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June 24, 2016

Tim Hornosky, P.G.
State Remediation Section
Division of Site Assessment, Remediation and Revitalization
Bureau of Land and Waste Management
South Carolina Department of Health and Environmental Control
2600 Bull Street
Columbia, South Carolina 29201

Re: Response to Comments, Focused Feasibility Study
Wix Plant Site, Dillon, South Carolina
Voluntary Cleanup Contract No. 13-5996-RP

Dear Mr. Hornosky:

On behalf of Wix Filtration Corp LLC (Wix), WSP USA Corp (WSP) is providing responses to the comments received from the South Carolina Department of Health and Environmental Control (SCDHEC) on April 4, 2016 concerning the Focused Feasibility Study (FFS), dated December 2015, for the Wix Plant Site located in Dillon, South Carolina (Enclosure A). The FFS report has been revised in accordance with the responses to comments and our April 21, 2016, teleconference discussing the FFS report and SCDHEC's comments. Two hard copies and one electronic copy of the revised FFS are provided with this letter (Enclosure B).

SCDHEC comments from the April 4, 2016, letter are provided below in *italicized* type, followed by WSP's response.

Comment 1. *General: The Detailed Evaluation Summary compares three remedies with significantly different degrees of action. All three seek to proactively remove the majority of the contaminant mass. The FFS provides a realistic assessment of the potential for each of the remedies to achieve the Remedial Action Objectives (RAOs) including reduction of groundwater contaminant levels to below the Maximum Contaminant Levels (MCLs) in a reasonable time frame. In order to appropriately compare these remedies, assumptions must be made with respect to time required for each remedy to achieve these RAOs. The assumed life cycles of the various remedies have a significant bearing on the overall cost, which is one consideration in the remedial selection. Because cost impacts the relative suitability of the remedies, it is calculated in detail. However, the FFS does not provide adequate justification for the assumed life cycles for each remedy. For example, Alternatives 2 and 3 are similar in that both involve initial excavation of the most contaminated soils. Alternative 2 is assigned a shorter life cycles because it includes additional active remediation, while Alternative 3 does not. However there is no information provided as to how the authors arrived at relative life cycles of 7 and 10 years, respectively. Please include the calculations that provide the basis for the estimated times necessary to reach RAOs for each remedial alternative.*

<u>WSP Response</u>

As provided in Section 6.1.7, the costs developed for this analysis are planning-level estimates and may vary from minus 30 to plus 50% in accordance with U.S. Environmental Protection Agency

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) guidance[1]. Unit prices for materials, equipment, and labor were selected from various sources, including published cost books, product vendors, construction companies, and project-specific experience.

The assumed life cycles inputted into this analysis were derived from professional knowledge of each remedial technology's effectiveness given the physical site conditions (e.g., depth to groundwater, soil type, hydraulic conductivity, etc.), and the nature and levels of contaminants, as described in Sections 2.3 and 3.3 of the FFS and summarized below:

- Depth to groundwater – average depth to groundwater of 3 feet below ground surface (bgs).
- Soil Permeability- low permeability due to interbedded clay and sand, with assumed values of less than 1 x 10^{-9} square centimeters.
- Hydraulic Conductivity – Low hydraulic conductivity value of 0.06 feet per day calculated for the clayey deposits screened by the shallow monitoring wells.
- Contaminant nature and concentration- Toluene is the dominant constituent detected in groundwater. Toluene concentrations in soil have been detected above its generic soil saturation concentration (820 milligrams per kilogram), and toluene concentrations in groundwater near its solubility limit (520,000 micrograms per liter at 25 degrees Celsius).
- Area of impact – 22,000 square feet (sf) of impacted soil, and 42,800 sf of impacted groundwater, as indicated by the sample data summarized in Section 3.3 of the FFS.

As discussed during the April 21, 2016, teleconference, WSP revised the number of years in the life cycle estimates (e.g., 10 years) to a range in the number of years (e.g., 10 to 15 years) to account for uncertainty in the planning-level estimates. Factors contributing to each life cycle estimate are provided below.

- Alternative 1 – Minimal effectiveness of Air Sparge/ Soil Vapor Extraction (AS/SVE) treatment (ongoing since November 2009) due to site conditions listed above, including high groundwater table and low soil permeability. Although conversion to a dual phase system will dewater the area, mass reduction from a modified AS/SVE is anticipated to remain minimal due to the low permeability and hydraulic conductivity. Therefore the estimated timeframe is 15 to 20 years.
- Alternative 2 – Mass removal through excavation, followed by air sparge treatment in the gravel backfilled area (i.e., more permeable flow zone), is expected to remove the majority of the toluene mass, with residual mass reduction through natural attenuation projected to take several years to meet the cleanup objectives. As stated in Section 4.2, the remedial action objectives include demonstration of statistically significant decreasing trends in toluene groundwater concentrations indicating the SCMCL will be met within a reasonable timeframe. The estimated timeframe of Alternative 2 is 5 to 10 years.
- Alternative 3 – Mass removal through excavation, followed by Aggressive Fluid Vapor Recovery (AFVR), is also expected to remove the majority of the toluene mass, with residual mass reduction through the natural attenuation process projected to take several years to meet the cleanup objectives. The air sparge applied in Alternative 2 is anticipated to be slightly more effective at

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[1] U.S. Environmental Protection Agency. 1988. Guidance for Conducting Remedial Investigation and Feasibility Studies Under CERCLA, Interim Final. October.

mass removal than AFVR due to the continuous operation of the air sparge equipment, and the high effectiveness of sparging in a permeable gravel material; therefore, a slightly longer life cycle was assume for Alternative 3 (7 to 10 years total).

Comment 2. *Section 3.3.2 Groundwater: The calculation used to determine the volume of impacted groundwater skipped the step of converting from cubic feet to gallons. The volume of 188,300 (cubic feet) should be multiplied by 7.48, giving an impacted groundwater volume of 1,408,634 gallons.*

WSP Response
WSP has corrected the error in Section 3.3.2 in the revised FFS, and the groundwater volume is provided as 1,408,634 gallons.

Comment 3. *Section 5.2.1 No Action: As indicated in the text, CERCLA would require that the site be evaluated at least once every five years in the event that contaminants remain onsite above levels that allow for unrestricted use. Please note that this condition applies to any remedy that leaves contaminants onsite above levels that allow for unrestricted use.*

WSP Response
WSP understands that the site will be evaluated at least once every five years in the event that contaminants remain onsite above levels that allow for unrestricted use, irrespective of anticipated institutional controls that would limit use of the property.

Comment 4. *Section 6.1.4: Long-Term Effectiveness and Permanence: Please cite the source of the "Reliability with Time" criterion.*

WSP Response
WSP has removed the "Reliability with Time" criterion and updated the description of the "Adequacy and Reliability of Controls" criterion to be consistent with the aforementioned CERCLA guidance.

Comment 5. *Section 6.1.6: Implementability: This criterion also considers availability of services and materials. Please provide discussion of implementability with regard to hazardous waste disposal for excavated soils.*

WSP Response
WSP revised Section 6.1.6 in the FFS to add a criterion for availability of services and materials, and a discussion of implementability with regard to the disposal of excavated soils as hazardous waste.

Comment 6. *Section 6.2.1: The 20 year estimate seems excessive. Please provide justification for this assumption, for example estimated radius of influence, soil permeability, area of impact, etc.*

WSP Response
The lifecycle estimate for Alternative 1 was based on professional judgement given site conditions described in Sections 2.3 and 3.3 of the FFS, and summarized under WSP response to Comment 1.

As stated in WSP's Response to Comment 1, WSP updated the lifecycle estimates in the revised FFS to provide ranges in total number of years that capture the potential for faster than expected cleanup.

Comment 7. *Section 6.2.1.1; 6.2.3.1; 6.3.1: The evaluation states that Alternative 1 generates waste (spent carbon) and consumes energy (electric blower motor), which is true, but does not make a similar statement with regard to Alternative 3, which is calculated to generate 700 tons of hazardous waste, and requires operation of a diesel excavator and haul trucks to remove waste. Thus, Alternative 1 has been assigned a lower score for overall protection of human health and the environment than Alternative 3. That renders the comparison subjective and suggests bias. Please provide estimated waste quantities and energy consumption in order to accurately compare alternatives.*

WSP Response

WSP agrees that Alternative 3 will generate waste and consume energy, including operation of an excavator and haul trucks to remove waste. WSP updated Section 6.3.1 to indicate the Alternative 3 also generates waste and consumes energy. Although all three remedial alternatives will generate waste and consume energy, the quantity of energy consumed by Alternative 3 over the remedial lifecycle is anticipated to be much less than Alternatives 1 and 2. The implementation period of Alternative 3 will be approximately three weeks (relatively short-term), whereas the implementation period of Alternatives 1 and 2 will be years (relatively long-term). The basis for the assumption that Alternative 3 uses less energy than Alternatives 1 and 2 include the following:

- Contractor mobilization to site twice per month for operations, maintenance and system monitoring tasks under Alternatives 1 and 2 (minimum 24 roundtrips per year). This compares to daily roundtrips to the site for an excavation crew (estimated at 4-5 people) over a period of three weeks, plus one roundtrip for AFVR pilot study, under Alternative 3.
- At least one hazardous waste pickup per quarter (4 per year) for disposal of anticipated hazardous waste from treatment system operations in Alternatives 1 and 2 (e.g., spent vapor-phase carbon, spent liquid-phase carbon, spent bag filters). This compares to approximately a total of 40-50 haul truck loads (10-12 yards per load) of hazardous waste soil and 1-2 vacuum trucks of hazardous waste groundwater under Alternative 3.
- Continuous electrical power for operation of a dual phase system equipment (blower, transfer pumps, system controls, remote monitoring program, and air compressor). Based on electrical usage at sites with similar treatment systems, Alternatives 1 and 2 would have an estimated 5-10 kilowatts of average energy demand, and an estimated use of 45,000-90,000 kilowatt hours per year. This compares to an estimated use of 50 gallons per day of diesel fuel for an excavator over a period of three weeks (750 gallons of diesel fuel total), and 50-100 gallons of diesel fuel for a vacuum truck operation over an 8-hour vacuum extraction event in Alternative 3.

Comment 8. *Section 7: Section 7 presents the rationale that risk to site workers from a properly designed and functioning treatment system is greater than the risk presented from uncontrolled residual contamination. The Department rejects this conclusion as unsupported. Further, greater risk is presented to site workers during excavation and hauling than during operation of a treatment system similar to the one which has operated at the site since 2009. This statement should be removed.*

WSP Response

WSP will remove the risk to site workers from the discussion in Section 7.

Comment 9. *The Department has given due consideration to Section 7, Recommended Alternative. The Department agrees that excavation and off-site disposal of the most highly contaminated soils is the most effective and timely of the alternatives evaluated, and is prepared to approve this component as part of a selected remedial alternative. However, the Department does not agree that leaving residual contamination in place untreated (MNA) will result in lower potential impact to human health and the environment as the FFS suggests. In a conference call between the Department and WSP on March 25, 2016, the Department provided additional technical information to WSP that may offer a significant improvement in contaminant mass reduction in a short time frame, without significant additional capital costs. This remedy would require the reinstallation of wells into the area of excavation. It would also benefit greatly from backfilling the excavated area with a more permeable material, such as the suggested in Alternative 2, rather than re-use of overburden soils as in Alternative 3. The Department is amenable to having a conference call with the project team to discuss information of these features into a selected remedy.*

WSP Response
Based on the discussions during the April 22, 2016, teleconference, WSP updated the description of Remedial Alternative 3 in the revised FFS to include the following activities: backfill the excavation area with more permeable material, installation of a 4-inch diameter stainless steel extraction well, implementation of a pilot AFVR event at the extraction well, and potential completion of an additional recovery event(s) based on evaluation of the pilot test results.

Comment 10. *Table 6.1 (Implementability) indicates that the excavation considered under Alternative 2 would require a pre-design study to design an excavation shoring system, but that Alternative 3 would not. Please clarify the difference between excavation in alternatives 2 and 3 that results in this discrepancy.*

WSP Response
Table 6.1 (Implementability) has been corrected to state "This technology requires completion of a pre-design study to select the appropriate nutrients for the biosparge system, replacement of malfunctioning components of the existing AS/SVE system, and installation of associated transfer pipelines and wells. In addition, this alternative requires long-term O&M and monitoring."

If you have any questions concerning the responses to comments or the revised FFS, please do not hesitate to contact us at the above number, or either Scott Van Pelt or Paul Caulford of Mann + Hummel at (843) 841-6876.

Sincerely,

Pamela K. Groff

Pam Groff, P.E.
Technical Manager – Environmental
South Carolina Professional Engineer #30147

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Enclosures

cc/encl: Scott Van Pelt, Mann + Hummel (Electronic copy only)
Paul Caulford, Mann + Hummel (Electronic copy only)
Keith Clark, Mann + Hummel (Electronic copy only)
Monty Gibson, Mann + Hummel (Electronic copy only)
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James Hiller, ERM (Electronic copy only)
Weston Adams, Esquire, Nelson Mullins Riley & Scarborough LLP (Electronic copy only)

Enclosure A – SCDHEC April 4, 2016 Comments Letter on Focused Feasibility Study

D H E C
PROMOTE PROTECT PROSPER
Catherine E. Heigel, Director
Promoting and protecting the health of the public and the environment

April 4, 2016

Mr. Scott Van Pelt
Wix Filtration Corp LLC
1422 Wix Road
Dillon, SC 29536-7939

RE: Review of Focused Feasibility Study dated December 21, 2015

Wix Filtration Corp, LLC
Site ID# 403139, VCC-13-5996-RP
Dillon County

Dear Mr. Van Pelt,

The Department has reviewed the above referenced Focused Feasibility Study (FFS). The FFS was submitted to allow selection of a preferred remedy by the Department, consistent with the South Carolina Hazardous Waste Management Act and voluntary cleanup contract (VCC)-13-5996-RP. The following comments were generated during this review. These comments require revision of the FFS prior to selection of a remedy by the Department.

1. General: The Detailed Evaluation Summary compares three remedies with significantly different degrees of action. All three seek to proactively remove the majority of the contaminant mass. The FFS provides a realistic assessment of the potential for each of the remedies to achieve the Remedial Action Objectives (RAOs) including reduction of groundwater contaminant levels to below the Maximum Contaminant Levels (MCLs) in a reasonable time frame. In order to appropriately compare these remedies, assumptions must be made with respect to the time required for each remedy to achieve these RAOs. The assumed life cycles of the various remedies have a significant bearing on the overall cost, which is one consideration in the remedial selection. Because cost impacts the relative suitability of the remedies, it is calculated in detail. However, the FFS does not provide adequate justification for the assumed life cycles for each remedy. For example, Alternatives 2 and 3 are similar in that both involve initial excavation of the most contaminated soils. Alternative 2 is assigned a shorter life cycle because it includes additional active remediation, while Alternative 3 does not. However there is no information provided as to how the authors arrived at relative life cycles of 7 and 10 years, respectively. Please include the calculations that provide the basis for the estimated times necessary to reach RAOs for each remedial alternative.

2. Section 3.3.2 Groundwater: The calculation used to determine the volume of impacted groundwater skipped the step of converting from cubic feet to gallons. The volume of 188,300

(cubic feet) should be multiplied by 7.48, giving an impacted groundwater volume of 1,408,634 gallons.

3. Section 5.2.1 No Action: As indicated in the text, CERCLA would require that the site be evaluated at least once every five years in the event that contaminants remain onsite above levels that allow for unrestricted use. Please note that this condition applies to any remedy that leaves contaminants onsite above levels that allow for unrestricted use.

4. Section 6.1.4 Long-Term Effectiveness and Permanence: Please cite the source of the "Reliability with Time" criterion.

5. Section 6.1.6 Implementability: This criterion also considers availability of services and materials. Please provide discussion of implementability with regard to hazardous waste disposal for excavated soils.

6. Section 6.2.1: The 20 year estimate seems excessive. Please provide justification for this assumption, for example estimated radius of influence, soil permeability, area of impact, etc.

7. Sections 6.2.1.1; 6.2.3.1; 6.3.1: The evaluation states that Alternative 1 generates waste (spent carbon) and consumes energy (electric blower motor), which is true, but does not make a similar statement with regard to Alternative 3, which is calculated to generate 700 tons of hazardous waste, and requires operation of a diesel excavator and haul trucks to remove waste. Thus, Alternative 1 has been assigned a lower score for overall protection of human health and the environment than Alternative 3. That renders the comparison subjective and suggests bias. Please provide estimated waste quantities and energy consumption in order to accurately compare alternatives.

8. Section 7 presents that rationale that risk to site workers from a properly designed and functioning treatment system is greater than the risk presented from uncontrolled residual contamination. The Department rejects this conclusion as unsupported. Further, greater risk is presented to site workers during excavation and hauling than during operation of a treatment system similar to the one which has operated at the site since 2009. This statement should be removed.

9. The Department has given due consideration to Section 7, Recommended Alternative. The Department agrees that excavation and off-site disposal of the most highly contaminated soils is the most effective and timely of the alternatives evaluated, and is prepared to approve this component as part of a selected remedial alternative. However, the Department does not agree that leaving residual contamination in place untreated (MNA) will result in lower potential impact to human health and the environment as the FFS suggests. In a conference call between the Department and WSP on March 25, 2016, the Department provided additional technical information to WSP that may offer a significant improvement in contaminant mass reduction in a short time frame, without significant additional capital costs. This remedy would require the reinstallation of wells into the area of the excavation. It would also benefit greatly from backfilling the excavated area with a more permeable material, such as that suggested in Alternative 2, rather than re-use of overburden soils as in Alternative 3. The Department is amenable to having a conference call with the project team to discuss incorporation of these features into a selected remedy.

10. Table 6-1 (Implementability) indicates that the excavation considered under Alternative 2 would require a pre-design study to design an excavation shoring system, but that Alternative 3 would

not. Please clarify the difference between excavation in alternatives 2 and 3 that results in this discrepancy.

Please revise the FFS as indicated in the comments above, and submit the revised FFS to my attention on or before May 25, 2016. If you have questions, or would like to set up a meeting or conference call to discuss this project you can reach me at (803) 898-0733, or by email at hornostr@dhec.sc.gov

Kindest Regards,

Tim Hornosky, P.G.
State Remediation Section
Division of Site Assessment, Remediation & Revitalization
Bureau of Land & Waste Management

cc: R. Gary Stewart, BLWM
Buck Graham, Pee Dee EQC (Florence)
Eric Johnson, WSP
Weston Adams, Nelson Mullins
File # 403139

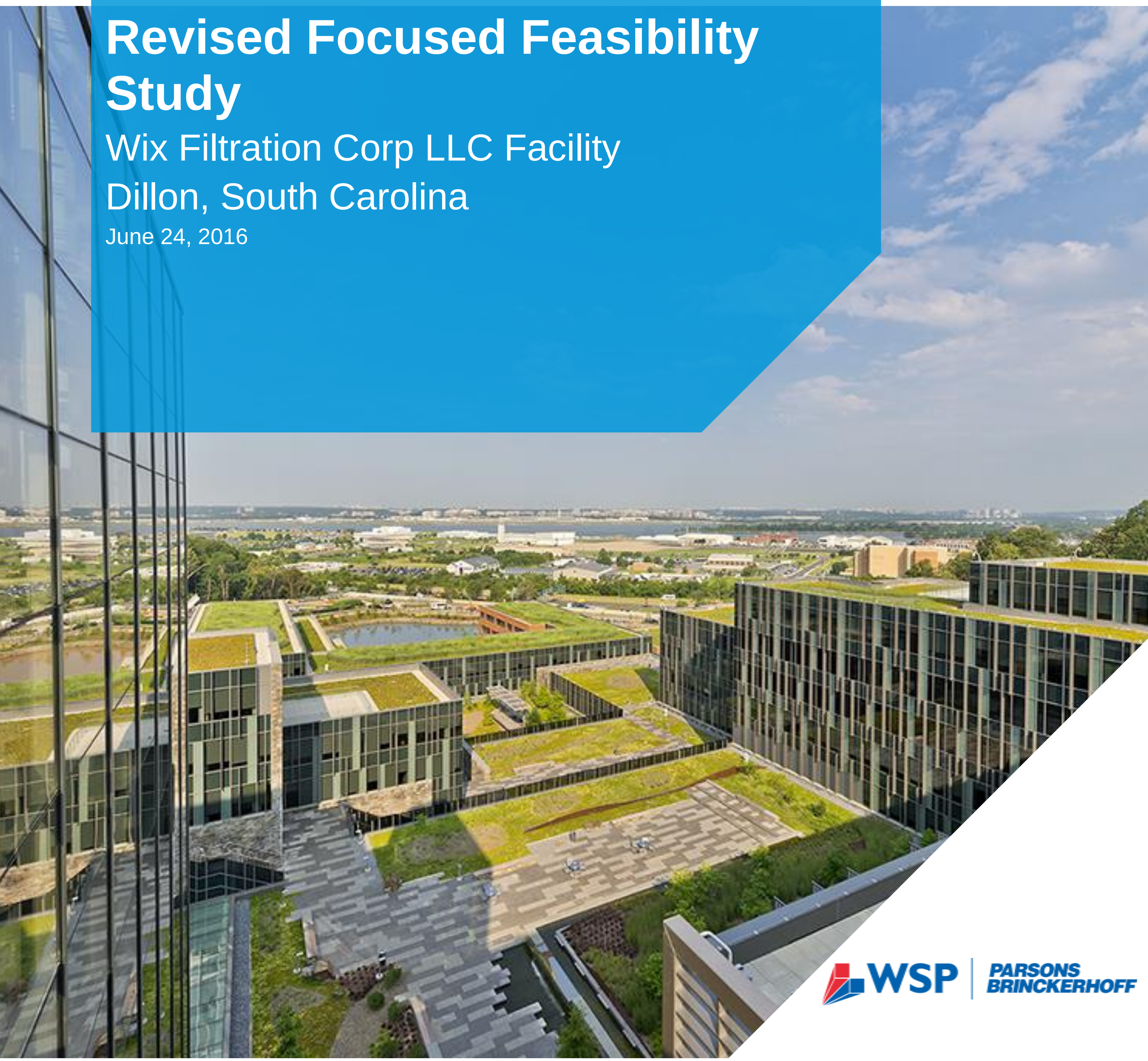
Enclosure B – Revised Focused Feasibility Study

Revised Focused Feasibility Study

Wix Filtration Corp LLC Facility

Dillon, South Carolina

June 24, 2016



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Revised Focused Feasibility Study

Wix Filtration Facility
Dillon, South Carolina

June 24, 2016

Client

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SOUTH CAROLINA
LICENSED PROFESSIONAL ENGINEER
No. 30147
PAMELA K. GROFF
6/24/16

Pamela K. Groff
South Carolina Professional Engineer #30147

Table of Contents

1 Introduction

On behalf of Wix Filtration Corporation LLC (Wix), WSP USA Corp. has prepared this Focused Feasibility Study (FFS) report for the Wix Filtration facility in Dillon, South Carolina, (Site) in fulfillment of Item 3.C of Voluntary Cleanup Contract (VCC) Number 13-5996-RP. The objectives of the FFS are to develop remedial action objectives (RAOs), identify and screen applicable remedial technologies and institutional controls, and recommend a remedial alternative to achieve the RAOs. The FFS is focused by providing descriptive, but not detailed, discussions of technologies allowing the selection of a limited number of potentially applicable remedial alternatives for evaluation. As noted in WSP's Remedial Investigation (RI) Report Addendum, dated September 29, 2015, the remedial alternative recommended in the FFS report will be designed during the remedial action work phase (Item 4 of VCC Number 13-5996-RP).

2 Site Background

2.1 Site Description

The Site is located at 1422 Wix Road in Dillon, Dillon County, South Carolina (Figure 2-1) and consists of approximately 80 acres of land. The facility includes a 376,000-square-foot manufacturing building (Figure 2-2) and several small ancillary structures located to the east (hazardous waste shed), north (fire water pump house), and west (paint storage building). Paved parking and loading areas are located to the north and south of the manufacturing building. Fifteen acres of the property, located to the north and east of the manufacturing building, are leased to a local farmer. According to facility personnel, Progress Energy owns and operates a power substation on approximately 4 acres of land in the northeast portion of the Wix property.

The Site is located in a mixed industrial, agricultural, and residential area. The property is bordered to the north by farmland and the Franco Manufacturing facility, to the east by cultivated and wooded farmland, to the south by farmland and residential properties, and to the west by the CSX Transportation railroad line and residence/small business.

The facility obtains both drinking and production water from Trico Water Company, Inc., which is located in the city of Dillon. No water supply wells are located on the Wix property.

2.2 Site History

The facility was constructed in 1977 on agricultural land by Wix Filters. The Affinia Group acquired the facility in November 2004. Facility operations from 1977 to present include the manufacture of fuel filters, oil filters, and air filters for automotive, diesel, racing, agricultural, and industrial applications. Activities conducted at the facility include metal parts fabrication, element curing, assembly, painting, printing, and packaging and shipment.

During the early years of manufacturing operations, toluene-containing paints were prepared in the southwest portion of the facility. Based on available information, it is believed the toluene was stored in an underground storage tank (UST) outside of the building and dispensed via a sub-grade piping network to various locations within the manufacturing building. Areas of historical toluene use and storage are shown on Figure 2-3. After closing of the UST in the mid-1980s, toluene used in the paint formulation was stored in drums inside the paint room located in the southwestern portion of the building.

No facility documentation was available for review related to the historical use of chlorinated solvents at the Wix facility. The only record of probable chlorinated solvent use is from a July 2012 environmental database report, which lists U.S. Environmental Protection Agency (EPA) hazardous waste code D039 for one of the hazardous waste streams generated at the facility. This waste code is for material containing a characteristically hazardous concentration of tetrachloroethene (PCE).

The only other available information concerning chlorinated solvent use was obtained via conversations with long-tenured facility workers. Based on these discussions, it is believed that chlorinated solvents were used for a period of time in a production area of the facility Using this anecdotal information, it is believed the majority of the solvent storage and use occurred in a relatively small area in the southwestern portion of the facility.

2.3 Geology and Hydrogeology

The predominant surface soil units at the Site are the Orangeburg loamy sand (eastern portion of the Site) and the Coxville fine sandy loam (western portion of the Site; U.S. Department of Agriculture 2014). The Orangeburg is a well-drained soil derived from loamy marine deposits. In Orangeburg soils, the water table is typically encountered at depths greater than 6.5 feet below ground surface (bgs). The Coxville is a poorly drained soil derived from clayey marine deposits. The Coxville typically has a high water table, within 12 inches of the ground surface.

The Site is located in the Middle Coastal Plain physiographic sub-province of the Atlantic Coastal Plain. Geologically, the Coastal Plain physiographic province in eastern South Carolina is characterized by a series of generally seaward-dipping terrigenous clastic stratigraphic units that are punctuated at the surface by a sequence of fluvial and coastal terraces. The surficial deposits reflect the interaction between terrestrial and marine processes and are characterized by relict marsh plains and barrier islands (ridges). The region has been modified by repeated cycles of sea-level transgressions (rise) and regressions (fall).

In the Dillon area, the Pliocene-age Duplin formation, consisting of sands and clays, outcrops at the ground surface (U.S. Geological Survey 2014). The Duplin formation unconformably overlies older Cretaceous-age deposits (Black Creek formation) over much of its extent. Lithologically, the Black Creek formation consists of gray to black lignitic clay with thin beds of fine-grained micaceous sand and thick lenses of cross-bedded sand.

The shallow water-table (approximately 2 to 3 feet bgs) was encountered within the Duplin formation during the 2014 RI activities, and represents the upper-most water-bearing zone at the Site. The Black Creek aquifer underlies the surficial aquifer and is comprised of sediments from the Black Creek formation. The Black Creek aquifer is the primary source of public, industrial and agricultural water in much of the Coastal Plain of South Carolina. According to South Carolina Department of Natural Resources, the potentiometric surface of the Black Creek aquifer is approximately 60 feet mean sea level (MSL) in the vicinity of the Site (South Carolina Department of Natural Resources [SCDNR] 2009). Groundwater flow in the Black Creek aquifer is generally in an eastward direction toward the coast.

As presented in Figure 2-4, the following unconsolidated deposits were encountered in the subsurface:

- 0-15 feet bgs (approximate): yellowish red, brown and gray fat clay
- 15-25 feet bgs (approximate): gray to light gray interbedded clay and sand
- 25-36 feet bgs (approximate): yellow to light gray poorly-graded sand with silt
- 36 feet bgs (approximate): black hard clay

During the RI, the water table was encountered at 2 to 3 feet bgs in soil borings and 3.92 feet-bgs (MW-12; 130.54 feet MSL) to 6.35 feet-bgs (MW-15; 124.76 feet MSL) in monitoring wells (WSP 2014a). Historical data indicate that the depth to the water table can vary as much as approximately 7 feet at a given well location (Appendix A). Based on the data obtained as part of the semi-annual monitoring events, groundwater levels are typically highest in the winter and lowest in the late summer, which probably reflect seasonal variations in evapotranspiration rather than precipitation. The operation of the air sparge/soil vapor extraction (AS/SVE) system may also impart some influence of the elevation of the groundwater surface. Recharge to the water table is primarily by infiltration of rainfall, although the drainage ditches and wooded wetland area west of the main building may also provide a local source of groundwater recharge.

As presented in the RI Report (WSP 2014a), shallow groundwater flow is generally westward toward the wooded area. The variability in groundwater elevations in the area around wells MW-1, MW-2, MW-3, and MW-4R probably reflects the localized influence of the AS/SVE system on the hydrologic conditions in the shallow subsurface. Vertical gradients were calculated for the shallow and deep well nests (i.e., MW-11/MW-11-36 and MW-12/MW-12-38) using the EPA online vertical gradient calculator (EPA 2014). For the MW-11 nest, a downward vertical gradient with a magnitude of 0.02 was calculated; for the MW-12 nest, a downward vertical gradient with a magnitude of 0.20 was calculated. The downward vertical gradient calculated for the MW-11 nest suggests groundwater flow in the deeper portions of the surficial water-bearing zone is not discharging to the wetland area. Although no monitoring wells have been advanced into the Black Creek aquifer onsite, data available from the SCDNR indicates that the potentiometric surface of the Black Creek aquifer is more than 60 feet deeper than the surficial water-bearing zone. Therefore, it appears that the surficial water-bearing zone and the Black Creek aquifer are not in direct hydraulic communication.

WSP conducted slug tests on MW-1, MW-3, MW-13 and MW-12-38 during the 2014 RI. An average hydraulic conductivity (K) of 0.06 feet per day (ft/day) was calculated for the clayey deposits screened by the shallow monitoring wells. For the predominately sand deposits screened by deep monitoring well MW-12-38, the K value determined from the slug test was 0.9 ft/day. The results for the shallow monitoring wells are consistent with the clayey sediments encountered in the shallow subsurface (Bouwer 1978) and the silty sand materials present within the screened interval for the deep monitoring well (Heath 1987).

2.4 Investigations

2.4.1 Overview

In October 2005, workers detected a paint-like odor in shallow soil material excavated during repairs to an underground water line west of the manufacturing building. Based on this finding, eight soil samples and three groundwater samples were collected from the area and analyzed for volatile organic compounds (VOCs) typically associated with paint products to determine the presence/absence of these chemicals in the area (Environmental Resources Management [ERM] 2011a). The analytical results for the soil samples indicated elevated toluene concentrations, with a maximum detection of 1,630 milligrams per kilogram (mg/kg). Toluene was detected in the groundwater samples from temporary monitoring wells at concentrations ranging from 7,610 micrograms per liter (µg/l) to 184,000 µg/l. Upon receipt of the sampling data, Wix provided written notification of the discovery of a suspected release of toluene to South Carolina Department of Health and Environmental Control (SCDHEC) in early December 2005.

Beginning in spring 2006, SCDHEC-approved activities were conducted at the site to investigate and remediate the environmental impacts from the toluene release. These activities have included the following:

- 2006 Environmental Site Assessment (ERM 2007a) and supplemental assessment activities in 2010 and 2011 to evaluate the nature and the extent of impacts associated with the toluene release (ERM 2011a).
- 2008 Remedial Options Assessment and 2008 Remedial Action Plan to select and implement an applicable remedial technology to mitigate the environmental impacts (ERM 2008).
- 2014 RI to characterize of VOC impacts to environmental media in the release area (WSP 2014a and 2014b).
- Implementation of an interim groundwater monitoring program to gather additional data on VOC concentrations in groundwater in the release area.
- 2015 RI Addendum to gather additional site data to further characterize the extent of VOCs in sub-slab vapor and assess the performance and effectiveness of the existing AS/SVE system in the toluene release area (WSP 2015a and 2015b).

2.4.2 Soil and Sediment

A total of 56 soil samples have been collected and submitted for VOC analysis from 53 soil borings during site characterization activities performed by ERM and WSP (Figure 2-5). Soil sampling activities and findings were summarized in the following documents:

- ERM's Data Report of Phase II Environmental Assessment, dated February 26, 2007 (ERM 2007b)
- ERM's March 2011 Semi-Annual Groundwater Monitoring Report, dated March 30, 2011 (ERM 2011b)
- ERM's March 2012 Semi-Annual Groundwater Monitoring Report, dated March 28, 2012 (ERM 2012)
- WSP's RI Report, dated August 21, 2014 (WSP 2014a)

Tabulated analytical results are provided in Appendix A. Toluene concentrations are compared to the EPA Maximum Contaminant Level (MCL)-based soil screening level (SSL) and the generic soil saturation concentration (C_{sat}) on Figure 2-5. The MCL-based SSL for toluene (0.69 mg/kg) represents a concentration in soil that will theoretically result in a toluene concentration in groundwater that is protective of potential groundwater receptors (EPA 2015a). The C_{sat} for toluene (820 mg/kg) is indicative of immiscible product phase in the soil material (EPA 2015a). The equations used to derive the MCL-based SSL and C_{sat} are based on conservative, simplifying assumptions about the release and transport of contaminants to the groundwater system (EPA 2015a).

Investigation results identified toluene as the primary contaminant in the soil at the Site. The highest toluene concentrations were detected in saturated soil samples from 6-8 feet bgs at the STB-2 (1,800 mg/kg) and STB-8 (2,000 mg/kg) locations during ERM's characterization activities in 2006. The highest toluene concentration detected during WSP's 2014 characterization activities was detected in the sample collected from 2.5 feet bgs at the SB-9 (1,620 mg/kg) location. In addition, other VOCs, including aromatic compounds (e.g., ethylbenzene, xylenes, and naphthalene), trimethylbenzenes, and acetone, were detected at much lower (less than 10 mg/kg) in soils during site characterization activities.

Shallow subsurface soils with toluene concentrations at levels of concern are present in the area south and east of the historical toluene storage and use areas. The toluene-affected material in the release area includes saturated soil at a depth of approximately 3 feet bgs. Secondary contaminants (e.g., cis-1,2-dichloroethene [DCE]) were detected at concentrations above the EPA MCL-based SSL (0.021 mg/kg) in some samples collected during the investigations. No compound was detected at concentrations above the EPA industrial soil regional screening level (RSL; EPA 2015a).

In the sediment samples, only one compound, p-isopropyltoluene (0.0049 mg/kg), was detected in sediment sample (SED-1) collected from the drainage ditch (Figure 2-5).

2.4.3 Groundwater

Fifteen shallow monitoring wells (MW-1 through MW-15) were installed during ERM's groundwater characterization activities. Two deep wells (MW-11-36 and MW-12-38) and one replacement monitoring well (MW-4R) were installed during WSP's 2014 groundwater characterization activities (Figure 2-6). Replacement well MW-13R was installed in April 2015 to replace MW-13 (Figure 2-6). Well construction details are presented in Table 2-1.

SCDHEC requested Wix implement an interim, semi-annual groundwater sampling program to monitor VOC concentrations in groundwater; the sampling program commenced in August 2007. The results of the most recent (August 2015) interim groundwater sampling event conducted by ERM are discussed below, and tabulated historical results from ERM's September 2015 Ground Water Monitoring Report are provided in Appendix A (ERM 2015).

Shallow groundwater contains VOCs above the South Carolina MCLs (SCMCLs), with toluene representing the primary contaminant (ERM 2015). Secondary contaminants detected above the SCMCL include benzene and cis-1,2-DCE. The highest concentrations of toluene (above the SCMCL of 1,000 µg/l) are found in the area extending from the building to the vicinity of the former toluene UST (Figure 2-7). Compared to the aqueous solubility limit of toluene (520,000 µg/l at 25 degrees Celsius), samples collected from MW-4R and MW-13R contained toluene at concentrations over 20% the aqueous solubility limit, while samples collected from MW-2, MW-3, and MW-12 contained toluene at concentrations over 10% the aqueous solubility limit (Figure 2-7). These locations, with the exception of MW-13R, roughly coincide with soil sample locations exceeding the C_{sat}. Toluene concentrations decrease to levels below the SCMCL a short distance hydraulically downgradient (west) of the more impacted area. Toluene was not detected in the sample from deep monitoring well MW-11-36, while trace levels of toluene, less than the laboratory reporting limit, were detected in the sample from deep monitoring well MW-12-38; this indicates the vertical extent of toluene-affected groundwater is generally limited to the predominately clayey deposits occurring to a depth of less than 25 feet.

Benzene concentrations above the SCMCL of 5 µg/l are present in a small sub-area of the toluene-impacted shallow groundwater; locations with benzene detections in the August 2015 results include MW-2, MW-3, and MW-11. cis-1,2-DCE concentrations above the SCMCL of 70 µg/l are limited to the groundwater sample collected from the well MW-14 inside the southwestern portion of the manufacturing building. However, cis-1,2-DCE was detected at levels below the SCMCL in August 2015 samples collected from MW-2, MW-3, MW-11-36, and MW-12. In addition to the above compounds, VOCs detected in groundwater at concentrations less than the SCMCLs, if promulgated, include other aromatic compounds (ethylbenzene and xylenes) and chlorinated ethenes such as PCE and trichloroethylene (TCE; Appendix A).

2.4.4 Sub-Slab Vapor

Evaluation of the historical groundwater sampling results indicated elevated concentrations of toluene and the presence of ancillary VOCs (e.g., benzene) in the vicinity of the former paint room and area immediately west of the manufacturing building. Given the potential for vapor intrusion of these compounds, three sub-slab vapor samples were collected to evaluate VOC concentrations in the sub-slab vapor underneath the southwestern portion of the manufacturing building as part of the 2014 RI (Figure 2-8).

Toluene was not detected above the industrial air RSL in any of the sub-slab vapor samples. However, the human health risk assessment (HHRA) conducted as part of the 2014 RI indicated the PCE and TCE concentrations in the sub-slab samples represented an unacceptable risk for facility workers, based on potential exposure to the hypothetical concentrations of PCE and TCE in indoor air as a result of vapor intrusion into the manufacturing building. The HHRA is summarized below and further described in the RI Report (WSP 2014a).

As the 2014 HHRA was based on a limited data set (three samples), supplemental RI activities were completed in April 2015 to refine the analysis of the vapor intrusion exposure pathway. Ten additional sub-slab vapor samples were collected in the building area, including four samples in what is believed to be the former PCE use and storage area in the southwestern portion of the building, and six samples in other areas of the building (e.g., office areas; Figure 2-8).

The April 2015 sub-slab vapor sample results are provided in the 2015 RI Report Addendum (WSP 2015b). In general, the VOC concentrations in the April 2015 sub-slab vapor samples were lower than those detected in the April 2014 samples, and the highest concentrations were found in samples collected from the manufacturing area in the southwest portion of the building.

2.5 Human Health Risk Assessment

The 2014 HHRA was provided in the RI Report (WSP 2014a), and updated in 2015 in the RI Report Addendum (WSP 2015b). The purpose of the HHRA is to estimate the nature and probability of adverse health effects in humans who may be exposed to toluene and other volatile chemicals in affected environmental media at the Site under current and potential future land use scenarios. The HHRA is based on a series of health-protective assumptions about exposure characteristics. The assumptions used in the HHRA are intentionally conservative and therefore tend to overestimate the calculated non-cancer and theoretical excess cancer risks for the Site.

Based on then applicable risk assessment guidance (which included 2002 EPA draft vapor intrusion guidance, now superseded), in the 2014 HHRA the potential effects of exposure to affected soil, groundwater, and sub-slab vapor at the Site were assessed, as appropriate, and unacceptable risk was noted for utility/construction workers potentially exposed to toluene and cis-1,2-DCE in shallow groundwater and to benzene, toluene, TCE, and xylenes in trench air while conducting sub-grade work in the toluene-impacted area. The evaluation of the vapor intrusion exposure pathway in the 2014 HHRA noted an unacceptable risk for facility workers potentially exposed to the hypothetical concentrations of PCE and TCE in indoor air as a result of vapor intrusion into the manufacturing building; however, this conclusion was based on only three sub-slab vapor samples, and additional sampling was deemed necessary to provide a technically sound assessment.

An updated risk characterization was performed in 2015, following the additional sub-slab vapor sampling performed in April 2015. The updated risk characterization not only includes both the April 2014 and April 2015 sub-slab vapor data but also incorporates technical information presented in EPA’s June 2015 “Office of Solid Waste and Emergency Response Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air” (Technical Guide; EPA 2015b). The EPA’s 2015 Technical Guide supersedes and replaces EPA’s previous draft vapor intrusion guidance (EPA 2002), which was used to prepare the 2014 HHRA included in the RI Report. The updated 2015 risk characterization concluded the potential risks posed by the vapor intrusion exposure pathway at the Wix facility are within EPA’s acceptable excess cancer risk range, and no adverse non-cancer health effects are likely associated with potential exposures to chemicals of potential concern (COPCs) in indoor air by vapor intrusion. Therefore, evaluation of the sub-slab vapor data from the 2014 and 2015 investigations indicates the vapor intrusion exposure pathway at the Wix facility does not pose a human health concern.

2.6 Site Remediation

An AS/SVE system was selected by ERM as the remedial technology to remove toluene mass from the release area. ERM completed installation of the system in November 2009 and began operating the AS/SVE system in December 2009. The system configuration consists of five AS wells installed to the top of the fat clay layer (approximately 8 feet bgs) and two horizontal SVE wells installed at a depth of 3.5 feet bgs. Air is injected into the five AS wells to force toluene-containing vapors into the vadose, or unsaturated zone, which are then removed via the SVE wells. The designed radius of influence (ROI) of the AS/SVE system (6,400 square feet [sf]) encompasses monitoring wells MW-1 through MW-4R. The design assumes a vertical treatment zone extending 4.5 feet, from the depth of the SVE wells (3.5 feet bgs) to a maximum depth of the air sparge wells (8 feet bgs). Based on the estimated area and vertical extent of treatment, the ROI is approximately 28,800 cubic feet (1,067 cubic yards [CY]). The AS/SVE system layout is shown on Figure 2-9.

WSP performed an engineering evaluation of the AS/SVE remedial system to determine whether the AS/SVE system is effectively removing toluene mass from the source area. The evaluation included an assessment of the technology's suitability for the site conditions and a review of the system's design and operating capabilities, based on background information provided by ERM. A summary of the findings from this remedial system evaluation is provided in this section, and the full engineering evaluation is provided in the RI Report Addendum (WSP 2015b).

The engineering evaluation concluded the AS/SVE system has low suitability for the site conditions (e.g., soil permeability, depth to groundwater, contaminant concentrations) in the impacted area. The low permeability of the soils (assumed less than 1×10^{-9} square centimeters) and high water table (typically above the depth of the SVE wells) limit the system's ability to capture and treat VOC-containing soil vapors. In addition to the deficiencies in the vertical configuration of the system, the system's horizontal configuration limits its capture of toluene-affected mass to the western portion of the source area. An estimated 22% reduction in toluene mass has occurred within the system's radius of influence since system start-up; however, there was insufficient toluene concentration data from the system to determine if the mass reduction is due to migration, dilution, biodegradation, or AS/SVE system operation. Although the AS/SVE components are appropriately sized for the assumed design conditions, a site inspection performed by WSP in April 2015 identified several deficiencies in system operation, including the short-circuiting of sparged air to the ground surface, submergence of SVE wells, lack of air flow through the system, and malfunctioning equipment.

The evaluation recommended the completion of a FFS to evaluate remedial alternatives, including potential enhancements to the AS/SVE system, for the toluene source area. However, based on the technology's low suitability under the site conditions, enhancements to the system may result in only limited improvements in mass removal capability.

3 Nature and Extent of Impacts

3.1 Chemicals of Potential Concern

VOCs have been identified in site soil, groundwater, and sub-slab vapor samples as COPCs (WSP 2014a and WSP 2015b). The HHRA identified an unacceptable risk for utility/construction workers potentially exposed to toluene and cis-1,2-DCE in shallow groundwater and to benzene, toluene, TCE, and xylenes in trench air while conducting sub-grade work in the toluene-impacted area. The HHRA established that the potential risks posed by the vapor intrusion exposure pathway at the Wix facility are within EPA's acceptable excess cancer risk range, and no adverse non-cancer health effects are likely associated with potential exposures to COPCs in indoor air by vapor intrusion (WSP 2015b).

Toluene is the primary compound detected in site soils and groundwater; although other VOCs are present, their distribution and prevalence is not as extensive as toluene (see Section 2). Soil sampling data indicate the highest concentrations of toluene are present in the vicinity of the bottle fill station (Figure 2-5). Groundwater sampling data define the highest concentrations of toluene to the east and south of the former toluene UST (Figure 2-7).

3.2 Site Conceptual Model

The site conceptual model is described in the RI Report (WSP 2014a) and updated in the RI Report Addendum (WSP 2015b). A summary is provided below.

3.2.1 Occurrence and Potential Migration of Chemicals of Concern

The occurrence and migration of COPCs may be described as follows:

- Historic chemical storage and use during manufacturing activities resulted in a release of toluene to shallow subsurface soils. Routes of migration for toluene at the Site are principally through the infiltration of soil moisture to the saturated zone and then through the flow of groundwater. In the areas of the site where releases have occurred, groundwater flows generally to the west.
- COPCs are present primarily in shallow groundwater, with trace concentrations in deep groundwater. This indicates the vertical extent of toluene-affected groundwater is generally limited to the predominately clayey deposits occurring to a depth of less than 25 feet.
- Evaluation of the analytical results for soil and groundwater samples collected from the release area indicates toluene concentrations are suggestive of the presence of non-aqueous phase liquid in the shallow subsurface.
- Affected soil and groundwater does not extend beyond the property boundary.

3.2.2 Groundwater Use

As discussed in the RI Report (WSP 2014a), a public water supply well (PWS-1) owned and operated by Trico Water Company is present to the west of the Site (Figure 3-1). Based on information in the SCDNR database, this well is screened at a depth greater than 150 feet bgs. No other public water-supply wells or residential wells were definitively identified in the 0.25-mile search area east of the Site or the 0.50-mile area to the west. Discussions with SCDHEC and facility personnel indicated a private well has been installed on the residential property at 1433 Wix Road (tax parcel number 049-00-00-117), immediately south of the facility (Figure 3-1). However, the presence of this well could not be verified during the field reconnaissance, and communication with the public utilities indicated the residence is obtaining potable water from Trico Water (Arnette 2014).

Based on information obtained during the well survey, neither Trico Water nor the City of Dillon provides water to the residential property at 620 Scottland Road (tax parcel number 048-00-00-016; Figure 3-1). In addition, no water meter was observed along the road right-of-way fronting the property.

3.2.3 Exposure Pathways

The presence of COPCs in site media could result in the following exposure pathways:

- Vapor intrusion to site buildings – 2014 and 2015 sub-slab vapor results indicate that the potential risks posed by the vapor intrusion exposure pathway are within EPA's acceptable excess cancer risk range, and no adverse non-cancer health effects are likely associated with potential exposures to COPCs in indoor air by vapor intrusion (based on EPAs EPA's June 2015 "Office of Solid Waste and Emergency Response Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air" (Technical Guide; EPA 2015b)). Therefore, evaluation of the RI sub-slab vapor data indicates the vapor intrusion exposure pathway at the Wix facility does not pose a human health concern. Future construction of additional buildings on the property is not reasonably anticipated.
- Vapor intrusion to offsite buildings on neighboring properties is not a complete exposure pathway as affected soil and groundwater do not extend beyond property limits. Affected subsurface soil is capped by surface soils, asphalt, and concrete cover. Trenching for utility/construction work is not anticipated under normal circumstances in the affected area; however, exposure to affected soils by utility/construction workers will be considered as a potential future exposure pathway.
- Groundwater is not used and is not planned to be used at the site. As a result, groundwater use is not a current or future exposure pathway for the subject property, assuming implementation of the appropriate activity and use limitations.

3.2.4 Receptors

The facility is a light manufacturing facility and is located in a mixed industrial, agricultural, and residential area. The Site is zoned "ID-1-Light Industrial District Uses" (Jones 2014). Some of the permitted uses under ID-1 are manufacturing, utilities, transportation and warehousing, and crop and animal production. Residential use is not permitted in an ID-1 zoning district. The anticipated future use of the facility is non-residential (e.g., light industrial), and the surrounding area will likely remain a mixture of industrial, agricultural, and residential uses. Activity and use limitations will be implemented to ensure that the property is not used for residential purposes, or other uses involving the frequent presence of children (e.g., school or daycare), where significant risks could result.

Manufacturing operations at the Site are conducted 24 hours a day, 5 to 7 days a week, with the number of work days per week dependent on product demand. Based on information obtained during a 2012 site visit, 350 full-time and 120 temporary workers were employed at the facility. A metal chain-link security fence surrounds the portions of the facility where manufacturing activities are conducted, and limits the opportunities for trespassing by unauthorized individuals. In addition, vehicle access to the manufacturing building area is only possible through locked gates.

The potential current human receptors at the Site are construction and utility workers performing short-term intrusive activities (e.g., digging/trenching) in the impacted area at the Site. A trespasser is not considered a likely potential receptor because of current Site controls to affected areas of the Site.

Given that the Site will likely remain light industrial in the future, the potential future human receptors are facility workers and construction and utility workers. Future trespassers were not considered future receptors because their exposures would be less than the facility worker, who would have a longer exposure duration and greater exposure frequency.

3.3 Volume of Media

3.3.1 Soil

The volume of affected soil is defined by the horizontal and vertical limits of toluene above the MCL-based SSL in soil (0.69 mg/kg). The horizontal extent of toluene-containing soil above the MCL-based SSL is estimated at 22,000 sf (Figure 3-2). Based on the investigations summarized in Section 2.4.2, the limits of impacted soil, including saturated material, extend from a depth of 2 feet bgs to a maximum depth of 8 feet bgs in some areas. Therefore, the vertical extent of affected soil averages approximately 6 feet. The vertical extent extends from the vadose zone into the uppermost portion of the saturated zone. This represents approximately 132,000 cubic feet, or 4,900 CY of soil. Assuming a soil density of 1.7 tons per CY, the mass of soil requiring remediation is estimated at 8,300 tons.

3.3.2 Groundwater

The volume of affected groundwater is defined by the horizontal and vertical limits of toluene above the SCMCL (1,000 μg/l) in groundwater. The horizontal extent of affected groundwater is estimated to be 42,800 sf (Figure 3-3). As stated in Section 2.4.3, the vertical extent of toluene-affected groundwater extends from the depth to groundwater (approximately 3 feet bgs) to the predominately clayey deposits occurring to a depth of less than 25 feet bgs. Therefore, vertical extent of affected groundwater averages approximately 22 feet. Assuming a specific yield of 20%, this represents a volume of toluene-affected groundwater of approximately 1,408,634 gallons.

4 Identification of ARARs and Remedial Action Objectives

4.1 Identification of ARARs

Applicable or relevant and appropriate requirements (ARARs) are used to determine the appropriate extent of site cleanup, to scope and formulate the remedial action alternatives, and to govern the implementation and operation of the selected action. Applicable requirements are those legally enforceable cleanup standards, standards of control, and other substantive requirements promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, or other circumstance found at a site. Relevant and appropriate requirements are federal or state standards, criteria, or limitations that while not legally applicable to a site, address problems sufficiently similar to those found so that their use is well-suited to the particular site. There are three major types of ARARs: chemical-specific, location-specific, and action-specific. A short description of each is provided below:

- Chemical-Specific: Set health or risk-based concentration limits or ranges for various environmental media for specific substances. The requirements provide protective site cleanup levels or a basis for the calculation of cleanup levels. They are also used to indicate an acceptable level of discharge, to determine treatment and disposal requirements, and to assess the effectiveness of the remedy.
- Location-Specific: Restrictions placed on the type of activities to be conducted based upon site-specific characteristics or the site's location. The local characteristics of the site must be evaluated with regard to potential adverse effects that remedial alternatives may have on existing features (e.g., wetlands, floodplains, historically significant features). These ARARs provide a basis for assessing restrictions during the formulation and evaluation of potential site-specific remedies.
- Action-Specific: Triggered by particular activities that are selected to accomplish the remedy; they govern the design, construction, and operation of remedial actions. They provide a basis for assessing the implementability and effectiveness of the potential remedial alternatives.

In addition, remedial activities may address environmental policies or guidance that are not ARARs, but should be considered during the development of the RAOs, remedial goals, and remedial action alternatives.

Federal and South Carolina laws and regulations were reviewed to identify potential ARARs for the site. These regulations and guidelines are summarized in Table 4-1.

4.2 Remedial Action Objectives

The following RAOs are developed to protect human health and the environment:

- Reduce toluene concentrations in source area soils to minimize potential migration to shallow groundwater.
- Mitigate human health risks from the potential exposure of affected media at the site.
- Demonstration of statistically significant decreasing trends in toluene groundwater concentrations indicating the SCMCL will be met within a reasonable timeframe.

The area requiring remediation is generally limited to the area west of the facility, as shown on Figures 3-2 and 3-3. Remediation of this area would eliminate most of the toluene mass and thereby reduce impacts to shallow groundwater. Although all affected groundwater and soil would not be addressed by active remediation, institutional controls will be implemented for those areas that may result in potential unacceptable risks to human health.

5 Identification and Screening of Remediation Technologies

5.1 Identification of Technologies and Process Options

After identifying applicable general remedial actions, potentially applicable technologies and process options are identified based on the media, nature of the chemicals at the site, current site conditions and physical features. The identification process involves listing remedial technologies that could be associated with the general remedial actions. For each remedial technology identified, process options are subsequently identified. Table 5-1 lists the response actions, technologies, and process options being considered for the Site.

5.2 Initial Screening of Identified Technologies and Process Options

An initial screening of identified technologies and process option was performed to provide a concise list of technologies/process options to be utilized in developing the potential remedial alternatives. This section summarizes the detailed screening of identified technologies and process options based on their potential stand-alone application to independently address VOCs in soil and groundwater.

WSP qualitatively evaluated the following criteria for each remedial technology/process option and assigned a rank of low, moderate, or high for each criterion:

- Effectiveness: Interpretation of identified risk, achievement of RAOs, and potential for significant reduction of toxicity, mobility, or volume of the Site-related COPCs.
- Technical Implementability: Applicability of technology to the Site with full consideration of topographic, geologic, and hydrogeologic constraints.
- Administrative Implementability: Applicability of the technology to the Site with full consideration of legal and public constraints. Technologies that cannot be implemented at the site because of an overriding administrative issue were removed from further consideration.
- Cost: The costs of construction and long-term costs to operate and maintain the alternatives were considered. Costs that are grossly excessive compared to the overall effectiveness of the alternative are also considered.

Table 5-1 presents a summary of the initial screening. The process options that are not considered for additional evaluation beyond the initial screening described in Section 5.2 are shaded in the table and an explanation for their rejection is provided. In certain instances, a technology/process option that would have otherwise been eliminated because of its inability to act as a stand-alone technology/process option was retained because of its potential application in conjunction with other remedial technologies. (For example, engineering/institutional controls were retained because of their potential application with other technologies/process options). Technologies and process options passing the initial screening and retained for further evaluation in the development of remedial alternatives are presented in Section 5.3.

The evaluation and assigned ranking for each technology/process option are relative to other technologies/process options that achieve the same RAOs.

5.2.1 No Action

The “No-Action” alternative is considered as a baseline for comparisons with other alternatives proposed in the FFS. The No-Action remedial alternative would not include any remedial measures to address the soil and groundwater contamination at the site. Therefore, the cost of this technology is low, and the technical and administrative implementability is high, but the effectiveness of achieving the RAOs is also low.

The No Action response action was not retained for further evaluation based on its ineffectiveness to achieve the RAOs for the Site.

5.2.2 Institutional Controls/Engineering Controls

Institutional controls include actions such as deed restrictions and management procedures that would prevent human exposure to contaminants by controlling the property's use, communicate and plan for potential exposures to impacted media, and restricting access. An example of a deed restriction would be to prohibit residential development of the Site under recorded restrictive covenants filed at the Dillon County Register of Deeds. The restrictive covenants would also state that the groundwater contains VOCs, and that onsite water supply wells would not be permitted. Some extent of construction-related activities for industrial purposes normally would be allowed on the deed-restricted property, although the exact extent of the permitted industrial development is dependent on the final restrictive covenant language agreed to by SCDHEC. Institutional controls of this sort are potentially applicable to the site.

Examples of engineering controls include use of the public water supply rather than onsite wells, placement of a cap/cover to prevent potential contact with contaminated media, and installation of a vapor intrusion mitigation system for buildings in the affected area. Water is currently supplied to the facility by the city of Dillon, and site data show that a vapor mitigation system is not required for the existing building.

Institutional and engineering controls do not reduce the volume, toxicity, or mobility of VOCs. Therefore, institutional and engineering controls generally have a moderate degree of effectiveness, unless used in concert with other technologies. However, certain exposure pathways may be controlled or eliminated through institutional and engineering controls. The implementability of institutional and engineering controls is high. The cost of institutional and engineering controls is low.

Although not retained as an independent option due to inability to meet the RAOs, institutional and engineering controls were retained in conjunction with other remedial alternative because of effectiveness at eliminating exposure pathways.

5.2.3 Excavation

Excavation is a physical treatment to remove affected soil for offsite disposal at a permitted disposal facility. The vertical and horizontal limits of excavation would target affected soils to the extent practical in the source area. Unaffected soils excavated from depths above affected soils would be stockpiled for reuse as backfill or managed for offsite disposal, while affected soils would be transported offsite for treatment and disposal. The excavation would be backfilled with the stockpiled soil or offsite material (e.g., borrow fill, gravel). As the vertical limit of affected material exceeds the depth to groundwater (3 feet bgs), dewatering may be implemented to maximize the practical extent of removal. This technology would be highly effective at mass removal and attaining the RAOs. Resources required to implement the work are available (e.g., excavation equipment and operators, hazardous and non-hazardous waste transportation and disposal personnel, vehicles, and facilities). Waste transportation and disposal facilities including Clean Harbors and US Ecology Inc. have the operators, transportation vehicles, and disposal facilities to manage hazardous and non-hazardous waste in accordance with federal, state, and local regulations. However, implementation of full source area excavation would be technically challenging due to utility and structural conflicts throughout the affected area, as well as administratively difficult due to the necessary interruption of manufacturing operations caused by disturbance along this main access driveway at the facility. Also, the cost to implement full source excavation would be very high, due to the disposal of soil as a potential hazardous waste. Although full source excavation was not retained as an independent option due to these implementation challenges and high costs, excavation was retained as part of a combined remedial approach to provide "hot spot" mass removal in advance of a polishing remedial technology, e.g., Aggressive Fluid Vapor Recovery (AFVR), bioremediation, or monitored natural attenuation, for residual mass removal.

5.2.4 AFVR

AFVR is a physical treatment using a high-pressure vacuum truck or trailer-mounted mobile system to extract groundwater and vapors from an extraction and/or monitoring well(s). During occasional extraction events (typically 8 to 24 hours) the vacuum unit would continuously provide a minimum air flow of 250 cubic feet per minute and a minimum vacuum of 25 inches of mercury at the vacuum pump intake. The extracted vapors are treated onsite using a catalytic converter on the vacuum truck or trailer prior to venting to the atmosphere, while the extracted fluid is managed within a tank (e.g., vacuum truck, frac tank) and transported offsite for disposal. The implementability would be technically challenging if applied at the existing 2-inch diameter monitoring wells, but practical if applied at a new 4-inch diameter extraction well. Availability of resources for implementation is high, including AFVR equipment and equipment operators, and waste transportation and disposal equipment, personnel, and facilities. Costs are anticipated to be moderate to high, depending on the volume of extracted groundwater generated for off-site transportation and disposal as a hazardous waste. The current site conditions (low soil permeability) are expected to limit its effectiveness. Therefore, this technology was not retained as an independent option. However, the technology was retained as a collaborative option with one or more other technologies.

5.2.5 Modified AS/SVE

AS/SVE is an *in situ* treatment method that consists of injecting air into the groundwater through drilled wells or driven points; as the VOCs in groundwater partition into the injected air, the VOC-laden air rises to the vadose zone where it is removed by the SVE system. This process has been in operation at the Site since December 2009. As summarized in Section 2.6 of this report and in the RI Report Addendum (WSP 2015b), AS/SVE has not been effective at achieving the RAOs. However, a modified AS/SVE system (i.e., conversion to a dual phase extraction [DPE] system), or a combined remedial alternative including AS/SVE (i.e., excavation of low permeable native soils followed by AS/SVE operations in a permeable backfill) may improve the toluene mass removal, thereby improving the potential to meet RAOs. The DPE modification would include groundwater extraction to lower the water table and improve vapor removal through the existing AS/SVE system. Implementability is high as it would use a previously implemented technology. Long-term O&M costs and energy consumption are financial and environmental considerations. Although the existing AS/SVE system was not retained for further evaluation due to the deficiencies identified in the 2015 evaluation, a modified AS/SVE system was retained for further evaluation, as an independent option and a collaborative option with one or more other technologies.

5.2.6 *In Situ* Chemical Oxidation

In situ chemical oxidation is a groundwater treatment technology that consists of injecting an oxidizer and potentially a catalyst into the groundwater through drilled wells or driven points. Organic compounds are oxidized, typically generating carbon dioxide and water, thus transforming hazardous constituents into non-hazardous inert compounds.

The saturated soils at the site have low permeability, and amendment delivery to less permeable affected areas is accomplished by diffusion. The shallow groundwater depth (3 feet bgs) also would increase the potential for short-circuiting of amendment fluids. Diffusion throughout the affected volume may take years to occur. The life-span of chemical oxidants capable of degrading site chemicals of concern (e.g., sodium persulfate) is limited to a few months, which is not likely adequate for diffusion of an oxidant to less permeable areas.

This process option has not been retained for detailed analysis because the low soil permeability at the site would inhibit effective delivery of the oxidizer into the subsurface, and the life span of the chemical oxidants is insufficient to completely oxidize the VOCs within the plume.

5.2.7 Bioremediation

Bioremediation is a groundwater technology that manipulates subsurface conditions (physical, chemical, biochemical, or microbiological) to enhance the microbial degradation of contaminants. The microorganisms break down VOCs by catabolic, metabolic, or cometabolic processes. Biostimulation involves the application of amendments containing micronutrients (e.g., nitrogen and phosphorus) and macronutrients (e.g., fermentable organic electron donors and electron acceptors such as oxygen and sulfate) via drilled wells or driven points to stimulate naturally occurring or introduced microbes to attenuate VOCs. Bioaugmentation is often completed in conjunction with biostimulation and involves introducing microbes that are known to degrade the chemicals of interest. Bioremediation typically generates carbon dioxide and water as end products, thus transforming hazardous constituents into non-hazardous inert compounds. Bioremediation can be applied broadly in a grid pattern to treat targeted areas or in treatment barrier configurations.

Similar to the application of *in situ* oxidation discussed above, biostimulant or bioaugmentation fluid delivery will be limited at the site due to the presence of low permeability soils and shallow groundwater table. Bioremediation has been not been retained as an independent option due to fluid delivery concerns, but was retained as a polishing remedial technology following excavation.

5.2.8 Monitored Natural Attenuation

Monitored natural attenuation (MNA) is recognized as a viable method of remediating many dissolved chemicals in groundwater that can be evaluated and compared to other methods of achieving site remediation as a part of the remedy selection process. Natural attenuation refers to the reliance on natural processes (within the context of a carefully evaluated and monitored site cleanup approach) to achieve site-specific remedial objectives within a time frame that is reasonable compared to that offered by other more active remediation methods. The natural attenuation processes include a variety of physical, chemical, or biological processes that, under favorable conditions, act to reduce the mass, toxicity, mobility, volume or concentration of constituents in soil or groundwater. These *in situ* processes include biodegradation; dispersion; dilution; sorption; volatilization; and chemical or biological stabilization, transformation, or destruction of contaminants.

Natural attenuation processes are typically occurring at all sites, but at varying rates and to varying degrees of effectiveness depending on the types and concentrations of constituents present and the physical, chemical, and biological characteristics of the soil and groundwater. Natural attenuation processes may reduce the potential risk posed by site contaminants in three ways:

- The constituents may be converted to a less toxic form through destructive processes such as biodegradation or abiotic transformation.
- Potential exposure levels may be reduced by lowering of concentration levels (through destructive processes, or by dilution or dispersion).
- Constituent mobility and bioavailability may be reduced by sorption to the soil or rock matrix.

Where conditions are favorable, natural attenuation processes may reduce contaminant mass or concentration at sufficiently rapid rates to be intergraded into a site’s soil or groundwater remedy. Following source control or removal measures, natural attenuation may be sufficiently effective to achieve remediation objectives at some sites without the aid of other (active) remedial measures. The natural flux of electron acceptors, such as dissolved oxygen, at the site is not sufficient to drive natural biodegradation of the high source area concentrations at the site. MNA was not retained as an independent remedial option, but was retained as a polishing remedial technology following active remediation or as a secondary remedial technology for areas outside the active remediation treatment area.

5.2.9 Combined Remedial Alternatives

The combined remedial alternatives would use two or more complimentary technologies to meet the RAOs. Two types of combined technologies were evaluated for this site:

- Excavation of soils with toluene concentrations above the C_{sat} near MW-4R followed by biosparging for residual mass reduction and MNA.
- Excavation of soils with toluene concentrations above the C_{sat} concentration near MW-4R followed by AFVR and MNA.

The C_{sat} was selected as an action level for excavation based on the correlation of soil concentrations above this concentration with the highest concentrations of toluene in groundwater. Although one soil sample from MW-12 contained toluene concentrations above the C_{sat}, other soil samples collected from the MW-12 area were well below C_{sat}. Additionally, groundwater concentrations at MW-12 have been measured at or below the SCMCL in recent monitoring events. Therefore, soil excavation of the MW-12 area is not included. Removal of the hot spot near MW-4R to the extent practical will accelerate the achievement of RAOs through the use of the polishing remedial technologies included in these combined remedial alternatives.

5.2.9.1 Soil Excavation with Biosparge and MNA

This combined technology would begin with “hot spot” excavation and offsite disposal of soils containing toluene concentrations above the C_{sat} near MW-4R. The excavated area would be backfilled with gravel (in lieu of native or borrow soil) to create a highly permeable treatment zone for groundwater containing residual toluene concentrations. A biosparge system, which combines bioremediation with AS/SVE, would be installed within the gravel backfill. The biosparge system would inject both air (and the limiting macronutrient oxygen contained therein) and micronutrients into the saturated backfill, and toluene-laden air will be collected by horizontal well screens placed in the unsaturated backfill. The nutrients would stimulate the indigenous toluene-oxidizing microorganisms and migrate with groundwater flow to areas beyond the biosparge system. The biosparge system would increase the footprint of active remediation. MNA would also be performed to monitor the physical, chemical, or biological reduction of residual toluene mass at the site.

This combined alternative would reduce the mass, toxicity, mobility, and concentrations of toluene through physical, chemical, and biological processes, and is technically and economically feasible to implement under the Site conditions. Although long-term O&M costs and energy consumption are financial and environmental considerations, capital cost for biosparge system operations may be reduced by reusing the functional components of the existing AS/SVE system. This combined technology can meet the RAOs, and was retained for further evaluation.

5.2.9.2 Soil Excavation with AFVR and MNA

This combined technology would begin with “hot spot” excavation of soil containing toluene concentrations above the C_{sat} near MW-4R, as described in the above combined technology. The saturated interval of the excavation (2 feet bgs to 5 feet bgs) would be backfilled with gravel to create a highly permeable groundwater flow zone; stockpiled overburden native soil or burrow soil would be used to backfill the remainder of the excavation area (0 to 2 feet bgs). A 4-inch diameter extraction well would installed within the gravel backfill for AFVR application. The AFVR technology would provide supplemental removal of toluene mass from extracted vapors and groundwater. Following the mass removal via excavation and AFVR, MNA would be implemented to monitor the physical, chemical, or biological reduction of toluene at the site. With the majority of the toluene mass removed, natural flux of limiting macro and micro-nutrients will have a more pronounced effect on attenuating the more diffuse areas of the plume. This combined technology reduces the mass, toxicity, mobility, and concentrations of VOCs. The alternative is technically feasible to implement, with resources available. The technology can meet the RAOs at a moderate cost; therefore, it was retained for further evaluation.

5.3 Technologies and Process Options Passing Initial Screening

As shown on Table 5-1 and described above, the technologies retained for further evaluation include modified AS/SVE system and the combined remedial alternatives: excavation of soils above the C_{sat} combined with biosparging and MNA, and excavation of soils with toluene concentrations above the C_{sat} followed by AFVR and MNA.

Institutional/engineering controls such as restrictions and requirements for construction-related activities in the affected area, and a deed restriction to prevent future groundwater use, can be easily implemented in combination with these technologies.

5.4 Development and Detailed Description of Remedial Alternatives

The technologies and process options that were retained in Section 5.3 represent either complementary or standalone measures, which may address one or more of the RAOs. This section assembles the candidate technologies and process options into remedial alternatives to achieve the RAOs.

The names assigned to the alternatives are intended to convey the major components included within each that distinguish them from one another; however, the names do not convey all components included in each alternative (for example, institutional/engineering controls are a component of all retained alternatives). The following sections provide a detailed description of all actions that are proposed under each alternative. Technical details included in the following descriptions are intended for the purposes of cost estimates associated with the typical accuracy of a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) compliant feasibility study (i.e. minus 30% to plus 50%). Detailed cost estimates for each alternative are presented in Appendix B.

All three retained alternatives include:

- The addition of institutional controls, including restrictive covenants, and the prevention of the installation of any onsite water supply wells.

- Long-term groundwater monitoring, with the monitoring frequency, duration, and location to be determined during remedial action planning.

For the purposes of this FFS, the disposal costs for all alternatives assume any waste derived from the source area soil or groundwater containing detectable levels of toluene, including but not limited to affected soil below 2 feet bgs (e.g., excavation, well installation, sampling), purged (untreated) groundwater, and remediation process derived waste (e.g., spent carbon), are a listed hazardous waste. The costs assume soils above 2 feet bgs are unaffected by the toluene release and therefore may be managed for onsite reuse (e.g., backfill) or non-hazardous waste.

5.4.1 Alternative 1 – Modified AS/SVE

The Modified AS/SVE alternative includes modifying the existing AS/SVE system for improved VOC removal. The alternative includes the following:

- Replacement of malfunctioning AS/SVE system equipment, as identified in the AS/SVE system evaluation provided in the RI Report Addendum (WSP 2015b).
- Installation of groundwater extraction equipment (e.g., extraction wells, submersible pumps, water conveyance and air supply piping) to enhance SVE operations by dewatering the area.
- Installation of groundwater treatment equipment (e.g., settling tank, activated carbon) to treat extracted water prior to discharge and construction/delivery of treatment trailer to house water treatment equipment.
- Groundwater monitoring and reporting.

Alternative 1 includes converting the existing AS/SVE system into a DPE system by installing submersible pumps, additional conveyance piping, and water treatment equipment. Groundwater would be collected in the wells and pumped back to treatment equipment in a new, water-phase treatment trailer. The extracted groundwater would be passed through filters to remove fines, amended with a sequestering agent to prevent precipitation and scaling, and passed through liquid phase carbon filters for VOC removal to meet effluent discharge limits; treated groundwater would be discharge to a permitted discharge point (e.g., surface water or publicly-owned treatment works [POTW]). Using the AS/SVE system vapor phase treatment equipment in the existing vapor-phase treatment trailer, the toluene-laden air will be treated through vapor phase carbon filters and then discharged to the atmosphere.

The cost estimate for Alternative 1 is presented in Table B-1 assumes filing the deed restriction for the institutional controls, aquifer testing to determine well yield, design and installation of the modified AS/SVE system, routine O&M activities, and system performance evaluation and reporting.

5.4.2 Alternative 2 – Excavation with Biosparging and MNA

Alternative 2 is a combined technology with excavation of soils above the C_{sat}, biosparging, and MNA. This includes:

- Excavation of soils with toluene concentrations above C_{sat} surrounding MW-4R.
- Backfill of the excavation areas with more permeable gravel.
- Installation of a biosparge system for air and nutrient injection into the saturated zone within the gravel beds, followed by capture of toluene-laden air via SVE system.
- Replacement of malfunctioning AS/SVE system equipment to be incorporated into the biosparge system, as identified in the AS/SVE system evaluation provided in the RI Report Addendum (WSP 2015b).
- Treatment of the captured toluene-laden air with the existing AS/SVE system treatment equipment.
- MNA to include groundwater sampling and reporting.

Alternative 2 includes excavation of soils with toluene concentrations above C_{sat}, backfilling the excavation areas with gravel for higher permeability, and installing a biosparge system in the lower portion of the gravel beds for air and nutrient injection into the saturated zone. The toluene-laden air would be captured by SVE wells within the upper portion of the gravel bed for treatment through the existing AS/SVE system treatment equipment. MNA would be implemented to monitor the natural attenuation of toluene in groundwater.

The cost estimate for Alternative 2 is presented in Table B-2 and includes filing the deed restriction for the institutional controls, pre-design testing for selecting the most suitable nutrient for biosparging, design and installation of the combined technology, semi-annual groundwater monitoring for MNA, and annual monitoring reports. Semi-annual groundwater monitoring of eight selected monitoring wells would be included to monitor the effects on the groundwater plume.

5.4.3 Alternative 3 – Soil Excavation with AFVR and MNA

Alternative 3 is a combined technology with excavation of soils above the C_{sat} near MW-4R followed by AFVR and MNA. This includes:

- Excavation of soils with toluene concentrations above C_{sat} near MW-4R.
- Backfill of the excavation area with permeable gravel from the base of excavation to 2 feet bgs, then backfill with native soil (excavated above 2 feet bgs) and borrow soil to the ground surface.
- Installation of a 4-inch diameter extraction well for the recovery of water and vapor in the excavation area.
- Completion of an AFVR pilot test at the extraction well in the excavation area.
- MNA to include groundwater sampling and reporting.

Alternative 3 includes excavation of soils with toluene concentrations above C_{sat}, then backfilling the excavation area with a more permeable gravel. The AFVR pilot test would provide information on the supplemental removal of toluene in soil vapor and groundwater. The effectiveness of the AFVR pilot application would be evaluated from the test data and subsequent groundwater monitoring program to determine if an additional AFVR application(s) is warranted. The natural attenuation of residual toluene at the site following these recovery events would be assessed through the monitoring program.

The cost estimate for Alternative 3 is presented in Table B-3 assumes filing the deed restriction for the institutional controls, pre-design testing and data evaluation for the natural attenuation parameters, design of the combined technology, and annual natural attenuation monitoring report. Semi-annual groundwater monitoring of eight selected monitoring wells would be included to monitor the effects on the groundwater plume.

6 Detailed Analysis of Alternatives

Nine evaluation criteria, as presented in the preamble of the National Contingency Plan (NCP), are used to perform the detailed analysis of alternatives. This analysis consists of the evaluation and presentation of information for each alternative that is relevant to the selection of the Site remedy. An overall comparison of the alternatives based on the nine evaluation criteria is presented in this section and in Table 6-1.

6.1 Criteria Definitions

The detailed evaluation process used in this FFS conforms to the EPA (1988) "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA - Interim Final." Nine evaluation criteria are presented in this guidance to address the statutory considerations of CERCLA:

- Overall protection of human health and the environment
- Compliance with ARARs
- Short-term effectiveness
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, and volume of contaminants
- Implementability
- Cost
- State acceptance
- Community acceptance

Assessment of the first two criteria, overall protection of human health and the environment and compliance with ARARs, relate directly to statutory requirements that must be satisfied. The next five criteria represent the technical criteria upon which the comparative screening or evaluation is based. The remaining criteria, state and community acceptance of the preferred alternative, are modifying criteria that will be informed by SCDHEC review and public participation.

6.1.1 Overall Protection of Human Health and the Environment

This criterion addresses how each alternative provides adequate protection and describes how the risks through each exposure pathway are eliminated, reduced, or controlled through treatment, engineering, or institutional controls. This analysis includes an assessment of long- and short-term effectiveness and compliance with any health-based cleanup requirements consistent with ARARs.

6.1.2 Compliance with ARARs

Section 121(d) of the Superfund Amendments and Reauthorization Act (SARA) and the NCP require that CERCLA remedial actions comply with all federal ARARs. State requirements must also be attained under Section 121(d)(2)(c) of SARA, if they are legally enforceable and consistently enforced statewide. ARARs are used to determine the appropriate extent of site cleanup, to scope and formulate remedial action alternatives, and to govern the implementation and operation of the selected action. A summary of potential ARARs is presented in Table 4-1. Further refinement of the list of ARARs may be necessary following the selection of an alternative groundwater remedy for the Site.

6.1.3 Short-Term Effectiveness

This criterion addresses the effects of each alternative during the implementation phase until the RAOs have been attained. The following are addressed for each remedial alternative:

- Potential Impacts on the Community During Remedial Action Implementation addresses risks resulting from the implementation of the remedial action.
- Potential Impacts on Workers During Remedial Action addresses threats that might be posed to workers during the implementation of a remedial action, as well as the effectiveness and reliability of protective measures that could be taken on site to mitigate those threats.
- Potential Environmental Impacts addresses the potential adverse effects on the environment resulting from the implementation of the alternative and the effectiveness and reliability of measures that may be taken to mitigate the adverse effects.
- Time Until Remedial Objectives are Achieved is based on an estimate of the time required to achieve RAOs onsite.

6.1.4 Long-Term Effectiveness and Permanence

This criterion addresses the extent of residual risk remaining at the Site after the RAOs have been met. The following are addressed by this criterion:

- Magnitude of Total Residual Risk assesses the long-term risk associated with exposure to residual contamination.
- Adequacy and Reliability of Controls assesses the adequacy and suitability of controls for any wastes or hazardous substances that will remain onsite. It includes an assessment of the type and degree of long-term management, monitoring, and operation and maintenance functions that must be performed to preserve long-term integrity of the remedial alternative.

6.1.5 Reduction of Toxicity, Mobility, and Volume through Treatment

This criterion addresses the preference stated in CERCLA Section 121 that remedial alternatives be selected that employ technologies that permanently and significantly reduce the toxicity, mobility, or volume of site-related constituents through treatment. This preference is to reduce the risks at a site through reduction in contaminant mobility, destruction of toxic contaminants, reduction of the total mass of contaminants, or reduction of total volume of contaminated media.

6.1.6 Implementability

The implementability criterion addresses the technical and administrative feasibility of each alternative. The availability of services and materials required for implementation of an alternative are key components to this evaluation. The following are appropriate criteria:

- Technical Feasibility - Difficulties in construction and operation, reliability, and unknowns associated with the remedial technologies in each alternative.
- Administrative Feasibility - Agency activity required for the implementation of the alternative.
- Availability of Services and Materials - Availability of adequate offsite treatment, storage capacity, and disposal capacity and services; the availability of necessary equipment and specialists, and provisions to ensure any necessary additional resources; the availability of services and materials; and availability of prospective technologies.

As stated in Section 5.4, soil below 2 feet bgs, untreated groundwater, and remediation process derived waste (e.g., spent carbon) are assumed to be classified as listed hazardous wastes. It is assumed that all three retained alternatives will generate hazardous waste streams through active remediation and groundwater monitoring activities. The availability of services and materials criterion for hazardous waste includes an assessment of the availability of 1) equipment and specialists for the management, transportation, and disposal of hazardous waste (e.g., equipment operators and waste transporters); 2) vehicles for the transportation of waste from the site to the disposal facility; and 3) hazardous waste disposal facilities willingness to accept the waste and provide adequate treatment, storage capacity, and disposal capacity and services. Hazardous waste management, transportation, and disposal companies (including Clean Harbors and US Ecology, Inc.) would be available to manage both small and bulk quantities of the hazardous waste anticipated to be generated at the Site in accordance with federal, state, and local regulations.

6.1.7 Cost

The application of cost estimates to alternative evaluation is addressed by the following factors:

- Capital - The direct and indirect capital costs associated with each remedial alternative. Direct capital costs include construction, equipment, land and site development, buildings and services, and waste disposal costs. Indirect capital costs include engineering expenses, legal fees, license or permit costs, start-up costs, and contingency allowances.
- O&M - O&M costs are post-construction costs necessary to maintain the effectiveness of a remedial action in the future. These costs include maintenance materials and labor costs, operating labor costs, energy, disposal of residues, insurance, taxes, costs of periodic site reviews, and licensing.
- Present Worth - Present worth analysis discounts future expenditures for each remedial alternative to a common base year. The net present worth (NPW) of an alternative is a combination of initial capital costs and the discounted value of O&M costs over the life of the remedy.

Table 6-1 presents summaries of the capital, annual O&M, total non-discounted cost, and NPW estimates for the alternatives carried forth for further evaluation. Detailed cost tables are included in Appendix B. Unit prices for materials, equipment, and labor were selected from various sources, including published cost books, product vendors, construction companies, and project-specific experience. The costs developed for this analysis are planning-level estimates and may vary from minus 30 to plus 50% in accordance with EPA guidance.

Two present worth costs for each alternative were calculated using two different discount rates. In accordance with EPA guidance for sites lead by a private party, a 7% discount rate (before taxes and after inflation) over a maximum of 30 years was used (EPA 2000). In addition, WSP calculated a separate present worth cost using a discount rate of 1.9% to reflect the current economic conditions and historically lower interest rates. This discount rate is quoted in the Office of Management and Budget (OMB) Circular No. A-94 for 2014 (OMB 2014). EPA guidance recommends using this annually adjusted rate for federal-lead sites (EPA 2000).

6.2 Detailed Evaluation Summary

Each of the remedial alternatives has been evaluated with respect to the criteria presented in Section 6.1. This analysis is intended to allow selection of the most appropriate remedial alternative for the site.

6.2.1 Alternative 1 – Modified AS/SVE

The Modified AS/SVE alternative includes modifying the AS/SVE system into a DPE system for groundwater and vapor treatment in the source area. The existing sparge wells will be modified into DPE wells, or new extraction wells will be installed for lowering the water table. New water and air supply conveyance piping will be installed to operate the water recovery component of the system. Vapor extraction and treatment will use the existing AS/SVE system. The groundwater will be treated through a new groundwater treatment system and discharged to a permitted discharge point (e.g., surface water or POTW). Because the alternative does not initially remove the most contaminated soil by excavation, a 15- to 20-year life has been assumed for cost purposes.

6.2.1.1 Overall Protection of Human Health and the Environment

Alternative 1 provides human health and environmental protection through active treatment and restoration of the impacted groundwater and soil. However, operation of the AS/SVE system consumes energy and generates waste throughout the projected 15- to 20-year life, thereby impacting the environment.

6.2.1.2 Compliance with ARARs

Chemical-specific ARARs identified for groundwater for this site are the SCMCLs. Toluene concentrations will decrease over time within the capture zone of the Modified AS/SVE system and may approach or achieve SCMCLs in some locations, although achievement of SCMCLs throughout the affected area is uncertain. ARARs are expected to be achieved in areas not managed using institutional and engineering controls where future groundwater use could hypothetically occur, because of the source control.

Excavated soils (from trenching for conveyance pipe installation), purged groundwater (from sampling activities), and spent carbon (from treatment system) are the predominant wastes to be generated through this alternative. Location-specific ARARs are the regulations pertaining to the potential disturbance of the wetlands located west of the targeted excavation area. Potential impacts to the wetlands will be minimized through implementation of engineering controls, such as erosion and sediment controls, in accordance with federal and state regulations.

Potential action-specific ARARs related to this alternative are associated with storm water discharges during construction, discharge of treated water to surface water or the POTW, and discharges of air streams from treatment systems (Table 4-1). Sedimentation and erosion controls, treatment and monitoring of discharges, and emission controls would be implemented as warranted by the relevant regulations and guidance.

6.2.1.3 Short-Term Effectiveness

The short-term effectiveness of Alternative 1 is as noted:

- There are no impacts on the community due to implementing this alternative.
- There is no potential impact on the workers while implementing Alternative 1. The work will be conducted in accordance with a health and safety plan and in compliance with applicable U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) regulations (e.g., 29 Code of Federal Regulations [CFR] 1910 and 1926), including appropriate selection of personal protective equipment (PPE) that will adequately protect site workers.
- The time to complete pre-design investigations (e.g., pumping tests) and obtain design approval is anticipated to be 1 year. Construction is expected to require 2 weeks. Although the time until implementation is relatively short, achieving RAOs is assumed to require a relatively long time (15 to 20 years) because the most contaminated soil will be left in place at the start of remediation.

6.2.1.4 Long -Term Effectiveness

The long-term effectiveness of Alternative 1 reduces the potential human health risks due to exposures to affected groundwater and soil at the Site. Alternative 1 relies on institutional controls as well as mechanical means to extract and treat groundwater and vapor that are easily monitored and can be enhanced if conditions change. The low permeability of soils and low hydraulic conductivity and low well yield (as evident during low flow sampling events) would reduce the ability to remove contaminant mass efficiently.

6.2.1.5 Reduction of Toxicity, Mobility, and Volume through Treatment

Alternative 1 reduces the toxicity, mobility, and volume of affected groundwater and soil via DPE and treatment.

6.2.1.6 Implementability

Implementation of Alternative 1 will utilize a previously implemented technology at the Site and include the following conditions:

- Continued use of city water.
- Obtaining restrictive covenants that prohibit use of site groundwater and provides the controls and restrictions for drilling and for some construction-related activities.
- Performance of an aquifer pumping test to determine yield and full-scale design.
- Replacement of malfunctioning AS/SVE system equipment, as identified in the AS/SVE system evaluation provided in the RI Report Addendum (WSP 2015b).

- Installation of groundwater extraction equipment (e.g., extraction wells, submersible pumps, water conveyance and air supply piping) to enhance SVE operations by dewatering the area.
- Installation of groundwater treatment equipment (e.g., settling tank, activated carbon) to treat extracted water prior to discharge and construction/delivery of a treatment trailer to house water treatment equipment.
- Startup and optimization of the treatment system.
- Groundwater monitoring and reporting.
- Periodic generation, management, and disposal of hazardous waste from remediation (e.g., spent carbon).

6.2.1.7 Cost

The estimated capital cost to implement Alternative 1 is $206,000, and the estimated total cost over the lifetime (capital and O&M cost) is $1,811,000 to $2,346,000 (Table B-1). The existing vapor phase treatment was assumed to be sufficient for treatment of the extracted vapors in the Modified AS/SVE system, and groundwater treatment equipment was assumed to include solids filtering, metals sequestration, and granular activated carbon for VOC removal. The capital costs include implementation of institutional controls, pre-design testing, remedial engineering design, and installation of modified AS/SVE system. The O&M costs include maintenance activities, equipment replacement, carbon changes, waste management and disposal, and semi-annual sampling and analysis of groundwater. Long-term groundwater monitoring is included in the O&M cost. Sampling of eight wells semi-annually is assumed; however, the monitoring frequency, duration, and locations will be determined during remedial action planning. O&M and monitoring will continue for 15 to 20 years. The NPW estimates for system O&M and groundwater monitoring, assuming discount rates of 7% and 1.9%, are $1,117,000 to $1,266,000 and $1,566,000 to $1,940,000, respectively (Table B-1).

6.2.2 Alternative 2 – Excavation of Soils with Biosparging and MNA

Alternative 2 includes the excavation of soils with toluene concentrations above the C_{sat} near MW-4R, backfill of the excavated area with gravel for improved permeability, and installation and operation of a biosparging system within the backfilled area. Restrictive covenants would be put in place to prohibit use of onsite groundwater. Because the most heavily contaminated soil will be removed at the start of implementation and an active remedy will be applied to address the residual contamination, a 5- to 10-year life has been assumed for cost purposes. System O&M as well as semi-annual groundwater monitoring, including MNA, would be conducted.

6.2.2.1 Overall Protection of Human Health and the Environment

Alternative 2 provides human health and environmental protection through active treatment and restoration of the impacted groundwater and prevents further migration of affected groundwater. The combined excavation and biosparge remedy will consume energy and generate waste throughout the projected 5- to 10-year life, thereby impacting the environment.

6.2.2.2 Compliance with ARARs

Chemical-specific ARARs associated with this alternative are the SCMCLs for toluene in groundwater and the toluene C_{sat} for soil. Toluene concentrations will decrease over time within the capture zone of the groundwater extraction system and may approach or achieve ARARs in some locations, although achievement of ARARs throughout the affected area is uncertain. ARARs are expected to be achieved in areas not managed using institutional and engineering controls where future groundwater use could hypothetically occur, because of source control.

Excavated soil, purged groundwater (from sampling activities), and spent carbon (from treatment system) are the predominant wastes to be generated through this alternative. Location-specific ARARs are the regulations pertaining to the potential disturbance of the wetlands located west of the targeted excavation area. Potential impacts to the wetlands will be minimized through implementation of engineering controls, such as erosion and sediment controls, in accordance with federal and state regulations.

Potential action-specific ARARs related to this alternative are associated with storm water discharges during excavation or biosparge system construction and discharges of air streams from treatment systems (Table 4-1). Additionally, potential action-specific ARARs related to this alternative are associated with injecting fluids (e.g., biological nutrients) into the subsurface (Table 4-1).

Sedimentation and erosion controls, treatment and monitoring of discharges, and emission controls would be implemented as warranted by the relevant regulations and guidance.

6.2.2.3 Short-Term Effectiveness

The short-term effectiveness of Alternative 2 is as noted:

- There are no impacts on the community due to implementing this alternative.
- There is no potential impact on the workers while implementing Alternative 2. The work will be conducted in accordance with a health and safety plan and in compliance with applicable OSHA regulations (e.g., 29 CFR 1910 and 1926), including appropriate selection of PPE that will adequately protect site workers.
- The time to complete pre-design investigations (bench scale study for biosparge nutrient selection, pre-design soil sampling) and obtain design approval is anticipated to be 1 year. Excavation is anticipated to take 3 weeks, and the biosparge system installation is anticipated to take 1 week. Achieving remedial objectives is estimated to require 5 to 10 years.

6.2.2.4 Long -Term Effectiveness

The long-term effectiveness of Alternative 2 reduces potential human health risks due to exposures to affected soil and groundwater at the Site. Alternative 2 relies on mechanical and biological means to treat groundwater and soil that are easily monitored and can be enhanced if conditions change.

6.2.2.5 Reduction of Toxicity, Mobility, and Volume through Treatment

Alternative 2 reduces the toxicity, mobility, and volume of affected soil and groundwater via excavation and biosparging.

6.2.2.6 Implementability

Implementation of Alternative 2 will be based solely on existing technology and include the following conditions:

- Continued use of city water.
- Obtaining restrictive covenants that prohibit use of site groundwater and provides the requirements and restrictions for drilling and for some construction-related activities.
- Pre-design soil sampling for defining the limits of excavation and shoring requirements.
- Pre-design studies for selecting the biosparge nutrient.
- xcavation of soils with toluene concentrations above C_{sat}, identified in area surrounding MW-4R.
- Management, transportation, and disposal of excavated soils as a hazardous waste.
- Post-excavation confirmation soil sampling and analysis.
- Backfill of the excavation area with gravel for improved permeability.
- Installation of a biosparge system for air and nutrient injection into the saturated zone within the gravel bed, followed by capture of toluene-laden air via SVE.
- Replacement of malfunctioning AS/SVE system equipment, as identified in the AS/SVE system evaluation provided in the RI Report Addendum (WSP 2015b).

- Abandonment of monitoring wells within the excavation areas (pre-excavation) and replacement (post-excavation), if deemed necessary.
- Treatment of the captured toluene-laden air with the components from the existing AS/SVE system treatment equipment.
- Groundwater monitoring and reporting.

6.2.2.7 Cost

The estimated capital cost to implement Alternative 2 is $545,000, and the estimated total cost over the lifetime (capital and O&M cost) is $1,055,000 to $1,565,000 (Table B-2). The capital costs include implementation of institutional controls, pre-design and post-excavation soil sampling, pre-design studies for biosparge nutrient selection, remedial design, excavation, and installation of the biosparge system (e.g., piping, wells, process equipment). The O&M costs include maintenance activities, equipment replacement, carbon changes, waste management and disposal, and semi-annual sampling and analysis of groundwater. Long-term groundwater monitoring is included in the O&M cost. Sampling of eight wells semi-annually is assumed; however, the monitoring frequency, duration, and locations will be determined during remedial action planning. O&M and groundwater MNA will continue for 5 to 10 years. The NPW of system O&M and groundwater monitoring costs, assuming discount rates of 7% and 1.9%, are $936,000 to $1,215,000 and $1,019,000 to $1,449,000, respectively (Table B-2).

6.2.3 Alternative 3 – Excavation of Soils with AFVR and MNA

Alternative 3 involves the excavation of soils with toluene concentrations above the C_{sat} near MW-4R, AFVR in the MW-4R area, followed by MNA. The saturated zone of the MW-4R excavation (2 to 5 feet bgs) would be backfilled with gravel to improve the collection of toluene-containing groundwater. Restrictive covenants will be put in place to prohibit use of onsite groundwater. Because the most heavily contaminated soil will be removed at the start of implementation followed by AFVR and the slower process of MNA for addressing the residual contamination, a 7- to 10-year time of remediation has been assumed for cost purposes. Semi-annual groundwater monitoring will be conducted to evaluate the MNA performance.

6.2.3.1 Overall Protection of Human Health and the Environment

Alternative 3 provides human health and environmental protection through active treatment of the highly contaminated areas and restoration of the affected groundwater. Although the hot spot excavation and AFVR events will consume energy and generate waste, the active portion of the remedial alternative is estimated to last 3 weeks, a short portion of the overall 7- to 10-year remedial life. The energy and waste generated by MNA, the longer term portion of the remedial alternative, is minimal; therefore, the overall environmental impact for this alternative is low.

6.2.3.2 Compliance with ARARs

Chemical-specific ARARs associated with this alternative are the SCMCLs for groundwater and the toluene C_{sat} for soil. Toluene concentrations will decrease and may approach or achieve ARARs, although achievement of ARARs throughout the affected area is uncertain. ARARs are expected to be achieved in areas not managed using institutional and engineering controls where future groundwater use could hypothetically occur.

Excavated soil and purged groundwater (from sampling activities) are the predominant wastes to be generated through this alternative. Location-specific ARARs are the regulations pertaining to the potential disturbance of the wetlands located west of the targeted excavation area. Potential impacts to the wetlands will be minimized through implementation of engineering controls, such as erosion and sediment controls, in accordance with federal and state regulations.

6.2.3.3 Short-Term Effectiveness

The short-term effectiveness of Alternative 3 is as noted:

- There are no impacts on the community due to implementing this alternative.

- There is no potential impact on the workers while implementing Alternative 3. The work will be conducted in accordance with a health and safety plan and in compliance with applicable OSHA regulations (e.g., 29 CFR 1910 and 1926), including appropriate selection of PPE that will adequately protect site workers.
- The time to complete pre-design testing and remedial design, and implement the combined remedial alternative is anticipated to be 1 year. Excavation is projected to take 3 weeks to complete, and a pilot test of AFVR technology will take less than 1 day. Achieving RAOs is estimated to require 7 to 10 years.

6.2.3.4 Long -Term Effectiveness

The long-term effectiveness of Alternative 3 mitigates potential human health risks due to exposures to affected groundwater and soil at the Site. Exposure to impacted soil and groundwater would be prevented through institutional controls. Source control would also reduce the volume of toluene-impacted groundwater.

6.2.3.5 Reduction of Toxicity, Mobility, and Volume through Treatment

Alternative 3 would reduce the toxicity, volume, and mobility of contaminants in groundwater. The excavation of soils with toluene concentrations above C_{sat}, as well as follow-up AFVR, will reduce the toluene mass in soil and volume of affected groundwater. The degradation reactions associated with the natural attenuation process would reduce residual toluene mass into non-hazardous end products.

6.2.3.6 Implementability

Implementation of Alternative 3 is technically feasible. Implementable components of Alternative 3 include:

- Continued use of city water.
- Obtaining restrictive covenants that prohibit use of site groundwater and provide the requirements and restrictions for drilling and for some construction-related activities.
- Pre-design soil sampling for defining the limits of excavation and shoring requirements.
- Excavation of soils with toluene concentrations above C_{sat} in area surrounding MW-4R, and installation of a 4-inch diameter extraction well.
- AFVR pilot study at new extraction well in the excavated area to evaluate the effectiveness of this technology in the recovery of additional toluene mass.
- Management, transportation, and disposal of excavated soils (from excavation) and extracted groundwater (from AFVR) as a hazardous waste.
- Post-excavation confirmation soil sampling and analysis.
- Backfill of the excavation area with native (unaffected) soil (0 to 2 feet bgs) and gravel for improved permeability (2 to 5 feet bgs).
- Abandonment of monitoring wells within the excavation areas (pre-excavation) and replacement (post-excavation), if deemed necessary.
- Groundwater monitoring, including natural attenuation monitoring, and reporting.

6.2.3.7 Cost

The estimated capital cost to implement Alternative 3 is $398,000, and the estimated total cost over the lifetime (capital and O&M cost) is $713,000 to $848,000 (Table B-3). The capital costs include implementation of institutional controls, pre-design testing, remedial design, excavation, and a pilot study of AFVR. The O&M costs consist of semi-annual sampling and analysis of groundwater for site-related constituents found in groundwater. Long-term groundwater monitoring is included in the O&M cost for 7 to 10 years. Sampling of eight wells semi-annually is assumed; however, the monitoring frequency, duration, and locations will be determined during remedial action planning. The estimates for NPW, assuming discount rates of 7% and 1.9%, are $625,000 to $694,000 and $685,000 to $797,000, respectively (Table B-3).

6.3 Comparative Analysis of Alternatives

This section presents a direct comparison of the alternatives. This comparative analysis is based on the nine detailed evaluation criteria.

6.3.1 Overall Protection of Human Health and the Environment

All alternatives would be protective of human health and the environment by mitigating exposures to affected soil and groundwater through deed restrictions and continued use of city water as a water supply source. Alternatives 2 and 3 have the potential to meet RAOs in a relatively short timeframe (10 years or less). Both Alternatives 1 and 2 require long-term operation of an active remedial measure, which consume energy and generate waste. Alternative 3 requires short-term operation of an active remedial measure, and the overall energy usage and waste generation are low. The overall protection of human health and the environment is assumed moderate for Alternatives 1 and 2 and high for Alternative 3.

6.3.2 Compliance with ARARs

All alternatives include active remediation, and ARARs will be approached or achieved. Alternative 1 would have to comply with water discharge requirements, and Alternatives 1 and 2 would have to comply with air emission requirements. The disposition of treatment residuals from all alternatives would have to be consistent with applicable waste regulations, and well construction in the alternatives would have to comply with South Carolina well construction standards. The potential for impacts to the wetlands located west of the targeted excavation area will be minimized through implementation of engineering controls, such as erosion and sediment controls, in accordance with federal and state regulations. The overall compliance with ARARs is assumed moderate for all three alternatives.

6.3.3 Short-Term Effectiveness

All alternatives would present some risk to workers through potential incidental ingestion, dermal contact, and inhalation of VOCs during remediation and monitoring activities, which could be minimized by utilizing proper PPE. Noise from the treatment units associated with Alternatives 1 and 2, and excavation equipment in Alternatives 2 and 3, could present some limited adverse impacts to onsite workers and nearby businesses. The risks to onsite workers and nearby businesses under all of these alternatives could, however, be minimized by following appropriate health and safety protocols, exercising sound engineering practices, and utilizing proper PPE.

It is estimated that Alternatives 1 through 3 would require approximately 1 year to design and up to 1 month to implement. Achieving remediation objectives is estimated to require 15 to 20 years for Alternative 1, 5 to 10 years for Alternative 2, and 7 to 10 for Alternative 3. The actual time period required for the groundwater to be remediated under all of the alternatives may vary from the estimates above and could be refined based on the results of groundwater monitoring and pre-design testing. Short-term effectiveness is assumed to be moderate for all three alternatives.

6.3.4 Long-Term Effectiveness and Permanence

It is anticipated that all retained alternatives would achieve RAOs and would be effective in the long-term. Alternatives 2 and 3 would address VOC source areas in less time than Alternative 1. It is anticipated that all retained alternatives would maintain reliable protection of human health and the environment over time. Implementation of all retained alternatives would generate waste; however, the amount of O&M waste generated by Alternative 3 is limited to groundwater monitoring-related waste, while the O&M waste generated by Alternatives 1 and 2 would also include treatment residues (e.g., spent carbon). Long-term effectiveness is assumed to be moderate for all three alternatives.

6.3.5 Reduction of Toxicity, Mobility, or Volume through Treatment

The active treatment components in Alternatives 1 through 3 would provide a reduction of toxicity and volume of the affected soil and groundwater. The effectiveness at reduction of toxicity, mobility, or volume through treatment is moderate for Alternative 1 and high for Alternatives 2 and 3.

6.3.6 Implementability

Alternative 1 is moderately difficult to implement as it requires a pre-design study to calculate modified system requirements (e.g., well yield, transfer pipe sizing, treatment capacity), installation of associated transfer pipelines and wells, replacement of malfunctioning components of existing AS/SVE system, and installation of new water treatment equipment and trailer. This alternative also requires long-term O&M and monitoring.

Alternative 2 would be the most difficult to implement in that it would require completion of a pre-design study for selection of the appropriate nutrients for the biosparge system, replacement of malfunctioning components of the existing AS/SVE system, and installation of associated transfer pipelines and wells. In addition, this alternative requires long-term O&M and monitoring.

Alternative 3 would be the easiest alternative to implement, since it requires minimal construction, and the long-term site work is limited to groundwater monitoring.

All equipment that would be used in the three retained alternatives is proven and commercially available. Transportation and disposal of treatment residues could be easily implemented using commercially-available equipment. Under all of the action alternatives, sampling for treatment effectiveness and groundwater monitoring would be necessary, but could be easily implemented.

Overall, Alternative 3 is considered easiest to implement.

6.3.7 Cost

The present-worth costs were calculated using discount rates of 7% and 1.9% over the expected time frames for each alternative. A 15- to 20-year life was assumed for Alternative 1, 5- to 10-year life for Alternative 2, and a 7- to 10-year life was assumed for Alternative 3. The estimated capital, annual operation and maintenance, and present-worth costs for each of the alternatives are presented in Table 6-1.

Alternative 3 (Excavation with AFVR and MNA) has the lowest costs. Alternative 1 (Modified AS/SVE) is the most costly.

7 Recommended Alternative

The RAOs proposed for affected media at the site were defined as:

- Reduce toluene concentrations in source area soils to minimize potential migration in the shallow groundwater system.
- Mitigate human health risks from the potential exposure of affected media at the site.
- Demonstration of statistically significant decreasing trends in toluene groundwater concentrations indicating the SCMCL will be met within a reasonable timeframe.

Several remedial technologies were considered, with three alternatives retained for further evaluation. All three alternatives meet the threshold criteria of protecting human health and the environment and meeting RAOs. All three alternatives eliminate exposure to onsite groundwater via implementation of restrictive covenants and use of city water. Each alternative includes a remedial component to reduce the toxicity of contaminants in soil and groundwater through active treatment. The three retained alternatives all reduce the potential for further degradation of soil and groundwater quality by performing source control. However, based on the balancing criteria, WSP recommends Alternative 3 – Excavation of Soils with AFVR and MNA. Alternative 3 is the easiest alternative to implement and lowest cost alternative. Alternative 3 is expected to achieve the RAOs in a shorter time-frame than Alternative 1, although it is expected to take about as long as Alternative 2.

In summary, the relatively long duration of Alternative 1 and high cost of Alternative 2 do not justify their selection. Therefore, WSP recommends Alternative 3.

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9 Acronyms

AFVR	aggressive fluid vapor recovery
ARARs	applicable or relevant and appropriate requirements
AS/SVE	air sparge/soil vapor extraction
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COPCs	chemicals of potential concern
C_{sat}	soil saturation concentration
CY	cubic yards
DCE	1,2-dichloroethene
DPE	dual phase extraction
EPA	Environmental Protection Agency
ERM	Environmental Resources Management
ft/day	feet per day
FFS	focused feasibility study
HHRA	human health risk assessment
K	hydraulic conductivity
MCL	Maximum Contaminant Level
µg/l	micrograms per liter
mg/kg	milligrams per kilogram
MNA	monitored natural attenuation
MSL	mean sea level
NCP	National Contingency Plan
NPW	net present worth
OMB	Office of Management and Budget
O&M	operation and maintenance
OSHA	Occupational Safety and Health Administration
PCE	tetrachloroethene
POTW	publicly-owned treatment works
PPE	personal protective equipment
RAO	remedial action objective
RI	Remedial Investigation
ROI	radius of influence
RSL	regional screening level
SARA	Superfund Amendments and Reauthorization Act
SCDHEC	South Carolina Department of Health and Environmental Control
SCDNR	South Carolina Department of Natural Resources
SCMCL	South Carolina Maximum Contaminant Level
sf	square feet
SSL	soil screening level
TCE	trichloroethylene
UST	underground storage tank
VCC	voluntary cleanup contract
VOC	volatile organic compound
Wix	Wix Filtration Corp LLC

Figures

REFERENCE:
7.5 MINUTE SERIES TOPOGRAPHIC QUADRANGLE
DILLON WEST, SOUTH CAROLINA
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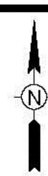

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SCALE, FEET

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FIGURE 2-1

SITE LOCATION MAP

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DILLON, SOUTH CAROLINA

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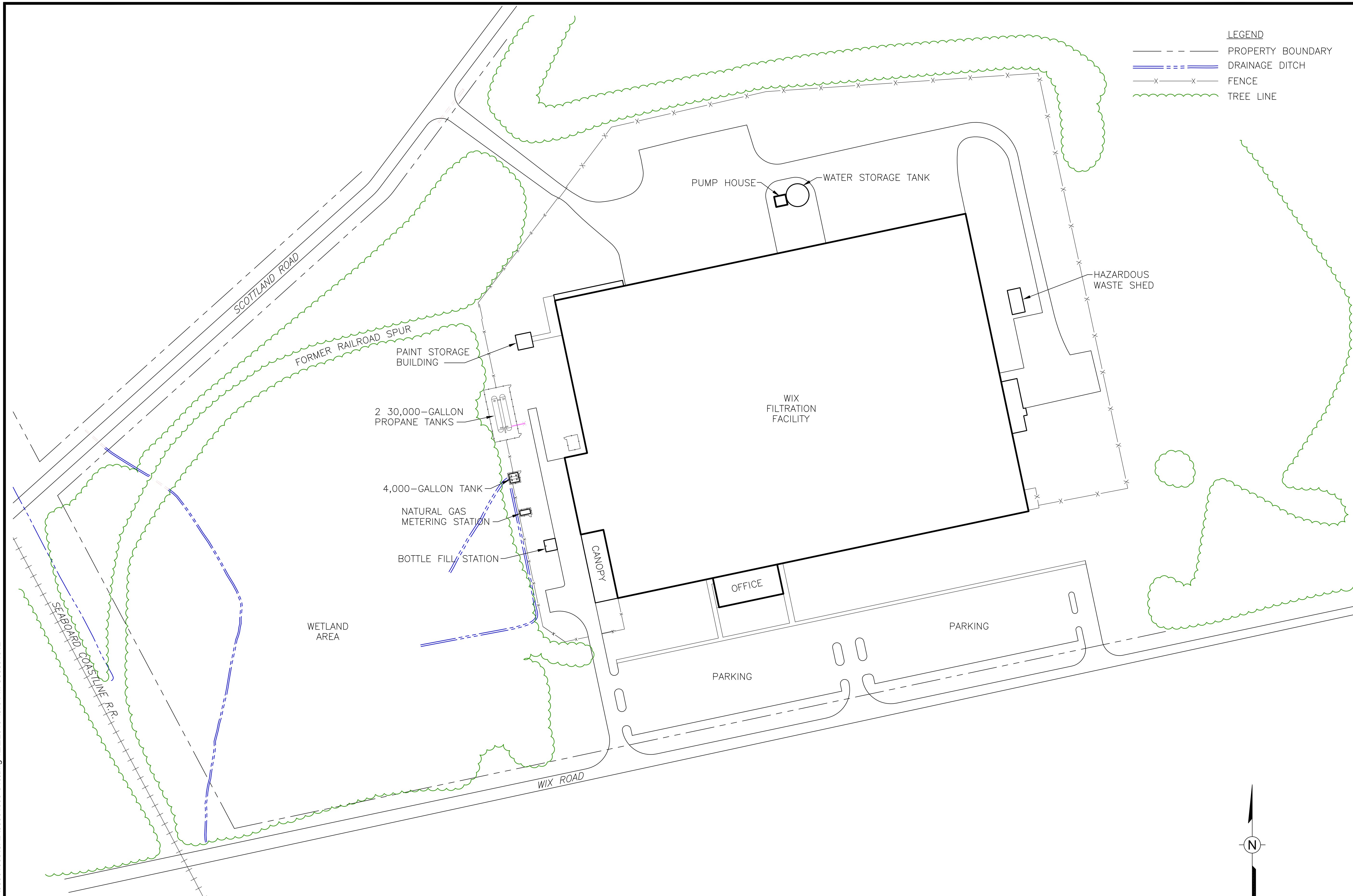

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2. GOOGLE EARTH PRO AERIAL.

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FIGURE 2-2

SITE LAYOUT

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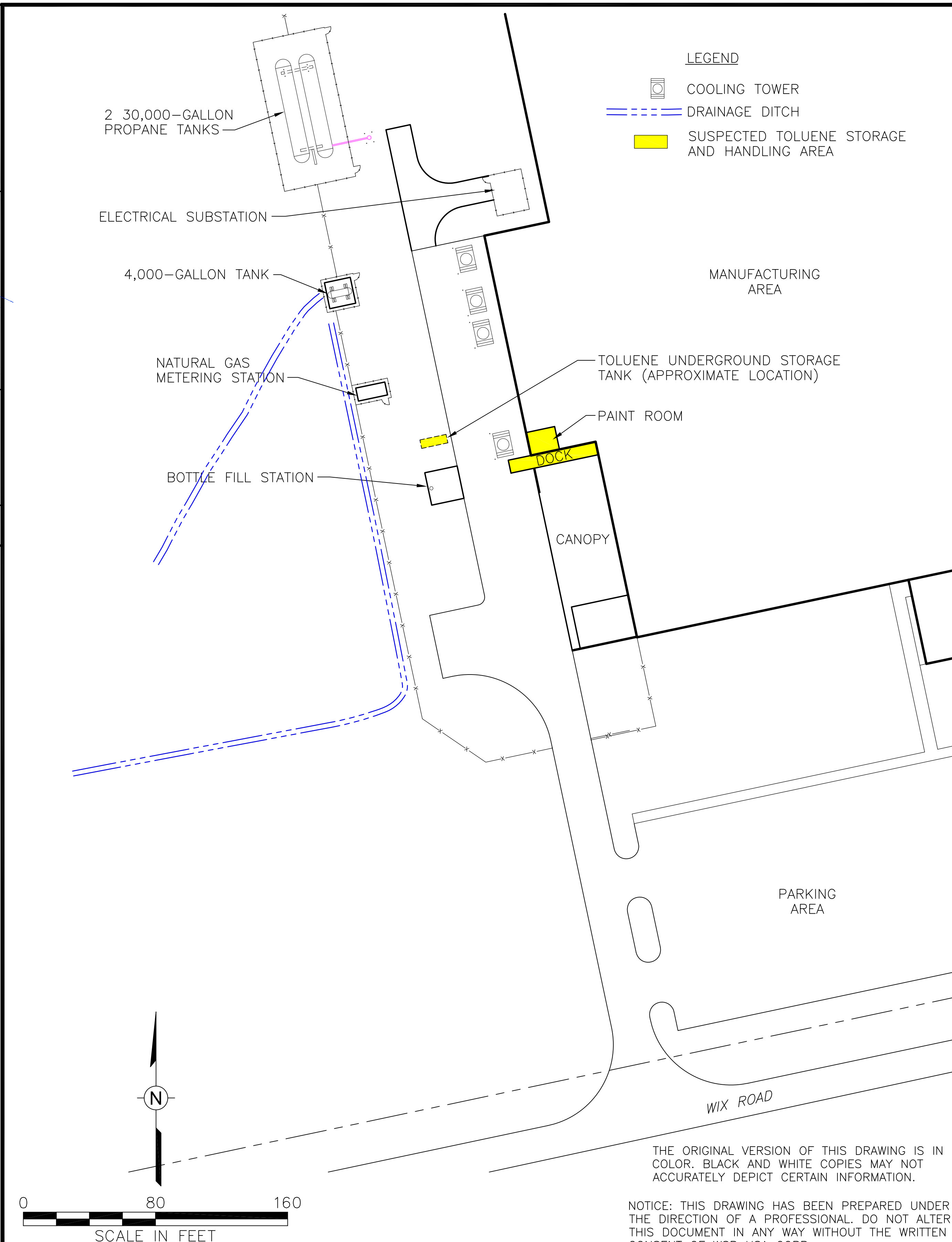

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FIGURE 2-3

AREAS OF PRESUMED HISTORICAL TOLUENE STORAGE AND USE

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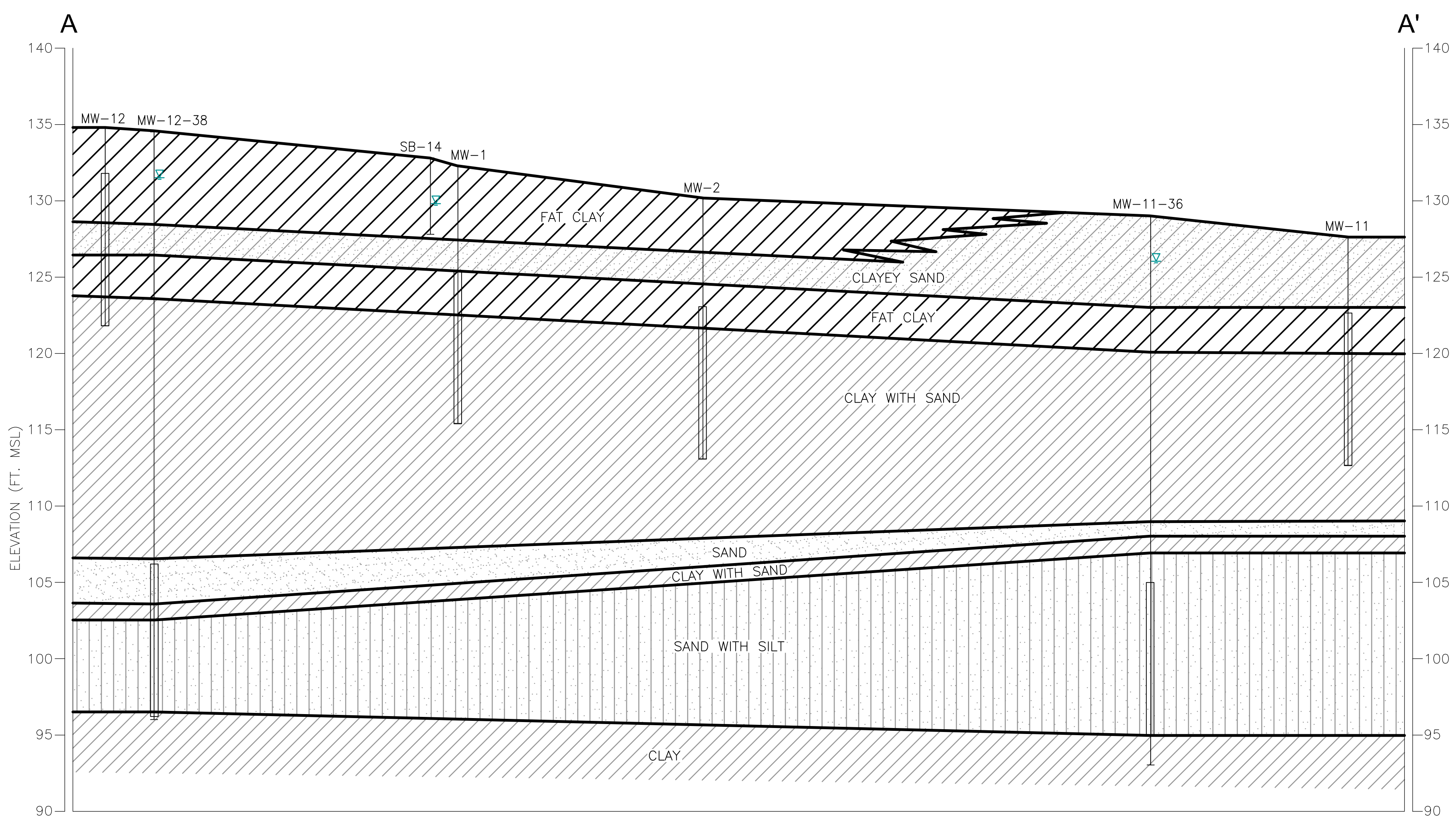
LEGEND

PROPERTY BOUNDARY
DRAINAGE DITCH
FENCE
TREE LINE
MONITORING WELL
SOIL BORING



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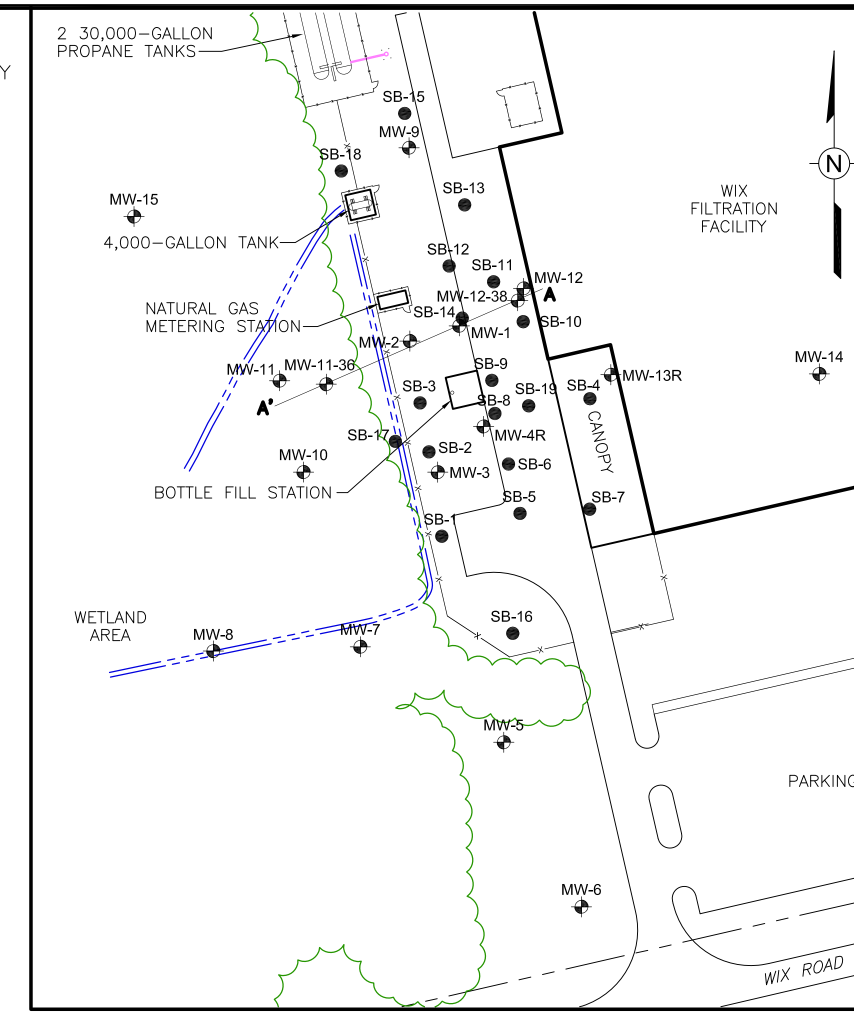
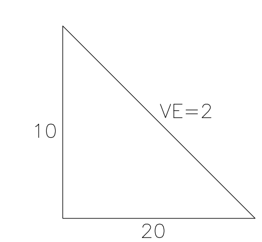


LOCATION MAP

SCALE: 1"=120'

LEGEND

GROUND SURFACE
SATURATED SOIL ENCOUNTERED DURING BORING INSTALLATION
JUNE 2014 GROUNDWATER ELEVATION
SCREENED INTERVAL
BOTTOM OF BORING
INFERRED LITHOLOGIC CONTACT



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VERTICAL SCALE IN FEET

0 20 40
HORIZONTAL SCALE IN FEET

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FIGURE 2-4

GEOLOGIC CROSS SECTION

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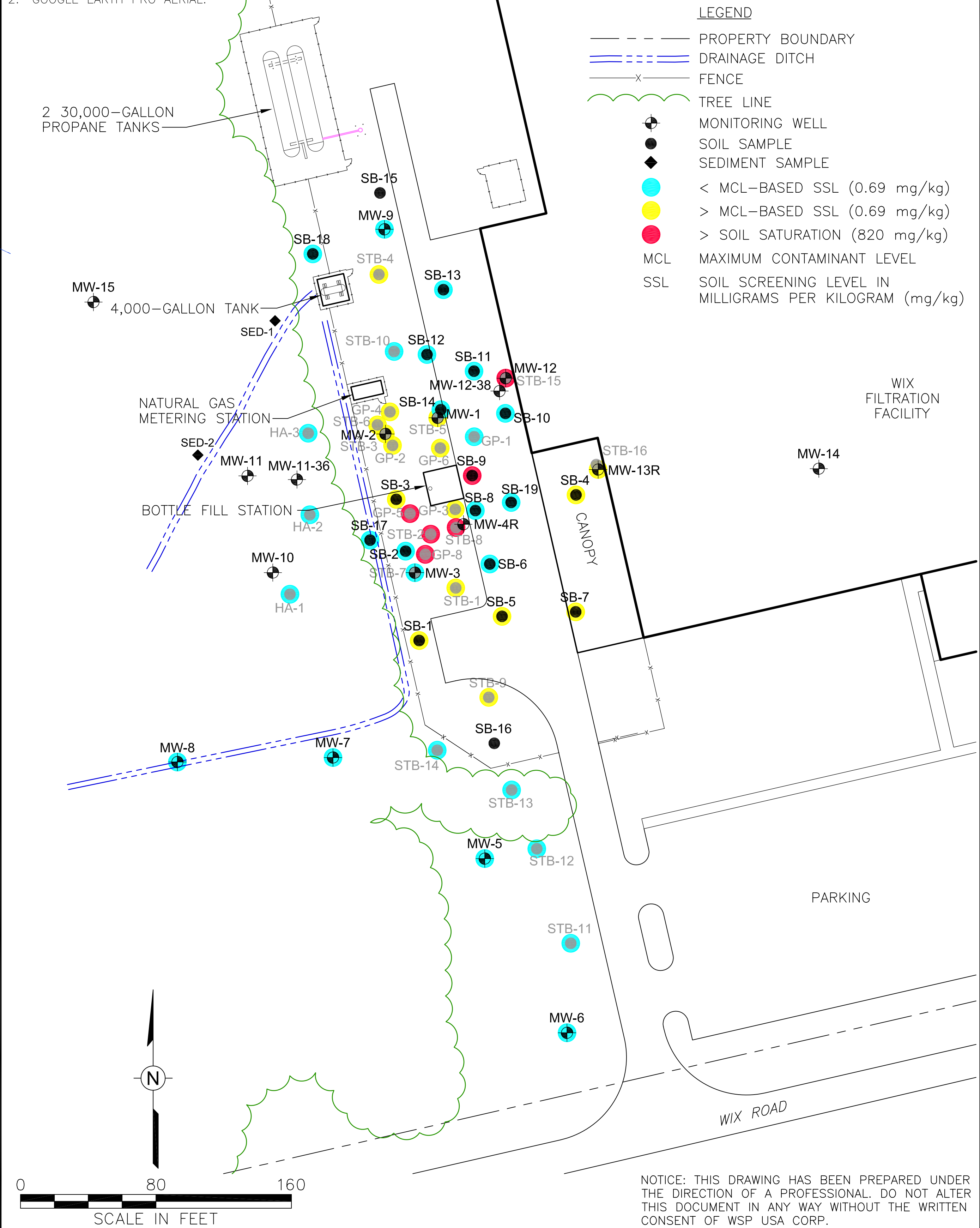

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FIGURE 2-5

SOIL SAMPLE LOCATIONS AND TOLUENE RESULTS

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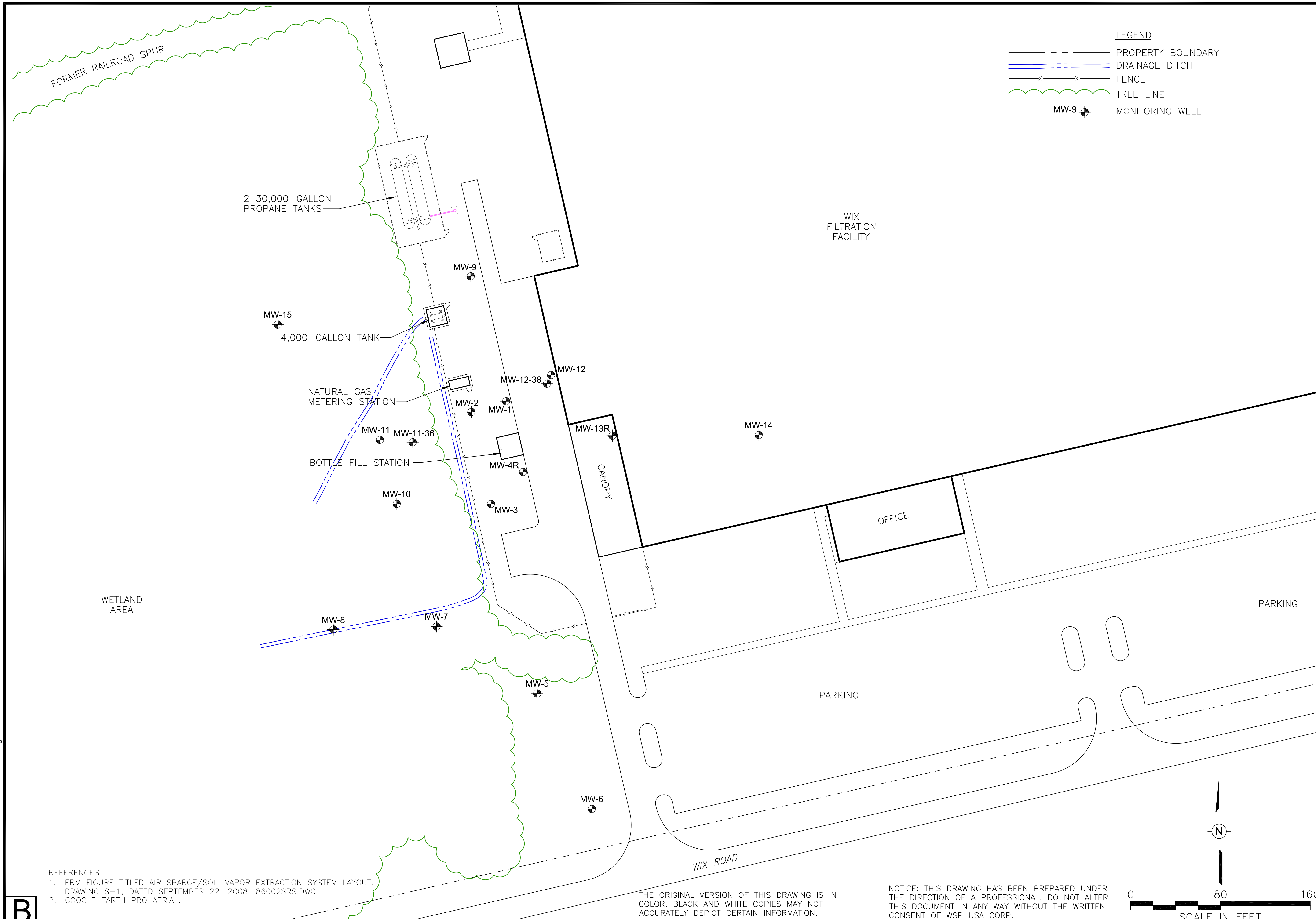

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FIGURE 2-6
MONITORING WELL LOCATIONS

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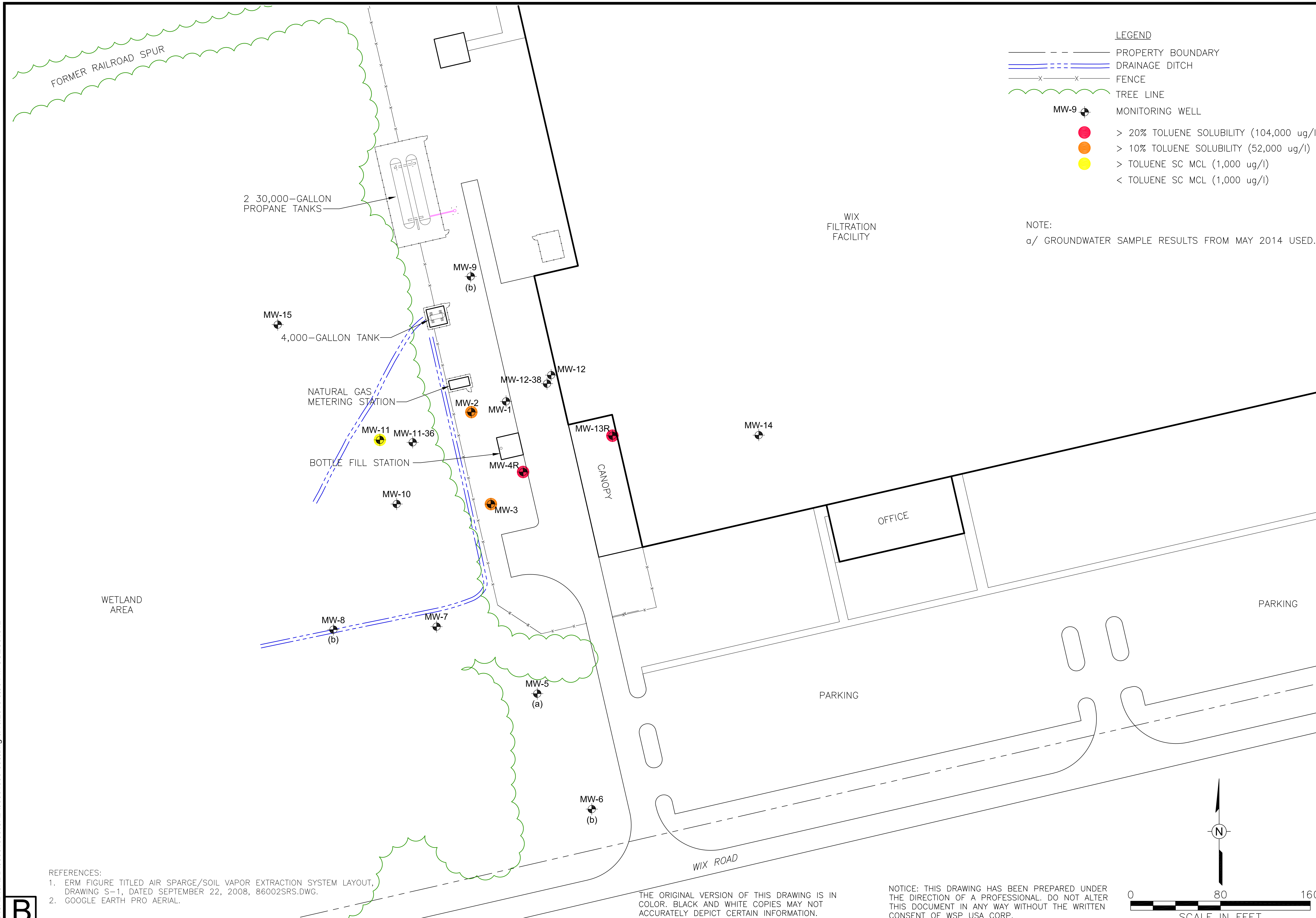

NOTE:

a/ GROUNDWATER SAMPLE RESULTS FROM MAY 2014 USED.

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1. ERM FIGURE TITLED AIR SPARGE/SOIL VAPOR EXTRACTION SYSTEM LAYOUT, DRAWING S-1, DATED SEPTEMBER 22, 2008, 86002SRS.DWG.
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FIGURE 2-7

TOLUENE CONCENTRATIONS IN GROUNDWATER AUGUST 2015

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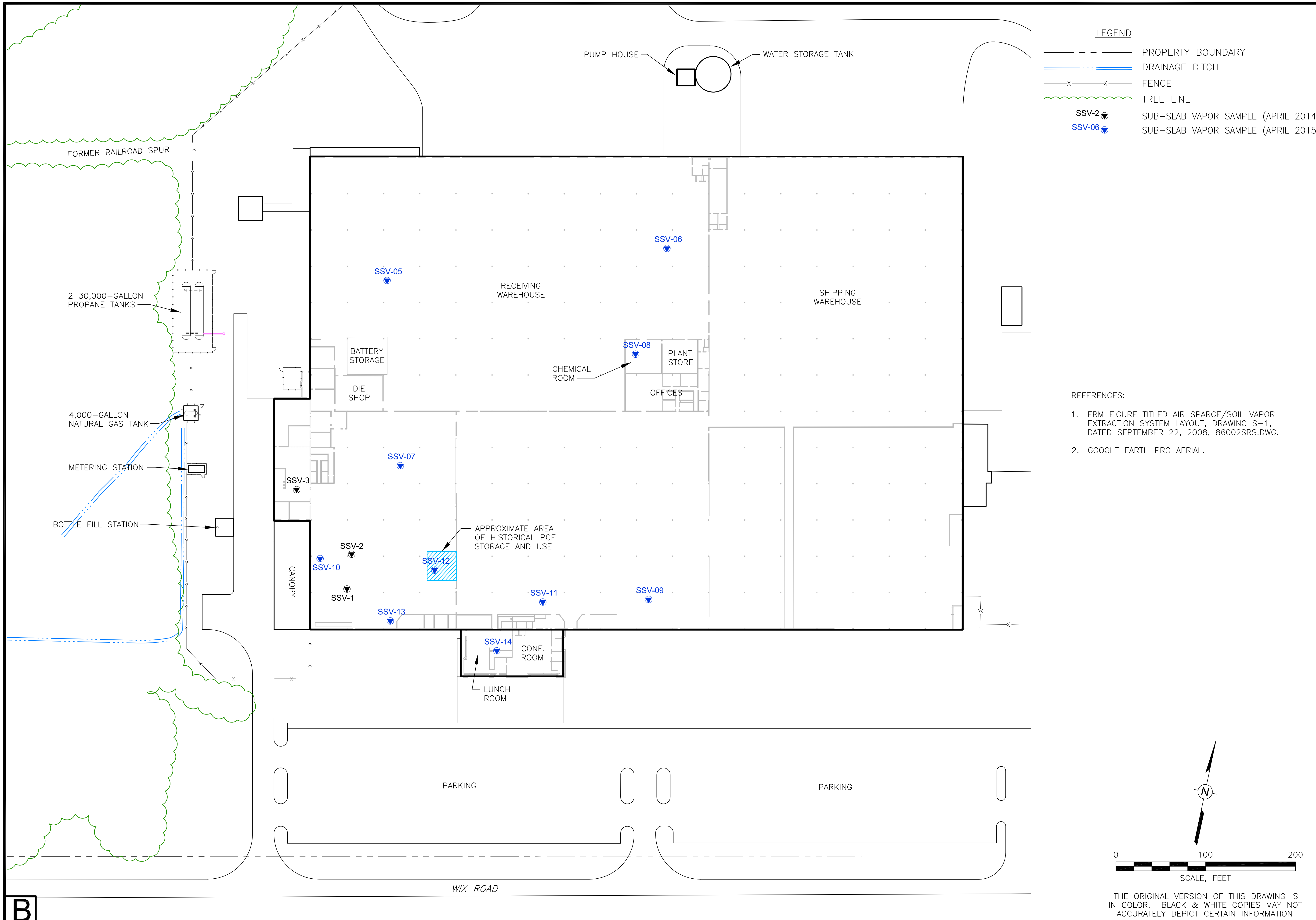

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1. ERM FIGURE TITLED AIR SPARGE/SOIL VAPOR EXTRACTION SYSTEM LAYOUT, DRAWING S-1, DATED SEPTEMBER 22, 2008, 86002SRS.DWG.
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FIGURE 2-8

SUB-SLAB VAPOR SAMPLE LOCATIONS
APRIL 2014 AND APRIL 2015

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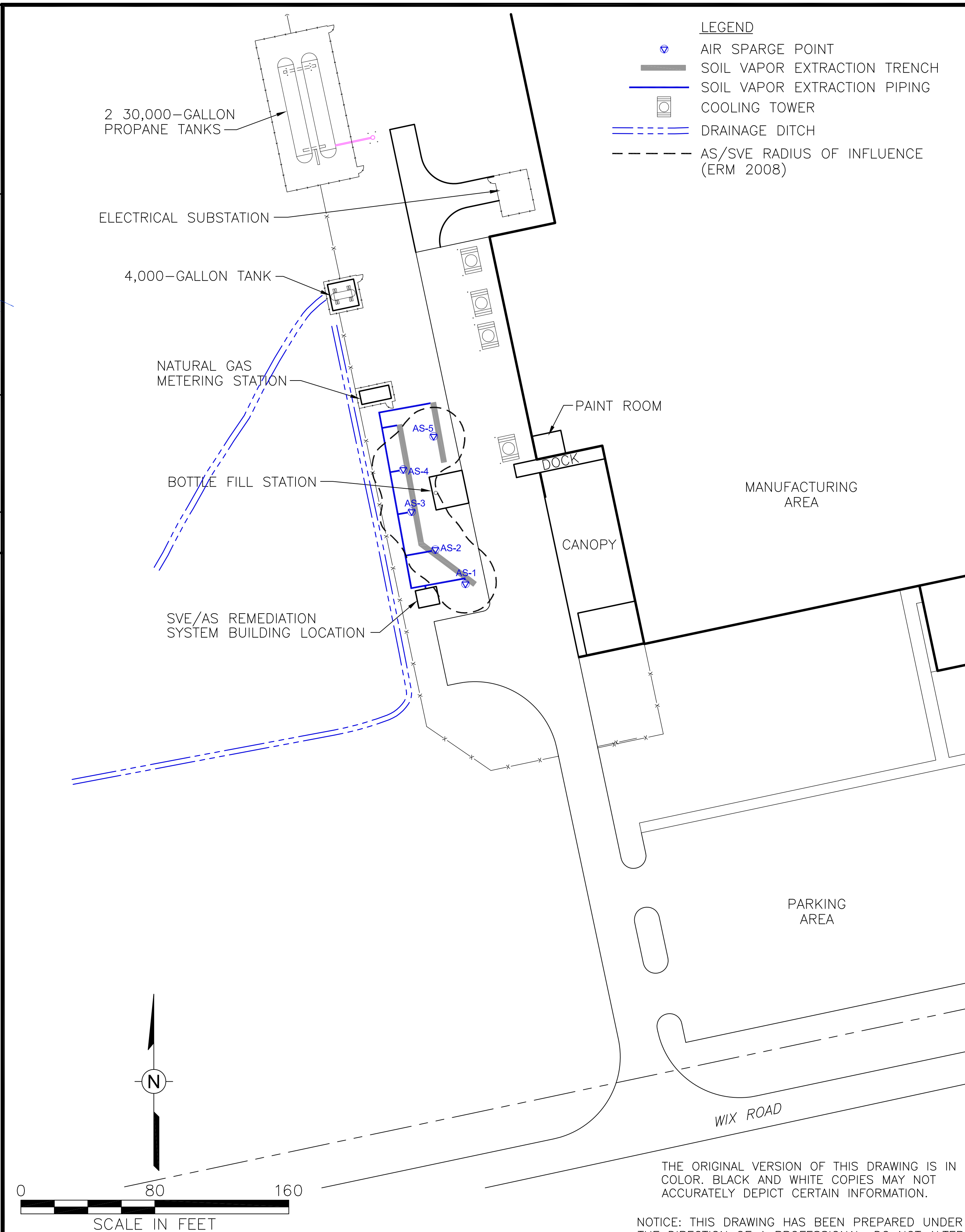

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FIGURE 2-9

AIR SPARGE/SOIL VAPOR EXTRACTION SYSTEM LAYOUT

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DILLON, SOUTH CAROLINA

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WIX FILTRATION CORP LLC
DILLON, SOUTH CAROLINA

DWG Name: 00031999-054
Checked: [handwritten initials] 12/21/2015
Approved: [handwritten initials]
Drawn By: EGC
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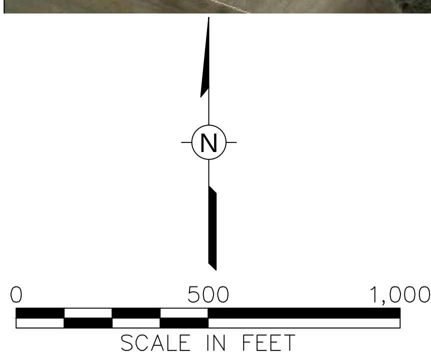

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WSP PARSONS BRINCKERHOFF WSP USA Corp. 13530 Dulles Technology Drive, Suite 300 Herndon, Virginia 20171 (703) 709-6500 www.wspgroup.com/usa	FIGURE 3–1 KNOWN AND POTENTIAL LOCATIONS OF PUBLIC AND PRIVATE WATER SUPPLY WELLS	WIX FILTRATION FACILITY DILLON, SOUTH CAROLINA PREPARED FOR WIX FILTRATION CORP LLC DILLON, SOUTH CAROLINA

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Drawn By: RJB 08/03/2014

Checked: 12/2/2015

Approved:

DWG Name: 00031999-055

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REFERENCES:
1. ERM FIGURE TITLED AIR SPARGE/SOIL VAPOR EXTRACTION SYSTEM LAYOUT, DRAWING S-1, DATED SEPTEMBER 22, 2008, 86002SRS.DWG.
2. GOOGLE EARTH PRO AERIAL.

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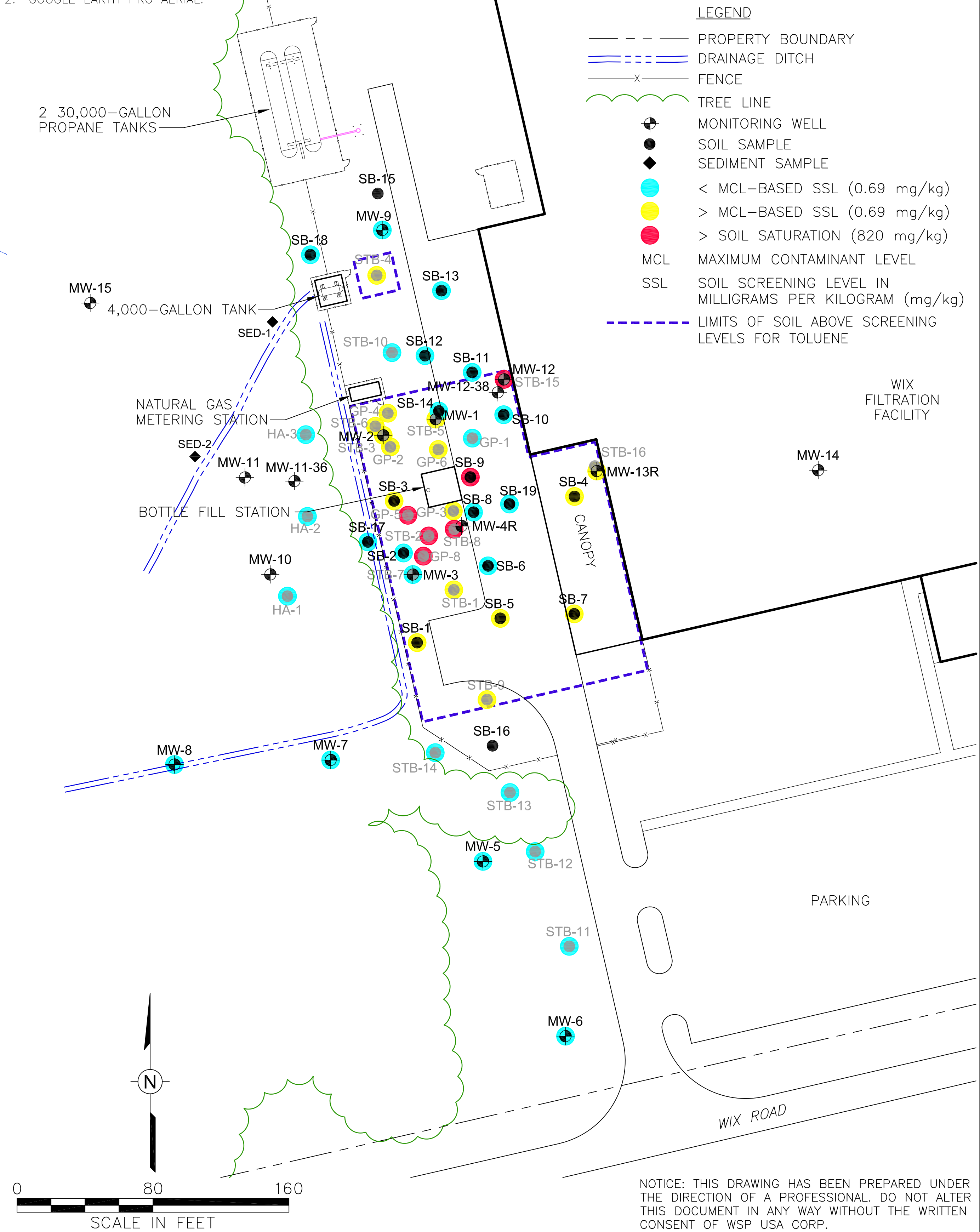

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FIGURE 3–2

LIMITS OF SOIL ABOVE SCREENING LEVELS FOR TOLUENE

WIX FILTRATION FACILITY
DILLON, SOUTH CAROLINA

PREPARED FOR
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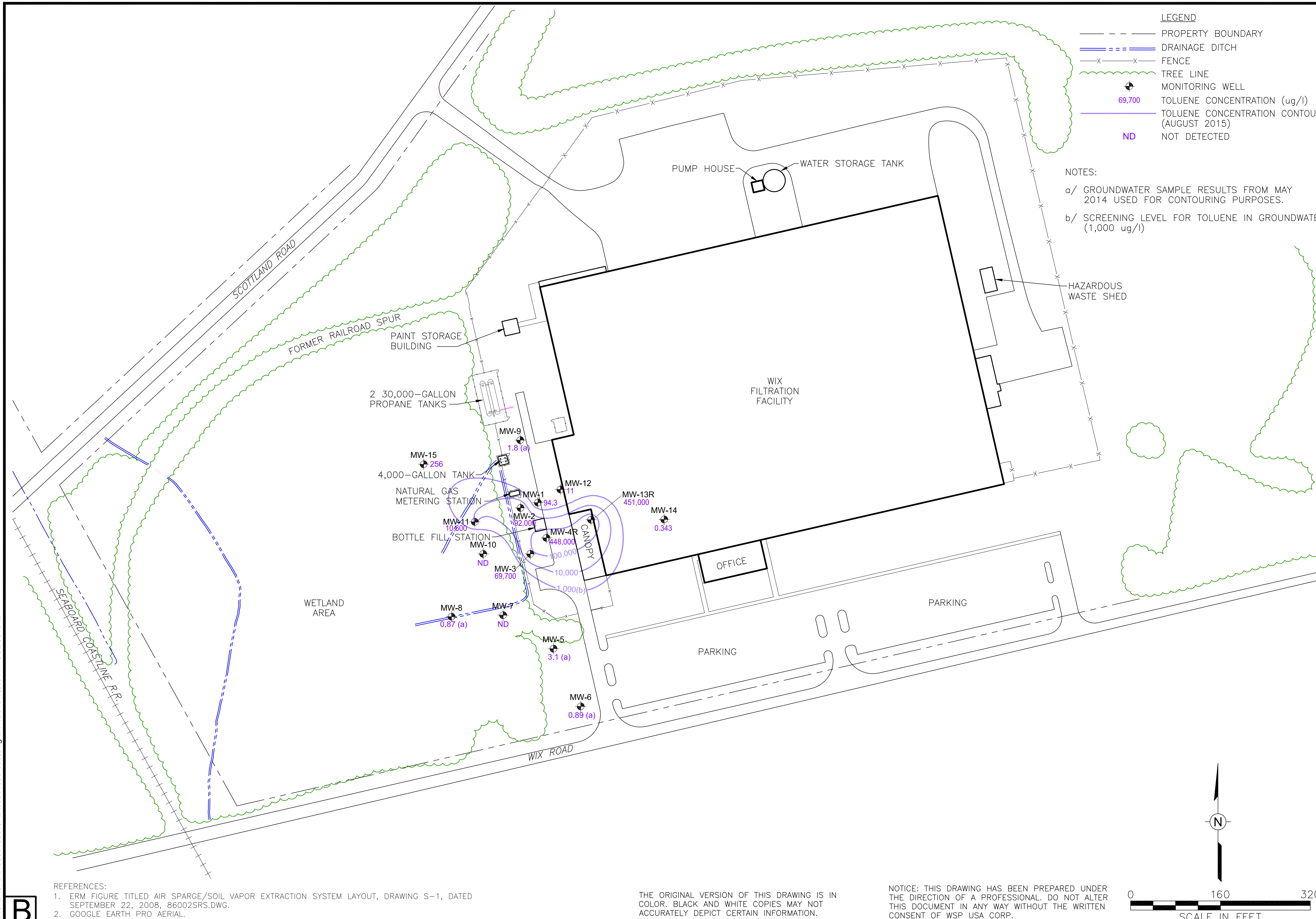
DILLON, SOUTH CAROLINA



LEGEND

— — —	PROPERTY BOUNDARY
═══	DRAINAGE DITCH
—x—x—	FENCE
~~	TREE LINE
⊕	MONITORING WELL
69,700	TOLUENE CONCENTRATION (ug/l)
———	TOLUENE CONCENTRATION CONTOUR (AUGUST 2015)
ND	NOT DETECTED

NOTES:

a/ GROUNDWATER SAMPLE RESULTS FROM MAY 2014 USED FOR CONTOURING PURPOSES.

b/ SCREENING LEVEL FOR TOLUENE IN GROUNDWATER (1,000 ug/l)

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Checked: 6/17/2016
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DWG Name: 00031999–059

WIX FILTRATION FACILITY
DILLON, SOUTH CAROLINA

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FIGURE 3–3

LIMITS OF GROUNDWATER ABOVE SCREENING LEVELS FOR TOLUENE

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2. GOOGLE EARTH PRO AERIAL.

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Tables

Table 2-1

Monitoring Well Construction
Wix Filtration Facility
Dillon, South Carolina (a)

Monitoring Well	Installation Date	Northing	Easting	Ground Surface (feet-msl)	Top-of-Casing (feet-msl)	Diameter (inches)	Material	Screened Interval (feet-bgs)	Screened Interval (feet-msl)
MW-1	May 17, 2006	954878.01	2486307.08	132.32	131.85	2	PVC	6.9 - 16.9	125.42 - 115.42
MW-2	May 17, 2006	954868.49	2486276.21	130.19	129.91	2	PVC	7.1 - 17.1	123.09 - 113.09
MW-3	May 17, 2006	954786.58	2486293.64	129.27	129.24	2	PVC	6.5 - 16.5	122.77 - 112.77
MW-4	*May 17, 2006*	*-*	*-*	*-*	*130.47 (b, c)*	*2*	*PVC*	*6.8 - 16.7*	*123.7 - 113.8*
MW-4R	May 8, 2014	954815.15	2486322.28	131.11	133.92	2	SS	2 - 12	129.11 - 119.11
MW-5	December 6, 2006	954617.76	2486334.89	129.24	129.20	2	PVC	5.6 - 15.2	123.64 - 114.04
MW-6	December 6, 2006	954514.94	2486383.44	129.97	129.97	2	PVC	6.4 - 16	123.57 - 113.97
MW-7	December 4, 2006	954677.44	2486245.27	128.38	128.48	2	PVC	7.7 - 17.4	120.68 - 110.98
MW-8	December 5, 2006	954674.78	2486153.39	127.46	130.73	2	PVC	10.3 - 19.9	117.16 - 107.56
MW-9	December 7, 2006	954989.31	2486275.68	132.11	132.01	2	PVC	5.2 - 15.2	126.91 - 116.91
MW-10	February 15, 2011	954786.63	2486209.75	127.88	130.78	2	PVC	5 - 15	122.88 - 112.88
MW-11	February 15, 2011	954843.72	2486194.80	127.63	131.01	2	PVC	5 - 14.95	122.63 - 112.68
MW-11-36	May 7, 2014	954841.56	2486223.97	129.04	131.63	2	PVC	25 - 35	104.04 - 94.04
MW-12	February 15, 2011	954901.41	2486347.26	134.81	134.46	2	PVC	3 - 13	131.81 - 121.81
MW-12-38	May 6, 2014	954893.80	2486343.61	134.51	134.15	2	PVC	28 - 38	106.51 - 96.51
MW-13	*February 15, 2011*	*954850.39*	*2486400.74*	*131.50*	*131.10 (b)*	*2*	*PVC*	*3 - 13*	*128.5 - 118.5*
MW-13R	April 30, 2015	954847.48	2486401.82	131.40	131.07	2	SS	2 - 12	129.40 - 119.40
MW-14	February 12, 2012	954847.97	2486532.10	135.51	135.25	1.5	PVC	10 - 20	125.51 - 115.51
MW-15	February 12, 2012	954946.34	2486103.83	128.82	131.11	2	PVC	5 - 15	123.82 - 113.82

a/ feet-bgs = feet below ground surface; feet-msl = feet above mean sea level; PVC = polyvinyl chloride; SS = stainless steel.
b/ Well abandoned.
c/ Historical survey data provided by ERM.

Gray italic text indicates monitoring well plugged and abandoned

Table 4-1

Summary of Potential ARARs
Wix Filtration Facility
Dillon, South Carolina (a)

Potential ARAR	Requirements/Purpose	Applicability
Chemical-Specific		
Federal		
40 CFR 265.94 - Maximum Concentration Limits for Groundwater Protection	Maximum concentration limits in groundwater for hazardous constituents for a regulated facility.	Relevant to the effectiveness of remedial alternatives considered.
EPA Regional Screening Levels for Chemical Contaminants at Superfund Sites (November 2015) - Soil Saturation Concentration for Toluene	Provides conservative estimate of soil saturation concentration, which is indicative of immiscible product phase in the soil material.	EPA guidance to be considered to define limits of toluene-source area to be remediated.
State		
South Carolina Regulations 61-68.H.9, Water Classifications & Standards - Quality Standards for Class GB Ground Waters; South Carolina Regulations 61-58.5.N.(2), State Primary Drinking Water Regulations - Maximum Contaminant Levels for Volatile Synthetic Organic Chemicals	Establishes groundwater quality standards for substances detected in Class GB groundwater.	Relevant to the effectiveness of remedial alternatives considered.
Location-Specific		
Federal		
Clean Water Act, 33 USC 1344, Section 404; 40 CFR 230-231 - Section 404(b)(1) Guidelines for Specification of Disposal Sites for Dredged or Fill Material and Section 404(c) Procedures	Discharge of dredged or fill material into wetland without permit is prohibited.	Relevant if construction of a remedial system is near a wetland.
Executive Order Protecting Wetlands; Executive Order 11990, Section 2; 40 CFR 6.302(a)	Requires federal agencies to minimize the destruction, loss, or degradation of wetlands.	Relevant to remediation activities taking place in and around wetlands.
Action-Specific		
Federal		
40 CFR 122 - NPDES	Applicable regulations which set water quality-based standards, which are used to determine NPDES permit discharge limits.	Relevant to storm water runoff from construction activities and discharges of treated groundwater to a surface water.
40 CFR 403 - General Pretreatment Regulations for Existing and New Sources of Pollution	Discharge to a POTW must comply with local POTW pretreatment program, including POTW-specific pollutants and reporting and monitoring requirements.	Relevant to discharges of treated groundwater to a POTW.
40 CFR Parts 144 - Underground Injection Control Program	Underground injection control program regulates the construction, operation, permitting, and closure of injection wells used to place fluids underground for storage or disposal.	Relevant to actions that result in the injection of amendments into the subsurface.
Clean Air Act - Sections 107, 109, 110, 111, and 112	Air emission requirements.	Relevant to remedial actions which may produce airborne pollutants.
National Primary and Secondary Ambient Air Quality Standards; 40 CFR 50	Application regulations for national primary and secondary ambient air quality standards.	Relevant to remedial actions which may produce airborne pollutants.
40 CFR 262 - Standards Applicable to Generators of Hazardous Waste	Applicable regulations to ensure that hazardous waste is appropriately identified and handled safely to protect human health and the environment.	Relevant to materials containing RCRA hazardous waste that are generated and stored onsite and transported offsite for disposal.
40 CFR 268 - Land Disposal Restrictions	Movement of excavated material to new location and placement in or on land will trigger land disposal restrictions for the excavated waste or closure requirements for the unit in which the waste is placed.	Relevant to materials containing RCRA hazardous waste subject to land disposal restrictions that are placed in another unit.

Table 4-1

Summary of Potential ARARs
Wix Filtration Facility
Dillon, South Carolina (a)

Potential ARAR	Requirements/Purpose	Applicability
State		
South Carolina Regulation 61-9 - Water Pollution Control Permits	Applicable regulations that set standards for direct (NPDES) and indirect (POTW) discharges to a surface water.	Relevant to storm water runoff from construction activities and discharges of treated groundwater to a surface water or POTW.
South Carolina Regulations 61-67 - Standards for Wastewater Facility Construction	Regulations apply to engineering design and construction of all wastewater treatment facilities and all wastewater collected and transmission facilities that require a concentration permit or state approval.	Potentially relevant to construction and operation of groundwater treatment system.
South Carolina Regulation 61-87 - Underground Injection Control Regulations	Underground injection control program regulates the construction, operation, permitting, and closure of injection wells used to place fluids underground for storage or disposal.	Relevant to actions that result in the injection of amendments into the subsurface.
South Carolina Regulation 61-71 - Well Standards	Regulations establish minimum standards for the construction, maintenance, and operation of monitoring wells and boreholes to ensure that underground sources of drinking water are not contaminated and public health is protected.	Relevant to actions which result in the installation of permanent or temporary monitoring wells and exploratory borings.
South Carolina Regulation 61-62.5 - Air Pollution Control Standards and Regulations	Air emission requirements.	Relevant to remedial actions which may produce airborne pollutants.
South Carolina Regulations 61-79.262- Standards Applicable to Generators of Hazardous Waste	Applicable regulations to ensure that hazardous waste is appropriately identified and handled safely to protect human health and the environment.	Relevant to materials containing RCRA hazardous waste that are generated and stored onsite and transported offsite for disposal.
South Carolina Regulations 61-79.268 - Land Disposal Restrictions	Movement of excavated material to new location and placement in or on land will trigger land disposal restrictions for the excavated waste or closure requirements for the unit in which the waste is placed.	Relevant to materials containing RCRA hazardous waste subject to land disposal restrictions that are placed in another unit.

a/ ARAR = Applicable or Relevant and Appropriate Requirement; CFR = Code of Federal Regulations; EPA = U.S. Environmental Protection Agency; USC = U.S. Code;
NPDES = National Pollutant Discharge Elimination System; POTW = publically owned treatment works; RCRA = Resource Conservation and Recovery Act.

Table 5-1

Initial Screening of Potential Remedial Technologies
Wix Filtration Facility
Dillon, South Carolina (a)

Response Actions	Remedial Technology	Process Option	Description	Effectiveness	Technical and Administrative Implementability	Cost	Evaluation
No Action	NA	NA	No Action	Low	High	Low	Eliminated as an option because of ineffectiveness to achieve RAOs.
Institutional/ Engineering Controls	NA	Deed Restrictions	Restriction of onsite property use to light industrial; groundwater cannot be used for water supply; drilling and construction activity restrictions.	Moderate	High	Low	Retained
	NA	Water Supply	Water supplied to the facility via the City of Dillon rathe than onsite wells.	Moderate	High	Low	Retained
Ex Situ Treatment	Physical Treatment	Excavation	Soil removal, transportation, and offsite treatment and disposal	High	Moderate	High	Eliminated as an independent remedial action because difficult implementability with utilities and structures located throughout the source area and high cost. Retained for further evaluation if limited to "hot spot" treatment and combined with other technologies.
		AFVR	High-vaccuum dual phase extraction application	Low	Moderate	Moderate to High	Eliminated as an independent remedial action due to low native soil permeability hindering its effectiveness. Retained for further evaluation if implemented following excavation as a supplemental treatment in a new, 4-inch diameter extraction well.
In Situ Treatment	Physical/Chemical Treatment	Modified AS/SVE	Injecting air into groundwater to transfer toluene from vadose zone soil into the air	Moderate	High	Low to Moderate	Existing AS/SVE system is ineffective due to low soil permeability, shallow groundwater table, and NAPL-indicative toluene concentrations in groundwater and soils. The AS/SVE system would be converted into a dual phase extraction system to dewater the area, therefore increasing the sparge capture and effectiveness of the treatment. However, low soil permeability and NAPL-indicative toluene concentrations in the source area would still hinder system effectiveness. This technology is retained for further evaluation due to ease of implementability.
		In Situ Chemical Oxidation	Injecting an oxidizer into groundwater to degrade organic contaminants	Low to Moderate	Moderate	Moderate	Eliminated because the technology is not applicable in low permeability soil the groundwater table is very shallow, which would lead to short-circuiting, and the oxidizer would be spent quickly resulting in ineffective treatment.
		Bioremediation	Injecting microbes and/or microbial nutrients into groundwater to stimulate microbial degradation of organic contaminants	Moderate	Low	Moderate	Not applicable as an independent technology due to low permeability soils, shallow groundwater table, and NAPL-indicative toluene concentrations; however, technology is potentially applicable if combined with other technologies to increase permeability and decrease toluene concentrations. Technology is retained for further evaluation to treat residual contamination after application of other technologies.
		MNA	Reducing mass or concentration through dispersion, dilution, sorption, volatilization, biodegradation, and abiotic degradation	Moderate	High	Low	Eliminated as an independent remedial action because technology will not b effective unless the source is controlled. Technology is retained for further evaluation to treat residual contamination after application of other technologies.
Combination of Remedial Alternatives	*Ex Situ* Treatment, followed by *In Situ* Treatment	Excavation of Soils with Biosparge and MNA	Hot spot removal, backfill with a highly permeable gravel bed, then install biosparge system in the backfilled area and then MNA	Moderate	High	Moderate	Retained
	Ex Situ Treatment, followed by *In Situ* Treatment	Excavation of Soils with AFVR and MNA	Hot spot mass removal by excation, backfill with a highly permeable gravel bed, then AFVR for additional mass removal and MNA to monitor groundwater concentrations	Moderate	High	Moderate	Retained

a/ NA = not applicable; AS/SVE = Air sparge/soil vapor extraction; AFVR = aggressive fluid vapor recovery; DPE = dual phase extraction; MNA = monitored natural attenuation; NAPL = non-aqueous phase liquid; RAO = remedial action objective.

[shaded box] = Eliminated from consideration

Table 6-1

Evaluation of Remedial Alternatives Against Criteria
Wix Filtration Facility
Dillon, South Carolina (a)

Evaluation Criteria	**Retained Remedial Alternatives**		
	Alternative 1 - Modified AS/SVE	**Alternative 2 - Excavation of Soils with Biosparging and MNA**	**Alternative 3 - Excavation of Soils with AFVR and MNA**
Overall Protection of Human Health and the Environment	**Moderate** - This alternative provides human health and environmental protection by mitigating exposures to affected soil and groundwater through deed restrictions and continued use of city water as a water supply source. Restoration of the impacted groundwater and soil would also be achieved over time. Energy consumption and waste generation relatively high due to mechanical processes applied over the entire remedial life.	**Moderate** - This alternative provides human health and environmental protection by mitigating exposures to affected soil and groundwater through deed restrictions and continued use of city water as a water supply source. Restoration of the impacted groundwater and soil would be achieved over time. Energy consumption and waste generation relatively high due to mechanical processes applied over the entire remedial life due to continuous operation of mechanical processes.	**High** - This alternative provides human health and environmental protection through active treatment and restoration of the impacted groundwater and soil. Energy consumption and waste generated over the entire remedial life is low due to short-term operation of mechanical processes.
Compliance with the ARARs	**Moderate** - Toluene concentrations will decrease over time within the capture zone but achievement of SCMCL throughout the affected area is uncertain. Technology would need to comply with water discharge and air emission requirements. The disposition of treatment residuals from all alternatives would have to be consistent with applicable waste regulations, and well construction in the alternatives would have to comply with South Carolina well construction standards.	**Moderate** - Toluene concentrations will decrease over time within the capture zone but achievement of SCMCL throughout the affected area is uncertain. Technology would need to comply with air emission requirements. The disposition of treatment residuals from all alternatives would have to be consistent with applicable waste regulations, and well construction in the alternatives would have to comply with South Carolina well construction standards.	**Moderate** - Toluene concentrations will decrease over time within the capture zone but achievement of SCMCL throughout the affected area is uncertain. The disposition of treatment residuals from all alternatives would have to be consistent with applicable waste regulations, and well construction in the alternatives would have to comply with South Carolina well construction standards.
Short-Term Effectiveness	**Moderate** - Some risk to workers through potential incidental ingestion, dermal contact, and inhalation of VOCs during remediation and monitoring activities, which could be minimized by utilizing proper PPE. Noise from the treatment units could present some limited adverse impacts to onsite workers and nearby businesses. Risks could be minimized by following appropriate health and safety protocols, exercising sound engineering practices, and utilizing proper PPE. Achievement of RAOs would require at least 20 years, based on low permeability of soils.	**Moderate** - Some risk to workers through potential incidental ingestion, dermal contact, and inhalation of VOCs during remediation and monitoring activities, which could be minimized by utilizing proper PPE. Noise from the treatment units and excavation could present some limited adverse impacts to onsite workers and nearby businesses. Risks could be minimized by following appropriate health and safety protocols, exercising sound engineering practices, and utilizing proper PPE. The short-term effectiveness of this alternative is moderate for mitigating exposures, but achievement of RAOs objectives would require an estimated 7 years to be observed.	**Moderate** - Some risk to workers through potential incidental ingestion, dermal contact, and inhalation of VOCs during remediation and monitoring activities, which could be minimized by utilizing proper PPE. Noise from the treatment units and excavation could present some limited adverse impacts to onsite workers and nearby businesses. The short-term effectiveness of this alternative is high for mitigating exposures, but achievement of RAOs would require 10 years to be observed.
Long-Term Effectiveness and Permanence	**Moderate** - The alternative will mitigate exposures but may not achieve the SCMCLs across the site.	**Moderate** - This alternative will mitigate exposures but may not achieve the SCMCLs across the site depending on further evaluation of MNA parameters.	**Moderate** - This alternative will mitigate exposures but may not achieve the SCMCLs across the site depending on further evaluation of MNA parameters.
Reduction of Toxicity, Mobility, and Volume through Treatment	**Moderate** - This alternative will reduce the mass of toluene over time and reduce the mobility of toluene remaining above the SCMCL.	**High** - This alternative will reduce the mass of toluene over time and reduce the mobility of toluene remaining above the SCMCL.	**High** - This alternative will reduce the mass of toluene over time and reduce the mobility of toluene remaining above the SCMCL.

Table 6-1

Evaluation of Remedial Alternatives Against Criteria
Wix Filtration Facility
Dillon, South Carolina (a)

Evaluation Criteria	Retained Remedial Alternatives								
	Alternative 1 - Modified AS/SVE			Alternative 2 - Excavation of Soils with Biosparging and MNA			Alternative 3 - Excavation of Soils with AFVR and MNA		
Implementability	**Moderate**- This technology requires a pre-design study to calculate modified system requirements (e.g., well yield, transfer pipe sizing, treatment capacity), installation of associated transfer pipelines and wells, replacement of malfunctioning components of existing AS/SVE system, and installation of new water treatment equipment and trailer. In addition, this alternative requires long-term O&M and monitoring.			**Low** - This technology requires completion of a pre-design study to design an excavation shoring system and selection of the appropriate nutrients for the biosparge system, replacement of malfunctioning components of the existing AS/SVE system, and installation of associated transfer pipelines and wells. In addition, this alternative requires long-term O&M and monitoring.			**High** - This technology requires minimal construction (excavation and extraction well installation only), and the ongoing, long-term site work is limited to groundwater monitoring.		
Cost		Minimum	Maximum		Minimum	Maximum		Minimum	Maximum
	Years of Site O&M =	15	20	Years of Site O&M =	5	10	Years of Site O&M =	7	10
	Capital Cost =	$ 206,000	$ 206,000	Capital Cost =	$ 545,000	$ 545,000	Capital Cost =	$ 398,000	$ 398,000
	Annual Site O&M Cost =	$ 107,000	$ 107,000	Annual Site O&M Cost =	$ 102,000	$ 102,000	Annual Site O&M Cost =	$ 45,000	$ 45,000
	Total Cost (Non-Discounted) =	$ 1,811,000	$ 2,346,000	Total Cost (Non-Discounted) =	$ 1,055,000	$ 1,565,000	Total Cost (Non-Discounted) =	$ 713,000	$ 848,000
	NPV (7% Discount Rate) =	$ 1,117,000	$ 1,266,000	NPV (7% Discount Rate) =	$ 936,000	$ 1,215,000	NPV (7% Discount Rate) =	$ 625,000	$ 694,000
	NPV (1.9% Discount Rate) =	$ 1,566,000	$ 1,940,000	NPV (1.9% Discount Rate) =	$ 1,019,000	$ 1,449,000	NPV (1.9% Discount Rate) =	$ 685,000	$ 797,000

a/ AFVR = aggressive fluid vapor recovery; ARAR = Applicable or relevant and appropriate requirement; AS/SVE = air sparge/soil vapor extraction; SCMCL = South Carolina maximum contaminant level; RAO = remedial action objective; MNA = monitored natural attenuation; NAPL = non-aqueous phase liquid; NPV = net present value; O&M = operation and maintenance.

Appendix A – Historical Groundwater Elevation and Analytical Results Summary (ERM)

Appendix A
Ground Water Gauging
Data Summary

APPENDIX A. GROUND WATER GAUGING DATA SUMMARY - WIX FILTRATION FACILITY, DILLON, SC

Monitor Well	Gauging Date	TOC Elevation (ft NAVD)	Depth to Product (ft BTOC)	Depth to Water (ft BTOC)	Ground Water Elevation (ft NAVD)
MW-1	05/24/06	131.56	--	3.85	127.71
MW-1	01/04/07	131.56	--	3.25	128.31
MW-1	01/11/08	131.56	--	5.69	125.87
MW-1	03/12/09	131.56	--	3.09	128.47
MW-1	09/01/09	131.56	--	5.45	126.11
MW-1	03/10/10	131.56	--	--	--
MW-1	09/09/10	131.56	--	5.69	125.87
MW-1	02/23/11	131.56	--	2.51	129.05
MW-1	08/11/11	131.56	--	6.21	125.35
MW-1	02/13/12	131.56	--	5.13	126.43
MW-1	08/09/12	131.56	--	5.42	126.14
MW-1	02/12/13	131.56	--	3.00	128.56
MW-1	08/06/13	131.56	--	3.66	127.90
MW-1	02/24/14	131.56	--	0.40	131.16
MW-1	09/03/14	131.56	--	5.07	126.49
MW-1	03/04/15	131.56	--	1.35	130.21
MW-1	08/18/15	131.56	--	5.83	125.73
MW-4	05/24/11	130.47	--	4.30	126.17
MW-4	01/04/07	130.47	--	2.71	127.76
MW-4	01/11/08	130.47	--	6.39	124.08
MW-4	03/12/09	130.47	--	2.82	127.65
MW-4	09/01/09	130.47	--	6.70	123.77
MW-4	03/10/10	130.47	--	2.84	127.63
MW-4	09/09/10	130.47	--	7.77	122.70
MW-4	02/23/11	130.47	--	3.04	127.43
MW-4	08/11/11	130.47	--	9.04	121.43
MW-4	02/13/12	130.47	--	5.21	125.26
MW-4	08/09/12	130.47	--	Well damaged	
MW-4	02/12/13	130.47	--	Well damaged	
MW-4	08/06/13	130.47	--	Well damaged	
MW-4	02/24/14	130.47	--	Well damaged	
MW-4R	09/03/14	133.92	--	2.73	131.19
MW-4R	03/04/15	133.92	--	4.20	129.72
MW-4R	08/18/15	133.92	--	7.68	126.24
MW-7	01/04/07	128.24	--	0.55	127.69
MW-7	01/11/08	128.24	--	4.90	123.34
MW-7	03/12/09	128.24	--	1.21	127.03
MW-7	09/01/09	128.24	--	5.00	123.24
MW-7	03/10/10	128.24	--	1.42	126.82
MW-7	09/09/10	128.24	--	6.16	122.08

Monitor Well	Gauging Date	TOC Elevation (ft NAVD)	Depth to Product (ft BTOC)	Depth to Water (ft BTOC)	Ground Water Elevation (ft NAVD)
MW-2	05/24/06	129.58	--	3.58	126.00
MW-2	01/04/07	129.58	--	1.65	127.93
MW-2	01/11/08	129.58	--	5.54	124.04
MW-2	03/12/09	129.58	--	1.87	127.71
MW-2	09/01/09	129.58	--	5.99	123.59
MW-2	03/10/10	129.58	--	1.77	127.81
MW-2	09/09/10	129.58	--	6.74	122.84
MW-2	02/23/11	129.58	--	2.35	127.23
MW-2	08/11/11	129.58	--	7.66	121.92
MW-2	02/13/12	129.58	--	4.29	125.29
MW-2	08/09/12	129.58	--	5.71	123.87
MW-2	02/12/13	129.58	--	4.66	124.92
MW-2	08/06/13	129.58	--	1.99	127.59
MW-2	02/24/14	129.58	--	0.51	129.07
MW-2	09/03/14	129.58	--	3.91	125.67
MW-2	03/04/15	129.58	--	1.10	128.48
MW-2	08/18/15	129.58	--	6.62	122.96
MW-5	05/24/11	128.97	--	--	--
MW-5	01/04/07	128.97	--	1.22	127.75
MW-5	01/11/08	128.97	--	5.03	123.94
MW-5	03/12/09	128.97	--	1.21	127.76
MW-5	09/01/09	128.97	--	5.36	123.61
MW-5	03/10/10	128.97	--	1.07	127.90
MW-5	09/09/10	128.97	--	6.39	122.58
MW-5	02/23/11	128.97	--	1.75	127.22
MW-5	08/11/11	128.97	--	7.49	121.48
MW-5	02/13/12	128.97	--	5.39	123.58
MW-5	08/09/12	128.97	--	5.28	123.69
MW-5	02/12/13	128.97	--	2.47	126.50
MW-5	08/06/13	128.97	--	1.67	127.30
MW-5	02/24/14	128.97	--	0.60	128.37
MW-5	09/03/14	128.97	--	4.15	124.82
MW-5	03/04/15	128.97	--	0.30	128.67
MW-5	08/18/15	128.97	--	6.59	122.38
MW-8	01/04/07	130.91	--	4.22	126.69
MW-8	01/11/08	130.91	--	8.01	122.90
MW-8	03/12/09	130.91	--	4.28	126.63
MW-8	09/01/09	130.91	--	5.85	125.06
MW-8	03/10/10	130.91	--	2.84	128.07
MW-8	09/09/10	130.91	--	9.18	121.73

Monitor Well	Gauging Date	TOC Elevation (ft NAVD)	Depth to Product (ft BTOC)	Depth to Water (ft BTOC)	Ground Water Elevation (ft NAVD)
MW-3	05/24/06	129.06	--	2.82	126.24
MW-3	01/04/07	129.06	--	1.10	127.96
MW-3	01/11/08	129.06	--	4.61	124.45
MW-3	03/12/09	129.06	--	1.32	127.74
MW-3	09/01/09	129.06	--	4.76	124.30
MW-3	03/10/10	129.06	--	1.15	127.91
MW-3	09/09/10	129.06	--	5.87	123.19
MW-3	02/23/11	129.06	--	1.75	127.31
MW-3	08/11/11	129.06	--	6.94	122.12
MW-3	02/13/12	129.06	--	4.27	124.79
MW-3	08/09/12	129.06	--	5.03	124.03
MW-3	02/12/13	129.06	--	3.43	125.63
MW-3	08/06/13	129.06	--	1.38	127.68
MW-3	02/24/14	129.06	--	0.63	128.43
MW-3	09/03/14	129.06	--	4.01	125.05
MW-3	03/04/15	129.06	--	0.40	128.66
MW-3	08/18/15	129.06	--	5.03	124.03
MW-6	05/24/11	129.73	--	--	--
MW-6	01/04/07	129.73	--	1.64	128.09
MW-6	01/11/08	129.73	--	5.86	123.87
MW-6	03/12/09	129.73	--	2.09	127.64
MW-6	09/01/09	129.73	--	6.23	123.50
MW-6	03/10/10	129.73	--	--	--
MW-6	09/09/10	129.73	--	6.74	122.99
MW-6	02/23/11	129.73	--	2.57	127.16
MW-6	08/11/11	129.73	--	8.23	121.50
MW-6	02/13/12	129.73	--	4.62	125.11
MW-6	08/09/12	129.73	--	6.20	123.53
MW-6	02/12/13	129.73	--	3.62	126.11
MW-6	08/06/13	129.73	--	3.06	126.67
MW-6	02/24/14	129.73	--	1.30	128.43
MW-6	09/03/14	129.73	--	4.71	125.02
MW-6	03/04/15	129.73	--	1.21	128.52
MW-6	08/18/15	129.73	--	5.98	123.75
MW-9	01/04/07	131.76	--	3.55	128.21
MW-9	01/11/08	131.76	--	5.67	126.09
MW-9	03/12/09	131.76	--	3.58	128.18
MW-9	09/01/09	131.76	--	6.19	125.57
MW-9	03/10/10	131.76	--	3.00	128.76
MW-9	09/09/10	131.76	--	6.98	124.78

APPENDIX A. GROUND WATER GAUGING DATA SUMMARY - WIX FILTRATION FACILITY, DILLON, SC

Monitor Well	Gauging Date	TOC Elevation (ft NAVD)	Depth to Product (ft BTOC)	Depth to Water (ft BTOC)	Ground Water Elevation (ft NAVD)
MW-7	02/23/11	128.24	--	1.38	126.86
MW-7	08/11/11	128.24	--	6.74	121.50
MW-7	02/13/12	128.24	--	3.50	124.74
MW-7	08/09/12	128.24	--	5.22	123.02
MW-7	02/12/13	128.24	--	2.69	125.55
MW-7	08/06/13	128.24	--	1.12	127.12
MW-7	02/24/14	128.24	--	0.10	128.14
MW-7	09/03/14	128.24	--	4.63	123.61
MW-7	03/04/15	128.24	--	0.01	128.23
MW-7	08/18/15	128.24	--	6.58	121.66
MW-8	02/23/11	130.91	--	4.28	126.63
MW-8	08/11/11	130.91	--	10.50	120.41
MW-8	02/13/12	130.91	--	5.63	125.28
MW-8	08/09/12	130.91	--	5.44	125.47
MW-8	02/12/13	130.91	--	4.42	126.49
MW-8	08/06/13	130.91	--	5.37	125.54
MW-8	02/24/14	130.91	--	3.89	127.02
MW-8	09/03/14	130.91	--	7.91	123.00
MW-8	03/04/15	130.91	--	3.77	127.14
MW-8	08/18/15	130.91	--	9.60	121.31
MW-9	02/23/11	131.76	--	3.61	128.15
MW-9	08/11/11	131.76	--	7.29	124.47
MW-9	02/13/12	131.76	--	4.71	127.05
MW-9	08/09/12	131.76	--	6.29	125.47
MW-9	02/12/13	131.76	--	5.62	126.14
MW-9	08/06/13	131.76	--	4.53	127.23
MW-9	02/24/14	131.76	--	2.76	129.00
MW-9	09/03/14	131.76	--	5.86	125.90
MW-9	03/04/15	131.76	--	3.70	128.06
MW-9	08/18/15	131.76	--	6.58	125.18
MW-10	02/23/11	130.34	--	3.72	126.62
MW-10	08/11/11	130.34	--	8.29	122.05
MW-10	02/13/12	130.34	--	5.48	124.86
MW-10	08/09/12	130.34	--	4.41	125.93
MW-10	02/12/13	130.34	--	4.00	126.34
MW-10	08/06/13	130.34	--	5.60	124.74
MW-10	02/24/14	130.34	--	4.27	126.07
MW-10	09/03/14	130.34	--	6.59	123.75
MW-10	03/04/15	130.34	--	4.12	126.22
MW-10	08/18/15	130.34	--	7.40	122.94
MW-11	02/23/11	130.59	--	3.49	127.10
MW-11	08/11/11	130.59	--	8.99	121.60
MW-11	02/13/12	130.59	--	5.47	125.12
MW-11	08/09/12	130.59	--	4.09	126.50
MW-11	02/12/13	130.59	--	3.79	126.80
MW-11	08/06/13	130.59	--	5.56	125.03
MW-11	02/24/14	130.59	--	4.05	126.54
MW-11	09/03/14	130.59	--	7.24	123.35
MW-11	03/04/15	130.59	--	4.02	126.57
MW-11	08/18/15	130.59	--	7.50	123.09
MW-12	02/23/11	134.56	--	1.79	132.77
MW-12	08/11/11	134.56	--	4.26	130.30
MW-12	02/13/12	134.56	--	5.39	129.17
MW-12	08/09/12	134.56	--	8.32	126.24
MW-12	02/12/13	134.56	--	5.09	129.47
MW-12	08/06/13	134.56	--	4.55	130.01
MW-12	08/06/13	134.56	--	3.58	130.98
MW-12	09/03/14	134.56	--	4.74	129.82
MW-12	03/04/15	134.56	--	3.63	130.93
MW-12	08/18/15	134.56	--	5.09	129.47
MW-13	02/23/11	131.42	--	3.10	128.32
MW-13	08/11/11	131.42	--	8.30	123.12
MW-13	02/13/12	131.42	--	5.72	125.70
MW-13	08/09/12	131.42	--	7.00	124.42
MW-13	02/12/13	131.42	--	6.87	124.55
MW-13	08/06/13	131.42	--	2.32	129.1
MW-13	02/24/14	131.42	--	2.39	129.03
MW-13	09/03/14	131.42	--	2.39	129.03
MW-13	03/04/15	131.42	--	2.56	128.86
MW-13	08/18/15	131.42	--	5.63	125.79
MW-14	02/13/12	135.01	--	10.42	124.59
MW-14	08/09/12	135.01	--	11.1	123.91
MW-14	02/12/13	135.01	--	11.53	123.48
MW-14	08/06/13	135.01	--	6.75	128.26
MW-14	02/24/14	135.01	--	6.25	128.76
MW-14	09/03/14	135.01	--	6.25	128.76
MW-14	03/04/15	135.01	--	5.75	129.26
MW-14	08/18/15	135.01	--	11.65	123.36
MW-15	02/13/12	130.84	--	6.78	124.06
MW-15	08/09/12	130.84	--	8.32	122.52
MW-15	02/12/13	130.84	--	6.10	124.74
MW-15	08/06/13	130.84	--	4.85	125.99
MW-15	02/24/14	130.84	--	4.30	126.54
MW-15	09/03/14	130.84	--	4.30	126.54
MW-15	03/04/15	130.84	--	3.99	126.85
MW-15	08/18/15	130.84	--	9.61	121.23
MW-11D	09/03/14	131.63	--	6.95	124.68
MW-11D	03/04/15	131.63	--	2.76	128.87
MW-11D	08/18/15	131.63	--	8.95	122.68
MW-12D	09/03/14	134.15	--	9.13	125.02
MW-12D	03/04/15	134.15	--	5.40	128.75
MW-12D	08/18/15	134.15	--	10.87	123.28

NGVD = National Geodetic Vertical Datum of 1929 TOC = Top of PVC Casing "--" = Not detected or no data available

Appendix B
Ground Water Analytical Data Summary

APPENDIX B. GROUND WATER ANALYTICAL DATA SUMMARY - WIX FILTRATION FACILITY, DILLON, SC

EPA 8260 (ug/l) Sample Location	Sample Date	Acetone	Benzene	cis-1,2-DCE	trans-1,2-DCE	1,2-DCE (Total)	1,1-DCE	Ethylbenzene	2-Hexanone	Isopropylbenzene	p-Isopropyltoluene	n-Propylbenzene	Toluene	TCE	PCE	1,2,4-Trimethylbenzene	1,3,5-Trimethylbenzene	1,1,1-TCA	Xylene (Total)	m&p-Xylene	o-Xylene	Carbon disulfide	2-Butanone	sec-Butylbenzene	n-Butylbenzene	tert-Butylbenzene	Styrene	2-Chlorotoluene	4-Chlorotoluene	Methylene Chloride	Naphthalene	Vinyl Chloride
SC GWr Std (MCL)		NE	5	70	100	170	7	700	NE	NE	NE	NE	1,000	5	5	NE	NE	200	10K	NE	NE	360	NE	NE	NE	NE	100	NE	NE	NE	NE	2
MW-1	05/25/06	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	340,000	ND	ND	ND	ND	ND	230	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-1	08/08/07	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	260,000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-1	01/10/08	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	231,000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-1	08/14/08	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	254,000	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-1	03/12/09	ND	69.8	4.02	ND	4.02	ND	45.9	ND	ND	4.1	ND	286,000	ND	ND	2.18	ND	ND	44	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-1	09/01/09	ND	57.9	2.85	ND	2.85	ND	25.4	ND	ND	3.3	ND	229,000	ND	ND	1.86	1.57	ND	26	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-1	03/10/10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	326,000	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-1	09/09/10	62	ND	2.66	ND	ND	ND	48.4	ND	1.02	8.13	3.81	332,000	ND	1.24	10.8	4.05	ND	51.4	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-1	02/23/11	ND	60.3	2.8	ND	2.8	ND	ND	ND	ND	6.75	1.91	282,000	ND	ND	6.39	2.31	ND	ND	--	--	2.93	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-1	08/12/11	ND	63.2	2.92	ND	ND	ND	35.6	ND	ND	6.02	1.43	364,000	ND	2.08	3.81	1.56	ND	37	--	--	1.52	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DUP-01	08/12/11	ND	58.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	338,000	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-1	02/13/12	ND	20.4	ND	ND	ND	ND	ND	ND	ND	ND	ND	18,100	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-1	08/10/12	ND	54.3	1.95	ND	ND	ND	9.28	ND	ND	0.988(j)	0.436(J)	66,700	ND	0.353(J)	1.56	0.614(j)	ND	10.4	--	--	0.292(J)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DUP-01	08/10/12	ND	53	2.2	ND	ND	ND	10.8	ND	ND	0.33(J)	ND	44,200	ND	0.404	3.47	1.23	ND	12.7	--	--	0.351(J)	ND	ND	ND	ND	0.422(J)	0.754(J)	ND	ND	ND	ND
MW-1	02/12/13	ND	25.6	1.01	ND	ND	ND	0.72(J)	ND	ND	ND	ND	167	ND	ND	1.17	ND	ND	0.669(J)	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DUP-01	02/12/13	ND	24.8	1.04	ND	ND	ND	1.4	ND	0.290(J)	ND	ND	114	ND	ND	1.47	0.287(J)	ND	1.46(J)	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.41(J)	ND
MW-1	08/07/13	ND	6.57	0.257(J)	ND	ND	ND	ND	ND	ND	ND	ND	164	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	0.359	ND	ND
MW-1	02/25/14	ND	0.321(J)	ND	ND	ND	ND	0.978	ND	ND	ND	ND	1,050	ND	ND	ND	ND	ND	1.33(J)	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DUP-01	02/25/14	ND	0.313(J)	0.392(j)	ND	.392(J)	ND	9:50 AM	ND	ND	ND	ND	1,450	ND	ND	ND	ND	ND	1.87(J)	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-1	09/04/14	ND	5.95	0.479(J)	ND	ND	ND	ND	ND	ND	ND	ND	19	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DUP-01	09/04/14	ND	6.06	0.436(J)	ND	ND	ND	ND	ND	ND	ND	ND	20	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-1	03/04/15	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	17	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.917(J)	ND
DUP-01	03/04/15	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	81	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-1	08/19/15	ND	0.446(J)	ND	ND	ND	ND	ND	ND	ND	ND	ND	68	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DUP-01	08/19/15	ND	0.488(J)	ND	ND	ND	ND	ND	ND	ND	ND	ND	94	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-2	05/24/06	ND	21	ND	ND	ND	ND	3.0	ND	ND	ND	ND	11,000	ND	ND	ND	ND	ND	2.8	2.4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-2	08/08/07	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	31,100	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-2	01/10/08	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	127,000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-2	08/14/08	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	81,500	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-2	03/12/09	ND	56.4	1.89	ND	1.89	ND	27.9	ND	ND	1.24	1.21	141,400	ND	ND	1.1	ND	ND	18.9	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-2	09/01/09	ND	44.8	1.39	ND	1.39	ND	11.9	ND	ND	1.74	ND	91,800	ND	ND	ND	ND	ND	12.4	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-2	03/10/10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	99,400	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-2	09/09/10	ND	69.1	1.72	ND	ND	ND	25.5	ND	ND	7.48	1.69	167,000	ND	ND	2.81	ND	ND	24.3	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-2	02/23/11	ND	60	1.72	ND	ND	ND	21	ND	ND	2.94	1.57	115,000	ND	ND	1.73	ND	ND	20.7	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-2	08/12/11	ND	61.6	1.44	ND	ND	ND	10.4	ND	ND	1.03	ND	96,600	ND	ND	ND	ND	ND	11	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-2	02/13/12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	222,000	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-2	08/10/12	18.6(J)	64.2	1.84	ND	ND	ND	23.8	ND	0.303(J)	3.82	1.32	137,000		0.295(J)	2.22	0.722(J)	ND	24.4	--	--	0.629(J)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-2	02/12/13	29.5(J)	61.4	1.97	ND	ND	ND	20.1	ND	0.295(J)	3.02	1.23	131,000	0.266(J)	0.303(J)	2.08	0.587(J)	ND	22.3	--	--	1.36	ND	ND	ND	ND	ND	ND	ND	ND	1.36(J)	ND
MW-2	08/07/13	46.4	52.6	1.35	ND	ND	ND	15.1	ND	ND	2.41	0.787(J)	112,000	ND	ND	1.39	0.450(J)	ND	16.9	--	--	0.449(J)	ND	ND	ND	ND	ND	ND		0.349(J)	ND	ND
DUP-01	08/07/13	49.5	49.6	1.43	ND	ND	ND	15.1	ND	ND	2.22	0.733(J)	101,000	ND	ND	1.57	0.580(J)	ND	17.2	--	--	0.394(J)	ND	ND	ND	ND	ND	ND		0.583(J)	ND	ND
MW-2	02/25/14	10.8(J)	50.3	1.39	ND	ND	ND	19	ND	ND	2.95	1.03	105,000	ND	0.260(J)	2.53	0.736(J)	ND	19.1	--	--	0.603(J)	ND	ND	ND	ND	ND	ND	ND	ND	1.49(J)	ND
MW-2	09/04/14	30.1	51.4	1.48	ND	ND	ND	12.8	ND	0.851(J)	1.62	0.747(J)	63,300	ND	ND	1.33	0.752(J)	ND	13.9	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-2	03/04/15	90.8	40.5	1.08	ND	ND	ND	17.2	ND	ND	2.76	0.953(J)	85,100	0.304(J)	ND	1.6	0.560(J)	ND	20.2	--	--	ND	2.83(J)	ND	ND	ND	ND	ND	ND	ND	0.304(J)	ND
MW-2	08/19/15	90.9	44.4	1.39	ND	ND	ND	19.2	ND	ND	2.91	4.28	92,000	ND	ND	2.02	0.887(J)	ND	35.2	--	--	0.303(J)	3.90(J)	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-3	05/24/06	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	210,000	ND	ND	2,100	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DUP-1	05/24/06	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	220,000	ND	ND	2,100	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-3	08/08/07	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	142,000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DUP-1	08/08/07	ND	25.3	2.3	ND	2.3	ND	28.5	5.7	16.3	ND	ND	132,000	ND	ND	134	ND	ND	86.4	39.7	46.7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-3	01/10/08	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	78,300	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DUP-1	01/10/08	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	90,300	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-3	08/14/08	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	57,800	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-3	03/12/09	ND	9.85	ND	ND	ND	ND	15.2	ND	23.8	5.43	35.8	14,200	ND	ND	173	60.2	ND	30.1	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-3	09/01/09	ND	13.8	1.09	ND	1.09	ND	22.7	ND	22.3	7.55	50.1	41,000	ND	ND	159	69.6	ND	63.9	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-3	03/10/10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	112	6,470	ND	ND	150	184	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-3	09/09/10	ND	ND	ND	ND	ND	ND	23.7	ND	21.3	6.1	36.2	65,300	ND	ND	156	55.3	ND	68.0	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

APPENDIX B. GROUND WATER ANALYTICAL DATA SUMMARY - WIX FILTRATION FACILITY, DILLON, SC

EPA 8260 (ug/l) Sample Location	Sample Date	Acetone	Benzene	cis-1,2-DCE	trans-1,2-DCE	1,2-DCE (Total)	1,1-DCE	Ethylbenzene	2-Hexanone	Isopropylbenzene	p-Isopropyltoluene	n-Propylbenzene	Toluene	TCE	PCE	1,2,4-Trimethylbenzene	1,3,5-Trimethylbenzene	1,1,1-TCA	Xylene (Total)	m&p-Xylene	o-Xylene	Carbon disulfide	2-Butanone	sec-Butylbenzene	n-Butylbenzene	tert-Butylbenzene	Styrene	2-Chlorotoluene	4-Chlorotoluene	Methylene Chloride	Naphthalene	Vinyl Chloride
SC GWr Std (MCL)		NE	5	70	100	170	7	700	NE	NE	NE	NE	1,000	5	5	NE	NE	200	10K	NE	NE	360	NE	NE	NE	NE	100	NE	NE	NE	NE	2
MW-3	02/23/11	474	29.4	1.67	ND	ND	ND	38.4	ND	25	5.19	48.1	156,000	ND	ND	165	60.7	ND	113.0	--	--	1.27	66.2	1.46	3.5	25.7	3.5	25.7	66.2	1.46	3.5	25.7
MW-3	08/13/11	ND	20.2	1.13	ND	ND	ND	13.9	ND	8.38	1.49	15	104,000	ND	ND	70.6	21	ND	42.2	--	--	ND	ND	ND	1.26	ND	1.26	ND	ND	ND	1.26	ND
MW-3	02/13/12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	161,000	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-3	08/10/12	43.6(J)	21.4	1.29	ND	ND	ND	21.5	ND	11.6	2.41	20.6	93,500	ND	0.465(J)	93.4	30.9	ND	66.5	--	--	ND	5.82(J)	0.797(J)	ND	ND	1	ND	ND	ND	ND	ND
MW-3	02/12/13	58.7	25.5	1.73	ND	ND	ND	33.2	ND	18.6	4.15	33.8	128,000	0.377(J)	0.742(J)	173	57.3	ND	111	--	--	0.417(J)	ND	ND	ND	ND	ND	ND	ND	ND	2.04(J)	ND
MW-3	08/07/13	ND	16.8	1.04	ND	ND	ND	12.5	ND	7.21	1.5	8.89	25,400	ND	ND	65.4	21.7	ND	33.4	--	--	ND	ND	ND	ND	ND	ND	ND		0.789(J)	ND	ND
MW-3	02/25/14	ND	19.3	1.39	ND	ND	ND	17	ND	9.35	2.95	14.9	20,000	0.281(J)	ND	92.8	34.5	ND	40.6	--	--	ND	ND	ND	1.52	ND	ND	ND	ND	ND	0.664(J)	ND
MW-3	09/04/14	6.71(J)	21.80	1.22	ND	ND	ND	16.40	ND	7.42	2.15	14.90	52,700	0.309(J)	ND	74	23.8	ND	49.8	--	--	ND	ND	0.912(J)	1.27	ND	ND	17.2	ND	ND	1.85(J)	ND
MW-3	03/04/15	ND	17.30	1.29	ND	ND	ND	11.90	ND	7.22	1.73	11.90	4,960	ND	ND	63	21.2	ND	16.7	--	--	0.306(J)	ND	0.680(J)	ND	ND	ND	ND	ND	ND	0.427	ND
MW-3	08/19/15	12.4(J)	22.20	1.55	ND	ND	ND	33.40	ND	11.30	2.49	25.60	69,700	0.331(J)	0.177(J)	118	39.7		89.9	--	--	ND	ND	1.06	2.93	ND	ND	ND	ND	ND	ND	ND
MW-4	05/24/06	27	27	4.8	ND	5.1	ND	3.4	ND	ND	ND	1.1	41,000	ND	ND	ND	1.6	ND	9.3	4.1	5.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-4	08/08/07	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	169,000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-4	01/10/08	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	321,000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-4	08/14/08	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	321,000	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DUP-1	08/14/08	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	333,000	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-4	03/12/09	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	340,000	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DUP-1	03/13/09	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	349,000	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-4	09/01/09	64.7	81.1	12.9	ND	12.9	ND	25.5	ND	4.07	2.06	ND	272,000	ND	1.03	33.1	9.09	ND	56.2	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-4	03/10/10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	112	450,000	ND	ND	150	184	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DUP-1	03/10/10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	112	447,000	ND	ND	150	184	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-4	09/09/10	72.8	93.4	13.4	ND	ND	ND	27.4	ND	5.32	1.5	8.31	296,000	ND	1.31	37.4	11.5	ND	59.2	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DUP-1	09/09/10	70.0	93.1	13.6	ND	ND	ND	25.1	ND	4.71	1.23	6.98	304,000	ND	1.26	32.4	9.87	ND	54.6	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-4	02/24/11	157	95	14	ND	ND	ND	33.3	ND	5.89	1.83	9.44	267,000	ND	ND	40.4	12.8	ND	71.1	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-4	08/12/11	230	118	14	ND	ND	ND	36.8	ND	8.49	3.65	13.6	449,000	ND	2.4	61.5	18.8	ND	79.4	--	--	2.11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-4	02/13/12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	384,000	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-4	08/10/12	287	20.2	14.1	ND	ND	ND	34.8	ND	5.81	1.5	8.25	404,000	ND	ND	37.4	11.8	ND	72	--	--	2.71	24.7(J)	ND	ND	ND	0.954(J)	ND	ND	ND	ND	ND
MW-4	09/04/14	607	76.5	12.20	0.839(j)	ND	ND	45.4	ND	13.1	9.3	ND	327,000	ND	2.65	115	36.5	ND	105	--	--	2.65	63.5	1.04	1.77	ND	ND	27.2	ND	ND	2.77(J)	ND
MW-4	03/04/15	629	40.5	12.30	0.410(J)	ND	ND	46.8	ND	8.81	4.01	17.8	449,000	0.416(J)	3.81	74.3	24.8	ND	97.9	--	--	3.85	ND	ND	0.423(J)	ND	ND	ND	ND	ND	0.866(J)	ND
MW-4	08/19/15	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	448,000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-5	01/04/07	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-6	01/04/07	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-7	01/04/07	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-7	DUP-1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-7	08/08/07	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	59.7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-7	08/23/07	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-7	01/10/08	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-7	08/14/08	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-7	03/13/09	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-7	09/01/09	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-7	03/10/10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-7	09/09/10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-7	02/23/11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	7.76	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-7	08/11/11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-7	02/13/12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DUP-01	02/13/12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-7	08/09/12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-7	02/12/13	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-7	08/06/13	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.586(J,B)	ND	ND	0.229(J)	ND	ND	0.437(J)	--	--	ND	ND	ND	ND	ND	ND	ND	ND	0.800J	ND	ND
MW-7	02/24/14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-7	09/03/14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.569(J)	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-7	09/03/14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.199(J)	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-7	08/18/15	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

APPENDIX B. GROUND WATER ANALYTICAL DATA SUMMARY - WIX FILTRATION FACILITY, DILLON, SC

EPA 8260 (ug/l) Sample Location	Sample Date	Acetone	Benzene	cis-1,2-DCE	trans-1,2-DCE	1,2-DCE (Total)	1,1-DCE	Ethylbenzene	2-Hexanone	Isopropylbenzene	p-Isopropyltoluene	n-Propylbenzene	Toluene	TCE	PCE	1,2,4-Trimethylbenzene	1,3,5-Trimethylbenzene	1,1,1-TCA	Xylene (Total)	m&p-Xylene	o-Xylene	Carbon disulfide	2-Butanone	sec-Butylbenzene	n-Butylbenzene	tert-Butylbenzene	Styrene	2-Chlorotoluene	4-Chlorotoluene	Methylene Chloride	Naphthalene	Vinyl Chloride
SC GWr Std (MCL)		NE	5	70	100	170	7	700	NE	NE	NE	NE	1,000	5	5	NE	NE	200	10K	NE	NE	360	NE	NE	NE	NE	100	NE	NE	NE	NE	2
MW-8	01/04/07	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-9	01/04/07	ND	ND	3.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
			ND																													
MW-10	02/23/11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.38	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-10	08/11/11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.31	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-10	02/13/12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.26	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-10	08/09/12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-10	02/12/13	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-10	08/06/13	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	).614(J,B)	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	0.670(J)	ND	ND
MW-10	02/24/14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-10	09/03/14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.553(J)	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-10	03/04/15	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-10	08/18/15	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-11	02/23/11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	13,200	ND	ND	1.9	ND	ND	5.19	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-11	08/11/11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	16,300	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-11	02/12/12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	42,900	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-11	08/09/12	ND	0.443(J)	ND	ND	ND	ND	0.845(J)	ND	ND	ND	ND	3,070	ND	ND	0.400(J)	ND	ND	1.04(J)	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-11	02/12/13	ND	0.650(J)	ND	ND	ND	ND	1.06	ND	ND	ND	ND	1,910	ND	ND	0.593(J)	ND	ND	1.14(J)	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-11	08/06/13	ND	13.3	ND	ND	ND	ND	18.1	ND	0.931(J)	1.16	1.29	19,900	ND	ND	5.42	1.88	ND	19.1	--	--	ND	ND	ND	ND	ND	ND	ND	ND	1.71(J)	ND	ND
MW-11	02/24/14	ND	10.1	ND	ND	ND	ND	16.9	ND	1.01	1.99	1.94	47,900	ND	ND	8.2	ND	2.59	20.8	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-11	09/04/14	ND	4.32	ND	ND	ND	ND	1.04	ND	0.883(J)	0.566(J)	0.23(J)	792	ND	ND	1.4	0.668(J)	ND	2.56	--	--	ND	ND	0.437	ND	ND	ND	ND	ND	ND	ND	ND
MW-11	03/04/15	ND	11.2		0.410(J)	ND	ND	19	ND	1.21	1.96	2.28	65,700	0.416(J)	ND	8.01	2.8	ND	25.6	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-11	08/18/15	3.58(J)	11.4	ND	ND	ND	ND	12.4	ND	0.587(J)	0.670(J)	1.53	10,600	ND	ND	8.93	1.56		17.1	--	--	ND	ND	ND	ND	ND	ND	ND	ND	0.686(J)	ND	ND
MW-11D	09/03/14	ND	1.8	14.7	0.611(J)	ND	ND	ND	ND	ND	ND	ND	0.574(J)	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-11D	03/04/15	ND	1.68	17.2	0.354(J)	ND	ND	ND	ND	ND	ND	ND	0.248(J)	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-11D	08/18/15		2.22	22.6	0.299(J)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-12	02/24/11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	494	ND	ND	1.05	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-12	08/11/11	ND	0.528(J)	13.3	ND	ND	ND	191	ND	1.48	5.94	2.84	94,500	ND	ND	27	13.2	ND	230	--	--	ND	ND	ND	1.54	ND	1.54	ND	ND	ND	1.54	ND
MW-12	02/13/12	ND	0.742(J)	ND	ND	ND	ND	62.6	ND	ND	ND	ND	5,770	ND	ND	ND	ND	ND	66.8	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-12	08/09/12	ND	1.04	10.1	ND	ND	ND	91.9	ND	0.588(J)	3.53	1.29	7,060	ND	ND	11.7	6.15	ND	94.5	--	--	ND	ND	0.263(J)	1.09	ND	ND	ND	ND	ND	ND	ND
MW-12	02/12/13	ND	2.00	8.06	ND	ND	ND	82.9	ND	0.520(J)	2.85	1.03	498	ND	ND	9.35	5.15	ND	69.8	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.52(J)	ND
MW-12	08/07/13	ND	ND	1.03	ND	ND	ND	126	ND	0.664(J)	2.94	1.43	46,100	0.671(J)	ND	15.5	7.53	ND	138	--	--	ND	ND	ND	ND	ND	ND	ND	ND	0.528(J)	1.52(J)	ND
MW-12	02/25/14	ND	ND	19.6	ND	ND	ND	127	ND	0.652(J)	ND	1.86	58,100	ND	0.294(J)	17.7	8.65	ND	134	--	--	ND	ND	0.229(J)	1.3		0.577(J)	ND	ND	ND	0.843(J)	ND
MW-12	09/04/14	ND	1.5	12.0	ND	ND	ND	87.4	ND	1	1.8	0.638(J)	98.1	ND	ND	8.53	4.82	ND	78.9	--	--	ND	ND	0.538(J)	0.979(J)	ND	ND	ND	ND	ND	1.74(J)	ND
MW-12	03/05/15	ND	1.05	9.2	ND	ND	ND	97	ND	0.532(J)	1.94	1.37	32,500	0.502(J)	0.721(J)	10.3	4.75	ND	81	--	--	ND	ND	0.479(J)	ND	ND	ND	ND	ND	ND	0.371(J)	ND
MW-12	08/18/15	ND	1.03	11.5	ND	ND	ND	95.9	ND	0.489(J)	1.7	0.913(J)	11.30	0.197(J)	ND	10.6	2.95	ND	43.4	--	--	ND	ND	0.240(J)	0.614(J)	ND	ND	ND	ND	ND	ND	ND
MW-12D	09/04/14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	8.62	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-12D	03/04/15	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.213(J)	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-12D	08/18/15	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.346(J)	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-13	02/24/11	35800	ND	86.5	7.07	ND	ND	ND	ND	14.8	ND	21.8	371,000	ND	ND	99.3	30.4	ND	187	--	--	7.04	695	ND	ND	ND	ND	ND	695	ND	ND	ND
MW-13	08/11/11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	446,000	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-13	02/13/12	86,800	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	459,000	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-13	08/09/12	66,100	80.6	62	7.27	ND	ND	52.8	ND	89.5	6.97	156	666,000	ND	9	501(E)	218(E)	ND	402	--	--	7.15	741	0.545(J)	7.06	80.8	7.03	142	23.1	1.51(J)	3.23(J)	0.439(J)
MW-13	02/12/13	75,300	77.7	63.3	4.62	ND	ND	51.6	ND	22.6	1.42	38.6	395,000	3.08	ND	177	56.7	ND	219	--	--	7.34	962	ND	ND	ND	ND	ND	ND	2.65(J)	2.41(J)	0.541(J)
MW-13	08/07/13	36,700	69	62.3	6.01	ND	ND	ND	ND	ND	0.829(J)	22.3	533,000	ND	ND	120	41.2	ND	ND	--	--	3.48	516	0.654(J)	ND	ND	ND	ND	ND	1.53(J)	1.02(J)	ND
MW-13	02/25/14	26,800	76.2	62.5	4.38	ND	ND	43.3	ND	19.2	1.2	31	545,000	2.42	4.82	128	48.3	ND	171	--	--	4.27	407	ND	1.69	ND	ND	ND	ND	1.42(J)	1.09(J)	0.393(J)
MW-13	09/04/14	14,100	78.2	42.2	2.15	44.35	ND	45.8	ND	16.6	1.32	32.8	490,000	2.37	ND	135	44.5	ND	182	--	--	3.52	185	0.936(J)	1.18	ND	ND	ND	ND	0.799(J)	2.59(J)	ND
MW-13	03/05/15	18,700	71.6	44.5	1.3	ND	ND	47.7	3.88(J)	18.2	1.07	31.8	441,000	1.23	4.77	137	47.1	ND	183	--	--	4.83	393	0.760(J)	1.22	ND	ND	ND	ND	0.236(J)	1.03(J)	0.356(J)
MW-13	08/19/15	45,300	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	451,000	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	695	ND	ND	ND
MW-14	02/12/12	ND	ND	436	ND	ND	1.27	ND	ND	ND	ND	ND	ND	ND	1.24	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

APPENDIX B. GROUND WATER ANALYTICAL DATA SUMMARY - WIX FILTRATION FACILITY, DILLON, SC

EPA 8260 (ug/l) Sample Location	Sample Date	Acetone	Benzene	cis-1,2-DCE	trans-1,2-DCE	1,2-DCE (Total)	1,1-DCE	Ethylbenzene	2-Hexanone	Isopropylbenzene	p-Isopropyltoluene	n-Propylbenzene	Toluene	TCE	PCE	1,2,4-Trimethylbenzene	1,3,5-Trimethylbenzene	1,1,1-TCA	Xylene (Total)	m&p-Xylene	o-Xylene	Carbon disulfide	2-Butanone	sec-Butylbenzene	n-Butylbenzene	tert-Butylbenzene	Styrene	2-Chlorotoluene	4-Chlorotoluene	Methylene Chloride	Naphthalene	Vinyl Chloride
SC GWr Std (MCL)		NE	5	70	100	170	7	700	NE	NE	NE	NE	1,000	5	5	NE	NE	200	10K	NE	NE	360	NE	NE	NE	NE	100	NE	NE	NE	NE	2
MW-14	08/09/12	ND	ND	447	ND	ND	87(J)	ND		0.293(J)		0.865(J)	23		0.864(J)	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-14	02/12/13	ND	ND	513	8.67	ND	1.58	ND	ND	ND	ND	ND	1.34	ND	1.06	0.584(J)	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.274(J)
MW-14	08/07/13	23	0.260(J)	994	491	ND	2.4	ND	ND	ND	ND	ND	2.03(B)	0.244(J)	1.28	0.341(J)	ND	ND	ND	--	--	ND	ND	0.248(J)	ND	ND	ND	ND	ND	0.667(J)	ND	0.580(J)
MW-14	02/24/14	ND	0.286(J)	1,310	0.659(J)	ND	3.14	ND	ND	ND	ND	ND	1.00	0.351(J)	1.45	ND	ND	ND	ND	--	--	ND	ND	0.215(J)	ND	ND	ND	ND	ND	ND	ND	0.887(J)
MW-14	09/04/14	ND	0.365(J)	1,300	25.2	ND	3.81	ND	ND	ND	ND	ND	1	0.346(J)	1.12	ND	ND	ND	ND	--	--	ND	ND	0.685(J)	0.54(J)	ND	ND	ND	ND	ND	ND	0.887(J)
MW-14	03/05/14	ND	ND	918	1.14	ND	146	ND	ND	ND	ND	ND	0.223(J)	ND	1.08	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.471(J)
MW-14	08/18/15	ND	0,255(J)	1,100	0.533(J)		2.84	ND	ND	ND	ND	ND	0.343(J)	0.274(J)	0.990(J)	ND	ND	ND	ND	--	--	ND	ND	0.240(J)	0.333(J)	ND	ND	ND	ND	ND	ND	0.922(J)
MW-15	02/12/12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-15	08/09/12	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.624(J)	0.731(J)	3	ND	ND	0.541(J)	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-15	02/12/13	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.303(J)	0.290(J)	0.684(J)	ND	ND	0.884(J)	0.283(J)	ND	0.279(J)	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-15	08/06/13	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	.594(J,B)	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	0.898(J)	ND	ND
MW-15	02/24/14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-15	09/03/14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	32.5	ND	ND	0.473(J)	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-15	03/04/15	ND	ND	ND	ND	ND	ND	0.202(J)	ND	ND	ND	ND	256	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-15	08/18/15	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Temporary Monitor Wells																																
TW-1	11/18/05	ND	54.1	3.93	ND	ND	8.02	39.3	ND	ND	1.88	2.58	140,000	ND	ND	ND	ND	7.52	30.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TW-2	11/18/05	ND	23.7	2.68	ND	ND	ND	13.8	ND	2.8	3.75	6.49	7,610	ND	ND	28.4	6.64	ND	13	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TW-3	11/18/05	ND	55.0	9.15	ND	ND	1.51	21.9	ND	5.9	1.03	9.85	184,000	ND	1.26	61.1	12.7	ND	44.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TW-3	DUP-1	51.6	57.8	13.3	ND	ND	ND	43.4	ND	12.8	2.48	24.1	184,000	ND	2.07	137	32.3	ND	88.7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
QA/QC Samples	**Equipment blanks**																															
EB-1	11/18/05	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.41	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
EB-1	05/25/06	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
EB-1	01/04/07	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
EB-1	08/08/07	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
EB-1	01/10/08	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
QA/QC Samples	**Field blanks**																															
FB-1	11/18/05	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
FB-1	05/25/06	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
FB-1	01/04/07	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
FB-1	08/08/07	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
FB-2	08/23/07	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
FB-1	01/10/08	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
QA/QC Samples	**Laboratory trip blanks**																															
TB-1	11/18/05	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.73	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TB-1	01/04/07	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TB-2	08/23/07	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TB	01/10/08	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trip Blank	08/14/08	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trip Blank	03/13/09	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.6	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trip Blank	09/01/09	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trip Blank	03/10/10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trip Blank	09/09/10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trip Blank	02/23/11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	46.8	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trip Blank	08/11/11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	46.8	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trip Blank	02/12/12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	46.8	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trip Blank	08/09/12	3.25(J)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	46.8	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trip Blank	02/12/13	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	46.8	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TB-01	08/07/13	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	46.8	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	0.427	ND	ND
TB-01	02/25/14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TB-01	09/03/14	38.3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TB-01	03/04/15	38.3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TB-01	08/18/15	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

ND = Not detected above analytical method quantitation limit   NE = Not established   "--" - Not analyzed   J - Approximate Value   E - Exceeded Calibration Range   NS - Not Sampled

Blue font - compound exceeds South Carolina MCL if an MCL has been established

Appendix B – Remedial Alternatives Cost Estimates

Table B-1

Alternative 1 - Modified AS/SVE System Detailed Costs
Wix Filtration Facility
Dillon, South Carolina

	Quantity	Units	Unit Cost	Total Cost	Assumptions
CAPITAL COSTS					
Institutional and Engineering Controls				$ 20,000	
Prepare Site Monitoring Plan	1	LS	$ 10,000	$ 10,000	
Filing of Deed Restriction	1	LS	$ 10,000	$ 10,000	
Modified AS/SVE System Implementation				$ 185,700	
Work Plan Preparations	1	LS	$ 20,000	$ 20,000	
Pre-Design Testing and Data Evaluation	1	LS	$ 10,000	$ 10,000	
Air Sparge Modifications - DPE System Design	1	LS	$ 20,000	$ 20,000	
Field Work Oversight	2	WK	$ 11,000	$ 22,000	
Site Mobilization/Demobilization	1	LS	$ 10,000	$ 10,000	
Trenching and Air Supply/ Water Conveyance Transfer Piping Installation	1	LS	$ 5,000	$ 5,000	
Submersible Pnuematic Pumps	4	EA	$ 4,000	$ 16,000	
Water Treatment System Equipment Building	1	LS	$ 25,000	$ 25,000	
Electrical Supply/Installation	1	LS	$ 10,000	$ 10,000	
Air Compressor for Submersible Pumps	1	EA	$ 5,000	$ 5,000	
Settling Tank	1	EA	$ 2,500	$ 2,500	
Bag Filter Units	2	EA	$ 5,000	$ 10,000	
Sequestration System	1	EA	$ 5,000	$ 5,000	
Granular Activated Carbon	1,000	LBS	$ 1.20	$ 1,200	
Contractor Startup Assistance	2	DAY	$ 1,500	$ 3,000	
Waste Management and Disposal	1	LS	$ 5,000	$ 5,000	
Modified O&M Plan	1	LS	$ 1,000	$ 1,000	
Completion Report	1	EA	$ 15,000	$ 15,000	
			Total Capital Costs	**$ 206,000**	(1)

Table B-1

Alternative 1 - Modified AS/SVE System Detailed Costs
Wix Filtration Facility
Dillon, South Carolina

	Quantity	Units	Unit Cost	Total Cost	Assumptions
ANNUAL COSTS					
Modified AS/SVE System Implementation				$ 62,840	
Bimonthly Contractor Site Visits	24	EA	$ 1,000	$ 24,000	
VOCs by EPA Method 8260B - Water	12	EA	$ 90	$ 1,080	
VOCs by EPA Method TO-15 - Vapor	12	EA	$ 180	$ 2,160	
Carbon Disposal and Replacement - Vapor and Water Phases	4	EA	$ 3,000	$ 12,000	
Electricity	12	MO	$ 300	$ 3,600	
Routine Equipment Repair/Replacement	1	LS	$ 5,000	$ 5,000	
Semiannual System Reporting	2	EA	$ 7,500	$ 15,000	
Semi-Annual Groundwater Monitoring and Reporting				$ 43,380	(2)
Number of Sampling Events	2	EA	-	-	
Number of Wells Sampled Per Event	8	EA	-	-	
Number of Field Duplicates Per Event - QA/QC	1	EA	-	-	
Number of Field Blanks Per Event - QA/QC	1	EA	-	-	
Number of Trip Blanks Per Event - QA/QC	1	EA	-	-	
Field Sampling	2	EA	$ 9,000	$ 18,000	
Waste Management	2	EA	$ 1,200	$ 2,400	
VOCs by EPA Method 8260B	22	EA	$ 90	$ 1,980	
Low Flow Sampling Equipment	2	EA	$ 8,000	$ 16,000	
Treatment Performance Analysis & Reporting	2	EA	$ 2,500	$ 5,000	
			Total Annual Site O&M Costs	**$ 107,000**	

	MINIMUM	MAXIMUM	
Number of Years of Site O&M	15	20	
Total Annual O&M Costs	$ 1,605,000	$ 2,140,000	
Effective Annual Discount Rate for PRP-Lead Sites	7%	7%	(3)
O&M Net Present Worth	$ 911,000	$ 1,060,000	
Effective Annual Discount Rate for Federal-Lead Sites	1.9%	1.9%	(4)
O&M Net Present Worth	$ 1,360,000	$ 1,734,000	
Total Alternative 1 Costs Including O&M (Non-Discounted Rate)	**$ 1,811,000**	**$ 2,346,000**	
Total Alternative 1 Costs Including O&M (7% Discounted Rate)	**$ 1,117,000**	**$ 1,266,000**	(3)
Total Alternative 1 Costs Including O&M (1.9% Discounted Rate)	**$ 1,566,000**	**$ 1,940,000**	(4)

Assumptions

(1) Capital and annual cost subtotals rounded up to the nearest $1,000.
(2) Includes quality assurance/quality control samples (duplicates, equipment blanks, and trip blanks), where appropriate.
(3) Discount rate of 7% from "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study", U.S. Army Corps of Engineers and U.S. Environmental Protection Agency, July 2000.
(4) Discount rate of 1.9% from "Memorandum for the Heads of Departments and Agencies Regarding 2014 Discount Rates for [Office of Management and Budget] OMB Circular No. A-94 [Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs]", Executive Office of the President, February 7, 2014.

Table B-2

Alternative 2 - Combination Treatment
Excavation of Soils with Toluene Concentrations above Csat near MW-4R with Biosparge Detailed Costs
Wix Filtration Facility
Dillon, South Carolina

	Quantity	Units	Unit Cost	Total Cost	Assumptions
CAPITAL COSTS					
Institutional and Engineering Controls				$ 20,000	
Prepare Site Monitoring Plan	1	LS	$ 10,000	$ 10,000	
Filing of Deed Restriction	1	LS	$ 10,000	$ 10,000	
Excavation Soils with Toluene Concentration above C_{sat} (MW-4R area)				$ 379,170	(1)
Mob/Site Prep	1	LS	$ 5,000	$ 5,000	
Work Plan Preparations	1	LS	$ 20,000	$ 20,000	
Monitoring Well Abandonment	1	LS	$ 15,000	$ 15,000	
Surface Removal (asphalt, conc)	1,200	SF	$ 1	$ 1,200	
Overburden Removal	300	CY	$ 10	$ 3,000	
Contaminated Soil Excavation	400	CY	$ 12	$ 4,800	
Slide Rail Shoring/Geotech design	1	LS	$ 30,000	$ 30,000	
Water Management/Disposal	3,000	GAL	$ 2.50	$ 7,500	
Transportation/Disposal - Concrete/ Asphalt	25	TON	$ 30	$ 750	
Transportation/Disposal - Clean Overburden	500	TON	$ 30	$ 15,000	
Transportation/Disposal - Hazardous	700	TON	$ 250	$ 175,000	
Gravel Backfill Material	700	CY	$ 25	$ 17,500	
Backfill/Compaction Labor and Equipment	700	CY	$ 10	$ 7,000	
Engineering Oversight	3	WK	$ 9,000	$ 27,000	
Post-Excavation Confirmation Sampling & Analysis	10	EA	$ 100	$ 1,000	
Office Engineer Support	15	HR	$ 128	$ 1,920	
Site Restoration/New MWs/Demob	1	LS	$ 30,000	$ 30,000	
Surveying	1	LS	$ 2,500	$ 2,500	
Completion Report	1	LS	$ 15,000	$ 15,000	
Bio-Sparge System				$ 145,000	
In situ Microcosm and Bench Scale	1	LS	$ 50,000	$ 50,000	
Biostimulants and Augments	1	LS	$ 50,000	$ 50,000	
Bio-Sparge System Design	1	LS	$ 15,000	$ 15,000	
Field Work Oversight	1	WK	$ 11,000	$ 11,000	
Site Mobilization/Demobilization	1	LS	$ 10,000	$ 10,000	
Trenching and Transfer Piping Installation	1	LS	$ 5,000	$ 5,000	
Blower	0	LS	$ 5,000	$ -	
Electrical Supply/Installation	1	LS	$ -	$ -	
Contractor Startup Assistance	2	DAY	$ 1,500	$ 3,000	
Modified O&M Plan	1	LS	$ 1,000	$ 1,000	
			Total Capital Costs	**$ 545,000**	(2)

Table B-2

Alternative 2 - Combination Treatment
Excavation of Soils with Toluene Concentrations above Csat near MW-4R with Biosparge Detailed Costs
Wix Filtration Facility
Dillon, South Carolina

	Quantity	Units	Unit Cost	Total Cost	Assumptions
ANNUAL COSTS					
Bio-Sparge System				$ 56,960	
Bimonthly Contractor Site Visits	24	EA	$ 1,000	$ 24,000	
Biosparge Nutrients	12	MO	$ 100	$ 1,200	
VOCs by EPA Method TO-15 - Vapor	12	EA	$ 180	$ 2,160	
Carbon Disposal and Replacement - Vapor and Water Phases	2	EA	$ 3,000	$ 6,000	
Electricity	12	MO	$ 300	$ 3,600	
Routine Equipment Repair/Replacement	1	LS	$ 5,000	$ 5,000	
Semiannual System Reporting	2	EA	$ 7,500	$ 15,000	
Semi-Annual Groundwater Monitoring and Reporting				$ 44,980	(3)
Number of Sampling Events	2	EA	-	-	
Number of Wells Sampled Per Event	8	EA	-	-	
Number of Field Duplicates Per Event - QA/QC	1	EA	-	-	
Number of Field Blanks Per Event - QA/QC	1	EA	-	-	
Number of Trip Blanks Per Event - QA/QC	1	EA	-	-	
Field Sampling	2	EA	$ 9,000	$ 18,000	
Waste Management	2	EA	$ 1,200	$ 2,400	
VOCs by EPA Method 8260B	22	EA	$ 90	$ 1,980	
Alkalinity	20	EA	$ 20	$ 400	
Nitrate, Sulfate	20	EA	$ 55	$ 1,100	
Ferrous Iron	20	EA	$ 5	$ 100	
Low Flow Sampling Equipment	2	EA	$ 8,000	$ 16,000	
Treatment Performance Analysis & Reporting	2	EA	$ 2,500	$ 5,000	
			Total Annual Site O&M Costs	**$ 102,000**	

	MINIMUM	MAXIMUM	
Number of Years of Site O&M	5	10	
Total Annual O&M Costs	$ 510,000	$ 1,020,000	
Effective Annual Discount Rate for PRP-Lead Sites	7%	7%	(4)
O&M Net Present Worth	$ 391,000	$ 670,000	
Effective Annual Discount Rate for Federal-Lead Sites	1.9%	1.9%	(5)
O&M Net Present Worth	$ 474,000	$ 904,000	
Total Alternative 2 Costs Including O&M (Non-Discounted Rate)	**$ 1,055,000**	**$ 1,565,000**	
Total Alternative 2 Costs Including O&M (7% Discounted Rate)	**$ 936,000**	**$ 1,215,000**	(4)
Total Alternative 2 Costs Including O&M (1.9% Discounted Rate)	**$ 1,019,000**	**$ 1,449,000**	(5)

Assumptions

(1) Assumes limited local excavations near soil toluene concentrations greater than C_{sat} (MW-12 and MW-3/MW-4 areas), plus excavation near MW-13 due to NAPL-indicative concentrations.

(2) Capital and annual cost subtotals rounded up to the nearest $1,000.

(3) Includes quality assurance/quality control samples (duplicates, equipment blanks, and trip blanks), where appropriate.

(4) Discount rate of 7% from "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study", U.S. Army Corps of Engineers and U.S. Environmental Protection Agency, July 2000.

(5) Discount rate of 1.9% from "Memorandum for the Heads of Departments and Agencies Regarding 2014 Discount Rates for [Office of Management and Budget] OMB Circular No. A-94 [Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs]", Executive Office of the President, February 7, 2014.

Table B-3

Alternative 3 - Combination Treatment
Excavation of Soils with Toluene above Csat near MW-4R with AFVR and MNA Detailed Costs
Wix Filtration Facility
Dillon, South Carolina

	Quantity	Units	Unit Cost	Total Cost	Assumptions
CAPITAL COSTS					
Institutional and Engineering Controls				$ 20,000	
Prepare Site Monitoring Plan	1	LS	$ 10,000	$ 10,000	
Filing of Deed Restriction	1	LS	$ 10,000	$ 10,000	
Excavation Soils with Toluene Concentration above C_{sat} (MW-4R Area)				$ 356,670	(1)
Mob/Site Prep	1	LS	$ 5,000	$ 5,000	
Work Plan Preparations	1	LS	$ 20,000	$ 20,000	
Monitoring Well Abandonment	1	LS	$ 15,000	$ 15,000	
Surface Removal (asphalt, conc)	1,200	SF	$ 1	$ 1,200	
Overburden Removal/Stockpile for Backfill	300	CY	$ 10	$ 3,000	
Contaminated Soil Excavation	400	CY	$ 12	$ 4,800	
Slide Rail Shoring/Geotech design	1	LS	$ 30,000	$ 30,000	
Water Management/Disposal	3,000	GAL	$ 2.50	$ 7,500	
Transportation/Disposal - Concrete/ Asphalt	25	TON	$ 30	$ 750	
Transportation/Disposal - Clean Overburden	0	TON	$ 30	$ -	
Transportation/Disposal - Hazardous	700	TON	$ 250	$ 175,000	
Gravel Fill Material - Saturated Zone	400	CY	$ 25	$ 10,000	
Backfill/Compaction Labor and Equipment	700	CY	$ 10	$ 7,000	
Engineering Oversight	3	WK	$ 9,000	$ 27,000	
Post-Excavation Confirmation Sampling & Analysis	10	EA	$ 100	$ 1,000	
Office Engineer Support	15	HR	$ 128	$ 1,920	
Site Restoration/New MWs/Demob	1	LS	$ 30,000	$ 30,000	
Surveying	1	LS	$ 2,500	$ 2,500	
Completion Report	1	LS	$ 15,000	$ 15,000	
Aggressive Fluid Vapor Recovery				$ 20,700	
Extraction Well EW-1 Installation - Total Depth of 5 ft bgs	1	LS	$ 2,000	$ 2,000	
EW-1 Installation Waste Management/Disposal - Non-Hazardous (Installed in Clean Excavation Fill Material)	1	LS	$ 200	$ 200	
Number of AFVR Events at EW-1 (Pilot Study)	1	-	-	-	
AFVR Vacuum Extraction Services	1	EA	$ 5,000	$ 5,000	
Field Oversight	1	EA	$ 1,000	$ 1,000	
Extracted Groundwater Waste Management/Disposal - Hazardous	5,000	GAL	2.50	$ 12,500	
			Total Capital Costs	**$ 398,000**	(2)

Table B-3

Alternative 3 - Combination Treatment
Excavation of Soils with Toluene above Csat near MW-4R with AFVR and MNA Detailed Costs
Wix Filtration Facility
Dillon, South Carolina

	Quantity	Units	Unit Cost	Total Cost	Assumptions
ANNUAL COSTS					
Semi-Annual Groundwater Monitoring and Reporting				$ 44,980	(3)
Number of Sampling Events	2	EA	-	-	
Number of Wells Sampled Per Event	8	EA	-	-	
Number of Field Duplicates Per Event - QA/QC	1	EA	-	-	
Number of Field Blanks Per Event - QA/QC	1	EA	-	-	
Number of Trip Blanks Per Event - QA/QC	1	EA	-	-	
Field Sampling	2	EA	$ 9,000	$ 18,000	
Waste Management	2	EA	$ 1,200	$ 2,400	
VOCs by EPA Method 8260B	22	EA	$ 90	$ 1,980	
Alkalinity	20	EA	$ 20	$ 400	
Nitrate, Sulfate	20	EA	$ 55	$ 1,100	
Ferrous Iron	20	EA	$ 5	$ 100	
Low Flow Sampling Equipment	2	EA	$ 8,000	$ 16,000	
MNA Performance Analysis & Reporting	2	EA	$ 2,500	$ 5,000	
			Total Annual Site O&M Costs	**$ 45,000**	

	MINIMUM	MAXIMUM	
Number of Years of Site O&M	7	10	
Total Annual O&M Costs	$ 315,000	$ 450,000	
Effective Annual Discount Rate for PRP-Lead Sites	7%	7%	(4)
O&M Net Present Worth	$ 227,000	$ 296,000	
Effective Annual Discount Rate for Federal-Lead Sites	1.9%	1.9%	(5)
O&M Net Present Worth	$ 287,000	$ 399,000	
Total Alternative 3 Costs Including O&M (Non-Discounted Rate)	**$ 713,000**	**$ 848,000**	
Total Alternative 3 Costs Including O&M (7% Discounted Rate)	**$ 625,000**	**$ 694,000**	(4)
Total Alternative 3 Costs Including O&M (1.9% Discounted Rate)	**$ 685,000**	**$ 797,000**	(5)

Assumptions

(1) Assumes limited local excavations near soil toluene concentrations greater than C_{sat} (MW-12 and MW-3/MW-4 areas), plus excavation near MW-13 due to NAPL-indicative concentrations.

(2) Capital and annual cost subtotals rounded up to the nearest $1,000.

(3) Includes quality assurance/quality control samples (duplicates, equipment blanks, and trip blanks), where appropriate.

(4) Discount rate of 7% from "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study", U.S. Army Corps of Engineers and U.S. Environmental Protection Agency, July 2000.

(5) Discount rate of 1.9% from "Memorandum for the Heads of Departments and Agencies Regarding 2014 Discount Rates for [Office of Management and Budget] OMB Circular No. A-94 [Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs]", Executive Office of the President, February 7, 2014.

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