equipment's efficacy.

The following sections describe the treatment equipment, as well as the contingency equipment, included in the groundwater response action. Conceptual process diagrams for the groundwater treatment equipment are provided in Appendix A, Sheet 5.

9.3.1 Filtration

Suspended particle filtration downstream of the equalization tank was evaluated for reducing (1) precipitation of dissolved minerals within treatment equipment and (2) effluent suspended particle concentration according to the recent NPDES permit requirement. The system influent's total suspended particle concentrations under anticipated and maximum (worst case) conditions are estimated to be 1.1 mg/l and 9.5 mg/l, respectively. The average particle size is estimated at 2.67 microns under both anticipated and worst case scenarios (Appendix A, Table A-2). These influent concentrations are well below the NPDES requirement for total suspended solids (30 mg/l monthly average, or 45 mg/l maximum). Since a portion of the suspended particles will likely settle out of suspension in the equalization tank, the influent's total suspended solids concentration is a conservative estimate for the probable downstream concentrations. Based on the available data, filtration is not anticipated.

However, should the concentration of suspended solids increase, or equipment inspections identify a build-up of solids, or if the contingency for ion exchange resin is exercised, filtration units will be installed downstream of the air stripper. The filtration units will consist of one or more bag filter vessels, positioned in parallel or in series. The bag filters will remove solid precipitates that may result from precipitation of dissolved minerals within the water treated by the air stripper, thereby removing suspended solids before discharge. The first bag filter in each set will remove larger particles, while the second bag filter will remove finer particles not removed by the previous bag filter. Final mesh sizes for the filter bags will be determined during initial operation of the system. The bag filters will be monitored using pressure indicators installed upstream of every filter unit. These indicators will be used to monitor for pressure build up in the bag filter housing.

9.3.2 Synthetic Resin

AMBERSORB^{TM} 560, a synthetic media, is a treatment technology capable of meeting the treatment objectives for both VOCs and 1,4-dioxane removal. The hydrophobic media consists of a mixture of meso and macropores with a strong affinity for VOCs and 1,4-dioxane. As the influent water passes through the media bed, the organic constituents are absorbed to the media and removed from the water stream. The synthetic resin treatment will consist of a 2-vessel configuration with alternating lead and lag vessels in operation. The water stream passes through the operating vessels for a predetermined time or until breakthrough of the lead vessel occurs, at which time the lead vessel is taken off line and its media bed is regenerated. Once the media bed is regenerated, the vessel is returned to operation as the lag vessel, and the cycle is repeated.

The regeneration process removes the absorbed organic constituents from the media by processing low-pressure steam through the bed. After exiting the bed, the steam (or gas) containing the organic constituents is discharged to the atmosphere. Based on groundwater concentrations and system flow rates assumed under both anticipated (average) and worst case (maximum) conditions (see Appendix A, Table A-1), the regeneration process is anticipated to occur every 6 days and last up to 12 hours; this will be confirmed through pre-design testing to occur prior to installation. As shown in Appendix A, Table A-3, the chlorinated VOC plus 1,4-dioxane discharge rates per day of regeneration under average and maximum conditions, assuming the regeneration process takes 12 hours, are estimated at 5.1 pounds per day and 18.5 pounds per day, respectively. The discharge rates per year under average and maximum conditions, assuming the regeneration process occurs every 6 days, are 308 pounds per year and 1,127 pounds per year, respectively.

9.3.3 pH Buffering

The pH concentrations from the individual extraction wells are estimated at 4.4 to 4.9 standard units (SU). Based on the combined influent flow, the treatment system influent is expected to have an estimated pH of 4.7 SU. As this pH is outside of the anticipated NPDES permit range (6 to 9 SU), pH buffering will be included in the treatment system. The pH buffering system design includes an integrated controller, which will continuously monitor the pH, a metering pump for injecting the buffering solution, and a caustic solution (sodium hydroxide [NaOH]) storage container. The integrated controller will signal a metering pump to inject the caustic solution at a rate designed to maintain pH within the permit range.

9.3.4 Transfer Pumps

Transfer pumps will be used to transfer water through the treatment equipment. The transfer pumps will be rated for at least a minimum flow of 95 gpm and be capable of overcoming the dynamic head to reach the discharge location.

9.3.5 Effluent Discharge

The treated water will be conveyed in a single HDPE conveyance pipe and discharged into Stony Run through Outfall 001. A preliminary layout of the discharge pipe is provided in Appendix A, Sheet 2. No discharge will be performed until the renewed permit is issued by MDE. Water discharge monitoring for flow rate and water quality will be conducted in accordance with the NPDES permit. The effluent results for COCs will also be compared to the Groundwater Cleanup Standards (Section 6.1). To minimize stream erosion, riprap will be installed in the area immediately downstream of the outfall.

9.4 Equipment Building and Utilities

A pre-engineered building, equipped with an overhead door and personnel door, will be used to house the treatment equipment, satellite waste accumulation area, and a work area for storing tools and performing maintenance activities. The building will be sized in accordance with the anticipated and contingent treatment equipment and other proposed uses. The building's approximate location is shown on Sheet 2. Electrical power will be supplied to the treatment building via a separate power drop and meter. Additionally, a public water supply connection will be provided at the building location and a phone or internet service connection will be provided to the PLC for remote monitoring, control, and autodialing capability.

9.5 Process Logic Control

The system design will incorporate telemetry and instrumentation that will provide automated operation and remote monitoring capability. Automatic actuation of the treatment system's equipment will be controlled via a computerized PLC system. The PLC will control the operation of system, including groundwater collection from the subsurface, groundwater conveyance to the treatment system, transfer of groundwater through the treatment system, and discharge of treated groundwater. The PLC will automatically deactivate the entire system in the event of an alarm condition (e.g., preventive overflow switch is activated).

Control of each component of the treatment system (local equipment) and extraction well (via cellular connection to local equipment) will be accomplished using a PLC type system. The control system will allow remote monitoring and control of the treatment system. All controls will be mounted inside a Master Control Panel that will be placed on the equipment building. Alarm conditions will be communicated via automatically delivered electronic message and/or telephone call. The equipment operation is explained as follows.

9.6 Equipment Testing and System Startup

Following installation, all pumping, conveyance, and treatment equipment will be tested to verify proper performance before startup and initial full-scale operation of the system. The groundwater conveyance piping will be hydrostatic leak tested before burial, and all treatment equipment, telemetry, and instrumentation will be calibrated and tested. During the testing, the PLC operation will also be checked to verify proper ladder logic control and signal function.

The system start-up procedure will begin by activating the submersible pump at the hydraulically furthest extraction well (RW-2D). Groundwater from RW-2D will be pumped to the equalization tank inside the treatment building in order to start the treatment process. Subsequently, the pump at the next farthest well (RW-1D) will be turned on followed by extraction wells RW-1S, RW-2S, and RW-3S, respectively. After all extraction wells are contributing to the total flow through the system, the effluent will be monitored and sample(s) collected for off-site laboratory analysis in accordance with the NPDES permit. Additional parameters (e.g., total suspended solids, hardness, etc.) may also be collected to assist with startup monitoring. The system will be turned off until results are received back from the laboratory and confirmed to be within the NPDES permit limits and the groundwater cleanup standards for COCs.

9.7 System Operation, Maintenance and Monitoring

9.7.1 System Operation and Maintenance

After completing the start-up period, long-term operation and maintenance (O&M) activities will be conducted by WSP, or its designated subcontractor, on a regular basis to ensure optimum system performance. WSP will prepare an O&M Plan for the selected treatment system that will include detailed operating and maintenance information, inspection forms, and spare parts list from the vendor(s) selected for equipment delivery and installation. The O&M Plan will be updated to include as-built design drawings, noting any necessary changes during system installation. Equipment failure and shutdown procedures will be incorporated into the system operation, and the information included with the O&M documentation.

9.7.2 System Monitoring

For continuous operation, the discharge will be monitored in accordance with the NPDES permit after the system startup and confirmation testing. Influent and effluent samples will also be collected from the treatment system on a routine basis and analyzed in accordance with permits issued for the operation of the system. At a minimum, water samples will be analyzed using methods approved for VOCs (including 1,4-dioxane) to measure dissolved VOC mass recovery and verify that discharge criteria are satisfied. The number of samples, sampling frequency, and required analysis will be determined upon issuance of permits. The sampling pertaining to system monitoring will be included as part of the operation and maintenance (O&M) activities for the system.

9.7.3 Groundwater Monitoring

Performance groundwater monitoring will be conducted periodically to gather data to evaluate the effectiveness of the groundwater collection system. The primary monitoring objective is to ensure the hydraulic control of the VOC-affected area by limiting further potential migration of VOCs in the groundwater system to off-property receptors. As part of the data analysis to determine achievement of the RAOs, the observed heads, or water levels, from the site will be compared to the modeled heads generated from predictive flow simulations. The groundwater monitoring program will be conducted in accordance with the Groundwater Monitoring Plan provided in Appendix G.

9.8 Action Levels

The action levels for the groundwater response action include the groundwater cleanup criteria for COCs (Section 6.1) and the NDPES permit discharge limits at the time of discharge. The limits for the most recent NPDES permit are provided in Table 10. The groundwater treatment equipment will be designed to meet or exceed these action levels, including the cleanup criterion for 1,4-dioxane; the estimated effluent concentrations are provided in Table 11. However, should the system discharge exceed an action level, the system will be shut down until a contingency measure is implemented to rectify the issue. Immediately thereafter, a confirmation sample of the system effluent will be collected to confirm treatment in accordance with the action levels.

9.9 Potential Contingency Measures

The proposed groundwater collection and treatment system is a proven technology for hydraulic containment. Groundwater flow modeling using site-specific data from the pumping tests was conducted to optimize extraction well locations and pumping rates to provide adequate capture of the VOC plumes. Potential contingency measures and equipment have been evaluated should unexpected conditions occur.

Contingency measures will be evaluated and implemented should the response action fail to contain and treat the groundwater as designed. If the groundwater collection system does not meet the containment objective, then modifications to the pumping rate(s) at extraction wells will be evaluated. If the water treatment system is not as effective as designed, then contingency treatment equipment will be considered, as outlined below. Should the treated water effluent exceed the NPDES permit limits at the time of discharge, MDE will be notified immediately. The system will be shut down until the cause of the exceedance (e.g., change in influent concentrations or removal efficiency) is determined and resolved, then an additional system effluent sample will be collected to confirm the NPDES permit limits are met.

9.9.1 Contingency Measures for the Selected Groundwater Response Action

The treatment equipment was selected based on the combined influent flow rate and water quality under assumed and worst case (maximum) concentrations. Safety factors and conservative assumptions were applied as appropriate to minimize or eliminate the need for contingency measures. However, the system is capable of being modified to accommodate the unexpected conditions.

Examples of potential contingency measures include:

- Replacement or alternate equipment (e.g., pumps, piping, or treatment equipment)
- Adjusting system flow rate (increasing or decreasing) by adjusting the pumping rate at individual extraction wells, or deactivating extraction wells
- Additional equipment:
    - Iron sequestering in the treatment system to reduce the potential for iron precipitation
    - Ion exchange resin in the treatment system to remove selected metals to achieve discharge limitations
    - Liquid-phase GAC for secondary treatment of VOCs in water

The need for contingency measures will be evaluated during operation.

9.9.1.1 Replacement or Alternate Equipment

If a component of the groundwater collection and treatment system (e.g., submersible pump, transfer pump, piping, or treatment equipment vessel) fails to operate as designed and cannot be repaired, then the inoperable equipment will be taken out of service and replaced in-kind, or replaced with an alternate model capable of meeting the response action objectives.

Equipment may also be replaced if alternate equipment demonstrates a more efficient treatment method for the given COCs. As stated previously, additional information on treatment for 1,4-dioxane will be collected as part of the groundwater treatment system pre-design studies. Equipment required for an alternate VOCs and 1,4-dioxane removal process to the synthetic resin system, including flow equalization tanks, air stripping, and advance oxidation process, is provided below.

9.9.1.1.1 Equalization Tank

A flow equalization tank will stabilize the influent flow and reduce downstream cycling of system components by providing a stable reservoir of untreated water. The residence time in the equalization tank will promote settling of suspended solids into the cone-bottom of the tank and equalize any variability in the influent's water quality concentrations. The sediment level in the cone-bottom of the equalization tank will be monitored during routine site maintenance activities, drained from the tank (as needed), and drummed for off-site disposal in accordance with all local, state, and federal regulations.

9.9.1.1.2 Air Stripper

A sliding tray air stripper will be used to remove chlorinated VOCs from the recovered groundwater by blowing air upward through holes in the trays and forcing dissolved VOCs to partition into the vapor phase. The vapor will be discharged through a stack on top of the stripper, and the treated groundwater will be pumped to the discharge manhole. The air stripper model was selected based on the assumed influent flow rate and minimum 99 percent removal efficiency.

The EZ-Tray 12.4 SS Model manufactured by QED Environmental or other equivalent was selected, which can achieve at least 99 percent removal of the key chlorinated VOCs present in the groundwater. Although an increase in system influent water flow is not anticipated, this air stripper is designed to handle flow rates up to a maximum of 120 gpm, which corresponds to 1.5 times the assumed flow rate and 1.3 times the maximum flow rate. As shown in Appendix A, Table A-4, the air stripper chlorinated VOC removal rate is estimated at 0.5 pounds per day (179 pounds per year) assuming the anticipated chlorinated VOC concentrations in groundwater, and 1.0 pounds per day (378 pounds per year) assuming the maximum (worst case) chlorinated VOC concentrations.

The manufacturer's recommended air flow rate through the stripper is 600 cubic feet per minute (cfm). Based on the water's mass loading rate and recommended air flow rate, the chlorinated VOC vapor concentration is estimated at 9.1 milligrams per cubic meter (mg/m^3) assuming the anticipated VOC concentrations in groundwater, or 19.2 mg/m^3 assuming maximum (worst case) VOC concentrations.

A 7.5 horsepower (hp) blower, sized for a maximum air flow of 1,100 cfm, will be selected, with its motor installed as either totally enclosed, fan cooled (TEFC) or explosive-proof (EXP). The motor's electrical specifications will be either 1- phase or 3-phase, with 230/460 voltage (V) for 3-phase or 230 V for 1-phase.

9.9.1.1.3 Advanced Oxidation Process

Advanced oxidation technology will be used to oxidize1,4-dioxane and residual VOCs (post-air stripping) via chemical reaction with ozone and hydrogen peroxide. The ozone dissociates and reacts with hydrogen peroxide to produce hydroxyl radicals (°OH), which oxidize the organic contaminants. After sufficient reaction time, complete mineralization of the organic contaminants to carbon dioxide and water are achieved.

The advanced oxidation reactor includes a series of injection, mixing, and reaction modules to maintain proper ratios of hydrogen peroxide to ozone (e.g., 1.5:1). The process starts with the injection of a specified dose of hydrogen peroxide into the influent water stream of the HiPOX reactor (e.g., 45 mg/l). As the water processes through the reactor, ozone is injected through multiple points in the reactor. Following each ozone injection port, the dosed fluid processes through an in-line mixer to ensure that the ozone is mixed into solution, and then through a reaction zone.

9.9.1.2 Flow Adjustments

The system flow rate may require adjustment to improve treatment efficiency or equipment operations. This will be accomplished by increasing or decreasing the pumping rate at individual wells or deactivating individual wells.

9.9.1.3 Additional Equipment

Additional equipment may be required if the actual influent concentration differs from the design, or if the equipment does not operate as designed. Additional treatment equipment components evaluated for this response action are listed below.

9.9.1.3.1 Iron Sequestering

Although iron concentrations in the system effluent are not limited by the NPDES permit, iron precipitation from extracted groundwater often leads to iron scaling or buildup of ferric iron sediment on treatment equipment. Therefore, the mass loading of iron was calculated to determine if iron sequestering was required. Based on the groundwater quality data, iron concentrations in the system influent are estimated to be 624.4 μg/l under anticipated conditions and 1,055 μg/l under maximum (worst case) conditions. Calculations presented in Appendix A, Table A-2, indicate that the mass of iron precipitate produced is estimated at 0.593 pounds per day under the anticipated mass loading scenario, and 1.2 pound per day under maximum (worst case) scenario. Based on these calculations, iron sequestering is not deemed necessary.

However, should the iron concentrations measured in the operating system water exceed the design concentrations, or excessive scaling and ferric oxide sediment be observed within treatment equipment, an iron sequestering agent could be injected into the treatment system water. The iron sequestering agent would be metered into the system prior to air stripping to keep the iron in solution and prevent the formation of iron precipitates. The metering rate will be determined based on qualitative observations of the treatment equipment (e.g., observations of iron scaling) and analytical testing for iron.

9.9.1.3.2 Ion Exchange Resin

The current NPDES permit requires monitoring for four metals (zinc, copper, nickel and lead), and includes permit maximum daily concentrations for each total (unfiltered) metal. Based on the anticipated influent concentrations, the total concentrations of all permit-monitored metals are below their respective NPDES permit limits; therefore, ion resin treatment is not anticipated. However, assuming maximum (worst case) influent concentrations, the concentration of total copper (15.4 μg/l) would be above its recent NPDES permit limit (13 μg/l). Therefore, ion resin exchange treatment is a contingency to remove divalent metals from the aqueous water stream. The influent metals concentrations will be evaluated upon system startup, and should the concentrations exceed the NPDES permit in more than one sampling event, treatment of metals using ion resin will be initiated.

Based on the design flow rate, a 60 cubic foot capacity carbon steel vessel would be required. The vessel would be filled with resin in acid, sodium or calcium ionic forms.

9.9.1.3.3 Liquid-Phase GAC

Liquid-phase GAC units may be needed after the air stripper as pre-treatment to reduce operating costs for advanced oxidation. If necessary, the GAC units will be placed downstream of the air stripper and filtration equipment, and will have a minimum design flow rate of 95 gpm.

10 Permits, Notifications, and Contingencies

10.1 Permits

Federal, state, and local permitting and emissions control requirements were evaluated for the groundwater containment system's operation[2]. Based on the proposed remedial system design, the following permit requirements were identified for a more detailed evaluation:

- NPDES General Discharge Permit
- MDE Water Appropriation and Use Permit
- MDE ARMA air emissions control requirements

10.1.1 NPDES Permit

The site currently operates under State Discharge Permit No. 07-DP-3442 and NPDES Permit No. MD 0069094 for discharges from a facility manufacturing high performance or high speed couplings and groundwater remediation activities. The permit was issued on July 1, 2009, and expired on June 30, 2014. No discharge will be performed until the renewed permit is issued by MDE.

10.1.2 MDE Water Appropriation and Use Permit

In Maryland, for sites that plan to perform an activity that withdraws water from the State's surface and/or underground waters, a Water Appropriation and Use Permit issued by the MDE Water Management Administration, Water Supply Program, may apply under Code of Maryland Regulations (COMAR) 26.17.06 and 26.17.07. Based on a review of the applicability criteria and discussions with MDE, any site which has an annual average groundwater use that exceeds 5,000 gpd is subject to the permitting requirements. Additionally, sites with an average withdraw rate of 10,000 gpd or more may be subject to a public information hearing, as well as requirements to notify contiguous property owners and certify compliance with Business Occupations and Professions Article 12, Section 205, Annotated Code of Maryland (water conservation technology).

Since the estimated groundwater withdrawal rates under both anticipated and worst case conditions exceed 100,000 gpd, a water appropriation and use permit will be required for the hydraulic containment systems. A Water Appropriation and Use Permit application will be submitted to MDE in advance of system installation. If any system operations are performed in advance of the permit approval, the average water withdraw will not exceed a maximum of 5,000 gpd until issuance of the permit.

10.1.3 MDE ARMA Air Emissions Control Requirements

The operation of two treatment equipment components, the synthetic resin system (during the regeneration process only) and alternative air stripper, result in air emissions. WSP reviewed the MDE Air Quality Permits Program regulations to determine if an air permit would be required for the construction and operation of the these components. Maryland issues General Permits to Construct, Permits to Construct, Permits to Operate, and Title V Air Permits to regulated sources of air emissions.

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[2] Any applicable permits related to the system's construction (e.g., electrical, plumbing, grading) will be secured by the Contractor in advance of construction.

All installations which are potential sources of air pollution are regulated and require a permit or approval from the MDE, except those installations which are specifically exempt under the State's Air Quality Regulations (COMAR 26.11.02.10). To allow faster processing of permits, the MDE regulates certain small stationary source installations through the issuance of an air quality General Permit to Construct. MDE has a General Permit to Construct for Groundwater Air Strippers and Soil Vapor Extraction Systems. The permit covers systems where the contamination is a result of gasoline, No. 1 and No. 2 fuel oils, kerosene, diesel, and jet fuels; and the soil is treated in place by means of vapor or groundwater extraction. Because the contamination at the subject site is the result of a release of chlorinated VOCs, the general permit does not apply at this site. There are no other general permits that would be applicable for the operation of the proposed air stripper.

WSP reviewed the MDE's sources exempt from permits to construct and operate in COMAR 26.11.02.10, and the estimated VOC discharge rate using maximum flow and maximum concentrations for the synthetic resin (during regeneration process only; Appendix A, Table A-3) and air stripper (continuous discharge; Appendix A, Table A-4). Both the synthetic resin regeneration operations and the air stripper operations meet the exemption in COMAR 26.11.02.10X based on the following:

- The proposed installation is not subject to any source-specific State or federal limitation or emission standard.
- The estimated emissions contain less than 1 pound per day of a Class I toxic air pollutant (COMAR 26.11.15.01B(4)).
- The pre-control potential to emit from the proposed installation combined with any potential increase from other installations that could be caused by the installation of the synthetic resin system or alternative air stripper, are less than 1 ton per calendar year for VOCs, each pollutant for which there is a federal ambient air quality standard, and each Class II toxic air pollutant defined in COMAR 26.11.15.01B(5).

Based on the aforementioned exemption, the synthetic resin system or alternate air stripper would not subject the site to any requirements under the Title V air permit program.

In conclusion, the installation of the synthetic resin system or alternate air stripper onsite does not appear to subject the facility to any MDE air permitting or approval.

10.2 Notifications

MDE will be informed of any changes to the project implementation schedule, as discussed in Section 11, and the construction completion of the response action, as discussed in Section 14.1. MDE will be also be notified if any previously undiscovered contaminants, undiscovered storage tanks, or other environmental concerns are identified.

10.3 Contingencies

Section 9.9 describes contingency measures for the proposed response action. Should unexpected site conditions be encountered (e.g., free product, buried tanks, previously unidentified contamination), a work plan addendum with a proposed response action will be submitted to MDE for approval. A public informational meeting will be held to discuss the change in remedy.

11 Project Implementation Schedule

The proposed project implementation schedule is provided in Figure 14. Installation of the vapor mitigation measures for the new buildings will be completed during the development of the property for commercial use. Construction of the proposed hydraulic containment system is expected to begin within 90 calendar days of MDE approval of the RAP and issuance of the required permits. WSP will prepare bid specification documents for Contractors following submittal of this plan, and will submit the bid specification documents to the potential Contractors following MDE's approval. After issuance of permits, WSP will retain a qualified Contractor to install the groundwater collection and treatment system. Assuming no significant delays, the installation and startup of the proposed system should take no more than 120 calendar days to complete.

A Construction Completion and Implementation Report and Operation & Maintenance Plan will be submitted to MDE within 60 days of completing system installation and startup. The Remedial Action Report will be submitted within 60 days of completion of remedial activities.

Weather, procurement of subcontractors, and equipment availability may affect this schedule. However, every effort will be made to adhere to the proposed schedule. Exact schedule details related to various construction activities will be prepared by the contractor prior to commencement of any construction activities. Should any modifications to the implementation schedule become necessary, MDE will be advised of the revised schedule.

12 Health and Safety

A detailed health and safety plan (HASP) will be prepared prior to the implementation of the approved RAP. In accordance with MDE guidance, the plan will reference applicable regulations to the project activities (i.e. applicable sections of the Occupational Safety and Health Administration (OSHA) regulations, 29 CFR 1910 [General Industry – Hazardous Waste Site Operations, Excavations, Personal Protective Equipment, Respiratory Protection] and 29 CFR 1926 [Construction]). Components of the HASP will include:

- Appropriate personal protective equipment (PPE) and monitoring devices that must be utilized by workers to ensure that all worker protection requirements are met, and the rationale for the PPE selected.
- Site control measures that will be maintained during RAP implementation to restrict access (e.g. security guards, warning fences).
- Dust abatement or suppression methods.
- Compliance by all on-site workers with OSHA guidelines for managing contaminated material regardless of their characterization as hazardous or non-hazardous. The remedial contractor must possess the necessary certification for the transportation of any controlled hazardous substance.

13 Waste Management

Waste generated during the construction of the groundwater response action will include soil, drilling cuttings, development water, disposable sampling, and PPE. Any waste material generated during construction of the groundwater collection and treatment system will be characterized, managed, and disposed of in accordance with all local, state, and federal regulations.

14 Reporting

14.1 Construction Completion and Implementation Report

As indicated in the previous section, a Construction Completion and Implementation Report will be submitted to MDE within 60 days of the installation and start-up of the groundwater collection and treatment system. The report will summarize the system construction activities and include as-built drawings for the extraction well and other system components. The monitoring data gather during the start-up phase will also be provided in the report and evaluated with respect to the NPDES permit and system design parameters.

14.2 Operation, Maintenance and Monitoring Reports

Operation, Maintenance and Monitoring (OM&M) reports will be provided to MDE on a quarterly basis for each calendar year of system operation. Each OM&M Report will be submitted during the first month of the subsequent quarter and include the following information:

- A summary of the quarter's operations, maintenance, and monitoring activities, including explanations for any periods of non-operation lasting more than one week
- Quarterly, annual, and historical water extraction and mass removal volumes for the system
- System monitoring results along with an evaluation of the treatment system efficiency and compliance with the discharge permit requirements
- Groundwater data collection and evaluation in accordance with the approved Groundwater Monitoring Program
- A summary of any recommended system or monitoring program changes for the coming quarter

15 Administrative Requirements

A copy of the certified zoning statement for the property is included in Appendix H. In accordance with the MDE VCP guidance, the statement certifies the current and proposed future use of the property, upon which the response action is based, are in conformance with all applicable zoning requirements.

EMERSUB 16 will file a performance bond or other form of financial security (surety bond, letter of credit, escrow account, environmental insurance or other mechanism approved by MDE) no later than 10 days after MDE approval of the RAP and before conducting any work on the property pursuant to the approved RAP. The financial security instrument will be sufficient to satisfy MDE's requirements to secure and stabilize the property, if future circumstances warrant. Given the site conditions and planned property redevelopment, any activities that may be necessary to stabilize the site should be limited in nature.

16 Project Completion

16.1 Criteria for Project Completion

16.1.1 Soil

The activities outlined below will be performed to ensure completion of the soil response action at the site.

- Quality assurance oversight of construction activities during development to ensure the appropriate handling and management of any VOC-impacted soil and proper installation of vapor mitigation components (vapor barrier and passive sub-slab venting system) in the warehouse buildings.
- Completion of initial acceptance tests for passive sub-slab venting system to gather information on operation and performance.
- MDE approval and subsequent implementation of the Soil Management Plan by property developer.

16.1.2 Groundwater

The activities outlined below will be performed to ensure completion of the groundwater response action at the site.

- Collection and analysis of water level from the approved monitoring network to verify the hydraulic response during remedial pumping by containment systems.
- Regular monitoring and reporting of effluent samples from treatment system to ensure adequate VOC removal efficiency and attainment of permit discharge limits.
- Collection and evaluation of water quality data from onsite monitoring wells in both Surficial and Lower Patapsco aquifers to assess trends in VOC concentrations associated with mass removal from the groundwater system.
- Collection and evaluation of water quality data from offsite deep (Lower Patapsco Aquifer) monitoring wells near the site to ensure the capture and containment of site-related VOCs.

16.2 Certification of Completion

Conditions related to the impacted soil that will need to be achieved prior to issuance of the Certificate of Completion include the following:

- Documentation with the Anne Arundel County Circuit Court Land Records Department indicating restrictions on property use are recorded on the land deed.
- Notice to MDE prior to any future soil disturbance activities at the Site below areas covered by the existing building slab. This written notice will be required at least 15 days prior to any planned excavation activities at the Site that will penetrate through the concrete floor slab.
- As-built construction drawings showing the installation of vapor mitigation systems in building areas.
- Documentation concerning the characterization and disposal of any VOC-impacted soil material excavated from areas pursuant to applicable regulatory requirements, and certification of imported soil used as clean fill.
- Preparation of Operation and Maintenance (O&M) Plan for vapor mitigation systems, and documentation of system inspections.

The goal for completion of the groundwater response action is to meet the following criteria:

- Documentation indicating a restriction on the use of groundwater underlying the property.
- Concentrations in samples from onsite monitoring wells are below the groundwater cleanup criteria, or statistical analysis of sampling data indicates a decreasing concentration trend and attainment of the groundwater cleanup criteria within a specified timeframe.
- Statistical analysis of sampling data from offsite monitoring wells indicates a stable or decreasing concentration trend for site-related VOCs.

Given the pending property transfer, TC Harmans Road LLC will be responsible for recordation of the use restrictions indicated above on the land deed. All areas of the Site will be subject to the institutional controls specified in the deed notice. TC Harmans Road LLC will maintain ownership and control of the Site during all phases of development.

16.3 Post-Remediation Requirements

Post remediation care requirements will include compliance with the conditions placed on the COC and the institutional controls recorded for the Site. Deed restrictions will be issued as part of the COC and will be recorded within 30 days after issuance of the COC.

In addition, MDE and the WSSC (for excavations and/or grading within the WSSC easement area) will be provided written notice at least 15 days prior to any planned excavation activities at the Site that will occur within areas of potentially VOC-containing soil . Written notice of planned excavation activities will include the proposed date(s) for the excavation, location of the excavation, health and safety protocols (as required), clean fill source (as required), and proposed characterization.

Continual evaluation of the groundwater monitoring data will be conducted to assess COC concentrations and determine when to terminate pumping within the Surficial Aquifer or both aquifer units. After a decision is made to cease operation of the hydraulic containment systems(s), two years of quarterly groundwater sample data will be collected from the monitoring network wells to determine attainment of the cleanup standards. The collection of quarterly groundwater samples will be conducted to assess any seasonal differences or fluctuations in COC concentrations in the aquifer. The approach to determine attainment of the groundwater cleanup criteria for the COCs listed in Section 6 will be generally similar to the sequential statistical test method described in the U.S. EPA guidance document *Methods for Evaluating the Attainment of Cleanup Standards, Volume 2: Ground Water* (July 1992). If the 2 years of groundwater sampling data do not indicate attainment of the COC cleanup criteria in one or more monitoring points, additional groundwater sampling will be completed in only those wells. After collecting the additional groundwater quality data, the sampling results will be analyzed using the same approach or another statistical method selected by EMERSUB 16 and acceptable to MDE.

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18 Acronyms

µg/l	Micrograms per liter
AOC	Area of Concern
ARMA	Air and Radiation Management Administration
bgs	Below ground surface
cfm	Cubic feet per minute
COC	Contaminants of concern
DCA	Dichloroethane
DCE	Dichloroethene
DPE	dual phase extraction
ESI	Environmental Simulations Incorporated
EZVI	Emulsified Zero Valent Iron
ft	Foot (feet)
ft msl	Feet mean sea level
ft/day	Feet per day
ft^2/day	Square feet per day
GAC	granular activated carbon
gpd	Gallons per day
gpm	Gallons per minute
HASP	Health and safety plan
HDPE	High density polyethylene
hp	Horsepower
K	Hydraulic conductivity
MDE	Maryland Department of the Environment
mg/kg	Milligrams per kilogram
mg/l	Milligrams per liter
mg/m^3	Milligrams per cubic meter
NPDES	National Pollutant Discharge Elimination System
OM&M	Operation, Maintenance and Monitoring
PLC	Process logic control
PPE	Personal protective equipment
PVC	Polyvinyl chloride
RAOs	Response action objectives
RAP	Response Action Plan
S	Storativity
SSRA	Site-specific risk assessment
SU	Standard units
SVE	soil vapor extraction
T	Transmissivity
TCA	Trichloroethane
TDH	Total dynamic head
UVB	Unterdruck-Verdampfer-Brunnen
V	Voltage
VCP	Voluntary Cleanup Program
VOCs	Volatile Organic Compounds

Figures

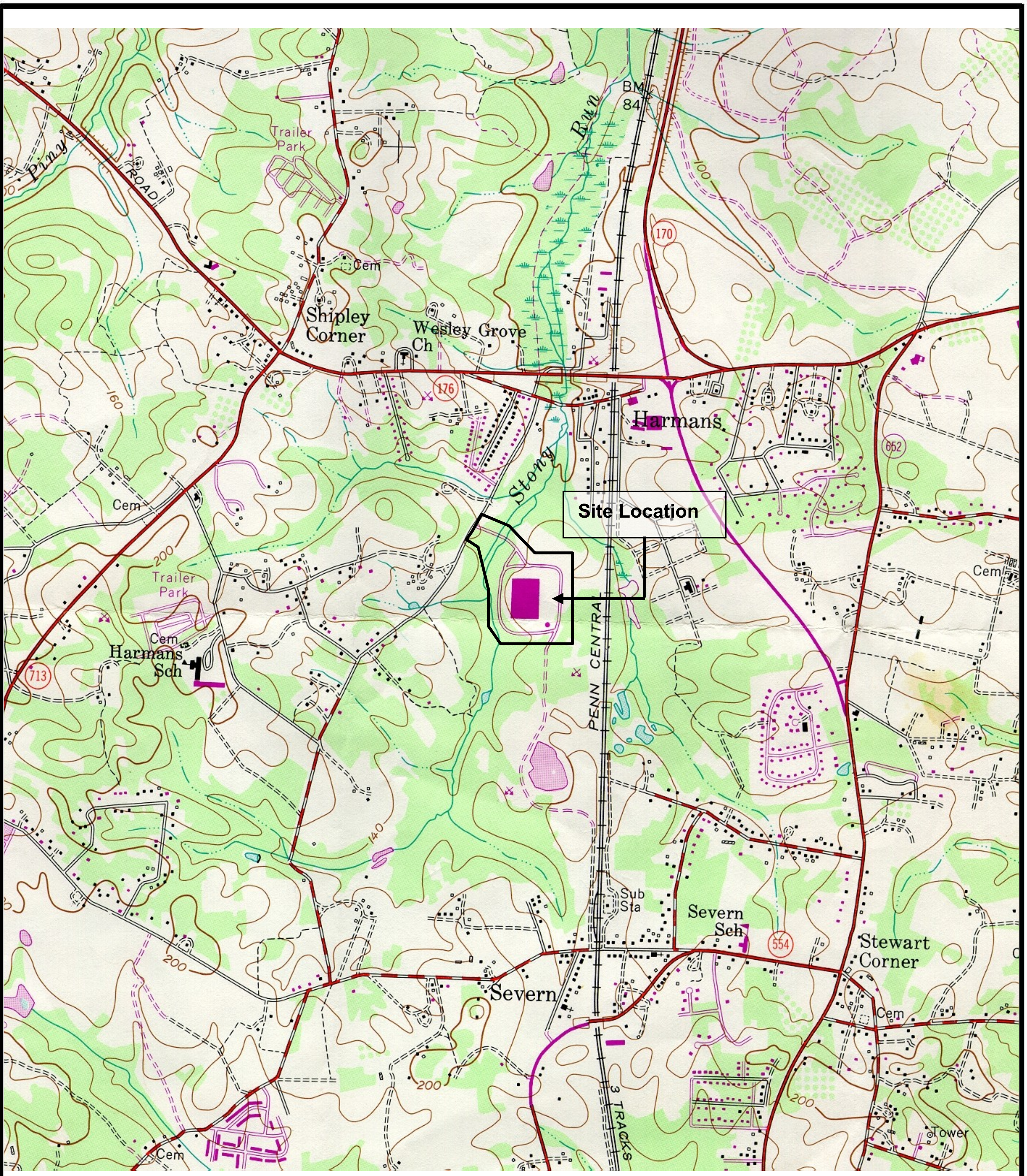
DWG Name:

Checked:

Approved:

Drawn By:

A



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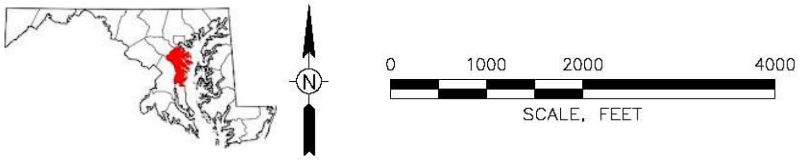

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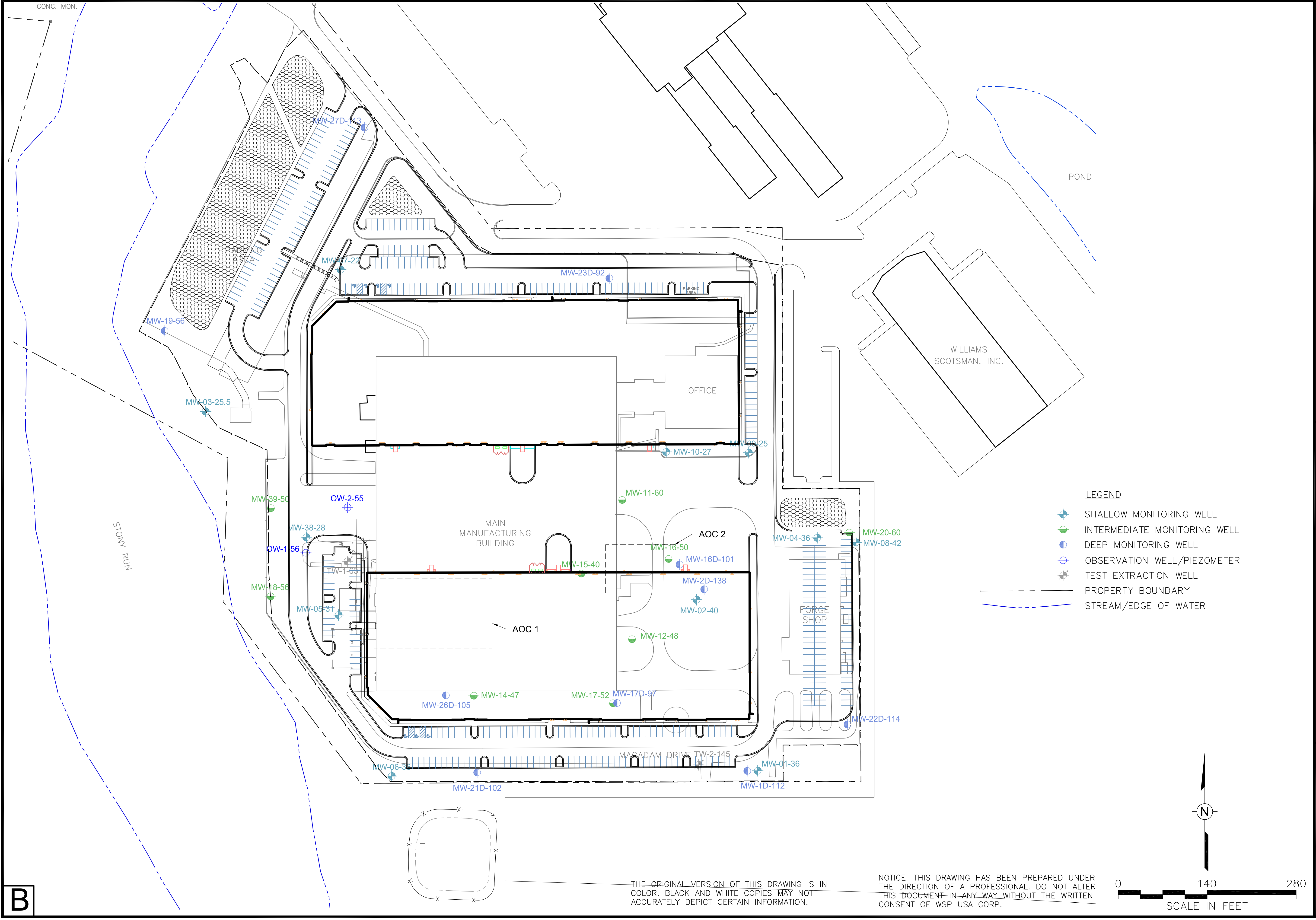
FIGURE 1

SITE LOCATION MAP

FORMER KOP-FLEX FACILITY
HANOVER, MARYLAND

PREPARED FOR

EMERSON
ST. LOUIS, MISSOURI



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Checked:
Approved: RG 4/15/2015
DWG Name: 00003705-222

FORMER KOP-FLEX FACILITY
HANOVER, MARYLAND
PREPARED FOR
EMERSON
ST. LOUIS, MISSOURI

Figure 2

CURRENT AND FUTURE SITE LAYOUT WITH EXISTING WELL LOCATIONS

WSP
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Reston, Virginia 20191
(703) 709-6500
www.wspgroup.com/usa

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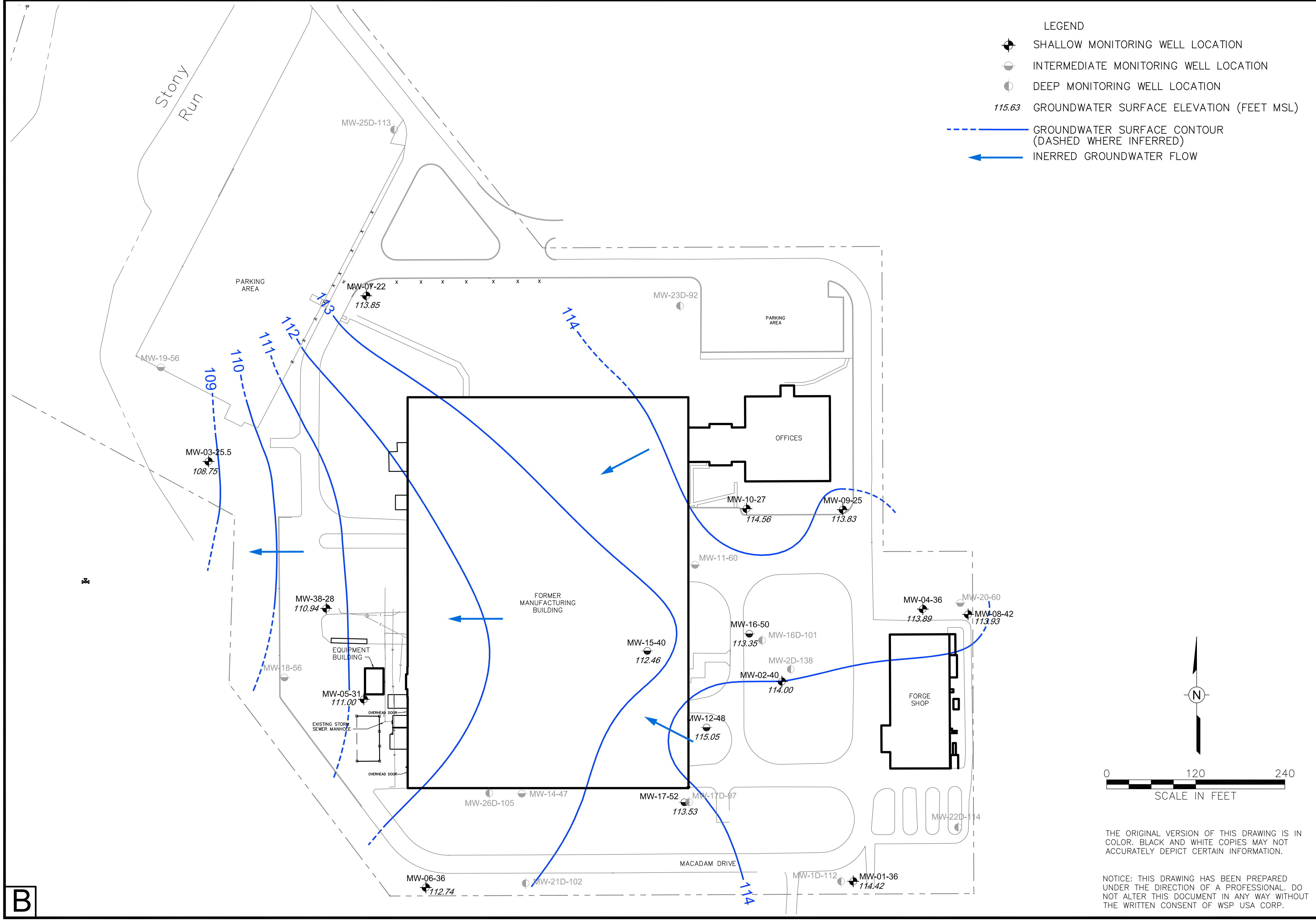

LEGEND

⌖	SHALLOW MONITORING WELL LOCATION
⊖	INTERMEDIATE MONITORING WELL LOCATION
◐	DEEP MONITORING WELL LOCATION
115.63	GROUNDWATER SURFACE ELEVATION (FEET MSL)
- - - —	GROUNDWATER SURFACE CONTOUR (DASHED WHERE INFERRED)
←	INERRED GROUNDWATER FLOW

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FORMER KOP-FLEX FACILITY
HANOVER, MARYLAND
PREPARED FOR
EMERSON
ST. LOUIS, MISSOURI

Figure 4

GROUNDWATER SURFACE CONTOUR MAP
SURFICIAL AQUIFER
DECEMBER 2014

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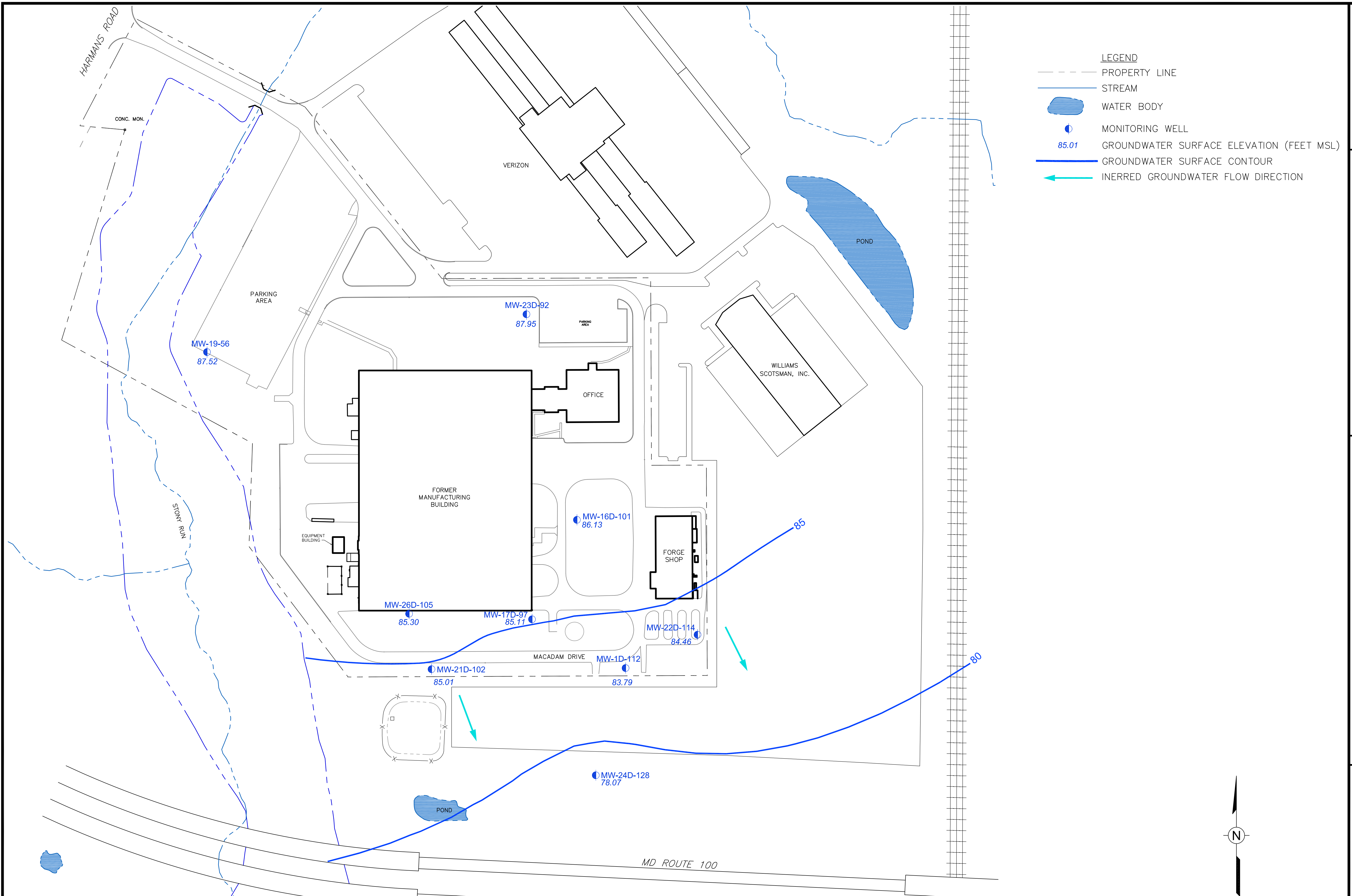

B

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Approved: 4/10/2015
DWG Name: 00003705-210

FORMER KOP-FLEX FACILITY
HANOVER, MARYLAND
PREPARED FOR
EMERSON
ST. LOUIS, MISSOURI

Figure 5

POTENTIOMETRIC CONTOUR SURFACE MAP
LOWER PATAPSCO AQUIFER
DECEMBER 2014

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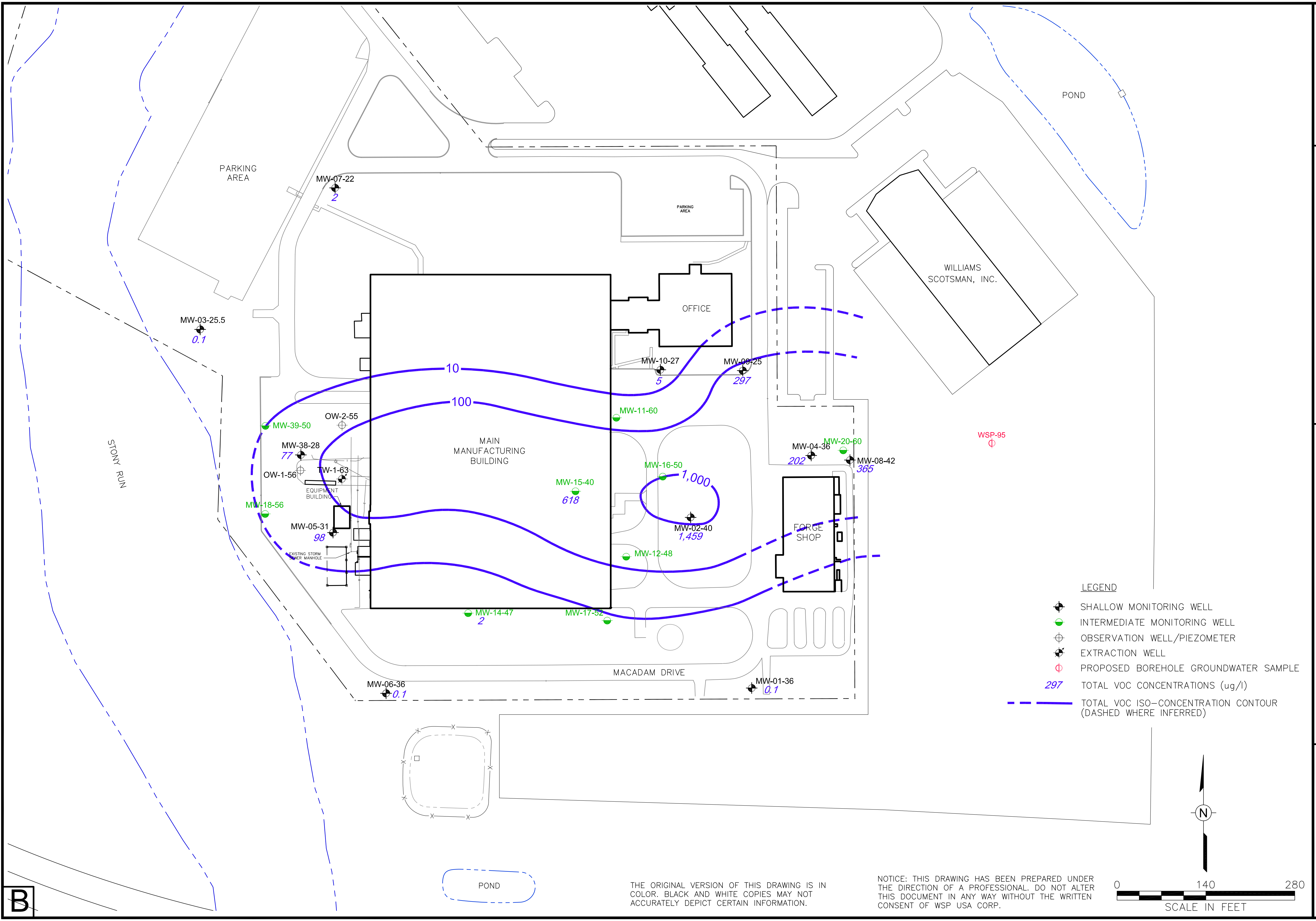

LEGEND

⊕	SHALLOW MONITORING WELL
⊖	INTERMEDIATE MONITORING WELL
⊕	OBSERVATION WELL/PIEZOMETER
⊕	EXTRACTION WELL
Φ	PROPOSED BOREHOLE GROUNDWATER SAMPLE
297	TOTAL VOC CONCENTRATIONS (ug/l)
– – —	TOTAL VOC ISO–CONCENTRATION CONTOUR (DASHED WHERE INFERRED)

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DWG Name: 00003705–225

FORMER KOP–FLEX FACILITY
HANOVER, MARYLAND
PREPARED FOR
EMERSON
ST. LOUIS, MISSOURI

Figure 8

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

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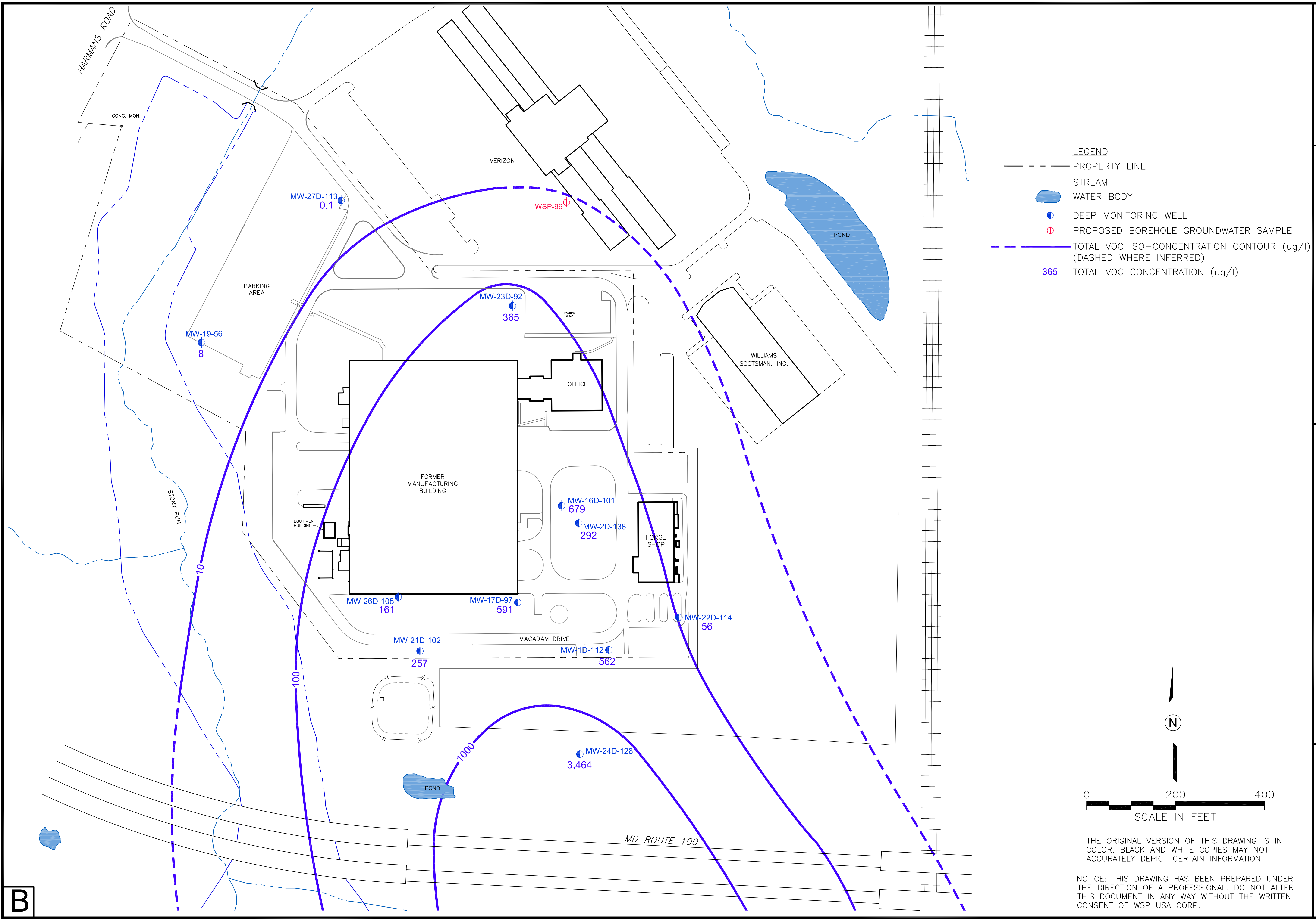

LEGEND
- PROPERTY LINE
- STREAM
- WATER BODY
- ◐ DEEP MONITORING WELL
- PROPOSED BOREHOLE GROUNDWATER SAMPLE
- TOTAL VOC ISO-CONCENTRATION CONTOUR (ug/l) (DASHED WHERE INFERRED)
- 365 TOTAL VOC CONCENTRATION (ug/l)

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Checked: MML
Approved: RLJ 4/23/2015
DWG Name: 00003705-231

FORMER KOP-FLEX FACILITY
HANOVER, MARYLAND
PREPARED FOR
EMERSON
ST. LOUIS, MISSOURI

Figure 10

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

WSP

WSP USA Corp.
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Reston, Virginia 20191
(703) 709-6500
www.wspgroup.com/usa

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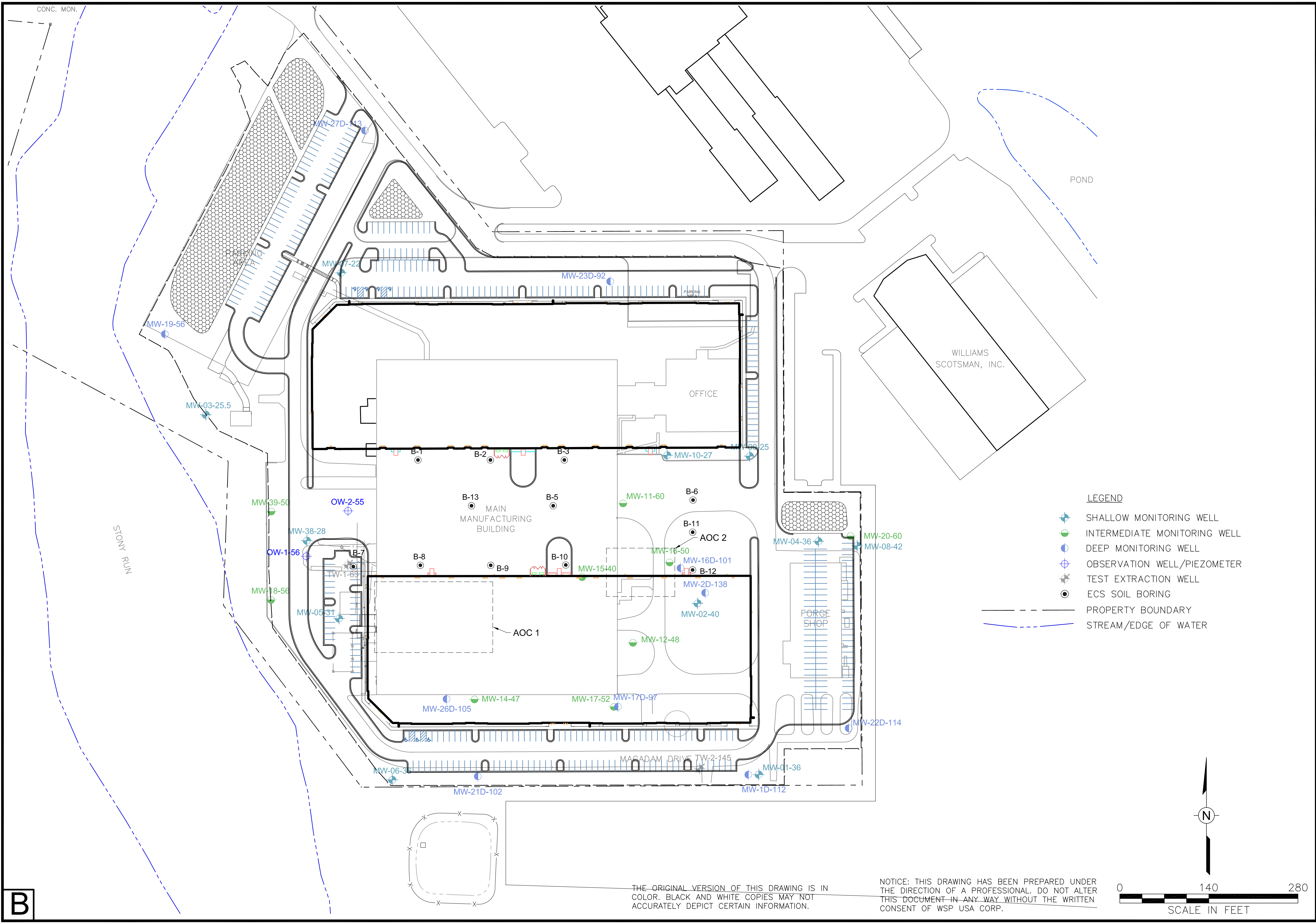

LEGEND

- ✦ SHALLOW MONITORING WELL
- ◒ INTERMEDIATE MONITORING WELL
- ◐ DEEP MONITORING WELL
- ⊕ OBSERVATION WELL/PIEZOMETER
- ✧ TEST EXTRACTION WELL
- ⊙ ECS SOIL BORING
- — — PROPERTY BOUNDARY
- — — STREAM/EDGE OF WATER

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DWG Name: 00003705-230

FORMER KOP-FLEX FACILITY
HANOVER, MARYLAND
PREPARED FOR
EMERSON
ST. LOUIS, MISSOURI

Figure 11

ECS SOIL BORING LOCATIONS IN THE FUTURE LOADING DOCK AREA (SEPTEMBER 2014)

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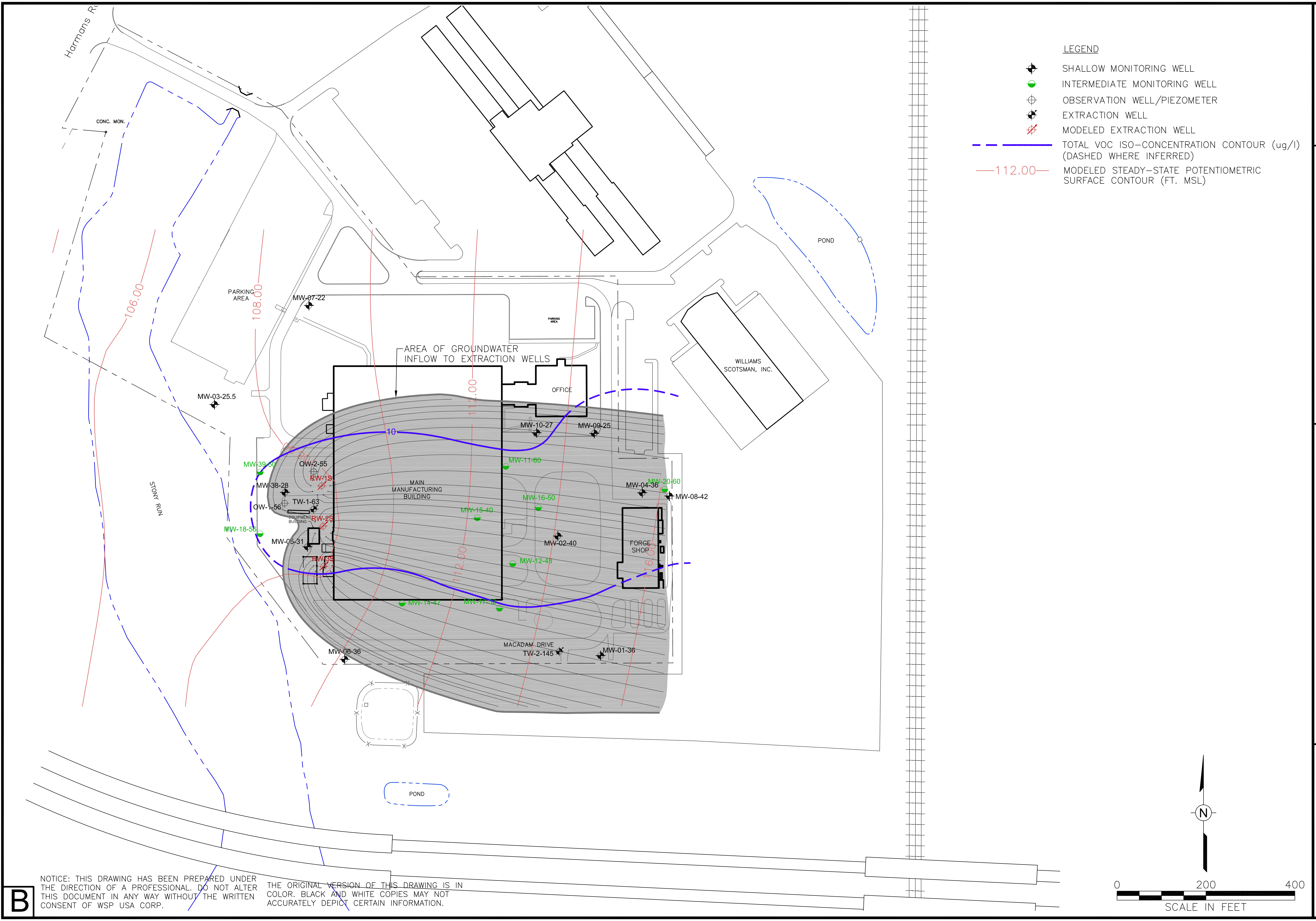

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DWG Name: 00003705-233

FORMER KOP-FLEX FACILITY
HANOVER, MARYLAND

PREPARED FOR
EMERSON
ST. LOUIS, MISSOURI

Figure 12

CURRENT SITE LAYOUT WITH SIMULATED
CAPTURE AREA FOR SURFICIAL AQUIFER
(INDIVIDUAL WELL DISCHARGE=3 GPM)

WSP

WSP USA Corp.
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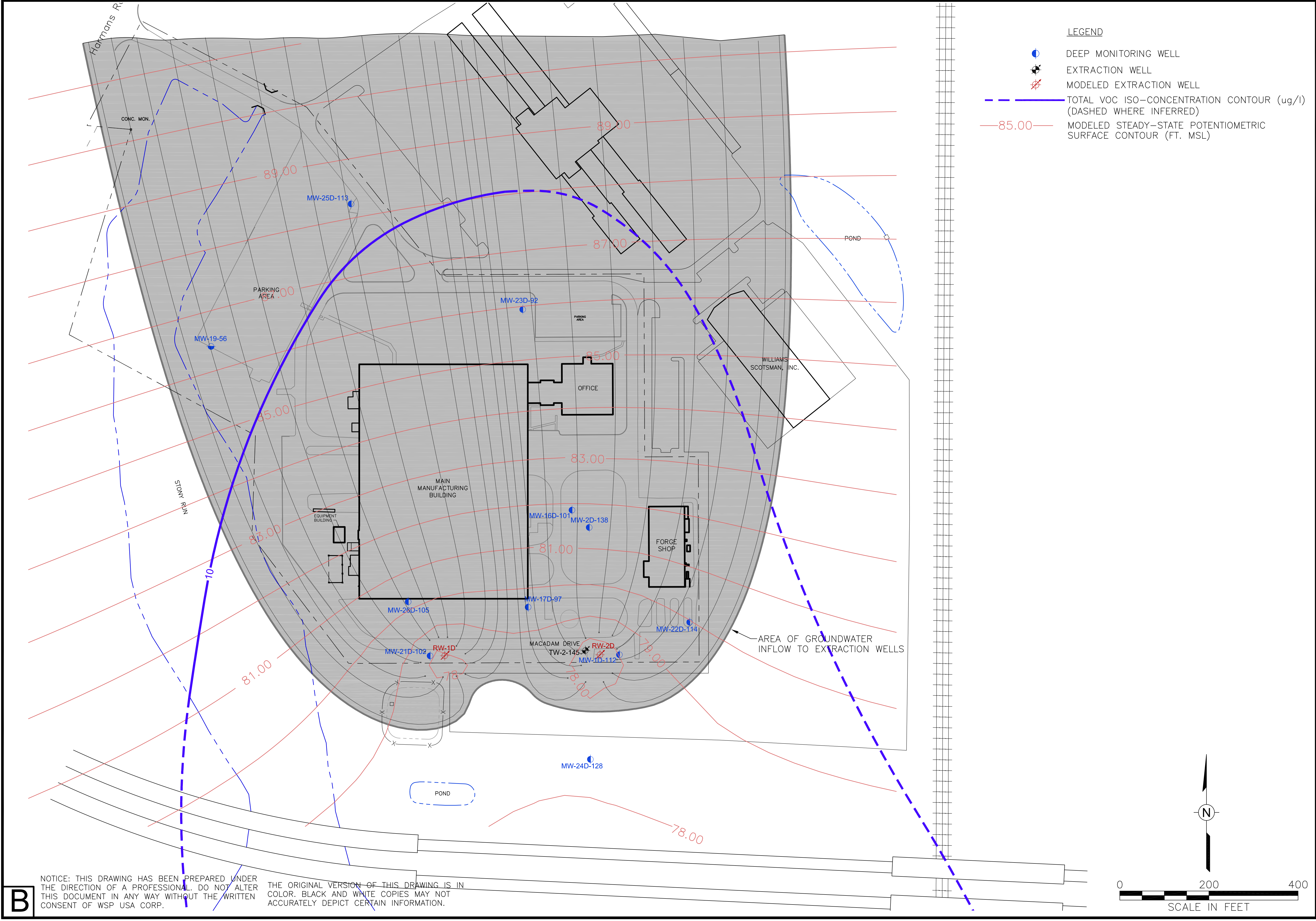

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Approved: RG 4/24/2015
DWG Name: 00003705–232

FORMER KOP–FLEX FACILITY
HANOVER, MARYLAND
PREPARED FOR
EMERSON
ST. LOUIS, MISSOURI

Figure 13

CURRENT SITE LAYOUT WITH SIMULATED CAPTURE AREA FOR THE LOWER PATAPSCO AQUIFER (INDIVIDUAL WELL DISCHARGE=35 GPM)

WSP USA Corp.
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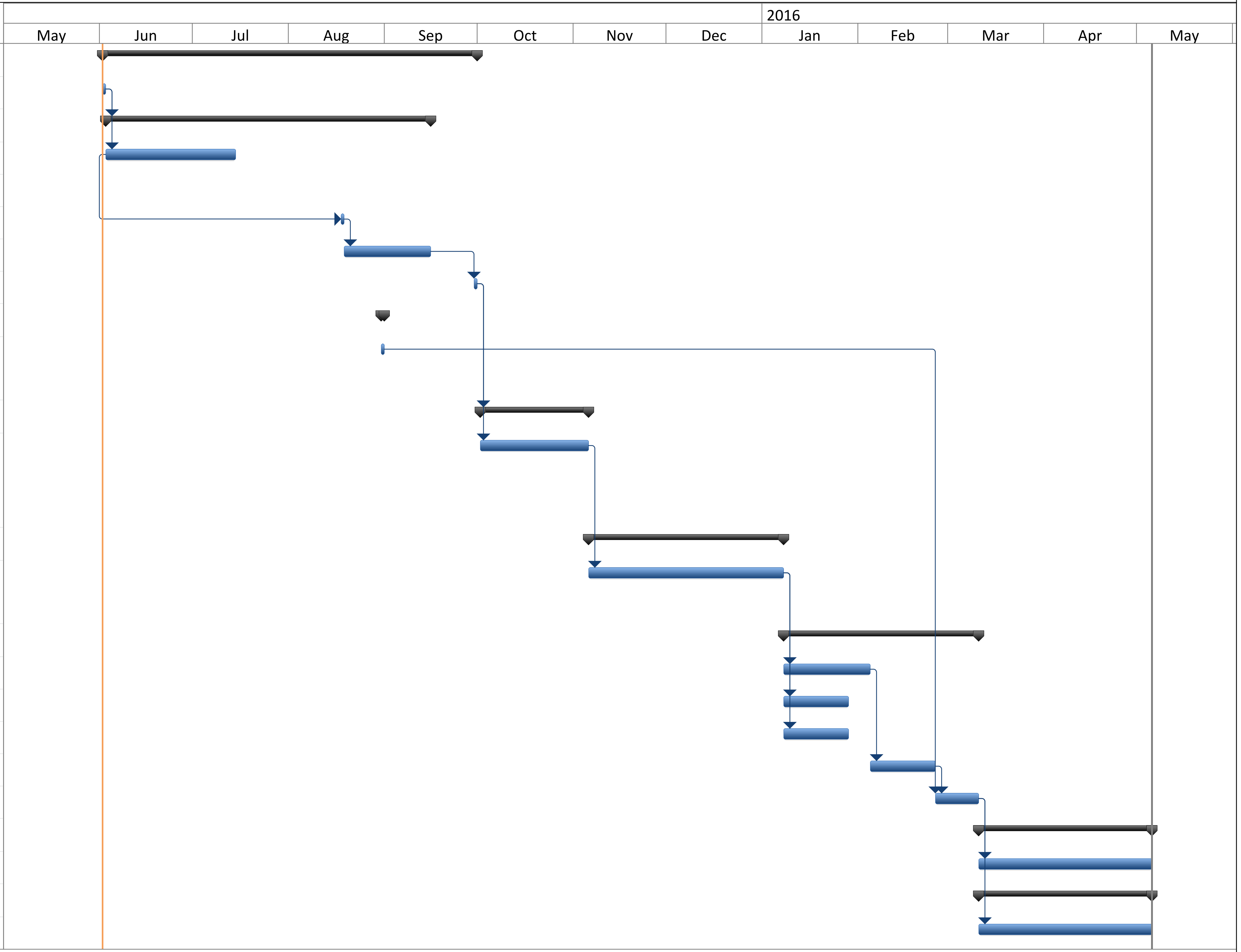
www.wspgroup.com/usa

Figure 14
Preliminary Project Implementation Schedule
Kop-Flex
Hanover, Maryland

ID	Task Name	Duration
1	**1. Response Work Plan (RAP)**	**87 days**
2	Submit Plan to MDE	1 day
3	**MDE Plan Review (75 Calendar Days)**	**75 days**
4	Public Notification and Comments	30 days
5	Public Meeting	1 day
6	MDE Plan Formal Review and Comments Letter	1 day
7	Response to MDE Comments and Revisions to RAP	20 days
8	MDE Approval	1 day
9	**2. Water Discharge and Withdrawal Permits**	**1 day**
10	MDE Issuance of NPDES Permit Renewal Application and Water Appropriation and Use Permit Application	1 day
11	**3. Groundwater Response Action Design**	**25 days**
12	Electrical Design, Process and Instrumentation Controls Design, Equipment Selection, and Equipment Building Selection	25 days
13	**4. Bid Solicitation & Contractor Procurement**	**45 days**
14	Earthwork, Well Installation, Electical, Control Panel, Equipment, and Equipment Building	45 days
15	**5. Installation & Startup**	**45 days**
16	Equipment and Equipment Building Fabrication	20 days
17	Well Installation	15 days
18	Earthwork	15 days
19	Equipment Delivery and Installation	15 days
20	Startup	10 days
21	**6. Construction Completion & Implementation Report**	**40 days**
22	Submit Report to MDE	40 days
23	**7. Operations & Maintenance Plan**	**40 days**
24	Submit Report to MDE	40 days



Note: Schedule is subject to change depending on MDE input and approval.

WSP USA Corp.
20150602_KopFlex RAP Project Schedule_DFT

Revised: Tue 6/2/15

Tables

Table 1

Summary of COCs Detected in Groundwater Samples (2009 - 2014)
On-Property Monitoring Wells
Former Kop-Flex Facility
Hanover, Maryland (a)

Monitoring Well		Acetone	Benzene	Bromoform	2-Butanone (MEK)	Chloroethane	Chloroform	Chloromethane	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,1-Dichloroethane	1,2-Dichloroethane	1,1-Dichloroethene	1,2-Dichloroethene	cis-1,2-Dichloroethene	1,4- Dioxane	Ethylbenzene	Isopropylbenzene	p-Isopropyltoluene
MW-01-36																			
	May-09	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	NA	ND	ND	NA
	Oct-09	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	NA	ND	ND	NA
	May-10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	NA	ND	ND	NA
	Oct-10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	NA	ND	ND	NA
	Jun-11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	NA	ND	ND	NA
	Dec-11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	ND	NA	ND	ND	NA
	Jun-12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	ND	NA	ND	ND	NA
	Dec-12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	ND	NA	ND	ND	NA
	Jul-13	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	ND	ND	ND	NA	ND
	Dec-13	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	ND	ND	ND	NA	ND
	Jun-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	ND	11.6	ND	NA	ND
	Dec-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	ND	ND	ND	NA	ND
MW-01D-112																			
	Jun-12	ND	ND	ND	ND	ND	ND	ND	ND	ND	63	ND	310	NR	ND	430	ND	ND	NA
	Dec-12	ND	ND	ND	ND	ND	ND	ND	ND	ND	77	6.4	380	NR	ND	422	ND	ND	NA
	Jul-13	ND	ND	ND	ND	ND	ND	ND	ND	ND	70.9	6.2	389	NR	ND	439.0	ND	NA	ND
	Dec-13 (g)	ND	ND	ND	ND	ND	ND	ND	ND	ND	45.2	4.40	288	NR	ND	290.0 (l)	ND	NA	ND
	Jun-14 (g)	ND	ND	ND	ND	ND	ND	ND	ND	ND	45.7	4.70	320	NR	ND	326.0 (c)	ND	NA	ND
	Dec-14 (n)	ND	ND	ND	ND	ND	ND	ND	ND	ND	34.0	4.00	209	NR	ND	279.0 (c)	ND	NA	ND
MW-02-40																			
	May-09	ND	ND	ND	ND	120	ND	ND	ND	ND	1,200	9	600	7	NR	NA	ND	ND	NA
	Oct-09	ND	ND	ND	17	240	ND	ND	ND	ND	2,900	12	1,200	12	NR	NA	ND	ND	NA
	May-10	ND	ND	ND	ND	ND	ND	ND	ND	ND	3,200	16	1,800	15	NR	NA	ND	ND	NA
	Oct-10	ND	ND	ND	ND	ND	ND	ND	ND	ND	3,400	15	2,000	13	NR	NA	ND	ND	NA
	Jun-11	ND	ND	ND	ND	280	ND	ND	ND	ND	3,300	ND	2,200	ND	NR	NA	ND	ND	NA
	Nov-11	ND	ND	ND	22	130	1	ND	ND	ND	1,600	15	1,800	NR	9	1140	ND	ND	NA
	Jun-12 (d)	ND	ND	ND	ND	ND	ND	ND	ND	ND	1,900	ND	1,900	NR	ND	983	ND	ND	NA
	Dec-12	ND	ND	ND	ND	62	ND	ND	ND	ND	880	10	820	NR	5.8	747	ND	ND	NA
	Jul-13	ND	ND	ND	7	47.6	ND	ND	ND	ND	755	10.3	890	NR	5.6	933.0	ND	NA	ND
	Dec-13 (h)	ND	ND	ND	ND	29	ND	ND	ND	ND	486.0	5.60	457	NR	ND	671.0 (i)	ND	NA	ND
	Jun-14 (h)	ND	ND	ND	ND	28.7	ND	ND	ND	ND	643.0	8.50	678	NR	ND	629.0 (c)	ND	NA	ND
	Dec-14 (h)	ND	ND	ND	ND	29	ND	ND	ND	ND	567	7	528	NR	ND	301 (c)	ND	NA	ND
MW-02D-138																			
	Jul-11	ND	ND	ND	ND	ND	ND	ND	ND	ND	16	2	120	ND	NR	NA	ND	ND	NA
	Nov-11	ND	ND	ND	ND	ND	ND	ND	ND	ND	17	2	130	NR	ND	116	ND	ND	NA
	Jun-12	ND	ND	ND	ND	ND	ND	ND	ND	ND	16	ND	130	NR	ND	118	ND	ND	NA
	Dec-12	ND	ND	ND	ND	ND	ND	ND	ND	ND	17	2.0	130	NR	ND	101	ND	ND	NA
	Jul-13	ND	ND	ND	ND	ND	ND	ND	ND	ND	18.5	2.1	170	NR	ND	130.0	ND	NA	ND
	Dec-13	ND	ND	ND	ND	ND	ND	ND	ND	ND	13.0	1.50	118	NR	ND	109.0 (h)	ND	NA	ND
	Jun-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	19.7	1.80	166	NR	ND	121.0 (n)	ND	NA	ND
	Dec-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	19.7	1.80	147	NR	ND	103.0 (n)	ND	NA	ND

Table 1

Summary of COCs Detected in Groundwater Samples (2009 - 2014)
On-Property Monitoring Wells
Former Kop-Flex Facility
Hanover, Maryland (a)

Monitoring Well		Acetone	Benzene	Bromoform	2-Butanone (MEK)	Chloroethane	Chloroform	Chloromethane	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,1-Dichloroethane	1,2-Dichloroethane	1,1-Dichloroethene	1,2-Dichloroethene	cis-1,2-Dichloroethene	1,4- Dioxane	Ethylbenzene	Isopropylbenzene	p-Isopropyltoluene
MW-03-25.5																			
	May-09	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	NA	ND	ND	NA
	Oct-09	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	NA	ND	ND	NA
	May-10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	NA	ND	ND	NA
	Oct-10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	NA	ND	ND	NA
	Jun-11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	NA	ND	ND	NA
	Nov-11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	ND	ND	ND	ND	NA
	Jun-12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	ND	ND	ND	ND	NA
	Dec-12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	ND	ND	ND	ND	NA
	Jul-13	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	ND	ND	ND	NA	ND
	Dec-13	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	ND	ND	ND	NA	ND
	Jun-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	ND	ND	ND	NA	ND
	Dec-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	ND	ND	ND	NA	ND
MW-04-36																			
	May-09	ND	ND	ND	ND	ND	ND	ND	ND	ND	130	ND	350	ND	NR	NA	ND	ND	NA
	Oct-09	ND	ND	ND	ND	ND	ND	ND	ND	ND	150	ND	410	3	NR	NA	ND	ND	NA
	May-10	ND	ND	ND	ND	ND	ND	ND	ND	ND	290	8	1,100	ND	NR	NA	ND	ND	NA
	Oct-10	ND	ND	ND	ND	ND	ND	ND	ND	ND	130	3	360	ND	NR	NA	ND	ND	NA
	Jun-11	ND	ND	ND	ND	ND	ND	ND	ND	ND	81	2	200	ND	NR	NA	ND	ND	NA
	Dec-11	ND	ND	ND	ND	ND	ND	ND	ND	ND	87	2	250	NR	ND	212	ND	ND	NA
	Jun-12	ND	ND	ND	ND	ND	ND	ND	ND	ND	68	ND	180	NR	ND	158	ND	ND	NA
	Dec-12	ND	ND	ND	ND	ND	ND	ND	ND	ND	100	2	210	NR	ND	188	ND	ND	NA
	Jul-13	ND	ND	ND	ND	ND	ND	ND	ND	ND	108	2.3	233	NR	ND	232.0	ND	ND	ND
	Dec-13	ND	ND	ND	ND	ND	ND	ND	ND	ND	67.0	1.40	188	NR	ND	178.0 (h)	ND	NA	ND
	Jun-14	ND	ND	ND	ND	ND	1.3	ND	ND	ND	198.0 (c)	7.20	908 (c)	NR	ND	456.0 (h)	ND	NA	ND
	Dec-14 (g)	ND	ND	ND	ND	ND	ND	ND	ND	ND	38.2	ND	128	NR	ND	23.7	ND	NA	ND
MW-05-31																			
	May-09	ND	ND	ND	ND	ND	ND	ND	ND	ND	9	ND	4	ND	NR	NA	ND	ND	NA
	Oct-09	ND	ND	ND	ND	ND	ND	ND	ND	ND	11	ND	5	ND	NR	NA	ND	ND	NA
	May-10	ND	ND	ND	ND	ND	ND	ND	ND	ND	12	ND	7	ND	NR	NA	ND	ND	NA
	Oct-10	ND	ND	ND	ND	ND	ND	ND	ND	ND	8	ND	4	ND	NR	NA	ND	ND	NA
	Jun-11	ND	ND	ND	ND	ND	ND	ND	ND	ND	7	ND	3	ND	NR	NA	ND	ND	NA
	Dec-11	ND	ND	ND	ND	ND	ND	ND	ND	ND	4.1	ND	ND	NR	ND	246	ND	ND	NA
	Jun-12	ND	ND	ND	ND	ND	ND	ND	ND	ND	7	ND	ND	NR	ND	211	ND	ND	NA
	Dec-12	ND	ND	ND	ND	ND	ND	ND	ND	ND	3.4	ND	ND	NR	ND	245	ND	ND	NA
	Jul-13	ND	ND	ND	ND	ND	ND	ND	ND	ND	3.3	ND	2.2	NR	ND	205.0	ND	NA	ND
	Dec-13	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.9	ND	1.5	NR	ND	137.0 (h)	ND	NA	ND
	Jun-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	3.0	ND	1.9	NR	ND	92.3	ND	NA	ND
	Dec-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.8	ND	1.7	NR	ND	91.2	ND	NA	ND

Table 1

Summary of COCs Detected in Groundwater Samples (2009 - 2014)
On-Property Monitoring Wells
Former Kop-Flex Facility
Hanover, Maryland (a)

Monitoring Well		Acetone	Benzene	Bromoform	2-Butanone (MEK)	Chloroethane	Chloroform	Chloromethane	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,1-Dichloroethane	1,2-Dichloroethane	1,1-Dichloroethene	1,2-Dichloroethene	cis-1,2-Dichloroethene	1,4- Dioxane	Ethylbenzene	Isopropylbenzene	p-Isopropyltoluene
MW-06-36																			
	May-09	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	NA	ND	ND	NA
	Oct-09	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	NA	ND	ND	NA
	May-10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	NA	ND	ND	NA
	Oct-10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	NA	ND	ND	NA
	Jun-11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	NA	ND	ND	NA
	Dec-11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	ND	ND	ND	ND	NA
	Jun-12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	ND	ND	ND	ND	NA
	Dec-12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	ND	ND	ND	ND	NA
	Jul-13	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	ND	ND	ND	NA	ND
	Dec-13	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	ND	ND	ND	NA	ND
	Jun-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	ND	ND	ND	NA	ND
	Dec-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	ND	ND	ND	NA	ND
MW-07-22																			
	May-09	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	NA	ND	ND	NA
	Oct-09	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	NA	ND	ND	NA
	May-10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	NA	ND	ND	NA
	Oct-10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	NA	ND	ND	NA
	Jun-11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	NA	ND	ND	NA
	Dec-11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	ND	ND	ND	ND	NA
	Jun-12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	ND	ND	ND	ND	NA
	Dec-12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	ND	ND	ND	ND	NA
	Jul-13	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	ND	ND	ND	NA	ND
	Dec-13	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	ND	2.4	ND	NA	ND
	Jun-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	ND	ND	ND	NA	ND
	Dec-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	ND	2.2	ND	NA	ND
MW-08-42																			
	May-09	ND	ND	ND	ND	ND	ND	ND	ND	ND	210	5	250	1	NR	NA	ND	ND	NA
	Oct-09	ND	ND	ND	ND	ND	ND	ND	ND	ND	260	5	310	1	NR	NA	ND	ND	NA
	May-10	ND	ND	ND	ND	ND	ND	ND	ND	ND	249	5	240	1	NR	NA	ND	ND	NA
	Oct-10	ND	ND	ND	ND	ND	ND	ND	ND	ND	170	3	200	ND	NR	NA	ND	ND	NA
	Jun-11	ND	ND	ND	ND	ND	3	ND	ND	ND	300	6	350	1	NR	NA	ND	ND	NA
	Dec-11	ND	ND	ND	ND	ND	2	ND	ND	ND	140	3	190	NR	ND	361	ND	ND	NA
	Jun-12 (g)	ND	ND	ND	ND	ND	ND	ND	ND	ND	140	ND	150	NR	ND	445	ND	ND	NA
	Dec-12	ND	ND	ND	ND	ND	ND	ND	ND	ND	180	4.1	210	NR	ND	418	ND	ND	NA
	Jul-13	ND	ND	ND	ND	ND	1.1	ND	ND	ND	164	4.4	208	NR	1.2	456.0	ND	ND	ND
	Dec-13	ND	ND	ND	ND	ND	1.2	ND	ND	ND	78.2	2.00	129	NR	ND	254.0 (h)	ND	NA	ND
	Jun-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	89.9	1.90	142	NR	ND	219.0 (h)	ND	NA	ND
	Dec-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	59.4	1.60	111	NR	ND	190.0	ND	NA	ND
MW-09-25																			
	May-09	ND	ND	ND	ND	ND	1	ND	ND	ND	17	2	250	ND	NR	NA	ND	ND	NA
	Oct-09	ND	ND	ND	ND	ND	1	ND	ND	ND	18	ND	300	ND	NR	NA	ND	ND	NA
	May-10	ND	ND	ND	ND	ND	ND	ND	ND	ND	16	2	240	ND	NR	NA	ND	ND	NA
	Jun-11	ND	ND	ND	ND	ND	ND	ND	ND	ND	16	2	290	ND	NR	NA	ND	ND	NA
	Nov-11	ND	ND	ND	ND	ND	ND	ND	ND	ND	14	1	220	NR	ND	86	ND	ND	NA
	Jun-12	ND	ND	ND	ND	ND	ND	ND	ND	ND	8	ND	160	NR	ND	71.3	ND	ND	NA
	Dec-12	ND	ND	ND	ND	ND	ND	ND	ND	ND	12	1.2	150	NR	ND	69.2	ND	ND	NA
	Jul-13	ND	ND	ND	ND	ND	ND	ND	ND	ND	10.9	1.2	170	NR	ND	69.5	ND	NA	ND
	Dec-13	ND	ND	ND	ND	ND	ND	ND	ND	ND	10.5	1.30	181	NR	ND	97.7 (h)	ND	NA	ND
	Jun-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	8.5	1.20	193	NR	ND	53.9 (h)	ND	NA	ND
	Dec-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	11.1	1.40	179	NR	ND	96.1	ND	NA	ND

Table 1

Summary of COCs Detected in Groundwater Samples (2009 - 2014)
On-Property Monitoring Wells
Former Kop-Flex Facility
Hanover, Maryland (a)

Monitoring Well		Acetone	Benzene	Bromoform	2-Butanone (MEK)	Chloroethane	Chloroform	Chloromethane	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,1-Dichloroethane	1,2-Dichloroethane	1,1-Dichloroethene	1,2-Dichloroethene	cis-1,2-Dichloroethene	1,4- Dioxane	Ethylbenzene	Isopropylbenzene	p-Isopropyltoluene
MW-10-27																			
	May-09	ND	ND	ND	ND	ND	6	ND	ND	ND	ND	ND	4	ND	NR	NA	ND	ND	NA
	Oct-09	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	3	ND	NR	NA	ND	ND	NA
	May-10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	4	ND	NR	NA	ND	ND	NA
	Oct-10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	3	ND	NR	NA	ND	ND	NA
	Jun-11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	4	ND	NR	NA	ND	ND	NA
	Nov-11	ND	ND	ND	ND	ND	4	ND	ND	ND	ND	ND	4	NR	ND	ND	ND	ND	NA
	Jun-12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	ND	3.3	ND	ND	NA
	Dec-12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.4	NR	ND	ND	ND	ND	NA
	Jul-13	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.9	NR	ND	ND	ND	NA	ND
	Dec-13	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.9	NR	ND	3.4	ND	NA	ND
	Jun-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.3	NR	ND	13.1	ND	NA	ND
	Dec-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.1	NR	ND	2.4	ND	NA	ND
MW-11-60																			
	May-09	ND	ND	ND	ND	ND	ND	ND	ND	ND	67	9	740	2	NR	NA	ND	ND	NA
	Oct-09	ND	ND	ND	ND	38	2	ND	ND	ND	620	16	2,100	8	NR	NA	ND	ND	NA
	May-10	ND	ND	ND	ND	ND	ND	ND	ND	ND	130	10	750	3	NR	NA	ND	ND	NA
	Oct-10	ND	ND	ND	ND	ND	ND	ND	ND	ND	110	9	540	2	NR	NA	ND	ND	NA
	Jun-11	ND	ND	ND	ND	ND	ND	ND	ND	ND	94	8	720	2	NR	NA	ND	ND	NA
	Dec-11	ND	ND	ND	ND	ND	ND	ND	ND	ND	60	7	430	NR	ND	575	ND	ND	NA
	Jun-12 (h)	ND	ND	ND	ND	ND	ND	ND	ND	ND	130	ND	730	NR	ND	487	ND	ND	NA
	Dec-12	ND	ND	ND	ND	40	1.9	ND	ND	ND	1,000	20	1,800	NR	12	1,160	ND	ND	NA
	Jul-13	ND	ND	ND	ND	11.6	1.4	ND	ND	ND	403	13	1,360	NR	7.2	787.0	ND	NA	ND
	Dec-13 (c)	ND	ND	ND	ND	38.1	ND	ND	ND	ND	742.0	12.80	1,520	NR	10.5	1,000.0	ND	NA	ND
	Jun-14 (m)	ND	ND	ND	ND	ND	ND	ND	ND	ND	75.2	4.90	442	NR	ND	372.0 (c)	ND	NA	ND
	Dec-14 (c)	ND	ND	ND	ND	ND	ND	ND	ND	ND	190.0	ND	695	NR	ND	397.0 (c)	ND	NA	ND
MW-12-48																			
	May-09	ND	ND	ND	ND	7	2	ND	ND	ND	840	29	2,200	22	NR	NA	ND	ND	NA
	Oct-09	ND	ND	ND	ND	5	1	ND	ND	ND	680	21	1,900	16	NR	NA	ND	ND	NA
	May-10	ND	ND	ND	ND	ND	ND	ND	ND	ND	1,100	20	2,300	25	NR	NA	ND	ND	NA
	Oct-10	ND	ND	ND	ND	ND	ND	ND	ND	ND	610	26	2,200	19	NR	NA	ND	ND	NA
	Jun-11	ND	ND	ND	ND	11	2	ND	ND	ND	750	34	2,800	24	NR	NA	ND	ND	NA
	Nov-11	ND	ND	ND	ND	6	3	ND	ND	ND	440	39	2,400	NR	22	1,550	ND	ND	NA
	Jun-12 (c)	ND	ND	ND	ND	ND	ND	ND	ND	ND	430	ND	1,700	NR	ND	1,130	ND	ND	NA
	Dec-12	ND	ND	ND	ND	30	2.0	ND	ND	ND	460	31	1,600	NR	19	1,240	ND	ND	NA
	Jul-13	ND	ND	ND	ND	152	2.1	ND	ND	ND	869	39.2	2,840	NR	35.2	1,530.0	ND	NA	ND
	Dec-13 (l)	ND	ND	ND	ND	52	ND	ND	ND	ND	439.0	26.20	1,530	NR	ND	1,720.0 (i)	ND	NA	ND
	Jun-14 (c)	ND	ND	ND	ND	83.6	ND	ND	ND	ND	1,210.0	43.50	3,510	NR	33.2	182.0 (n)	ND	NA	ND
	Dec-14 (i)	ND	ND	ND	ND	145.0	ND	ND	ND	ND	1,370.0	37.50	3,350	NR	34.8	1,270.0 (n)	ND	NA	ND
MW-14-47																			
	May-09	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	NA	ND	ND	NA
	Oct-09	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	3	ND	NR	NA	ND	ND	NA
	May-10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	5	ND	NR	NA	ND	ND	NA
	Oct-10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	3	ND	NR	NA	ND	ND	NA
	Jun-11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	5	ND	NR	NA	ND	ND	NA
	Nov-11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	5.8	NR	ND	6.9	ND	ND	NA
	Jun-12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	5	NR	ND	7.4	ND	ND	NA
	Dec-12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	ND	3.6	ND	ND	NA
	Jul-13	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.6	NR	ND	3.0	ND	NA	ND
	Dec-13	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	ND	ND	ND	NA	ND
	Jun-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.2	NR	ND	3.3	ND	NA	ND
	Dec-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	ND	2.2	ND	NA	ND

Table 1

Summary of COCs Detected in Groundwater Samples (2009 - 2014)
On-Property Monitoring Wells
Former Kop-Flex Facility
Hanover, Maryland (a)

Monitoring Well		Acetone	Benzene	Bromoform	2-Butanone (MEK)	Chloroethane	Chloroform	Chloromethane	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,1-Dichloroethane	1,2-Dichloroethane	1,1-Dichloroethene	1,2-Dichloroethene	cis-1,2-Dichloroethene	1,4- Dioxane	Ethylbenzene	Isopropylbenzene	p-Isopropyltoluene
MW-15-40																			
	Sep-10	ND	ND	ND	ND	4	1	ND	ND	ND	370	16	1,300	9	NR	NA	ND	ND	NA
	Oct-10	ND	ND	ND	ND	ND	ND	ND	ND	ND	180	9	670	5	NR	NA	ND	ND	NA
	Jun-11	ND	ND	ND	ND	8	ND	ND	ND	ND	210	3	300	2	NR	NA	ND	ND	NA
	Dec-11	ND	ND	ND	ND	4	ND	ND	ND	ND	190	7	530	NR	3	345	ND	ND	NA
	Jun-12 (h)	ND	ND	ND	ND	ND	ND	ND	ND	ND	200	ND	500	NR	ND	575	ND	ND	NA
	Dec-12	ND	ND	ND	ND	11	ND	ND	ND	ND	320	5.2	540	NR	4.2	272	ND	ND	NA
	Jul-13	ND	ND	ND	ND	ND	ND	ND	ND	ND	153	ND	465	NR	5.5	2,530.0	ND	NA	ND
	Dec-13 (g)	ND	ND	ND	ND	3	ND	ND	ND	ND	181.0	3.00	289	NR	2.8	228.0 (h)	ND	NA	ND
	Jun-14 (n)	ND	ND	ND	ND	ND	ND	ND	ND	ND	57.0	4.40	433 (c)	NR	5.8	92.8 (g)	ND	NA	ND
	Dec-14 (m)	ND	ND	ND	ND	ND	ND	ND	ND	ND	71.0	ND	318	NR	ND	208.0 (n)	ND	NA	ND
MW-16-50																			
	Sep-10	ND	ND	ND	23	480	13	6	3	ND	8,300	57	16,000	67	NR	NA	22	10	NA
	Oct-10	ND	ND	ND				ND	ND	ND	4,900	42	12,000	52	NR	NA	ND	ND	NA
	Jun-11	ND	ND	ND	ND	660	ND	ND	ND	ND	3,400	ND	19,000	ND	NR	NA	ND	ND	NA
	Dec-11	ND	ND	ND	23	560	7	ND	1.7	ND	8,200	53	18,000	NR	59	1,930	12	4.6	NA
	Jun-12 (f)	ND	ND	ND	ND	ND	ND	ND	ND	ND	4,300	ND	11,000	NR	ND	2,050	ND	ND	NA
	Dec-12	ND	ND	ND	18	460	5.8	ND	1.3	1.1	14,000	52	14,000	NR	56	1,740	7.6	3.3	NA
	Jul-13	46.5	ND	1.8	ND	1,290	7.2	2.7	1.4	ND	3,600	61.3	17,900	NR	59.1	2,260.0	9.9	NA	ND
	Dec-13 (k)	ND	ND	ND	ND	266	ND	ND	ND	ND	2,050.0	ND	19,400	NR	ND	2,840.0 (d)	ND	NA	ND
	Jun-14 (k)	ND	ND	ND	ND	278	ND	ND	ND	ND	3,850.0	ND	16,400	NR	ND	1,570.0 (i)	ND	NA	ND
	Dec-14	ND	ND	ND	17	ND	2.2	ND	ND	ND	5,910.0 (p)	18.90	4,670 (p)	NR	32.6	451.0 (h)	4	NA	2
MW-16D-101																			
	Jan-11	ND	ND	ND	ND	3	4	ND	ND	ND	110	4	330	ND	NR	NA	ND	ND	NA
	Jun-11	ND	ND	ND	ND	ND	ND	ND	ND	ND	100	4	400	ND	NR	NA	ND	ND	NA
	Dec-11	ND	2	ND	ND	ND	ND	ND	ND	ND	72	4	240	NR	ND	267	ND	ND	NA
	Jun-12	ND	ND	ND	ND	ND	ND	ND	ND	ND	49	ND	150	NR	ND	215	ND	ND	NA
	Dec-12	ND	1.3	ND	ND	ND	ND	ND	ND	ND	55	3	130	NR	ND	189	ND	ND	NA
	Jul-13	ND	ND	ND	ND	ND	ND	ND	ND	ND	54.3	3	193	NR	ND	246.0	ND	NA	ND
	Dec-13	ND	ND	ND	ND	ND	ND	ND	ND	ND	43.2	2.20	155	NR	ND	218.0 (h)	ND	NA	ND
	Jun-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	57.6	3.50	191	NR	ND	232.0 (h)	ND	NA	ND
	Dec-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	90.0	4.10 (n)	288	NR	ND	251.0 (h)	ND	NA	ND
MW-17-52																			
	Sep-10	ND	ND	ND	ND	ND	ND	ND	ND	ND	10	ND	7	ND	NR	NA	ND	ND	NA
	Oct-10	ND	ND	ND	ND	ND	ND	ND	ND	ND	3	ND	5	ND	NR	NA	ND	ND	NA
	Jun-11	ND	ND	ND	ND	ND	ND	ND	ND	ND	2	ND	2	ND	NR	NA	ND	ND	NA
	Nov-11	ND	ND	ND	ND	1	ND	ND	ND	ND	46	ND	41	NR	ND	22	ND	ND	NA
	Jun-12 (c)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	ND	10.2	ND	ND	NA
	Dec-12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	ND	4.4	ND	ND	NA
	Jul-13	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.6	NR	ND	4.3	ND	NA	ND
	Dec-13	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	ND	ND	ND	NA	ND
	Jun-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.4	NR	ND	34.3	ND	NA	ND
	Dec-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	ND	2.5	ND	NA	ND
MW-17D-97																			
	Sep-10	ND	ND	ND	ND	4	1	ND	ND	ND	150	12	940	7	NR	NA	ND	ND	NA
	Oct-10	ND	ND	ND	ND	ND	ND	ND	ND	ND	190	13	1,300	9	NR	NA	ND	ND	NA
	Jun-11	ND	ND	ND	ND	ND	ND	ND	ND	ND	290	ND	2,100	ND	NR	NA	ND	ND	NA
	Nov-11	ND	ND	ND	ND	15	1	ND	ND	ND	270	14	1,900	NR	14	575	ND	ND	NA
	Jun-12 (c)	ND	ND	ND	ND	ND	ND	ND	ND	ND	290	ND	1,000	NR	ND	618	ND	ND	NA
	Dec-12	ND	ND	ND	ND	41	1.3	ND	ND	ND	470	17	1,800	NR	19	669	ND	ND	NA
	Jul-13	ND	ND	ND	ND	68.4	1.3	ND	ND	ND	496	17	2,310	NR	22.3	612.0	ND	NA	ND
	Dec-13 (m)	ND	ND	ND	ND	37	ND	ND	ND	ND	326.0	13.60	2,100	NR	16.8	592.0 (l)	ND	NA	ND
	Jun-14 (c)	ND	ND	ND	ND	ND	ND	ND	ND	ND	143.0	10.20	1,260	NR	ND	435.0	ND	NA	ND
	Dec-14	ND	ND	ND	ND	2	ND	ND	ND	ND	66.2	4.60	484	NR	3.8	23.3	ND	NA	ND

Table 1

Summary of COCs Detected in Groundwater Samples (2009 - 2014)
On-Property Monitoring Wells
Former Kop-Flex Facility
Hanover, Maryland (a)

Monitoring Well		Acetone	Benzene	Bromoform	2-Butanone (MEK)	Chloroethane	Chloroform	Chloromethane	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,1-Dichloroethane	1,2-Dichloroethane	1,1-Dichloroethene	1,2-Dichloroethene	cis-1,2-Dichloroethene	1,4- Dioxane	Ethylbenzene	Isopropylbenzene	p-Isopropyltoluene
MW-18-56																			
	Dec-11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	ND	13.6	ND	ND	NA
	Jun-12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	ND	ND	ND	ND	NA
	Dec-12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	ND	ND	ND	ND	NA
	Jul-13	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	ND	ND	ND	NA	ND
	Dec-13	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	ND	ND	ND	NA	ND
	Jun-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	ND	4.6	ND	NA	ND
	Dec-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	ND	ND	ND	NA	ND
MW-19-56																			
	Dec-11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	8	NR	ND	5.9	ND	ND	NA
	Jun-12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	ND	4.0	ND	ND	NA
	Dec-12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	ND	3.6	ND	ND	NA
	Jul-13	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	6	NR	ND	5.5	ND	NA	ND
	Dec-13	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	3.5	NR	ND	4.1	ND	NA	ND
	Jun-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	3.7	NR	ND	6.3	ND	NA	ND
	Dec-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	4.0	NR	ND	4.2	ND	NA	ND
MW-20-60																			
	Dec-11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	ND	11.9	ND	ND	NA
	Jun-12	ND	ND	ND	ND	ND	ND	ND	ND	ND	8.5	ND	51	NR	ND	272	ND	ND	NA
	Dec-12	ND	ND	ND	ND	ND	ND	ND	ND	ND	30	3.1	120	NR	ND	506	ND	ND	NA
	Jul-13	ND	ND	ND	ND	ND	ND	ND	ND	ND	83.8	6.2	255	NR	1.5	845.0	ND	NA	ND
	Dec-13 (g)	ND	ND	ND	ND	ND	ND	ND	ND	ND	121.0	7.00	333	NR	ND	1,230.0 (i)	ND	NA	ND
	Jun-14 (g)	ND	ND	ND	ND	ND	ND	ND	ND	ND	173.0	8.80	359	NR	2.1	1,010.0 (i)	ND	NA	ND
	Dec-14 (m)	ND	ND	ND	ND	ND	ND	ND	ND	ND	166.0	9.30	302	NR	ND	660.0 (i)	ND	NA	ND
MW-21D-102																			
	Jun-12	ND	ND	ND	ND	ND	ND	ND	ND	ND	12	ND	90	NR	ND	84.2	ND	ND	NA
	Dec-12	ND	ND	ND	ND	ND	ND	ND	ND	ND	14	ND	90	NR	ND	81.8	ND	ND	NA
	Jul-13	ND	ND	ND	ND	ND	ND	ND	ND	ND	11.9	ND	102	NR	ND	80.1	ND	NA	ND
	Dec-13	ND	ND	ND	ND	ND	ND	ND	ND	ND	10.1	ND	82.4	NR	ND	70.0	ND	NA	ND
	Jun-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	8.3	ND	76.5	NR	ND	77.0 (g)	ND	NA	ND
	Dec-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	10.4	ND	105.0	NR	ND	138.0	ND	NA	ND
MW-22D-114																			
	Jun-12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	27	NR	ND	29	ND	ND	NA
	Dec-12	ND	ND	ND	ND	ND	ND	ND	ND	ND	4.5	ND	38	NR	ND	41	ND	ND	NA
	Jul-13	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.7	ND	34.2	NR	ND	31.8	ND	NA	ND
	Dec-13	ND	ND	ND	ND	ND	ND	ND	ND	ND	3.7	ND	43.5	NR	ND	35.3 (g)	ND	NA	ND
	Jun-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	3.5	ND	44.2	NR	ND	39.3	ND	NA	ND
	Dec-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.0	ND	27.0	NR	ND	22.8	ND	NA	ND
MW-23D-92																			
	Jun-12	ND	ND	ND	ND	ND	ND	ND	ND	ND	29	ND	120	NR	ND	149	ND	ND	NA
	Aug-12	ND	ND	ND	ND	ND	ND	ND	ND	ND	39	2.2	130	NR	ND	NA	ND	ND	NA
	Dec-12	ND	ND	ND	ND	ND	ND	ND	ND	ND	32	2.0	110	NR	ND	130	ND	ND	NA
	Jul-13	ND	ND	ND	ND	ND	ND	1.5	ND	ND	32.7	2.3	131	NR	ND	186.0	ND	NA	ND
	Dec-13	ND	ND	ND	ND	ND	ND	ND	ND	ND	25.6	1.7	101	NR	ND	165.0 (h)	ND	ND	ND
	Jun-14	ND	1.2	ND	ND	ND	ND	ND	ND	ND	29.1	2.3	101	NR	ND	132.0 (g)	ND	NA	ND
	Dec-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	28.3	1.90	157.0	NR	ND	151.0	ND	NA	ND
MW-27D-113																			
	Sep-13	ND	ND	ND	ND	ND	2.1	ND	ND	ND	ND	0.17 J	ND	NR	ND	0.9 J	ND	NA	ND
	Dec-13	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	ND	ND	ND	NA	ND
	Jun-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	ND	ND	ND	NA	ND
	Dec-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	ND	ND	ND	NA	ND

Table 1

Summary of COCs Detected in Groundwater Samples (2009 - 2014)
On-Property Monitoring Wells
Former Kop-Flex Facility
Hanover, Maryland (a)

Monitoring Well		Acetone	Benzene	Bromoform	2-Butanone (MEK)	Chloroethane	Chloroform	Chloromethane	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,1-Dichloroethane	1,2-Dichloroethane	1,1-Dichloroethene	1,2-Dichloroethene	cis-1,2-Dichloroethene	1,4- Dioxane	Ethylbenzene	Isopropylbenzene	p-Isopropyltoluene
MW-26D-105																			
	Mar-13	ND	ND	ND	ND	ND	ND	ND	ND	ND	12.4	ND	98.2	NR	ND	118.0	ND	NA	ND
	Jul-13	ND	ND	ND	ND	ND	ND	ND	ND	ND	13.5	ND	120	NR	ND	99.2	ND	NA	ND
	Dec-13	ND	ND	ND	ND	ND	ND	ND	ND	ND	6.9	ND	51.5	NR	ND	60.7	ND	NA	ND
	Jun-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	5.2	ND	42.4	NR	ND	39.8	ND	NA	ND
	Dec-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	7.5	ND	78	NR	ND	73.0	ND	NA	ND
MW-38-28																			
	Jun-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	9.5	ND	ND	NR	ND	51.8	ND	NA	ND
	Dec-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	8.7	ND	ND	NR	ND	68.7	ND	NA	ND
MW-39-50																			
	Jun-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	3.2	NR	ND	6.3	ND	NA	ND
	Dec-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	ND	ND	ND	NA	ND

Table 1

Summary of COCs Detected in Groundwater Samples (2009 - 2014)
On-Property Monitoring Wells
Former Kop-Flex Facility
Hanover, Maryland (a)

Monitoring Well		Methylene Chloride	Methyl-tert-butyl Ether	Naphthalene	Tetrachloroethene	Toluene	1,1,1-Trichloroethane	1,1,2-Trichloroethane	Trichloroethene	Vinyl Chloride	Xylene (total)	Total Detected VOCs
MW-01-36												
	May-09	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---
	Oct-09	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---
	May-10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---
	Oct-10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---
	Jun-11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---
	Dec-11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---
	Jun-12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---
	Dec-12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---
	Jul-13	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---
	Dec-13	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---
	Jun-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	12
	Dec-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---
MW-01D-112												
	Jun-12	ND	ND	ND	ND	ND	96	ND	ND	ND	ND	899
	Dec-12	ND	ND	ND	ND	ND	120	1.6	1.7	ND	ND	1,009
	Jul-13	ND	ND	ND	ND	ND	98.8	1.5	1.8	ND	ND	1,007
	Dec-13 (g)	ND	ND	ND	ND	ND	62.4	ND	ND	ND	ND	690
	Jun-14 (g)	ND	ND	ND	ND	ND	62.4	ND	ND	ND	ND	759
	Dec-14 (n)	ND	ND	ND	ND	ND	35.8	ND	ND	ND	ND	562
MW-02-40												
	May-09	3	ND	ND	3	ND	150	ND	8	2	ND	2,102
	Oct-09	5	ND	ND	7	ND	380	ND	17	4	3	4,797
	May-10	ND	ND	ND	11	ND	520	ND	22	5	ND	5,589
	Oct-10	ND	ND	ND	11	ND	2,700	ND	23	4	ND	8,166
	Jun-11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	5,780
	Nov-11	4.4	ND	ND	8	ND	2,800	1	22	6	3.3	7,561
	Jun-12 (d)	ND	ND	ND	ND	ND	6,100	ND	ND	ND	ND	10,883
	Dec-12	ND	ND	ND	3.6	ND	350	ND	11	ND	ND	2,889
	Jul-13	ND	ND	ND	4	ND	541	ND	11.7	2.8	ND	3,208
	Dec-13 (h)	ND	ND	ND	ND	ND	228.0	ND	5.7	ND	ND	1,882
	Jun-14 (h)	16.3	ND	ND	ND	ND	599.0	ND	11.2	ND	ND	2,614
	Dec-14 (h)	ND	ND	ND	ND	ND	21	ND	6	ND	ND	1,459
MW-02D-138												
	Jul-11	ND	ND	ND	ND	ND	28	ND	ND	ND	ND	166
	Nov-11	ND	ND	ND	ND	ND	27	ND	ND	ND	ND	292
	Jun-12	ND	ND	ND	ND	ND	28	ND	ND	ND	ND	292
	Dec-12	ND	ND	ND	ND	ND	23	ND	ND	ND	ND	273
	Jul-13	ND	ND	ND	ND	ND	23	ND	ND	ND	ND	344
	Dec-13	ND	ND	ND	ND	ND	15.9	ND	ND	ND	ND	257
	Jun-14	ND	ND	ND	ND	ND	26.9	ND	ND	ND	ND	335
	Dec-14	ND	ND	ND	ND	ND	20.2	ND	ND	ND	ND	292

Table 1

Summary of COCs Detected in Groundwater Samples (2009 - 2014)
On-Property Monitoring Wells
Former Kop-Flex Facility
Hanover, Maryland (a)

Monitoring Well		Methylene Chloride	Methyl-tert-butyl Ether	Naphthalene	Tetrachloroethene	Toluene	1,1,1-Trichloroethane	1,1,2-Trichloroethane	Trichloroethene	Vinyl Chloride	Xylene (total)	Total Detected VOCs
MW-03-25.5												
	May-09	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---
	Oct-09	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---
	May-10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---
	Oct-10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---
	Jun-11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---
	Nov-11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---
	Jun-12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---
	Dec-12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---
	Jul-13	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---
	Dec-13	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---
	Jun-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---
	Dec-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---
MW-04-36												
	May-09	ND	ND	ND	1	ND	100	ND	3	ND	ND	584
	Oct-09	ND	ND	ND	1	ND	100	ND	3	ND	ND	667
	May-10	ND	ND	ND	5	ND	180	ND	8	ND	ND	1,591
	Oct-10	ND	ND	ND	2	ND	75	ND	3	ND	ND	573
	Jun-11	ND	ND	ND	ND	ND	32	ND	2	ND	ND	317
	Dec-11	ND	ND	ND	ND	ND	47	ND	2	ND	ND	600
	Jun-12	ND	ND	ND	ND	ND	25	ND	ND	ND	ND	431
	Dec-12	ND	ND	ND	ND	ND	26	ND	2	ND	ND	528
	Jul-13	ND	ND	ND	ND	ND	27.9	ND	2.3	ND	ND	606
	Dec-13	ND	ND	ND	ND	ND	21.3	ND	1.7	ND	ND	457
	Jun-14	ND	ND	ND	3.2	ND	104.0	ND	8.0	ND	ND	1,686
	Dec-14 (g)	ND	ND	ND	ND	ND	11.8	ND	ND	ND	ND	202
MW-05-31												
	May-09	ND	ND	ND	ND	ND	6	ND	ND	ND	ND	19
	Oct-09	ND	ND	ND	ND	ND	6	ND	ND	ND	ND	22
	May-10	ND	ND	ND	ND	ND	6	ND	ND	ND	ND	25
	Oct-10	ND	ND	ND	ND	ND	5	ND	ND	ND	ND	17
	Jun-11	ND	ND	ND	ND	ND	5	ND	ND	ND	ND	15
	Dec-11	ND	ND	ND	ND	ND	4	ND	ND	ND	ND	255
	Jun-12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	218
	Dec-12	ND	ND	ND	ND	ND	2.2	ND	ND	ND	ND	251
	Jul-13	ND	ND	ND	ND	ND	2.4	ND	ND	ND	ND	213
	Dec-13	ND	ND	ND	ND	ND	1.8	ND	ND	ND	ND	143
	Jun-14	ND	ND	ND	ND	ND	2.5	ND	ND	ND	ND	100
	Dec-14	ND	ND	ND	ND	ND	2.0	ND	ND	ND	ND	98

Table 1

Summary of COCs Detected in Groundwater Samples (2009 - 2014)
On-Property Monitoring Wells
Former Kop-Flex Facility
Hanover, Maryland (a)

Monitoring Well	Methylene Chloride	Methyl-tert-butyl Ether	Naphthalene	Tetrachloroethene	Toluene	1,1,1-Trichloroethane	1,1,2-Trichloroethane	Trichloroethene	Vinyl Chloride	Xylene (total)	Total Detected VOCs
MW-06-36											
May-09	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---
Oct-09	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---
May-10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---
Oct-10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---
Jun-11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---
Dec-11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---
Jun-12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---
Dec-12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---
Jul-13	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---
Dec-13	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---
Jun-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---
Dec-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---
MW-07-22											
May-09	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---
Oct-09	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---
May-10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---
Oct-10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---
Jun-11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---
Dec-11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---
Jun-12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---
Dec-12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---
Jul-13	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---
Dec-13	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2
Jun-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---
Dec-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2
MW-08-42											
May-09	ND	ND	ND	1	ND	100	ND	4	ND	ND	571
Oct-09	ND	ND	ND	1	ND	70	ND	4	ND	ND	651
May-10	ND	ND	ND	2	ND	65	ND	4	ND	ND	566
Oct-10	ND	ND	ND	ND	ND	25	ND	3	ND	ND	401
Jun-11	ND	ND	ND	1	ND	23	ND	4	ND	ND	688
Dec-11	ND	ND	ND	ND	ND	13	ND	2	ND	ND	711
Jun-12 (g)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	735
Dec-12	ND	ND	ND	ND	ND	9.0	ND	3.1	ND	ND	824
Jul-13	ND	ND	ND	1.1	ND	6.4	ND	3.6	ND	ND	846
Dec-13	ND	ND	ND	ND	ND	4.7	ND	1.8	ND	ND	471
Jun-14	ND	ND	ND	ND	ND	3.3	ND	1.6	ND	ND	458
Dec-14	ND	ND	ND	ND	ND	2.0	ND	1.3	ND	ND	365
MW-09-25											
May-09	ND	ND	ND	ND	ND	16	ND	ND	ND	ND	286
Oct-09	ND	ND	ND	ND	ND	13	ND	ND	ND	ND	332
May-10	ND	ND	ND	ND	ND	10	ND	ND	ND	ND	268
Jun-11	ND	ND	ND	ND	ND	10	ND	ND	ND	ND	318
Nov-11	ND	ND	ND	ND	ND	8	ND	ND	ND	ND	330
Jun-12	ND	ND	ND	ND	ND	6	ND	ND	ND	ND	245
Dec-12	ND	ND	ND	ND	ND	5.5	ND	ND	ND	ND	238
Jul-13	ND	ND	ND	ND	ND	6.4	ND	ND	ND	ND	258
Dec-13	ND	ND	ND	ND	ND	4.6	ND	ND	ND	ND	295
Jun-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	257
Dec-14	ND	ND	ND	ND	ND	9.4	ND	ND	ND	ND	297

Table 1

Summary of COCs Detected in Groundwater Samples (2009 - 2014)
On-Property Monitoring Wells
Former Kop-Flex Facility
Hanover, Maryland (a)

Monitoring Well		Methylene Chloride	Methyl-tert-butyl Ether	Naphthalene	Tetrachloroethene	Toluene	1,1,1-Trichloroethane	1,1,2-Trichloroethane	Trichloroethene	Vinyl Chloride	Xylene (total)	Total Detected VOCs
MW-10-27												
	May-09	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10
	Oct-09	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	3
	May-10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	4
	Oct-10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	3
	Jun-11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	4
	Nov-11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	8
	Jun-12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	3
	Dec-12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2
	Jul-13	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	3
	Dec-13	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	5
	Jun-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	15
	Dec-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	5
MW-11-60												
	May-09	ND	ND	ND	ND	ND	47	ND	4	ND	ND	869
	Oct-09	4	ND	ND	3	ND	230	2	13	1	ND	3,037
	May-10	ND	ND	ND	ND	ND	67	ND	5	ND	ND	965
	Oct-10	ND	ND	ND	ND	ND	52	ND	5	ND	ND	718
	Jun-11	ND	ND	ND	ND	ND	29	ND	3	ND	ND	856
	Dec-11	ND	ND	ND	ND	ND	16	ND	ND	ND	ND	1,088
	Jun-12 (h)	ND	ND	ND	ND	ND	35	ND	ND	ND	ND	1,382
	Dec-12	6.7	ND	ND	4	ND	300	2.9	13	ND	ND	4,360
	Jul-13	ND	ND	ND	1.6	ND	103	1	8.8	1.6	ND	2,699
	Dec-13 (c)	ND	ND	ND	ND	ND	343.0	ND	10.3	ND	ND	3,677
	Jun-14 (m)	9	ND	ND	ND	ND	21.7	ND	ND	ND	ND	925
	Dec-14 (c)	ND	ND	ND	ND	ND	28.8	ND	ND	ND	ND	1,311
MW-12-48												
	May-09	3	ND	ND	4	ND	120	3	16	2	ND	3,248
	Oct-09	2	ND	ND	3	ND	87	2	13	2	ND	2,732
	May-10	ND	ND	ND	4	ND	160	ND	9	3	ND	3,621
	Oct-10		ND	ND	3	ND	110	2	13	2	ND	2,985
	Jun-11	3	ND	ND	3	ND	110	3	16	2	ND	3,758
	Nov-11	2	ND	ND	3	ND	85	4	17	2	ND	4,573
	Jun-12 (c)	ND	ND	ND	ND	ND	63	ND	ND	ND	ND	3,323
	Dec-12	ND	ND	ND	2.0	ND	48	3.3	13	ND	ND	3,448
	Jul-13	6.6	ND	ND	4	ND	77.2	3.2	16.7	2.6	ND	5,578
	Dec-13 (l)	ND	ND	ND	ND	ND	41.8	ND	ND	ND	ND	3,809
	Jun-14 (c)	ND	ND	ND	ND	ND	125.0	ND	17.8	ND	ND	5,205
	Dec-14 (i)	ND	ND	ND	ND	ND	78.8	ND	ND	ND	ND	6,286
MW-14-47												
	May-09	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---
	Oct-09	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	3
	May-10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	5
	Oct-10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	3
	Jun-11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	5
	Nov-11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	13
	Jun-12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	12
	Dec-12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	4
	Jul-13	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	6
	Dec-13	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---
	Jun-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	6
	Dec-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2

Table 1

Summary of COCs Detected in Groundwater Samples (2009 - 2014)
On-Property Monitoring Wells
Former Kop-Flex Facility
Hanover, Maryland (a)

Monitoring Well		Methylene Chloride	Methyl-tert-butyl Ether	Naphthalene	Tetrachloroethene	Toluene	1,1,1-Trichloroethane	1,1,2-Trichloroethane	Trichloroethene	Vinyl Chloride	Xylene (total)	Total Detected VOCs
MW-15-40												
	Sep-10	ND	ND	ND	4	ND	27	2	15	1	ND	1,749
	Oct-10	ND	ND	ND	2	ND	22	2	7	ND	ND	897
	Jun-11	ND	ND	ND	ND	ND	51	ND	2	ND	ND	576
	Dec-11	ND	ND	ND	1	ND	48	ND	4.7	ND	ND	1,133
	Jun-12 (h)	ND	ND	ND	ND	ND	47	ND	ND	ND	ND	1,322
	Dec-12	ND	ND	ND	1.2	ND	150	ND	5.2	ND	ND	1,309
	Jul-13	ND	ND	ND	ND	ND	43.2	ND	ND	ND	ND	3,197
	Dec-13 (g)	ND	ND	ND	ND	ND	107.0	ND	2.4	ND	ND	817
	Jun-14 (n)	10.2	ND	ND	ND	ND	13.7	ND	ND	ND	ND	617
	Dec-14 (m)	ND	ND	ND	ND	ND	20.7	ND	ND	ND	ND	618
MW-16-50												
	Sep-10	28	ND	17	250	7	160,000	4	370	ND	101	185,758
	Oct-10	ND	ND	ND	140	ND	71,000	3	190	6	ND	88,333
	Jun-11	ND	ND	ND	ND	ND	21,000	ND	130	ND	ND	44,190
	Dec-11	30	ND	7.1	110	4.2	100,000	3	220	14	57	129,295
	Jun-12 (f)	ND	ND	ND	ND	ND	41,000	ND	ND	ND	ND	58,350
	Dec-12	30	ND	4.5	69	3.4	30,000	3.5	160	9.2	36	60,661
	Jul-13	29.5	ND	6	83.8	4.4	29,400	4.3	ND	17.7	46.2	54,832
	Dec-13 (k)	ND	ND	ND	ND	ND	12,000.0	ND	ND	ND	ND	36,556
	Jun-14 (k)	ND	ND	ND	ND	ND	30,500.0	ND	213.0	ND	ND	52,811
	Dec-14	7	ND	3	30.7	1.6	15,000.0 (p)	ND	63.8	5.1	17	26,236
MW-16D-101												
	Jan-11	8	ND	2	ND	ND	82	ND	2	ND	3	548
	Jun-11	ND	ND	ND	ND	ND	75	ND	2	ND	ND	581
	Dec-11	ND	ND	ND	ND	ND	64	ND	1	ND	ND	650
	Jun-12	ND	ND	ND	ND	ND	33	ND	ND	ND	ND	447
	Dec-12	ND	ND	ND	ND	ND	29	ND	ND	ND	ND	407
	Jul-13	ND	ND	ND	ND	ND	23.8	ND	ND	ND	ND	520
	Dec-13	ND	ND	ND	ND	ND	21.3	ND	ND	ND	ND	440
	Jun-14	ND	ND	ND	ND	ND	28.9	ND	ND	ND	ND	513
	Dec-14	ND	ND	ND	ND	ND	44.3	ND	1.8	ND	ND	679
MW-17-52												
	Sep-10	ND	ND	ND	ND	ND	7	ND	ND	ND	ND	24
	Oct-10	ND	ND	ND	ND	ND	2	ND	ND	ND	ND	10
	Jun-11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	4
	Nov-11	ND	ND	ND	ND	ND	22	ND	ND	ND	ND	132
	Jun-12 (c)	ND	ND	ND	ND	ND	23	ND	ND	ND	ND	33
	Dec-12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	4
	Jul-13	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	6
	Dec-13	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---
	Jun-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	37
	Dec-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	3
MW-17D-97												
	Sep-10	5	ND	ND	1	ND	26	ND	9	1	ND	1,156
	Oct-10	ND	ND	ND	2	ND	42	ND	10	ND	ND	1,566
	Jun-11	ND	ND	ND	ND	ND	29	ND	ND	ND	ND	2,419
	Nov-11	3	ND	ND	3	ND	38	2	12	ND	ND	2,847
	Jun-12 (c)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1,908
	Dec-12	4.7	ND	ND	1.5	ND	36.0	ND	11	ND	ND	3,071
	Jul-13	6.6	ND	ND	2	ND	36.2	ND	10.9	1.5	ND	3,584
	Dec-13 (m)	ND	ND	ND	ND	ND	22.6	ND	7.9	ND	ND	3,116
	Jun-14 (c)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1,848
	Dec-14	ND	ND	ND	ND	ND	4.3	ND	2.9	ND	ND	591

Table 1

Summary of COCs Detected in Groundwater Samples (2009 - 2014)
On-Property Monitoring Wells
Former Kop-Flex Facility
Hanover, Maryland (a)

Monitoring Well		Methylene Chloride	Methyl-tert-butyl Ether	Naphthalene	Tetrachloroethene	Toluene	1,1,1-Trichloroethane	1,1,2-Trichloroethane	Trichloroethene	Vinyl Chloride	Xylene (total)	Total Detected VOCs
MW-18-56												
	Dec-11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	14
	Jun-12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---
	Dec-12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---
	Jul-13	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---
	Dec-13	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---
	Jun-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	5
	Dec-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---
MW-19-56												
	Dec-11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	14
	Jun-12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	4
	Dec-12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	4
	Jul-13	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	12
	Dec-13	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	8
	Jun-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10
	Dec-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	8
MW-20-60												
	Dec-11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	12
	Jun-12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	332
	Dec-12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	659
	Jul-13	ND	ND	ND	ND	ND	ND	2	ND	ND	ND	1,194
	Dec-13 (g)	ND	ND	ND	ND	ND	ND	2.5	ND	ND	ND	1,694
	Jun-14 (g)	5.6	ND	ND	ND	ND	ND	3.3	2.1	ND	ND	1,564
	Dec-14 (m)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1,137
MW-21D-102												
	Jun-12	ND	ND	ND	ND	ND	8	ND	ND	ND	ND	194
	Dec-12	ND	ND	ND	ND	ND	5.7	ND	ND	ND	ND	192
	Jul-13	ND	ND	ND	ND	ND	5	ND	ND	ND	ND	199
	Dec-13	ND	ND	ND	ND	ND	4.1	ND	ND	ND	ND	167
	Jun-14	ND	ND	ND	ND	ND	2.8	ND	ND	ND	ND	165
	Dec-14	ND	ND	ND	ND	ND	3.2	ND	ND	ND	ND	257
MW-22D-114												
	Jun-12	ND	ND	ND	ND	ND	8	ND	ND	ND	ND	64
	Dec-12	ND	ND	ND	ND	ND	10	ND	ND	ND	ND	94
	Jul-13	ND	ND	ND	ND	ND	6.5	ND	ND	ND	ND	75
	Dec-13	ND	ND	ND	ND	ND	8.4	ND	ND	ND	ND	91
	Jun-14	ND	ND	ND	ND	ND	9.0	ND	ND	ND	ND	96
	Dec-14	ND	ND	ND	ND	ND	4.2	ND	ND	ND	ND	56
MW-23D-92												
	Jun-12	ND	ND	ND	ND	ND	36	ND	ND	ND	ND	334
	Aug-12	ND	ND	ND	ND	ND	35	ND	ND	ND	ND	206
	Dec-12	ND	ND	ND	ND	ND	31	ND	ND	ND	ND	305
	Jul-13	ND	ND	ND	ND	ND	28.6	ND	ND	ND	ND	382
	Dec-13	ND	ND	ND	ND	ND	21.3	ND	ND	ND	ND	315
	Jun-14	ND	ND	ND	ND	ND	24.7	ND	ND	ND	ND	290
	Dec-14	ND	ND	ND	ND	ND	26.5	ND	ND	ND	ND	365
MW-27D-113												
	Sep-13	ND	1.3	ND	ND	ND	ND	ND	ND	ND	ND	4
	Dec-13	ND	1.4	ND	ND	ND	ND	ND	ND	ND	ND	1
	Jun-14	ND	1.6	ND	ND	ND	ND	ND	ND	ND	ND	2
	Dec-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---

Table 1

Summary of COCs Detected in Groundwater Samples (2009 - 2014)
On-Property Monitoring Wells
Former Kop-Flex Facility
Hanover, Maryland (a)

Monitoring Well		Methylene Chloride	Methyl-tert-butyl Ether	Naphthalene	Tetrachloroethene	Toluene	1,1,1-Trichloroethane	1,1,2-Trichloroethane	Trichloroethene	Vinyl Chloride	Xylene (total)	Total Detected VOCs
MW-26D-105												
	Mar-13	ND	ND	ND	ND	5.6	6.3	ND	ND	ND	ND	241
	Jul-13	ND	ND	ND	ND	ND	6.6	ND	ND	ND	ND	239
	Dec-13	ND	ND	ND	ND	ND	2.7	ND	ND	ND	ND	122
	Jun-14	ND	ND	ND	ND	ND	1.8	ND	ND	ND	ND	89
	Dec-14	ND	ND	ND	ND	ND	2.8	ND	ND	ND	ND	161
MW-38-28												
	Jun-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	61
	Dec-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	77
MW-39-50												
	Jun-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10
	Dec-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---

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a/ all samples measured in ppb (ug/L);
E = result exceeds calibration range
ND = not detected; NA = Not analyzed
NR = not reported
b/suspected laboratory contaminant
c/ sample run at a 10x dilution
d/ sample run at 50x dilution
e/ estimated below the detection limit;
f/sample run at a 250x dilution
g/sample run at a 2x dilution
h/sample run at a 5x dilution
i/sample run at a 25x dilution
k/sample run at 200x dilution
l/sample run at 20x dilution
m/sample run at 4x dilution
n/sample run at 2.5x dilution
p/sample run at 400x dilution

Table 2

Soil Sample Results, Proposed Loading Dock Area
Former Kop-Flex Facility
Hanover, MD
September 2014 (a)

Analyte	**Sample ID** **Date Collected** **Sample Depth (ft)**	B-1 25-Sep-14 3-4		B-2 25-Sep-14 2-3		B-3 25-Sep-14 3-4		B-4 25-Sep-14 3-4		B-5 25-Sep-14 1-2		B-6 25-Sep-14 2-3		B-7 25-Sep-14 4-5		B-8 25-Sep-14 4-5		B-9 25-Sep-14 3-4		B-10 25-Sep-14 2-3	
Volatile Organic Compounds (mg/kg)	**MDE Residential Soil Cleanup Standard (mg/kg)**																				
Carbon Disulfide	780	0.0053	U	0.0049	U	0.0057	U	0.0043	U	0.0028	J	0.0055	U	0.0051	U	0.0033		0.0055	U	0.0046	U
1,1,1-Trichloroethane	16,000	0.0053	U	0.0049	U	0.0057	U	0.0043	U	0.0056	U	0.0084		0.0051	U	0.0054	U	0.0055	U	0.0046	U
Polycyclic Aromatic Hydrocarbons (mg/kg)																					
Fluoranthene	310	0.01	U	0.01	U	0.01	U	0.0163		0.01	U	0.0105	U	0.0111	U	0.0106	U	0.0102	U	0.0355	
Phenanthrene	2,300	0.01	U	0.01	U	0.01	U	0.0158		0.01	U	0.0105	U	0.0111	U	0.0106	U	0.0102	U	0.108	U
Pyrene	230	0.01	U	0.01	U	0.01	U	0.0102	U	0.01	U	0.0105	U	0.0111	U	0.0106	U	0.0102	U	0.0199	
Gasoline Range Organics (mg/kg)																					
Gasoline Range Organics	230	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.11	U	0.11	U	0.11	U	0.1	U	0.11	U
Diesel Range Organics (mg/kg)																					
Diesel Range Organics	230	8	U	8	U	8	U	8	U	8	U	8.4	U	8.9	U	8.5	U	8.2	U	8.6	U
Polychlorinated Biphenyls (mg/kg)																					
Total Polychlorinated Biphenyls	NA	ND		ND		ND		ND		ND		ND		ND		ND		ND		ND	
Total Metals Analysis (mg/kg)																					
Arsenic	3.6 (c)	1.79		2.19		0.605		0.527		1.21		1.15		1.73		5.3		6.06		2.37	
Barium	1,600	9		2.73		1.27		3.03		2.39		7.55		6.54		7.42		1.63		3.32	
Cadmium	3.9	0.414	Ub	0.388	Ub	0.401	Ub	0.411	Ub	0.397	Ub	0.412	Ub	0.411	Ub	0.401	Ub	0.342	Ub	0.426	Ub
Chromium	23	10.3		2.08		1.75		2.9		2		3.89		6.14		13.2		4.4		5.42	
Lead	400	3.04		0.906		0.526		1.06		0.849		2.04		2.73		2.41		0.766		1.1	
Mercury	2.3	0.0829	Ub	0.0775	Ub	0.0802	Ub	0.0821	Ub	0.0795	Ub	0.0825	Ub	0.0823	Ub	0.0802	Ub	0.0684	Ub	0.0853	Ub
Selenium	39	0.945		0.388	Ub	0.401	Ub	0.411	Ub	0.397	Ub	0.591		0.631		0.865		0.342	Ub	0.464	
Silver	39	0.414	Ub	0.388	Ub	0.401	Ub	0.411	Ub	0.397	Ub	0.412	Ub	0.411	Ub	0.401	Ub	0.342	Ub	0.426	Ub

a - All samples were collected by ECS Mid-Atlantic, LLC
b - Samples analyzed at dilution factor of 2
U - Undetected, value reported is the laboratory reporting limit
J - Indicates an estimated value between method detection limit and reporting limit
NA -not analyzed
ND- not detected
mg/kg - milligrams per kilogram
c - Anticipated Typical Concentrations for Eastern Maryland

Table 3

Groundwater Sampling Results for Additional Hydrogeochemical Parameters
Surficial Aquifer
Former Kop-Flex Facility
Hanover, Maryland (a, b)

Sample ID	**MW-05-31**		**MW-18-56**		**MW-38-28**		**TW-01-63**	
Date Sampled	10/02/14		10/02/14		10/02/14		10/02/14	
Parameters								
Metals (µg/L)								
Aluminum (total)	2,280		207		1,930		723	
Aluminum (dissolved)	2,190		165		1,400		692	
Copper (total)	10.7		5	U	5	U	9.4	
Copper (dissolved)	12.1		5.7		5	U	8.4	
Iron (total)	50	U	50	U	2,640		50	U
Iron (dissolved)	50	U	50	U	2,280		50	U
Lead (total)	5	U	5	U	5	U	5	U
Lead (dissolved)	5	U	5	U	5	U	5	U
Manganese (total)	71.6		17.6		7.7		15	
Manganese (dissolved)	70.3		17.1		7.3		14.7	
Nickel (total)	5	U	8.5		151		19.2	
Nickel (dissolved)	5	U	8.9		147		18.8	
Zinc (total)	16.3		10.3		175		11.4	
Zinc (dissolved)	25		18.2		171		10	U
Total Hardness (mg/L)	51.9		16.9		2.9		18.5	
Total Petroleum Hydrocarbons (mg/L)	5	U	5	U	5	U	5	U
Total Suspended Solids (mg/L)	5.1	U	3		27.3		2.5	U

---

a/ ug/L = micrograms per liter; mg/L = miligrams per liter

b/ Data Validation Qualifier:
U = analyte not detected above reporting limit

Table 4

Groundwater Sampling Results for Inorganic Parameters
Lower Patapsco Aquifer
Former Kop-Flex Facility
Hanover, Maryland (a, b)

Sample ID	**MW-1D**		**MW-2D**		**MW-16D**		**MW-17D**		**MW-21D**		**MW-26D**	
Date Sampled	12/12/13		12/11/13		12/11/13		12/13/13		12/12/13		12/12/13	
Parameters												
Metals (ug/L)												
Copper (total)	29		3.4		7.3		22		2.7		6.3	
Copper (dissolved)	4.3		2		4.4		1	U	1.8		1.4	
Iron (total)	430		100	U	290		3,400		150		200	
Iron (dissolved)	130		100	U	100	U	100	U	100	U	100	U
Lead (total)	2		1	U	1	U	1.3		1	U	1	U
Lead (dissolved)	1	U	1	U	1	U	1	U	1	U	1	U
Manganese (total)	60		14		35		150		5.6		12	
Manganese (dissolved)	46		12		25		11		3.7		8.7	
Nickel (total)	22		9.5		20		20		3.1		6.1	
Nickel (dissolved)	12		8.1		16		4.2		3.5		6.2	
Zinc (total)	44		20	U	37		47		20	U	35	
Zinc (dissolved)	22		20	U	32		20	U	20	U	20	U
Hardness (mg/L)	17		16		27		160		8.8		16	
Total Alkalinity (mg/L)	17		NA		NA		140		10	U	13	

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a/ ug/L = micrograms per liter; mg/L = miligrams per liter; NA = not analyzed

b/ Data Validation Qualifier:

U = analyte not detected above reporting limit

Table 5

Aquifer Property Estimates from April-May 2014 Constant Rate Test on the Surficial Aquifer
Former Kop-Flex Facility
Hanover, Maryland

	Hydraulic Conductivity (feet/day) (a)		Transmissivity ($feet^2$/day)		
Well ID	**Drawdown**	**Recovery**	**Drawdown**	**Recovery**	**Storativity**
TW-1	5.2	5.8	146	162	---
MW-18	8.5	10.1	237	282	0.00071
MW-39	8.2	15.6	139	266	0.00082
OW-1	10.6	10.5	298	295	0.00073
OW-2	11	10.8	308	301	0.00087
Geometric Mean:	9.21		245		

---

a/ Hydraulic conductivity was calculate by dividing the transmissivity by the thickness of the sand unit. An average sand unit thickness of 28 feet was used for all wells except MW-39, where the thickness value was 17 feet.

Table 6

Aquifer Property Estimates from May 2014 Constant Rate Test
on the Lower Patapsco Aquifer
Former Kop-Flex Facility
Hanover, Maryland

	Hydraulic Conductivity (feet/day) (a)		Transmissivity ($feet^2$/day)		
Well ID	**Drawdown**	**Recovery**	**Drawdown**	**Recovery**	**Storativity**
TW-2	16.5	17.8	1,320	1,420	---
MW-1D	14.6	19.0	1,170	1,520	0.000092
MW-17D	17.8	17.5	1,420	1,400	0.00018
MW-21D	18.5	18.1	1,480	1,450	0.00015
MW-22D	17.3	16.3	1,380	1,300	0.00060
MW-24D	18.4	17.3	1,470	1,380	0.00060
MW-16D	19.3	---	1,540	---	0.00015
MW-26D	20.3	---	1,620	---	0.00011
Geometric Mean:	17.7		1,410		

---

a/ Hydraulic conductivity was calculate by dividing the transmissivity by the assumed thickness of the Lower Patapsco Aquifer (80 feet).

Table 7

Input Parameters for Steady State Flow Simulations in the Surficial Aquifer
Former Kop-Flex Facility
Hanover, Maryland

Parameter	**Value**	**Source**
Local Groundwater Flow Regime		
Upgradient Reference Head	115.5 feet MSL	Monitoring well hydrographs (2008-2014)
Hydraulic Gradient (magnitude)	0.008	2013 and 2014 groundwater surface contours
Hydraulic Gradient (direction)	West-Northwest	2013 and 2014 groundwater surface contours
Stony Run Head Values	106 - 108 feet MSL	Assumed values based on ground surface topography
Aquifer Properties		
Aquifer Top	124 feet MSL	Approximate ground surface elevation in main building are
Aquifer Bottom	67 feet MSL	Site hydrogeologic cross-sections
Porosity	0.35	Assumed value for unconsolidated silt and sand (Schwartz and Zheng 2003)
Hydraulic Conductivity	5.5 feet/day	Equivalent value for layered clayey and sandy deposits
Pond Recharge	0.001 feet/day	Assumed value from evaluation of flow system
Extraction Wells Design		
Screen Length	35 feet	
Depth to Top of Screen	22 feet	
Well Diameter	4 inches	
Borehole Diameter	8 inches	

Table 8

Proposed Recovery Well Construction and Operation Summary
Groundwater Containment System
Former Kop-Flex Facility
Hanover, Maryland (a, b)

Location	Aquifer	Well Diameter	Well Construction Material	Estimated Extraction Well Screened Interval			Anticipated Pump Intake Depth	Piezometer Diameter	Piezometer Construction Material	Estimated Piezometer Screened Interval			Anticipated Flow Rate	Maximum Flow Rate
		(inches)		(ft bgs)		(ft bgs)	(ft bgs)	(inches)	(inches)	(ft bgs)		(ft bgs)	(gpm)	(gpm)
RW-1S	Surficial	4	PVC	25	-	60	50	1	PVC	25	-	60	3.0	3.3
RW-2S	Surficial	4	PVC	25	-	60	50	1	PVC	25	-	60	3.0	3.3
RW-3S	Surficial	4	PVC	25	-	60	50	1	PVC	25	-	60	3.0	3.3
RW-1D	Lower Patapsco	6	PVC	100	-	140	90	1	PVC	100	-	140	35.0	38.5
RW-2D	Lower Patapsco	6	PVC	100	-	140	90	1	PVC	100	-	140	35.0	38.5
												Total:	79.0	86.9

---

a/ gpm = gallons per minute; ft bgs = feet below ground surface
b/ Maximum flow rate is the anticipated flow multiplied by a safety factor of 1.1.

Table 9

Input Parameters for Steady State Flow Simulations in the Lower Patapsco Aquifer
Former Kop-Flex Facility
Hanover, Maryland

Parameter	Value	Source
Local Groundwater Flow Regime		
Upgradient Reference Head	88 feet MSL	Well MW-23D hydrograph (2012-2014)
Hydraulic Gradient (magnitude)	0.006	2013 and 2014 potentiometric surface contours
Hydraulic Gradient (direction)	South-Southeast	2013 and 2014 potentiometric surface contours
Aquifer Properties		
Aquifer Top	50 feet MSL	Site hydrogeologic cross-sections
Aquifer Bottom	-30 feet MSL	Site hydrogeologic cross-sections
Porosity	0.30	Assumed value from published modeling studies of aquifer (Achmad 1991, Wilson and Achmad 1995)
Hydraulic Conductivity	15 feet/day	2014 constant discharge pumping test
Extraction Wells Design		
Screen Length	50 feet	
Depth to Top of Screen	100 feet	
Well Diameter	6 inches	
Borehole Diameter	10 inches	

Table 10

Previous NPDES Permit Monitoring Requirements
Former Kop-Flex Facility
Hanover, Maryland

Parameter	Units	Quality or Concentration Minimum	Monthly Average	Daily Maximum	Frequency of Analysis	Sample Type	
Flow	gpd			-	1/Month	Measured	(a)
Total Volatile Organics	ug/l			100	1/Month	Grab	(a, b)
1,1-Dichloroethene	ug/l		32		1/Month	Grab	(a, b)
BOD5	mg/l		30	45	1/Month	Grab	
Total Suspended Solids	mg/l		30	45	1/Month	Grab	
Oil & Grease	mg/l			15	1/Month	Grab	
Dissolved Oxygen	mg/l	5			1/Month	Grab	
pH	SU	6.0		9.0	1/Month	Grab	
Total Zinc	ug/l			120	1/Month	Grab	(c)
Dissolved Zinc	ug/l			Report	1/Month	Grab	(c)
Total Copper	ug/l			13	1/Month	Grab	(c)
Dissolved Copper	ug/l			Report	1/Month	Grab	(c)
Total Nickel	ug/l			470	1/Month	Grab	(c)
Dissolved Nickel	ug/l			Report	1/Month	Grab	(c)
Total Lead	ug/l			65	1/Month	Grab	(c)
Dissolved Lead	ug/l			Report	1/Month	Grab	(c)
Hardness (as CaCO3)	mg/l			Report	1/Month	Grab	

There shall be no discharge of floating solids or persistent foam in other than trace amounts. Persistent foam is foam that does not dissipate within one half-hour of point of discharge.

---

a/ The Department may authorize a monitoring frequency reduction to once per month, based upon a written request by the permittee. Such a request shall describe the alternate method(s) being employed by the permittee to ensure consistent compliance with effluent limitations. These alternate methods may consist of alternate effluent monitoring tests and/or modified inspection, operation, or maintenance procedures which are used to prevent or predict effluent variability, or the additional use of carbon column units as part of the treatment system operation.

b/ Total Volatile Organics is defined as the sum of the constituents present in the wastewater according to EPA Method 601. The permittee shall include in the quarterly Discharge Monitoring Report the total sum and each individual concentration of detected constituents.

c/ The permittee shall use EPA Methods 200.7 or 200.8 for testing. An alternate test method may be substituted as long as the Department concurs that its detection level is less than the applicable Toxic Substance Criteria in COMAR 26.08.02.03 or the permittee demonstrates to the Department that a lower detection level is not practically achievable for this wastewater. Sample preservation procedures, container materials, and maximum allowable holding times must be specified in any application to the Department for use of an alternate test method(s). Written approval from the Department must be given before any alternate test method(s) is used. The integrity of all testing shall be ensured by following all sample preservation procedures, container materials, and maximum allowable holding times for the test method(s) specified. If a variance from the prescribed preservation techniques, container materials, and maximum holding times applicable is requested sufficient data shall be provided in the application to the Department to assure the integrity of the sample.

Table 11

Estimated Effluent Water Concentrations
Groundwater Containment System
Former Kop-Flex Facility
Hanover, Maryland

Constituents	**Groundwater Cleanup Standards**	**Previous NPDES Permit Limits** (b)	**Estimated Effluent Water Concentration**
<u>VOC\:</u>			
1,1,1-Trichloroethane	200	NS	< 200
1,1,2-Trichloroethane	5	NS	< 5
1,1-Dichloroethane	90	NS	< 90
1,1-Dichloroethene	7	32 (c)	< 7
1,2-Dichloroethane	5	NS	< 5
Trichloroethene	5	NS	< 5
cis-1,2-Dichloroethene	70	NS	< 70
Vinyl Chloride	2	NS	< 2
Total VOCs	-	100 (d)	< 100
1,4-dioxane	6	NS	< 6

---

a/ All concentrations provided in micrograms per liter (ug/l); NS = no standard; VOCs = volatile organic compounds

b/ NPDES Discharge Permit Limits provided by the site's State Discharge Permit No. 07-DP-3442 and NPDES Permit No. MD 0069094, which was issued on July 1, 2009, and expired on June 30, 2014. No discharge will be performed until the renewed permit is issued by MDE.

c/ NPDES permit monthly average concentration maximum.

d/ NPDES permit daily maximum concentration limit.

Appendix A – Engineering Design Drawings and Calculations

INDEX OF DRAWINGS

DRAWING NUMBER	SHEET NUMBER	DESCRIPTION
00003705-D41	1	TITLE SHEET
00003705-D42	2	GROUNDWATER COLLECTION AND TREATMENT SYSTEM PLAN
00003705-D43	3	PUMP INSTALLATION, PIPING, WELL VAULT, AND MISCELLANEOUS DETAILS
00003705-D44	4	CLEANOUT VAULT AND MISCELLANEOUS DETAILS
00003705-D45	5	GROUNDWATER TREATMENT PROCESSES

TITLE SHEET

GROUNDWATER COLLECTION AND TREATMENT SYSTEM

FORMER KOP-FLEX FACILITY
HANOVER, MARYLAND

PREPARED FOR

EMERSON
ST. LOUIS, MISSOURI

D

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STEPHEN JAMES KRETSCHMAN 43362

SJ Kretsch

5/19/2015
DATE

DRAWN BY	RA 04/15/2015
CHECKED	SJK 05/18/2015
APPROVED	SJK 05/18/2015

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TITLE SHEET

GROUNDWATER COLLECTION AND TREATMENT SYSTEM
FORMER KOP-FLEX FACILITY
HANOVER, MARYLAND
PREPARED FOR
EMERSON
ST. LOUIS, MISSOURI

WSP

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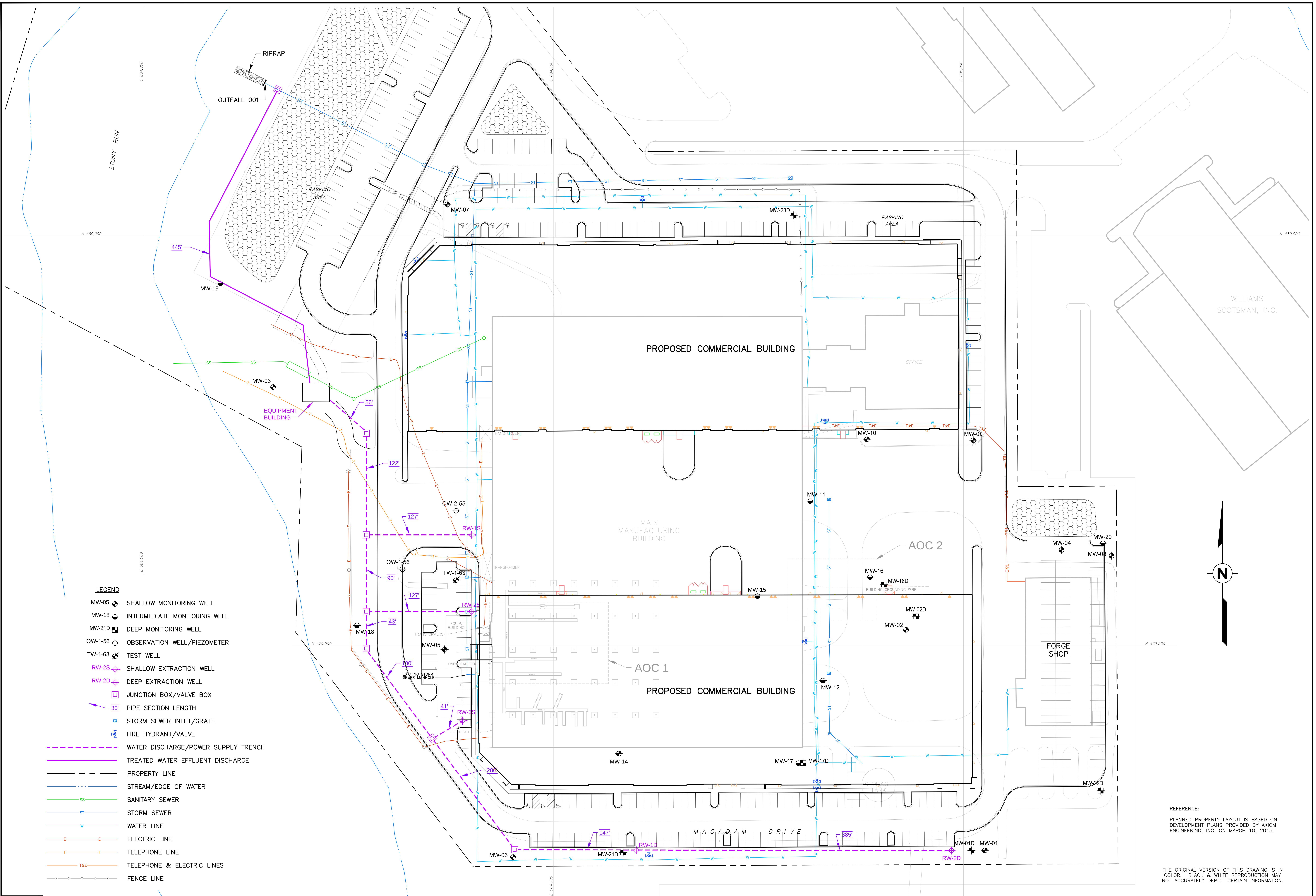
SHEET 1

Drawing Number
00003705-D41



REFERENCE:

PLANNED PROPERTY LAYOUT IS BASED ON DEVELOPMENT PLANS PROVIDED BY AXIOM ENGINEERING, INC. ON MARCH 18, 2015.

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5/19/2015
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GROUNDWATER COLLECTION AND TREATMENT SYSTEM PLAN

FORMER KOP-FLEX FACILITY
HANOVER, MARYLAND

PREPARED FOR
EMERSON
ST. LOUIS, MISSOURI

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SHEET 2

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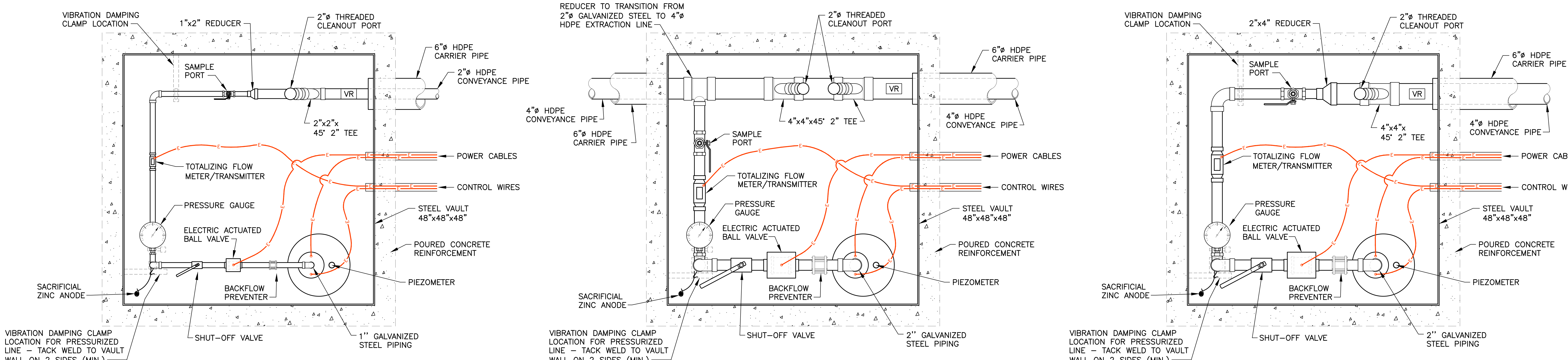


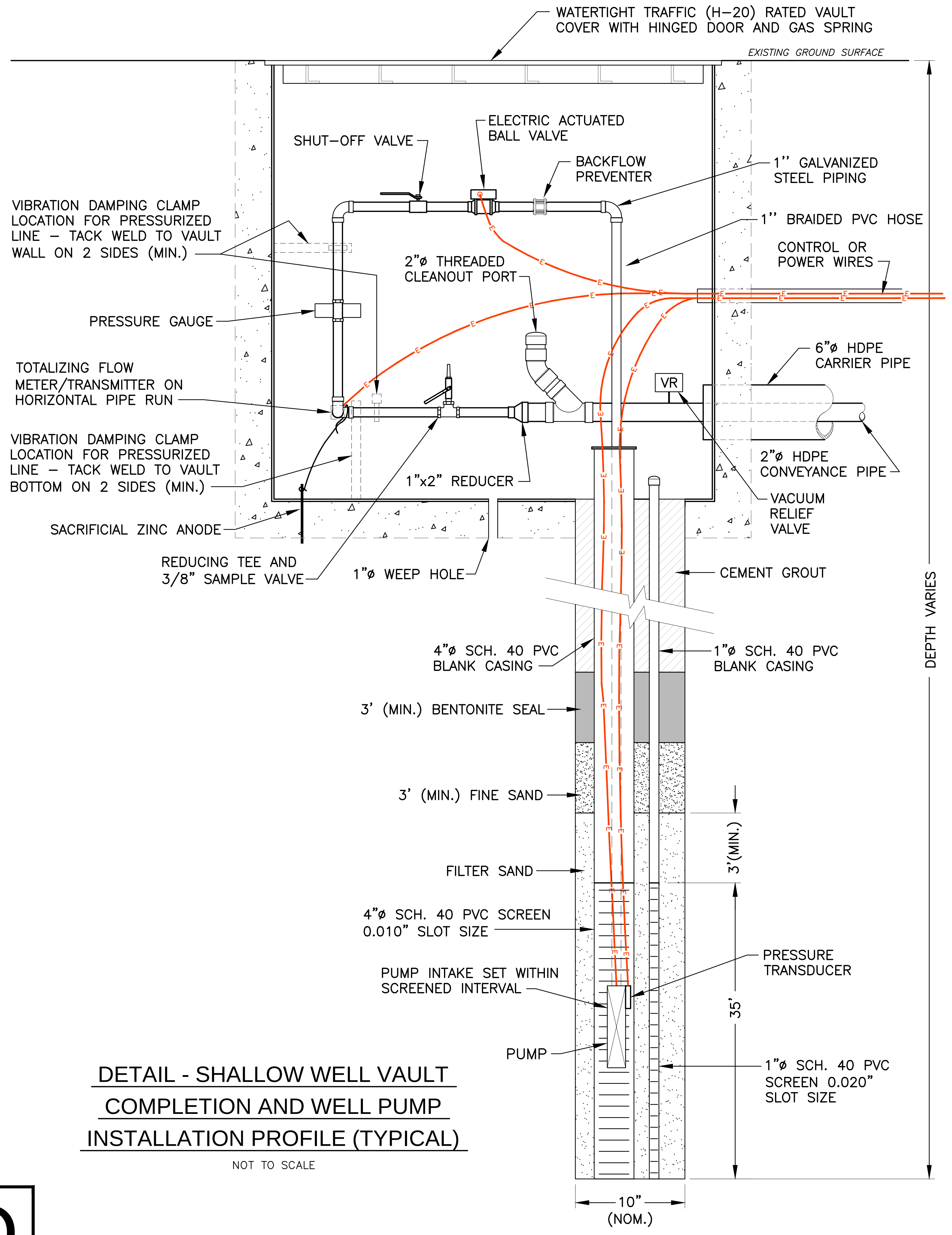
WELL VAULTS RW-1S, 2S, AND 3S

WELL VAULT RW-1D

WELL VAULT RW-2D

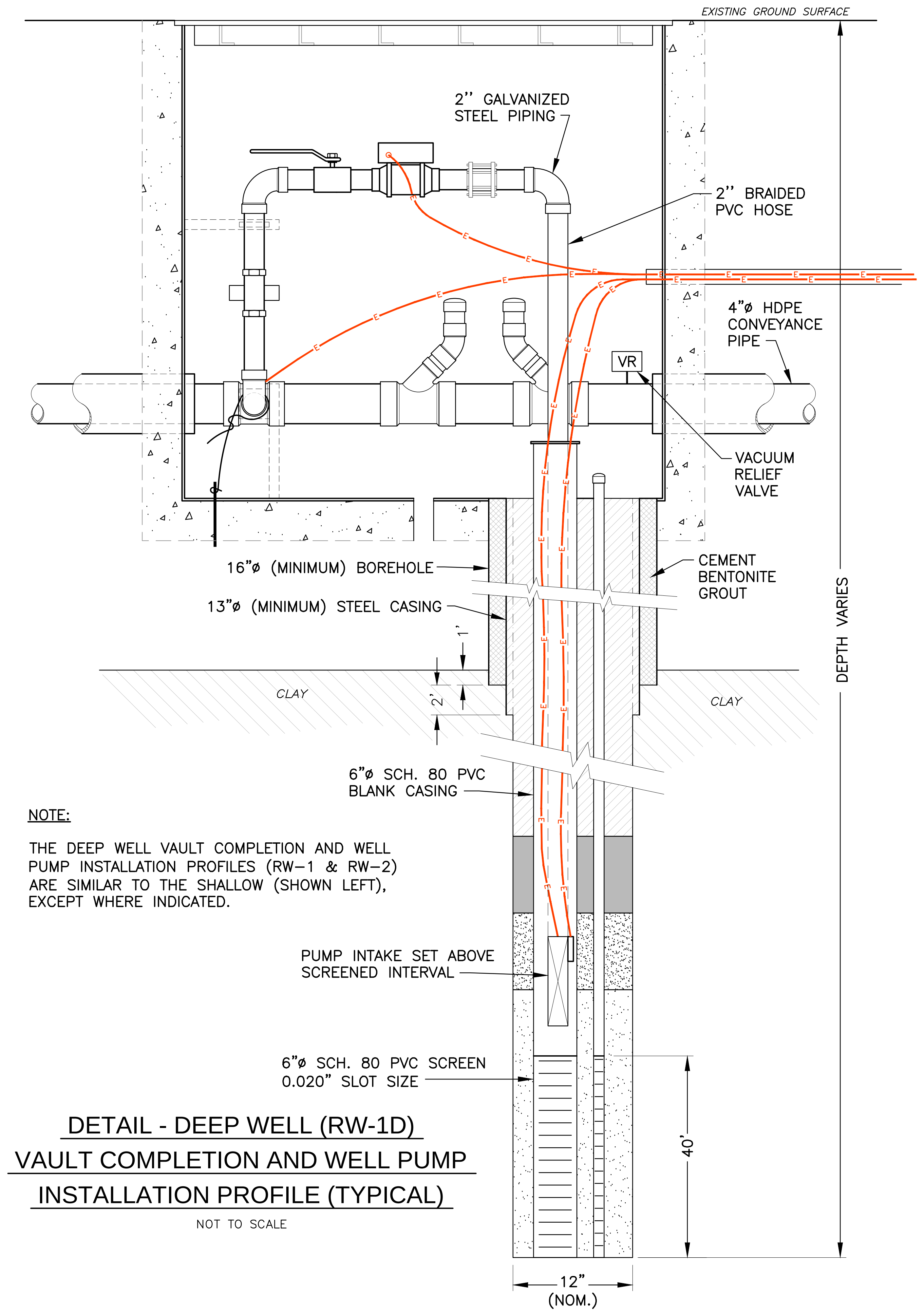
WELL VAULT COMPLETION AND WELL PUMP INSTALLATION PLAN DETAILS (TYPICAL)

NOT TO SCALE



DETAIL - SHALLOW WELL VAULT COMPLETION AND WELL PUMP INSTALLATION PROFILE (TYPICAL)

NOT TO SCALE

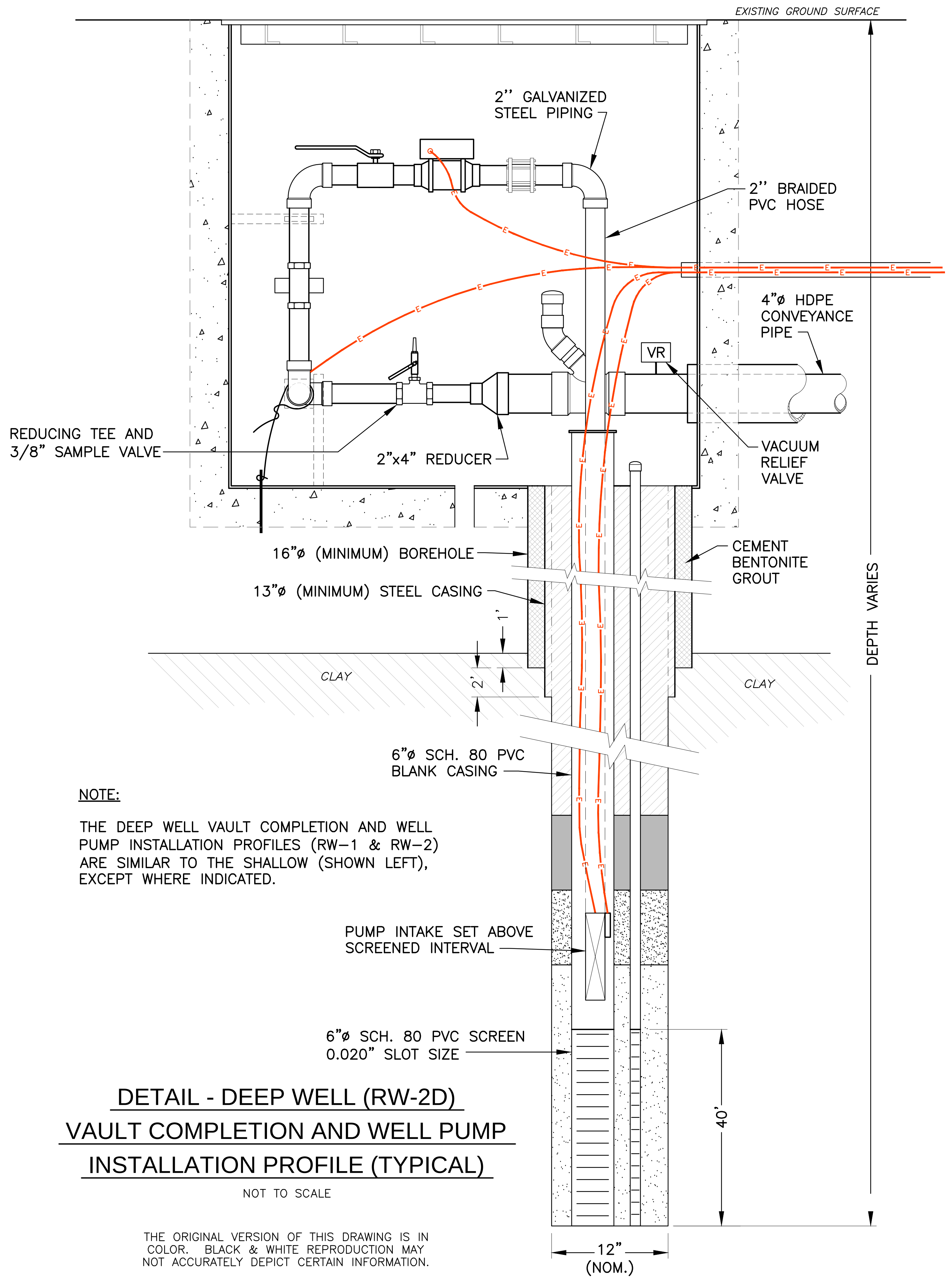


NOTE:

THE DEEP WELL VAULT COMPLETION AND WELL PUMP INSTALLATION PROFILES (RW–1 & RW–2) ARE SIMILAR TO THE SHALLOW (SHOWN LEFT), EXCEPT WHERE INDICATED.

DETAIL - DEEP WELL (RW-1D) VAULT COMPLETION AND WELL PUMP INSTALLATION PROFILE (TYPICAL)

NOT TO SCALE



NOTE:

THE DEEP WELL VAULT COMPLETION AND WELL PUMP INSTALLATION PROFILES (RW–1 & RW–2) ARE SIMILAR TO THE SHALLOW (SHOWN LEFT), EXCEPT WHERE INDICATED.

DETAIL - DEEP WELL (RW-2D) VAULT COMPLETION AND WELL PUMP INSTALLATION PROFILE (TYPICAL)

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PUMP INSTALLATION, PIPING, WELL VAULT, AND MISCELLANEOUS DETAILS

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SHEET 3

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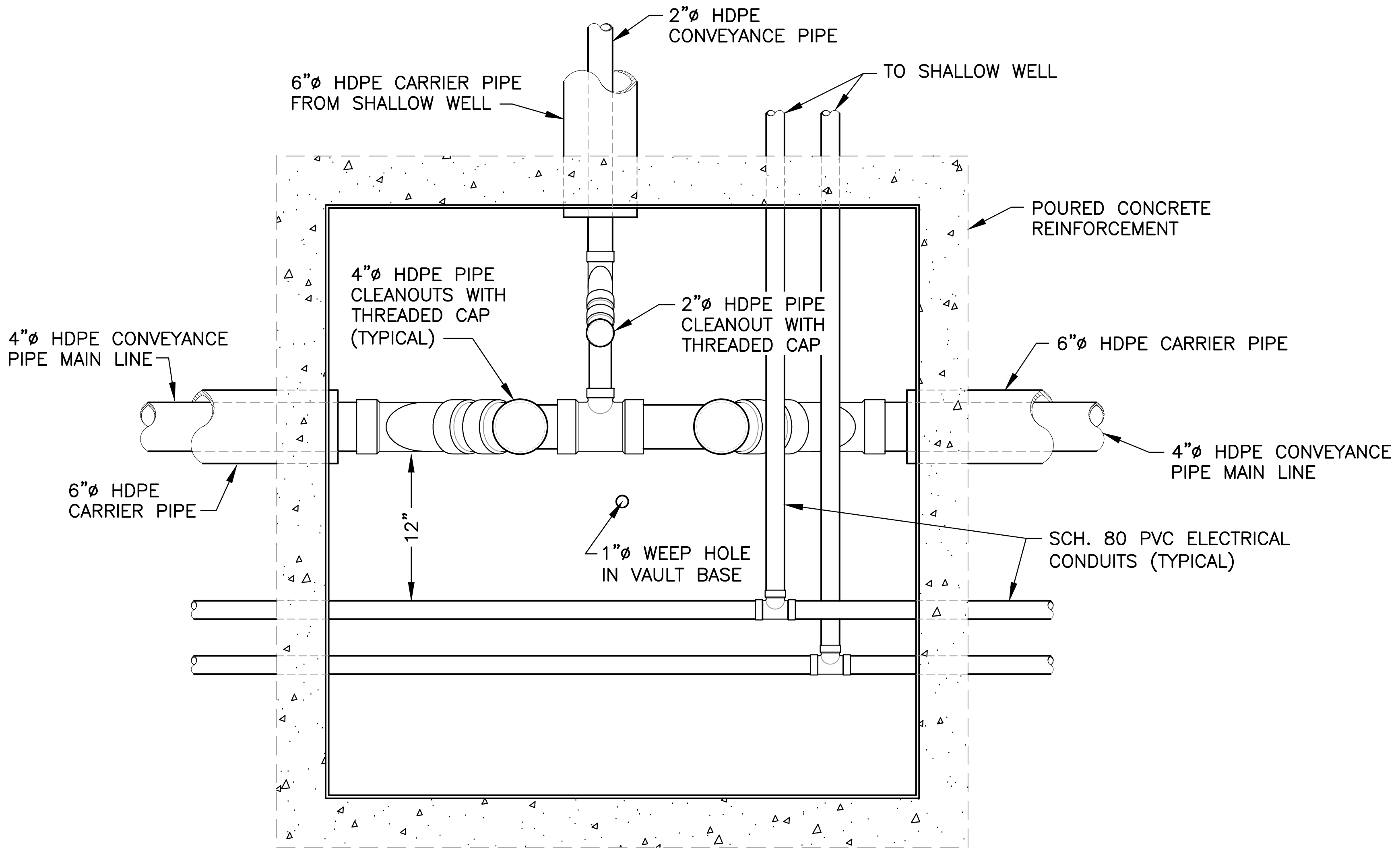
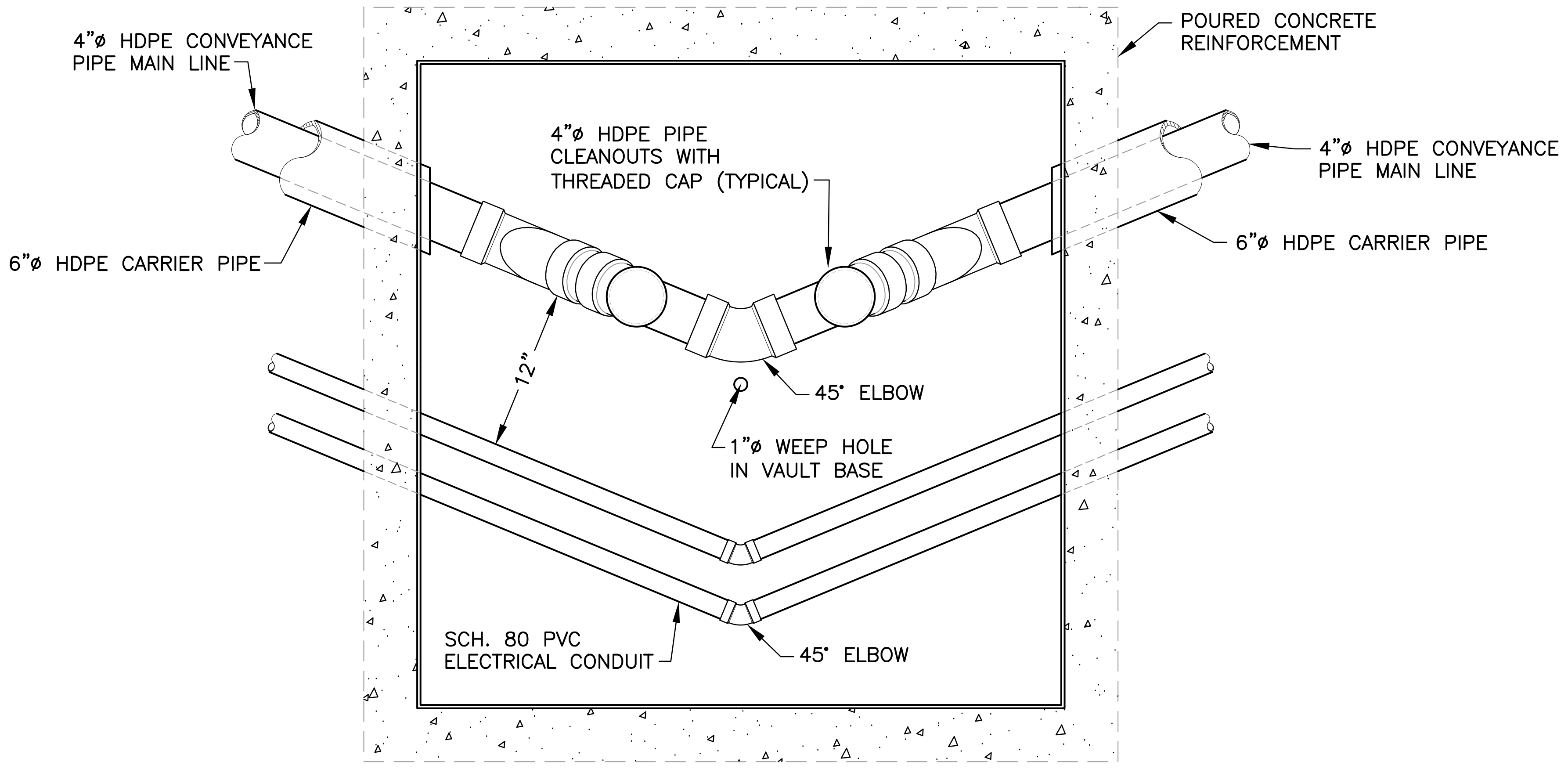


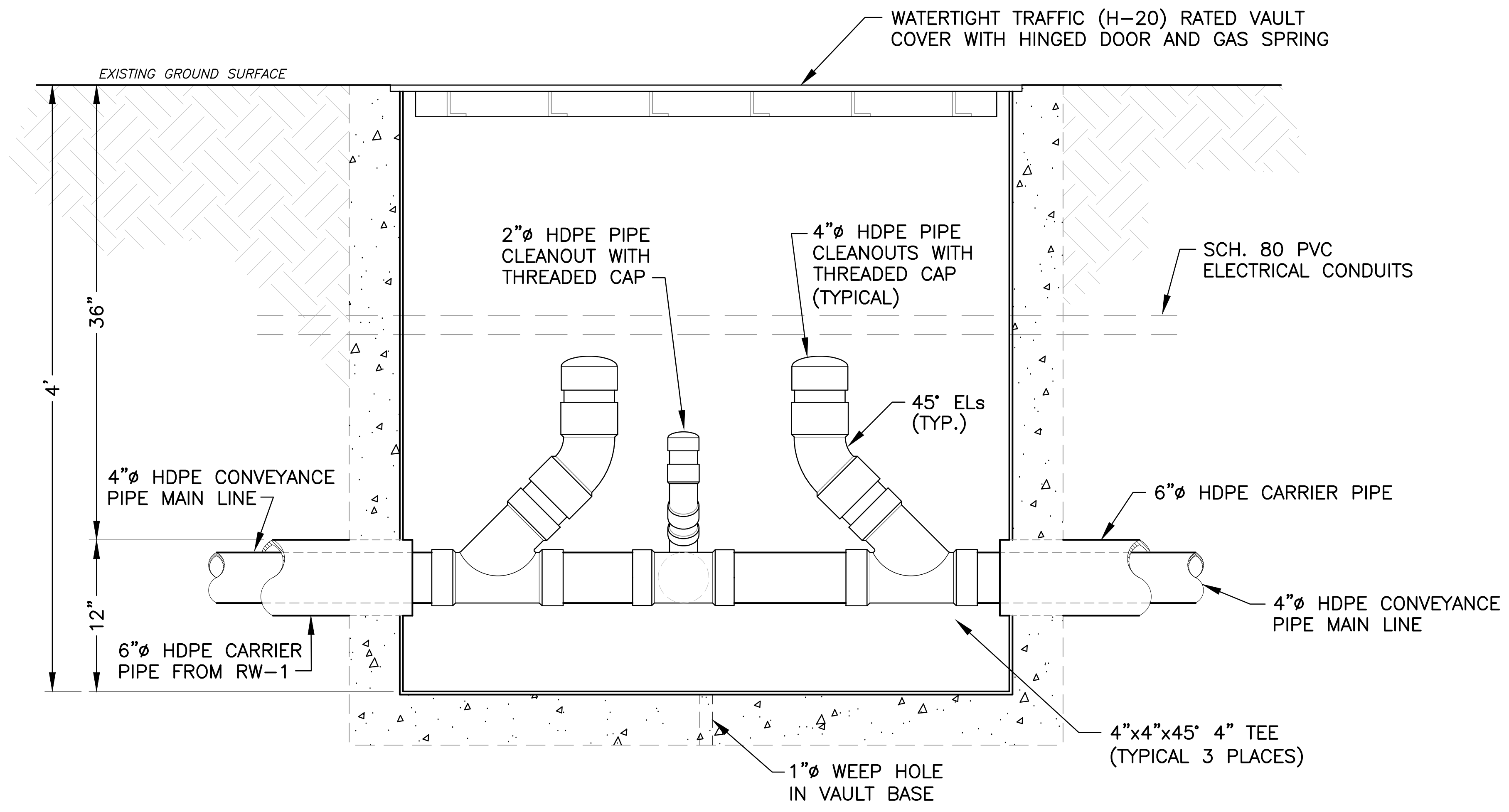
TEE CLEANOUT VAULT / JUNCTION BOX PLAN VIEW

APPROXIMATE SCALE, INCHES
0 10 20



45° CLEANOUT VAULT PLAN VIEW

APPROXIMATE SCALE, INCHES
0 10 20



TEE CLEANOUT VAULT / JUNCTION BOX PROFILE

APPROXIMATE SCALE, INCHES
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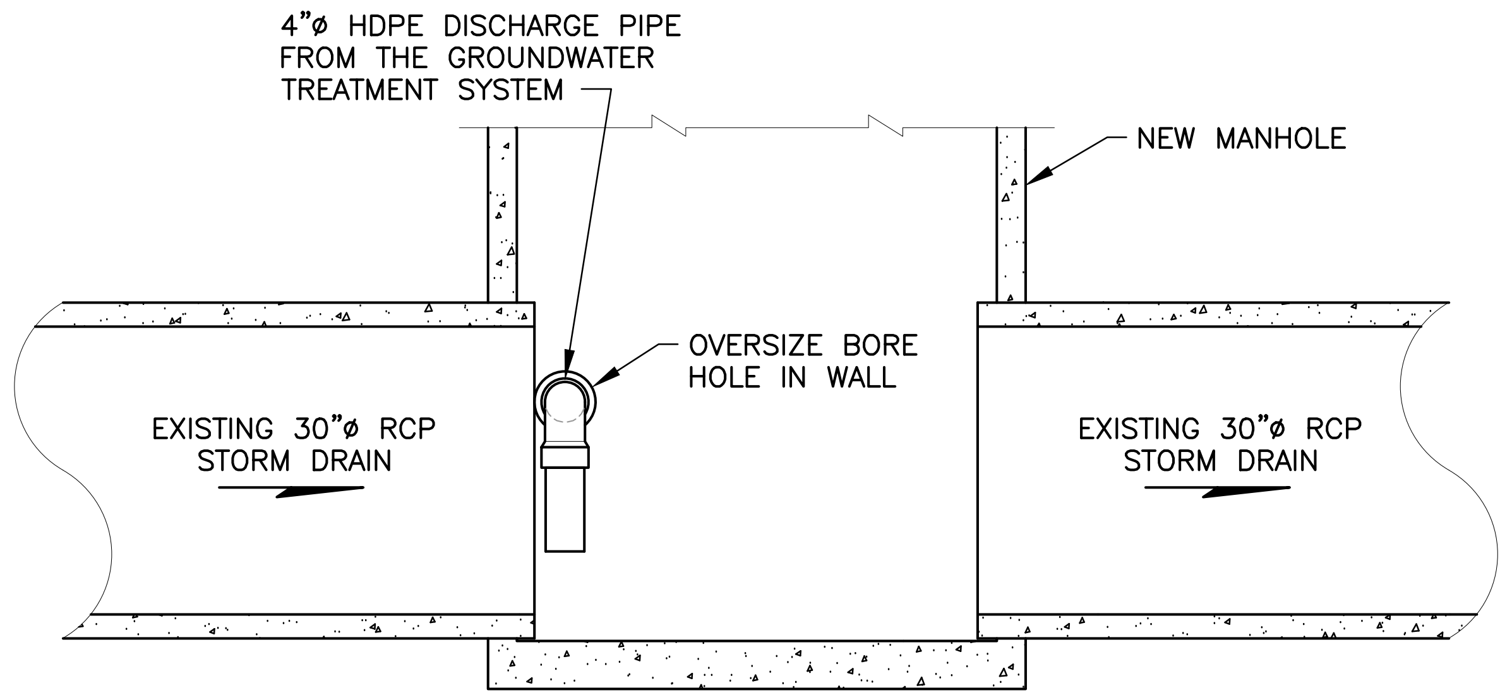
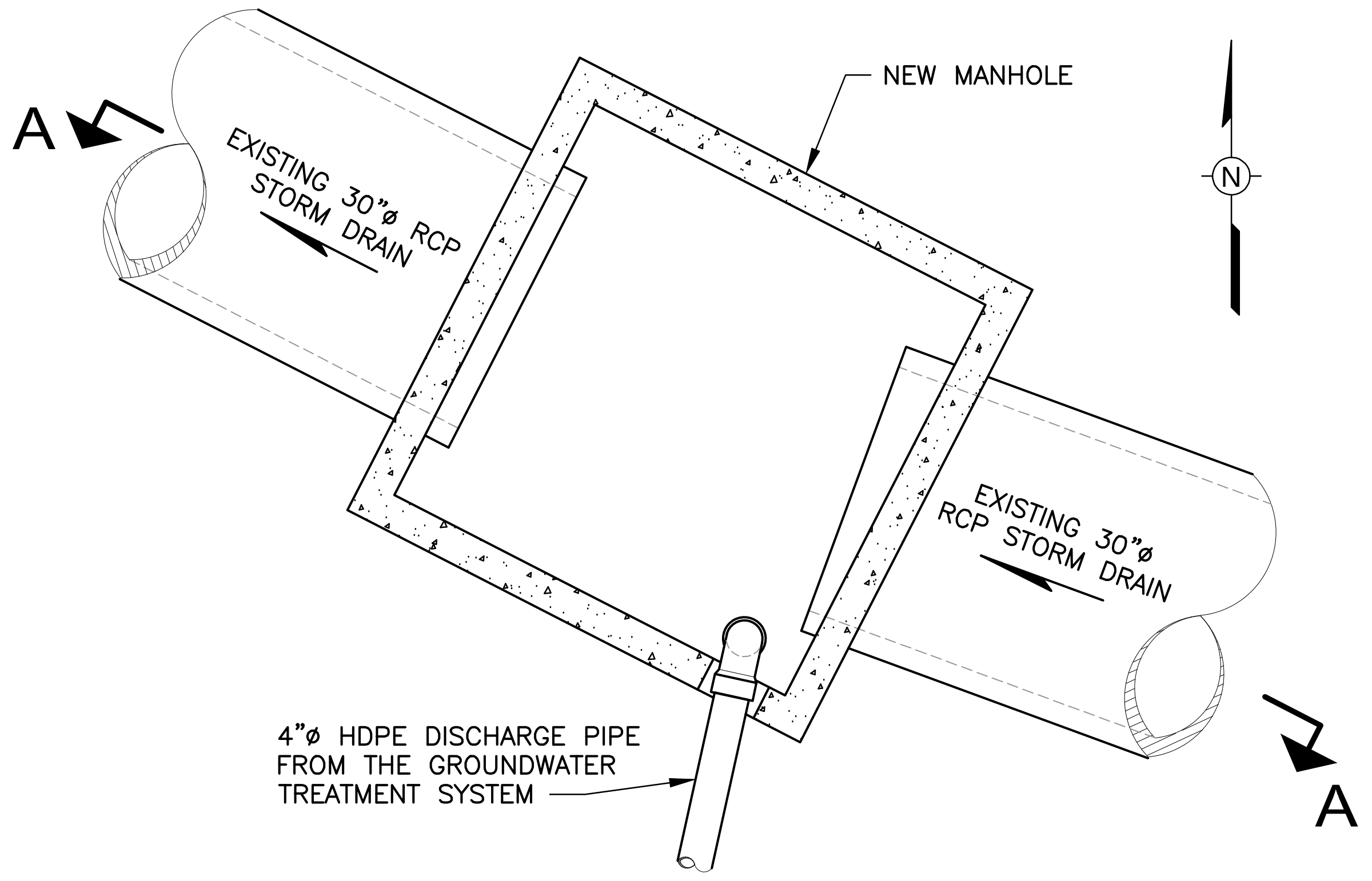


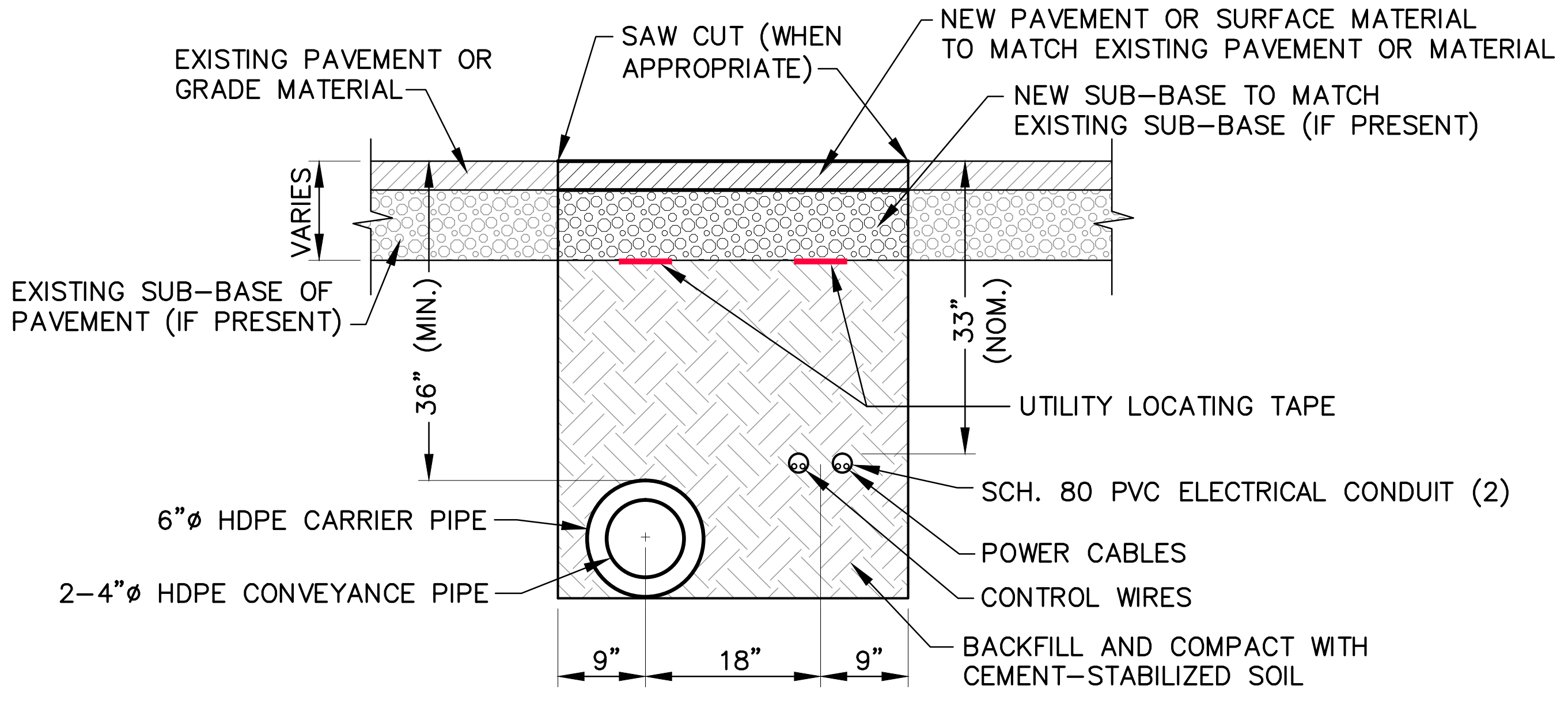
DETAIL - DISCHARGE MANHOLE SECTION A-A

NOT TO SCALE



DISCHARGE MANHOLE PLAN VIEW

NOT TO SCALE



TYPICAL TRENCH SECTION

NOT TO SCALE

(WATER CONVEYANCE & CARRIER PIPES, CONTROL WIRES & POWER CABLES, AND CONDUITS)

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DJ Kretsch
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CLEANOUT VAULT AND MISCELLANEOUS DETAILS

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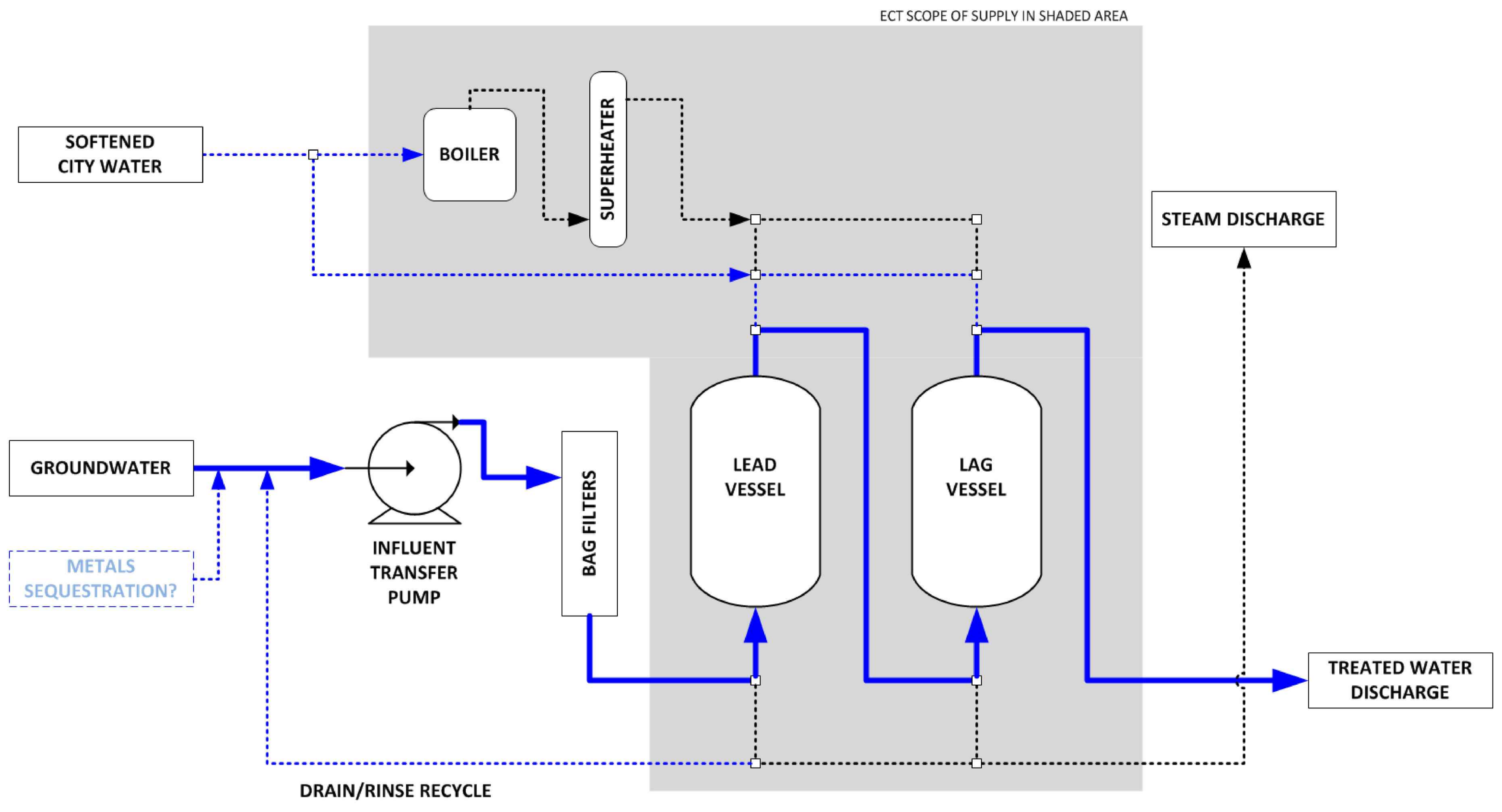
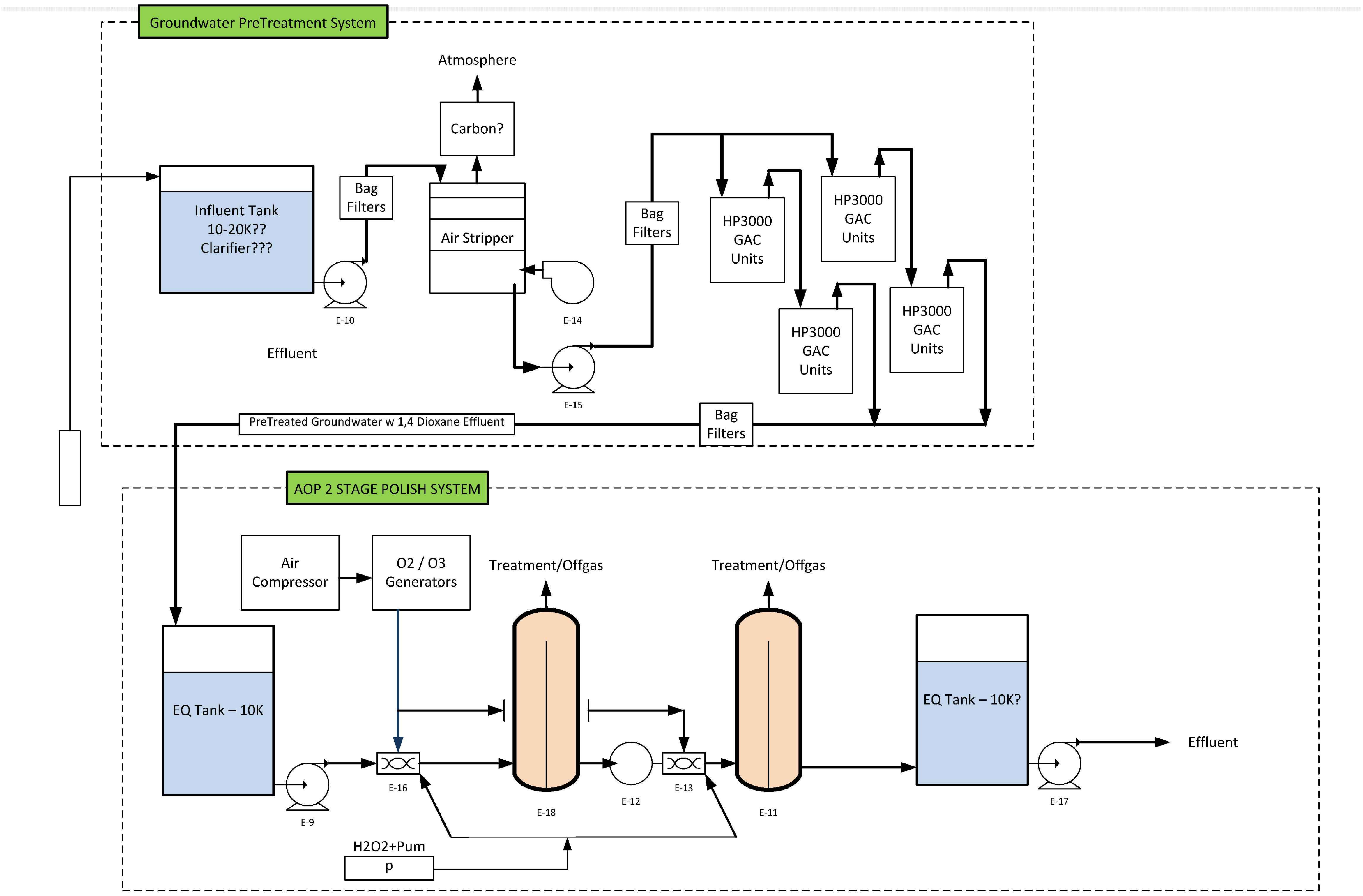


PRELIMINARY GROUNDWATER TREATMENT DESIGN

SYNTHETIC RESIN PROCESS



ALTERNATE GROUNDWATER TREATMENT DESIGN

ADVANCED OXIDATION PROCESS

NOTE:

THE GROUNDWATER TREATMENT PROCESS WILL BE SELECTED FOLLOWING PRE-DESIGN TESTING. SEE THE RESPONSE ACTION PLAN FOR MORE INFORMATION.

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43392

5/19/2015

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GROUNDWATER TREATMENT PROCESSES

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SHEET 5

Drawing Number
00003705–D45

Appendix B – Analytical Results

Analytical Report for

WSP Environment & Energy - Reston

Certificate of Analysis No.: 13121306

Project Manager: James Edwards
Project Name : Kop-Flex
Project Location: Hanover, MD
Project ID : 3705-07

December 20, 2013
Phase Separation Science, Inc.
6630 Baltimore National Pike
Baltimore, MD 21228
Phone: (410) 747-8770
Fax: (410) 788-8723

OFFICES:
6630 BALTIMORE NATIONAL PIKE
ROUTE 40 WEST
BALTIMORE, MD 21228
410-747-8770
800-932-9047
FAX 410-788-8723

PHASE SEPARATION SCIENCE, INC.

December 20, 2013

James Edwards
WSP Environment & Energy - Reston
11190 Sunrise Valley Dr., Ste. 300
Reston, VA 20191

Reference: PSS Work Order(s) No: **13121306**
Project Name: Kop-Flex
Project Location: Hanover, MD
Project ID.: 3705-07

Dear James Edwards :

This report includes the analytical results from the analyses performed on the samples received under the project name referenced above and identified with the Phase Separation Science (PSS) Work Order(s) numbered **13121306**.

All work reported herein has been performed in accordance with current NELAP standards, referenced methodologies, PSS Standard Operating Procedures and the PSS Quality Assurance Manual unless otherwise noted in the Case Narrative Summary. PSS is limited in liability to the actual cost of the sample analysis done.

PSS reserves the right to return any unused samples, extracts or related solutions. Otherwise, the samples are scheduled for disposal, without any further notice, on January 17, 2014. This includes any samples that were received with a request to be held but lacked a specific hold period. It is your responsibility to provide a written request defining a specific disposal date if additional storage is required. Upon receipt , the request will be acknowledged by PSS, thus extending the storage period.

This report shall not be reproduced except in full, without the written approval of an authorized PSS representative. A copy of this report will be retained by PSS for at least 5 years, after which time it will be disposed of without further notice, unless prior arrangements have been made.

We thank you for selecting Phase Separation Science, Inc. to serve your analytical needs. If you have any questions concerning this report, do not hesitate to contact us at 410-747-8770 or info@phaseonline.com.

Sincerely,

Dan Prucnal

Dan Prucnal
Laboratory Manager

Sample Summary

Client Name: WSP Environment & Energy - Reston

Project Name: Kop-Flex

Work Order Number(s): 13121306

Project ID: 3705-07

The following samples were received under chain of custody by Phase Separation Science (PSS) on 12/13/2013 at 11:39 am

Lab Sample Id	Sample Id	Matrix	Date/Time Collected
13121306-001	MW-26D	WATER	12/12/13 09:00
13121306-002	MW-26D	WATER	12/12/13 09:00
13121306-003	MW-21D	WATER	12/12/13 10:55
13121306-004	MW-21D	WATER	12/12/13 10:55
13121306-005	MW-1D	WATER	12/12/13 15:55
13121306-006	MW-1D	WATER	12/12/13 15:55
13121306-007	MW-17D	WATER	12/13/13 09:20
13121306-008	MW-17D	WATER	12/13/13 09:20
13121306-009	MW-22D	WATER	12/12/13 12:55
13121306-010	MW-22D	WATER	12/12/13 12:55
13121306-011	MW-2D	WATER	12/11/13 16:40
13121306-012	MW-2D	WATER	12/11/13 16:40
13121306-013	MW-16D	WATER	12/11/13 11:02
13121306-014	MW-16D	WATER	12/11/13 11:02

Please reference the Chain of Custody and Sample Receipt Checklist for specific container counts and preservatives. Any sample conditions not in compliance with sample acceptance criteria are described in Case Narrative Summary.

Notes:

1. The presence of a common laboratory contaminant such as methylene chloride may be considered a possible laboratory artifact. Where observed, appropriate consideration of data should be taken.
2. The following analytical results are never reported on a dry weight basis: pH, flashpoint, moisture and paint filter test.
3. Drinking water samples collected for the purpose of compliance with SDWA may not be suitable for their intended use unless collected by a certified sampler [COMAR 26.08.05.07.C.2].
4. The analyses of 1,2-dibromo-3-chloropropane (DBCP) and 1,2-dibromoethane (EDB) by EPA 524.2 and calcium, magnesium, sodium and iron by EPA 200.8 are not currently promulgated for use in testing to meet the Safe Drinking Water Act and as such cannot be used for compliance purposes. The listings of the current promulgated methods for testing in compliance with the Safe Drinking Water Act can be found in the 40 CFR part 141.1, for the primary drinking water contaminates, and part 141.3, for the secondary drinking water contaminates.
5. The analyses of chlorine, pH, dissolved oxygen, temperature and sulfite for non-potable water samples tested for compliance for Virginia Pollution Discharge Elimination System (VDPES) permits and Virginia Pollutant Abatement (VPA) permits, have a maximum holding time of 15 minutes established by 40CFR136.3.
6. Sample prepared under EPA 3550C with concentrations greater than 20 mg/Kg should employ the microtip extraction procedure if required to meet data quality objectives.

Standard Flags/Abbreviations:

B	A target analyte or common laboratory contaminant was identified in the method blank. Its presence indicates possible field or laboratory contamination.
C	Results Pending Final Confirmation.
E	The data exceeds the upper calibration limit; therefore, the concentration is reported as estimated.
Fail	The result exceeds the regulatory level for Toxicity Characteristic (TCLP) as cited in 40 CFR 261.24 Table 1.
J	The target analyte was positively identified below the reporting limit but greater than the LOD.
LOD	Limit of Detection. An estimate of the minimum amount of a substance that an analytical process can reliably detect. An LOD is analyte and matrix specific.
ND	Not Detected at or above the reporting limit.
RL	PSS Reporting Limit.
U	Not detected.

Sample Summary

Client Name: WSP Environment & Energy - Reston

Project Name: Kop-Flex

Work Order Number(s): **13121306**

Certifications:

NELAP Certifications: PA 68-03330, VA 2200
State Certifications: MD 179, WV 303
Regulated Soil Permit: P330-12-00268
NSWC USCG Accepted Laboratory
LDBA MWAA LD1997-0041-2015

CERTIFICATE OF ANALYSIS

No: 13121306

WSP Environment & Energy - Reston, Reston, VA

December 20, 2013

Project Name: Kop-Flex
Project Location: Hanover, MD
Project ID: 3705-07

Sample ID: **MW-26D** **Date/Time Sampled:** **12/12/2013 09:00** **PSS Sample ID:** **13121306-001**
Matrix: **WATER** **Date/Time Received:** **12/13/2013 11:39**

Total Cu, Pb, Zn, Fe, Mn, Ni + Hardness Analytical Method: EPA 200.8 Preparation Method: 200.8

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Copper	**6.3**	ug/L	1.0		1	12/16/13	12/20/13 13:57	1034
Iron	**200**	ug/L	100		1	12/16/13	12/17/13 19:56	1034
Lead	ND	ug/L	1.0		1	12/16/13	12/17/13 19:56	1034
Manganese	**12**	ug/L	1.0		1	12/16/13	12/17/13 19:56	1034
Nickel	**6.1**	ug/L	1.0		1	12/16/13	12/17/13 19:56	1034
Zinc	**35**	ug/L	20		1	12/16/13	12/17/13 19:56	1034
Hardness (Ca & Mg)	**16**	mg/L	0.66		1	12/16/13	12/17/13 19:56	1034

Alkalinity Analytical Method: EPA 310.2 Preparation Method: ALKALINITY

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Alkalinity, Total (CaCO3)	**13**	mg/L	10		1	12/20/13	12/20/13 12:24	1044

Sample ID: **MW-26D** **Date/Time Sampled:** **12/12/2013 09:00** **PSS Sample ID:** **13121306-002**
Matrix: **WATER** **Date/Time Received:** **12/13/2013 11:39**

Dissolved Cu, Pb, Zn, Fe, Mn, Ni Analytical Method: EPA 200.8 Preparation Method: 200.8

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Copper	**1.4**	ug/L	1.0		1	12/18/13	12/18/13 18:01	1034
Iron	ND	ug/L	100		1	12/18/13	12/18/13 18:01	1034
Lead	ND	ug/L	1.0		1	12/18/13	12/18/13 18:01	1034
Manganese	**8.7**	ug/L	1.0		1	12/18/13	12/18/13 18:01	1034
Nickel	**6.2**	ug/L	1.0		1	12/18/13	12/18/13 18:01	1034
Zinc	ND	ug/L	20		1	12/18/13	12/18/13 18:01	1034

CERTIFICATE OF ANALYSIS

No: 13121306

WSP Environment & Energy - Reston, Reston, VA

December 20, 2013

Project Name: Kop-Flex
Project Location: Hanover, MD
Project ID: 3705-07

Sample ID: MW-21D **Date/Time Sampled: 12/12/2013 10:55** **PSS Sample ID: 13121306-003**
Matrix: WATER **Date/Time Received: 12/13/2013 11:39**

Total Cu, Pb, Zn, Fe, Mn, Ni + Hardness Analytical Method: EPA 200.8 Preparation Method: 200.8

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Copper	**2.7**	ug/L	1.0		1	12/16/13	12/20/13 14:03	1034
Iron	**150**	ug/L	100		1	12/16/13	12/17/13 20:26	1034
Lead	ND	ug/L	1.0		1	12/16/13	12/17/13 20:26	1034
Manganese	**5.6**	ug/L	1.0		1	12/16/13	12/17/13 20:26	1034
Nickel	**3.1**	ug/L	1.0		1	12/16/13	12/17/13 20:26	1034
Zinc	ND	ug/L	20		1	12/16/13	12/17/13 20:26	1034
Hardness (Ca & Mg)	**8.8**	mg/L	0.66		1	12/16/13	12/17/13 20:26	1034

Alkalinity Analytical Method: EPA 310.2 Preparation Method: ALKALINITY

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Alkalinity, Total (CaCO3)	ND	mg/L	10		1	12/20/13	12/20/13 12:26	1044

Sample ID: MW-21D **Date/Time Sampled: 12/12/2013 10:55** **PSS Sample ID: 13121306-004**
Matrix: WATER **Date/Time Received: 12/13/2013 11:39**

Dissolved Cu, Pb, Zn, Fe, Mn, Ni Analytical Method: EPA 200.8 Preparation Method: 200.8

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Copper	**1.8**	ug/L	1.0		1	12/18/13	12/18/13 18:43	1034
Iron	ND	ug/L	100		1	12/18/13	12/18/13 18:43	1034
Lead	ND	ug/L	1.0		1	12/18/13	12/18/13 18:43	1034
Manganese	**3.7**	ug/L	1.0		1	12/18/13	12/18/13 18:43	1034
Nickel	**3.5**	ug/L	1.0		1	12/18/13	12/18/13 18:43	1034
Zinc	ND	ug/L	20		1	12/18/13	12/18/13 18:43	1034

CERTIFICATE OF ANALYSIS

No: 13121306
WSP Environment & Energy - Reston, Reston, VA
December 20, 2013

Project Name: Kop-Flex
Project Location: Hanover, MD
Project ID: 3705-07

Sample ID: MW-1D **Date/Time Sampled: 12/12/2013 15:55** **PSS Sample ID: 13121306-005**
Matrix: WATER **Date/Time Received: 12/13/2013 11:39**

Total Cu, Pb, Zn, Fe, Mn, Ni + Hardness Analytical Method: EPA 200.8 Preparation Method: 200.8

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Copper	**29**	ug/L	1.0		1	12/16/13	12/17/13 20:32	1034
Iron	**430**	ug/L	100		1	12/16/13	12/17/13 20:32	1034
Lead	**2.0**	ug/L	1.0		1	12/16/13	12/17/13 20:32	1034
Manganese	**60**	ug/L	1.0		1	12/16/13	12/17/13 20:32	1034
Nickel	**22**	ug/L	1.0		1	12/16/13	12/17/13 20:32	1034
Zinc	**44**	ug/L	20		1	12/16/13	12/17/13 20:32	1034
Hardness (Ca & Mg)	**17**	mg/L	2.9		1	12/16/13	12/17/13 20:32	1034

Alkalinity Analytical Method: EPA 310.2 Preparation Method: ALKALINITY

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Alkalinity, Total (CaCO3)	**17**	mg/L	10		1	12/20/13	12/20/13 12:27	1044

Sample ID: MW-1D **Date/Time Sampled: 12/12/2013 15:55** **PSS Sample ID: 13121306-006**
Matrix: WATER **Date/Time Received: 12/13/2013 11:39**

Dissolved Cu, Pb, Zn, Fe, Mn, Ni Analytical Method: EPA 200.8 Preparation Method: 200.8

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Copper	**4.3**	ug/L	1.0		1	12/18/13	12/18/13 18:49	1034
Iron	**130**	ug/L	100		1	12/18/13	12/18/13 18:49	1034
Lead	ND	ug/L	1.0		1	12/18/13	12/18/13 18:49	1034
Manganese	**46**	ug/L	1.0		1	12/18/13	12/18/13 18:49	1034
Nickel	**12**	ug/L	1.0		1	12/18/13	12/18/13 18:49	1034
Zinc	**22**	ug/L	20		1	12/18/13	12/18/13 18:49	1034

CERTIFICATE OF ANALYSIS

No: 13121306
WSP Environment & Energy - Reston, Reston, VA
December 20, 2013

Project Name: Kop-Flex
Project Location: Hanover, MD
Project ID: 3705-07

Sample ID: MW-17D **Date/Time Sampled: 12/13/2013 09:20** **PSS Sample ID: 13121306-007**
Matrix: WATER **Date/Time Received: 12/13/2013 11:39**

Total Cu, Pb, Zn, Fe, Mn, Ni + Hardness Analytical Method: EPA 200.8 Preparation Method: 200.8

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Copper	**22**	ug/L	1.0		1	12/16/13	12/17/13 20:38	1034
Iron	**3,400**	ug/L	100		1	12/16/13	12/17/13 20:38	1034
Lead	**1.3**	ug/L	1.0		1	12/16/13	12/17/13 20:38	1034
Manganese	**150**	ug/L	1.0		1	12/16/13	12/17/13 20:38	1034
Nickel	**20**	ug/L	1.0		1	12/16/13	12/17/13 20:38	1034
Zinc	**47**	ug/L	20		1	12/16/13	12/17/13 20:38	1034
Hardness (Ca & Mg)	**160**	mg/L	25		1	12/16/13	12/17/13 20:38	1034

Alkalinity Analytical Method: EPA 310.2 Preparation Method: ALKALINITY

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Alkalinity, Total (CaCO3)	**140**	mg/L	20		2	12/20/13	12/20/13 12:47	1044

Sample ID: MW-17D **Date/Time Sampled: 12/13/2013 09:20** **PSS Sample ID: 13121306-008**
Matrix: WATER **Date/Time Received: 12/13/2013 11:39**

Dissolved Cu, Pb, Zn, Fe, Mn, Ni Analytical Method: EPA 200.8 Preparation Method: 200.8

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Copper	ND	ug/L	1.0		1	12/18/13	12/18/13 18:55	1034
Iron	ND	ug/L	100		1	12/18/13	12/18/13 18:55	1034
Lead	ND	ug/L	1.0		1	12/18/13	12/18/13 18:55	1034
Manganese	**11**	ug/L	1.0		1	12/18/13	12/18/13 18:55	1034
Nickel	**4.2**	ug/L	1.0		1	12/18/13	12/18/13 18:55	1034
Zinc	ND	ug/L	20		1	12/18/13	12/18/13 18:55	1034

CERTIFICATE OF ANALYSIS

No: 13121306

WSP Environment & Energy - Reston, Reston, VA

December 20, 2013

Project Name: Kop-Flex
Project Location: Hanover, MD
Project ID: 3705-07

Sample ID: MW-22D **Date/Time Sampled: 12/12/2013 12:55** **PSS Sample ID: 13121306-009**
Matrix: WATER **Date/Time Received: 12/13/2013 11:39**

Total Cu, Pb, Zn, Fe, Mn, Ni + Hardness Analytical Method: EPA 200.8 Preparation Method: 200.8

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Copper	**4.7**	ug/L	1.0		1	12/16/13	12/20/13 14:10	1034
Iron	ND	ug/L	100		1	12/16/13	12/17/13 20:44	1034
Lead	ND	ug/L	1.0		1	12/16/13	12/17/13 20:44	1034
Manganese	**11**	ug/L	1.0		1	12/16/13	12/17/13 20:44	1034
Nickel	**9.0**	ug/L	1.0		1	12/16/13	12/17/13 20:44	1034
Zinc	ND	ug/L	20		1	12/16/13	12/17/13 20:44	1034
Hardness (Ca & Mg)	**14**	mg/L	0.66		1	12/16/13	12/17/13 20:44	1034

Alkalinity Analytical Method: EPA 310.2 Preparation Method: ALKALINITY

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Alkalinity, Total (CaCO3)	ND	mg/L	10		1	12/20/13	12/20/13 12:29	1044

Sample ID: MW-22D **Date/Time Sampled: 12/12/2013 12:55** **PSS Sample ID: 13121306-010**
Matrix: WATER **Date/Time Received: 12/13/2013 11:39**

Dissolved Cu, Pb, Zn, Fe, Mn, Ni Analytical Method: EPA 200.8 Preparation Method: 200.8

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Copper	**3.0**	ug/L	1.0		1	12/18/13	12/18/13 19:01	1034
Iron	ND	ug/L	100		1	12/18/13	12/18/13 19:01	1034
Lead	ND	ug/L	1.0		1	12/18/13	12/18/13 19:01	1034
Manganese	**9.0**	ug/L	1.0		1	12/18/13	12/18/13 19:01	1034
Nickel	**7.6**	ug/L	1.0		1	12/18/13	12/18/13 19:01	1034
Zinc	ND	ug/L	20		1	12/18/13	12/18/13 19:01	1034

CERTIFICATE OF ANALYSIS

No: 13121306

WSP Environment & Energy - Reston, Reston, VA

December 20, 2013

Project Name: Kop-Flex
Project Location: Hanover, MD
Project ID: 3705-07

Sample ID: MW-2D **Date/Time Sampled: 12/11/2013 16:40** **PSS Sample ID: 13121306-011**
Matrix: WATER **Date/Time Received: 12/13/2013 11:39**

Total Cu, Pb, Zn, Fe, Mn, Ni + Hardness Analytical Method: EPA 200.8 Preparation Method: 200.8

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Copper	**3.4**	ug/L	1.0		1	12/16/13	12/20/13 14:40	1034
Iron	ND	ug/L	100		1	12/16/13	12/17/13 20:50	1034
Lead	ND	ug/L	1.0		1	12/16/13	12/17/13 20:50	1034
Manganese	**14**	ug/L	1.0		1	12/16/13	12/17/13 20:50	1034
Nickel	**9.5**	ug/L	1.0		1	12/16/13	12/17/13 20:50	1034
Zinc	ND	ug/L	20		1	12/16/13	12/17/13 20:50	1034
Hardness (Ca & Mg)	**16**	mg/L	0.66		1	12/16/13	12/17/13 20:50	1034

Sample ID: MW-2D **Date/Time Sampled: 12/11/2013 16:40** **PSS Sample ID: 13121306-012**
Matrix: WATER **Date/Time Received: 12/13/2013 11:39**

Dissolved Cu, Pb, Zn, Fe, Mn, Ni Analytical Method: EPA 200.8 Preparation Method: 200.8

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Copper	**2.0**	ug/L	1.0		1	12/18/13	12/18/13 19:07	1034
Iron	ND	ug/L	100		1	12/18/13	12/18/13 19:07	1034
Lead	ND	ug/L	1.0		1	12/18/13	12/18/13 19:07	1034
Manganese	**12**	ug/L	1.0		1	12/18/13	12/18/13 19:07	1034
Nickel	**8.1**	ug/L	1.0		1	12/18/13	12/18/13 19:07	1034
Zinc	ND	ug/L	20		1	12/18/13	12/18/13 19:07	1034

Sample ID: MW-16D **Date/Time Sampled: 12/11/2013 11:02** **PSS Sample ID: 13121306-013**
Matrix: WATER **Date/Time Received: 12/13/2013 11:39**

Total Cu, Pb, Zn, Fe, Mn, Ni + Hardness Analytical Method: EPA 200.8 Preparation Method: 200.8

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Copper	**7.3**	ug/L	1.0		1	12/16/13	12/20/13 14:46	1034
Iron	**290**	ug/L	100		1	12/16/13	12/17/13 20:56	1034
Lead	ND	ug/L	1.0		1	12/16/13	12/17/13 20:56	1034
Manganese	**35**	ug/L	1.0		1	12/16/13	12/17/13 20:56	1034
Nickel	**20**	ug/L	1.0		1	12/16/13	12/17/13 20:56	1034
Zinc	**37**	ug/L	20		1	12/16/13	12/17/13 20:56	1034
Hardness (Ca & Mg)	**27**	mg/L	2.9		1	12/16/13	12/17/13 20:56	1034

CERTIFICATE OF ANALYSIS

No: 13121306

WSP Environment & Energy - Reston, Reston, VA

December 20, 2013

Project Name: Kop-Flex
Project Location: Hanover, MD
Project ID: 3705-07

Sample ID: **MW-16D**	**Date/Time Sampled:** **12/11/2013 11:02**	**PSS Sample ID:** **13121306-014**	
Matrix: **WATER**	**Date/Time Received:** **12/13/2013 11:39**		

Dissolved Cu, Pb, Zn, Fe, Mn, Ni | Analytical Method: EPA 200.8 | Preparation Method: 200.8

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Copper	**4.4**	ug/L	1.0		1	12/18/13	12/18/13 19:13	1034
Iron	ND	ug/L	100		1	12/18/13	12/18/13 19:13	1034
Lead	ND	ug/L	1.0		1	12/18/13	12/18/13 19:13	1034
Manganese	**25**	ug/L	1.0		1	12/18/13	12/18/13 19:13	1034
Nickel	**16**	ug/L	1.0		1	12/18/13	12/18/13 19:13	1034
Zinc	**32**	ug/L	20		1	12/18/13	12/18/13 19:13	1034

Case Narrative Summary

Client Name: WSP Environment & Energy - Reston

Project Name: Kop-Flex

Work Order Number(s): 13121306
Project ID: 3705-07

Any holding time exceedances, deviations from the method specifications, regulatory requirements or variations to the procedures outlined in the PSS Quality Assurance Manual are outlined below.

Sample Receipt:

Two coolers were received. All sample receipt conditions were acceptable. The temperatures observed were 5 and 6 degrees C.

General Comments:

Nickel added to metals analysis per client. Hold Alkalinity for sample MW-16D and MW-2D per client.

NELAP accreditation was held for all analyses performed unless noted below. See www.phaseonline.com for complete PSS scope of accreditation.

Analytical Data Package Information Summary

Work Order(s): 13121306
Report Prepared For: WSP Environment & Energy - Reston, Reston
Project Name: Kop-Flex
Project Manager: James Edwards

Method	Client Sample Id	Analysis Type	Lab Sample Id	Analyst	Mtx	Prep Batch	Analytical Batch	Sampled	Prepared	Analyzed
EPA 200.8	MW-26D	Initial	13121306-001	1034	W	48489	110691	12/12/2013	12/16/2013 08:53	12/17/2013 19:56
	MW-21D	Initial	13121306-003	1034	W	48489	110691	12/12/2013	12/16/2013 08:53	12/17/2013 20:26
	MW-1D	Initial	13121306-005	1034	W	48489	110691	12/12/2013	12/16/2013 08:53	12/17/2013 20:32
	MW-17D	Initial	13121306-007	1034	W	48489	110691	12/13/2013	12/16/2013 08:53	12/17/2013 20:38
	MW-22D	Initial	13121306-009	1034	W	48489	110691	12/12/2013	12/16/2013 08:53	12/17/2013 20:44
	MW-2D	Initial	13121306-011	1034	W	48489	110691	12/11/2013	12/16/2013 08:53	12/17/2013 20:50
	MW-16D	Initial	13121306-013	1034	W	48489	110691	12/11/2013	12/16/2013 08:53	12/17/2013 20:56
	48489-1-BKS	BKS	48489-1-BKS	1034	W	48489	110691	--------	12/16/2013 08:53	12/17/2013 18:20
	48489-1-BLK	BLK	48489-1-BLK	1034	W	48489	110691	--------	12/16/2013 08:53	12/17/2013 18:14
	Metals - 3 S	MS	13121207-003 S	1034	W	48489	110691	12/11/2013	12/16/2013 08:53	12/17/2013 18:32
	Outfall-2 S	MS	13121307-002 S	1034	W	48489	110691	12/12/2013	12/16/2013 08:53	12/17/2013 21:14
	Metals - 3 SD	MSD	13121207-003 SD	1034	W	48489	110691	12/11/2013	12/16/2013 08:53	12/17/2013 18:38
	MW-26D	Reanalysis	13121306-001	1034	W	48489	110794	12/12/2013	12/16/2013 08:53	12/20/2013 13:57
	MW-21D	Reanalysis	13121306-003	1034	W	48489	110794	12/12/2013	12/16/2013 08:53	12/20/2013 14:03
	MW-22D	Reanalysis	13121306-009	1034	W	48489	110794	12/12/2013	12/16/2013 08:53	12/20/2013 14:10
	MW-2D	Reanalysis	13121306-011	1034	W	48489	110794	12/11/2013	12/16/2013 08:53	12/20/2013 14:40
	MW-16D	Reanalysis	13121306-013	1034	W	48489	110794	12/11/2013	12/16/2013 08:53	12/20/2013 14:46
	48577-1-BKS	BKS	48577-1-BKS	1034	W	48577	110794	--------	12/20/2013 08:37	12/20/2013 13:34
	48577-1-BLK	BLK	48577-1-BLK	1034	W	48577	110794	--------	12/20/2013 08:37	12/20/2013 13:27
	Outfall-2 DL RE SD	MSD	13121307-002 SD	1034	W	48577	110794	12/12/2013	12/20/2013 08:37	12/20/2013 13:51
EPA 200.8	MW-26D	Initial	13121306-002	1034	W	48534	110738	12/12/2013	12/18/2013 09:19	12/18/2013 18:01
	MW-21D	Initial	13121306-004	1034	W	48534	110738	12/12/2013	12/18/2013 09:19	12/18/2013 18:43
	MW-1D	Initial	13121306-006	1034	W	48534	110738	12/12/2013	12/18/2013 09:19	12/18/2013 18:49
	MW-17D	Initial	13121306-008	1034	W	48534	110738	12/13/2013	12/18/2013 09:19	12/18/2013 18:55
	MW-22D	Initial	13121306-010	1034	W	48534	110738	12/12/2013	12/18/2013 09:19	12/18/2013 19:01
	MW-2D	Initial	13121306-012	1034	W	48534	110738	12/11/2013	12/18/2013 09:19	12/18/2013 19:07
	MW-16D	Initial	13121306-014	1034	W	48534	110738	12/11/2013	12/18/2013 09:19	12/18/2013 19:13
	48534-1-BKS	BKS	48534-1-BKS	1034	W	48534	110738	--------	12/18/2013 09:19	12/18/2013 17:55
	48534-1-BLK	BLK	48534-1-BLK	1034	W	48534	110738	--------	12/18/2013 09:19	12/18/2013 17:49

Analytical Data Package Information Summary

Work Order(s): 13121306
Report Prepared For: WSP Environment & Energy - Reston, Reston
Project Name: Kop-Flex
Project Manager: James Edwards

Method	Client Sample Id	Analysis Type	Lab Sample Id	Analyst	Mtx	Prep Batch	Analytical Batch	Sampled	Prepared	Analyzed
EPA 200.8	MW-26D S	MS	13121306-002 S	1034	W	48534	110738	12/12/2013	12/18/2013 09:19	12/18/2013 18:31
	MW-26 SD	MSD	13121306-002 SD	1034	W	48534	110738	12/12/2013	12/18/2013 09:19	12/18/2013 18:37
EPA 310.2	MW-26D	Initial	13121306-001	1044	W	48586	110791	12/12/2013	12/20/2013 14:09	12/20/2013 12:24
	MW-21D	Initial	13121306-003	1044	W	48586	110791	12/12/2013	12/20/2013 14:09	12/20/2013 12:26
	MW-1D	Initial	13121306-005	1044	W	48586	110791	12/12/2013	12/20/2013 14:09	12/20/2013 12:27
	MW-17D	Initial	13121306-007	1044	W	48586	110791	12/13/2013	12/20/2013 14:09	12/20/2013 12:47
	MW-22D	Initial	13121306-009	1044	W	48586	110791	12/12/2013	12/20/2013 14:09	12/20/2013 12:29
	48586-1-BKS	BKS	48586-1-BKS	1044	W	48586	110791	--------	12/20/2013 14:09	12/20/2013 12:21
	48586-1-BLK	BLK	48586-1-BLK	1044	W	48586	110791	--------	12/20/2013 14:09	12/20/2013 12:20
	48586-1-BSD	BSD	48586-1-BSD	1044	W	48586	110791	--------	12/20/2013 14:09	12/20/2013 12:23
	MW-26 D	MD	13121306-001 D	1044	W	48586	110791	12/12/2013	12/20/2013 14:09	12/20/2013 12:25

Blank Summary 13121306

WSP Environment & Energy - Reston, Reston, VA

Kop-Flex

Analytical Method: **EPA 200.8** Prep Method: E200.8_PREP

Matrix: **WATER**

Sample Id: **48534-1-BLK** Lab Sample Id: **48534-1-BLK**

Date Analyzed: Dec-18-13 17:49 Analyst: 1034 Date Prep: Dec-18-13 09:19 Tech: 1033

Seq Number: 110738

Parameter	Cas Number	Result	RL	LOD	Units	Flag	Dil
Copper	7440-50-8	ND	1.000	0.5000	ug/L	U	1
Iron	7439-89-6	ND	100	50.00	ug/L	U	1
Lead	7439-92-1	ND	1.000	0.5000	ug/L	U	1
Manganese	7439-96-5	ND	1.000	0.5000	ug/L	U	1
Nickel	7440-02-0	ND	1.000	0.5000	ug/L	U	1
Zinc	7440-66-6	ND	20.00	10.00	ug/L	U	1
Hardness (Ca & Mg)	HARDCAM(	ND	0.7000	0.7000	mg/L	U	1

Blank Summary 13121306

WSP Environment & Energy - Reston, Reston, VA

Kop-Flex

Analytical Method: **EPA 200.8** Prep Method: E200.8_PREP

Matrix: **WATER**

Sample Id: **48489-1-BLK** Lab Sample Id: **48489-1-BLK**

Date Analyzed: Dec-17-13 18:14 Analyst: 1034 Date Prep: Dec-16-13 08:53 Tech: 1034

Seq Number: 110691

Parameter	**Cas Number**	**Result**	**RL**	**LOD**	**Units**	**Flag**	**Dil**
Calcium	7440-70-2	ND	100	50.00	ug/L	U	1
Copper	7440-50-8	1.320	1.000	0.5000	ug/L		1
Iron	7439-89-6	ND	100	50.00	ug/L	U	1
Lead	7439-92-1	ND	1.000	0.5000	ug/L	U	1
Magnesium	7439-95-4	ND	100	50.00	ug/L	U	1
Manganese	7439-96-5	ND	1.000	0.5000	ug/L	U	1
Nickel	7440-02-0	ND	1.000	0.5000	ug/L	U	1
Zinc	7440-66-6	ND	20.00	10.00	ug/L	U	1
Hardness (Ca & Mg)	HARDCAM(	ND	0.7000	0.7000	mg/L	U	1

Sample Id: **48577-1-BLK** Lab Sample Id: **48577-1-BLK**

Date Analyzed: Dec-20-13 13:27 Analyst: 1034 Date Prep: Dec-20-13 08:37 Tech: 1034

Seq Number: 110794

Parameter	**Cas Number**	**Result**	**RL**	**LOD**	**Units**	**Flag**	**Dil**
Copper	7440-50-8	ND	1.000	0.5000	ug/L	U	1

Blank Summary 13121306

WSP Environment & Energy - Reston, Reston, VA

Kop-Flex

Analytical Method: **EPA 310.2**
Prep Method: Alkalinity_Prep
Matrix: **WATER**

Sample Id: **48586-1-BLK**
Lab Sample Id: **48586-1-BLK**
Date Analyzed: Dec-20-13 12:20
Analyst: 1044
Seq Number: 110791
Date Prep: Dec-20-13 14:09
Tech: 1044

Parameter	Cas Number	Result	RL	LOD	Units	Flag	Dil
Alkalinity, Total (CaCO3)		ND	10.00	10.00	mg/L	U	1

Blank Spike Recovery

Project Name: Kop-Flex

Work Order #: 13121306 **Project ID:** 3705-07

Prep Batch #: 48534 **Date Prepared:** 12/18/2013 09:19 **Sample ID:** 48534-1-BKS **Matrix:** Water

Lab Batch ID: 110738 **Date Analyzed:** 12/18/2013 17:49 **Analyst:** 1034

Reporting Units: ug/L

BLANK /BLANK SPIKE RECOVERY STUDY

Dissolved Cu, Pb, Zn, Fe, Mn, Ni Analytes	Blank Result [A]	Spike Added [B]	Blank Spike Result [C]	Blank Spike %R [D]	Control Limits %R	Flags
Copper	<1.000	40.00	35.11	88	85-115	
Iron	<100	400	386.4	97	85-115	
Lead	<1.000	40.00	36.24	91	85-115	
Manganese	<1.000	40.00	36.10	90	85-115	
Nickel	<1.000	40.00	36.62	92	85-115	
Zinc	<20.00	40.00	36.23	91	85-115	

Prep Batch #: 48489 **Date Prepared:** 12/16/2013 08:53 **Sample ID:** 48489-1-BKS **Matrix:** Water

Lab Batch ID: 110691 **Date Analyzed:** 12/17/2013 18:14 **Analyst:** 1034

Reporting Units: ug/L

BLANK /BLANK SPIKE RECOVERY STUDY

Total Cu, Pb, Zn, Fe, Mn, Ni + Hardness Analytes	Blank Result [A]	Spike Added [B]	Blank Spike Result [C]	Blank Spike %R [D]	Control Limits %R	Flags
Calcium	<100	500	522.1	104	85-115	
Copper	1.320	50.00	46.73	93	85-115	
Iron	<100	500	512.9	103	85-115	
Lead	<1.000	50.00	48.17	96	85-115	
Magnesium	<100	500	536.1	107	85-115	
Manganese	<1.000	50.00	50.77	102	85-115	
Nickel	<1.000	50.00	48.96	98	85-115	
Zinc	<20.00	50.00	53.27	107	85-115	

Prep Batch #: 48577 **Date Prepared:** 12/20/2013 08:37 **Sample ID:** 48577-1-BKS **Matrix:** Water

Lab Batch ID: 110794 **Date Analyzed:** 12/20/2013 13:27 **Analyst:** 1034

Reporting Units: ug/L

BLANK /BLANK SPIKE RECOVERY STUDY

Total Cu, Pb, Zn, Fe, Mn, Ni + Hardness Analytes	Blank Result [A]	Spike Added [B]	Blank Spike Result [C]	Blank Spike %R [D]	Control Limits %R	Flags
Copper	<1.000	40.00	41.30	103	85-115	

Blank Spike Recovery [D] = 100*(([C]-[A])/[B])

H= Recovery of BS,BSD or both exceeded the laboratory control limits
F = RPD exceeded the laboratory control limits
L = Recovery of BS,BSD or both below the laboratory control limits

LCS/LCSD Recoveries

Project Name: Kop-Flex

Work Order #: 13121306

Project ID: 3705-07

Prep Batch #:	48586	**Date Prepared:**	12/20/2013 14:09	**Sample:**	48586-1-BKS	**Analyst:**	1044
Lab Batch ID:	110791	**Date Analyzed:**	12/20/2013 12:21	**Method:**	Alkalinity_Prep / E310.2	**Matrix:**	Water
Units:	mg/L						

BLANK /BLANK SPIKE / BLANK SPIKE DUPLICATE RECOVERY STUDY

Alkalinity **Analytes**	**Blank Sample Result [A]**	**Spike Added [B]**	**Blank Spike Result [C]**	**Blank Spike %R [D]**	**Spike Added [E]**	**Blank Spike Duplicate Result [F]**	**Blk. Spk Dup. %R [G]**	**RPD %**	**Control Limits %R**	**Control Limits %RPD**	**Flag**
Alkalinity, Total (CaCO3)	<10.00	60.00	60.69	101	60.00	61.28	102	1	90-110	20	

Relative Percent Difference RPD = 200*|(D-G)/(D+G)|
Laboratory Control Sample (LCS) Percent Recovery [D] = 100*(C)/[B]
Laboratory Control Sample Duplicate (LCSD) Percent Recovery [G] = 100*(F)/[E]

Phase Separation Science, Inc.
6630 Baltimore National Pike
Baltimore, MD 21228

H= Recovery of BS,BSD or both exceeded the laboratory control limits
F = RPD exceeded the laboratory control limits
L = Recovery of BS,BSD or both below the laboratory control limits

CHAIN OF CUSTODY RECORD

1312306

Page 1 of 1 (1 of 2)

Project Number: 3705-07

Site and Location: Kop-Flex Hanover MD

Contact Name: James.Edwards

Contact Email: @wspgroup.com

Sampler's Name: James Edwards

Sampler's Signature:

Matrices:
S = Soil:
Aq = Water
A = Air: Bu = Bulk
W = Wipe
Bi = Biota:
OW = Oily Waste:
O = Other

Requested Analyses

Nº

	Sample Identification:	Depth	Date	Time	Matrix	Number of Containers	Total Metals	Dissolved Metals	Hardness	Alkalinity						Remarks
1,2	MW-26D	—	12-12	900	Aq	3	X	X	X	X						* Dissolved Metals
3,4	MW-21D	—	12-12	1055			X	X	X	X						Field Filtered
5,6	MW-1D	—	12-12	1555			X	X	X	X						* Metals Zn, Cu
7,8	MW-17D	—	12-13	920			X	X	X	X						Pb, Fe, Mn
9,10	MW-22D	—	12-12	1255			X	X	X	X						only
11,12	MW-2D	—	12-11	1640			X	X	X	X						
13,14	MW-16D	—	12-11	1162			X	X	X	X						

# of Coolers: 2
Custody Seal: Abs ~~Ab~~ Pres
Ice Present: ~~5.6°C~~ Temp: 5.6°C
Shipping Carrier: Client

Relinquished by (Signature): Jayas Bin
Date | Time: 12-13-13 11:39
Received by (Signature):

Relinquished by (Signature):
Date | Time:
Received by (Signature):

Turn-Around Time: Standard

Tracking Number: —

Laboratory Name: PSS

Laboratory Location: Baltimore, MD

Custody Seal Numbers: —

Method of Shipment: hand

WSP Environment & Energy

☒ Reston Office: 11190 Sunrise Valley Dr., #300, Reston, VA 20191 / Tel: 703-709-6500
☐ Pittsburgh Office: 750 Holiday Dr., #410, Pittsburgh, PA 15220 / Tel: 412-604-1040
☐ San Jose Office: 2025 Gateway Place, #435, San Jose, CA 95110 / Tel: 408-453-6100
☐ New Jersey Office: 200 Cottontail Ln., Somerset, NJ 08873 / Tel: 732-564-0888
☐ Denver Office: 4600 South Ulster, #930, Denver, CO 80237 / Tel: 303-850-9200
☐ Minneapolis Office: 123 North 3rd St., #808, Minneapolis, MN 55401 / Tel: 612-343-0510
☐ Woburn Office: 300 Trade Center, Suite 4690, Woburn, MA 01801
☐ Cazenovia Office: 5 Sullivan St., Cazenovia, NY 13035 / Tel: 315-655-3900

CHAIN OF CUSTODY RECORD

1312306

Page ~~01~~ 2 of ~~01~~ 2

Project Number: 3705-07	Site and Location: Kop-Flex Hanover MD	
Contact Name: James Edwards	Contact Email: Edwards@wspgroup.com	
Sampler's Name: James Edwards	Sampler's Signature:	

Matrices:
S = Soil:
Aq = Water
A = Air: Bu = Bulk
W = Wipe
Bi = Biota:
OW = Oily Waste:
O = Other

Requested Analyses

Nº

	Sample Identification:	Depth	Date	Time	Matrix	Number of Containers	TOC	COD								Remarks
1,2	MW-26D	—	12-12	900	Aq	2	X	X								* Hold Samples
3,4	MW-21D	—	12-12	1055			X	X								
5,6	MW-1D	—	12-12	~~420~~ 1555			X	X								
7,8	MW-17D	—	12-13	~~1255~~ 920			X	X								
9,10	MW-22D	—	12-12	1255			X	X								
11,12	MW-2D	—	12-11	1640			X	X								
13,14	MW-16D	—	12-11	1102			X	X								

# of Coolers: 2
Custody Seal: Abs
Ice Present: Pres Temp: 5.6 °C
Shipping Carrier: Client

Relinquished by (*Signature*):	12-13-13 11:39 Date | Time	Received by (*Signature*): Roby Pleaf	Laboratory Name: PSS
Relinquished by (*Signature*):	Date | Time	Received by (*Signature*):	Laboratory Location: Baltimore, MD
			Custody Seal Numbers: —
Turn-Around Time: Hold		Tracking Number:	Method of Shipment: —

WSP Environment & Energy

☒ Reston Office: 11190 Sunrise Valley Dr., #300, Reston, VA 20191 / Tel: 703-709-6500
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☐ Denver Office: 4600 South Ulster, #930, Denver, CO 80237 / Tel: 303-850-9200
☐ Minneapolis Office: 123 North 3rd St., #808, Minneapolis, MN 55401 / Tel: 612-343-0510
☐ Woburn Office: 300 Trade Center, Suite 4690, Woburn, MA 01801
☐ Cazenovia Office: 5 Sullivan St., Cazenovia, NY 13035 / Tel: 315-655-3900

Phase Separation Science, Inc

Sample Receipt Checklist

Work Order #	13121306	**Received By**	Robyn Rhudy
Client Name	WSP Environment & Energy - Restor	**Date Received**	12/13/2013 11:39:00 AM
Project Name	Kop-Flex	**Delivered By**	Client
Project Number	3705-07	**Tracking No**	Not Applicable
Disposal Date	01/17/2014	**Logged In By**	Robyn Rhudy

Shipping Container(s)

No. of Coolers	1	Ice	Present
		Temp (deg C)	5
Custody Seal(s) Intact?	N/A	Temp Blank Present	No
Seal(s) Signed / Dated?	N/A		

Sampler Name Not Provided

N/A

Documentation

COC agrees with sample labels?	Yes
Chain of Custody	Yes

Sample Container

		Custody Seal(s) Intact?	Not Applicable
Appropriate for Specified Analysis?	Yes	Seal(s) Signed / Dated	Not Applicable
Intact?	Yes		
Labeled and Labels Legible?	Yes		

Total No. of Samples Received 14

Total No. of Containers Received 35

Preservation

Metals	(pH<2)	No
Cyanides	(pH>12)	N/A
Sulfide	(pH>9)	N/A
TOC, COD, Phenols	(pH<2)	Yes
TOX, TKN, NH3, Total Phos	(pH<2)	N/A
VOC, BTEX (VOA Vials Rcvd Preserved)	(pH<2)	N/A
Do VOA vials have zero headspace?		N/A

Comments: (Any "No" response must be detailed in the comments section below.)

For any improper preservation conditions, list sample ID, preservative added (reagent ID number) below as well as documentation of any client notification as well as client instructions. Samples for pH, chlorine and dissolved oxygen should be analyzed as soon as possible, preferably in the field at the time of sampling. Samples which require thermal preservation shall be considered acceptable when received at a temperature above freezing to 6°C. Samples that are hand delivered on the day that they are collected may not meet these criteria but shall be considered acceptable if there is evidence that the chilling process has begun such as arrival on ice.

Two coolers were received. All sample receipt conditions were acceptable. The temperatures observed were 5 and 6 degrees C.

Samples Inspected/Checklist Completed By: Robyn Rhudy
Robyn Rhudy
Date: 12/13/2013

PM Review and Approval:
Simon Crisp
Date: 12/20/2013

www.pacelabs.com

Pace Analytical Services, Inc.
9800 Kincey Ave. Suite 100
Huntersville, NC 28078
(704)875-9092

October 10, 2014

Keith Green
WSP Environmental Strategies
11190 Sunrise Valley Dr
Suite 300
Reston, VA 20191

RE: Project: 3705-02 HANOVER MD KOPFLEX
Pace Project No.: 92219888

Dear Keith Green:

Enclosed are the analytical results for sample(s) received by the laboratory on October 03, 2014. The results relate only to the samples included in this report. Results reported herein conform to the most current TNI standards and the laboratory's Quality Assurance Manual, where applicable, unless otherwise noted in the body of the report.

Analyses were performed at the Pace Analytical Services location indicated on the sample analyte page for analysis unless otherwise footnoted.

If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Kevin Godwin
kevin.godwin@pacelabs.com
Project Manager

Enclosures

cc: Mr. James Edwards, WSP Environmental Strategies

CERTIFICATIONS

Project:	3705-02 HANOVER MD KOPFLEX
Pace Project No.:	92219888

Charlotte Certification IDs

9800 Kincey Ave. Ste 100, Huntersville, NC 28078
North Carolina Drinking Water Certification #: 37706
North Carolina Field Services Certification #: 5342
North Carolina Wastewater Certification #: 12
South Carolina Certification #: 99006001
Florida/NELAP Certification #: E87627
Kentucky UST Certification #: 84
West Virginia Certification #: 357
Virginia/VELAP Certification #: 460221

Asheville Certification IDs

2225 Riverside Dr., Asheville, NC 28804
Florida/NELAP Certification #: E87648
Massachusetts Certification #: M-NC030
North Carolina Drinking Water Certification #: 37712
North Carolina Wastewater Certification #: 40
South Carolina Certification #: 99030001
West Virginia Certification #: 356
Virginia/VELAP Certification #: 460222

SAMPLE SUMMARY

Project: 3705-02 HANOVER MD KOPFLEX
Pace Project No.: 92219888

Lab ID	Sample ID	Matrix	Date Collected	Date Received
92219888001	**MW-05-31**	Water	10/02/14 13:23	10/03/14 10:35
92219888002	**MW-18-56**	Water	10/02/14 14:00	10/03/14 10:35
92219888003	**MW-38-28**	Water	10/02/14 17:25	10/03/14 10:35
92219888004	**TW-01-63**	Water	10/02/14 16:53	10/03/14 10:35
92219888005	**EB-100214-01**	Water	10/02/14 17:57	10/03/14 10:35

SAMPLE ANALYTE COUNT

Project: 3705-02 HANOVER MD KOPFLEX
Pace Project No.: 92219888

Lab ID	Sample ID	Method	Analysts	Analytes Reported	Laboratory
92219888001	**MW-05-31**	EPA 1664B	AM1	1	PASI-C
		EPA 1664B	AM1	1	PASI-C
		EPA 6010	JMW	8	PASI-A
		EPA 6010	SH1	7	PASI-A
		SM 2540D	TEP	1	PASI-A
92219888002	**MW-18-56**	EPA 1664B	AM1	1	PASI-C
		EPA 1664B	AM1	1	PASI-C
		EPA 6010	JMW	8	PASI-A
		EPA 6010	SH1	7	PASI-A
		SM 2540D	TEP	1	PASI-A
92219888003	**MW-38-28**	EPA 1664B	AM1	1	PASI-C
		EPA 1664B	AM1	1	PASI-C
		EPA 6010	JMW	8	PASI-A
		EPA 6010	SH1	7	PASI-A
		SM 2540D	TEP	1	PASI-A
92219888004	**TW-01-63**	EPA 1664B	AM1	1	PASI-C
		EPA 1664B	AM1	1	PASI-C
		EPA 6010	JMW	8	PASI-A
		EPA 6010	SH1	7	PASI-A
		SM 2540D	TEP	1	PASI-A
92219888005	**EB-100214-01**	EPA 1664B	AM1	1	PASI-C
		EPA 1664B	AM1	1	PASI-C
		EPA 6010	JMW	8	PASI-A

ANALYTICAL RESULTS

Project: 3705-02 HANOVER MD KOPFLEX
Pace Project No.: 92219888

Sample: MW-05-31 **Lab ID: 92219888001** Collected: 10/02/14 13:23 Received: 10/03/14 10:35 Matrix: Water

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
HEM, Oil and Grease	Analytical Method: EPA 1664B							
Oil and Grease	ND	mg/L	5.0	1		10/06/14 09:22		
1664 SGT-HEM, TPH	Analytical Method: EPA 1664B							
Total Petroleum Hydrocarbons	ND	mg/L	5.0	1		10/06/14 09:25		
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010							
Aluminum	**2280**	ug/L	100	1	10/06/14 21:20	10/07/14 18:57	7429-90-5	
Copper	**10.7**	ug/L	5.0	1	10/06/14 21:20	10/07/14 18:57	7440-50-8	
Iron	ND	ug/L	50.0	1	10/06/14 21:20	10/07/14 18:57	7439-89-6	
Lead	ND	ug/L	5.0	1	10/06/14 21:20	10/07/14 18:57	7439-92-1	
Manganese	**71.6**	ug/L	5.0	1	10/06/14 21:20	10/07/14 18:57	7439-96-5	
Nickel	ND	ug/L	5.0	1	10/06/14 21:20	10/07/14 18:57	7440-02-0	
Hardness, Total (SM 2340B)	**51900**	ug/L	662	1	10/06/14 21:20	10/07/14 18:57		
Zinc	**16.3**	ug/L	10.0	1	10/06/14 21:20	10/07/14 18:57	7440-66-6	
6010 MET ICP, Dissolved	Analytical Method: EPA 6010 Preparation Method: EPA 3010							
Aluminum, Dissolved	**2190**	ug/L	100	1	10/06/14 18:05	10/08/14 19:34	7429-90-5	
Copper, Dissolved	**12.1**	ug/L	5.0	1	10/06/14 18:05	10/08/14 19:34	7440-50-8	
Iron, Dissolved	ND	ug/L	50.0	1	10/06/14 18:05	10/08/14 19:34	7439-89-6	
Lead, Dissolved	ND	ug/L	5.0	1	10/06/14 18:05	10/08/14 19:34	7439-92-1	
Manganese, Dissolved	**70.3**	ug/L	5.0	1	10/06/14 18:05	10/08/14 19:34	7439-96-5	
Nickel, Dissolved	ND	ug/L	5.0	1	10/06/14 18:05	10/08/14 19:34	7440-02-0	
Zinc, Dissolved	**25.0**	ug/L	10.0	1	10/06/14 18:05	10/08/14 19:34	7440-66-6	
2540D Total Suspended Solids	Analytical Method: SM 2540D							
Total Suspended Solids	ND	mg/L	5.1	1		10/08/14 06:14		

ANALYTICAL RESULTS

Project: 3705-02 HANOVER MD KOPFLEX
Pace Project No.: 92219888

Sample: MW-18-56 **Lab ID: 92219888002** Collected: 10/02/14 14:00 Received: 10/03/14 10:35 Matrix: Water

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
HEM, Oil and Grease	Analytical Method: EPA 1664B							
Oil and Grease	ND	mg/L	5.0	1		10/06/14 09:23		
1664 SGT-HEM, TPH	Analytical Method: EPA 1664B							
Total Petroleum Hydrocarbons	ND	mg/L	5.0	1		10/06/14 09:25		
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010							
Aluminum	**207**	ug/L	100	1	10/06/14 21:20	10/07/14 19:16	7429-90-5	
Copper	ND	ug/L	5.0	1	10/06/14 21:20	10/07/14 19:16	7440-50-8	
Iron	ND	ug/L	50.0	1	10/06/14 21:20	10/07/14 19:16	7439-89-6	
Lead	ND	ug/L	5.0	1	10/06/14 21:20	10/07/14 19:16	7439-92-1	
Manganese	**17.6**	ug/L	5.0	1	10/06/14 21:20	10/07/14 19:16	7439-96-5	
Nickel	**8.5**	ug/L	5.0	1	10/06/14 21:20	10/07/14 19:16	7440-02-0	
Hardness, Total (SM 2340B)	**16900**	ug/L	662	1	10/06/14 21:20	10/07/14 19:16		
Zinc	**10.3**	ug/L	10.0	1	10/06/14 21:20	10/07/14 19:16	7440-66-6	
6010 MET ICP, Dissolved	Analytical Method: EPA 6010 Preparation Method: EPA 3010							
Aluminum, Dissolved	**165**	ug/L	100	1	10/06/14 18:05	10/08/14 19:43	7429-90-5	
Copper, Dissolved	**5.7**	ug/L	5.0	1	10/06/14 18:05	10/08/14 19:43	7440-50-8	
Iron, Dissolved	ND	ug/L	50.0	1	10/06/14 18:05	10/08/14 19:43	7439-89-6	
Lead, Dissolved	ND	ug/L	5.0	1	10/06/14 18:05	10/08/14 19:43	7439-92-1	
Manganese, Dissolved	**17.1**	ug/L	5.0	1	10/06/14 18:05	10/08/14 19:43	7439-96-5	
Nickel, Dissolved	**8.9**	ug/L	5.0	1	10/06/14 18:05	10/08/14 19:43	7440-02-0	
Zinc, Dissolved	**18.2**	ug/L	10.0	1	10/06/14 18:05	10/08/14 19:43	7440-66-6	
2540D Total Suspended Solids	Analytical Method: SM 2540D							
Total Suspended Solids	**3.0**	mg/L	2.6	1		10/08/14 06:15		

ANALYTICAL RESULTS

Project: 3705-02 HANOVER MD KOPFLEX
Pace Project No.: 92219888

Sample: MW-38-28 **Lab ID: 92219888003** Collected: 10/02/14 17:25 Received: 10/03/14 10:35 Matrix: Water

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
HEM, Oil and Grease	Analytical Method: EPA 1664B							
Oil and Grease	ND	mg/L	5.0	1		10/06/14 09:23		
1664 SGT-HEM, TPH	Analytical Method: EPA 1664B							
Total Petroleum Hydrocarbons	ND	mg/L	5.0	1		10/06/14 09:25		
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010							
Aluminum	**1930**	ug/L	100	1	10/06/14 21:20	10/07/14 19:19	7429-90-5	
Copper	ND	ug/L	5.0	1	10/06/14 21:20	10/07/14 19:19	7440-50-8	
Iron	**2640**	ug/L	50.0	1	10/06/14 21:20	10/07/14 19:19	7439-89-6	
Lead	ND	ug/L	5.0	1	10/06/14 21:20	10/07/14 19:19	7439-92-1	
Manganese	**7.7**	ug/L	5.0	1	10/06/14 21:20	10/07/14 19:19	7439-96-5	
Nickel	**151**	ug/L	5.0	1	10/06/14 21:20	10/07/14 19:19	7440-02-0	
Hardness, Total (SM 2340B)	**2920**	ug/L	662	1	10/06/14 21:20	10/07/14 19:19		
Zinc	**175**	ug/L	10.0	1	10/06/14 21:20	10/07/14 19:19	7440-66-6	
6010 MET ICP, Dissolved	Analytical Method: EPA 6010 Preparation Method: EPA 3010							
Aluminum, Dissolved	**1400**	ug/L	100	1	10/06/14 18:05	10/08/14 19:46	7429-90-5	
Copper, Dissolved	ND	ug/L	5.0	1	10/06/14 18:05	10/08/14 19:46	7440-50-8	
Iron, Dissolved	**2280**	ug/L	50.0	1	10/06/14 18:05	10/08/14 19:46	7439-89-6	
Lead, Dissolved	ND	ug/L	5.0	1	10/06/14 18:05	10/08/14 19:46	7439-92-1	
Manganese, Dissolved	**7.3**	ug/L	5.0	1	10/06/14 18:05	10/08/14 19:46	7439-96-5	
Nickel, Dissolved	**147**	ug/L	5.0	1	10/06/14 18:05	10/08/14 19:46	7440-02-0	
Zinc, Dissolved	**171**	ug/L	10.0	1	10/06/14 18:05	10/08/14 19:46	7440-66-6	
2540D Total Suspended Solids	Analytical Method: SM 2540D							
Total Suspended Solids	**27.3**	mg/L	4.2	1		10/08/14 06:15		

ANALYTICAL RESULTS

Project:	3705-02 HANOVER MD KOPFLEX
Pace Project No.:	92219888

Sample: TW-01-63 **Lab ID: 92219888004** Collected: 10/02/14 16:53 Received: 10/03/14 10:35 Matrix: Water

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
HEM, Oil and Grease	Analytical Method: EPA 1664B							
Oil and Grease	ND	mg/L	5.0	1		10/06/14 09:24		
1664 SGT-HEM, TPH	Analytical Method: EPA 1664B							
Total Petroleum Hydrocarbons	ND	mg/L	5.0	1		10/06/14 09:25		
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010							
Aluminum	**723**	ug/L	100	1	10/06/14 21:20	10/07/14 19:22	7429-90-5	
Copper	**9.4**	ug/L	5.0	1	10/06/14 21:20	10/07/14 19:22	7440-50-8	
Iron	ND	ug/L	50.0	1	10/06/14 21:20	10/07/14 19:22	7439-89-6	
Lead	ND	ug/L	5.0	1	10/06/14 21:20	10/07/14 19:22	7439-92-1	
Manganese	**15.0**	ug/L	5.0	1	10/06/14 21:20	10/07/14 19:22	7439-96-5	
Nickel	**19.2**	ug/L	5.0	1	10/06/14 21:20	10/07/14 19:22	7440-02-0	
Hardness, Total (SM 2340B)	**18500**	ug/L	662	1	10/06/14 21:20	10/07/14 19:22		
Zinc	**11.4**	ug/L	10.0	1	10/06/14 21:20	10/07/14 19:22	7440-66-6	
6010 MET ICP, Dissolved	Analytical Method: EPA 6010 Preparation Method: EPA 3010							
Aluminum, Dissolved	**692**	ug/L	100	1	10/06/14 18:05	10/08/14 19:49	7429-90-5	
Copper, Dissolved	**8.4**	ug/L	5.0	1	10/06/14 18:05	10/08/14 19:49	7440-50-8	
Iron, Dissolved	ND	ug/L	50.0	1	10/06/14 18:05	10/08/14 19:49	7439-89-6	
Lead, Dissolved	ND	ug/L	5.0	1	10/06/14 18:05	10/08/14 19:49	7439-92-1	
Manganese, Dissolved	**14.7**	ug/L	5.0	1	10/06/14 18:05	10/08/14 19:49	7439-96-5	
Nickel, Dissolved	**18.8**	ug/L	5.0	1	10/06/14 18:05	10/08/14 19:49	7440-02-0	
Zinc, Dissolved	ND	ug/L	10.0	1	10/06/14 18:05	10/08/14 19:49	7440-66-6	
2540D Total Suspended Solids	Analytical Method: SM 2540D							
Total Suspended Solids	ND	mg/L	2.5	1		10/08/14 06:15		

ANALYTICAL RESULTS

Project: 3705-02 HANOVER MD KOPFLEX
Pace Project No.: 92219888

Sample: EB-100214-01 **Lab ID: 92219888005** Collected: 10/02/14 17:57 Received: 10/03/14 10:35 Matrix: Water

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
HEM, Oil and Grease	Analytical Method: EPA 1664B							
Oil and Grease	ND	mg/L	5.0	1		10/06/14 09:24		
1664 SGT-HEM, TPH	Analytical Method: EPA 1664B							
Total Petroleum Hydrocarbons	ND	mg/L	5.0	1		10/06/14 09:25		
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010							
Aluminum	ND	ug/L	100	1	10/06/14 21:20	10/07/14 19:25	7429-90-5	
Copper	ND	ug/L	5.0	1	10/06/14 21:20	10/07/14 19:25	7440-50-8	
Iron	ND	ug/L	50.0	1	10/06/14 21:20	10/07/14 19:25	7439-89-6	
Lead	ND	ug/L	5.0	1	10/06/14 21:20	10/07/14 19:25	7439-92-1	
Manganese	ND	ug/L	5.0	1	10/06/14 21:20	10/07/14 19:25	7439-96-5	
Nickel	ND	ug/L	5.0	1	10/06/14 21:20	10/07/14 19:25	7440-02-0	
Hardness, Total (SM 2340B)	ND	ug/L	662	1	10/06/14 21:20	10/07/14 19:25		
Zinc	ND	ug/L	10.0	1	10/06/14 21:20	10/07/14 19:25	7440-66-6	

QUALITY CONTROL DATA

Project: 3705-02 HANOVER MD KOPFLEX
Pace Project No.: 92219888

QC Batch: GCSV/19089
Analysis Method: EPA 1664B
QC Batch Method: EPA 1664B
Analysis Description: 1664 HEM, Oil and Grease
Associated Lab Samples: 92219888001, 92219888002, 92219888003, 92219888004, 92219888005

METHOD BLANK: 1300064
Matrix: Water
Associated Lab Samples: 92219888001, 92219888002, 92219888003, 92219888004, 92219888005

Parameter	Units	Blank Result	Reporting Limit	Analyzed	Qualifiers
Oil and Grease	mg/L	ND	5.0	10/06/14 09:16	

LABORATORY CONTROL SAMPLE: 1300065

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Oil and Grease	mg/L	40	37.9	95	78-114	

MATRIX SPIKE SAMPLE: 1300066

Parameter	Units	92219888001 Result	Spike Conc.	MS Result	MS % Rec	% Rec Limits	Qualifiers
Oil and Grease	mg/L	ND	40	38.1	95	78-114	

QUALITY CONTROL DATA

Project: 3705-02 HANOVER MD KOPFLEX
Pace Project No.: 92219888

QC Batch: GCSV/19090
Analysis Method: EPA 1664B
QC Batch Method: EPA 1664B
Analysis Description: 1664 SGT-HEM, TPH
Associated Lab Samples: 92219888001, 92219888002, 92219888003, 92219888004, 92219888005

METHOD BLANK: 1300067
Matrix: Water
Associated Lab Samples: 92219888001, 92219888002, 92219888003, 92219888004, 92219888005

Parameter	Units	Blank Result	Reporting Limit	Analyzed	Qualifiers
Total Petroleum Hydrocarbons	mg/L	ND	5.0	10/06/14 09:24	

LABORATORY CONTROL SAMPLE: 1300068

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Total Petroleum Hydrocarbons	mg/L	20	18.8	94	64-132	

MATRIX SPIKE SAMPLE: 1300071

Parameter	Units	92219888001 Result	Spike Conc.	MS Result	MS % Rec	% Rec Limits	Qualifiers
Total Petroleum Hydrocarbons	mg/L	ND	20	18.3	92	64-132	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: 3705-02 HANOVER MD KOPFLEX
Pace Project No.: 92219888

QC Batch: MPRP/17056
Analysis Method: EPA 6010
QC Batch Method: EPA 3010
Analysis Description: 6010 MET
Associated Lab Samples: 92219888001, 92219888002, 92219888003, 92219888004, 92219888005

METHOD BLANK: 1300610
Matrix: Water
Associated Lab Samples: 92219888001, 92219888002, 92219888003, 92219888004, 92219888005

Parameter	Units	Blank Result	Reporting Limit	Analyzed	Qualifiers
Aluminum	ug/L	ND	100	10/07/14 18:51	
Copper	ug/L	ND	5.0	10/07/14 18:51	
Hardness, Total (SM 2340B)	ug/L	ND	662	10/07/14 18:51	
Iron	ug/L	ND	50.0	10/07/14 18:51	
Lead	ug/L	ND	5.0	10/07/14 18:51	
Manganese	ug/L	ND	5.0	10/07/14 18:51	
Nickel	ug/L	ND	5.0	10/07/14 18:51	
Zinc	ug/L	ND	10.0	10/07/14 18:51	

LABORATORY CONTROL SAMPLE: 1300611

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Aluminum	ug/L	5000	4870	97	80-120	
Copper	ug/L	500	489	98	80-120	
Hardness, Total (SM 2340B)	ug/L		31000			
Iron	ug/L	5000	4730	95	80-120	
Lead	ug/L	500	503	101	80-120	
Manganese	ug/L	500	481	96	80-120	
Nickel	ug/L	500	487	97	80-120	
Zinc	ug/L	500	485	97	80-120	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 1300612 1300613

Parameter	Units	92219888001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Aluminum	ug/L	2280	5000	5000	7100	7150	96	98	75-125	1	20	
Copper	ug/L	10.7	500	500	494	500	97	98	75-125	1	20	
Hardness, Total (SM 2340B)	ug/L	51900			82000	82800				1		
Iron	ug/L	ND	5000	5000	4700	4730	93	94	75-125	1	20	
Lead	ug/L	ND	500	500	481	487	96	97	75-125	1	20	
Manganese	ug/L	71.6	500	500	543	544	94	95	75-125	0	20	
Nickel	ug/L	ND	500	500	473	476	94	95	75-125	1	20	
Zinc	ug/L	16.3	500	500	485	491	94	95	75-125	1	20	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: 3705-02 HANOVER MD KOPFLEX
Pace Project No.: 92219888

QC Batch: MPRP/17055
Analysis Method: EPA 6010
QC Batch Method: EPA 3010
Analysis Description: 6010 MET Filtered
Associated Lab Samples: 92219888001, 92219888002, 92219888003, 92219888004

METHOD BLANK: 1300593
Matrix: Water
Associated Lab Samples: 92219888001, 92219888002, 92219888003, 92219888004

Parameter	Units	Blank Result	Reporting Limit	Analyzed	Qualifiers
Aluminum, Dissolved	ug/L	ND	100	10/08/14 19:27	
Copper, Dissolved	ug/L	ND	5.0	10/08/14 19:27	
Iron, Dissolved	ug/L	ND	50.0	10/08/14 19:27	
Lead, Dissolved	ug/L	ND	5.0	10/08/14 19:27	
Manganese, Dissolved	ug/L	ND	5.0	10/08/14 19:27	
Nickel, Dissolved	ug/L	ND	5.0	10/08/14 19:27	
Zinc, Dissolved	ug/L	ND	10.0	10/08/14 19:27	

LABORATORY CONTROL SAMPLE: 1300594

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Aluminum, Dissolved	ug/L	5000	4880	98	80-120	
Copper, Dissolved	ug/L	500	487	97	80-120	
Iron, Dissolved	ug/L	5000	4890	98	80-120	
Lead, Dissolved	ug/L	500	490	98	80-120	
Manganese, Dissolved	ug/L	500	488	98	80-120	
Nickel, Dissolved	ug/L	500	489	98	80-120	
Zinc, Dissolved	ug/L	500	486	97	80-120	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 1300595 1300596

Parameter	Units	92219888001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Aluminum, Dissolved	ug/L	2190	5000	5000	6710	6780	90	92	75-125	1	20	
Copper, Dissolved	ug/L	12.1	500	500	464	475	90	93	75-125	2	20	
Iron, Dissolved	ug/L	ND	5000	5000	4600	4680	91	93	75-125	2	20	
Lead, Dissolved	ug/L	ND	500	500	448	459	89	91	75-125	2	20	
Manganese, Dissolved	ug/L	70.3	500	500	522	528	90	92	75-125	1	20	
Nickel, Dissolved	ug/L	ND	500	500	450	461	89	91	75-125	2	20	
Zinc, Dissolved	ug/L	25.0	500	500	468	474	89	90	75-125	1	20	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: 3705-02 HANOVER MD KOPFLEX
Pace Project No.: 92219888

QC Batch: WET/33600
Analysis Method: SM 2540D
QC Batch Method: SM 2540D
Analysis Description: 2540D Total Suspended Solids
Associated Lab Samples: 92219888001, 92219888002, 92219888003, 92219888004

METHOD BLANK: 1301822
Matrix: Water
Associated Lab Samples: 92219888001, 92219888002, 92219888003, 92219888004

Parameter	Units	Blank Result	Reporting Limit	Analyzed	Qualifiers
Total Suspended Solids	mg/L	ND	2.5	10/08/14 06:13	

LABORATORY CONTROL SAMPLE: 1301823

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Total Suspended Solids	mg/L	250	264	106	90-110	

SAMPLE DUPLICATE: 1301824

Parameter	Units	92219888001 Result	Dup Result	RPD	Max RPD	Qualifiers
Total Suspended Solids	mg/L	ND	5.5		10	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALIFIERS

Project:	3705-02 HANOVER MD KOPFLEX
Pace Project No.:	92219888

DEFINITIONS

DF - Dilution Factor, if reported, represents the factor applied to the reported data due to changes in sample preparation, dilution of the sample aliquot, or moisture content.

ND - Not Detected at or above adjusted reporting limit.

J - Estimated concentration above the adjusted method detection limit and below the adjusted reporting limit.

MDL - Adjusted Method Detection Limit.

PQL - Practical Quantitation Limit.

RL - Reporting Limit.

S - Surrogate

1,2-Diphenylhydrazine (8270 listed analyte) decomposes to Azobenzene.

Consistent with EPA guidelines, unrounded data are displayed and have been used to calculate % recovery and RPD values.

LCS(D) - Laboratory Control Sample (Duplicate)

MS(D) - Matrix Spike (Duplicate)

DUP - Sample Duplicate

RPD - Relative Percent Difference

NC - Not Calculable.

SG - Silica Gel - Clean-Up

U - Indicates the compound was analyzed for, but not detected.

N-Nitrosodiphenylamine decomposes and cannot be separated from Diphenylamine using Method 8270. The result reported for each analyte is a combined concentration.

Acid preservation may not be appropriate for 2-Chloroethylvinyl ether, Styrene, and Vinyl chloride.

Pace Analytical is TNI accredited. Contact your Pace PM for the current list of accredited analytes.

TNI - The NELAC Institute.

LABORATORIES

PASI-A	Pace Analytical Services - Asheville
PASI-C	Pace Analytical Services - Charlotte

QUALITY CONTROL DATA CROSS REFERENCE TABLE

Project: 3705-02 HANOVER MD KOPFLEX
Pace Project No.: 92219888

Lab ID	Sample ID	QC Batch Method	QC Batch	Analytical Method	Analytical Batch
92219888001	**MW-05-31**	EPA 1664B	GCSV/19089		
92219888002	**MW-18-56**	EPA 1664B	GCSV/19089		
92219888003	**MW-38-28**	EPA 1664B	GCSV/19089		
92219888004	**TW-01-63**	EPA 1664B	GCSV/19089		
92219888005	**EB-100214-01**	EPA 1664B	GCSV/19089		
92219888001	**MW-05-31**	EPA 1664B	GCSV/19090		
92219888002	**MW-18-56**	EPA 1664B	GCSV/19090		
92219888003	**MW-38-28**	EPA 1664B	GCSV/19090		
92219888004	**TW-01-63**	EPA 1664B	GCSV/19090		
92219888005	**EB-100214-01**	EPA 1664B	GCSV/19090		
92219888001	**MW-05-31**	EPA 3010	MPRP/17056	EPA 6010	ICP/15378
92219888002	**MW-18-56**	EPA 3010	MPRP/17056	EPA 6010	ICP/15378
92219888003	**MW-38-28**	EPA 3010	MPRP/17056	EPA 6010	ICP/15378
92219888004	**TW-01-63**	EPA 3010	MPRP/17056	EPA 6010	ICP/15378
92219888005	**EB-100214-01**	EPA 3010	MPRP/17056	EPA 6010	ICP/15378
92219888001	**MW-05-31**	EPA 3010	MPRP/17055	EPA 6010	ICP/15369
92219888002	**MW-18-56**	EPA 3010	MPRP/17055	EPA 6010	ICP/15369
92219888003	**MW-38-28**	EPA 3010	MPRP/17055	EPA 6010	ICP/15369
92219888004	**TW-01-63**	EPA 3010	MPRP/17055	EPA 6010	ICP/15369
92219888001	**MW-05-31**	SM 2540D	WET/33600		
92219888002	**MW-18-56**	SM 2540D	WET/33600		
92219888003	**MW-38-28**	SM 2540D	WET/33600		
92219888004	**TW-01-63**	SM 2540D	WET/33600		

Pace Analytical®	**Sample Condition Upon Receipt (SCUR)** Document Number: **F-CHR-CS-003-rev.15**	Page 1 of 2 Issuing Authority: Pace Huntersville Quality Office

Client Name: WSP Environmental

Courier: ☑ Fed Ex ☐ UPS ☐ USPS ☐ Client ☐ Commercial ☐ Pace Other________

Custody Seal on Cooler/Box Present: ☑ yes ☐ no Seals intact: ☑ yes ☐ no

Optional
Proj. Due Date:
Proj. Name:

Packing Material: ☐ Bubble Wrap ☒ Bubble Bags ☐ None ☐ Other________

Thermometer Used: IR Gun [✓ T1401] **Type of Ice:** [✓ Wet] Blue None ☑ Samples on ice, cooling process has begun

Temp Correction Factor **T1401** No Correction

Corrected Cooler Temp.: 3.8 °C **Biological Tissue is Frozen:** Yes No [✓ N/A]

Temp should be above freezing to 6°C

Date and Initials of person examining contents: MW 10-3-14

				Comments:
Chain of Custody Present:	☑ Yes	☐ No	☐ N/A	1.
Chain of Custody Filled Out:	☑ Yes	☐ No	☐ N/A	2.
Chain of Custody Relinquished:	☑ Yes	☐ No	☐ N/A	3.
Sampler Name & Signature on COC:	☑ Yes	☐ No	☐ N/A	4.
Samples Arrived within Hold Time:	☑ Yes	☐ No	☐ N/A	5.
Short Hold Time Analysis (<72hr):	☐ Yes	☑ No	☐ N/A	6.
Rush Turn Around Time Requested:	☐ Yes	☑ No	☐ N/A	7.
Sufficient Volume:	☑ Yes	☐ No	☐ N/A	8.
Correct Containers Used:	☑ Yes	☐ No	☐ N/A	9.
-Pace Containers Used:	☑ Yes	☐ No	☐ N/A	
Containers Intact:	☑ Yes	☐ No	☐ N/A	10.
Filtered volume received for Dissolved tests	☑ Yes	☐ No	☐ N/A	11.
Sample Labels match COC: -Includes date/time/ID/Analysis Matrix:________	☑ Yes	☐ No	☐ N/A	12.
All containers needing preservation have been checked.	☑ Yes	☐ No	☐ N/A	13.
All containers needing preservation are found to be in compliance with EPA recommendation.	☑ Yes	☐ No	☐ N/A	
exceptions: VOA, coliform, TOC, O&G, WI-DRO (water)	☑ Yes	☐ No		
Samples checked for dechlorination:	☐ Yes	☐ No	☑ N/A	14.
Headspace in VOA Vials (>6mm):	☐ Yes	☐ No	☑ N/A	15.
Trip Blank Present:	☐ Yes	☐ No	☑ N/A	16.
Trip Blank Custody Seals Present	☐ Yes	☐ No	☑ N/A	
Pace Trip Blank Lot # (if purchased):________				

Client Notification/ Resolution:

Field Data Required? Y / N

Person Contacted: ____________________ Date/Time: ____________

Comments/ Resolution: ____________________

SCURF Review: Date: 10/3/14

SRF Review: Date: 10/6/14

Note: Whenever there is a discrepancy affecting North Carolina compliance samples, a copy of this form will be sent to the North Carolina DEHNR Certification Office (i.e out of hold, incorrect preservative, out of temp, incorrect containers)

Place label here

WO# : 92219888

92219888

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CHAIN-OF-CUSTODY / Analytical Request Document

The Chain-of-Custody is a LEGAL DOCUMENT. All relevant fields must be completed accurately.

Page: 1 of 1

1781957

Section A
Required Client Information:
Company: WSP
Address: 11190 Sunrise Valley Dr.
Suite 300, RESTON, VA
Email To: PAM GROFF
Phone: 703.709.6500 Fax:
Requested Due Date/TAT:

Section B
Required Project Information:
Report To: PAM.GROFF@WSPGROUP.COM
Copy To:
Purchase Order No.:
Project Name: Hanover, MD KOPFLEX
Project Number: 3705-02

Section C
Invoice Information:
Attention: Accounts Payable
Company Name: WSP
Address:
Pace Quote Reference:
Pace Project Manager:
Pace Profile #: 4362-1

REGULATORY AGENCY
☐ NPDES ☐ GROUND WATER ☐ DRINKING WATER
☐ UST ☐ RCRA ☐ OTHER ______

Site Location STATE: MD

Section D
Required Client Information

SAMPLE ID
(A-Z, 0-9 / ,-)
Sample IDs MUST BE UNIQUE

Matrix Codes MATRIX	CODE
Drinking Water	DW
Water	WT
Waste Water	WW
Product	P
Soil/Solid	SL
Oil	OL
Wipe	WP
Air	AR
Tissue	TS
Other	OT

ITEM #	SAMPLE ID	MATRIX CODE (see valid codes to left)	SAMPLE TYPE (G=GRAB C=COMP)	COLLECTED COMPOSITE START DATE	COLLECTED COMPOSITE START TIME	COLLECTED COMPOSITE END/GRAB DATE	COLLECTED COMPOSITE END/GRAB TIME	SAMPLE TEMP AT COLLECTION	# OF CONTAINERS	Unpreserved	H_2SO_4	HNO_3	HCl	NaOH	$Na_2S_2O_3$	Methanol	Other	Analysis Test Y/N	Oil, Grease 1664 mod	Metals-total	Metals-field filtered	TSS	Hardness	Residual Chlorine (Y/N)	Pace Project No./ Lab I.D.
1	MW-05-31	WT	G			10/2/14	1323	8	5	3		2							X	X	X	X	X		001
2	MW-18-56	WT	G			10/2/14	1400	8	5	3		2							X	X	X	X	X		002
3	MW-38-28	WT	G			10/2/14	1725	8	5	3		2							X	X	X	X	X		003
4	TW-01-63	WT	G			10/2/14	1653	8	5	3		2							X	X	X	X	X		004
5	EB-100214-01	WT	G			10/2/14	1757		3	2		1							X	X	[illegible]		X		005
6																									
7																									
8																									
9																									
10																									
11																									
12																									

10/2/14

92219888

Requested Analysis Filtered (Y/N)

ADDITIONAL COMMENTS	RELINQUISHED BY / AFFILIATION	DATE	TIME	ACCEPTED BY / AFFILIATION	DATE	TIME	SAMPLE CONDITIONS: Temp in °C	Received on Ice (Y/N)	Custody Sealed Cooler (Y/N)	Samples Intact (Y/N)
Metals - Fe, Al, Mn, Cu, Pb, Ni, Zn	Pam Groff / WSP	10/2/14	1920	Jaclyn Wilson Pace	10/3/14	1035	3.8	Y	~~N~~ Y JW 10314	Y
Custody Seals: 02511, 02514										
02513, 02512										
*2 coolers in shipment										

ORIGINAL

SAMPLER NAME AND SIGNATURE
PRINT Name of SAMPLER: Pam Groff
SIGNATURE of SAMPLER:
DATE Signed (MM/DD/YY): 10/2/14

*Important Note: By signing this form you are accepting Pace's NET 30 day payment terms and agreeing to late charges of 1.5% per month for any invoices not paid within 30 days.

F-ALL-Q-020rev.07, 15-May-2007

Appendix C – WSP Field Standard 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. Do not leave blank lines between field book entries. If a mistake is made in an entry, cross out the mistake with a single line 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 #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 ≤1 kg/month of acute hazardous waste ≤100 kg/month of acute spill residue or soil §§261.5(a) and (e)	Between 100 - 1,000 kg/month §262.34(d)	≥1,000 kg/month >1 kg/month of acute hazardous waste >100 kg/month of acute spill residue or soil Part 262 and §261.5(e)
EPA ID Number	Not required §261.5	Required §262.12	Required §262.12
On-Site Accumulation Quantity	≤1,000 kg ≤1 kg acute ≤100 kg of acute spill residue or soil §§261.5(f)(2) and (g)(2)	≤6,000 kg §262.34(d)(1)	No limit
Accumulation Time Limits	None §261.5	≤180 days or ≤270 days (if greater than 200 miles) §§262.34(d)(2) and (3)	≤90 days §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. 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).

- 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.

FIELD STANDARD OPERATING PROCEDURE #9

Soil Sampling Procedure

The soil sampling procedures outlined in this standard operating procedure (SOP) are designed to ensure that collected soil samples are representative of current site conditions. Soil samples can be collected for onsite screening or for offsite laboratory analysis. 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.

9.1 Acronyms and Abbreviations

ºF	degrees Fahrenheit
HASP	Health and Safety Plan
IDW	investigation derived waste
PID	photoionization detector
PPE	personal protective equipment
QAPP	Quality Assurance Project Plan
QA/QC	quality assurance/quality control
SOP	standard operating procedure
USCS	Unified Soil Classification System
VOC	volatile organic compound

9.2 Materials

- Field book
- PPE
- Air quality monitoring equipment
- Utility knife
- Mixing tray or bowl
- Heavy-duty zipper-style plastic bags (quart or snack size)
- Plastic sheeting
- Expanding ruler or tape measure
- Munsell color chart
- Sampling containers and labeling/shipping supplies
- Field test kits, as needed
- Soil sampling method specific materials:
    - Stainless steel trowels, shovels, or spoons
    - Bucket augers, auger extension rods, auger handle, pipe wrenches

  - Split-spoon samplers, pipe wrenches
  - Direct push acetate liners
  - Shelby tube samplers
- Decontamination supplies

9.3 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 conducting soil sampling and assumes the user is familiar with basic field procedures, such as recording field notes (SOP 1), utility location (SOP 2), sample shipment procedures (SOP 3), sample collection and quality assurance procedures (SOP 4), investigation derived waste (IDW) management procedures (SOP 5), equipment decontamination (SOP 6), and use and calibration of sampling and monitoring equipment (SOPs 7 and 8). 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 project-specific work plan. Before soil sampling, be sure to review the project-specific work plan or Quality Assurance Project Plan (QAPP) and any applicable state and federal guidelines or sampling procedures. All sampling and monitoring 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 and HASP
- QAPP

9.4 General Procedures

Soil samples are collected using a variety of techniques and equipment, depending on the type (e.g., surface, subsurface) and purpose (e.g., lithological logging, headspace evaluation, laboratory analysis) of the sampling, and most sampling events employ more than one equipment type or methodology. Subsurface soil sampling, for example, often includes sample collection from split-spoon, macro-core, or other dedicated sampling devices advanced into the subsurface. Recovered cores are often logged (using a Munsell color chart and other logging aids), screened for volatile organic compounds (VOCs) using a photoionization detector (PID), and sampled for laboratory analysis using disposable stainless steel spoons or other discrete sampling devices.

All types of soil sampling, regardless of the equipment used, share common handling and management procedures that are designed to ensure the integrity of the samples collected. These procedures include:

- The use of new, disposable or decontaminated sampling equipment
- The use and rotation of the appropriate PPE

- Selection of a suitable sampling location and staging area

Wear a clean pair of new, disposable gloves each time a different sample is collected and don the gloves immediately prior to collection. This limits the possibility of cross-contamination from accidental contact with gloves soiled during collection of the previous sample. 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. <u>In no case should gloved hands be used as a soil sampling device: always use the appropriate spoon, trowel, or sampler to move the soil from the sampling device to the laboratory-supplied containers.</u>

9.4.1 Equipment Selection

Collect all samples using either new, disposable equipment, such as polyethylene liners or single-use stainless steel spoons; or properly decontaminated sampling equipment, such as hand augers, split-spoon cutting shoes, or trowels. Soil sampling equipment should be selected based on the analytical requirements of the project and the project-specific conditions likely to be encountered. The equipment should be constructed of non-reactive, non-leachable materials (e.g., stainless steel, Teflon®, Teflon®-coated steel, polyethylene, polypropylene, etc.) which are compatible with the chemical constituents at the site. When choosing sampling equipment, give consideration to:

- the types of soil or fill present
- the required depth of the sample
- the volume of sample required
- the analytes of interest

Select the types of equipment and decontamination procedures based on the types of sampling to be performed and decontamination may require multiple steps or differing cleaning methods, depending on the sampling goals (see SOP 6 for decontamination procedures). In no case should disposable, single use materials (e.g., macro-core liners, soil baskets, etc.) be used to collect more than one sample.

9.4.2 Sampling Considerations

In preparing for sampling, you should perform the following activities (with all observations and measurements noted in the field book):

- Perform a quick reconnaissance of the site to identify sampling locations.
- Record the approximate ambient air temperature, precipitation, wind (direction and speed), tide, and other field conditions in the field book. In addition, any site-specific conditions or situations that could potentially affect the samples at the sample locations should be recorded.
- Record sample locations with respect to a permanent feature.
- Record a description of the sampling location.
- Survey the breathing zone around the sampling location with a PID, as necessary (see HASP), to ensure that the level of PPE is appropriate.

When sampling soil, it is important to find a suitable sampling location away from any sources of cross-contamination that could compromise the integrity of the samples. Consider the following:

- Position the sample collection area away from fuel-powered equipment, such as drill rigs or excavators, and upwind of other site activities (e.g., purging, sampling, decontamination) that could influence the sample. This is particularly important when screening samples in the field for VOCs with a PID, but should not be limited to the active sample collection.

- Store samples already collected from the field for laboratory analysis in clean containers and securely stage, if possible, in an uncontaminated area of the site.

9.5 Soil Collection

Soil samples can be collected from surface or subsurface depths, depending on the project requirements. Surface soils are generally those within 0.5 to 1 foot of the ground surface and can be collected using trowels, soil probes, or hand augers. Be aware that some states have specific definitions of what constitutes a surface soil sample. Subsurface soils are generally deeper and require specialized equipment to recover the samples. In most cases, subsurface soils will be collected using a drill rig or excavator to prevent the soil from being mixed with soils from a shallower interval.

Push or drive the method-specific sampling equipment (e.g., trowel, hand auger, hollow corers, split-spoon, direct push sampler, rotosonic core barrel sampler, excavator bucket) into the soil to the desired sampling depth using cleaned equipment. Record in the field book the depth interval through which the sampler was advanced and, if appropriate, the number of blows needed to drive the sampling device (i.e., when using a cathead-equipped drill rig; record the blows for every 6 inches the split-spoon sampler is advanced). If additional soil is needed to provide sufficient sample volume, repeat this step taking care to ensure that the same depth interval is collected during the resample. Use core catchers on the leading end of the sampler (if available) for soils that lack cohesiveness and are subject to crumbling and falling out of the sampler.

Withdraw the sampling equipment from the interval and collect sample by the safest way possible (i.e., avoid entering an excavation by collecting the sample from an excavator bucket at ground surface). Samples collected from an excavator bucket should be taken from the center of the material to ensure material is representative of the desired sampling interval.

Dedicated soil samplers recovered from the boring or, in the case of rotosonic cores, the soils themselves, should be placed on plastic sheeting noting the orientation of the sample (i.e., which end is “up”) and the depth interval. Measure the length of the material recovered relative to the interval the sampler was advanced in percent notation (e.g., 75%) or as a fraction of the total length of the sample interval (e.g., [3/4] indicating 3 out of 4 feet) and record this information in the field book. If field screening for organic vapors is required, break or cut the soil core every 3 to 4 inches and quickly scan the breaks in the core material with the appropriate air quality monitoring equipment (e.g., PID). Record the readings in the field book. These measurements can be used to select appropriate soil samples for VOC or headspace analysis, if required (see procedures below).

Should any sample location require a vertical or horizontal offset from the proposed location, indicate the reason and record the actual sample location in the field book.

9.5.1 Undisturbed Soil Samples

Undisturbed soil samples collected for geotechnical parameters (e.g., porosity, permeability, etc.) generally require the use of specialized undisturbed sampling equipment (e.g., Shelby tube or sealed Geoprobe® liner) and collection procedures. The sampling device, once retrieved, is typically capped or sealed (to maintain the sample in its relatively undisturbed state), labeled with the sample name, orientation of the sample (i.e., top and bottom), depth interval, and shipped to the appropriate geotechnical laboratory. Follow sample labeling, preparation, and shipping procedures in SOPs 3 and 4.

9.5.2 Volatile Organic Compound Sampling

Analytical soil samples for VOC analysis should be collected <u>immediately</u> after screening with the PID to avoid loss of constituents to the atmosphere. Transfer the soil from the portion of the soil core to be sampled (usually the area where the highest PID readings were observed) directly into the sample containers; <u>do not composite or mix soils</u>

for VOC analysis. Place the soil in the sampling container such that no headspace is present above the soil when the cover is placed on the jar. If sampling by US Environmental Protection Agency Method 5035 is required, follow manufacturer's specifications to use a closed-system sampler (e.g., Encore® samplers). Collect quality assurance/quality control (QA/QC) samples, if appropriate, in accordance with SOP 4, the project-specific work plan, and the QAPP.

9.5.3 Soil Headspace Analysis

Collect soil samples for field-based headspace analysis, if required as part of the project-specific work plan, after obtaining the sample for VOC analysis. First, examine the soil and remove coarse gravel, organic material (e.g., roots, grass, and woody material) and any other debris. Collect the sample using decontaminated or dedicated spoons or trowels and place in a heavy-duty zipper-style plastic bag and seal the bag. Label the sample indicating the sampling location, depth, and date. Shake the sample vigorously for approximately 15 seconds to disaggregate the sample and expose as much surface area of the soil as possible (to release the VOCs to the atmosphere within the bag). If necessary, warm the sample to room temperature (70º Fahrenheit, [ºF]) by placing the bag in a heated room or vehicle. This step is critical when the ambient temperature is below 32ºF.

The VOCs, if present, will volatilize into the sealed bag. Allow the bag to stand (to achieve equilibrium) for approximately 15 minutes. Carefully open the bag slightly and place the tip of the PID into the opening. Do not insert the tip of the probe into the soil material and avoid the uptake of water droplets. Record the highest PID measurement, which typically occurs within the first 2 to 5 seconds. Erratic PID responses may result from high organic vapor concentrations or elevated headspace moisture. If these conditions exist, qualify the headspace data in the field book. It is also important to record the ambient temperature, humidity, and whether moisture was present in plastic bag. Duplicate 10% of the headspace samples by collecting two samples from the same location. Generally, duplicate sample values should be consistent to ±20%. Samples collected for headspace screening cannot be retained for laboratory analysis.

9.5.4 Semi- and Non-Volatile Analytical Sample Collection

Collect remaining organic samples then inorganic samples in the following order of volatilization sensitivity:

- Extractable organics, petroleum hydrocarbons, aggregate organics, and oil and grease
- Metals
- Inorganic non-metallic and physical and aggregate properties
- Microbiological samples
- Radionuclides

Collect soil samples for semi- and non-volatile parameters by separating clumps of soil material and mixing the soils (using stainless steel bowls and spoons, or other appropriate equipment) to a homogeneous particle size and texture. Transfer the contents to the sample container using a decontaminated or dedicated stainless steel spoon. Collect QA/QC samples in accordance with SOP 4, the project-specific work plan, and the QAPP.

If approved by the appropriate regulatory agency and specified in the project-specific work plan, composite soil samples can be collected to minimize the total number of analytical samples. Composite samples consist of equal aliquots (same sample size) of soil from each location being sampled (e.g., from each borehole or from multiple areas of a soil pile), by mixing the waste to a homogeneous particle size and texture using new or decontaminated stainless steel bowls and a stainless steel spoon or trowel. Transfer the contents to the appropriate laboratory-supplied sample container using a stainless steel spoon. Collect QA/QC samples in accordance with SOP 4 and the project-specific work plan or QAPP, if required.

If necessary, conduct field tests or screening on soils in accordance with the project-specific work plan and manufacturer's specifications for field testing equipment.

9.5.5 Sample Labeling and Preparation for Shipment

Once collected, prepare the soil samples for offsite laboratory analysis:

1. Clean the outside of the sample container, if necessary
2. Affix a sample tag or label to each sample container and complete all required information (sample number, date, time, depth interval, sampler's initials, analysis, preservatives, place of collection)
3. Place clear tape over the tag or label (if non-waterproof labels are used)
4. Preserve samples immediately after collection by placing them into an insulated cooler filled with bagged wet ice to maintain a temperature of approximately 4°Celcius
5. Record the sample designation, date, time, depth interval, and the sampler's initials in the field book and on a sample tracking form, if appropriate
6. Complete the chain-of-custody forms with appropriate sampling information, including:
    - Location
    - Sample name
    - Sample collection date and time
    - Number of sample containers
    - Analytical method
7. Complete sample packing and ship in accordance with proper procedures

Do not ship hazardous waste samples without first consulting a WSP compliance professional.

9.5.6 Soil Classification

Soil classification should be performed whenever soil samples are being collected to provide context for the analysis. WSP prefers following the Unified Soil Classification System (USCS) logging procedures as described in ATSM D2488[1] . The emphasis of soil classification in the field must be on describing the soils using ALL of the required descriptors; categorization of the USCS group name or symbol alone may not provide details about the soils that could later prove useful. Avoid geologic interpretation or the use of local formation names, which are often difficult to determine in the field without the regional framework. Record ALL of the following information for each soil type:

- Depth interval
- USCS group name
- USCS group symbol
- Color, using Munsell chart (in moist condition)
- Percent of cobbles or boulders, or both (approximate; by volume)
- Percent of gravel, sand, or fines, or all three (approximate; by dry weight)
- Particle-size range:
    - Gravel—fine, medium, coarse

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[1] Note that certain states/regulatory programs may require soil classification under a secondary system (e.g., US Department of Agriculture) or the use of hydrochloric acid to test the reaction with soil (none, weak, strong).

  - Sand—fine, medium, coarse
- Particle angularity: angular, subangular, subrounded, rounded
- Particle shape: (if appropriate) flat, elongated, flat and elongated
- Maximum particle size or dimension
- Hardness of coarse sand and larger particles
- Plasticity of fines: non-plastic, low, medium, high
- Dry strength: none, low, medium, high, very high
- Dilatancy: none, slow, rapid
- Toughness: low, medium, high
- Odor (mention only if organic or unusual)
- Moisture: dry, moist, wet

For intact samples also include:

- Consistency (fine-grained [clay] soils only): very soft, soft, firm, hard, very hard
- Structure: stratified, laminated, fissured, slickensided, lensed, homogeneous
- Cementation: weak, moderate, strong
- Additional comments: presence of roots or root holes, presence of mica, gypsum, etc., surface coatings on coarse-grained particles, caving or sloughing of auger hole or trench sides, difficulty in augering or excavating, etc.

Use the following standard descriptors for the textural percentages:

- Trace: 0 to 10%[2]
- Little: 11 to 20%
- Some: 21 to 35%
- And: 36 to 50%

Example descriptions, using the information listed above, would read as follows:

8-10' – Well Graded Sand, SW (5YR2/6) fine- to medium-grained sand, trace medium sub-angular rounded gravel (up to 0.5" in diameter); medium dense to dense; wet with slow dilatancy; moderate solvent-like odor between 9' and 10'.

10-12' – Lean Clay with Gravel, CL (5YR2/6) low plasticity clay with some fine to coarse grained angular to subangular gravels (up to 0.25" in diameter) and trace fine to medium grained rounded sands, very stiff, moist with no dilatancy, no odors.

9.6 Closing Notes

Once sampling is completed, secure the boreholes/locations in accordance with the project-specific project work plan. Mark all sample locations with spray paint, stakes, or other appropriate marker for future reference.

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[2] The use of "Trace" for describing the fraction of clay soils is inappropriate for field-based logs as clay contents of less than 20% in fine-grained soils cannot be reliably determined in the field.

Decontaminate all equipment prior to departure and properly manage all PPE and IDW in conformance with applicable regulations.

FIELD STANDARD OPERATING PROCEDURE #17
Solid Waste Sampling Procedure

Solid waste sampling procedures outlined in this standard operating procedure (SOP) are designed to ensure that solid waste samples are representative of the materials from which they were collected and that they have not been altered or contaminated by the sampling and handling methods. Solid waste materials are commonly stored or staged in open (e.g., waste piles, outfalls, surface impoundments) or closed units (e.g., drums, tanks and associated ancillary equipment, containers, sumps). Solid waste samples can be collected for onsite screening or for offsite laboratory analysis. 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.

17.1 Acronyms and Abbreviations

F	Fahrenheit
HASP	health and safety plan
IDW	investigation derived waste
NAPL	non-aqueous phase liquid
PID	photoionization detector
PPE	personal protective equipment
QAPP	Quality Assurance Project Plan
QA/QC	quality assurance/quality control
SOP	standard operating procedure
VOC	volatile organic compounds

17.2 Materials

- Field book
- PPE
- Air quality monitoring equipment
- Utility knife
- Mixing tray or bowl
- Hip-waders or rubber boots, as necessary
- Aluminum foil or heavy-duty zipper-style plastic bags (quart size)
- Plastic sheeting
- Expanding ruler or tape measure
- Sampling containers and labeling/shipping supplies
- Field test kits, as needed
- Waste sampling method-specific sampling equipment and materials:

    - Stainless steel trowels, shovels, or spoons
    - Bucket augers, auger extension rods, auger handle, pipe wrenches
    - Split-spoon samplers, pipe wrenches
    - Direct push acetate liners
    - Shelby tube samplers
- Decontamination supplies

17.3 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 conducting waste and wastewater sampling and assumes the user is familiar with basic field procedures, such as recording field notes (SOP 1), utility location (SOP 2), sample shipment procedures (SOP 3), sample collection and quality assurance procedures (SOP 4), investigation derived waste (IDW) management procedures (SOP 5), equipment decontamination (SOP 6), use and calibration of all sampling and monitoring equipment (SOPs 7 and 8), and waste water sampling (SOP 18). 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 project-specific work plan. Before sampling, be sure to review the project-specific work plan or Quality Assurance Project Plan (QAPP) and any applicable state and federal guidelines or sampling procedures. All sampling and monitoring 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 and HASP
- QAPP

17.4 General Procedures

Solid waste sampling presents a number of unique challenges for safe collection due to the potentially hazardous environment(s) where waste materials are located. Sampling of closed waste containers (e.g., drums, tanks, etc.) is considered a higher hazard risk because of the potential of exposure to toxic gases and flammable/explosive atmospheres. While opening closed waste containers for sampling purposes, monitor the breathing zone to ensure that the working environment does not contain hazardous levels of flammable/explosive gasses or toxic vapors, and follow the appropriate safety requirements stipulated in the HASP. Do not bodily enter tanks, sumps, waste containers, pipes, such as storm sewers or other drainage conveyances, during sample collection. **WSP personnel are not authorized to open closed units that are unlabeled or contain unknown contents.**

Each sampling situation will have unique set of equipment requirements and techniques. The selected procedures and equipment are project-specific and should be discussed by the project team before arriving onsite. All types of solid waste sampling, however, regardless of the equipment used, share common handling and management procedures that are designed to ensure the integrity of the samples collected. These procedures include:

- The use of new, disposable or decontaminated sampling equipment
- The use and rotation of the appropriate PPE (e.g., hip-waders or rubber boots and gloves, and Saranex or Tyvek duct-taped to nitrile gloves, etc.)
- Selection of a suitable sampling location and staging area

Collect all samples using either new, disposable equipment, or properly decontaminated sampling equipment. Solid waste sampling equipment should be selected based on the analytical requirements of the project and the project-specific conditions likely to be encountered. The equipment should be constructed of non-reactive, non-leachable materials (e.g., stainless steel, Teflon®, Teflon®-coated steel, polyethylene, polypropylene, etc.) which are compatible with the chemical constituents at the site. When choosing sampling equipment, give consideration to:

- the type and location of the waste unit
- the required depth of the sample
- the volume of sample required
- the analytes of interest

Select the decontamination procedures based on the types of sampling to be performed and media encountered; decontamination may require multiple steps or differing cleaning methods, depending on the sampling objectives and media encountered (see SOP 6 for decontamination procedures). In no case should disposable, single use materials be used to collect more than one sample.

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 analytical samples and must be changed any time during sample collection when their cleanliness is compromised.

If possible, find a suitable sampling location by selecting an area that is away from any sources of cross-contamination that could compromise the integrity of the samples. This includes positioning the sample collection area away from fuel-powered equipment, such as drill rigs or excavators, and upwind of other site activities (e.g., purging, sampling, decontamination) that could influence the sample. Extension rods or other appropriate devices can be used, as necessary, to allow the sample to be collected at a distance (or through deeper water) to minimize the risk to the sampler.

Once you have arrived on site and are prepared to conduct the waste sampling, note all observations and measurements in the field book.

- Perform a quick reconnaissance of the site to identify sampling locations
- Record the approximate ambient air temperature, precipitation, wind (direction and speed), tidal, and other field conditions in the field book. In addition, any site-specific conditions or situations that could potentially affect the sampling should be recorded
- Describe the sampling location
- Position fuel powered equipment downwind and at least 10 feet from the sampling location; make sure that the exhaust faces downwind
- Record pertinent information about the waste unit (e.g., type, capacity, markings, condition, and contents)
- Evaluate the accessibility to the waste unit, including ladders or stairs, and ensure that proper grounding is present, if needed

- Survey around the sampling location with a photoionization detector (PID), as necessary (see HASP), to ensure that the level of PPE is appropriate
- Mark sampling locations with a stake or flag for future reference; if available, record locations with respect to a permanent feature

17.4.1 Safety Considerations

Solid waste sampling may present a number of unique challenges for safe collection. Solid waste materials are frequently heterogeneous due to the physical characteristics of the matrix (e.g., particle size, viscosity, etc.), the distribution of hazardous constituents within the matrix, or the manner in which the material was managed or disposed. Because waste often stratifies over time due to different densities of phases, settling of solids, or varying wastes constituents generated at different times, both solid and liquid waste samples may need to be collected (see SOP 18 for waste water sampling procedures). Consult and involve WSP's compliance professionals during all phases of solid waste sampling.

Caution should be exercised when sampling *in situ* wastes (e.g., soil piles) because of the potential presence of explosive/flammable gases and/or toxic vapors. Ground or sediment surface or stockpiles may not be stable and could present an engulfment hazard. Do not attempt to sample surface impoundments used to manage potentially hazardous wastes from a boat; all sampling should be conducted from the banks or piers of surface impoundments.

Caution should be exercised when sampling closed waste containers, such as sealed drums, because of the potential presence of explosive/flammable gases and/or toxic vapors. Visually inspect all waste units for the following:

- pressurization (bulging/dimples)
- crystals formed around the drum opening
- leaks, holes, stains
- labels, markings, hazardous warnings
- composition and type (steel/poly and open/bung)
- dead vegetation around drum
- condition, age, rust, potential shock sensitivity (as indicated by contents listed on waste label)
- sampling accessibility (including a determination if it qualifies as a confined space)

Waste containers showing evidence of pressurization and/or crystals should be furthered assessed to determine if remote opening is needed. If containers cannot be accessed for sampling, heavy equipment may be necessary to stage the containers before sampling. Adequate time should be allowed for the contents to stabilize after a container is handled.

A grounding strap must be used when sampling metal waste containers, such as 55-gallon steel drums, due to the potential presence of explosive/flammable gases. First attach a grounding strap, then touch the waste container opening with a gloved hand and allow an electrically conductive path to form, as appropriate. Using spark-resistant tools, slowly open the waste container (e.g., vents, pressure release valves, bung or drum ring and/or lid) to allow the unit to vent to the atmosphere. Do not attempt to use a manual bung wrench or de-header on drums that potentially contain shock-sensitive, reactive, explosive or flammable materials. Screen the breathing zone for explosive gases and toxic vapor with air monitoring instruments before commencing sampling. Once sampling is complete (re)seal the waste container in accordance with the manufacturer's instructions.

17.4.2 Sampling Considerations

When collecting solid waste samples, consider the following:

- Collect waste water samples first to avoid disturbing the bottom and suspending solid wastes or sediment in the water column
- If collecting several solid waste samples from a stream, ditch, or river, start sampling at the downstream location and progressively move upstream

17.5 Solid Waste Sample Collection Procedures

Solid waste samples should be collected in accordance with the project-specific work plan. Typical sampling equipment includes : (1) scoops or trowels, (2) corers or grab samplers (e.g., hand augers, sludge judge), (3) dredges (e.g., Ekman, Peterson, or Ponar), (4) composite liquid waste samplers, bailers, or drum thief samplers, and (5) excavating or drilling equipment (e.g., split-spoon sampler, backhoe bucket). Follow the manufacturer’s operation manual for proper sampling procedures.

At the desired sampling location, clear away any accumulated surface debris. Place absorbent pads (if appropriate), sampling equipment and sample containers in a safe location near the waste that is to be sampled. If a grid system is being used to collect samples, lay out the grid according to the project-specific work plan.

Push the method-specific sampling equipment into the solid waste materials to the desired sampling depth using decontaminated or dedicated, disposable equipment. Tilt the sampling equipment at a slight angle, if necessary, to avoid losing waste materials. If a liquid sample is not required, decant liquid into a separate container or back into the vessel being sampled. If a liquid sample is required, decant any liquid directly into sample containers (see SOP 18). Record the depth interval through which the sampler was advanced in the field book. If additional sample volume is needed, repeat this step. Occasionally solid waste materials lack cohesiveness and are subject to crumbling and falling out of the sampler. The use of core catchers on the leading end of the sampler may help retain the sample until it is retrieved to the surface; core catchers must be evaluated for compatibility with the proposed analytical program before use.

Note the state, quantity, phases, and color of the solid waste in the field book. If field screening for organic vapors is required, break or cut the waste materials and quickly scan the breaks in the material with the appropriate air quality monitoring equipment (e.g., PID). Record the readings in the field book.

17.5.1 Volatile Organic Compound Sampling

If required by the project-specific sampling plan, immediately collect samples for analysis of volatile organic compound (VOC) after screening the sample with the PID to avoid loss of the compounds to the atmosphere. Transfer the waste materials from the center portion of the sample interval to be sampled directly into the sample containers; do not composite or mix waste materials for VOC analysis. If sampling by US Environmental Protection Agency Method 5035 is required, follow manufacturer’s specifications to use a closed-system sampler (e.g., Encore samplers). Collect quality assurance/quality control (QA/QC) samples in accordance with SOP 4 and the project-specific work plan or QAPP, if required.

17.5.2 Headspace Analysis

If required by the project-specific work plan, collect samples for field-based headspace analysis after obtaining the sample for VOC analysis. First, examine the contents of the sample and remove coarse gravel, organic material (e.g., roots, grass, and woody material) and any other debris. Collect the sample using decontaminated spoons or trowels and seal it in a heavy-duty zipper-style plastic bag. Label the sample indicating the sampling location, depth, and date. Shake the sample vigorously for approximately 15 seconds to disaggregate the sample and expose as much surface area of the soil as possible (to release the VOCs to the atmosphere within the bag). If necessary, warm the sample to room temperature (70º Fahrenheit, F) by placing the bag in a heated room or vehicle. This step is very important when the ambient temperature is below 32ºF.

After waiting approximately 15 minutes, carefully open the bag slightly and place the tip of the PID into the opening. Do not insert the tip of the probe into the soil and avoid the uptake of water droplets. Record the highest meter response, which typically occurs within the first 2 to 5 seconds. Erratic PID response may result from high organic vapor concentrations or elevated headspace moisture. If these conditions exist, qualify the headspace data in the field book. It is also important to record the ambient temperature, humidity, and whether moisture was present in plastic bag. Duplicate 10% of the headspace samples by collecting two samples from the same location. Generally, duplicate sample values should be consistent to plus or minus 20%. Samples collected for headspace screening cannot be retained for laboratory analysis.

17.5.3 Semi- and Non-Volatile Analytical Sample Collection

Collect remaining organic samples then inorganic samples in the following order of volatilization sensitivity:

- Extractable organics, petroleum hydrocarbons, aggregate organics, and oil and grease
- Metals
- Inorganic non-metallic and physical and aggregate properties
- Microbiological samples
- Radionuclides

Collect solid waste samples for non-volatile parameters by separating clumps of waste material and mixing the waste to a homogeneous particle size and texture using new or decontaminated stainless steel bowls and a stainless steel spoon or trowel. Transfer the contents to the appropriate laboratory-supplied sample container using a stainless steel spoon. Collect QA/QC samples in accordance with SOP 4 and the project-specific work plan or QAPP, if required.

If approved by the appropriate regulatory agency and/or specified in the project-specific work plan, composite waste samples can be collected to minimize the number of samples to be analyzed when sampling highly contaminated areas. Using the appropriate sampling technique, collect equal aliquots (same sample size) from each location by mixing the waste to a homogeneous particle size and texture using new or decontaminated stainless steel bowls and a stainless steel spoon or trowel. Transfer the contents to the appropriate laboratory-supplied sample container using a stainless steel spoon. Collect QA/QC samples in accordance with SOP 4 and the project-specific work plan or QAPP, if required.

Interstitial water, or pore water, is the water occupying the space between solid particles. It can be isolated to provide either a matrix for toxicity testing or an indication of the concentration and partitioning of contaminants with a solid matrix. Pore water samples may be collected in the field using any available technology that will preserve the integrity of the analytes of interest during collection (e.g., lysimeter) or extracted in the laboratory from field-collected waste. The substrate type will dictate the volume of sample needed. In all cases, consult the laboratory conducting the analyses to provide estimates of the amount of sample necessary to obtain the desired quantity of pore water.

If necessary, conduct field tests or screening of waste materials in accordance with the project-specific work plan and manufacturer's specifications for field testing equipment.

17.5.4 Non-Aqueous Phase Liquid Sampling Procedures

Non-aqueous phase liquids (NAPL) are not typically collected from solid waste units. However, if NAPL samples are required, the sampling options and techniques should be discussed with the assigned WSP compliance professional and project manager to ensure that the NAPL is not considered to be a hazardous material for the purpose of shipping to the laboratory (SOP 3). Samples of NAPL should be collected using the same procedures as above and placed in the appropriate laboratory-supplied containers, packed on ice, and shipped to the analytical laboratory using procedures outlined in SOP 3.

17.5.5 Sample Labeling and Preparation for Shipment

Once collected, prepare the waste samples for offsite laboratory analysis by:

- Cleaning the outside of the sample container
- Affixing a sample tag or label to each sample container and complete all required information (sample number, date, time, sampler's initials, analysis, preservatives, place of collection)
- Placing clear tape over the tag or label (if non-waterproof labels are used)
- Preserving samples immediately after collection by placing them into an insulated cooler filled with bagged wet ice to maintain a temperature of approximately 4°Celcius
- Recording the sample designation, date, time, and the sampler's initials in the field book and on a sample tracking form, if appropriate
- Completing the chain-of-custody forms with appropriate sampling information
- Securing the sample packing and shipping in accordance with proper procedures

Do not ship hazardous waste samples without first consulting a WSP compliance professional.

17.6 Closing Notes

Once sampling is completed, secure the waste unit(s) in accordance with the project-specific project work plan. Decontaminate all equipment prior to departure and properly manage all PPE and IDW in conformance with applicable regulations.

Appendix D –Summary of Aquifer Test Results

WSP

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August 28, 2014

Derek E. Chase
Director, Environmental Affairs
Emerson Electric Co.
8000 West Florissant Ave.
St. Louis, MO 63136-8506

Re: Summary of Aquifer Testing and Results
Kop-Flex VCP Site #31, Hanover, Maryland

Dear Derek:

WSP USA Corp. has prepared this letter report describing the aquifer testing conducted at the Kop-Flex Site located at 7565 Harmans Road in Hanover, Anne Arundel County, Maryland and WSP's evaluation of the results. Groundwater pumping tests were performed on the Surficial Aquifer and Lower Patapsco Aquifer between April and May 2014. The results of the pumping tests will be used to assist in the design of extraction well systems for the hydraulic containment of volatile organic compound (VOC)-affected groundwater within these water-bearing zones at the site. Specific goals for the pumping tests included the following:

- evaluate the range of potential sustainable yields for a pumping well in the affected portion of the aquifer
- assess the hydraulic influence of groundwater withdrawal from an extraction well
- estimate the aquifer hydraulic properties

The field work was performed in accordance with the Scope of Work for Aquifer Testing, dated March 12, 2014, which is consistent with standard field hydrogeologic investigation procedures and applicable technical guidance for site investigations developed the US Environmental Protection Agency (EPA), and American Society of Testing and Materials (ASTM). This letter report provides information on the aquifer testing procedures, including the installation of pumping and observation wells for each test, and WSP's evaluation of the test data.

Aquifer Testing Procedures

General

Aquifer testing was first conducted on the Surficial Aquifer in the area immediately west of the main manufacturing building and then the deeper Lower Patapsco Aquifer in the southern portion of the site. The time period between the cessation of the drawdown phase for the first test and beginning of pumping for the second test was approximately four days. For each test, field data were gathered during pre-test (background) water level monitoring, step-drawdown testing of the groundwater extraction well, and a 72-hour constant discharge pumping test. The constant discharge test was designed to record water level changes in the aquifer during and following the cessation of groundwater pumping. Aquifer properties, particularly the hydraulic conductivity (K)/ transmissivity (T) and storativity, control the change in hydraulic head under non-steady state flow conditions. Water level readings over the duration of the constant discharge test were used to calculate the aquifer hydraulic parameters.

Well and Piezometer Installation

Surficial Aquifer

Extraction well (TW-1), two monitoring wells (MW-38 and MW-39), and two observation wells/piezometers (OW-1 and OW-2) were installed in early April 2014 for the purpose of conducting the pumping test in the Surficial Aquifer. The piezometers and monitoring well MW-39 were placed at incremental distances hydraulically cross-gradient and downgradient of TW-1, and completed within the lower portion of the thick sand unit screened by the extraction well. Monitoring well MW-38, which is paired with piezometer OW-1, was installed within the predominately fine-grained silt and clay deposits overlying the sand unit. This well was used to gather data on head changes in the fine-grained unit in response to groundwater withdrawals from the underlying sand deposits. The well and piezometer locations are shown in Figure 1, and a summary of well construction information is provided in Table 1.

The well and piezometer boreholes were installed using the rotosonic drilling method. During drilling, continuous soil cores were collected and logged from the ground surface to the borehole termination depth. Extraction well TW-1 was installed above the top of the clayey aquitard separating the Surficial and Lower Patapsco aquifers, which was encountered at a depth of approximately 63 feet below ground surface (bgs). The well was constructed of 4-inch inside diameter (ID) Schedule 40 polyvinyl chloride (PVC) casing with 30 feet of 0.020-inch horizontally slotted screen. Shallow monitoring well MW-38 was drilled to a depth of 28 feet bgs and constructed of 2-inch inside ID Schedule 40 PVC casing with 10 feet of 0.010-inch horizontally slotted screen. Monitoring well MW-39 and the two piezometers were completed at depths ranging from 50 feet to 56 feet bgs, and were constructed of 2-inch inside ID Schedule 40 PVC casing with 10 feet of 0.020-inch horizontal slotted screen. The monitoring wells and piezometers were completed at grade with a protective steel cover set in a concrete pad and fitted with a locking well cap. The extraction well was completed above grade with a protective steel cover set in a 2-foot square concrete pad. The logging and well construction information was recorded in a field notebook, and as-built diagrams were prepared for the newly installed wells and piezometers (Enclosure A).

The new wells and piezometers were developed by pumping to remove sediments and ensure effective communication between the screen and surrounding aquifer material. Turbidity, pH, temperature, and specific conductance were periodically monitored during the development process to ensure that water representative of the screened potion of the aquifer was entering the well. For wells screened in the sand unit, development continued until the discharge was relatively free of suspended sediments.
The drilling activities were conducted with clean equipment to prevent potential cross-contamination between well locations in accordance with WSPs' Standard Operating Procedures (SOPs). The drilling equipment (core barrels and temporary casing) were cleaned using a portable steam cleaner. All decontamination fluids generated during the drilling activities were contained in 55-gallon steel drums and managed with other investigation-derived waste from the well installation activities.

After completing the installation of the wells and piezometers, ground surface and top of casing elevations were surveyed to the nearest 0.01-foot by a Maryland-licensed surveyor. The horizontal locations of the wells and piezometers were also determined to the nearest 0.1 foot and referenced to the State plane coordinate system.

Lower Patapsco Aquifer

In early April 2014, a deep, double-cased extraction well (TW-2) was installed along the southern property boundary for conducting the pumping test in the Lower Patapsco Aquifer. The location of well TW-2 is shown in Figure 1 and the corresponding well construction information is provided in Table 1. The extraction well borehole was installed using the rotosonic drilling method. During the drilling, continuous soil cores were collected and logged from the ground surface to the borehole termination depth. During borehole installation, a permanent, 8-inch diameter outer steel casing was set into the clayey confining unit at a depth of 64 feet bgs and pressure grouted in place. After allowing the grout seal to cure for approximately 1.5 days, the well borehole was advanced through the remaining silt and clay deposits comprising the confining unit and into the underlying Lower Patapsco Aquifer.

Upon encountering the coarser grained deposits characteristic of this hydrogeologic unit, a depth-discrete sampling tool was placed at the bottom of the borehole and driven into the undisturbed aquifer materials using the drilling rig. After sampling the groundwater at the selected depth, the sampler was removed and the borehole extended to an appropriate depth for collection of the next sample. The drilling and groundwater sampling process continued until termination of the borehole at a depth of 156 feet bgs. A total of six depth discrete groundwater samples were collected at 10-foot intervals from the Lower Patapsco Aquifer at the TW-2 location. Groundwater was purged from the sampling equipment using a small electric submersible pump prior to collection for subsequent field screening and laboratory analysis. Hydrogeochemical parameters (temperature, pH and specific conductivity) were monitored during the purging process to ensure the sampler was collecting water representative of the aquifer system. Each groundwater sample was field screened for 1,1-Dichloroethene (DCE) and other chlorinated ethenes using the Color-Tec© method, and the field screening results recorded in a field notebook. All groundwater samples were submitted to the Phase Separation Science laboratory in Baltimore, Maryland and analyzed for VOCs using USEPA SW-846 test method 8260B.

The analytical and 1,1-DCE field screening results for the depth discrete samples collected from the well borehole are summarized in Table 2. Given the top of the Lower Patapsco Aquifer was encountered at a depth of 95 feet bgs, the sampling data indicates the majority of the VOC mass occurs from approximately 100 feet bgs to 145 feet bgs in this portion of the site. Concentrations of total chlorinated ethanes and ethenes over this depth interval ranged from 10 mircograms per liter (µg/l) to 408 µg/l. As for the compounds detected, the laboratory results are consistent with existing groundwater quality data, with 1,1-DCE being the predominant site-related VOC and noticeably lower concentrations of chlorinated compounds. The Color-Tec© screening results closely track the depth-related variations in total chlorinated VOC concentrations in the groundwater samples.

Based on the field screening results, the extraction well was installed to a depth of 145 feet bgs and constructed of 4-inch ID Schedule 40 PVC casing with 45 feet of 0.020-inch horizontally slotted screen. The well was completed approximately 2 feet above grade with a protective steel cover set in a concrete pad. The logging and well construction information recorded during the installation activities are presented in the well borehole log included in Enclosure A.

Well TW-2 was developed by pumping to remove sediments and ensure effective communication between the screen and surrounding aquifer material. Turbidity, pH, temperature, and specific conductance were periodically monitored during the development process to ensure that water representative of the screened potion of the aquifer was entering the well. Development continued until the well discharge was relatively free of suspended sediments.

The drilling and groundwater profiling activities were conducted with clean equipment to prevent potential cross-contamination within the borehole. The drilling equipment was cleaned using a portable steam cleaner. The sampling tool was decontaminated after the collection of each sample using a non-phosphating soap and water solution, followed by a tap water then distilled water rinse. All decontamination fluids generated during the drilling activities were contained in 55-gallon steel drums and managed with other investigation-derived waste from the well installation activities.

After completing the well installation, the ground surface and top of casing elevations were surveyed to the nearest 0.01-foot by a Maryland-licensed surveyor. The horizontal location of the well was also determined to the nearest 0.1 foot and referenced to the State plane coordinate system.

Surficial Aquifer Test

Pre-Test Water Level Monitoring

The background monitoring for the Surficial Aquifer test began the morning of April 21, 2014, to identify and evaluate the presence of any antecedent water level trends and external factors that may influence hydraulic heads in the aquifer. During this test phase, water level data were collected from monitoring well MW-39 and piezometers OW-1 and OW-2 screened in the sand unit, and shallow monitoring well MW-38. Water levels were measured at a very short time interval until early the morning of April 28, 2014, using pressure transducers installed in each of the above monitoring points. The transducers measure the water level, which is determined relative to atmospheric pressure, and record the readings in an electronic data logger. In addition, water levels in the extraction well and monitoring wells and piezometers in the test area were measured manually shortly before and after the background monitoring period using an electronic water-level indicator.

Step Drawdown Test

A step drawdown test was conducted on the extraction well, which consisted of applying higher incremental pumping rates and measuring the water levels in TW-1 and selected wells and piezometers at each successive rate. The objective of the step test was to determine the range of sustainable pumping rates for the extraction well, from which an appropriate rate could be selected for the constant-rate pumping test, and evaluate the response (i.e., drawdown) in the water level in the aquifer. The step drawdown test for TW-1 was conducted on April 29, 2014.

The extraction well pumping rate was varied between 5 gallons per minute (gpm) and 14 gpm by means of an in-line valve, which regulated the discharge from a constant-speed submersible pump installed in TW-1. The pumping rate for the extraction well was monitored throughout each step using an in-line flow meter to ensure there were no erratic changes in the well discharge. A constant extraction rate was maintained throughout each pumping step. The groundwater discharge was routed to a pair of weir tanks placed a short distance north of well TW-1. The water was then transferred to another weir tank located near the southeastern portion of the manufacturing building. Water placed into this tank was treated using granular activated carbon (GAC) to remove chlorinated VOCs and ion exchange resin to remove trace metals (particularly copper) and then discharged to the storm water sewer inlet near the southeast building corner. The water entering the storm water sewer eventually discharged to Stony Run at Outfall 001 in accordance with the facility's National Pollutant Discharge Elimination System (NPDES) Permit MD0069094 and State Discharge Permit No. 07-DP-3442.

Water levels were measured in extraction well TW-1, piezometers OW-1 and OW-2, and monitoring well MW-18 using data logging pressure transducers. The pressure transducers were programmed to collect water level data on a logarithmic scale, which allows for more rapid measurements at the beginning of the test than near the end of the test. Manual measurements using an electronic water level indicator were also made in TW-1 during the test to gather real-time data on the water level in the well and ensure no damage to the pump due to excessive drawdown during pumping.

Constant Discharge Rate Test

The constant-rate pumping test consisted of the continuous extraction of groundwater from extraction well TW-1 at the selected pumping rate (11 gpm) continuously for approximately 3 days. The constant-rate test began on the morning of April 29, 2014, approximately 17 hours following the completion of the step drawdown test. WSP field personnel regularly measured the discharge rate from the extraction well using the in-line flow meter. The management and disposal of well discharge from the constant rate test was identical to the process described for the step drawdown test.

Data logging pressure transducers were placed in the extraction well (TW-1), piezometers OW-1 and OW -2, and monitoring wells MW-18, MW-38, and MW-39. The pressure transducers were programmed to collect and record water levels on a logarithmic scale. Manual water level measurements were also made in TW-1 during the test to ensure no decrease in well yield and associated increase in drawdown during pumping. In addition, manual water level measurements were periodically collected at monitoring wells shallow well MW-5 and intermediate well MW-14 (see Figure 1 for locations of these wells).

Groundwater discharge samples were collected two times during the constant discharge rate test:

- April 29, 2014, after an elapsed pumping time of two hours
- May 2, 2014, after an elapsed pumping time of approximately 71 hours

The groundwater samples were collected in pre-preserved, 40-ml glass vials and submitted to the Phase Separation Science laboratory in Baltimore, Maryland. Both samples were analyzed for VOCs using USEPA SW-846 Test Method 8260B and 1,4-dioxane using modified USEPA method 8260B with selective ion monitoring (SIM).

Water level recovery data were collected at the extraction well, piezometers, and monitoring wells containing pressure transducers immediately after completing the drawdown phase of the test. The recovery portion of the test was started the morning of May 2, 2014, and continued until the water levels in the extraction and observation wells were changing at a rate of less than 0.1 feet per hour. The recovery phase of the test was stopped after 23.5 hours.

Lower Patapsco Aquifer Test

Pre-Test Water Level Monitoring

The background monitoring for the Lower Patapsco Aquifer test began around noon on May 1, 2014, to identify and evaluate the presence of any antecedent water level trends and external factors influencing hydraulic heads in the aquifer. During this test phase, water level data were collected from extraction well TW-2, the MW-17/MW-17D well pair, and monitoring well MW-21D. Water levels were measured at a short time interval until the morning of May 5, 2014, using pressure transducers installed in each of the above monitoring points. The transducers measured the water level, which is determined relative to atmospheric pressure, and record the readings in an electronic data logger. In addition, water levels in the extraction well and intermediate and deep monitoring wells in the test area were measured manually before and after the background monitoring period using an electronic water-level indicator.

Step Drawdown Test

A step drawdown test was conducted on the extraction well, which consisted of applying higher incremental pumping rates and measuring the water levels in TW-2 and selected monitoring wells at each successive rate. The objective of the step test was to determine the range of sustainable pumping rates for TW-2, from which an appropriate rate could be selected for the constant discharge rate test, and evaluate the response (i.e., drawdown) in the water level in the aquifer. WSP conducted the step drawdown test for TW-2 on May 5, 2014.

The extraction well pumping rate was varied between approximately 22 gpm and 44 gpm by means of an in-line valve, which regulated the discharge from a constant-speed electric submersible pump. The pumping rate for the extraction well was monitored throughout each step using an in-line flow meter to ensure there were no erratic changes in the well discharge. A constant extraction rate was maintained throughout each pumping step. The TW-2 discharge was routed to the weir tank located near the southeastern portion of the manufacturing building. Water placed into this tank was treated using GAC media to remove chlorinated VOCs, and then discharged to the storm water sewer inlet near the southeast building corner. This water eventually discharged to Stony Run in accordance with the facility's NPDES Permit MD0069094 and State Discharge Permit No. 07-DP-3442.

Water levels were measured in TW-2 and deep monitoring wells MW-1D, MW-17D, MW-21D, and MW-22D using data logging pressure transducers. The pressure transducers were programmed to collect water level data on a logarithmic scale, which allows for more rapid measurements at the beginning of the test than near the end of the test. Manual measurements using an electronic water level indicator were also made in TW-2 during the test to gather real-time data on the water level in the well and ensure no damage to the pump due to excessive drawdown during pumping.

Constant Discharge Rate Test

The constant-rate pumping test consisted of the continuous withdrawal of groundwater TW-2 at the selected pumping rate (38 gpm) continuously for approximately 3 days. The constant-rate test began in the late morning of May 6, 2014, approximately 17.5 hours following the completion of the step drawdown test. WSP field personnel regularly measured the discharge rate from the extraction well using the in-line flow meter. The management and disposal of well discharge from the constant rate test was identical to the process described for the step drawdown test.

Data logging pressure transducers were used to collect water level data from TW-2, and monitoring wells MW-1D, MW-21D, MW-22D, MW-24D, and the MW-17/MW-17D well pair. The pressure transducers were programmed to collect and record water levels on a logarithmic scale. Manual water level measurements were also made in TW-2 during the test to real-time monitor the well yield and associated drawdown in the well during pumping. In addition, manual water level measurements were periodically collected at monitoring wells intermediate wells MW-12 and MW-14, and deep wells MW-16D and MW-26D (see Figure 1 for locations of these wells).

Groundwater discharge samples were collected at two times during the constant discharge rate test:

- May 6, 2014, after an elapsed pumping time of approximately two hours

- May 9, 2014, after an elapsed pumping time of 68.5 hours

The groundwater samples were collected in pre-preserved, 40-ml glass vials and submitted to the Phase Separation Science laboratory in Baltimore, Maryland. Both samples were analyzed for VOCs using USEPA SW-846 Test Method 8260B and 1,4-dioxane using modified USEPA method 8260B with SIM.

Water level recovery data were collected at the extraction and monitoring wells containing pressure transducers immediately after completing the drawdown phase of the test. The recovery portion of the test was started the morning of May 9, 2014, and continued until the water levels in the wells were changing at a rate of less than 0.1 feet per hour. The recovery phase of the test was stopped after 24 hours.

Aquifer Test Data Analysis

Groundwater Levels under Non-Pumping Conditions

Surficial Aquifer

The background monitoring data collected before performing the constant-rate test were evaluated to determine the presence and magnitude of any antecedent water level trends and external factors that may influence hydraulic heads in the aquifer, particularly in the thick sand unit screened TW-1. Figure 2 presents a hydrograph for well MW-39 during the monitoring period along with barometric pressure readings measured at the Thurgood Marshall-Baltimore Washington International (BWI) Airport a short distance north of the Kop-Flex facility. The inverse relationship between the water level and pressure, which is typical of the wells and piezometers screened in the sand unit, indicates a barometric pressure effect on the observed groundwater fluctuations in the well. (This phenomenon also appears to influence the hydraulic head in wells completed in the shallow silt and clay deposits, although the affect is noticeably subdued.) Evaluation of the background monitoring data indicates the following median barometric efficiencies for the wells and piezometers screened in the sand unit:[1]

- MW-39 – 0.25
- OW-1 – 0.42
- OW-2 – 0.27

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[1] Barometric efficiency is defined as the water level change caused by a barometric pressure change divided by that barometric pressure change.

The barometric pressure recorded at Marshall-BWI Airport during the pumping test activities decreased 0.52 inches of mercury (in. Hg) or 0.59 ft. of water (1 in of Hg = 1.13 ft. of water). Based on the barometric efficiencies provided above, the water level increase associated with this decline in the barometric pressure would have ranged from 0.15 ft. to 0.25 ft. Since the barometric pressure-related water level change is an order of magnitude less than the apparent drawdown in the observation points, the data collected during the constant discharge rate test were not corrected for barometric pressure effects.

Lower Patapsco Aquifer

A hydrograph of the background water level and barometric pressure data for monitoring well MW-17D is provided in Figure 3. As with the intermediate-depth wells in the Surficial Aquifer, the antithetic relationship between the groundwater elevation and pressure is indicative of a barometric pressure effect on the water level in this and other deep wells. The presence of barometric pressure-related water level changes is a common hydrologic phenomenon in aquifers under confined (or artesian) conditions. Using the background monitoring data, the median barometric efficiency for wells screened in the Lower Patapsco Aquifer was determined to be 0.23. During the constant rate test, the barometric pressure recorded at Marshall-BWI Airport increased 0.36 in. of Hg, or 0.41 ft. of water, during the first day of pumping. Based on the aforementioned site-specific barometric efficiency for the aquifer, the water level decrease associated with this rise in barometric pressure would have been less than 0.1 ft. Since the barometric pressure-related water level change is more than an order of magnitude less than the apparent drawdown in the observation points, the data collected during the constant discharge rate test were not corrected for barometric pressure effects.

In addition to the barometric pressure effects, a generally decreasing trend in the water levels appeared to be superimposed with other water level fluctuations in the wells screened in the Lower Patapsco Aquifer (Figure 3). Linear regression analysis was used to estimate the rate of the potentiometric surface decline during the background monitoring period, which determined to be -0.05 feet per day (ft/day). Both the drawdown and recovery data obtained from the deep wells during the constant discharge rate pumping test were adjusted for this local antecedent rate of hydraulic head decline in the aquifer.

Hydraulic Influence during Groundwater Withdrawal

Surficial Aquifer

The start of the drawdown phase of the constant discharge rate test coincided with the occurrence of an anomalous storm event in the mid-Atlantic region. A review of the precipitation records from the Marshall-BWI Airport weather station indicated a total of 8.1 inches of rainfall over a 36-hour period from mid-morning on April 29th through mid-evening on April 30th. Water level data collected from well MW-14, which was situated near the limit of hydraulic influence for the test, indicate a gradual increase in the groundwater surface from 715 minutes (approximately 12 hours) to 2,225 minutes (approximately 37 hours) of elapsed pumping time. The total rise of the water level in this well during and immediately following the storm event is estimated to be 0.90 feet. Although background monitoring identified the presence of barometric pressure effects on hydraulic heads, the observed change in the groundwater surface during the constant rate test was linked to the significant precipitation event in the region. Consequently, the time-drawdown data measured during the test were corrected for recharge associated with the infiltration of soil moisture from the storm. Figure 4 provides a typical plot of both the measured (uncorrected) and recharge corrected drawdown for the intermediate-depth wells and piezometers during the pumping phase of the test.

The corrected drawdown at the extraction well, and monitoring wells and piezometers, after an elapsed pumping time of approximately three days, is illustrated in Figure 5. (The aquifer drawdown in the immediate vicinity of well TW-1 was determined from the water level measured in the well casing and a well efficiency of 75 percent.)   A relatively large area of hydraulic influence was created within the sand unit at the selected test pumping rate of 11 gpm, as evidenced by more than 2 feet of drawdown in observation points located greater than 100 feet from the extraction well. In addition to the noticeable hydraulic response in the coarse grained deposits, drawdown of greater than one foot was also measured in shallow monitoring wells MW-5 and MW-38 in the test area (Figure 5). The appreciable displacement of the water level in these wells completed in the finer grained deposits suggests the underlying sand unit may be characterized as a leaky confined hydrogeologic unit.

The Hantush-Jacob solution was used to analyze the drawdown data from OW-1 and OW-2 after three days of pumping. Assuming steady-state flow in a leaky confined aquifer, zero drawdown would occur at an estimated radial distance of approximately 350 feet from the pumping well. However, this radius of influence at the test withdrawal rate of 11 gpm should be considered approximate due to relatively large amount of drawdown in the groundwater surface in the overlying silt and clay deposits.

Lower Patapsco Aquifer

The adjusted drawdown at TW-2 and surrounding monitoring wells shortly before the termination of pumping for the constant rate test is shown in Figure 6. (The aquifer drawdown in the immediate vicinity of TW-2 was determined from the water level measured in the well casing and a well efficiency of 75 percent.) As with the constant discharge rate test in the Surficial Aquifer, a large area of hydraulic influence was created within the upper portion of the aquifer at the selected test withdrawal rate of 38 gpm. Drawdown in the potentiometric surface of greater than 1.5 feet was detected in observation points located more than 400 feet from the extraction well. Based on the drawdown contours depicted in Figure 6, the cone of depression around the extraction well appears to form a slightly ellipsoidal area with the long (major) axis oriented in a generally east-west direction.

Plots of the corrected drawdown *vs.* time for the deep monitoring wells are consistent with aquifers characterized by a leaky or semi-confined condition. Although water level data collected from the intermediate-depth monitoring wells (MW-12, MW-14, and MW-17) indicate less than 0.2 feet of drawdown during the pumping portion of the test, these values do not take into consideration the effects of the increased recharge associated with the major storm event the week of April 27, 2014. In addition, a review of the data plots indicates a slight reduction in the observed drawdown after approximately two days of continuous pumping which may reflect enhanced transient leakage associated with the precipitation event. The measured drawdown in the deep wells during groundwater withdrawal supports the existing conceptual hydrogeologic model of the site, which indicates some limited hydraulic communication across the Lower Patapsco confining unit at a depth of approximately 60 feet bgs. For purposes of the pumping test data analysis, the Lower Patapsco Aquifer can be considered a semi-confined aquifer.

An analysis was performed on the late time drawdown data from monitoring wells located at radial distances of greater than 100 feet from TW-2 using the Theim solution for confined aquifers. Assuming steady state flow, the radial extent of hydraulic influence (i.e., zero drawdown) from the pumping well is estimated to be approximately 675 feet at a pumping rate of 38 gpm. The apparent radius of influence should be considered approximate because this solution method assumes a fully penetrating extraction well whereas TW-2 only partial penetrates the Lower Patapsco Aquifer.

Maximum Sustainable Well Yield

Surficial Aquifer

The step drawdown test conducted on April 28, 2014, was performed to evaluate the sustainable yield from the thick sand unit while pumping from well TW-1. Based on the measured drawdown in the test well during the various pumping steps, an extraction rate of 12-13 gpm is believed to approximate the maximum short term yield for an extraction well that fully penetrates this transmissive hydrogeologic unit. However, further evaluation of the water level and pumping rate data obtained during the constant rate test indicates the long term yield for an extraction well may be significantly less due to the limited available drawdown. Based on the constant discharge rate test data, the specific capacity, or yield per unit of well drawdown, of TW-1 is 1.2 gpm per foot (gpm/ft). Studies have consistently demonstrated the specific capacity of a continuously pumping well will decrease between 35 percent and 50 percent after one year as the water removed is derived primarily from aquifer storage. Assuming a conservative reduction of 50 percent, the long term specific capacity for the extraction well would then decrease to 0.6 gpm/ft. Based on the hydrogeologic data, a maximum drawdown of 12 feet would be possible in the well and still maintain a leaky confined condition for the sand unit. Based on this available drawdown, the long term sustainable yield for a well screened in the sand deposits is:

(0.60 gpm/ft) x (12 ft) = 7.2 gpm

The continuous, long term withdrawal of groundwater at rates up to 7 gpm would ensure radial flow to the extraction well under a leaky confined condition, with the potentiometric surface remaining above the upper boundary for the sand unit.

Lower Patapsco Aquifer

Evaluation of the sustainable yield for an extraction well screened in the upper portion of the Lower Patapsco Aquifer is largely based on the data gathered during the step drawdown test conducted on May 5, 2014. Given the drawdown observed during both the step and constant rate tests, a partially penetrating well that is constructed similar to TW-2 should be able to achieve long term sustainable yields approaching 50 gpm. The water level and pumping rate data obtained during the constant rate test were reviewed to support this determination concerning the long term yield for the extraction well. Using these measurements, the specific capacity of TW-2 is 3.3 gpm/ft. Assuming a 50 percent reduction during the first year of pumping, the long term specific capacity for the extraction well would decrease to 1.65 gpm/ft. The installation of the pump above the well screen would provide for a maximum available drawdown in the well of 45 feet. Based on the above, the long term sustainable yield for well TW-2 (74 gpm) is approximately 2x the pumping rate used during the constant discharge rate test.

Transmissivity and Hydraulic Conductivity

Surficial Aquifer

The data collected during the constant discharge rate test were analyzed using HydroSOLV's AQTESOLV® for Windows software program. The time and corrected drawdown for the extraction and observation wells were evaluated using the Cooley and Case solution for transient flow in a leaky confined aquifer overlain by a water table aquitard. The recovery data were analyzed using the Theis recovery method for confined aquifers.

Table 3 summarizes the calculated hydraulic parameters derived from the corrected drawdown and recovery data collected during the constant discharge rate pumping test. Transmissivity values were derived directly from the respective solution method; the corresponding K values were calculated by dividing the T value by the thickness of the sand unit in the area around the respective well. Estimated values for the hydraulic conductivity (K), transmissivity (T), and storativity of the sand deposits comprising the leaky confined unit are consistent with typical published values for this type of aquifer material. (WSP was unable to identify any published report providing information on the hydraulic properties of this hydrogeologic unit in Anne Arundel County, Maryland.) The hydraulic conductivity values for the sandy aquifer materials in the area west of the main manufacturing building ranged from 5.2 feet per day (ft/day) to 11 ft/day, with a geometric mean of 9.21 ft/day.

Lower Patapsco Aquifer

The data collected during the constant discharge rate test on the Lower Patapsco Aquifer were analyzed using HydroSOLV's AQTESOLV® for Windows software program. The time and corrected drawdown for the extraction and observation wells were evaluated using the Hantush solution for transient flow to a partially penetrating well in a leaky confined aquifer. The recovery data were analyzed using the Theis recovery method for confined aquifers.

Table 4 summarizes the calculated hydraulic parameters derived from the corrected drawdown and recovery data collected during the constant discharge rate pumping test. As with the analysis of the data for the Surficial Aquifer test, T values were determined directly from the respective solution equation. The K values were calculated by dividing the respective T value obtained from the selected solution method by the aquifer thickness in the general vicinity of the Kop-Flex site. Based on hydrogeologic information gathered during offsite well installation, the inferred thickness of the Lower Patapsco Aquifer in the site vicinity was estimated to be 80 feet.

Aquifer transmissivities obtained from the data analysis show a limited range of values, with a minimum of 1,170 square feet per day (ft^2/day) for well MW-1D to a maximum of 1,620 ft^2/day for MW-26D. The geometric mean of the transmissivity values obtained from the test is 1,410 ft^2/day. The calculated hydraulic conductivity values for the aquifer materials in the area around TW-2 varied from 14.6 ft/day to 20.3 ft/day, with a geometric mean K of 17.7 ft/day. The estimated geometric mean T and K values for the Lower Patapsco Aquifer are similar with the data cited in other hydrogeologic reports for the Coastal Plain deposits. Transmissivity values determined from well tests in the northwest portion of Anne Arundel County, including the Stevenson Road well southeast of the site, are typically on the order of 2,000 ft^2/day. The hydraulic conductivity and storativity values are also within the range of values typical for the unconsolidated sand deposits of the Lower Patapsco Aquifer.

Groundwater Discharge Sampling

Surficial Aquifer

Groundwater discharge samples were collected from the extraction well at the beginning (TW-1-Q1) and the end (TW-1-Q2) of the constant rate pumping test. The analytical results for these samples are summarized in Table 5. The primary chemicals of concern (COCs) at the Kop-Flex site – 1,1,1-trichloroethane (TCA) and its degradation products [1,1-dichloroethene (1,1-DCE), 1,1-dichloroethane (1,1-DCA), and 1,2-DCA], and 1,4-dioxane – were detected above the method detection limit in each of these samples. In addition, very low levels of chlorinated ethenes were also detected in both discharge samples. The total concentrations of the primary COCs were similar during the 3-day pumping period, with 2,730 micrograms per liter (ug/l) detected in the initial sample and 2,701 ug/l in the sample collected shortly before the end of pumping. The concentration of 1,1-DCE in the well discharge decreased from 870 ug/l to 670 ug/l over the test. Conversely, the concentration of 1,4-dioxane increased from the early to late samples.

Lower Patapsco Aquifer

Samples of the groundwater discharge samples were collected from well TW-2 at the beginning (Effluent 1) and the end (Effluent 2) of the constant rate pumping test. The laboratory analytical results for these samples are summarized in Table 6. The primary chemicals of concern (COCs) at the Kop-Flex site – 1,1,1-trichloroethane (TCA) and its degradation products (1,1-DCE and 1,1-DCA), and 1,4-dioxane – were detected above the method detection limit in each of these samples. In addition, trace levels of chlorinated ethenes (trichloroethene and cis-1,2-dichloroethene) were also detected in both discharge samples. The total concentrations of the primary COCs were similar during the 3-day pumping period, with 833 ug/l detected in the May 6th sample and 904 ug/l in the May 9th sample collected shortly before the termination of pumping. These total VOC levels are 1-2x lower than the concentrations found in monitoring wells MW-17D and MW-24D situated along the center-line of the groundwater plume. The lower concentrations probably reflect the extraction of water from both the impacted zone of the aquifer screened by TW-2 and a portion of the aquifer below this well that does not contain any site-related VOCs. The concentration of 1,1-DCE in the well discharge increased from 310 ug/l to 420 ug/l over the test. Conversely, the concentration of 1,4-dioxane decreased from the early to late samples.

If you have any questions concerning the information presented in the aquifer test summary, please do not hesitate to contact us.

Sincerely yours,

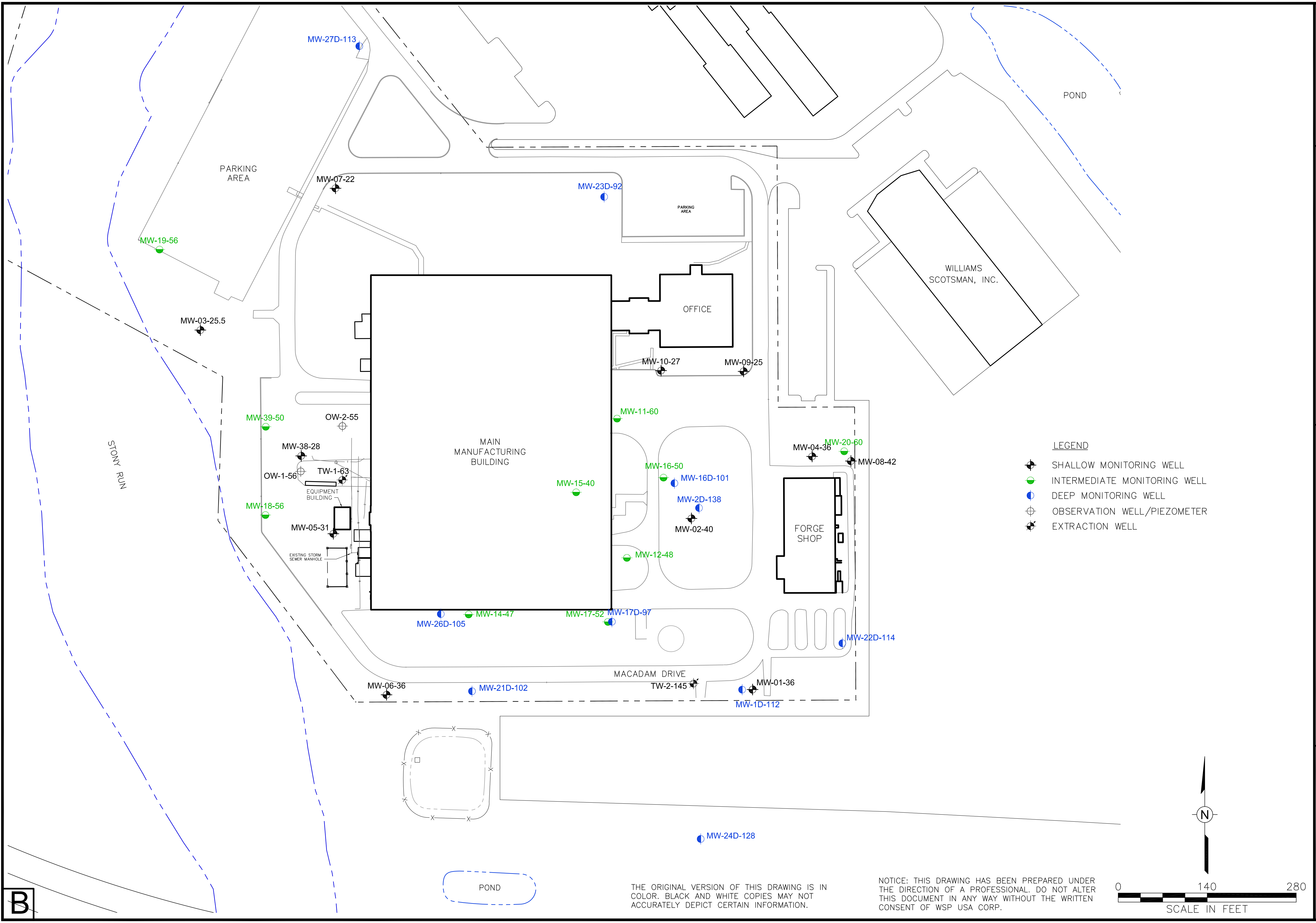
Robert E. Johnson

Eric Johnson
Senior Technical Manager

REJ:jpb:rlo

Enclosure

Figures



LEGEND

- ✦ SHALLOW MONITORING WELL
- ◒ INTERMEDIATE MONITORING WELL
- ◐ DEEP MONITORING WELL
- ⊕ OBSERVATION WELL/PIEZOMETER
- ✦ EXTRACTION WELL

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Drawn By: EGC
Checked:
Approved: RG 6/19/2014
DWG Name: 00003705-157

KOP-FLEX
HANOVER, MARYLAND
PREPARED FOR
EMERSON
ST. LOUIS, MISSOURI

Figure 1

WELL AND PIEZOMETER LOCATIONS
FOR AQUIFER TESTING ACTIVITIES

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Reston, Virginia 20191
(703) 709-6500
www.wspgroup.com/usa

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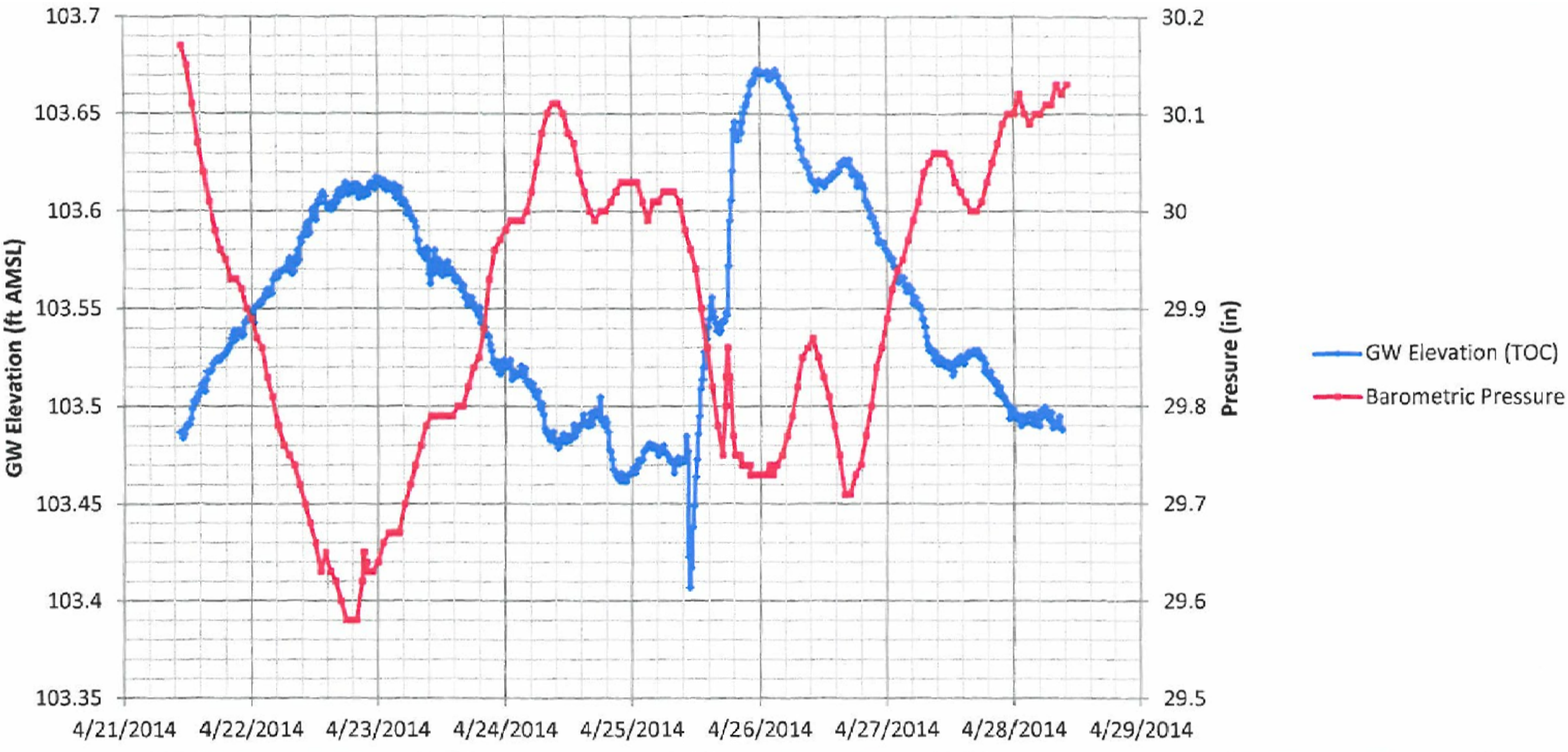

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Figure 2

TIME SERIES ANALYSIS OF WATER LEVEL
AND BAROMETRIC PRESSURE FOR WELL
MW-39-50, APRIL 21-28, 2014

KOP-FLEX
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ST. LOUIS, MISSOURI

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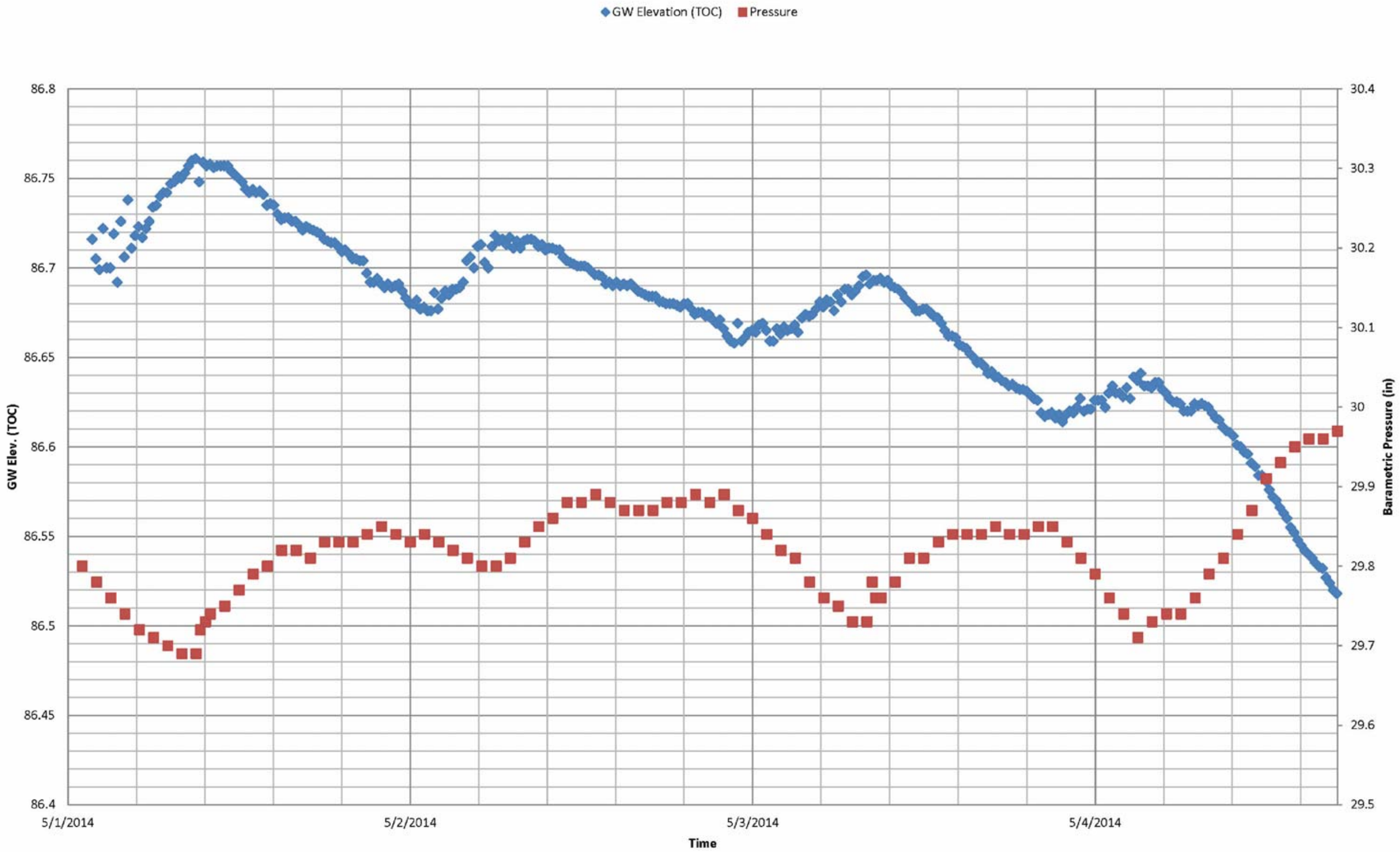

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Figure 3

TIME SERIES ANALYSIS OF WATER LEVEL AND BAROMETRIC PRESSURE FOR WELL MW-17D-97, MAY 1-5, 2014

KOP-FLEX
HANOVER, MARYLAND

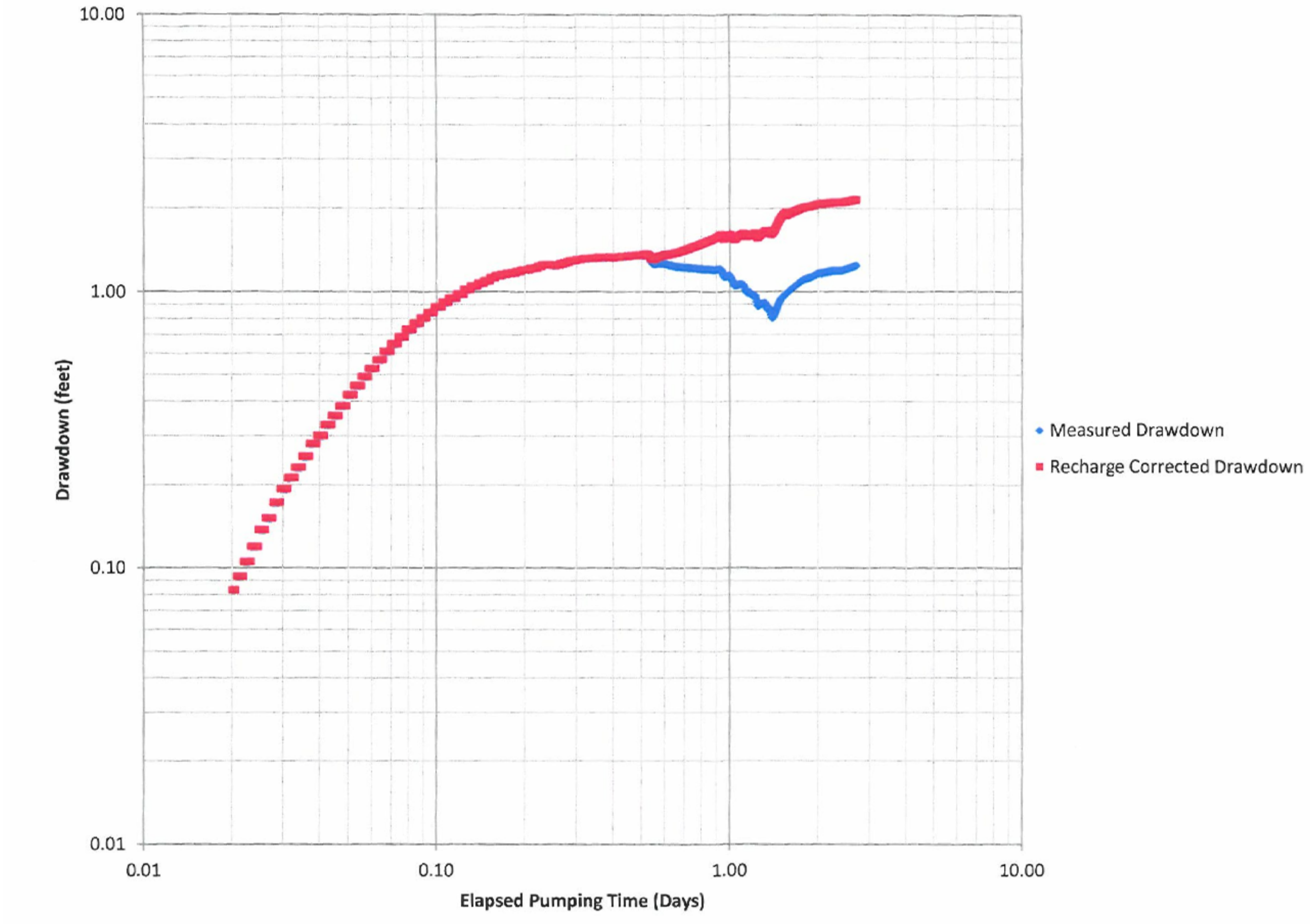
PREPARED FOR
EMERSON
ST. LOUIS, MISSOURI

Drawn By: EGC

Checked:

Approved: RG 6/23/2014

DWG Name: 00003705-158



A

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Figure 4

EXAMPLE OF REMOVING PRECIPITATION RECHARGE EFFECT FROM DRAWDOWN DATA, WELL MW-39-50

KOP-FLEX
HANOVER, MARYLAND

PREPARED FOR
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ST. LOUIS, MISSOURI

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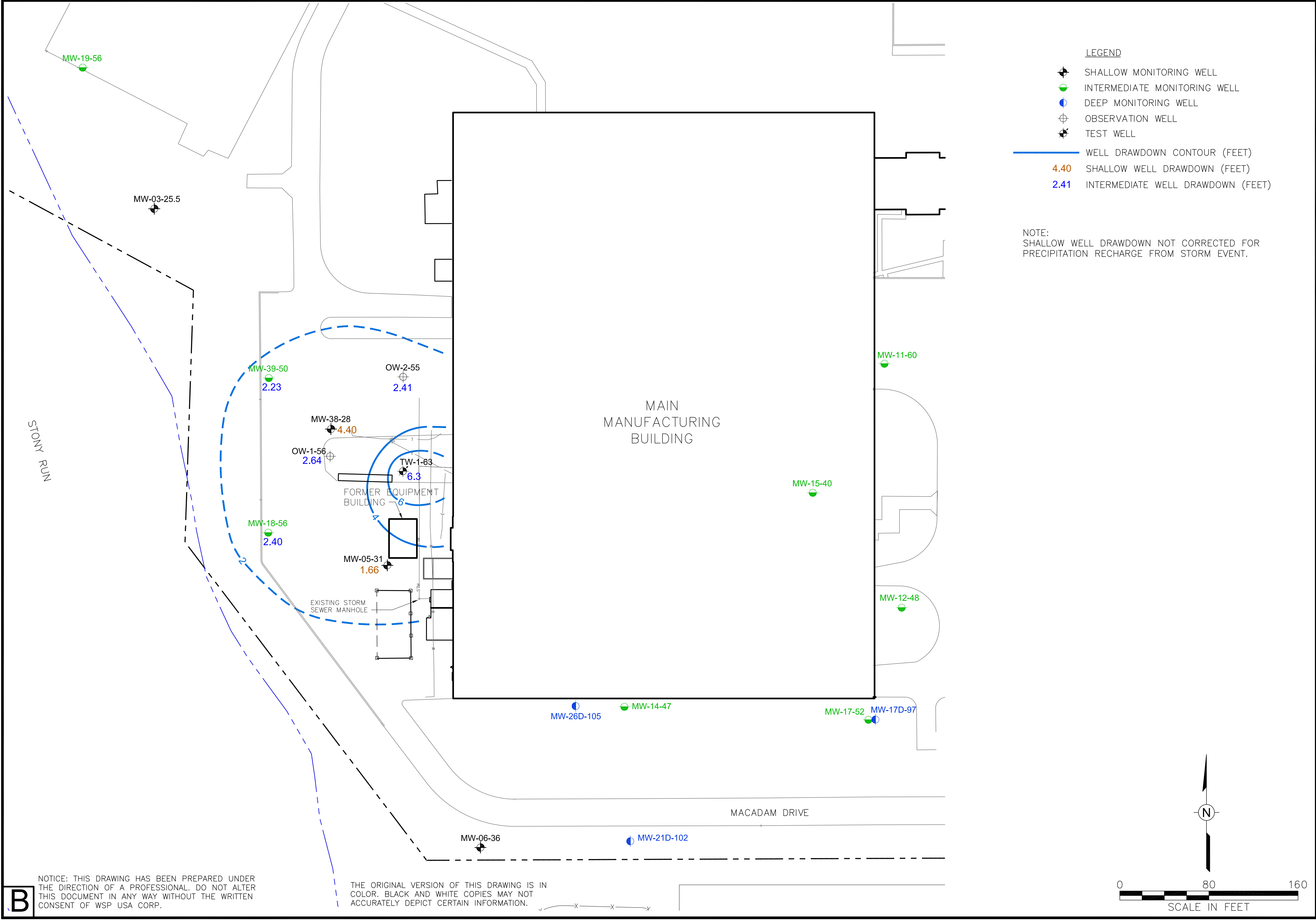
Checked:
Approved: 6/23/2014
DWG Name: 00003705-158



LEGEND

✦	SHALLOW MONITORING WELL
●	INTERMEDIATE MONITORING WELL
◐	DEEP MONITORING WELL
⊕	OBSERVATION WELL
✦	TEST WELL
—	WELL DRAWDOWN CONTOUR (FEET)
4.40	SHALLOW WELL DRAWDOWN (FEET)
2.41	INTERMEDIATE WELL DRAWDOWN (FEET)

NOTE:
SHALLOW WELL DRAWDOWN NOT CORRECTED FOR PRECIPITATION RECHARGE FROM STORM EVENT.

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KOP-FLEX
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Figure 5

WELL DRAWDOWN AT TERMINATION OF CONSTANT RATE TEST IN THE SURFICIAL AQUIFER

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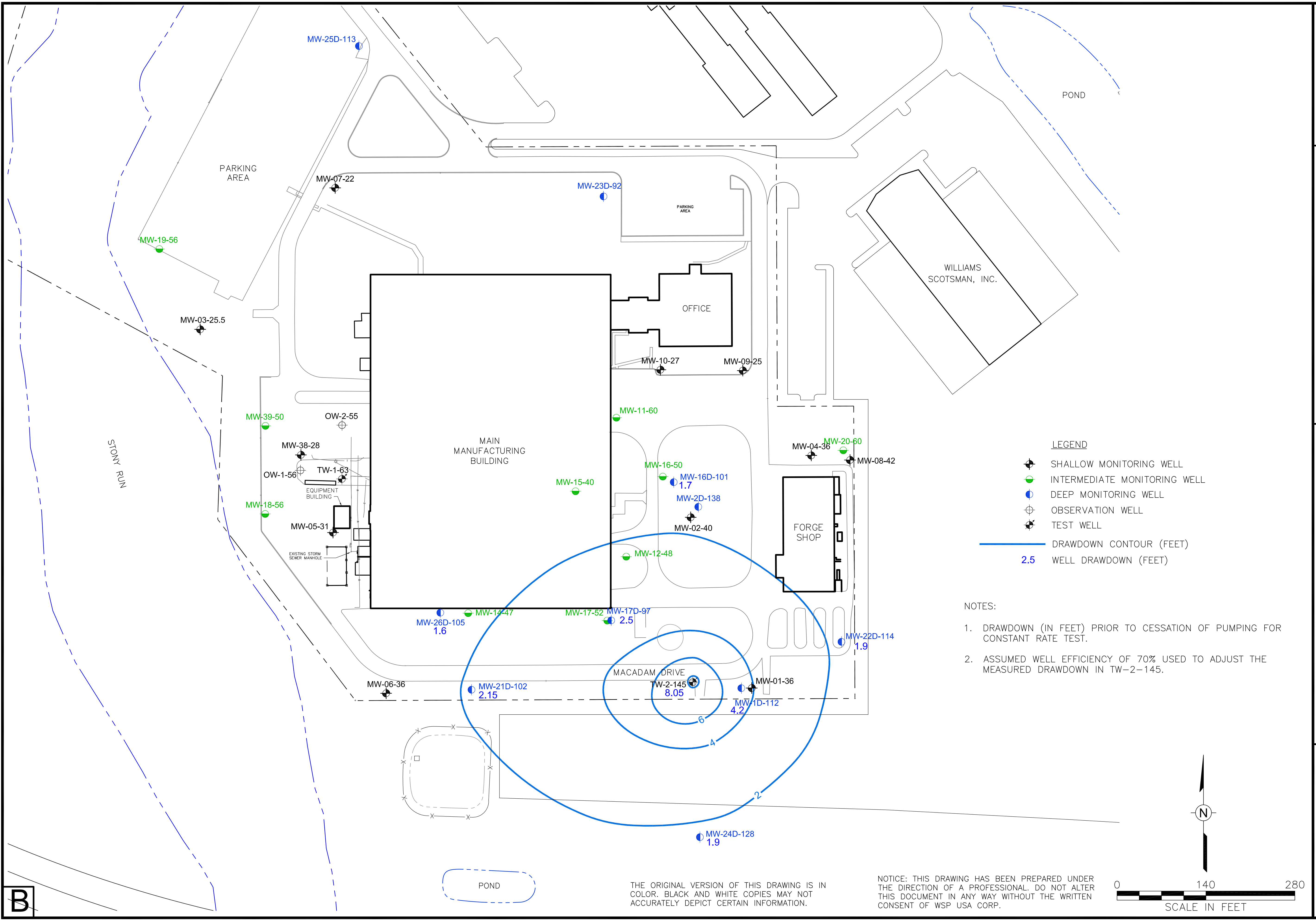

LEGEND

⊕	SHALLOW MONITORING WELL
⊖	INTERMEDIATE MONITORING WELL
◐	DEEP MONITORING WELL
⊕	OBSERVATION WELL
⊕	TEST WELL
—	DRAWDOWN CONTOUR (FEET)
2.5	WELL DRAWDOWN (FEET)

NOTES:

1. DRAWDOWN (IN FEET) PRIOR TO CESSATION OF PUMPING FOR CONSTANT RATE TEST.
2. ASSUMED WELL EFFICIENCY OF 70% USED TO ADJUST THE MEASURED DRAWDOWN IN TW-2-145.

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Drawn By: EGC
Checked:
Approved: RJG 5/29/2014
DWG Name: 00003705-155

KOP-FLEX
HANOVER, MARYLAND
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Figure 6

WELL DRAWDOWN AT TERMINATION OF CONSTANT RATE TEST IN THE LOWER PATAPSCO AQUIFER

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Tables

Table 1

Well and Piezometer Construction and Water Level Information
Kop-Flex VCP Site
Hanover, Maryland (a)

Well ID	Ground Elevation (feet MSL)	Top of Casin Elevation (feet MSL)	Total Depth (feet bgs)	Screen Interval (feet bgs)	Depth to Water (b) (feet)	Groundwater Elevation (c) (feet MSL)
TW-1	127.08	128.51	63	33 - 63	17.4	111.11
MW-38	123.64	123.40	27	17 - 27	11.94	111.46
MW-39	122.07	121.58	50	40 - 50	16.97	104.61
OW-1	124.39	124.06	56	46 - 56	20.93	103.13
OW-2	123.64	123.23	55	45 - 55	22.15	101.08
TW-2	128.64	129.88	145	100 - 145	45.76	84.12

---

a/ MSL = mean sea level
bgs = below ground surface

b/ Measurements with respect to the top of PVC well casing.

c/ Water level elevations for Surficial Aquifer wells based on April 28, 2014 depth to water measurements.
Water level elevations for well TW-2 in the Lower Patapsco Aquifer based on May 1, 2014 depth to water measurements.

Table 2

Extraction Well TW-2 Depth-Discrete Groundwater Sample Results
Kop-Flex VCP Site
Hanover, Maryland

Analyte (b)	Sample ID	TW-2 111	TW-2 121	TW-2 131	TW-2 141	TW-2 151	TW-2 161	MDE Class I/II Groundwater Quality Standard (µg/l)
	Sample Depth (ft.)	111	121	131	141	151	161	
	Sample Date	4/7/2014	4/8/2014	4/8/2014	4/8/2014	4/8/2014	4/8/2014	
1,1,1-Trichloroethane		54	1 U	8	5.4	1 U	1 U	200
1,1,2-Trichloroethane		1 U	1 U	1 U	1 U	1 U	1 U	5
1,1-Dichloroethane		71	1 U	40	17	1.2	1 U	90
1,1-Dichloroethene		**270**	**10**	**350**	**170**	5.3	1 U	7
1,2-Dichloroethane		3.7	1 U	4	3	1 U	1 U	5
Trichloroethene		1.3	1 U	3.2	1.3	1 U	1 U	5
cis-1,2-Dichloroethene		1 U	1 U	2.3	1	1 U	1 U	70
Total Detected Site VOCs		400	10	408	198	6.5	---	
1,1-Dichloroethene Field Screening Result		12 ppm	0.2 ppm	>14 ppm	8 ppm	0.1-0.2 ppm	<0.1 ppm	

---

a/ U = not detected at a concentration above the method detection limit
Values in bold indicate concentrations above the MDE groundwater standards.
b/ All concentrations in micrograms per liter (µg/l)

Table 3

Aquifer Property Estimates from April-May 2014 Constant Rate Test on the Surficial Aquifer
Kop-Flex VCP Site
Hanover, Maryland

Well ID	Hydraulic Conductivity (feet/day) (a) Drawdown	Hydraulic Conductivity (feet/day) (a) Recovery	Transmissivity ($feet^2$/day) Drawdown	Transmissivity ($feet^2$/day) Recovery	Storativity
TW-1	5.2	5.8	146	162	---
MW-18	8.5	10.1	237	282	0.00071
MW-39	8.2	15.6	139	266	0.00082
OW-1	10.6	10.5	298	295	0.00073
OW-2	11	10.8	308	301	0.00087
Geometric Mean	9.21		245		

---

a/ Hydraulic conductivity was calculate by dividing the transmissivity by the thickness of the sand unit. An average sand unit thickness of 28 feet was used for all wells except MW-39, where the thickness value was 17 feet.

Table 4

Aquifer Property Estimates from May 2014 Constant Rate Test
on the Lower Patapsco Aquifer
Kop-Flex VCP Site
Hanover, Maryland

	Hydraulic Conductivity (feet/day) (a)		Transmissivity (feet^2/day)		
Well ID	**Drawdown**	**Recovery**	**Drawdown**	**Recovery**	**Storativity**
TW-2	16.5	17.8	1,320	1,420	---
MW-1D	14.6	19.0	1,170	1,520	0.000092
MW-17D	17.8	17.5	1,420	1,400	0.00018
MW-21D	18.5	18.1	1,480	1,450	0.00015
MW-22D	17.3	16.3	1,380	1,300	0.00060
MW-24D	18.4	17.3	1,470	1,380	0.00060
MW-16D	19.3	---	1,540	---	0.00015
MW-26D	20.3	---	1,620	---	0.00011
Geometric Mean	17.7		1,410		

---

a/ Hydraulic conductivity was calculate by dividing the transmissivity by the assumed thickness of the Lower Patapsco Aquifer (80 feet).

Table 5

Extraction Well TW-1 Discharge Sample Results
Kop-Flex VCP Site
Hanover, Maryland

Analyte (b)	Sample ID Sample Date	TW-1-Q1 04/29/2014	TW-1-Q2 05/02/2014	MDE Class I/II Groundwater Quality Standard (µg/l)
1,1,1-Trichloroethane		58	51	200
1,1,2-Trichloroethane		5 U	1.6	5
1,1-Dichloroethane		180	170	90
1,1-Dichloroethene		870	670	7
1,2-Dichloroethane		9.1	4.7	5
Trichloroethene		13	6.2	5
cis-1,2-Dichloroethene		5 U	2.4	70
1,4-Dioxane (P-Dioxane)		1,600	1,800	NE
Total Detected VOCs		2,730	2,701	---

---

a/ U = not detected at a concentration above the method detection limit
NE = no standard established by MDE at this time
b/ All concentrations in micrograms per liter (µg/l)

Table 6

Extraction Well TW-2 Discharge Sample Results
Kop-Flex VCP Site
Hanover, Maryland

Analyte (b)	Sample ID Sample Date	TW-2 Effluent 1 5/6/2014	TW-2 Effluent 2 5/9/2014	MDE Class I/II Groundwater Quality Standard (µg/l)
1,1,1-Trichloroethane		71	53	200
1,1,2-Trichloroethane		1.3	1.1	5
1,1-Dichloroethane		82	68	90
1,1-Dichloroethene		310	420	7
1,2-Dichloroethane		6.6	6.5	5
Trichloroethene		1.9	3.8	5
cis-1,2-Dichloroethene		1 U	1.6	70
1,4-Dioxane (P-Dioxane)		410	360	NE
Total Detected VOCs		883	914	---

---

a/ U = not detected at a concentration above the method detection limit
NE = no standard established by MDE at this time
b/ All concentrations in micrograms per liter (µg/l)

Enclosure A – Boring and Well Completion Logs for Newly Installed Wells and Piezometers

Boring Log: MW-38

Project: Kop-Flex

Project No.: 3705

Location: Hanover, MD

Completion Date: April 4, 2014

Surface Elevation (feet AMSL*): Not Determined

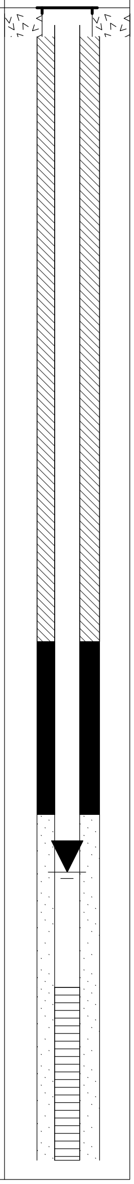
TOC Elevation (feet AMSL*): Not Determined

Total Depth (feet): 36

Borehole Diameter (inches): 7

**AMSL = Above mean sea level*

Sample Data					Subsurface Profile		
Depth	**Sample/Interval**	**PID/OVM (ppm)**	**Blow Count**	**% Recovery**	**Lithology**	**Description** Ground Surface	**Well Details**
2							
4							
6							
8						Refer to Boring Log for OW-1 for soil descriptions.	
10							
12			-	100			
14							
16							
18							
20							



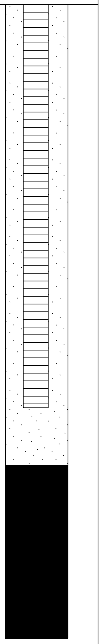
Geologist(s): Paul Zarella
Subcontractor: Cascade
Driller/Operator: Josh Siegler
Method: Rotosonic

WSP
1740 Massachusetts Ave
Boxborough, MA 01719
1-978-635-9600

Boring Log: MW-38

Project: Kop-Flex
Project No.: 3705
Location: Hanover, MD
Completion Date: April 4, 2014

Surface Elevation (feet AMSL*): Not Determined
TOC Elevation (feet AMSL*): Not Determined
Total Depth (feet): 36
Borehole Diameter (inches): 7
**AMSL = Above mean sea level*

Sample Data					Subsurface Profile		
Depth	Sample/Interval	PID/OVM (ppm)	Blow Count	% Recovery	Lithology	Description	Well Details
22 24			-	100		Refer to Boring Log for OW-1 for soil descriptions. *(continued)*	
26 28 30			-	100			
32 34							
36 38 40						Bottom of Boring at 36 feet	

Geologist(s): Paul Zarella
Subcontractor: Cascade
Driller/Operator: Josh Siegler
Method: Rotosonic

WSP
1740 Massachusetts Ave
Boxborough, MA 01719
1-978-635-9600

Boring Log: MW-39

Project: Kop-Flex
Project No.: 3705
Location: Hanover, MD
Completion Date: April 4, 2014

Surface Elevation (feet AMSL*): Not Determined
TOC Elevation (feet AMSL*): Not Determined
Total Depth (feet): 56
Borehole Diameter (inches): 7

**AMSL = Above mean sea level*

Sample Data

Depth	Sample/Interval	PID/OVM (ppm)	Blow Count	% Recovery
0–6			-	100
6–16			-	100
16–20				

Subsurface Profile

Description

Ground Surface

Poorly-Graded Sand (SP)
Fill: Strong brown (7.5 YR 6/8) coarse sand with some gravel. Loose, moist.

Well-Graded Sand (SW)
Reddish yellow (7.5 YR 6/6) fine to medium sand. Loose, moist.

Clayey Sand with Gravel (SC)
Dark gray (10 YR 4/1) clayey sand with some gravel. Coarse sand. Moist, dense.

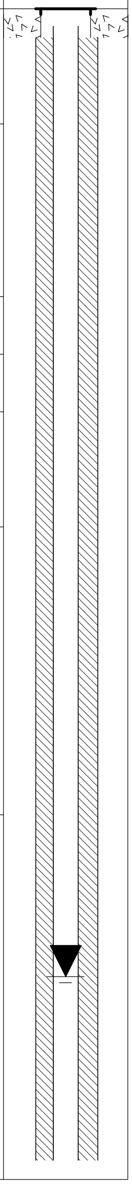
Poorly-Graded Sand (SP)
Reddish yellow (7.5 YR 6/8) medium sand, loose, moist. Trace coarse gravel.

Clayey Sand with Gravel (SC)
Mottled white (5 YR 8/1) and light red (2.5 YR 6/8) reddish yellow (7.5 YR 5/8) clayey medium sand with some gravel. Medium dense.

Lean Clay (CL)
White (5YR 8/1) mottled red (2.5 YR 4/8) and reddish yellow (7.5 yr 6/8) silty clay. Hard, dense, dry.

Lean Clay (CL)
Dark gray (10 YR 4/1) clay. Very dense, hard, dry. Trace silt. Medium soft to stiff.

Well Details



Geologist(s): Paul Zarella
Subcontractor: Cascade
Driller/Operator: Josh Siegler
Method: Rotosonic

WSP
1740 Massachusetts Ave
Boxborough, MA 01719
1-978-635-9600

Boring Log: MW-39

Project: Kop-Flex
Project No.: 3705
Location: Hanover, MD
Completion Date: April 4, 2014

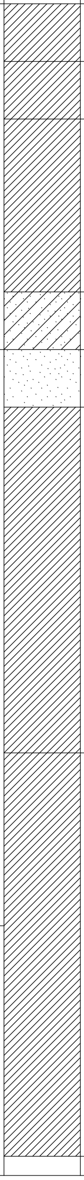
Surface Elevation (feet AMSL*): Not Determined
TOC Elevation (feet AMSL*): Not Determined
Total Depth (feet): 56
Borehole Diameter (inches): 7
**AMSL = Above mean sea level*

Sample Data

Depth	Sample/Interval	PID/OVM (ppm)	Blow Count	% Recovery
22				
24				
26				
28				
30				
			-	100
32				
34				
36				
38				
40				

Subsurface Profile

Lithology



Description

Lean Clay (CL)
Pinkish gray (7.5 YR 7/2) silty clay with reddish yellow (7.5 yr 6/8) mottling. Stiff, moist.

Lean Clay (CL)
White to pinkish gray (7.5 YR 8/1 - 7/2) silty clay with reddish yellow (7.5 YR 6/8) mottling. Stiff to very hard. At 24.5' bgs. lense of reddish yellow (7.5 YR 6/8) medium sand, loose, very wet.

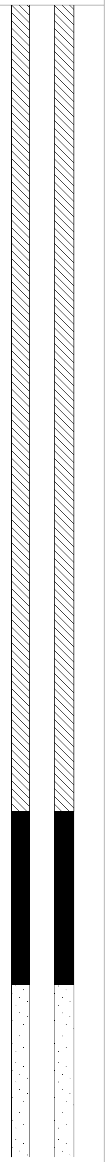
Clayey Sand (SC)
White (7.5 YR 8/1) clayey sand. Fine to medium grained, dense, moist to wet. Some reddish yellow (7.5 YR 7/8) mottling.

Poorly-Graded Sand (SP)
White (7.5 YR 8/1) mottled reddish yellow (7.5 YR 7/8) medium sand. Loose, wet.

Lean Clay (CL)
White to pinkish white (7.5 YR 8/1 - 8/2) fine sandy to silty clay. Medium soft to stiff. Minor reddish yellow (7.5 YR 6/8) mottling.

Lean Clay with Sand (CL)
Pinkish white (7.5 YR 8/2) sandy clay with reddish yellow (7.5 YR 7/8) mottling. Sand is medium grained. Few gravel. At 35' bgs. Fine to medium sandy lense.

Well Details



Geologist(s): Paul Zarella
Subcontractor: Cascade
Driller/Operator: Josh Siegler
Method: Rotosonic

WSP
1740 Massachusetts Ave
Boxborough, MA 01719
1-978-635-9600

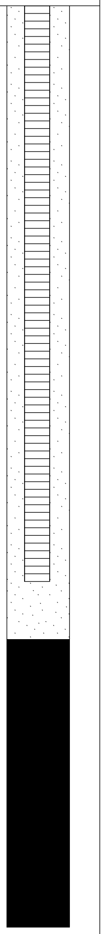
Boring Log: MW-39

Project: Kop-Flex
Project No.: 3705
Location: Hanover, MD
Completion Date: April 4, 2014

Surface Elevation (feet AMSL*): Not Determined
TOC Elevation (feet AMSL*): Not Determined
Total Depth (feet): 56
Borehole Diameter (inches): 7
**AMSL = Above mean sea level*

Sample Data					Subsurface Profile	
Depth	Sample/Interval	PID/OVM (ppm)	Blow Count	% Recovery	Lithology	Description
42 44			-	100	▨	***Lean Clay (CL)*** White (7.5 YR 8/1) mottled reddish yellow (7.5 YR 7/8) silty clay. Stiff, dry. Soft/wet area at 41' bgs.
46 48					░	***Well-Graded Sand (SW)*** White to pinkish white (7.5 YR 8/1 - 8/2)silty fine to medium sand. Loose, moist to wet.
50 52 54			-	100	▨	***Lean Clay (CL)*** White (7.5 YR 8/1) mottled reddish yellow (7.5 YR 6/8) (minor) silty clay. Mostly hard with medium soft to stiff areas. Very dry.
56 58 60						Bottom of Boring at 56 feet

Well Details



Geologist(s): Paul Zarella
Subcontractor: Cascade
Driller/Operator: Josh Siegler
Method: Rotosonic

WSP
1740 Massachusetts Ave
Boxborough, MA 01719
1-978-635-9600

Boring Log: OW-1

Project: Kop-Flex

Project No.: 3705

Location: Hanover, MD

Completion Date: April 4, 2014

Surface Elevation (feet AMSL*): Not Determined

TOC Elevation (feet AMSL*): Not Determined

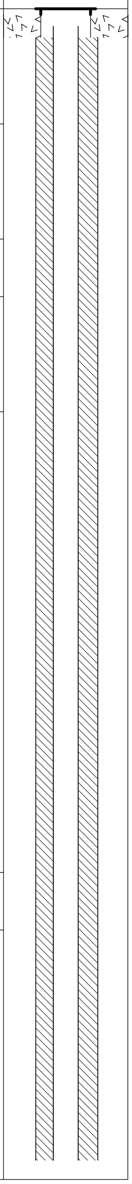
Total Depth (feet): 56

Borehole Diameter (inches): 7

**AMSL = Above mean sea level*

Sample Data					Subsurface Profile	
Depth	**Sample/Interval**	**PID/OVM (ppm)**	**Blow Count**	**% Recovery**	**Lithology**	**Description**
						Ground Surface
						Poorly-Graded Sand with Gravel (SP) Fill: Light brown (7.5 YR 6/3) coarse to medium sand and coarse gravel. Moist, loose.
2			-	100		***Lean Clay (CL)*** Very pale brown to white (10 YR 7/3 - 8/1) mottled reddish yellow (7.5 YR 5/8) silty clay. Dry, stiff.
4						***Lean Clay with Sand (CL)*** Yellowish red to red (5 YR 5/8) to (2.5 YR 4/8)
6						***Lean Clay (CL)*** White to pinkish white (7.5 YR 8/1 to 8/2) mottled reddish yellow (7.5 YR 6/8) silty clay. Dry, stiff.
8						***Lean Clay (CL)*** Red (10 R 4/6) white (10 R 8/1) and strong brown (7.5 YR 5/6) mottled clay with silt. Very stiff to hard, dry.
10			-	100		
12						
14						
16						***Lean Clay (CL)*** Light gray (7.5 yr 7/1) clay with dark red (2.5 yr 3/6) mottling. Very stiff, dry.
18						***Lean Clay (CL)*** Dark gray to very dark gray (7.5 YR 4/1 - 3/1) Silty clay. Stiff, dry. Fine sand lense at 20' and 21' bgs.
20						

Well Details



Geologist(s): Paul Zarella
Subcontractor: Cascade
Driller/Operator: Josh Siegler
Method: Rotosonic

WSP
1740 Massachusetts Ave
Boxborough, MA 01719
1-978-635-9600

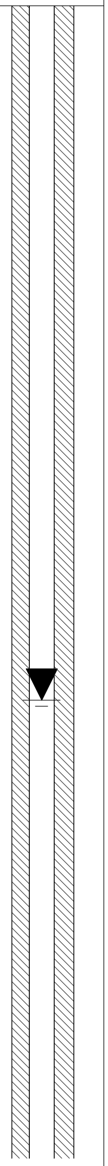
Boring Log: OW-1

Project: Kop-Flex
Project No.: 3705
Location: Hanover, MD
Completion Date: April 4, 2014

Surface Elevation (feet AMSL*): Not Determined
TOC Elevation (feet AMSL*): Not Determined
Total Depth (feet): 56
Borehole Diameter (inches): 7
**AMSL = Above mean sea level*

Sample Data					Subsurface Profile	
Depth	**Sample/Interval**	**PID/OVM (ppm)**	**Blow Count**	**% Recovery**	**Lithology**	**Description**
			-	100	▨	***Lean Clay (CL)*** Dark gray to very dark gray (7.5 YR 4/1 - 3/1) Silty clay. Stiff, dry. Fine sand lense at 20' and 21' bgs. *(continued)*
22					▨	***Lean Clay (CL)*** Pink (7.5 YR 3/6) and reddish yellow (7/5 YR 6/8) mottled silty clay. Trace sand. Hard, dry.
24					▨	
26					▨	***Lean Clay (CL)*** Dark red (2.5 YR 3/6) clay with some silt. Medium soft, moist.
28					▨	***Lean Clay (CL)*** White (7.5 YR 8/1) and dark red (2.5 YR 3/6) mottled clay with some silt. medium soft, moist.
30			-	100	░	***Well-Graded Sand (SW)*** Pink (7.5 YR 8/1) medium to fine sand. Loose, moist. Some reddish yellow (7.5 YR 7/8) mottling. Some clay towards 30'-31'.
32					░	
34					░	
36					░	
38					▨	***Lean Clay with Sand (CL)*** White (7.5 YR 8/3) mottled reddish yellow (7.5 YR 6/8) sandy clay. Fine sand. Medium soft.
40						

Well Details



Geologist(s): Paul Zarella
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WSP
1740 Massachusetts Ave
Boxborough, MA 01719
1-978-635-9600

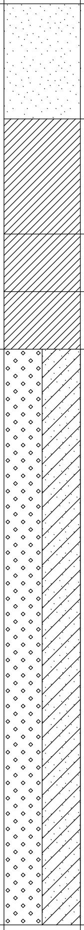
Boring Log: OW-1

Project: Kop-Flex
Project No.: 3705
Location: Hanover, MD
Completion Date: April 4, 2014

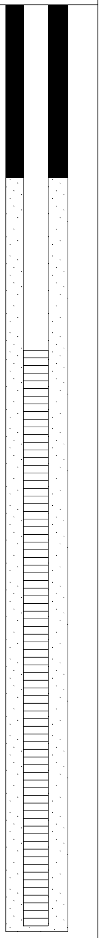
Surface Elevation (feet AMSL*): Not Determined
TOC Elevation (feet AMSL*): Not Determined
Total Depth (feet): 56
Borehole Diameter (inches): 7
**AMSL = Above mean sea level*

Sample Data					Subsurface Profile
Depth	**Sample/Interval**	**PID/OVM (ppm)**	**Blow Count**	**% Recovery**	**Description**
			-	100	***Poorly-Graded Sand (SP)*** White to pinkish white (7.5 YR 8/1 - 8/2) medium to coarse sand. Wet, loose. Some reddish yellow (7.5 YR 7/8) mottling. *(continued)*
42					***Lean Clay with Sand (CL)*** White (7.5 YR 8/1) and reddish yellow (7.4 YR 7/8) mottled fine sandy clay . Medium soft, moist.
44					***Lean Clay (CL)*** White (7.5 YR 8/1) and reddish yellow (7.4 YR 7/8) mottled silty clay. Stiff to very stiff. Dry to moist.
46					***Lean Clay with Sand (CL)*** Pinkish white (7.5 YR 8/2) sandy clay with coarse gravel. Stiff to medium soft, moist.
48					***Well-Graded Sand with Clay (SW-SC)*** White to pinkish white (7.5 YR 8/1-8/2) clayey fine to medium sand. Minor reddish yellow (7.5 YR 7/8) mottling. Wet, loose.
50			-	100	
52					
54					
56					Bottom of Boring at 56 feet
58					
60					

Lithology



Well Details



Geologist(s): Paul Zarella
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Driller/Operator: Josh Siegler
Method: Rotosonic

WSP
1740 Massachusetts Ave
Boxborough, MA 01719
1-978-635-9600

Boring Log: OW-2

Project: Kop-Flex

Project No.: 3705

Location: Hanover, MD

Completion Date: April 3, 2014

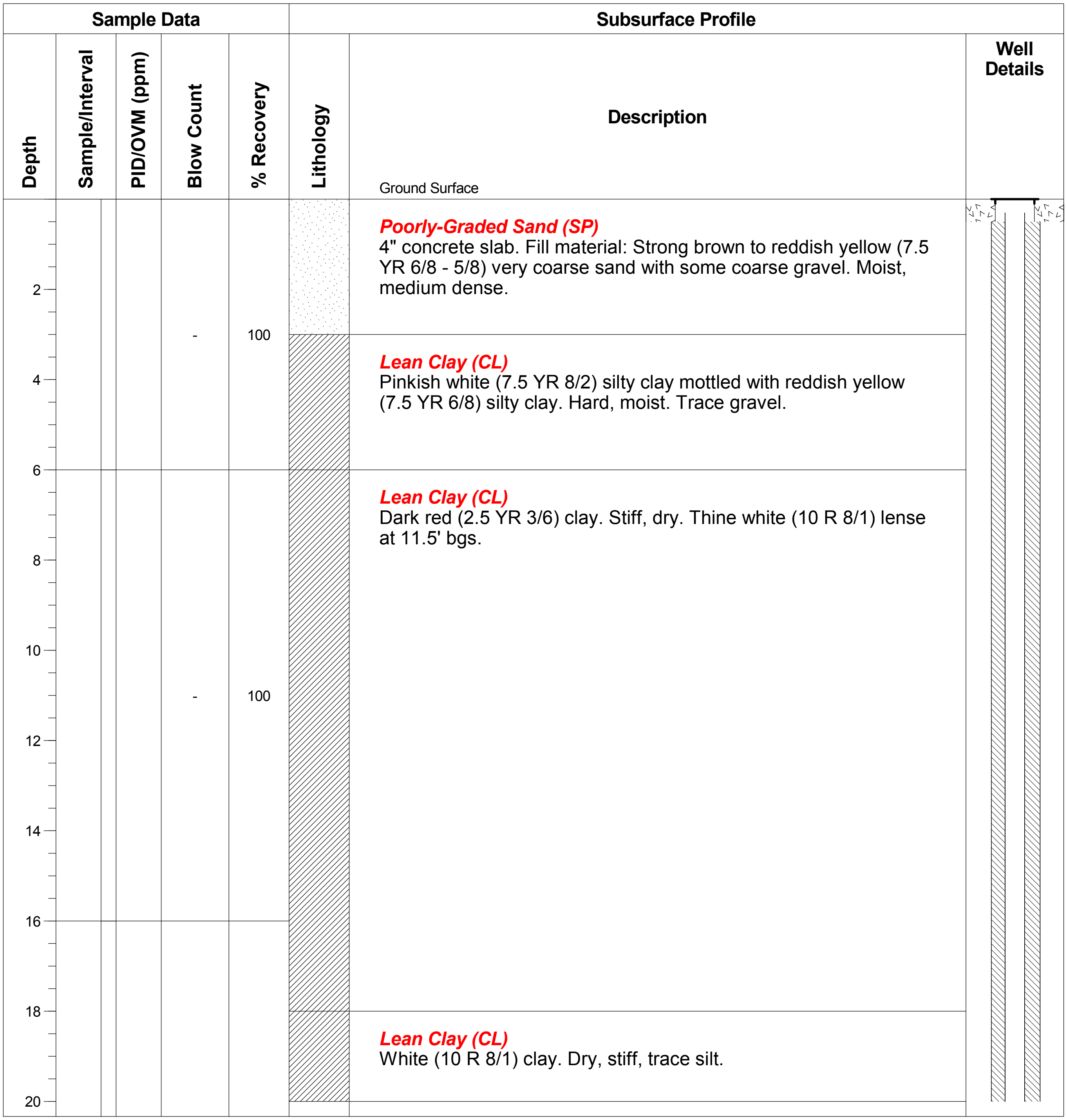
Surface Elevation (feet AMSL*): Not Determined

TOC Elevation (feet AMSL*): Not Determined

Total Depth (feet): 66

Borehole Diameter (inches): 7

**AMSL = Above mean sea level*



Poorly-Graded Sand (SP)
4" concrete slab. Fill material: Strong brown to reddish yellow (7.5 YR 6/8 - 5/8) very coarse sand with some coarse gravel. Moist, medium dense.

Lean Clay (CL)
Pinkish white (7.5 YR 8/2) silty clay mottled with reddish yellow (7.5 YR 6/8) silty clay. Hard, moist. Trace gravel.

Lean Clay (CL)
Dark red (2.5 YR 3/6) clay. Stiff, dry. Thine white (10 R 8/1) lense at 11.5' bgs.

Lean Clay (CL)
White (10 R 8/1) clay. Dry, stiff, trace silt.

Geologist(s): Paul Zarella
Subcontractor: Cascade
Driller/Operator: Josh Siegler
Method: Rotosonic

WSP
1740 Massachusetts Ave
Boxborough, MA 01719
1-978-635-9600

Boring Log: OW-2

Project: Kop-Flex	**Surface Elevation (feet AMSL*):** Not Determined
Project No.: 3705	**TOC Elevation (feet AMSL*):** Not Determined
Location: Hanover, MD	**Total Depth (feet):** 66
Completion Date: April 3, 2014	**Borehole Diameter (inches):** 7

*AMSL = Above mean sea level

Sample Data					Subsurface Profile		
Depth	**Sample/Interval**	**PID/OVM (ppm)**	**Blow Count**	**% Recovery**	**Lithology**	**Description**	**Well Details**
22			-	100		***Lean Clay (CL)*** Dark gray (7.5 YR 8/1) clay. Stiff, dry. Strong brown (7.5 YR 5/8) mottling at 22'-23' bgs.	▼
24 26 28						***Lean Clay (CL)*** Pinkish gray (7.5 YR 6/2) to pinkish white (7.5 YR 8/2) clay with some reddish yellow mottling (7.5 YR 6/8). Dense, stiff, dry.	
						Lean Clay (CL) White (10 R 8/1) mottled reddish yellow (7.5 YR 6/8) silty clay. Dense, very stiff, dry.	
30			-	100		***Lean Clay (CL)*** White (10 R 8/1) and Red (10 R 4/8) mottled silty clay. Very stiff, dry. "Marbled" appearance.	
32 34 36						***Poorly-Graded Sand (SP)*** Brownish yellow (10 YR 6/6) grading to pink (7.5 YR 8/3) medium sand. Loose, wet.	
38 40							

Geologist(s): Paul Zarella
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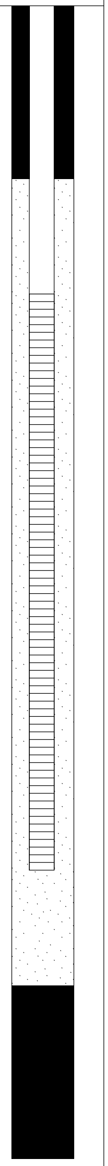
Boring Log: OW-2

Project: Kop-Flex
Project No.: 3705
Location: Hanover, MD
Completion Date: April 3, 2014

Surface Elevation (feet AMSL*): Not Determined
TOC Elevation (feet AMSL*): Not Determined
Total Depth (feet): 66
Borehole Diameter (inches): 7
**AMSL = Above mean sea level*

Sample Data					Subsurface Profile		
Depth	**Sample/Interval**	**PID/OVM (ppm)**	**Blow Count**	**% Recovery**	**Lithology**	**Description**	**Well Details**
42			-	100		***Clayey Sand (SC)*** Pinkish white (7.5 YR 8/2) mottled reddish yellow (7.5 YR 7/8) clayey sand. Fine to medium sand. Moist, medium dense.	
44						***Lean Clay (CL)*** White (10 YR 8/1) silty clay. Hard, dense, dry. some reddish yellow (7.5 YR 7/8) mottling.	
46 48 50			-	100		***Silty Sand (SM)*** White (10 YR 8/1) silty sand. Loose, with reddish yellow (7.5 YR 7/8) mottling. Wet. Trace to some clay.	
52 54 56 58 60						***Poorly-Graded Sand (SP)*** White to pinkish white (7.5 YR 8/1 to 8/2) medium sand mottled reddish yellow (7.5 YR 6/8). Loose, very wet. Coarser sand towards 56' bgs.	



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Project: Kop-Flex

Project No.: 3705

Location: Hanover, MD

Completion Date: April 3, 2014

Surface Elevation (feet AMSL*): Not Determined

TOC Elevation (feet AMSL*): Not Determined

Total Depth (feet): 66

Borehole Diameter (inches): 7

**AMSL = Above mean sea level*

Sample Data					Subsurface Profile		
Depth	**Sample/Interval**	**PID/OVM (ppm)**	**Blow Count**	**% Recovery**	**Lithology**	**Description**	**Well Details**
			-	100	░		■
62					▨	***Lean Clay (CL)*** Pinkish white (7.5 YR 8/1) mottled reddish yellow (7.5 YR 6/8) silty clay. Hard, dry.	■
64					▨		■
					▨	***Clayey Sand (SC)*** Pinkish white (7.5 YR 8/1) clayey sand. Sand is fine to medium. Wet, loose.	■
66						Bottom of Boring at 66 feet	
68							
70							
72							
74							
76							
78							
80							

Geologist(s): Paul Zarella
Subcontractor: Cascade
Driller/Operator: Josh Siegler
Method: Rotosonic

WSP
1740 Massachusetts Ave
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1-978-635-9600

Boring Log: TW-2

Project: Kop-Flex

Project No.: 3705

Location: Hanover, MD

Completion Date: April 8, 2014

Surface Elevation (feet AMSL*): Not Determined

TOC Elevation (feet AMSL*): Not Determined

Total Depth (feet): 156

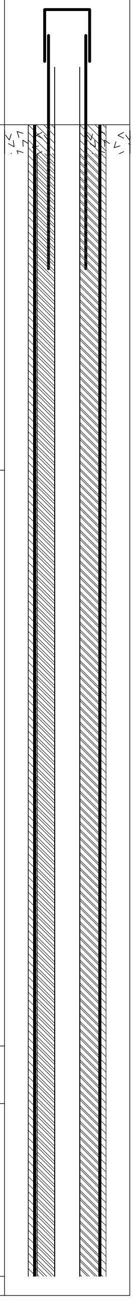
Borehole Diameter (inches): 12 (0'-61.5') 7 (61.5'- 156')

**AMSL = Above mean sea level*

Sample Data					Subsurface Profile	
Depth	**Sample/Interval**	**PID/OVM (ppm)**	**Blow Count**	**% Recovery**	**Lithology**	**Description**
						Ground Surface
0–6			-	100		***Poorly-Graded Sand (SP)*** Brownish yellow (10 YR 6/6) fine to medium sand. Loose, moist.
6–16			-	100		***Well-Graded Sand (SW)*** Pink (7.5 YR 8/3) fine to medium sand. with minor reddish yellow (7.5 YR 7/8) mottling. Loose, moist.
16–20						***Well-Graded Sand (SW)*** Dark Brown (7.5 YR 3/3) fine to medium sand. Loose, moist ***Poorly-Graded Sand (SP)*** Reddish yellow (7.5 YR 7/8) clayey medium to coarse sand with coarse gravel. Very moist to wet. Medium dense sand.

Depth scale: 2, 4, 6, 8, 10, 12, 14, 16, 18, 20

Well Details



Geologist(s): Paul Zarella
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Project: Kop-Flex
Project No.: 3705
Location: Hanover, MD
Completion Date: April 8, 2014

Surface Elevation (feet AMSL*): Not Determined
TOC Elevation (feet AMSL*): Not Determined
Total Depth (feet): 156
Borehole Diameter (inches): 12 (0'-61.5') 7 (61.5'- 156')
**AMSL = Above mean sea level*

Sample Data					Subsurface Profile		
Depth	**Sample/Interval**	**PID/OVM (ppm)**	**Blow Count**	**% Recovery**	**Lithology**	**Description**	**Well Details**
22 24			-	100	▨	***Fat Clay (CH)*** White to pinkish white (7/5 YR 8/1 - 8/2) mottled reddish yellow (7.5 YR 7/8) clay. Moist, soft to medium soft.	▨
26					▨	***Well-Graded Sand with Clay (SW-SC)*** Pink (7.5 YR 8/3) fine to medium clayey sand. Loose, moist, some clay clumps.	▨
28					▨	***Lean Clay (CL)*** Light gray (7.5 YR 7/1) clay. Hard, dry.	▨
30 32 34 36			-	100	▨	***Lean Clay (CL)*** Dusky red to dark red (5 R 3/4 - 3/6) silty clay. Dry to moist. Medium soft to stiff. Minor white (7.5 YR 8/1) mottling.	▨
38 40					▨	***Lean Clay with Sand (CL)*** White to light gray (7.5 YR 8/1 - 7/1) silty to fine sandy clay. Very stiff to hard. Dry.	▨

Geologist(s): Paul Zarella
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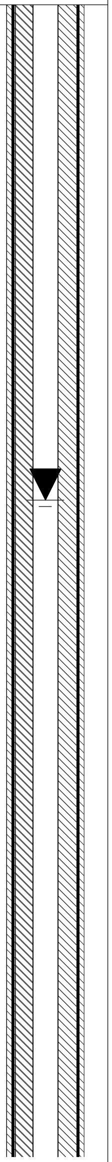
Boring Log: TW-2

Project: Kop-Flex
Project No.: 3705
Location: Hanover, MD
Completion Date: April 8, 2014

Surface Elevation (feet AMSL*): Not Determined
TOC Elevation (feet AMSL*): Not Determined
Total Depth (feet): 156
Borehole Diameter (inches): 12 (0'-61.5') 7 (61.5'- 156')

**AMSL = Above mean sea level*

Sample Data					Subsurface Profile		
Depth	**Sample/Interval**	**PID/OVM (ppm)**	**Blow Count**	**% Recovery**	**Lithology**	**Description**	**Well Details**
			-	100		***Lean Clay with Sand (CL)*** White to light gray (7.5 YR 8/1 - 7/1) silty to fine sandy clay. Very stiff to hard. Dry. *(continued)*	
42						***Lean Clay (CL)*** Dark gray to very dark gray (7.5 YR 4/1 -3/1) mottled light gray (7.5 YR 7/1) silty clay. Lense of fine sandy clay at 44'-45' bgs. Sand is light gray (7.5 YR 7/1).	
44							
46							
48						***Lean Clay with Sand (CL)*** Very pale brown (10 R 8/3) to yellow (10 R 7/8) fine sandy clay. Very stiff, dry.	
50			-	100		***Lean Clay (CL)*** Pinkish white to pinkish gray (7.5 YR 8/2 - 7/2) silty clay. Minor reddish yellow (7.5 YR 7/8) mottling. Very thin fine reddish yellow sandy lense (7.5 YR 7/8) at 50' bgs. 6" clayey sand lense at 51' bgs.	
52							
54							
56						***Lean Clay (CL)*** Dark Red (5 R 3/6) and white (7.5 YR 8/1) mottled clay with some silt. Stiff to hard, dry.	
58						***Lean Clay (CL)*** Red (5 R 4/8) mottled very dusky red (5 R 2.5/4) and white (5 R 8/1) clay. Very stiff to hard, dry, some silt.	
60							



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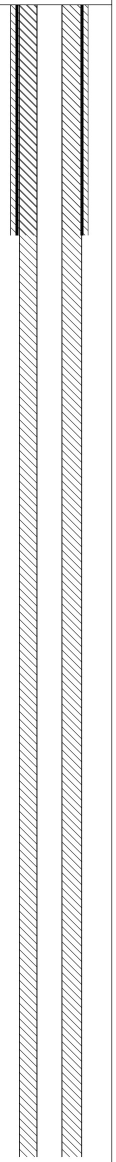
Sample Data					Subsurface Profile		
Depth	**Sample/Interval**	**PID/OVM (ppm)**	**Blow Count**	**% Recovery**	**Lithology**	**Description**	**Well Details**
62			-	100	▨	**Lean Clay (CL)** Dark Red (7.5 R 3/6) mottled white (7.5 YR 8/1) silty clay with medium sand. Hard, dry. *(continued)*	
64 66 68					▨	**Lean Clay (CL)** Red (10 R 4/6) clay. Very hard, dry. Some silt.	
70 72 74			-	100	▨	**Lean Clay (CL)** Red (10 R 4/6) mottled strong brown (7.5 YR 4/6) and minor white to light gray (7.5 YR 8/1 - 7/1) clay with some to few silt. Stiff to very stiff, dry.	
76 78					▨	**Lean Clay (CL)** Dark gray (7.5 YR 4/1) silty clay with thin laminae of light gray (7.5 YR 7/1) fine sand. Very stiff, dry.	
80					▨		



Boring Log: TW-2

Project: Kop-Flex
Project No.: 3705
Location: Hanover, MD
Completion Date: April 8, 2014

Surface Elevation (feet AMSL*): Not Determined
TOC Elevation (feet AMSL*): Not Determined
Total Depth (feet): 156
Borehole Diameter (inches): 12 (0'-61.5') 7 (61.5'- 156')
**AMSL = Above mean sea level*

Sample Data					Subsurface Profile		
Depth	**Sample/Interval**	**PID/OVM (ppm)**	**Blow Count**	**% Recovery**	**Lithology**	**Description**	**Well Details**
			-	100	▨	***Lean Clay with Sand (CL)*** Dark gray (7.5 YR 4/1) silty clay with some sand. Minor red (2.5 YR 5/6) coloration. Very stiff to hard. Carbonized plant matter present. Softer towards 86' bgs. Light gray (7.5 YR 7/1) fine sand laminations. *(continued)*	▨
82					▨		▨
84					▨		▨
86					▨		▨
88					▨		▨
90			-	100	▨	***Lean Clay with Sand (CL)*** Pinkish gray to pink (7.5 YR 7/2 - 7/3) silty clay with fine sand. Mottled. Carbonized plant matter present.	▨
92					▨	***Lean Clay (CL)*** Red (10 R 4/6) clay mottled white (10 R 8/1) and reddish yellow (7.5 YR 7/8). Some silt, hard, dry.	▨
94					░	***Poorly-Graded Sand with Gravel (SP)*** Brown (7.5 YR 4/4) coarse to medium sand with coarse gravel. (quartz gravel) Loose, wet.	■
96					░	***Poorly-Graded Sand with Gravel (SP)*** Pink (7.5 YR 7/3) coarse sand with gravel. Very coarse quartz gravel. Loose, wet.	■
98					░		░
100							

Geologist(s): Paul Zarella
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TOC Elevation (feet AMSL*): Not Determined
Total Depth (feet): 156
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**AMSL = Above mean sea level*

Sample Data

Depth	Sample/Interval	PID/OVM (ppm)	Blow Count	% Recovery
			-	100
102				
104				
106				
108				
110				
	TW-2 111'		-	100
112				
114				
116				
118				
120				

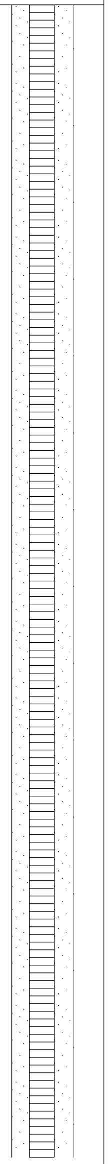
Subsurface Profile

Lithology | **Description** | **Well Details**

Poorly-Graded Gravel (GP)
Coarse quartz gravel and pebbles with some white (7.5 YR 8/1) clay and pink coarse sand (7.5 YR 8/3). Loose, wet. Some white clay clumps.

Lean Clay (CL)
White (7.5 YR 8/1) silty clay minor reddish yellow (7.5 YR 7/8) mottling. Stiff, dry.

Well-Graded Sand (SW)
Pink to pinkish white (5 YR 8/3) to 8/2) fine to medium sand with some silt. Loose to medium dense, wet. 4" white clay lense at 115' bgs. Some reddish yellow (7.5 YR 7/8) mottling in sand.



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Project: Kop-Flex
Project No.: 3705
Location: Hanover, MD
Completion Date: April 8, 2014

Surface Elevation (feet AMSL*): Not Determined
TOC Elevation (feet AMSL*): Not Determined
Total Depth (feet): 156
Borehole Diameter (inches): 12 (0'-61.5') 7 (61.5'- 156')
**AMSL = Above mean sea level*

Sample Data					Subsurface Profile		
Depth	**Sample/Interval**	**PID/OVM (ppm)**	**Blow Count**	**% Recovery**	**Lithology**	**Description**	**Well Details**
	TW-2 121'		-	100		***Poorly-Graded Sand (SP)*** Light reddish brown to pink (2.5 YR 7/3 - 7/4) with minor reddish brown (7.5 YR 7/8) mottling, medium sand. Loose, wet. Some white (7.5 YR 8/1) and yellowish brown (7.5 YR 7/8) mottled clay clumps. *(continued)*	
122							
124							
126							
128							
130							
	TW-2 131'		-	100			
132							
134							
136						***Poorly-Graded Sand (SP)*** Pink to reddish yellow (7.5 YR 8/3 - 7/6) medium to coarse sand with some gravel. White clay clumps. Loose, wet. Minor reddish yellow (7.5 YR 7/8) mottling of the sand. Gravel is coarse gravel to cobble.	
138							
140							

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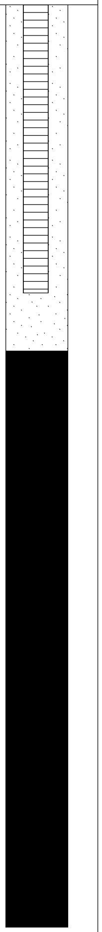
Boring Log: TW-2

Project: Kop-Flex	**Surface Elevation (feet AMSL*):** Not Determined
Project No.: 3705	**TOC Elevation (feet AMSL*):** Not Determined
Location: Hanover, MD	**Total Depth (feet):** 156
Completion Date: April 8, 2014	**Borehole Diameter (inches):** 12 (0'-61.5') 7 (61.5'- 156')

**AMSL = Above mean sea level*

Sample Data					Subsurface Profile		
Depth	**Sample/Interval**	**PID/OVM (ppm)**	**Blow Count**	**% Recovery**	**Lithology**	**Description**	**Well Details**
142 144 146	TW-2 141'		-	100		***Poorly-Graded Sand (SP)*** Pink to reddish yellow (7.5 YR 8/3 - 7/6) medium to coarse sand with some gravel. White clay clumps. Loose, wet. Minor reddish yellow (7.5 YR 7/8) mottling of the sand. Gravel is coarse gravel to cobble. *(continued)*	
148 150 152 154 156	TW-2 151'		-	100			
158 160	<-- TW-2 161'		-			Bottom of Boring at 156 feet	

Geologist(s): Paul Zarella
Subcontractor: Cascade
Driller/Operator: Josh Siegler
Method: Rotosonic

WSP
1740 Massachusetts Ave
Boxborough, MA 01719
1-978-635-9600

Boring Log: TW-I

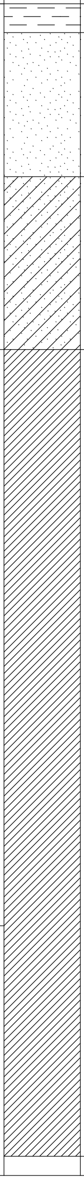
Project: Kop-Flex
Project No.: 3705
Location: Hanover, MD
Completion Date: April 2, 2014

Surface Elevation (feet AMSL*): Not Determined
TOC Elevation (feet AMSL*): Not Determined
Total Depth (feet): 66
Borehole Diameter (inches): 7
*AMSL = Above mean sea level

Sample Data

Depth	Sample/Interval	PID/OVM (ppm)	Blow Count	% Recovery
0–6			-	100
6–16			-	100
16–20				

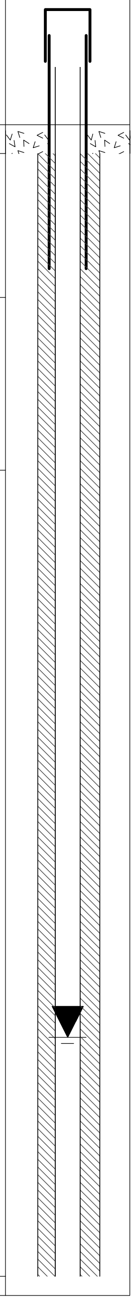
Subsurface Profile



Ground Surface

Depth	Description
0–0.5	***Organic Soil (OL/OH)*** Grass and moist top soil.
0.5–3	***Poorly-Graded Sand (SP)*** Reddish Yellow (7.5 YR 6/8) medium to coarse sand. Fill material. Sandy clay lense at 1.5' bgs.
3–6	***Clayey Sand with Gravel (SC)*** Pink (5 yr 7/4) clayey sand with gravel, few cobbles. Very coarse sand toward 6' bgs. Moist.
6–20	***Lean Clay (CL)*** Red (2.5 Yr 5/6 to 5/8) silty clay with trace sand. Very stiff. Hard and dry at 16' bgs. White (2.5 YR 8/1) sandy clay lenses at 8' bgs and 13' bgs.

Well Details



Geologist(s): Paul Zarella
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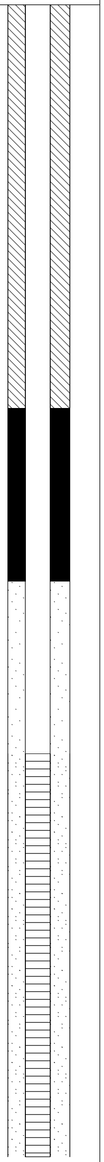
**AMSL = Above mean sea level*

Sample Data					Subsurface Profile		
Depth	**Sample/Interval**	**PID/OVM (ppm)**	**Blow Count**	**% Recovery**	**Lithology**	**Description**	**Well Details**
22 24			-	100	▨	***Lean Clay (CL)*** Light Gray (2.5 y 7/1) silty clay grading to dark gray (2.5 Y 5/1). Very hard to stiff, dry. Light gray (2.5 Y 7/1) silty fine sand at 26' bgs.	
26 28 30					▨	***Lean Clay (CL)*** Dark Gray (5 YR 4/1) silty clay. Very stiff to hard, dry.	
32			-	100	░	***Poorly-Graded Sand (SP)*** Reddish yellow (7.5 YR 6/6) coarse to medium sand mottled dark red (10 R 3/6).	
34 36 38 40					░	***Well-Graded Sand (SW)*** Pink (10 R 8/3) fine to medium sand, moist.	



Geologist(s): Paul Zarella
Subcontractor: Cascade
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Method: Rotosonic

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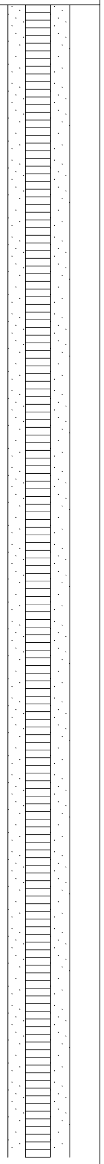
**AMSL = Above mean sea level*

Sample Data					Subsurface Profile		
Depth	**Sample/Interval**	**PID/OVM (ppm)**	**Blow Count**	**% Recovery**	**Lithology**	**Description**	**Well Details**
42 44			-	100		***Poorly-Graded Sand (SP)*** Yellowish Red (5 YR 5/6) medium to coarse sand. Moist, loose. Grades to pinkish white (5 YR 8/2) at 43' bgs. White (5 YR 8/1) silty clay lense at 45' bgs.	
46 48 50 52 54			-	100		***Poorly-Graded Sand (SP)*** Reddish yellow (7.5 YR 6/6) medium to coarse sand. Loose, wet. 8" white (7/5 YR 8/1) silty clay lense at 47' bgs.	
56 58 60						***Poorly-Graded Sand (SP)*** White (7.5 YR 8/1) medium sand with some reddish yellow (7.5 YR 6/8) mottling. Loose, wet, few to some coarse gravel.	

Geologist(s): Paul Zarella
Subcontractor: Cascade
Driller/Operator: Josh Siegler
Method: Rotosonic

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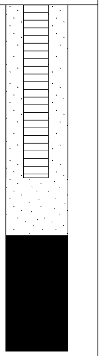
Borehole Diameter (inches): 7

**AMSL = Above mean sea level*

Sample Data					Subsurface Profile		
Depth	**Sample/Interval**	**PID/OVM (ppm)**	**Blow Count**	**% Recovery**	**Lithology**	**Description**	**Well Details**
62			-	100	░	***Poorly-Graded Sand (SP)*** White (7.5 YR 8/1) medium sand with some reddish yellow (7.5 YR 6/8) mottling. Loose, wet, few to some coarse gravel. *(continued)*	
64					▨	***Lean Clay (CL)*** White (7.5 YR 8/1) silty clay with reddish yellow (7.5 YR 6/8) mottling. Stiff, dry. Silty clay lense at 63' bgs.	
66 68 70 72 74 76 78 80						Bottom of Boring at 66 feet	

Geologist(s): Paul Zarella
Subcontractor: Cascade
Driller/Operator: Josh Siegler
Method: Rotosonic

WSP
1740 Massachusetts Ave
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1-978-635-9600

Appendix E – Soil Management Plan

Appendix E

SOIL MANAGEMENT PLAN
FORMER KOP-FLEX FACILITY
HANOVER MARYLAND

PURPOSE AND SCOPE

The purpose of this Plan is to outline soil handling, staging and reuse procedures that are required of persons excavating, drilling, or moving soil at the Former Kop-Flex facility in Hanover, Maryland. This Plan shall be followed by all persons performing earthwork or excavating soils at the subject site during the planned construction and other subsequent intrusive activities. A copy of this Plan shall remain on the premises and with the property records. This Plan addresses soil which is handled during site development and is not intended to propose additional excavation of impacted soil beyond the extent required for site development.

Although this Plan applies to earthwork or excavating soil across the entire site, Area of Concern 1 (AOC 1) is the only area where shallow soil impacts are known to be present at the site. At AOC 2, soil has been extensively evaluated, and impacted soil was excavated to depths of 18 to 23 feet below ground surface in 2013. Extensive investigation has also been conducted in other areas of the site. Based on the sampling data, no known shallow soil impacts remain other than in AOC 1.

The approximate limits of AOC 1 are displayed in Figure 2 of the Response Action Plan, which shows where constituents of concern (COCs) have been identified in soil beneath the concrete slab. The actual area of contamination may be more extensive. Therefore, this Plan should be implemented for management of all soils excavated from AOC 1, and for any excavation areas outside of AOC 1 where affected soil is suspected based on physical observations (e.g., staining, odors).

The procedures described in this Plan may be revised, as necessary, to address specific features of any future construction activities to ensure that all soil-disturbance activities are conducted in accordance with applicable laws and regulations.

The Plan describes the procedures to be implemented as part of any soil excavation activity, including, without limitation:

- Notice to EMERSUB 16 LLC
- Worker protection (Health and Safety)
- Procedures for soil excavation and management
- Characterization sampling of excavated soil
- Disposal of excavated soil
- Placement of geotextile along excavated surfaces
- Documentation of the soil excavation activities

The procedures, presented below, are intended to be consistent with applicable environmental laws and regulations regarding the disturbance, excavation, handling and disposal of contaminated soils, including the Maryland Department of Environment (MDE) Standards for Disposal of Controlled Hazardous Substances (COMAR 26.13.01.00) and U.S. Occupational Safety and Health Administration (OSHA) regulations for Hazardous Waste Operations and Emergency Response (29 CFR 1910.120) (HAZWOPER), the Hazard Communication Standard (29 CFR 1910.1200), and the OSHA Excavation Standard (29 CFR 1926 Subpart P).

NOTICE TO EMERSUB 16 LLC

Before conducting any excavation activities, a Figure shall be prepared identifying the proposed horizontal and vertical limits of soils to be disturbed. The Figure, along with a schedule for the work, shall be provided to EMERSUB 16 a minimum of two weeks before the start of planned activities.

Appendix E

SOIL MANAGEMENT PLAN
FORMER KOP-FLEX FACILITY
HANOVER MARYLAND

WORKER SAFETY

Any excavation work conducted at the facility shall be performed in accordance with applicable state and federal regulations concerning worker safety. This shall include, without limitation, the OSHA “excavation” regulation (29 CFR 1926, Subpart P), which requires, among other things, the supervision of a competent person, proper worker training, and appropriate protections to prevent collapse of the excavated area(s). Due to the potential for contact with contaminated soil, a site-specific Health and Safety Plan (HASP) shall be prepared prior to the start of excavation activities. The HASP must account for site-specific contaminants of concern. Workers involved in excavation activities shall be notified of the potential for encountering contaminated soil in and have appropriate training as required by 29 CFR 1910.120, 29 CFR 1910.1200, and 29 CFR 1926 Subpart P.

SOIL EXCAVATION AND MANAGEMENT

All soil excavation activities shall be conducted in a manner that minimizes (1) the exposure of potentially contaminated soils to precipitation and (2) the flow of contaminated storm water runoff to surrounding areas. To control storm water runoff during excavation activities, erosion and sediment control measures shall be implemented before any soil disturbance is conducted. These controls shall consist of silt fences, hay bales, and/or earthen berms installed and managed to intercept storm water runoff and prevent it from mixing with contaminated soil. Erosion and sediment controls will be inspected weekly, at a minimum, as well as after any measureable precipitation event. Such controls will be maintained in accordance with state and local laws and regulations until the work activity is complete and the area has been paved and/or re-vegetated (i.e., stabilized).

The excavated soils shall be screened with a photoionization detector (PID) using a head space screening method. Two PIDs lamps shall be used, a 10.6 electron volt (eV) lamp along with an 11.7 eV lamp, to allow for segregation of soils containing elevated concentrations of volatile organic compounds (VOCs). 1,1,1-trichorloethane (1,1,1-TCA), a primary constituent of concern, has an ionization potential of 11.0 eV and can only be detected by a PID with an 11.7 eV lamp.

Impacted soil shall be segregated in the field into stockpiles based on PID screening results and other observations (e.g., odors). Soils with similar PID readings shall be staged onsite in stockpiles not exceeding 200 cubic yards for characterization. All stockpiles must be underlain by polyethylene sheeting (minimum 10 mil thickness), bermed, and located at least 50 feet away from storm water drainage courses. Storm water that accumulates within the excavation(s) or bermed areas surrounding the stockpiled soils shall be pumped to temporary storage vessels. Dust control measures shall be implemented for all stockpiled material; such measures may include, among other things, applying water to wet soil stockpiles and the daily covering of stockpiles with polyethylene sheeting.

CHARACTERIZATION SAMPLING OF SOIL AND WATER

Excavated soil and accumulated storm water shall be characterized as either non-hazardous or hazardous waste, in accordance with the guidelines presented in "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods," U.S. Environmental Protection Agency (USEPA) publication SW-846. Representative grab samples shall be collected from each soil stockpile and temporary water storage vessel. The samples shall be placed in clean laboratory-supplied sample containers. Each sample container shall be labeled with a unique sample identification number, date and time of sample collection, analyses to be performed, and the sampler’s initials. Samples will be immediately placed in a cooler containing ice and chilled to approximately 4 degrees Celsius (°C). Before shipping, sample containers shall be wrapped using bubble wrap or other protective packing materials. In no case shall glass sample containers be allowed to touch each other inside the cooler. Additional ice, in watertight, re-sealable plastic bags, will be placed in the cooler and on top of the packed samples to continue to cool the samples during shipment to the analytical laboratory.

A chain-of-custody form shall serve as the record for tracking samples from collection to their receipt by the laboratory. Once samples are collected, their possession must be maintained under chain-of-custody procedures until they are delivered to the analytical laboratory. The sampler shall document each sample collected on a chain-of-custody form, which will state the project name and number; sampler's name and signature; sample identification number(s); sample matrix; date and time of sample collection; quantity of sample containers; analyses required; and custody sequence. The chain-of-custody form(s), sealed in a watertight packaging, shall accompany the samples inside the sealed shipping container. The chain-of-custody form(s) must be dry and legible upon receipt at the laboratory.

Each soil and water sample shall be analyzed for VOCs using USEPA SW-846 Method 8260B and any other parameters required by the disposal facility. Management of the excavated soil shall be based on the laboratory analytical results in combination with the MDE regulations under COMAR 26.13.01.00.

DISPOSAL

Any soil or water determined to be hazardous waste shall be managed in accordance with the Standards for Disposal of Controlled Hazardous Substances (COMAR 26.13.01.00) and disposed of at a Resource Conservation and Recovery Act-permitted facility. The VOC data shall be compared to the Land Disposal Restrictions (LDR) Universal Treatment Standards (UTS) to determine if treatment of the hazardous waste is required before disposal.

Any soil determined to be non-hazardous shall be disposed of offsite at a properly permitted non-hazardous waste disposal facility in accordance with the requirements of the disposal facility. Non-hazardous water shall be transported to an appropriate treatment facility licensed to accept the water.

Recycled concrete and asphalt shall be segregated, analyzed as necessary, and managed properly.

GEOTEXTILE PLACEMENT AND FILL PLACED IN EXCAVATION

If excavations are backfilled, clean soil shall be used from an offsite borrow source. Samples of the backfill source shall be analyzed in accordance with the parameters outlined in the MDE Voluntary Cleanup Program Clean Imported Fill Material Document to ensure that the material is free of contamination. Soil proposed for reuse as clean fill cannot contain asphalt or concrete unless the MDE approves of the use prior to transport.

Geotextile fabric or composite shall be placed on the bottom and sidewalls of the excavation(s) where affected soils are identified to serve as both a marker and barrier between clean soil/fill and VOC-impacted soil. Future utility trenches that will be installed in areas of affected soils shall be over-excavated at least one foot on all sides. Prior to installation of the utility, geotextile fabric shall be placed at the base of the trench and a layer of clean fill placed to replace the over-excavated soil material. If the soil excavated during the installation of utilities is in a non-impacted area, over excavation of the trench will not be necessary. Once the utility is placed in the excavation, the trench should be backfilled with clean fill (i.e. non-contaminated material).

Appendix E

SOIL MANAGEMENT PLAN
FORMER KOP-FLEX FACILITY
HANOVER MARYLAND

DOCUMENTATION

Soil excavation activities shall be documented in a summary report to include:

- Description of the work,
- Length, width, and depth of each soil excavation area,
- Volume of soil generated,
- Characterization results for soil and water generated during the excavation work,
- Management of the excavated soil and any associated storm water, including offsite facility(s) used for disposal,
- Placement of geotextile within the excavation area (with photo-documentation), and
- Backfilling of the excavation, including the source and analytical results for the clean fill material.

The report shall include a figure depicting the limits of the soil excavation work, copies of laboratory analytical reports for all disposal characterization samples and any material used as backfill, and manifests for the offsite disposal of soil and water. A copy of the summary report shall be provided to EMERSUB 16.

MARYLAND
Department of the Environment

Facts About...

VCP - Clean Imported Fill Material

The purpose of the Voluntary Cleanup Program (VCP) is to encourage the cleanup and redevelopment of properties throughout Maryland. In many cases, fill materials are imported onto a property as part of the redevelopment process. As more properties are relying upon the use of imported fill materials, the VCP has prepared this guidance document for assisting participants who anticipate using imported fill material at VCP sites.

Introduction

No one wants to introduce new contamination onto a VCP site through the importation of fill material that is believed to be clean. This document was developed specifically for VCP participants who seek guidance on steps to take to minimize the possibility of importing contaminated fill onto VCP sites.

Overview

Because fill material may come from a variety of sources, it is important to determine that any material brought onto a VCP site not only meets engineering specifications for a particular use, but that it also passes some level of screening to ensure that it is, in fact, clean.

Residential or Commercial/ Industrial Scenario

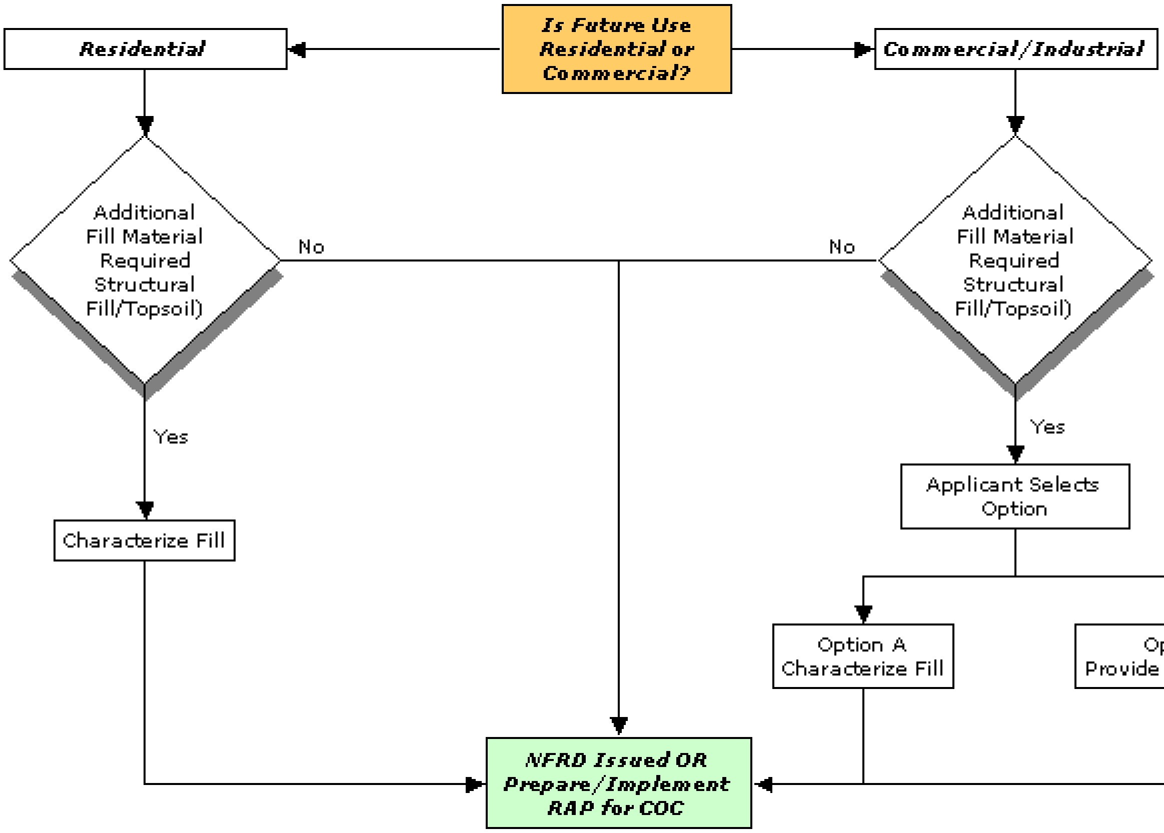
Depending upon the land use scenario, a VCP participant may be required to characterize the fill or provide a certification stating that the imported fill is not contaminated. As indicated in Exhibit 1, all imported fill materials for properties where the land use is determined to be residential must be characterized. In limited circumstances, the VCP may allow a participant to use imported fill material that has not been characterized for areas where no pathway will exist between the fill material and the property's end-users. In such circumstances, a Phase I Environmental Site Assessment conducted within a year from the date of scheduled delivery of fill material documenting that no recognized environmental conditions are present must be submitted to the VCP.

For commercial or industrial land uses, a VCP participant has the option of either characterizing the imported fill material or relying upon an affidavit from the vendor stating that the imported material has not been contaminated by controlled hazardous substances or oil. A template of the affidavit is attached to this guidance.

Selecting Fill Material

In general, the fill source area should be located in non-industrial areas, and not from sites undergoing an environmental cleanup. Non-industrial sites include those that were previously undeveloped, or used solely for residential or agricultural purposes. If the source is from an agricultural area, care should be taken to insure that the fill does not include pesticides, herbicides or metals. Unacceptable sources of fill material include industrial and/or commercial sites where

Exhibit 1: Use of Fill Material for Residential or Commercial/Industrial Decision Tree



hazardous materials were used, handled or stored as part of the business operations, or unpaved parking areas where petroleum hydrocarbons could have been spilled or leaked into the soil. Commercial sites to avoid include former gasoline service stations, retail strip malls that contained dry cleaners or photographic processing facilities, paint stores, auto repair and/or painting facilities, and agricultural supply stores. Industrial facilities to avoid include metal processing shops, manufacturing facilities, aerospace facilities, oil refineries, waste treatment plants, or other similar facilities.

Alternatives to using fill from construction sites include the use of fill material obtained from a commercial supplier of fill material or from soil pits in rural or suburban areas. However, care should be taken to ensure that those materials are also uncontaminated.

Table 1: Potential Contaminants Based on the Fill Source Area	
Fill Source	*Target Compounds/Recommended Analyses**
Land near to an existing highway	• Lead (EPA method 6020 [Rev 0 – 9/9]) • PAHs (EPA method 8270C [Rev 3 – 12/96)
Land near a mining area or rock quarry	• Heavy Metals (EPA method 6020 [Rev 0 – 9/9]) • Asbestos (polarized light microscopy) • pH
Agricultural land	• Pesticides (Organochlorine Pesticides: EPA method 8081A or 8080A; Organophosphorus Pesticides: EPA method 8141A; Chlorinated Herbicides: EPA method 8151A [Rev 1 – 12/96]) • Heavy Metals (EPA method 6020 [Rev 0 – 9/9])
Residential/acceptable commercial land	• VOCs (EPA Method 8260B (Rev 2 - 12/96); Note: The soil and sediment collection method has changed to EPA Method 5035) • SVOCs (EPA method 8270C) • TPH (modified EPA method 8015) • PCBs (EPA method 8082) • Heavy Metals including lead (EPA methods 6010B and 7471A) • Asbestos (OSHA Method ID-191)
*The recommended analyses should be performed in accordance with USEPA SW-846 methods (1996). Other possible analyses include Hexavalent Chromium: EPA method 3060A.	

Documentation and Analysis

In order to minimize the potential of introducing unacceptable fill material onto a site, it is necessary to verify through documentation that the fill source is appropriate and/or to have the fill material analyzed for potential contaminants based on the location and history of the source area. Fill documentation should include detailed information on the previous use of the land from where the fill is taken, whether an environmental site assessment was performed and its findings, and the results of any testing performed. It is recommended that an environmental professional, as defined by ASTM, should sign any such documentation. If such documentation is not available or is inadequate, samples of the fill material should be chemically analyzed. Analysis of the fill material should be based on the source of the fill and knowledge of the prior land use. The Department recommends using the analytical methods in Table 1 to determine whether potential contaminants are present in fill source areas.

Detectable amounts of compounds of concern within the fill material should be evaluated for risk in accordance with the *Soil and Groundwater Cleanup Guidance Document, August 2001*. A standard laboratory data package, including a summary of the QA/QC (Quality Assurance/Quality Control) sample results should also accompany all analytical reports. When possible, representative samples should be collected at the borrow area while the potential fill material is still in place, and analyzed prior to removal from the borrow area. In addition to performing the appropriate analyses of the fill material, an appropriate number of samples should also be determined based on the approximate volume or area of soil to be used as fill material. Table 2 can be used as a guide to determine the number of samples needed to adequately characterize the fill material when sampled at the borrow site.

Alternative Sampling

A Phase I environmental site assessment may be conducted prior to sampling to determine whether the borrow area may have been impacted by previous activities on the property. After the property has been evaluated, any sampling that may be required can be determined during a meeting with MDE. However, if it is not possible to analyze the fill material at the borrow area or determine that it is appropriate for use via a Phase I, it is recommended that the participant use Table 2 to determine the fill material sampling schedule. (See chart on Potential Contaminants Based on the Fill Source Area for appropriate analyses).

This sampling frequency may be modified upon consultation with the MDE if all of the fill material is derived from a common borrow area. However, fill material that is not characterized at the borrow area will need to be stockpiled either on or off-site until the analyses have been completed. In addition, should contaminants exceeding the criteria in *Soil and Groundwater Cleanup Guidance Document, August 2001* be identified in the stockpiled fill material, that material will be deemed unacceptable and new fill material will need to be obtained, sampled and analyzed. Therefore, MDE recommends that all sampling and analyses should be completed prior to delivery to the site to ensure the soil is free of contamination, and to eliminate unnecessary transportation charges for unacceptable fill material.

Composite sampling for fill material characterization may or may not be appropriate, depending on quality and homogeneity of source/borrow area, and compounds of concern. It is not acceptable to composite samples for volatile and semi-volatile constituents. Composite sampling for heavy metals, pesticides, herbicides or PAH's from unanalyzed stockpiled soil is also unacceptable, unless it is stockpiled at the borrow area and originates from the same source area. In addition, if samples are composited, they should be from the same soil layer, and not from different soil layers.

When very large volumes of fill material are anticipated, or when larger areas are being considered as borrow areas, MDE recommends that a Phase I be conducted on the area to ensure that the borrow area has not been impacted by previous activities on the property. After the property has been evaluated, any sampling that may be required can be determined during a meeting with MDE.

Table 2: Recommended Fill Material Sampling Schedule

Area of Individual Borrow Area	*Sampling Requirements*
2 acres or less	Minimum of 4 samples
2 to 4 acres	Minimum of 1 sample every 1/2 acre
4 to 10 acres	Minimum of 8 samples
Greater than 10 acres	Minimum of 8 locations with 4 sub samples per location
Volume of Borrow Area Stockpile	*Samples per Volume*
Up to 1,000 cubic yards	1 sample per 250 cubic yards
1,000 to 5,000 cubic yards	4 samples for first 1000 cubic yards +1 sample per each additional 500 cubic yards
Greater than 5,000 cubic yards	12 samples for first 5,000 cubic yards + 1 sample per each additional 1,000 cubic yards

Appendix F – Sub-Slab Vapor Venting System Plans and Specifications

VAPOR VENTING SYSTEM DESIGN SPECIFICATIONS

PART 1: GENERAL

1.01 DESCRIPTION

A. WORK INCLUDES FURNISHING AND INSTALLING VAPOR VENTING SYSTEM TO THE LINES, GRADES AND SPACING SHOWN ON THE CONSTRUCTION DRAWINGS AND AS SPECIFIED HEREIN.

B. WORK INCLUDES SEALING ALL UTILITY PENETRATIONS THROUGH THE SLAB AND FOUNDATION SYSTEM TO MITIGATE VAPOR PATHWAYS FROM PERIMETER UTILITIES ENTERING BUILDING AND FROM BENEATH BUILDING.

1.02 QUALITY ASSURANCE

A. ECS SHOULD BE NOTIFIED DURING THE CONSTRUCTION AND INSTALLATION OF THE VAPOR VENTING SYSTEM SO THAT CONDITIONS CAN BE DOCUMENTED PRIOR TO THE PLACMENT OF THE VAPOR BARRIER.

B. CONTRACTOR SHALL CHECK THE MATERIALS UPON DELIVERY TO ASSURE THAT PROPER MATERIALS HAVE BEEN RECEIVED.

C. CONTRACTOR SHALL PROTECT THE MATERIALS FROM DAMAGE. DAMAGED MATERIALS SHALL NOT BE INCORPORATED INTO THE VAPOR VENTING SYSTEM AND SHALL BE REPLACED.

PART 2: MATERIALS

2.01 VAPOR VENTING SYSTEM

A. LOCATION OF VENTING PIPE LINES MAY BE MOVED 2' IN ANY HORIZONTAL DIRECTION TO AVOID UNDERGROUND UTILITIES OR FOUNDATIONS. MAINTAIN 3" CLEARANCE OF PIPE FROM FOUNDATIONS, WALLS, AND COLUMNS (WITH THE EXCEPTION OF INTAKES/RISERS AND ASSOCIATED CONNECTIONS).

B. ALL UNDERSLAB VENT PIPE SHALL BE 2" I.D. SLOTTED OR PERFORATED SCHEDULE 40. PVC. SLOTS IN THE GAS COLLECTION PIPING SHALL FACE DOWNWARD ALLOWING ANY MOISTURE TO DRAIN.

C. COLLECTION PIPES AND VENT RISERS SHALL BE 4" SOLID PVC ENCASED IN IRON PIPE OR OTHER PROTECTION MECHANISM WHERE EXPOSED.

D. PLACEMENT OF RISER PIPE SHALL BE AS CLOSE TO THE COLUMN/WALL AS POSSIBLE. ANY JOGS IN THE RISER PIPE SHOULD MAINTAIN AN UPWARD SLOPE. (i.e., NO HORIZONTAL OR DOWNWARD TURNS OR SLOPES)

E. END CAPS FOR UNDERSLAB VENT PIPE SHALL BE GLUED AND SEALED WITH SUITABLE ELASTOMERIC PIPE CEMENT.

F. ROOF VENTS SHALL NOT BE LOCATED WITHIN 10 FEET OF OTHER VENTS FOR AIR HANDLING OR VENTILATION SYSTEMS, OR SPARKING SOURCES. REFER TO HVAC DRAWINGS FOR TYPICAL ROOF PENETRATION DETAILS.

B. A MINIMUM 4" OF AGGREGATE SUBBASE WITH ADEQUATE PORE SPACE SHALL BE UTILIZED. (AASHTO #57 STONE OR EQUAL, WITH LESS THAN 5% FINES)

D. ALL EXPOSED PIPING IN BUILDING SHALL BE LABELED "VENT SYSTEM DO NOT TAMPER".

2.02 VOLATILE ORGANIC COMPOUND/HYDROCARBON RESISTANT BARRIER (VOC/HRB)

A. PRIOR TO SLAB PLACEMENT, INSTALL MIN. 20 MIL POLY VAPOR BARRIER (VAPOR BLOCK 20 OR EQUAL).

B. EDGES OF VAPOR BARRIER SHOULD BE OVERLAPPED A MINIMUM OF 1.0 FEET.

C. EDGE OF BARRIER SHALL BE SEALED WITH COMPATIBLE TAPE. ALL PENETRATIONS SHALL ALSO BE SEALED WITH COMPATIBLE TAPE.

PART 3: EXECUTION

3.01 VAPOR VENTING SYSTEM INSTALLATION NOTES

A. CONTRACTOR SHALL EXCAVATE TO THE LINES, GRADES, AND SPACING SHOWN ON THE CONSTRUCTION DRAWINGS.

B. PVC SECTIONS SHOULD BE CUT TO LENGTH AND GLUED WITH COUPLINGS AS NEEDED.

C. EXACT VENT TO ROOF LOCATIONS SHOULD BE DETERMINED IN THE FIELD WITH OWNER, ARCHITECT AND CONTRACTOR. WALL VENT STACKS SHOULD BE AIR TIGHT

D. IN THE EVENT THAT UTILITIES OR OTHER CONSTRUCTION ELEMENTS INTERFERE WITH THE CONCEPTUAL LAYOUT OF THE VAPOR VENTING SYSTEM, ECS SHOULD BE NOTIFIED.

E. THE HORIZONTAL PERFORATED PIPING SHALL BE INSTALLED FLUSH TO THE POLY BARRIER AND A MIN. 2" ABOVE THE SUBGRADE.

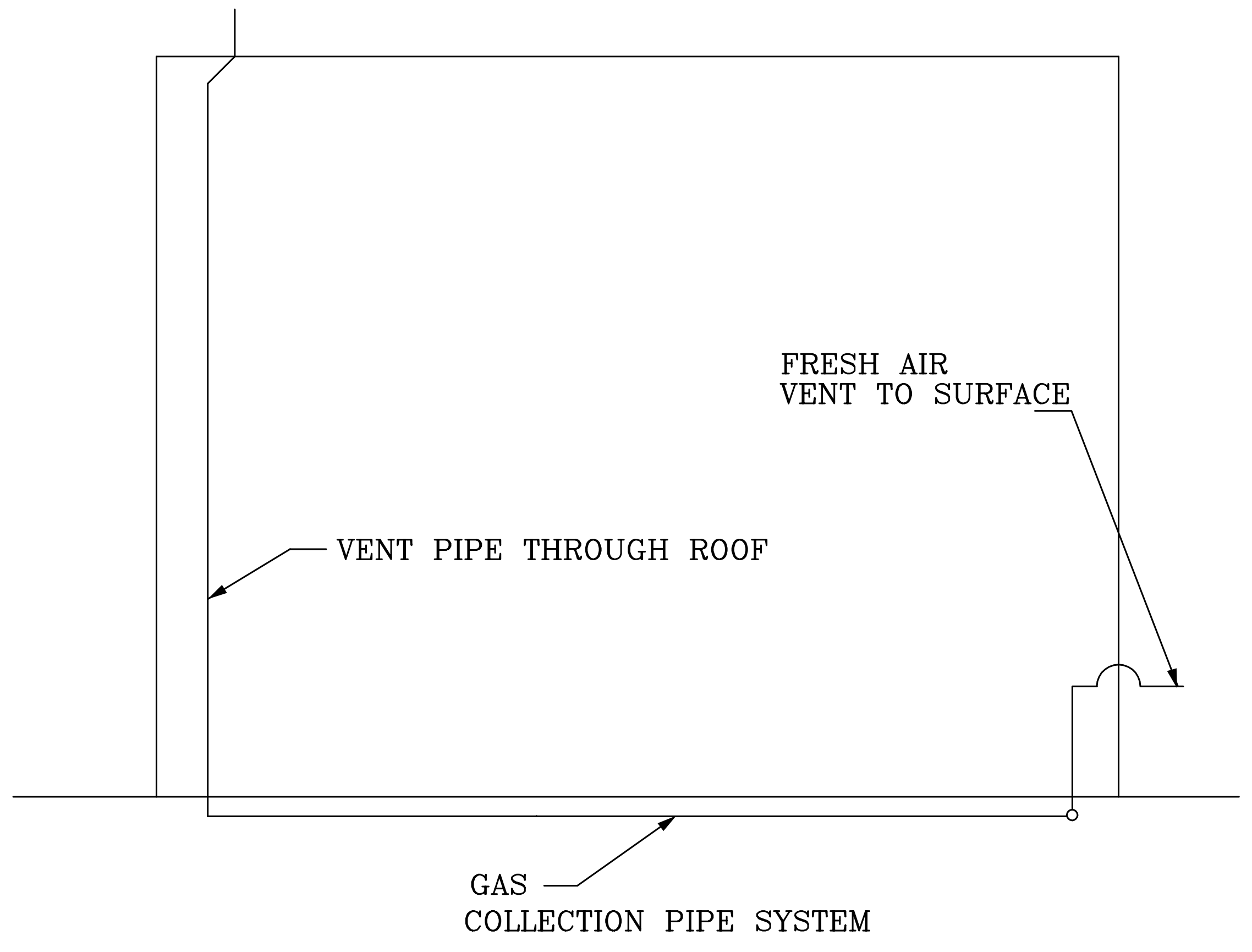
F. PRIOR TO PLACEMENT OF VOC/HRB, ECS SHALL BE NOTIFED AND PIPING SYSTEM OBSERVED.

G. PRIOR TO THE PLACEMENT OF CONCRETE SLAB, ECS SHALL BE NOTIFIED TO OBSERVE AND DOCUMENT PLACEMENT OF VOC/HRB.

H. UPON COMPLETION OF VAPOR BARRIER, EXTREME CARE SHOULD BE TAKEN TO PREVENT PUNCTURE. CONTRACTOR SHALL REPAIR ALL PUNCTURES JUST BEFORE SLAB PLACMENT, ECS SHALL BE ON SITE TO DOCUMENT CONDITION OF VAPOR BARRIER, DURING SLAB PLACMENT. PENATRATIONS IN THE VAPOR BARRIER WILL REQUIRE REPAIR PRIOR TO CONCRETE SLAB INSTALLATION

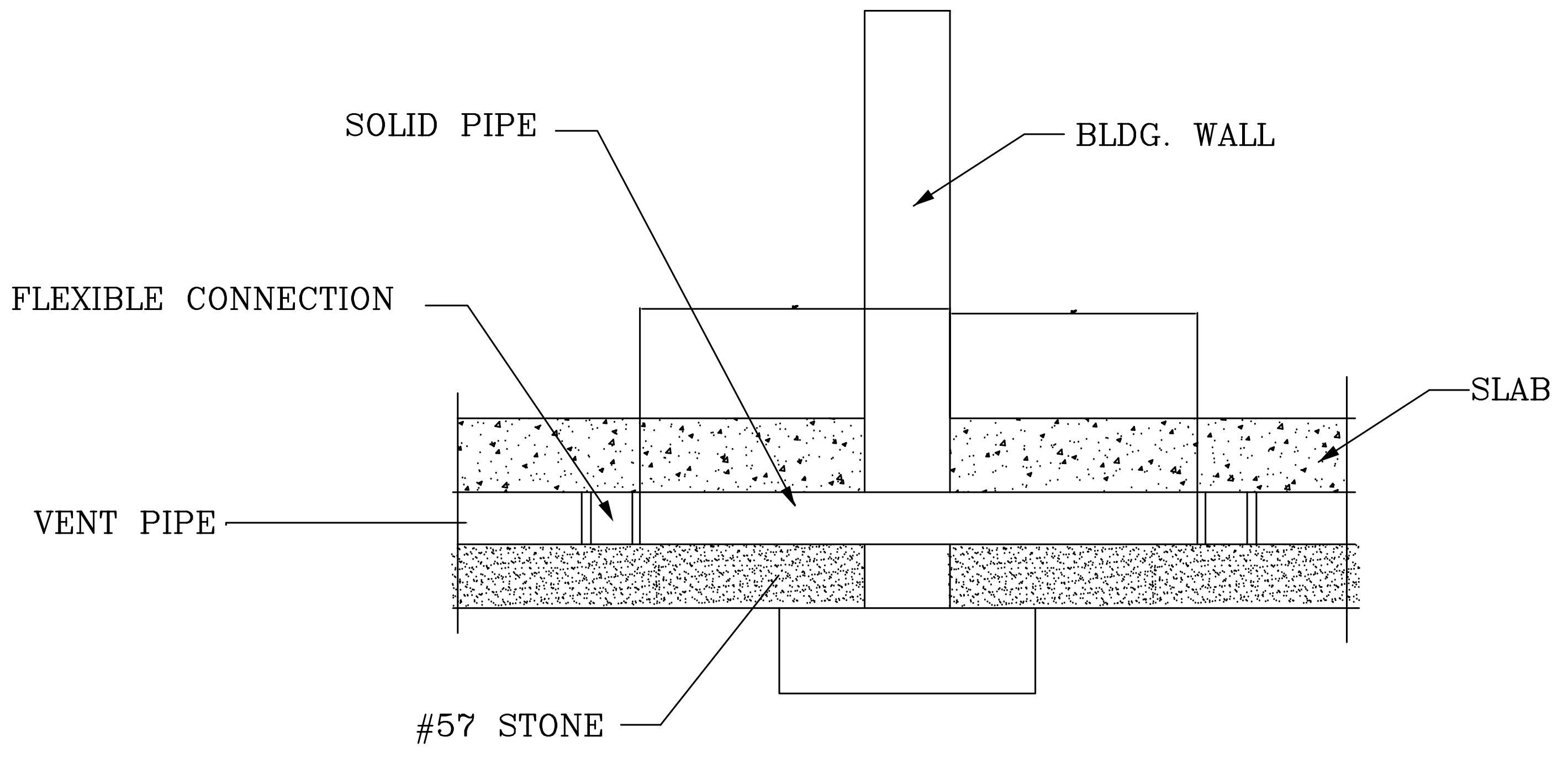
NOTES:

1. ALL OPENING, GAPS, AND JOINTS IN FLOOR AND WALL ASSEMBLIES IN CONTACT WITH SOIL OR GAPS AROUND PIPES, OR DRAINS PENETRATING THESE ASSEMBLIES SHALL BE FILED OR CLOSED WITH MATERIALS THAT PROVIDE A PERMANENT AIR-TIGHT SEAL. SEAL LARGE OPENINGS WITH NON-SHRINK MORTAR, GROUTS, OR EXPANDING FOAM MATERIALS AND SMALLER GAPS WITH AN ELASTOMERIC JOINT SEALANT, SICKAFLEX OR EQUIVALENT AS DEFINED IN ASTM C920-87.
2. A 20 MIL VOC AND HYDROCARBON RESISTANT VAPOR BARRIER SHALL BE PLACED OVER STONE PRIOR TO SLAB PLACMENT. (VAPOR BLOCK 20 OR EQUAL).
3. PIPES AND PERFORATIONS SHALL BE INSTALLED SO THAT ANY RAINWATER OR CONDENSATION DRAINS DOWNWARD INTO THE GROUND BENEATH THE SLAB AND VAPOR BARRIER.
4. ANY UTILITY CONNECTIONS BENEATH THE ONSITE STRUCTURE WHICH ALSO ENTER THE ONSITE STRUCTURE SHOULD BE AIR TIGHT.
5. SYSTEM MAINTENANCE SHALL INCLUDE INSPECTION AND REPAIR (AS NECESSARY) OF ALL SEALED SLAB JOINTS AND PENETRATIONS, ROOF VENTS, AND INTAKE VENTS ANNUALLY.



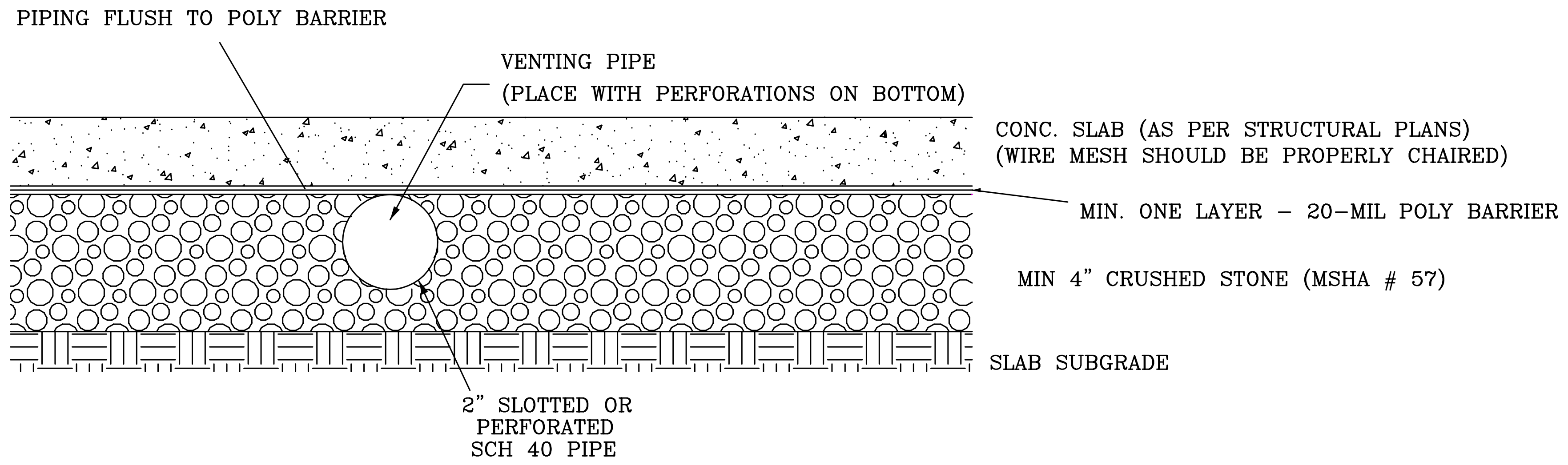
SCHEMATIC DESIGN DIAGRAM

NOT TO SCALE



TYPICAL VENT PIPE THROUGH BUILDING WALL

NOT TO SCALE



BELOW SLAB INSTALLATION

NOT TO SCALE

NO.	REVISIONS	DATE

Sub-Slab Vapor Venting System
Notes and Details
Kop-Flex Site
7555 and 7565 Harmans Road, Harmans, MD

TC Harmans Road, LLC

MMB	HMA	04/02/2015	6387-F	3 OF 4

Professional Certification. I hereby certify that these documents were prepared or approved by me, and that I am a duly licensed professional engineer under the laws of the State of Maryland.

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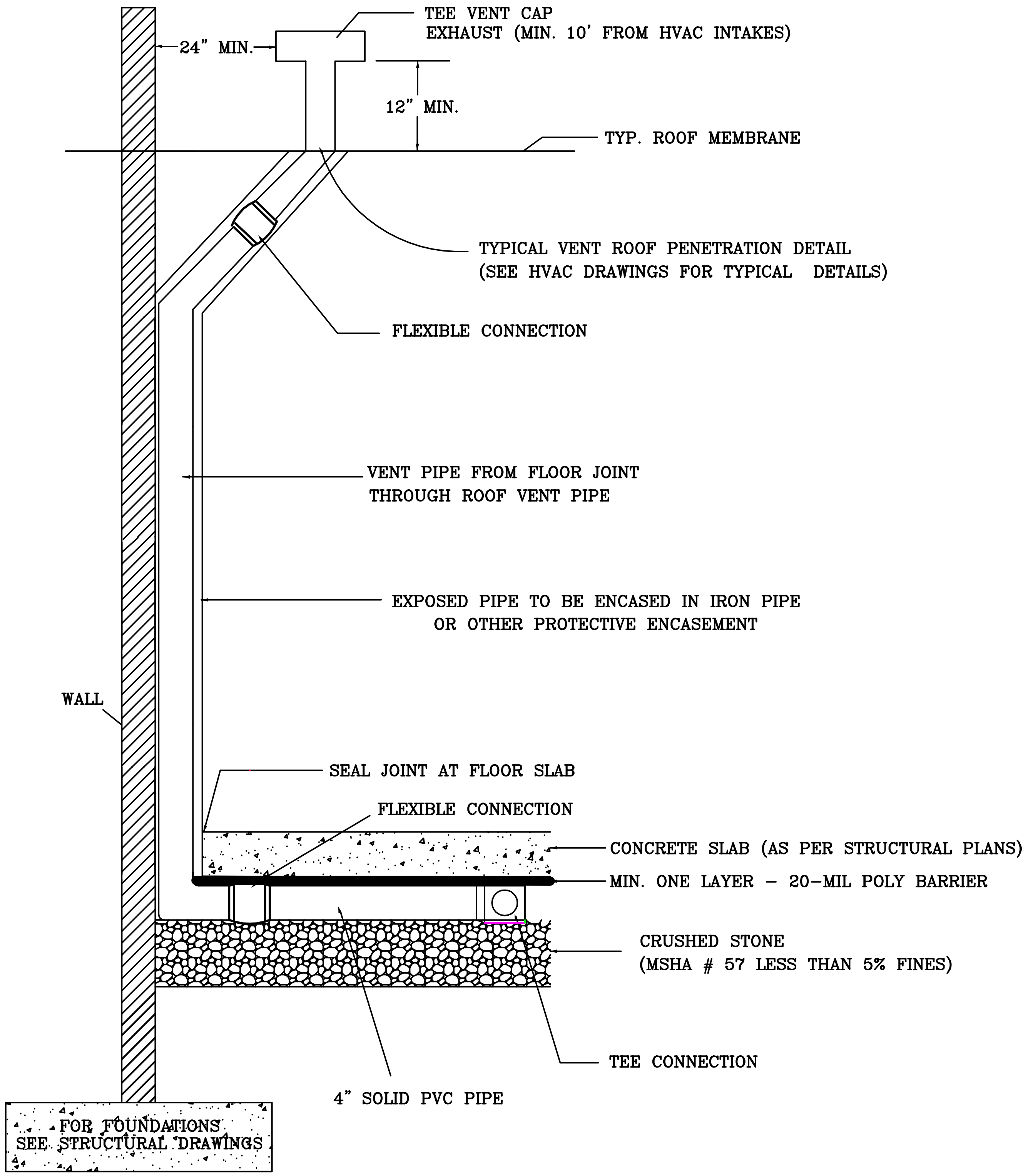
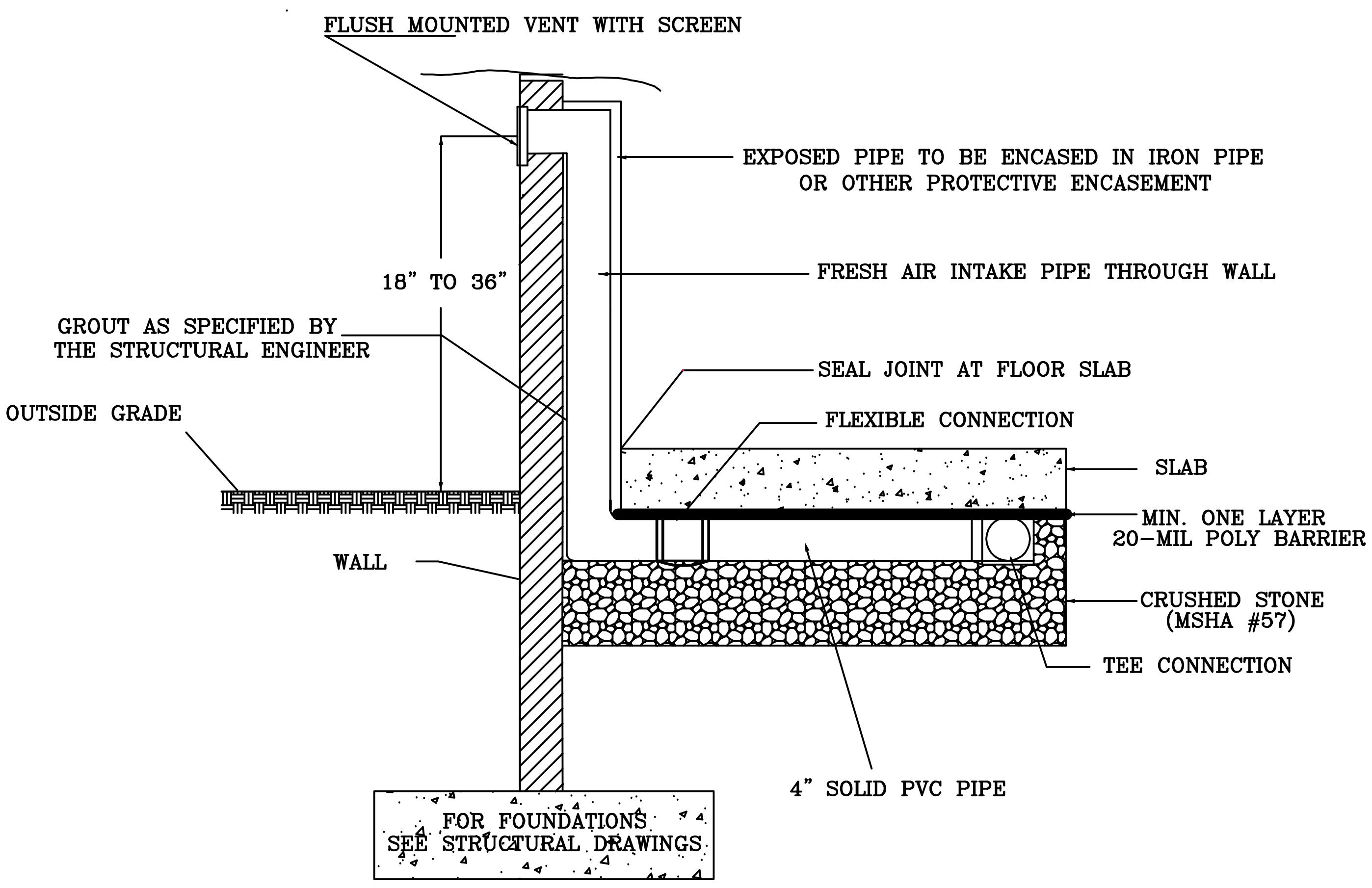


RISER PIPE DETAIL – TYPICAL OUTLET

NOT TO SCALE



INTAKE PIPE DETAIL – TYPICAL INTAKE

NOT TO SCALE

NO.	REVISIONS	DATE

Sub-Slab Vapor Venting System
Riser Details
Kop-Flex Site
7555 and 7565 Harmans Road, Harmans, MD

TC Harmans Road, LLC

MMB	HMA	04/02/2015	6387-F	4 of 4

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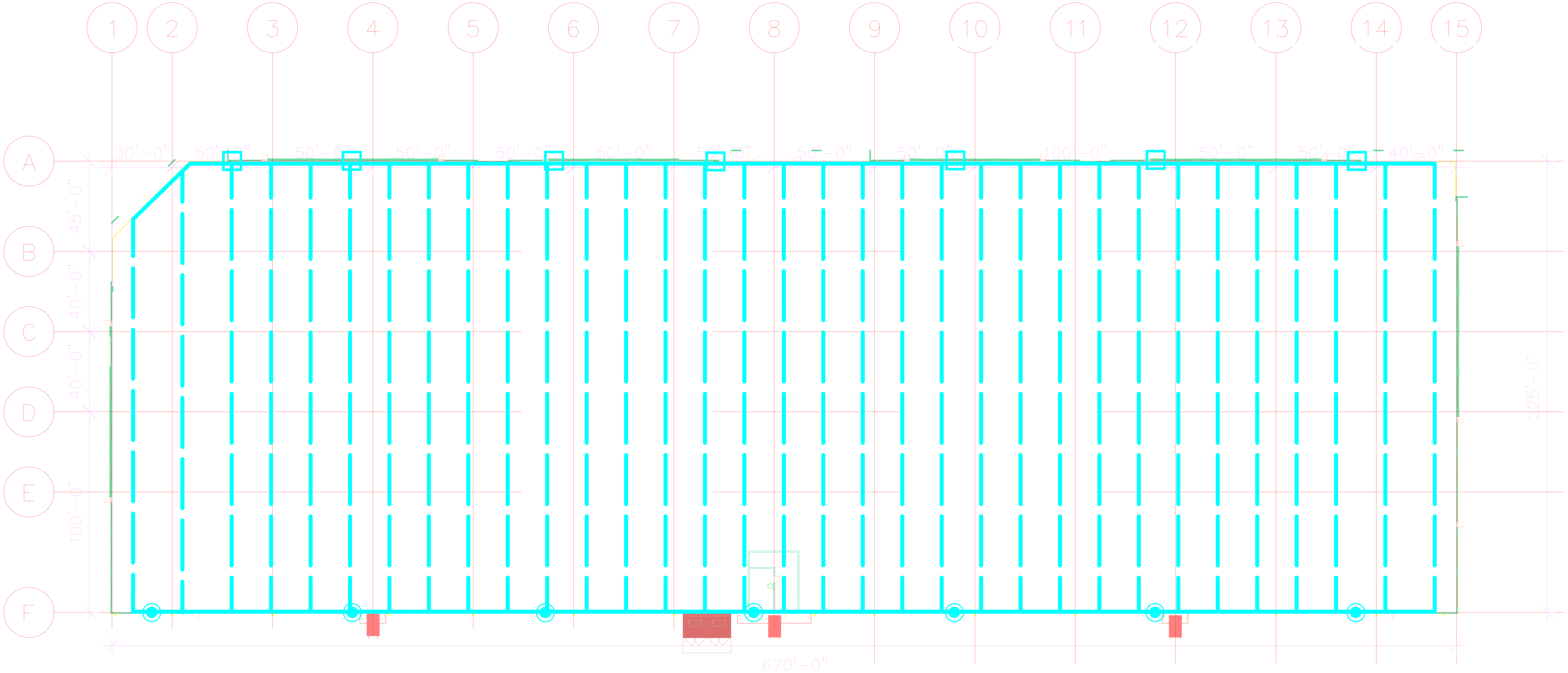

North Building

LEGEND

▬ ▬	– 2" DIAM. PERFORATED PIPE
▬▬	– 4" DIAM. PERFORATED PIPE
☐	– FRESH AIR INTAKE (7 LOCATIONS)
●	– VENT TO THE ROOF (7 LOCATIONS)

NO.	REVISIONS	DATE

Sub–Slab Vapor Venting System
Kop–Flex Site (North Building Layout)
7555 and 7565 Harmans Road
Harmans, Maryland

TC Harmans Road, LLC

MMB	HMA	04/02/2015	6387–F	1 OF 4

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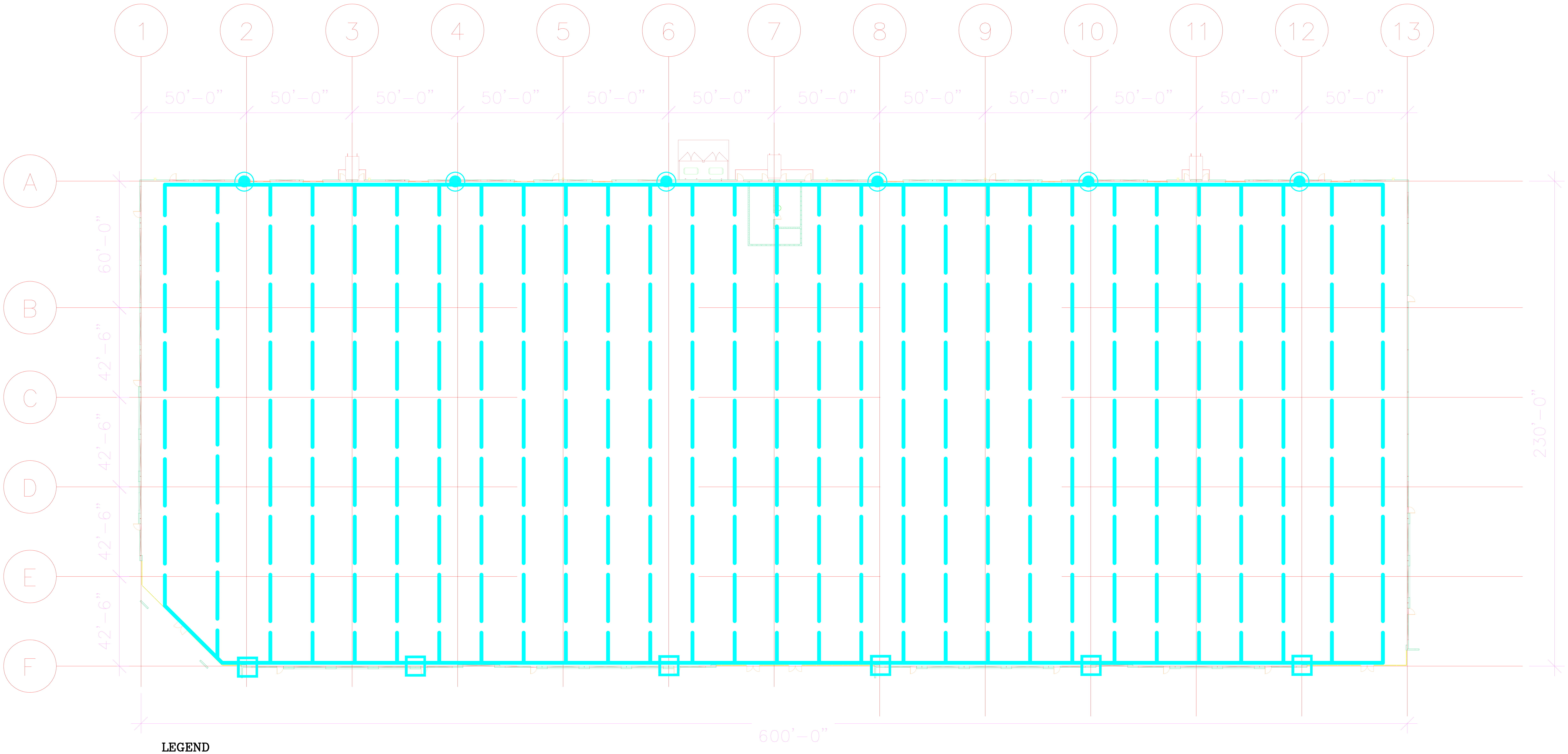

LEGEND

- - - – 2" DIAM. PERFORATED PIPE
— – 4" DIAM. PERFORATED PIPE
□ – FRESH AIR INTAKE (6 LOCATIONS)
◉ – VENT TO THE ROOF (6 LOCATIONS)

South Building

NO.	REVISIONS	DATE

Sub-Slab Vapor Venting System
Kop-Flex Site (South Building Layout)
7555 and 7565 Harmans Road
Harmans, Maryland

TC Harmans Road, LLC

MMB	HMA	04/02/2015	6387-F	2 OF 4

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Appendix G – Groundwater Monitoring Plan

Appendix H – Administrative Requirements - Zoning

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