**SABIC Innovative Plastics US LLC**
**Burkville, Alabama**
**EPA I.D. Number ALD 981 026 677**

# FACT SHEET

A draft Remediation Plan has been prepared for the SABIC Innovative Plastics facility. This hazardous waste facility is located in Burkville, Alabama. This fact sheet has been prepared to briefly advise the public of the principal permitting, legal and policy issues of the draft Remediation Plan.

## I. REMEDIATION PLAN REVIEW PROCESS

The purpose of the Remediation Plan review process is to allow the State and the public to evaluate SABIC's ability to comply with the hazardous waste management requirements of the AHWMMA, as amended.

## II. PROCEDURES FOR REACHING A FINAL DECISION

ADEM Admin. Code r. 335-14-8-.08(6)(b)1. requires that the public be given a 45-day comment period for each draft Remediation Plan. The comment period will begin on February 4, 2016, which is the date of publication of the public notice in major local newspaper(s) of general circulation, and will end on March 21, 2016. The public notice will also be broadcast over local radio station(s).

Any person interested in commenting on the application or draft Remediation Plan must do so within the 45-day comment period discussed above.

All persons wishing to comment on any of the permit conditions or the permit application should submit their comments in writing to the Alabama Department of Environmental Management, Permits and Services Division, 1400 Coliseum Blvd. (zip 36110-2059), P.O. Box 301463 (zip 36130-1463) Montgomery, Alabama, ATTENTION: Mr. Russell A. Kelly.

ADEM will consider all written comments received during the comment period while making a Remediation Plan decision for this facility. When the Department makes its final Remediation Plan decision, notice will be given to the applicant and each person who has submitted written comments or requested notice of the final Remediation Plan decision.

## III. FACILITY DESCRIPTION

SABIC operates a polycarbonate resin manufacturing plant located in Burkville, Lowndes County, Alabama on approximately 6,300 acres of land. The production area is approximately 300 acres located centrally within the property. On July 5, 2011 a spill of approximately 124 gallons of tetrachloroethylene (PCE) occurred from a heat exchanger located within the interior of the Chlorine Enclosure Building. Approximately 25 gallons exited the doorway at the northeast corner of the building and infiltrated into the gravel and surficial soils. Initial response actions included using absorbents to collect PCE pooling on the floor within the building and excavating soil outside the doorway. Confirmation samples collected along the bottom portion of the excavation indicated PCE concentrations above the ADEM preliminary screening value (PSV). Based on this finding, SABIC voluntarily agreed to undertake certain environmental investigations and remediation measures in accordance with appropriate regulatory procedures. On March 5, 2012, SABIC entered into Cleanup Agreement ALD 981 026 677 with ADEM. The Cleanup Agreement sets

forth specified procedures, conditions and schedules for SABIC to assess the extent of the PCE release and to perform remedial measures for protection of human health and the environment.

## IV. SUMMARY OF PROPOSED REMEDIATION PLAN

An updated Remediation Plan originally submitted on March 18, 2015 and revised on August 7, 2015 and November 25, 2015, is being implemented to address the PCE spill site at the Chlorine Enclosure Building in accordance with SABIC's Cleanup Agreement.

## VI. TECHNICAL CONTACT

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Imagine the result

# Remedial Plan

SABIC

Burkville, Alabama

ALD 981 026 677

Revised November 20, 2015

March 18, 2015

ARCADIS

# Remedial Plan

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## 1.0 Introduction

SABIC operates a polycarbonate resin manufacturing plant located in Burkville, Lowndes County, Alabama (**Figure 1**). The production area is approximately 300 acres and is located centrally within approximately 6,300 acres of land that is leased from the Industrial Development Board of the City of Montgomery (**Figure 2**).

A spill of tetrachloroethylene (PCE) occurred on July 5, 2011 and was excavated to remove PCE in soil; however, confirmation samples collected along the bottom portion of the excavation indicated PCE concentrations above the ADEM preliminary screening value (PSV). Based on this finding, SABIC voluntarily agreed to undertake certain environmental investigations and remediation measures in accordance with appropriate regulatory procedures.

On March 5, 2012, SABIC entered into Cleanup Agreement ALD 981 026 677 (Cleanup Agreement) with the ADEM. The Cleanup Agreement sets forth specified procedures, conditions and schedules for SABIC to assess the extent of the PCE release and to perform remedial measures for protection of human health and the environment. Since September 2011, SABIC has developed environmental work plans, implemented site investigations, evaluated remedial measures, and is implementing an interim remedial measure to address PCE and volatile organic compounds (VOCs) in in accordance with the requirements of the Cleanup Agreement.

This report summarizes the collected data, the results of associated data analyses (including screening-level evaluations human health and ecological risk), and interim remedial measures. The purpose of this report is to set forth the remedial plan to achieve site-specific cleanup goals.

## 2.0 Site Background

### 2.1 Release Incident

On July 5, 2011 approximately 124 gallons of PCE were released from a heat exchanger located within the interior of the Chlorine Piping Enclosure Building (Enclosure Building). PCE spilled onto the floor, and approximately 25 gallons exited the doorway at the northeast corner of the building and infiltrated into the gravel and surficial soils. Initial response actions included using absorbents to collect PCE pooling on the floor within the building and excavating soil outside of the doorway. Soil was excavated, contained in steel drums, and removed. Rainwater that collected in

the excavation was initially managed through treatment in the on-site wastewater treatment plant. Rainwater that collected over time in the excavation was containerized for off-site disposal. Drums of water and soil were disposed at an off-site treatment, storage and disposal facility (TSDF).

Initial response excavation was performed in several lifts with samples collected at depths of approximately 4 inches, 18 inches, and 32 inches below ground surface (bgs). Analytical results indicated that PCE concentrations in the upper 18 inches ranged from 2 to 4 milligrams per kilogram (mg/kg), with the highest PCE concentration (6,400 mg/kg) detected at 32 inches bgs.

Inquiry into past PCE handling practices in the area indicated that small incidental spills had possibly occurred in the vicinity of the Enclosure Building over time. The Enclosure Building is constructed on a sand footing and floor/wall seams are butt-jointed, so past PCE releases (if any) may have traveled down the joint space and dispersed laterally in the sand footing. Observations of the excavation indicated that a very small amount of PCE was exiting the sand footing beneath the building at approximately 24 inches bgs and perched rainwater had accumulated in the excavation. The excavation was temporarily covered, but left open for periodic inspection of potential PCE entering the excavation from the soil. Accumulated rainwater in the excavation was pumped into drums for transport and treatment. Upon consultation with the ADEM, the excavation was backfilled on December 2, 2011, as only a very small amount of free-phase PCE had been observed during only one event, and the open excavation presented a safety hazard.

### 2.2 Investigation

ARCADIS implemented a high-resolution site characterization (HRSC) investigation in April 2012 to investigate the extent of PCE in surface and subsurface soil and to assess groundwater quality. The April 2012 investigation identified soil samples with PCE detects and three of four groundwater samples collected from four temporary wells with detects of PCE concentrations above the ADEM PSVs for tap water. Following the April 2012 investigation, the next phase of investigation was completed in August 2012 to delineate the horizontal and vertical extent of PCE in the soil and groundwater. The Interim Comprehensive Investigation (CI) Work Plan was developed, reviewed, and approved by the ADEM on June 12, 2012 and implemented in August 2012. Findings and results from both the April and August 2012 investigations are documented in the Interim CI Report. The Interim CI Report was submitted to ADEM in November 2012.

Environmental investigations completed in April and August 2012 (Interim CI Report, 2012) delineated the horizontal and vertical extent of PCE in soil and groundwater with temporary groundwater sample points. Findings from these investigations resulted in a third phase of investigation to refine the conceptual site model, identify fate and transport parameters, identify constituents of potential concern (COPCs), install permanent groundwater wells, collect additional data for a human health, ecological, and environmental risk assessment, and evaluate potential interim remedial measures.

The Addendum 03 Work Plan for this third phase of investigation was submitted to ADEM on February 15, 2013 and approved on February 28, 2013. The Addendum 03 Investigation was completed in accordance with the Work Plan from April 2013 through August 2013. The Addendum 03 Investigation was completed to finalize the investigation phase and gather the necessary information from pumping and pilot tests to transition the Site to remedial alternatives evaluations.

In accordance with the Cleanup Agreement, quarterly groundwater monitoring events and associated quarterly reporting have been completed since July 2013. Quarterly groundwater events commenced following installation of the site groundwater monitoring system in July 2013.

### 2.3 Interim Remedial Plan

An interim remedial measure, which was designed prior to completion of the risk assessment, was proposed to initiate soil and groundwater treatment at the site to limit migration and remove PCE from soil and groundwater. The proposed interim remedial measures were presented to ADEM at a meeting and in the June 2014 Interim Remedial Measures Plan. The interim remedial measures consist of a hydraulic containment system that uses groundwater pumping and vapor recovery (soil vapor extraction - SVE). The specific goals of the interim remedial measures proposed to the ADEM were to:

- Hydraulically contain the PCE source area in the Brine Recovery Unit.
- Initiate treatment of groundwater downgradient of the source areas with PCE concentrations above 1,000 micrograms per liter (µg/L). Removal of this dissolved PCE mass will significantly limit the migration of PCE to downgradient locations.
- Initiate treatment of the vadose zone in the source areas through vapor extraction.

By hydraulically containing the source areas and treating the highest concentrations of PCE, the extent of the dissolved-phase PCE plume will decrease with time. The monitoring program discussed in Section 5 will be implemented to provide data necessary to evaluate the performance of the remedial system and determine if the remedial goals are being achieved. The construction of the interim remedial measure ~~will begin~~began in March 2015.

### 2.4 Risk Assessment

The site Risk Assessment was completed in September 2014 and approved by the ADEM in its letter dated December 23, 2014. The data collected from the investigation phase were evaluated and risk assessment datasets were prepared based on the anticipated exposure scenarios. Maximum detected concentrations were compared to appropriate screening levels to identify COPCs. A site conceptual exposure model (SCEM) was prepared that identified the receptors and their complete exposure pathways. Finally, excess lifetime cancer risk and non-cancer hazards estimates were calculated for the complete exposure pathways for each receptor as identified in the SCEM.

The risk assessment evaluated potential exposures of hypothetical future adult and child residents to soil and to groundwater used as a potable water supply. The risk assessment also evaluated exposure of site workers (i.e., commercial or industrial) and construction workers to soil, groundwater, and soil vapor at the Site.

The risk assessment determined that the risk drivers at the site are PCE and vinyl chloride (ARCADIS, 2014). Results of the risk assessment indicate that groundwater in the first saturated zone above the Mooreville Chalk should not be used as a potable water supply within the SABIC property. An ecological risk evaluation was prepared to evaluate potential exposure of aquatic life to concentrations of PCE and chloroform detected in a stream on the SABIC property. The measured surface water concentrations were compared to the ecological screening benchmarks and the concentrations were well below screening levels. Therefore, risk to ecological receptors is not expected to occur.

Site-specific remedial goals were not calculated for the Site because drinking water standards (i.e., Maximum Contaminant Levels [MCLs]) were available for the primary constituents of interest. Thus, the drinking water standards for PCE and vinyl chloride will be the remedial goals for groundwater.

## 3.0 Site Characterization

### 3.1 Topography and Surface Drainage

The northern part of Lowndes County, including the site, is in the Black Prairie district of the East Gulf Coastal Plain physiographic section. The Black Prairie, named for the black soil that is common in the area, is a gently to moderately-rolling prairie that is characterized by extensive grassland with areas of few trees except on alluvial terraces. The elevation of the land surface within SABIC property ranges from about 250 feet above mean sea level (ft msl) to the south at US Highway 80 to approximately 125 ft msl to the north along the bank of the Alabama River. The facility is located on a local topographic high with average land surface elevation ranging between 220 ft msl and 230 ft msl.

Surface water generally flows from topographic highs in the south to the north within flowing creeks and streams, including Tallawassee Creek, Rock Creek, and Pintlala Creek that are tributaries to the Alabama River (see **Figure 1**).

### 3.2 Soils

The United States Department of Agriculture Natural Resource Conservation Service (NRCS) lists the majority of the site as Bama Fine Sandy Loam 0 to 4 percent slopes. The soil in this unit is described as well-drained, alluvial terrace, and loamy fluviomarine deposits derived from sedimentary rock. Regionally, the soil profile consists of 0 to 5 inches of fine sandy loam, 5 to 42 inches of sandy clay loam, and 42 to 80 inches of sandy loam (NRCS, 2012). Within the plant production area, much of the original surface soil has been removed and the facility is underlain by approximately eight feet of low-permeability imported and compacted clay.

### 3.3 Site Geology and Hydrogeology

The site has been characterized through extensive subsurface and surface water studies that included the following:

- Collection of 237 soil samples from 29 soil borings.
- Collection of 94 groundwater samples from 45 vertical aquifer profile (VAP) borings.

- Quarterly groundwater sample collection from 36 monitoring and remedial pumping wells.

Groundwater underlying the site is contained in Quaternary alluvial deposits that range in thickness from about 30 to 40 feet with a saturated thickness typically less than 15 feet. The alluvial deposits are formed by ancestral flood plains of the Alabama River and associated large streams and creeks. These deposits are in a fining-upward sequence consisting of basal gravel with overlying sand, silt and clay. The alluvial deposits overlie the Mooreville Chalk confining ~~unitand~~unit and generally range in thickness of about 30 to 40 feet in the site area. Alluvial deposits are a potential source of water in the flood plains of the Alabama River, but generally are not developed for public water supplies in the site area (Planert*, et al.*, 1987).

The Mooreville Chalk underlies the Quaternary alluvial deposits and the chalk crops-out on the northern portion of the site in the direction of the Alabama River, in creek beds and stream bottoms to the north, and approximately two miles south of the site. The Mooreville Chalk consists of about 400 to 500 feet of chalk and calcareous clay within the site area. According to the United States Geological Survey (USGS) (Planert*, et al.*, 1987), the Mooreville Chalk is relatively impermeable and is not a source of water in the site area. The site is not located in a recharge area for any of the major regional aquifers (Eutaw, Gordo, and Coker aquifers) (Planert*, et al.*, 1987). Surface geology as mapped by the Geological Survey of Alabama is provided as **Figure 3**.

The shallow hydrostratigraphic layers beneath the site (shown in cross-section on **Figure 4**) consist of:

Upper Silts and Clays

Generally, the upper 20 feet at the site consists of silts and clays with minor sand content. Visual logging of soil borings, and data from the HPT, both indicate that this zone is low-permeability and generally unsaturated. Within the structural footprint of the plant, the upper 8 feet consists of low permeability and compact clay fill. The bottom of the upper zone consists of interbedded sand, silt, and clay as the contact with the lower sand is approached. These upper silts and clays are interpreted as alluvial terrace deposits.

*Lower Sand*

Approximately 10 to 15 feet of medium sand with occasional gravel underlie the upper silts and clays. Unlike the upper silts and clays, the lower sand is typically fully

saturated. As expected, visual logging of the soil borings, and data from the HPT, indicate that this zone has considerably higher permeability compared to the upper silts and clays. Hydraulic conductivity of the lower sand established through aquifer tests conducted as part of the site investigations is approximately $10^{-3}$ centimeters/second (2.8 ft/day); this result is consistent with the relative hydraulic conductivity indicated by the HPT for the lower sand.

*Mooreville Chalk*

The Mooreville Chalk is a lower confining unit encountered between 30 and 35 feet bgs and underlies the lower sand zone within the production area. To the north and south the Mooreville Chalk crops out in the bottom of streams and creeks, and the water table aquifer is effectively absent in these areas. The areas where the Mooreville Chalk crops out significantly influences lateral direction of groundwater flow. The Mooreville Chalk is a relatively impermeable unit consisting of 300 to 400 feet of compact chalk and calcareous clay. The low permeability of the Mooreville Chalk prevents vertical groundwater flow from the local water table aquifer to the underlying Eutaw aquifer.

### 3.4 Groundwater Flow

The groundwater table beneath the central portion of the facility follows the general topography and forms a local high with a groundwater divide in the vicinity of the PCE spill. Based on collected water level elevations, flow radiates outward in all directions from the facility. Beneath the impacted portion of the Brine Recovery unit, the dominant groundwater flow direction is north by northwest, although groundwater in portions of the area flows west and south (See **Figure 5** for groundwater level elevations and flow direction in the water table aquifer, November 2014). Most of the groundwater flows into streams to the north and west as base flow. There is no indication from quarterly groundwater monitoring, or computer-assisted modeling, that any groundwater impacted by the PCE release will exit the property as groundwater flow. Specifically, groundwater flowing to the north exits through seeps and base flow where the Mooreville Chalk crops out and the water table aquifer pinches out. To the west, the unnamed tributary flowing to Lake Berry bisects much of the water table aquifer, capturing most of the groundwater flowing toward the west.

### 3.5 Constituents of Concern

Those constituents detected in samples collected during site investigations at concentrations above the preliminary screening values for soils and groundwater were

designated as constituents of potential concern (COPC) (ADEM, 2008). Upon carrying COPCs through the risk and ecological risk assessments, COCs for groundwater were determined at the site. The COCs for the site are PCE and vinyl chloride in groundwater. Site COCs are provided in the Human Health and Ecological Risk Assessment Report (ARCADIS, 2014) and summarized below. **Figure 6** shows PCE concentrations and isoconcentrations during the November 2014 groundwater monitoring event. Although not identified as a site COC during site investigations and risk assessment, an area of elevated pH groundwater is comingled with the PCE source concentrations in the Brine Unit.

#### 3.5.1 Human Health

Identified risk drivers at the site are PCE and vinyl chloride in groundwater. Concentrations in groundwater were elevated and the results of the risk assessment indicated that groundwater in the first saturated zone above the Mooreville Chalk should not be used as a potable water supply within the SABIC property. Other calculated human health risks were below the ADEM benchmarks. Remedial goals were not calculated for the site. The drinking water standard for PCE of 5 µg/L will be the remedial goal for groundwater. There were no other elevated risks for other media of interest.

#### 3.5.2 Ecological

An evaluation of the ecological health at the site was performed as part of the overall risk assessment (ARCADIS, 2014). The ecological health evaluation consisted of a field and desktop evaluation of approximately 3,000 acres surrounding the operational area of the site, including the collection of surface water samples. The only constituents detected in surface water were PCE and chloroform. Surface water screening levels were selected in compliance with the ADEM water quality program. ADEM does not list water quality criteria for the constituent of interest for protection of ecological health. Therefore, these values were identified using the United States Environmental Protection Agency (USEPA) Region IV surface water screening values (USEPA 2001b).

Maximum detected concentrations for both PCE and chloroform in surface water were below the applicable USEPA Region IV screening levels for ecological health. PCE was detected at a maximum of 11.3 µg/L in surface water, which is well below the USEPA Region IV ecological screening value of 84 µg/L. Chloroform was detected at a maximum 1.2 µg/L in surface water, which is also well below the USEPA Region IV

ecological screening value of 289 µg/L. Since maximum concentrations were below applicable screening levels, it is concluded that water quality in the springs and surface water is not expected to cause adverse effects on ecological health.

### 3.6 Fate and Transport Mechanisms

To understand potential remedial technologies, the primary fate and transport mechanisms must be identified at the site. The primary fate and transport parameters include:

*Volatilization*

Volatilization can significantly affect the distribution of a constituent in the environment. In soils, the result is a decrease in the amount of a constituent in soil, provided there is no continuing or ongoing source of constituent mass, as the constituent volatilizes to soil gas and ultimately migrates to the atmosphere. The end result is a reduction in concentrations in soil and groundwater over time. Volatilization reactions are most significant in soils that are at or near the surface.

*Degradation*

Many organic compounds are subject to biodegradation reactions under aerobic and anaerobic conditions. During biodegradation, naturally occurring microorganisms in the subsurface transform a constituent to another state as a direct or indirect consequence of their metabolic processes. It is probable that some biodegradation processes have been acting to reduce constituent concentrations, and it is anticipated that these processes will continue to further reduce the concentration of constituents into the future. Abiotic processes such as geochemistry, temperature, and pH may also contribute to PCE degradation. However, with the lack of significant concentrations of PCE degradation products detected in samples (TCE, DCE, and vinyl chloride), natural biodegradation or abiotic processes do not appear to be significant within the areas affected by PCE.

*Leaching*

Constituents in soil have the potential to migrate to greater depths with infiltrating water. The detected presence of these constituents in groundwater is an indication that this process has occurred.

*Transport*

Constituents in solution in groundwater have the potential to be transported with the movement of groundwater and through dispersion/diffusion from areas of higher

concentration to areas of lower concentration. The detected presence of constituents in groundwater downgradient of the spill is an indication that this process has occurred. Given that the water table aquifer is predominantly comprised of the coarse-grained material associated with the lower sand, the dominant form of transport is anticipated to be through advection (i.e., the direct movement of constituents in solution with the movement of groundwater). A majority of the PCE in the groundwater will flow parallel with the dominant direction of groundwater flow, which is to the north and west, until the water table pinches out in the direction of the Mooreville Chalk outcrop areas and will then flow west toward the unnamed tributary flowing into Lake Berry. A subcomponent of flow is northeast toward a small creek near the Mooreville Chalk outcrop area and another subcomponent of flow is southwest toward Lake Berry.

## 4.0 Remedial Measures Evaluation

Potential remedial measures were evaluated to determine the optimum program to remediate COCs to meet site remedial goals. Groundwater assessment data indicates that PCE degradation is not occurring; therefore, a “No Remedial Action” measure with only monitored natural attenuation was not considered to be a feasible remedial measure at this time. Permeable reactive barriers (PRBs) were not considered because of the relatively high groundwater flow rates, the divergent groundwater flow paths, and the PRB length and depth that would be required to intersect the PCE plume. In-situ thermal remediation, in-situ chemical oxidation, enhanced in-situ bioremediation, hydraulic control, groundwater extraction and vapor recovery, and groundwater recirculation are discussed below.

### 4.1 Remedial Measures Alternatives

Groundwater extraction and vapor recovery through dual-phase extraction (DPE) wells and soil vapor extraction wells were selected as the preferred interim remedial measure to meet the following objectives:

- Proven effectiveness in removing significant volatile constituent mass under the hydrologic conditions found within the source area;
- Provides hydraulic containment to prevent further migration of the plume; and,
- Can be rapidly implemented with immediate improvement in site conditions.

In addition to the selected interim remedial measure, other alternative remedial measures were considered and may be used in the future to augment the interim

remedial system. The following sections discuss alternative remedial measures that were considered.

#### 4.1.1 In-Situ Thermal Remediation

In-situ thermal remediation (ISTR) is an aggressive treatment option that heats the subsurface to volatilize volatile organic compounds (VOCs) in groundwater and soil. While the increased vapor pressure is the dominant remediation mechanism afforded by the thermal process, several other significant benefits exist from the heating that expedite remedial timeframes. These include:

- The viscosities of vapor, groundwater, and non-aqueous phase liquid (NAPL) are reduced at elevated temperatures, resulting in improved mobility and recoverability of both vapors and liquids;
- The creation and expansion of steam within the soil pore space can enhance the effective porosity and improve vapor- and liquid-phase recovery;
- VOC adsorption coefficients are reduced when soil temperatures are increased, resulting in an increased rate of desorption from soil particles; and
- The azeotropic boiling point of PCE/water (88 °C) is lower than the pure compound boiling point (121 °C) and the boiling point of water (100 °C). As such, during the heating process, NAPL, if present within the saturated parts of the treatment zone, will undergo azeotropic boiling at the NAPL/water interface, which will expedite the transfer and recovery of NAPL from the liquid to the vapor phase.

While ISTR technically could be implemented at the site, there are significant disadvantages relative to other technologies:

- High cost make application to large areas cost-prohibitive;
- The need to install large numbers of heater or electrode wells and vapor recovery wells would be difficult within the restricted production area; and
- Relatively high costs per volume treated.

ISTR will not be retained for evaluation as a remedial measure for the following reasons:

- Lack of NAPL in the groundwater, making use of ISTR less beneficial;
- High cost to treat the groundwater;
- High groundwater flow rates, which would require an excessive number and spacing of heater or electrode wells and vapor recovery wells; and,
- Limited space within the production area to install heater or electrode wells and vapor recovery wells.

#### 4.1.2 In-Situ Chemical Oxidation

In-situ chemical oxidation (ISCO) has been used since the early 1990s to treat environmental contaminants. The objective of ISCO is to transform contaminants into innocuous end products such as carbon dioxide, water, and inorganic compounds. A chemical oxidant, often hydrogen peroxide with an iron salt (Fenton's reagent), potassium and sodium permanganate, or sodium persulfate, is injected through wells screened in areas where a reduction in groundwater concentrations is desired. Injection locations can be either permanently installed wells or temporary injection points installed using direct-push methods. When oxidants come in contact with chlorinated compounds, these compounds are broken down into non-toxic components. However, contact time between the oxidant and contaminant is the most important technical aspect of this technology, but it can be difficult to accomplish.

ISCO generally includes several oxidant injections over time accompanied by groundwater monitoring. A large number of injection wells may be required to treat areas with elevated PCE groundwater concentrations. The limited space within the production area restricts the area in which ISCO can be applied and may not be able to treat some portions of the groundwater. Many oxidant applications would be needed at the site because the relatively high groundwater flow rates would reduce the potential contact time between the oxidant and the PCE. The overall costs would be high relative to other technologies.

ISCO would require a large volume of oxidants to treat the groundwater, a large number of injection points, and a long duration of each injection event. ISCO is not infeasible but the above-mentioned challenges would reduce its effectiveness and the repetitive injection events with large volumes of oxidants would significantly increase the cost. Further, the production areas contain buried infrastructure that would have to be evaluated for the potential for negative reaction with the chemical oxidants.

#### 4.1.3 Enhanced In-Situ Bioremediation

Naturally occurring microorganisms in the subsurface can break down (biodegrade) organic compounds in the soil and groundwater. The rate of this degradation depends on the species of microorganisms, environmental conditions, and the available nutrients. Biodegradation can be enhanced or augmented by injecting nutrients and/or microorganisms that specifically degrade PCE and/or its breakdown products. Anaerobic conditions are necessary for microorganisms that degrade chlorinated VOCs to flourish. Advantages of enhanced bioremediation include limited operation and maintenance (O&M) costs and the use of non-toxic, non-hazardous materials.

Enhanced in-situ ~~biormediation~~bioremediation presents many of the same challenges as ISCO. Because natural biodegradation of PCE is not occurring at the site, and the aquifer is aerobic, creating and maintaining suitable conditions for growth of microbes typically requires multiple injections with relatively large volumes of nutrients and/or microbes. Similar to ISCO, this remedial approach generally includes several injections over time at multiple locations accompanied by groundwater monitoring. As with ISCO, close spacing of injection points is necessary. The limited space within the production area restricts the area in which amendments can be applied and may not be able to treat some portions of the groundwater. The relatively high groundwater flow rate would make it difficult to keep the aquifer anaerobic and injected amendments would quickly migrate downgradient with groundwater flow away from the injection area.

Enhanced biodegradation does not always result in a complete breakdown of chlorinated compounds. Breakdown products generated during biodegradation can include compounds that are more toxic and more mobile than the parent compound (e.g., vinyl chloride). Therefore, additional measures would need to be implemented to ensure complete breakdown of PCE in the groundwater. Control of potential soil vapors may require the installation and operation of a soil vapor extraction system.

Because the aquifer is aerobic and the PCE plume is not currently biodegrading, enhanced bioremediation would require a large volume of amendments to treat the groundwater, a large number of injection points, long duration of each injection event, and the need to reapply nutrients to maintain anaerobic and growth-stimulating conditions within the aquifer. Similar to ISCO, enhanced bioremediation is not infeasible but the above-mentioned challenges would reduce its effectiveness.

#### 4.1.4 Natural Attenuation

The primary lines of evidence for natural attenuation (NA) of PCE in groundwater are decreasing or stable concentration trends, with both time and distance from the source. The geochemical data collected during investigation and routine groundwater monitoring can be used to evaluate the potential for destructive mechanisms to contribute to NA, and provide an initial assessment on the feasibility of NA as a remedial alternative.

##### *4.1.4.1 Biotic*

Biodegradation of chlorinated ethenes via reductive dechlorination under anaerobic conditions generally follows a stepwise process, with the most highly substituted chlorinated ethenes reacting to form lesser substituted ethenes. Under anaerobic conditions, biodegradation of the more highly substituted chlorinated ethenes generally occurs more rapidly than that of daughter compounds (cis-1,2-DCE, trans-1,2-DCE) leading to accumulation of these species in groundwater. Similarly the degradation of products of cis-1,2-DCE, trans-1,2-DCE, and vinyl chloride (VC) occurs more slowly than that of the parent compound and will also accumulate. Under solely anaerobic conditions, this results in a plume distribution where the primary parent compounds (PCE) are present in the source area, while the more recalcitrant degradation products occur at greater distances from the source. Microbially mediated, anaerobic reductive dechlorination preferentially utilizes electron acceptors in the order of those which provide the most energy (e.g. oxygen, sulfate, nitrate, total iron and manganese) resulting in measureable changes to the geochemistry at a site which can be used to infer specific processes.

Natural attenuation (NA) of chlorinated solvents has been focused on anaerobic biodegradation mechanisms, and while these are important pathways, particularly for the higher chlorinated compounds (PCE and TCE) there is increasing evidence that aerobic and abiotic pathways may play a significant role in the attenuation of chlorinated solvents. Aerobic biodegradation is a viable pathway for the lesser chlorinated compounds (cis-1,2-DCE, trans-1,2-DCE and VC) for which degradation appears to occur more readily under aerobic conditions than anaerobic conditions. Aerobic biodegradation of TCE occurs much more slowly, and for PCE this process is negligible. The aerobic degradation of chlorinated ethenes produces water, chloride and carbon dioxide, and no stable metabolites are formed, making aerobic pathways difficult to assess based on generation of daughter compounds or geochemical changes.

A review of the geochemical data collected at the site during groundwater monitoring events indicated that groundwater within the source area (Brine Unit) has high pH (11 to 12), elevated groundwater temperatures (27 to 43 degrees C), negative ORP, and very low DO. This data does not provide evidence to support the occurrence of anaerobic biodegradation within the source area (Brine Unit). Further, electron acceptor concentrations (including nitrate, sulfate, total iron and total manganese) are variable across the site and no clear correlation between concentrations of electron acceptors and detection of chlorinated ethenes is evident. In addition, the lack of daughter compounds, particularly cis-1,2-DCE, trans-1,2-DCE and VC also supports that anaerobic biodegradation is not a dominant process within the source area (Brine Unit) or at the Site.

Concentrations of organic carbon in groundwater are low, and the aquifer is anticipated to be aerobic outside of the source area. Aerobic conditions will result in rapid degradation of cis-1,2-DCE, trans-1,2-DCE and VC if they are formed as a result of any anaerobic biodegradation within the source area, however, evidence for these processes is not established.

#### *4.1.4.2 Abiotic*

Screening of the geochemical properties at the site suggest that while reductive dechlorination under anaerobic conditions is unlikely to be the dominant attenuation mechanism, attenuation may be occurring through aerobic or abiotic pathways or other physical processes of natural attenuation (i.e., dispersion, sorption, volatilization, and dilution). Abiotic pathways have been observed at sites where iron minerals, including magnetite and pyrite, are present. At many sites, significant degradation of PCE and TCE is observed without the corresponding accumulation of daughter products, which is an indicator abiotic reactions may be occurring.

As noted in Section 4.1.4.1, relatively high temperature and high pH groundwater have been identified in the source area (Brine Unit). At elevated temperatures, the volatilization process is faster and results in higher concentrations of VOCs in the vapor phase. The results of the air sample collected during the dual phase extraction pilot test indicated that a significant mass of PCE was present in the vadose zone. The elevated mass in the vadose zone may be a result of the enhanced volatilization as a result of an elevated temperature.

It should be noted that several compounds were detected in air samples collected during the dual phase extraction pilot testing. With the exception of PCE, the

compounds in the air samples were at low concentrations or were not detected in groundwater samples collected from the adjacent observation wells. This may be a result of the elevated pH and temperature in this area. Natural attenuation using abiotic processes is not in feasible; however, abiotic processes alone will not be sufficient to remove the source mass. The promotion of abiotic attenuation of dissolved PCE at elevated temperature and pH will be evaluated annually after startup and will continue until all remedial activities have been completed and goals met as indicated by the ADEM.

#### 4.1.5 Hydraulic Control with Groundwater Extraction and Treatment

Hydraulic control is used to intercept, capture, or control groundwater flow. Hydraulic control as a remedial technology involves the extraction of groundwater to affect the movement of groundwater. A hydraulic-control system is capable of accomplishing a remedial objective of plume containment within a controlled boundary and minimizing exposure at the extraction point. Hydraulic control provides an added benefit of treating groundwater containing VOCs. A disadvantage is that hydraulic control systems require frequent and long-term maintenance.

Hydraulic control with SVE would be effective at containing the dissolved-phase PCE plume. To implement a hydraulic control remedial measure, groundwater and SVE wells would be installed. The extracted groundwater would be pumped to water treatment and treated with air stripping. A soil vapor extraction (SVE) system could also be installed to treat PCE in the vadose zone near the Enclosure Building where the release occurred. Combining hydraulic control with SVE would significantly reduce or eliminate migration of PCE in groundwater out of the source area and treat the vadose zone. The groundwater extraction would create a zone of hydraulic containment to significantly limit the mass of dissolved PCE migrating out of the source area and decrease groundwater PCE concentrations.

The selected interim remedial measure is a DPE system using groundwater pumping wells and soil vapor extraction wells and is retained as an effective remedial technology.

#### 4.1.6 Groundwater Recirculation

Groundwater recirculation is a form of hydraulic control where the extracted groundwater is treated and injected into the subsurface. The injected water creates groundwater mounds that would be used to redirect groundwater flow. The

uncontaminated injected water will flow through the source area and promote mobilization and attenuation of PCE. As the dissolved-phase PCE migrates downgradient of the source area, it is captured by the extraction wells. The process is then repeated creating a recirculation loop. Amendments could be added to the injected water so that enhanced bioremediation or ISCO can be employed as needed to address the PCE in groundwater.

#### 4.1.7 Institutional Controls

Institutional Controls (ICs) are non-engineered instruments, such as administrative and legal controls, that help to minimize the potential for human exposure and protect the integrity of the selected remedy. ICs work by limiting land or resource use and by providing information that helps modify or guide human behavior at properties where constituents prevent unlimited use and unrestricted exposure. For example, a remedy may use a legal instrument to prevent use of groundwater for potable purposes at a site (e.g., a groundwater use deed restriction) to prevent people from drinking groundwater. Common examples of ICs include zoning, building or excavation permits, well drilling prohibitions, and easements and restrictive real covenants.

As provided in the risk assessment report (ARCADIS, 2014), and in Section 2.4, identified risk drivers at the site are PCE and vinyl chloride in groundwater. All other calculated human health risks were below ADEM benchmarks. PCE and VC concentrations in groundwater are elevated and the results of the risk assessment indicated that groundwater in the first saturated zone above the Mooreville Chalk should not be used as a potable water supply within the SABIC property. The groundwater plume is entirely within SABIC property and constituents of concern are not expected to migrate beyond SABIC's property boundary. Groundwater use as a potable supply is prohibited already on SABIC property and all excavations within SABIC property are tracked and approved through an existing excavation permitting process.

Also as provided in the risk assessment report, SABIC voluntarily selected the Alabama drinking water standard maximum contaminant levels (MCLs) as the remedial goals for groundwater. An IC is not required at this time since SABIC is selecting the alternative that remediates the site to unrestricted use (e.g., COCs in groundwater will be remediated to Alabama drinking water quality standards). Therefore, an IC remedial alternative will not be retained for further evaluation at this time. Should an IC be required during a future property transfer, or site conditions change from future use

scenarios provided in the risk assessment report (ARCADIS, 2014), ADEM will be notified.

### 4.2 Remedial Measures Identification

As discussed above, multiple alternatives were evaluated for achieving remedial objectives of treating PCE source mass and containing the PCE groundwater plume within and downgradient of the source area in the Brine Recovery Unit. Based on the results of the aquifer tests, the DPE and SVE pilot tests, data collected during the 2012 and 2013 investigations, and experience with similar sites, the following technologies are selected:

- A hydraulic containment and treatment system in the PCE source areas and the high-concentration PCE areas of the dissolved plume; and,
- A SVE system that will be used in conjunction with the hydraulic containment system, and separately, to treat PCE in the vadose zone near the Enclosure Building where the release occurred.

### 4.3 Remedial Measure

The remedial measure will ~~include~~ consist of the interim remedial measure (IRM) which has already been developed for the site. Groundwater and soil vapor will be extracted from three (3) DPE wells designated PW-1 through PW-3. Extraction well PW-4 will be a hydraulic containment well, as the proposed location of this well is outside of the PCE source area. Thus, only groundwater will be extracted from PW-4. In addition, soil vapor only will be extracted through one SVE well (designated SVE-1) located north of the Enclosure Building. The location of the extraction wells is provided in the Remedial Measure design plans in **Appendix A**.

As provided, the goal of the remedial system and the selected remedial technology is to significantly reduce or eliminate migration of PCE in groundwater out of the source area and treat the vadose zone. By installing and operating groundwater extraction wells at the PCE source area, the groundwater surface will be depressed (e.g., hydraulic cone of depression) and a zone of hydraulic containment will be established. The hydraulic containment will significantly limit the mass of dissolved PCE migrating out of the source area. With continued system operation over time, the hydraulic containment process will decrease the concentration of PCE in groundwater in the source area and downgradient of the source area. In addition to hydraulic containment of dissolved PCE, the groundwater extraction system will extract the groundwater with

elevated pH levels. Groundwater with a lower pH will be drawn into the aquifer beneath the Brine Recovery Unit, which will result in a decrease in the pH of the groundwater. The effectiveness of the proposed remediation system will be evaluated using data and information collected in the monitoring program discussed in Section 5.0, Long-Term Monitoring.

#### 4.3.1 Remediation Well Locations

The extraction and SVE wells have been installed. Their locations were selected based on accessibility of drilling equipment, proximity to the source area, and highest PCE concentrations within the plume. The extraction wells were installed at the following locations:

- Extraction well PW-1 was used for the aquifer testing and the DPE and SVE pilot tests. This well is located adjacent to an area where the highest PCE concentrations have been detected in groundwater. The groundwater extracted from this well will depress the groundwater surface, resulting in hydraulic containment of this source area and a reduction in dissolved PCE migration to the north and to the west of the Brine Recovery Unit. The soil vapor extracted from this well will treat the vadose zone in the suspected PCE source area.

- The location of Extraction well PW-2 is north of the Control Room and Lab Building in the Brine Recovery Unit. This well will be used to extract groundwater from the high-concentration PCE plume hydraulically downgradient of the source area on the north side of the Enclosure Building.

- The location of extraction well PW-3 is south of the Enclosure Building. Groundwater extracted from this well will result in hydraulic containment of the source area beneath the Enclosure Building. In addition, soil vapor extracted from this well will treat PCE-contaminated soil in the vadose zone beneath the Enclosure Building.

- Hydraulic containment well PW-4 was installed near monitoring well MW-7. This well will be used to hydraulically contain the high-concentration dissolved-phase PCE plume.

- SVE-1 was installed on the north side of the Enclosure Building. Soil vapor will be extracted from the vadose zone at the area of highest PCE concentrations where the spill occurred. The SVE well will also extract vapors from beneath and north of the Enclosure Building.

#### 4.3.2 Remediation System Process

A process flow of the interim remediation system is presented in the remedial measure design plans in **Appendix A**. The DPE process includes extracting groundwater and soil vapor from extraction wells. The groundwater will be recovered from the extraction wells using electrical submersible pumps. The extracted groundwater will be routed through conveyance lines installed below ground and above ground as necessary to an influent groundwater manifold housed in a retrofitted steel container (equipment container). The extracted groundwater will be pumped into a 1,500-gallon aboveground storage tank.

An air stripping unit will be housed in the equipment container with the other process equipment. The groundwater extracted from the recovery wells will be routed to the proposed air stripping unit for treatment. The air stripping unit is sized to treat a flow rate of up to 120 gallons per minute at a PCE concentration of up to 5,000 µg/L. The estimated effluent concentration after treatment with the air stripping unit is less than 5 µg/L. At the startup of the remediation system, influent and effluent samples will be collected from the air stripping unit and analyzed using USEPA Method 8260. The results of these samples, along with the groundwater extraction rates, will be used to evaluate the performance of the air stripping unit.

After treatment with the air stripping unit, the pH of the groundwater will be adjusted using an automated system. The anticipated pH of the influent groundwater is approximately 11 standard units. Sulfuric acid at a strength of 50 percent will be injected in the effluent stream of the air stripping unit to reduce the pH from approximately 11 to between 6 and 9 standard units. The treated water will be discharged through the storm water sewer to synthetically lined holding ponds near the waste water treatment plant. The water in these ponds will be pumped into the waste water treatment plant and treated along with process water. The treated water from the waste water treatment plant will be discharged in compliance with SABIC's existing NPDES permit.

The extracted soil vapor will be routed from the extraction wells to a manifold located near the equipment building. Moisture will be separated from the extracted vapor using an air-water separator (AWS). The soil vapor will be routed through a rotary lobe vacuum blower, a heat exchanger, and vapor phase Granular Activated Carbon (GAC). The water that collects in the AWS will be pumped to the 1,500-gallon storage tank.

#### *4.3.2.1 Extraction Well Construction*

Extraction wells PW-1 through PW-4 were installed to a depth of up to approximately 30 feet bgs. Soil boring and installation logs are provided in **Appendix B**. The boreholes for the extraction wells were approximately 12 inches in diameter and installed using the same rotosonic drilling method as described in the Addendum 03 Work Plan. The extraction wells were constructed of 6-inch diameter, flush-joint polyvinyl chloride (PVC) casing and well screen. The screened intervals of the pumping wells were extended from approximately 10 to 30 feet bgs and were constructed of 0.010-inch, flush-joint, wire-wrapped PVC well screen. The annular space of the boreholes from 9 feet to 30 feet bgs was filled with a 20/30-sand pack. A cement/bentonite seal was installed in the remaining annular space up to the bottom of the vault.

The pit-less adapter shown on **Appendix A** was installed near the top of each well to allow easy installation and removal of the groundwater extraction pumps. A 6-inch diameter, vacuum-tight sanitary seal was installed at the top of the extraction wells. Electrical leads were routed through the sanitary seal and terminated in a twist-lock electrical receptacle mounted on the vault. Vacuum, water, and electrical piping were installed below ground. Construction specifications and drawings are provided in **Appendix A**.

The submersible pumps have a design flow rate of 20 gpm at a total dynamic head (TDH) of 180 feet of water. Based on the design requirements, the recommended groundwater pumps for the extraction wells are Grundfos® 25S15-9 (or equivalent) electric submersible pumps. The electrical submersible pumps are equipped with an internal ball check valve, 30 feet of 1.5-inch diameter chemical-resistant rubber hose, 30 feet of support cable, and 30 feet of electrical power supply cable.

#### *4.3.2.2 Electrical Pump Controls*

At a groundwater flow rate of 20 gpm, a drawdown of approximately 4.5 feet in the extraction wells is anticipated based on the step drawdown aquifer test. With over 14 feet of saturated screen, the groundwater extraction pumps will operate continuously. However, to protect the pumps and/or motors from running dry, power overloads, or a problematic power supply, a power supply sensor was installed on the electrical lines to the pumps. This sensor eliminates the need for down-well level sensors. If a pump is shut off, it will be automatically restarted within a preset time delay of between 2

minutes and 1 hour. The restart time delay will be programmed into the sensor based on data collected during system startup.

#### *4.3.2.3 Groundwater Extraction Manifold*

The groundwater discharge lines from the individual extraction wells will be routed to a manifold in the equipment container. Each line of the manifold will be equipped with a check valve, water flow transmitter, and gate valves. Groundwater exiting the manifold will be combined into a header pipe and routed to the air stripper. A 1,500-gallon HDPE equalization tank will be installed near the equipment container and will be provided with secondary containment. In addition, a 4-inch diameter schedule 80 chlorinated PVC (CPVC) conveyance line will be installed from the proposed location of the equipment container to the storm water drain.

### 4.3.3 SVE System

Soil vapor will be extracted from extraction wells PW-1 through PW-3 and SVE-1. Vacuum lines will be routed to each of these wells and vacuum will be applied to these wells with a vacuum blower located in the equipment container. The vacuum lines will be constructed of 3-inch diameter schedule 80 CPVC pipe. The vacuum lines will be terminated at the SVE manifold located in the equipment container. The vapors extracted from the wells will be routed through an air/moisture separator located in the process stream before the SVE blower. To enhance the efficiency of the vapor phase GAC treatment, a heat exchanger will be used to cool the air before entering the GAC. The extracted, cooled air will be treated with the GAC to remove VOCs.

#### *4.3.3.1 Soil-Vapor Extraction Well*

The SVE well was installed to a depth of approximately 15 feet bgs at the location shown in **Appendix A**. The SVE well was constructed of 4-inch diameter, flush-joint PVC casing and well screen. The screened interval of the well (from 5 to 15 feet bgs) is 0.010-inch, wire-wrapped, flush-joint PVC well screen. The annular space of the borehole from 3 to 15 feet bgs is filled with a 20/30-sand pack. A cement/bentonite seal was installed in the remaining annular space up to the bottom of the vault. The well will be completed in a locking steel vault. Construction details of the SVE well are presented in **Appendix A**.

#### *4.3.3.2 Vacuum Influence*

Based on flow and vacuum data collected during the DPE pilot test, significant vacuum influence was measured in observation well OW-3, which is located approximately 44 feet south of extraction well PW-1. As noted in the September 2013 Addendum 03 Investigation Report (ARCADIS, 2013), the vacuum influence was not distributed consistently in the vadose zone during the DPE and SVE pilot tests. The inconsistency in vacuum distribution is likely due to the unsaturated screen interval of the observation wells OW-1 and OW-2 being installed in clayey soil. Because the unsaturated portion of the lower sand unit did not intersect the screened interval at these well locations, the well screen was blinded and vacuum could not be measured.

The groundwater surface will be depressed by the groundwater extraction system, which will increase the thickness of the unsaturated sand. Given the confined flow resulting from the clay layer that extends from the ground surface to about 8 to 10 feet bgs and an increasing unsaturated sand interval, a consistent areal vacuum influence of approximately 55 feet can be achieved. This vacuum influence will be sufficient to initiate vadose zone treatment near the Enclosure Building and source areas. However, the vacuum influence will not encompass the entire Brine Recovery Unit area.

#### *4.3.3.3 SVE Manifold and Equipment*

The vacuum lines for the DPE and SVE wells will be connected to a SVE manifold that will be preassembled by the equipment manufacturer in the equipment container. Each line of the SVE manifold will contain a sample port, gate valve, vacuum gauge, and flow meter. The SVE header line will contain a gate valve, a sample port, and indicators for vacuum and flow.

Soil vapor will be extracted by the DPE and SVE wells and routed through conveyance piping to the steel equipment container, as discussed above. The vapor will then pass through a moisture-separator tank to remove excess moisture prior to entering the SVE blower. Soil vapor will be routed from the SVE blower through GAC for removal of VOCs. Treated soil vapor will be discharged to the atmosphere in accordance with requirements provided by the ADEM Air Division. Based on a maximum flow rate of 400 standard cubic feet per minute and a vacuum of up to 10 inches of mercury, a ~~Sutorbult~~ Sutorbilt Model 5LP (or equivalent) rotary lobe blower will be used. This blower will be equipped with a 25-horsepower explosion-proof motor and operates on 460-VAC, three-phase, electrical power.

A transfer pump will be used to pump water that collects in the moisture separator into the air stripper. Liquid-level sensors will be installed in the moisture-separator tank to control the transfer pump.

#### *4.3.3.4 Vapor Treatment System*

A 3,000-pound ESD VLPS-3000 vapor-phase GAC canister capable of treating up to 1,800 scfm will be used to treat the vapor extracted by the system. At an average mass recovery rate of 20 pounds per day and a carbon absorptivity of 20 percent, the 3,000 pounds of GAC would be spent in approximately 30 days. After the initial GAC change-out, significantly lower SVE influent concentrations will reduce the GAC change-out to once during the next six (6) months of system operation.

Sampling ports on the inlet and the discharge piping of the GAC vessel allow sampling of the air stream into and out of the GAC unit to assure VOCs do not break through. The interval between GAC recharge is estimated at six (6) months, depending on quantity of VOC recovered and the operational continuity and usage time of the SVE system. Recharge intervals will be estimated based on vapor concentrations and flowrates over the operating life of the system.

The GAC unit has no moving parts and does not require any routine maintenance other than replacement of GAC when spent. Breakthrough of VOCs will indicate the GAC is spent, but this is strictly a function of blower flowrate and VOC concentration, or more precisely the mass quantity of VOC removed. Monthly monitoring and laboratory analysis of inlet and outlet concentrations will provide an indication of when GAC requires replacement. In general, vapor phase adsorption is fairly efficient, so six (6) months or more would not be an excessive period between changeouts given removal rates.

A representative spent GAC sample will be collected and submitted for VOC chemical analyses using EPA Method 8260 and Toxic Characteristic Leaching Procedures (TCLP) VOCs by EPA Method 1311/8260. Laboratory analytical data associated with the collected solid sample will be used for waste characterization and profiling. Spent carbon will be either disposed of at a facility permitted to accept waste GAC or recycled (i.e., reactivation/regeneration, if possible).

#### *4.3.3.5 Baseline Data*

Prior to system startup, groundwater samples and field data will be collected from monitoring wells in the Brine Recovery Unit area to provide baseline data. Samples will be collected from Brine Recovery Unit area monitoring wells and observation wells in accordance with the Alabama Environmental Investigation and Remediation Guidance (AEIRG) and procedures in SABIC work plans approved by the ADEM. The results of the groundwater sample analyses and the field data will be compared with data collected during O&M events to evaluate the performance of the remedial system.

O&M events will be conducted weekly for the first month, monthly for the first year and either quarterly or semiannually thereafter; based on system performance. During O&M visits, adjustments will be made to the system as needed to optimize the system, based on the data collected. The performance of the system will be enhanced through the fine-tuning of extraction rates and vacuums. These fine-tuning adjustments are intended to enhance the performance of the system.

#### *4.3.3.6 O&M Reporting*

A startup report will be submitted to ADEM within 60 days of system activation. The report will include data collected during the first monthly sampling event. The startup report will also include an evaluation of system performance and recommendations for modifications, if necessary. The data collected during the O&M visits will be presented as site-specific checklists, data tables, and figures in the reports. An evaluation of the data, conclusions, and recommendations, if any, for modifications to the remedial system will be discussed in the report.

### 4.3.4 Implementation Timeline and Evaluation

The hydraulic containment and SVE system will be activated after completion of the baseline groundwater sampling. Startup activities are estimated to take up to two weeks to complete. The air and water flow rates will be adjusted as necessary during the system startup period to achieve the desired area of vacuum influence and groundwater capture zone. During the startup phase, depth to groundwater and vacuum will be measured daily in the Brine Recovery Unit monitoring wells and observation wells. This data will be used to estimate the influence and pore volume exchange rate of the SVE system. It will also be used to estimate the drawdown, capture zone, and influence of the hydraulic containment system. The data collected during system startup will also be used to calibrate the site hydrologic model.

### 4.4 Remedial Measures Evaluation

The remedial system operational and monitoring data will be compiled to evaluate the effectiveness of the remedial program. In addition, other remedial technologies will be assessed to provide information for a program that may appropriate. The evaluation may consist of continued operation of the remedial system, modifications to the remedial system, decommissioning of the remedial system, or implementation of a different remedial technology. If it is determined that effectiveness of the remedial system needs to be improved, groundwater recirculation is an option that will be evaluated first. Groundwater recirculation can be easily adapted into a groundwater extraction system; much of the required infrastructure will already be present, and it would enhance the performance of the existing remedial system rather than replace it. Remedial measures evaluations will be provided in the annual report in accordance with Part V.D.3 of the Cleanup Agreement.

## 5.0 Long-Term Monitoring

Routine quarterly monitoring events will be conducted until the end of the first year after remedial system operation. After the end of the first year of operation, a sufficient number of continuous quarterly monitoring events will have been completed to evaluate the frequency and number of wells sampled during routine groundwater monitoring events. In addition to the data collected during monthly O&M visits, the quarterly groundwater monitoring events will continue to include the collection of groundwater samples from monitoring wells and observation wells. The long-term monitoring network is provided on **Figure 7**. The long-term monitoring network is provided in Table III.1 of the Cleanup Agreement.

The current monitoring well network consists of 27 monitoring wells and 5 observation wells for a total of 32 groundwater locations, which will be used to:

- Document PCE concentrations at the site over time,
- Ensure that PCE concentrations in groundwater above the ADEM remedial goal of 5 µg/L do not exit the property boundary, and,
- Measure the effectiveness of the remedial system.

#### 5.1.1 Effectiveness Well Locations

Effectiveness wells consist of 17 monitoring wells (MW-1 through MW-12, MW-14 through MW-17, and MW-27) and 5 observation wells (OW-1 through OW-5). Effectiveness wells were installed during various phases of the groundwater investigation to evaluate the current and future migration of PCE and to monitor the effectiveness of the remedial measures. The effectiveness wells are all contained within the PCE plume and will be used to evaluate effectiveness of the remedial system in controlling plume movement and reducing PCE concentrations.

#### 5.1.2 Boundary Well Locations

Boundary wells consisting of ~~10~~ 8 monitoring wells (MW-13, ~~and~~ MW-18 through MW-22, MW-25, and MW-26) were designed to evaluate the current and future extent of the migration of PCE in groundwater. The boundary wells will be used to verify that PCE is not migrating off-site at concentrations exceeding the ADEM remedial goal of 5 µg/L. PCE was not detected in any of the boundary wells as of the most recent quarterly monitoring event in November 2014.

#### 5.1.3 Background Well Locations

Background wells consist of two monitoring wells (MW-23 and MW-24). The background wells were selected due to the distance from the PCE plume and the plant footprint and to allow for comparisons to background water quality.

### 5.2 Sampling Program

Samples collected as part of the Long-Term Monitoring Program will be in accordance with the following ADEM, EPA, and previously approved guidance:

- The most recent version of the AEIRG;
- USEPA Region 4 Science and Ecosystem Support Division (SESD) Field Branches Quality System and Technical Procedures (replaces the Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (EISOPQAM); ~~and,~~
- SABIC Work Plans and Addendums approved previously by the ADEM; and,
- The Cleanup ~~Agreeement~~Agreement.~~.~~

#### 5.2.1 Sample Collection Frequency

Samples will be collected on a quarterly basis for the first year that the remedial system is active. After the system has been active for a year, sufficient data will be available to perform a pre- and post-treatment trend analysis and re-evaluate the long-term sampling program. Following the trend analysis, the sample locations and sample frequency will be re-evaluated to optimize the collection of useful data. Sample collection frequency will be as specified in Part III of the Cleanup Agreement and includes groundwater samples collected on at least a semi-annual basis from each well in the monitoring well system (Table III.1 of the Cleanup Agreement).

#### 5.2.2 Sample Analyte Selection

Each groundwater sample will be analyzed for VOCs using USEPA Method 8260. Field parameters, including DO, turbidity, pH, conductivity, ORP, and temperature will be measured in active wells in the long-term monitoring network during each sampling event. Groundwater quality monitoring constituents are listed in Table III.2 of the Cleanup Agreement. Groundwater protection standards are listed in Table III.3 of the Cleanup Agreement.

### 5.3 Remedial Effectiveness Evaluation

#### 5.3.1 Trend Analyses

Time-series plots and intrawell Shewhart-Cumulative Sum (CUSUM) control charts will be used annually to evaluate trends of PCE concentration for effectiveness wells. PCE is referenced in this section because it is the primary COC; however, all VOCs and associated daughter products will be evaluated, if detected. Time-series plots will also provide for visual interpretations of trends. Trends will be evaluated only for wells where PCE was detected for a sufficient number of sampling events (four consecutive events above the laboratory method detection limit) to develop valid trends.

#### 5.3.2 Effectiveness Wells Monitoring

Following one year of monitoring after remediation system startup, effectiveness concentrations will be developed for each effectiveness well to benchmark remedial effectiveness across the extent of the PCE plume. The effectiveness concentrations will be developed using the site-wide groundwater model. The effectiveness monitoring wells will be evaluated based on comparison of PCE concentrations

predicted by the site-wide groundwater model to detected PCE concentration in groundwater samples. The site-wide groundwater model (already developed) is capable of predicting concentrations at effectiveness wells through a planning horizon of 30 years or more. Following development of effectiveness well concentrations, PCE concentrations detected in groundwater samples will be evaluated using the following criteria:

1) If PCE sample results are below the predicted PCE concentration, this will indicate the remedial measures are performing as intended and predicted by the site-wide model. The periodic sampling at the effectiveness well will continue.

2) If sample results are above the predicted PCE concentration, the effectiveness well and computer model will be evaluated to determine if the PCE concentration is increasing in the monitoring well due to migration of the PCE plume at dimensions and/or rate that was not expected or predicted.

PCE concentrations in the effectiveness monitoring wells are expected to change over time due to remedial measures and changes in the PCE source mass and groundwater remedial pumping. The site-wide groundwater model, along with routine monitoring, will be used to predict these changes. However, under all possible remedial scenarios, including no action, the PCE plume is not expected to migrate beyond the current SABIC property boundary.

#### 5.3.3 Boundary Wells Monitoring

Following one year of quarterly monitoring after remediation system startup, sample results from the boundary wells collected during the periodic sampling events will be compared to the PCE remedial goal (i.e., ~~e.g.,~~ Groundwater Protection Standard) of 5 µg/L. A series of actions will be based on the comparisons. These actions may include:

1. If sample results from boundary well samples are below the remedial goal of 5 µg/L, this will indicate that the PCE plume is not migrating beyond the boundary wells.

2. If sample results are above the remedial goal, this will trigger the collection and analysis of a verification sample from the monitoring well with the exceedance

within 30 days of SABIC's receipt of the final laboratory data from the periodic sampling event showing an increase over the remedial goal for PCE of 5 µg/L:

a. If the verification sample result is below the remedial goal, periodic monitoring will resume and SABIC will include all verification sampling results in the annual report.

b. If the verification sample result is above the remedial goal, SABIC will notify ADEM of the verified exceedance within 30 days of receipt of the final laboratory data for the verification samples. The notification letter will include sampling results from the periodic and verification sampling events and notification that SABIC will increase the frequency of periodic sampling at affected boundary wells until concentrations in the affected wells are below the remedial goal or for a minimum of four consecutive events with increased sampling frequency. An assessment of the cause of the exceedance(s) will be performed following the fourth event.

c. If the concentrations of PCE have not decreased below the remedial goal in the affected boundary wells within the four subsequent/ consecutive sampling events, an Assessment Plan will be developed. The Assessment Plan will evaluate groundwater within the vicinity of the boundary well(s) with a concentration above the remedial goal and will be submitted to ADEM.

d. Additional remedial measures will be implemented if justified by the results of the Assessment Plan to maintain control of groundwater at the site and/or modify the boundary well network, as needed.

### 5.4 Monitoring Well Network Optimization

The long-term monitoring program will be re-evaluated annually during operation of the remedial system. Spatial and temporal trends, groundwater modeling, and qualitative analyses may be used to evaluate the long-term monitoring well network.

#### 5.4.1 Spatial Analysis

Spatial analyses of the distribution of PCE and vinyl chloride throughout the site and correlation of concentrations between monitoring wells may be performed to re-

evaluate/identify the optimum number and location of boundary and effectiveness wells in the network. Spatial analyses may include “spatial tolerance” metrics to estimate the efficacy of the network when selected wells are removed sequentially from the network and/or groundwater modeling shows additional monitoring wells are needed where data gaps are predicted to exist. Monitoring wells may be removed from routine sample collection (not water level measurements) where analysis shows PCE concentrations are predicted as highly unlikely to increase.

#### 5.4.2 Temporal Analysis

Temporal analyses of the distribution of PCE and vinyl chloride in monitoring wells at the site may be performed to re-evaluate/identify the optimum frequency of sampling events at boundary and effectiveness wells in the network. Techniques developed by the USEPA and the Air Force Center for Environmental Excellence (AFCEE, 2005) will be used for temporal analyses.

### 5.5 Reporting

In accordance with Part V of the Cleanup Agreement, t~~T~~he effectiveness of the system and long-term monitoring program will be evaluated annually after startup and continued until all remedial activities have been completed and goals met as indicated by the ADEM. The reports will include data from groundwater monitoring, analysis of data, remedial actions (if any), and conclusions regarding the effectiveness of the monitoring program. If the analysis of the data warrants any change to the remedial action program, SABIC will include recommendations for revisions in the annual report.

The annual reports will include:

- Site history or reference to previously submitted site history.
- Descriptions of remedial measures activities over the past year.
- Groundwater monitoring activities, including:
    - Sample locations and dates
    - Analytical methods
    - Method reporting limits for each constituent reported
- A map of the groundwater monitoring system,

- Potentiometric surface maps,
- Isoconcentration maps,
- Tables of boundary well concentrations with comparison to the current remedial goal,
- Tables of effectiveness well concentrations with comparison to model-predicted concentrations,
- Trend analysis, and
- Recommendations for optimizing the interim remedial measures and/or the long-term monitoring well program.

## 6.0 References

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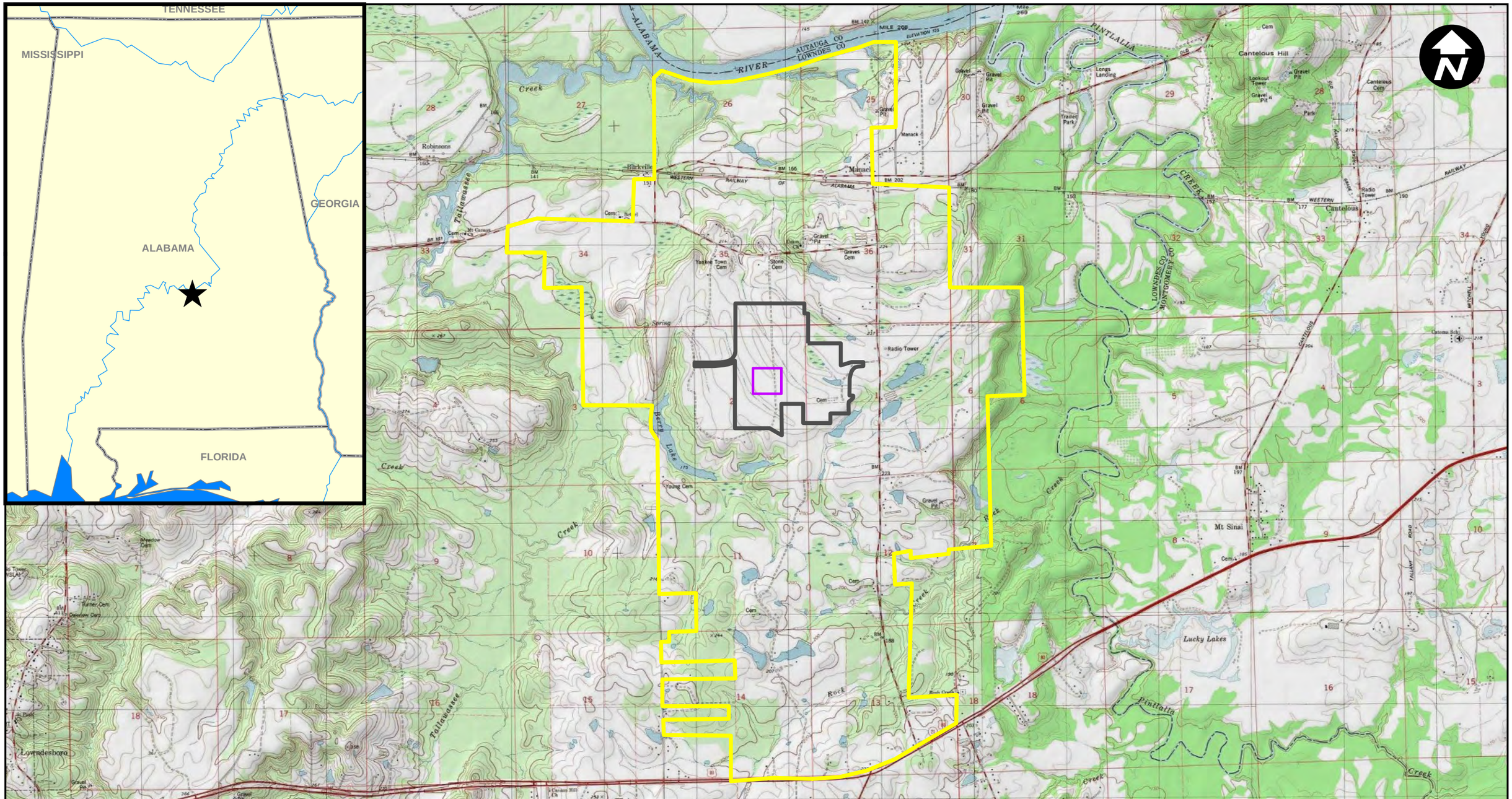



## LEGEND

- APPROXIMATE SABIC PROPERTY BOUNDARY
- PLANT FENCE LINE
- BRINE RECOVERY UNIT

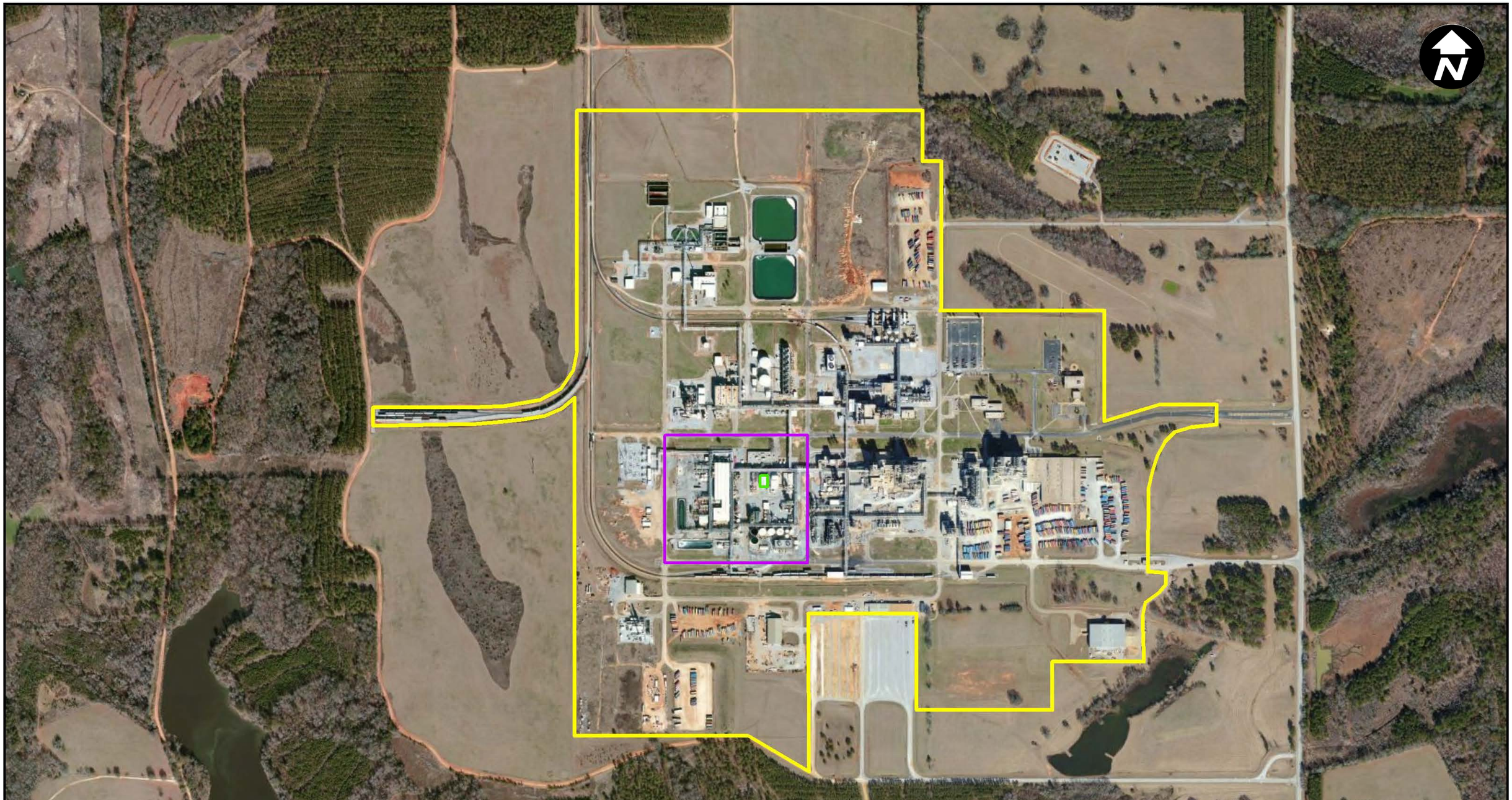
0 0.5 1
Miles

SABIC
BURKVILLE, ALABAMA

SITE LOCATION MAP AND TOPOGRAPHY

ARCADIS

FIGURE
1




**LEGEND**

- PLANT FENCE LINE
- BRINE RECOVERY UNIT
- COMPRESSION BUILDING

0 500 1,000

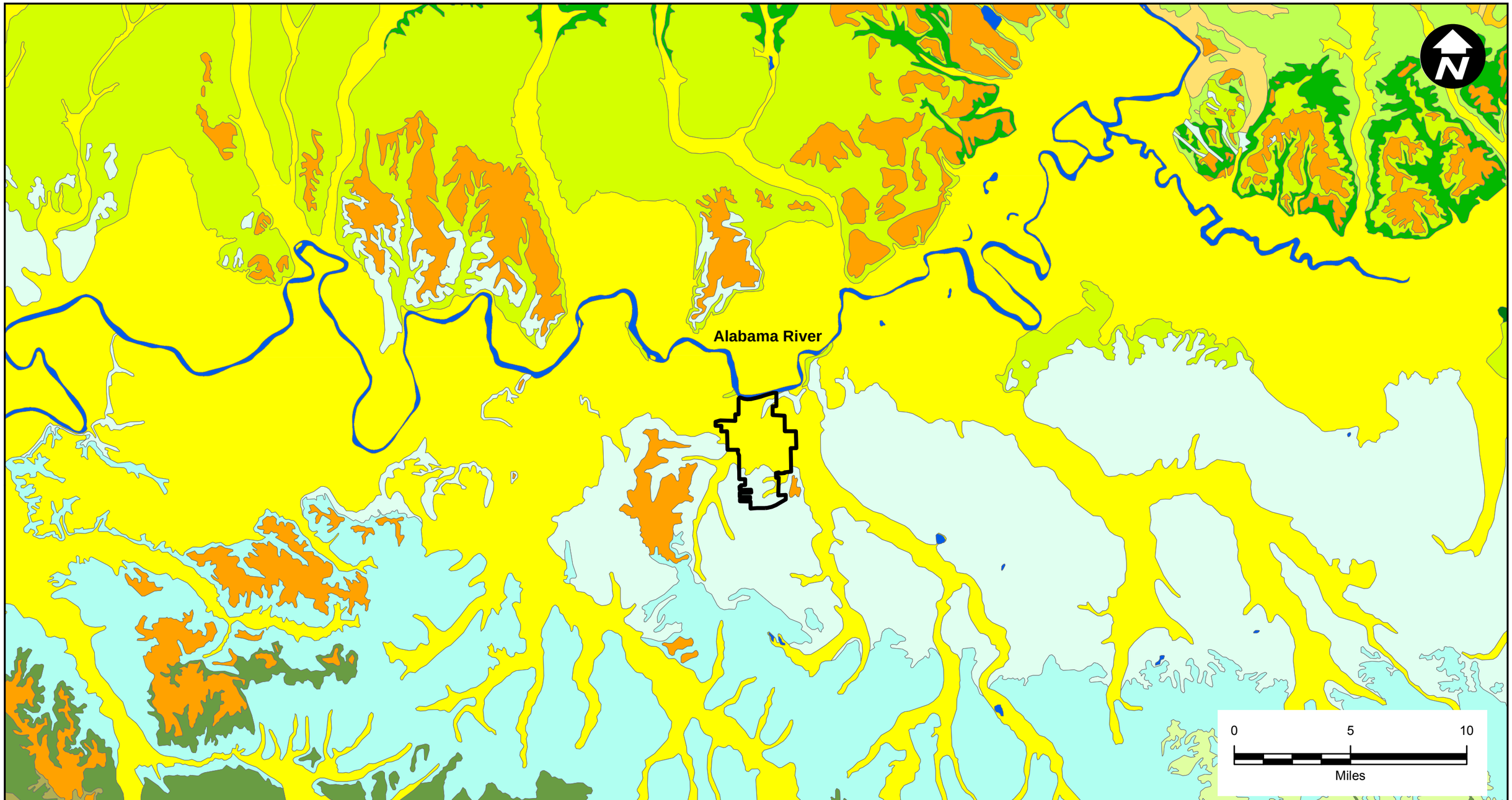
SCALE IN FEET

SABIC
BURKVILLE, ALABAMA

SITE LAYOUT MAP

ARCADIS

FIGURE
2




## LEGEND

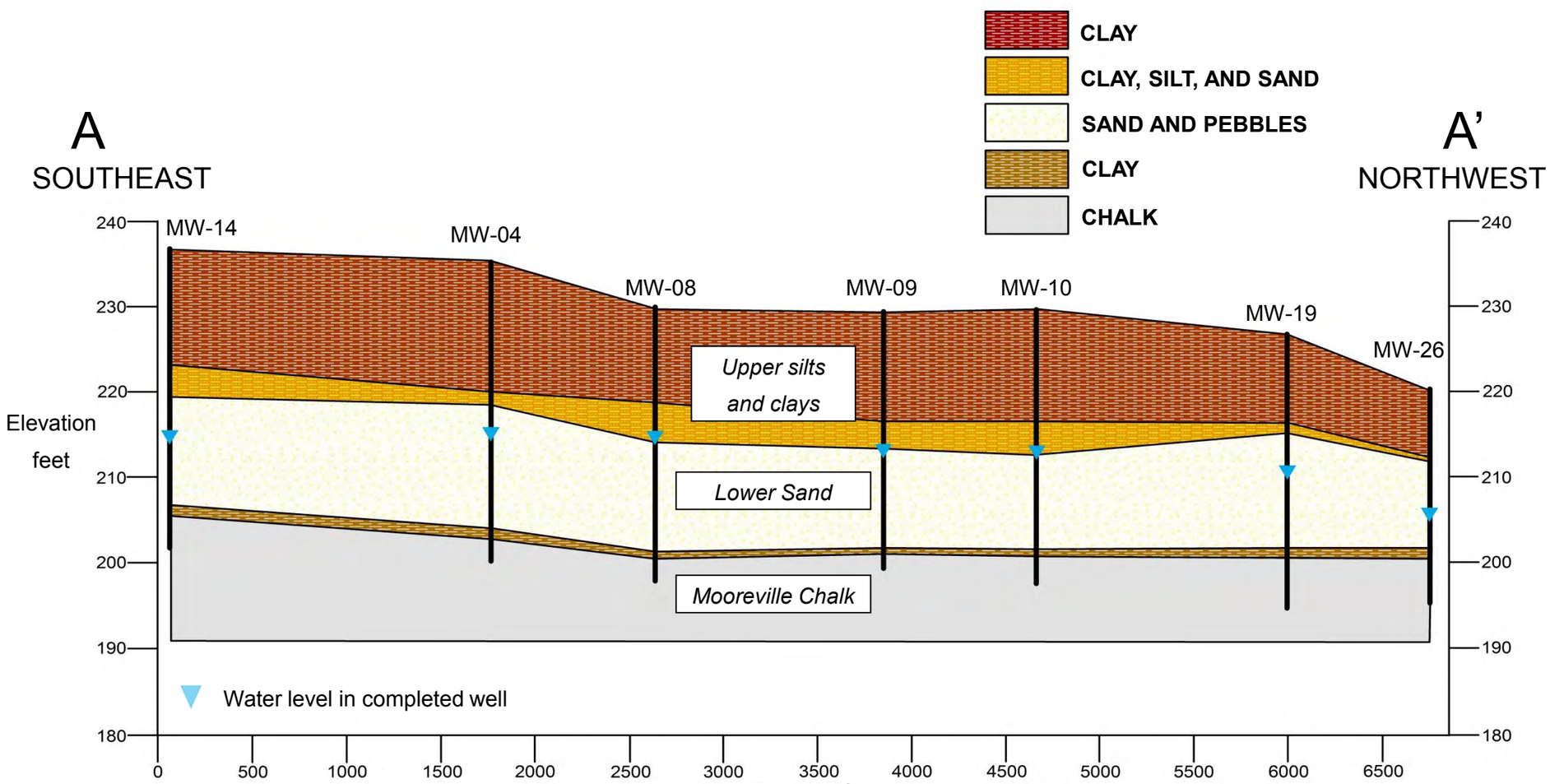
- APPROXIMATE SABIC PROPERTY BOUNDARY
- Alluvial, coastal, and low terrace deposits
- Clayton Formation
- Coker Formation
- Cusseta Sand Member of the Ripley Formation
- Demopolis Chalk
- Emuckfaw Group undifferentiated in part
- Eutaw Formation
- Gordo Formation
- High terrace deposits
- Kowaliga Gneiss
- Mooreville Chalk
- Prairie Bluff Chalk
- Ripley Formation
- Tuscaloosa Group undifferentiated
- Water

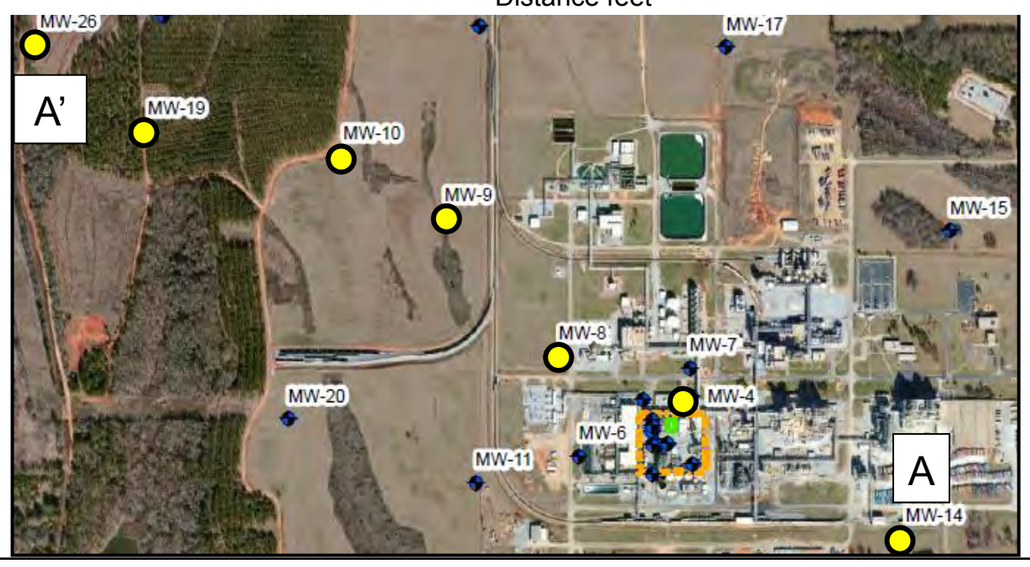
SABIC
BURKVILLE, ALABAMA

SITE GEOLOGY

ARCADIS

FIGURE
3



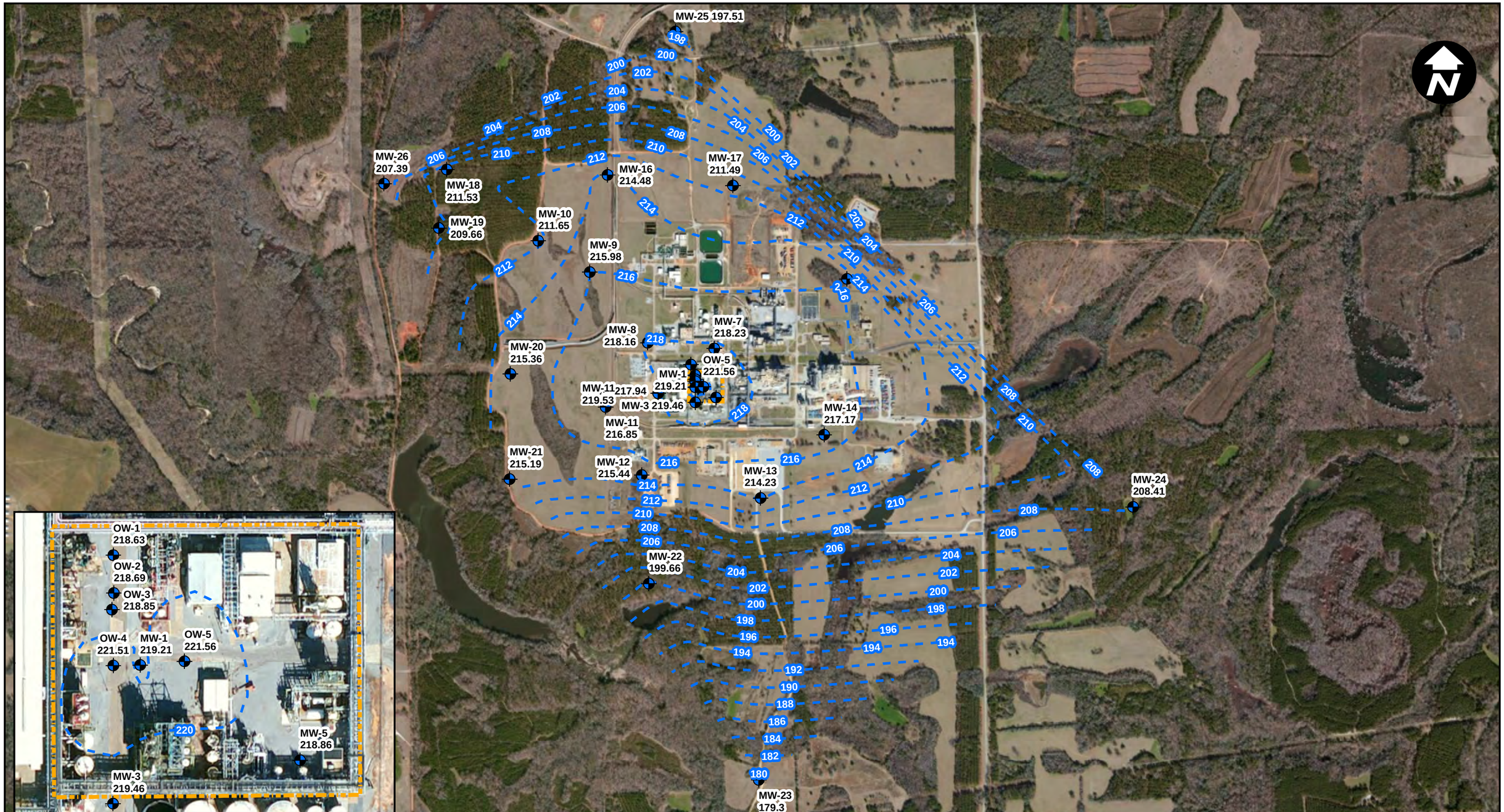




ARCADIS

**SABIC**
**BURKVILLE, ALABAMA**

**Figure 4 CROSS SECTION**

**Note:**
Vertical exaggeration = 50x




## LEGEND

MW-ID ELEVATION — MONITORING WELL AND GROUNDWATER ELEVATION (FEET AMSL)

ELEV — GROUNDWATER ELEVATION CONTOUR (FEET AMSL)

BRINE RECOVERY UNIT LOCATION

0 1,000 2,000

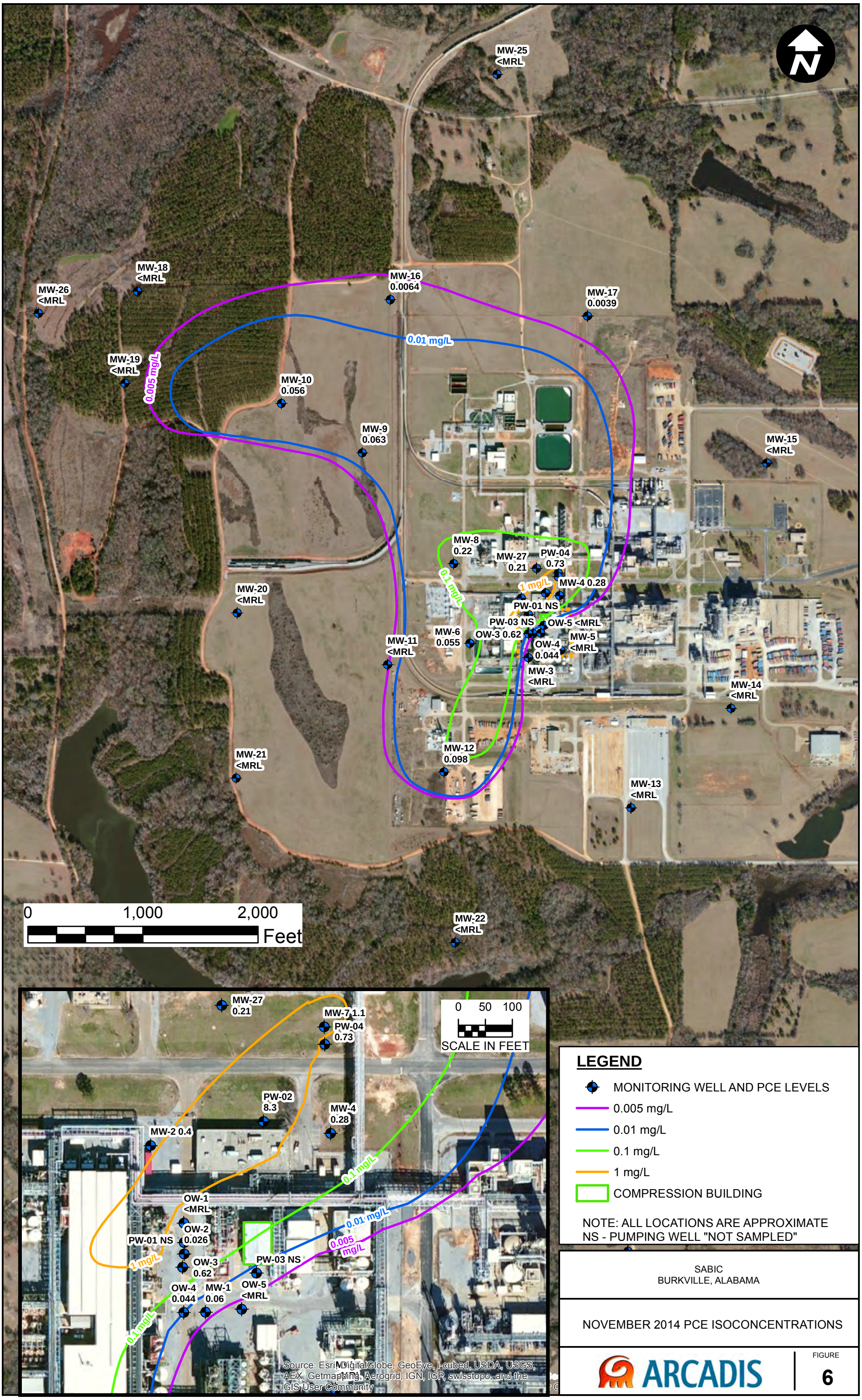
SCALE IN FEET

SABIC
BURKVILLE, ALABAMA

NOVEMBER 2014 GROUNDWATER ELEVATIONS AND CONTOURS

ARCADIS

FIGURE 5




## LEGEND

- MONITORING WELL AND PCE LEVELS
- 0.005 mg/L
- 0.01 mg/L
- 0.1 mg/L
- 1 mg/L
- COMPRESSION BUILDING

NOTE: ALL LOCATIONS ARE APPROXIMATE
NS - PUMPING WELL "NOT SAMPLED"

SABIC
BURKVILLE, ALABAMA

NOVEMBER 2014 PCE ISOCONCENTRATIONS

ARCADIS

FIGURE
6

be, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, GP,

## LEGEND

**Monitoring Well Type**

- Boundary
- Effectiveness
- BRINE RECOVERY UNIT LOCATION

0 1,000 2,000

SCALE IN FEET

SABIC
BURKVILLE, ALABAMA

BOUNDARY AND EFFECTIVENESS WELLS

ARCADIS

FIGURE
7

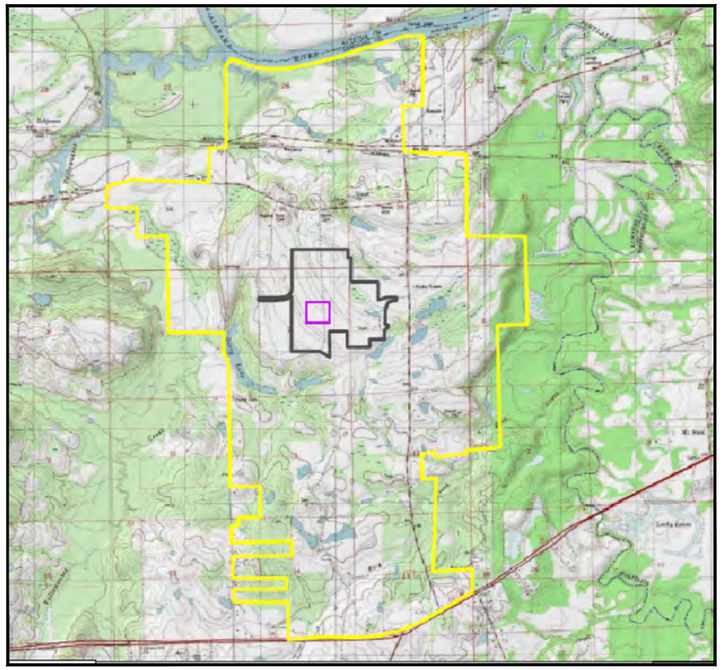
**Appendix A**

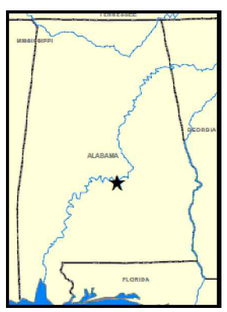
Remedial System Design Plans

# INTERIM REMEDIATION MEASURE
# CONSTRUCTION DRAWINGS

REVISION 8

# BRINE UNIT SABIC BURKVILLE






**DATE ISSUED**

**January 26, 2015**

**SABIC**
**ONE PLASTICS DRIVE,**
**BURKVILLE, ALABAMA**
**LOWNDES COUNTY**

ARCADIS

INDEX OF DRAWINGS


| SHEET TITLE | SHEET NO. |
|---|---|
| TITLE SHEET, VICINITY MAP, AND INDEX OF DRAWINGS | 1 |
| GENERAL NOTES | 2 |
| LOCATION OF EXTRACTION WELLS AND PIPING | 3 |
| ELECTRICAL LINE LOCATIONS | 4 |
| PIPE TRENCHING CROSS SECTION | 5 |
| GROUNDWATER EXTRACTION DETAIL | 6 |
| SOIL VAPOR EXTRACTION WELL DETAIL | 7 |
| REMEDIATION SYSTEM COMPOUND LAYOUT | 8 |
| PROCESS FLOW DIAGRAM | 9 |



CITY: DIV/GROUP: DB: LD: PIC: PM: TM: LYR:ON=*;OFF=*REF*
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## General

1. Contractor is to follow **SABIC Site Orientation Training** and all plant procedures and protocols at all times. Contractor is responsible for providing and maintaining safe access to work areas at all times.
2. Contractor responsible for obtaining and complying with all SABIC permits.
3. Contractor responsible for compliance with the latest national electric code (NEC) and all applicable city, county, state, and federal electrical codes.
4. Contractor responsible for complying with the International Building, Plumbing and Mechanical Codes.
5. Contractor responsible for providing lighted barricades and other safety equipment as necessary to protect all workers 24 hours a day during construction. Barricades to be in accordance with manual on uniform traffic control devices for streets and highways (MUTCD), federal highway administration (FHA). Use Barricade Tape, Cones and other safety devices as instructed in the **SABIC Site Orientation Training**.
6. Contractor accepts liability and is responsible for repair as necessary to original condition of any and all damaged utilities, structures, pavement, curbs, and vegetated areas; vegetated areas to include trees, shrubs, and grass.
7. Contractor to clean site to original condition, acceptable to ARCADIS and SABIC.
8. Contractor's workers shall be trained in accordance with OSHA regulations CFR 29, part 1910: 120, hazardous waste operations and emergency response.
9. Contractor must comply with ARCADIS' site specific health and safety plan.
10. The following is a list of materials and equipment for which manufacturer's or supplier's data sheets must be submitted prior to commencement of work:
    - Concrete
    - Asphalt
    - Electrical conduit and wire
    - CPVC Glue approved for pH 12.0
    - Piping and valves
    - Pipe rack/ securing devices
    - Remediation system anchors
    - Appurtenances
    - Anchor bolts and grouting systems for piping supports
    - Pipe supports & angle iron.
    - Well Vaults
    - All chemicals and solvents (MSDS must be provided)
    - Pitless Adapters and adapter seals
    - Vacuum tight sanitary well seals
11. Work to be performed between 7:00am - 5:00pm, Monday through Friday.
12. All work under this contract shall be performed in a manner which does not disrupt SABIC'S normal business activities, outside of the construction area.
13. Locations of wells, equipment container, and piping are approximate. Contractor to field verify locations of wells. Contractor will mark out the locations of piping, equipment compound, and gravel pad.

## Electrical

1. All aboveground electrical equipment and appurtenances to be housed in PVC and flex conduit meeting requirements in No. 2, general notes.
2. Contractor to submit proposed electrical layout for equipment and appurtenances to engineer for review prior to construction.
3. Contractor responsible for providing and installing correct wire AWG size and electrical conduit.
4. Sabic is responsible for providing and installing lockable on/off switch on power pole.
5. All electrical equipment provided by the contractor shall be Underwriters Laboratory (UL) listed and acceptable to SABIC.

## Civil

1. Contractor to field verify all horizontal and vertical dimensions and locations; any discrepancies shall be reported to the engineer prior to construction.
2. Elevation points and contours are not shown.
3. Contractor responsible for verifying location of all underground utilities with three lines of evidence prior to excavation activities. This includes but is not limited to subcontracting a utilities locator contractor.
4. Contractor to vertical saw cut asphalt/concrete pavement at excavation/ trench/ vault locations prior to excavation.
5. Pavement subgrade, shall be compacted to 98% ASATM D698 maximum density unless specified otherwise.
6. Excess soil generated during construction is to be stock piled on site and covered top, bottom, and sides with a plastic liner
7. Contractor to provide signed and sealed drawings by a qualified licensed Alabama Professional Engineer for tying down system and supporting the equipment container.
8. Contractor is responsible for providing road plates, lighted traffic controls, and any maintenance of traffic controls, as needed to keep all roadways open during trenching activities.
9. Arcadis to collect samples from excavated soil during trenching activities prior to using native soil as backfill.
10. Native soil not suitable for backfill material will be stockpiled on visqeen and covered at all times.
11. Certified clean Type III material is required for replacing any native soil not suitable for use as backfill.

## Mechanical

1. Contractor responsible for supply and assembly of all piping and appurtenances from well heads to equalization tank in treatment system area.
2. Water lines including appurtenances to be hydrostatically pressure tested for one hour @ 100 psi. All SVE air lines including appurtenances to be hydrostatically pressure tested for one hour @ 20 psi. All testing shall be witnessed by ARCADIS prior to filling in trenches.
3. All piping and electrical conduits on or in existing facility buildings to be secured to slab, pipe rack or wall with Unistrut and Straps or equivalent. Maximum unsupported length of piping shall be less than 6 feet.
4. Equipment/appurtenances on details are generic only. Size of units may be different than shown.
5. All appurtenances, connections, gaskets, seals etc. are to be petroleum resistant.
6. Contractor to provide all pipe fittings not shown (reducers, bushings, etc.)
7. Pipe supports to be provided within 6-inches of all valves and fittings.
8. Pipe connections not shown on drawings. Provide and install union connections as necessary.
9. Contractor is responsible for labeling all pipe and conduit every 100ft to include the following information: pressure or vacuum line, air, water or electrical, and flow direction.
10. All piping and piping supports will comply with the SABIC Design Guide Specifications # 1840.05, rev 1, 7/28/14
11. All piping materials will comply with the SABIC piping materials specifications 15052 Attachment 2, Rev 4, 5/11/2007.

## Decontamination notes:

1. Set up a decontamination area.
2. Decontamination shall include washing with a pressure washer (steam and detergent).
3. Decontaminate all equipment to ARCADIS' satisfaction prior to use at the site.
4. Pump decontamination generated fluids in 55-gallon drums. Allow solids to settle in drums. Decant liquids from 55-gallon drums to equalization tank.
5. Place all solids with soil in 55-gallon drums.
6. Decontaminate all equipment prior to leaving site.

Professional Engineer

| P.E.'s Number | State AL | Date Signed |
|---|---|---|
| | | |

| No. | Date | Revisions | By | Ckd |
|---|---|---|---|---|
| Rev 1 | 5/30/14 | Add additional notes to mechanical | ALH | KMW |
| Rev 4 | 8/12/14 | Add additional notes to General, Electrical, mechanical | ALH | KMW |
| Rev 6 | 10/30/14 | Add additional notes to General, Electrical, mechanical | ALH | KMW |
| Rev 8 | 1/26/15 | Add additional notes to Civil | ALH | KMW |

Project Mgr. (AE)
Designed by (KMW)
Drawn by (ALH)
Checked by (KMW)

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ARCADIS U.S., INC.

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SABIC CONSTRUCTION DRAWINGS

# General Notes

ARCADIS Project No. 13283007.0000
Date October 2014
ARCADIS
3522 Thomasville Rd
Tallahassee, FL 32309

2

CITY: DIV/GROUP: DB: LD: PIC: PM: TM: LYR:ON=*;OFF=*REF*
G:\ENVCAD\Tallahassee-FL\ACT\13283007\13283007 RAC 1_26_15 Rev6.dwg LAYOUT: SHEET 2 SAVED: 1/27/2015 6:00 AM ACADVER: 18.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ---- PLOTTED: 1/27/2015 6:02 AM BY: HOFMEISTER, AUSTIN
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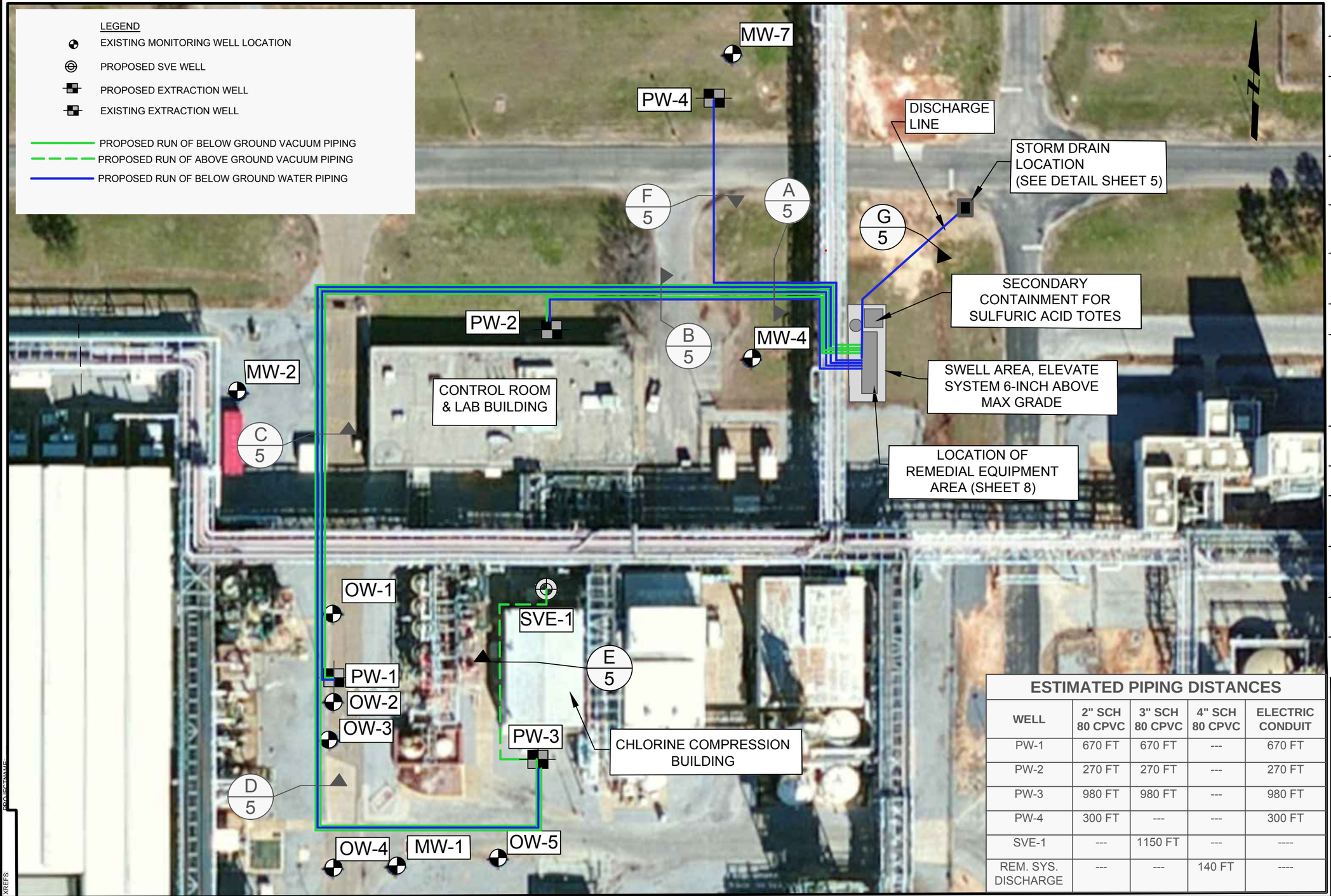


NOTES:

- LOCATION OF SVE PIPES ON CHLORINE COMPRESSOR BUILDING TO BE DETERMINED BY SABIC.
- CONTRACTOR IS RESPONSIBLE FOR PROVIDING ROAD PLATES, LIGHTED TRAFFIC CONTROLS, AND ANY MAINTENANCE OF TRAFFIC CONTROLS, NEEDED TO KEEP ALL ROADWAYS OPEN DURING CONSTRUCTION.(4 ROAD CROSSINGS, 30 FT WIDE)
- ARCADIS WILL COLLECT SAMPLES FROM EXCAVATED SOIL DURING TRENCHING ACTIVITIES PRIOR TO USING NATIVE SOIL AS BACKFILL.
- NATIVE SOIL NOT SUITABLE FOR BACKFILL MATERIAL WILL BE STOCKPILED ON VISQUEEN AND COVERED AT ALL TIMES.
- CERTIFIED CLEAN TYPE III MATERIAL IS REQUIRED FOR REPLACING ANY NATIVE SOIL NOT SUITABLE FOR USE AS BACKFILL.
- CONTRACTOR TO PROVIDE SUBMITTAL FOR PIPE SECURING DEVICES.
- CONTRACTOR IS RESPONSIBLE FOR PROPERLY LABELING ALL PIPING AND ELECTRICAL CONDUIT LABELING TO INCLUDE: COLOR CODE, FLOW DIRECTION, WATER/ GAS/ ELECTRIC, PRESSURE/ VACUUM. LABEL IN ACCORDANCE WITH SABIC SPECIFICATIONS.
- CONTRACTOR TO PERFORM PRIVATE UTILITY LOCATE PRIOR TO TRENCHING ACTIVITIES.
- CONTRACTOR TO VERIFY ESTIMATE PIPING DISTANCES PRIOR TO BID.
- ALL PIPING AND PIPING SUPPORTS WILL COMPLY WITH THE SABIC DESIGN GUIDE SPECIFICATION# 1840.05 REVISION 1, 7/28/14.
- ALL PIPING MATERIALS WILL COMPLY WITH THE SABIC PIPING MATERIALS SPECIFICATIONS 15052 ATTACHMENT 2, REV 4, 5/12/2007.
- SECONDARY CONTAINMENT FOR SULFURIC ACID IS A 12FT X 12FT COLLAPSE-A-TAINER PN# PAK593.
- CONTRACTOR TO PROVIDE SUBMITTAL FOR PVC SUCTION HOSE NEEDED TO CONNECT TRENCHED SVE LINES TO SYSTEM MANIFOLD.

## ESTIMATED PIPING DISTANCES

| WELL | 2" SCH 80 CPVC | 3" SCH 80 CPVC | 4" SCH 80 CPVC | ELECTRIC CONDUIT |
|---|---|---|---|---|
| PW-1 | 670 FT | 670 FT | --- | 670 FT |
| PW-2 | 270 FT | 270 FT | --- | 270 FT |
| PW-3 | 980 FT | 980 FT | --- | 980 FT |
| PW-4 | 300 FT | --- | --- | 300 FT |
| SVE-1 | --- | 1150 FT | --- | ---- |
| REM. SYS. DISCHARGE | --- | --- | 140 FT | ---- |

Professional Engineer

| P.E.'s Number | State | Date Signed |
|---|---|---|
| | AL | |

0 30' 60' 120'
SCALE IN FEET

THIS BAR REPRESENTS ONE INCH ON THE ORIGINAL DRAWING: USE TO VERIFY FIGURE REPRODUCTION SCALE

| No. | Date | Revisions | By | Ckd |
|---|---|---|---|---|
| Rev 2 | 7/24/14 | Move system to the East side of Pipe rack | ALH | KMW |
| Rev 4 | 8/12/14 | Move system to the Southeast side of Pipe rack | ALH | KMW |
| Rev 5 | 10/24/14 | Add secondary containment for Sulfuric acid storage | ALH | KMW |
| Rev 6 | 10/30/14 | Add notes | ALH | KMW |
| Rev 8 | 1/26/15 | Move/ relocate trench lines below ground surface | ALH | KMW |

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Project Mgr. (AE)
Designed by (KMW)
Drawn by (ALH)
Checked by (KMW)

ARCADIS
ARCADIS U.S., INC.

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SABIC CONSTRUCTION DRAWINGS

# Location of Extraction Wells and Piping

ARCADIS Project No. 13283007.0000
Date October 2014
ARCADIS 3522 Thomasville Rd Tallahassee, FL 32309

3

CITY: DIV/GROUP: DB: LD: PIC: PM: TM: LYR:ON=*;OFF=*REF* PAGESETUP: ---- PLOTSTYLETABLE: GRAYSCALE.CTB PLOTTED: 1/27/2015 6:02 AM BY: HOFMEISTER, AUSTIN
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XREFS: PROJECTNAME:

NOTES:

- LOCATION OF ELECTRICAL CONDUIT ON CONTROL ROOM/ LAB BUILDING TO BE DETERMINED BY SABIC.
- USE ELECTRICAL PULL BOXES AS NECESSARY.
- CONTRACTOR TO PROVIDE SUBMITTAL FOR ELECTRIC CONDUIT SECURING DEVICES.
- CONTRACTOR TO PROVIDE SUBMITTAL FOR ELECTRICAL CONDUIT, JUNCTION BOXES, AND WIRE.
- CONTRACTOR IS RESPONSIBLE FOR PROPERLY LABELING ALL PIPING AND ELECTRICAL CONDUIT LABELING TO INCLUDE: COLOR CODE, FLOW DIRECTION, WATER/ GAS/ ELECTRIC, PRESSURE/ VACUUM. LABEL AS DIRECTED BY SABIC.
- CONTRACTOR TO PERFORM PRIVATE UTILITY LOCATE PRIOR TO TRENCHING ACTIVITIES.
- CONTRACTOR IS RESPONSIBLE FOR PULLING WIRE THROUGH ALL CONDUIT.
- CONTRACTOR IS RESPONSIBLE FOR ALL ELECTRICAL CONNECTIONS TO EXTRACTION WELLS AND REMEDIATION SYSTEM.
- CONTRACTOR IS RESPONSIBLE FOR ALL ELECTRICAL CONNECTIONS NEEDED TO CONNECT THE SABIC POWER TO THE REMEDIATION SYSTEM.
- EXTRACTION WELL PUMPS REQUIRE 3 PHASE/ 480 VAC SERVICE FOR 1.5 HP MOTOR.
- ELECTRICAL WIRE AWG SIZING TO BE APPROVED BY ARCADIS AND SABIC PRIOR TO INSTALLATION.

ESTIMATED ELECTRICAL CONDUIT DISTANCES

| WELL | 2" SCH 80 CPVC | 3" SCH 80 CPVC | 4" SCH 80 CPVC | ELECTRIC CONDUIT |
|---|---|---|---|---|
| PW-1 | 670 FT | 670 FT | --- | 670 FT |
| PW-2 | 270 FT | 270 FT | --- | 270 FT |
| PW-3 | 980 FT | 980 FT | --- | 980 FT |
| PW-4 | 300 FT | --- | --- | 300 FT |
| REM. SYS. POWER | --- | --- | ---- | 350 FT |

Professional Engineer

P.E.'s Number | State AL | Date Signed

0 30' 60' 120'
SCALE IN FEET

THIS BAR REPRESENTS ONE INCH ON THE ORIGINAL DRAWING: USE TO VERIFY FIGURE REPRODUCTION SCALE

| No. | Date | Revisions | By | Ckd |
|---|---|---|---|---|
| Rev 2 | 7/24/14 | Move system to the East side of Pipe rack | ALH | KMW |
| Rev 4 | 8/12/14 | Add notes, move system location Southeast | ALH | KMW |
| Rev 5 | 10/24/14 | Add secondary containment for Sulfuric acid storage | ALH | KMW |
| Rev 5 | 10/24/14 | Add power line from control building to Rem. Sys. compound | ALH | KMW |
| Rev 8 | 1/26/15 | Move trenching, reroute power to wells | ALH | KMW |

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Project Mgr. (AE)
Designed by (KMW)
Drawn by (ALH)
Checked by (KMW)

ARCADIS
ARCADIS U.S., INC.

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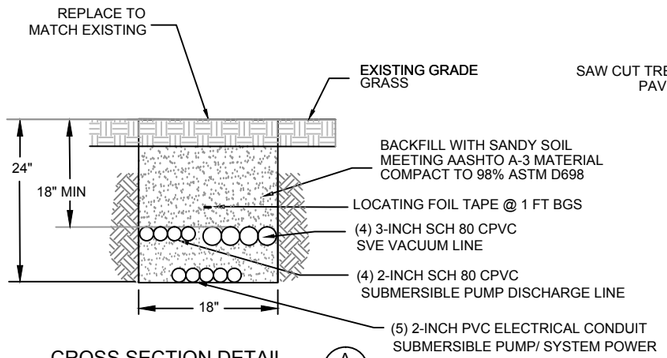
SABIC CONSTRUCTION DRAWINGS

# Electrical Line Locations

ARCADIS Project No. 13283007.0000
Date October 2014
ARCADIS 3522 Thomasville Rd Tallahassee, FL 32309

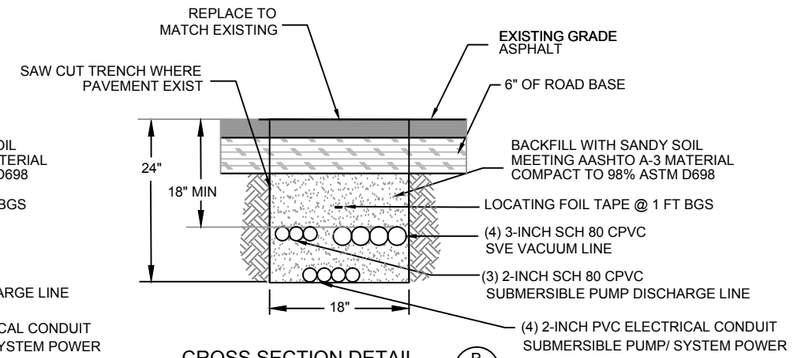
4

CITY: DIV/GROUP: DB: LD: PIC: PM: TM: LYR:ON=*;OFF=*REF*
G:\ENVCAD\Tallahassee-FL\ACT\13283007\13283007 RAC 1_26_15 Rev8.dwg LAYOUT: SHEET 4 SAVED: 1/27/2015 6:00 AM ACADVER: 18.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: GRAYSCALE.CTB PLOTTED: 1/27/2015 6:02 AM BY: HOFMEISTER, AUSTIN
PROJECTNAME:
XREFS:



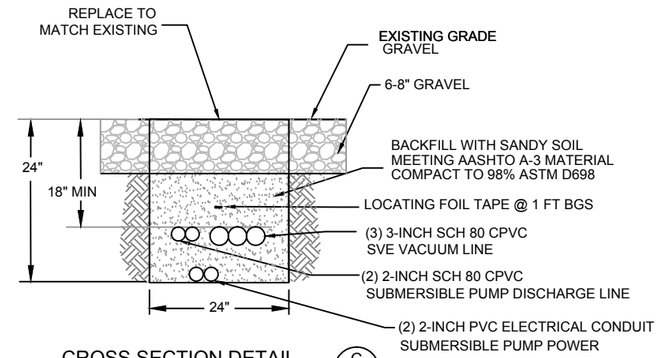

CROSS SECTION DETAIL (A/3)

NOT TO SCALE



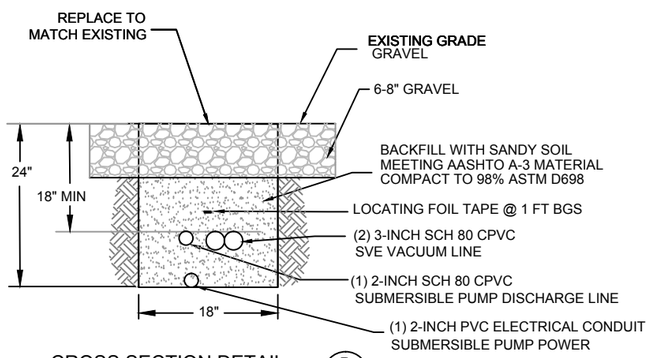

CROSS SECTION DETAIL (B/3)

NOT TO SCALE



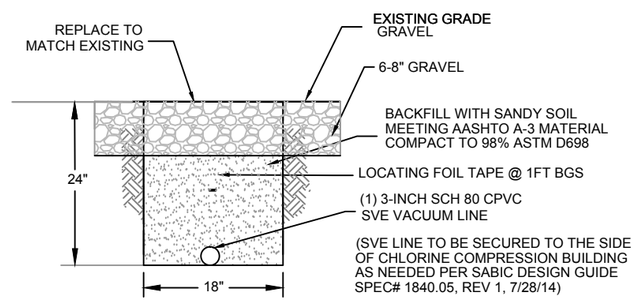

CROSS SECTION DETAIL (C/3)

NOT TO SCALE



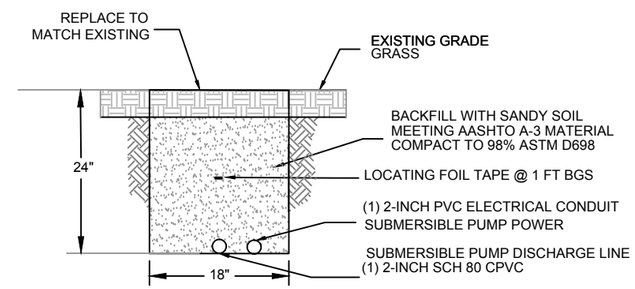

CROSS SECTION DETAIL (D/3)

NOT TO SCALE



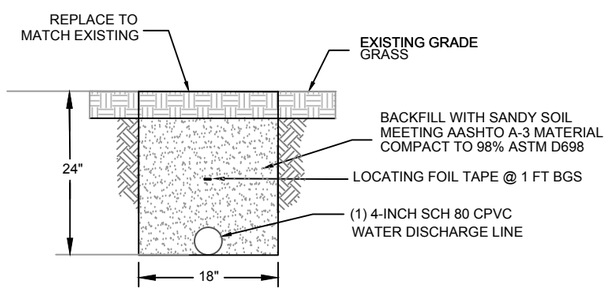

CROSS SECTION DETAIL (E/3)

NOT TO SCALE



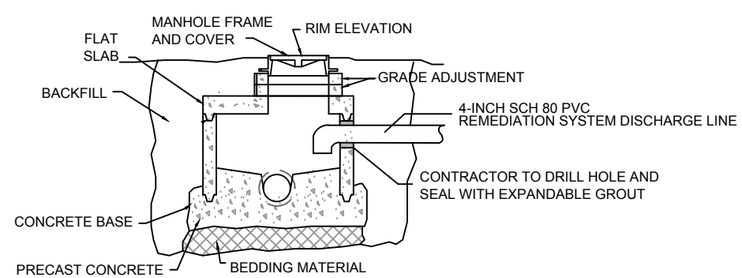

CROSS SECTION DETAIL (F/3)

NOT TO SCALE




CROSS SECTION DETAIL (G/3)

NOT TO SCALE




STORM DRAIN WATER DISCHARGE DETAIL

NOT TO SCALE

## ESTIMATED PIPING DISTANCES

| WELL | 2" SCH 80 CPVC | 3" SCH 80 CPVC | 4" SCH 80 CPVC | ELECTRIC CONDUIT |
|---|---|---|---|---|
| PW-1 | 670 FT | 670 FT | --- | 670 FT |
| PW-2 | 270 FT | 270 FT | --- | 270 FT |
| PW-3 | 980 FT | 980 FT | --- | 980 FT |
| PW-4 | 300 FT | --- | --- | 300 FT |
| SVE-1 | --- | 1150 FT | --- | ---- |
| REM. SYS. DISCHARGE | --- | --- | 140 FT | ---- |
| REM. SYS. POWER | --- | --- | --- | 350 FT |

NOTES:

- MINIMUM DEPTH OF ELECTRICAL LINES TO BE 2 FT BGS.
- PW-4 PIPING DOES NOT INCLUDE A SVE LINE.
- CONTRACTOR RESPONSIBLE FOR PROVIDING FENCING, STEEL ROAD PLATES AND LIGHTED SAFETY CONTROLS AROUND TRENCHES DURING CONSTRUCTION ACTIVITIES, AS INSTRUCTED IN THE SABIC SITE ORIENTATION TRAINING.
- BACKFILL MATERIAL TO BE APPROVED BY ARCADIS.
- CONTRACTOR IS RESPONSIBLE FOR PROVIDING PRIVATE UTILITY LOCATE PRIOR TO TRENCHING ACTIVITIES.
- ELECTRICAL WIRE AWG SIZING TO BE APPROVED BY ARCADIS AND SABIC PRIOR TO INSTALLATION.
- CONTRACTOR TO VERIFY ESTIMATED PIPING DISTANCES PRIOR TO BID.
- ALL PIPING MATERIALS WILL COMPLY WITH THE SABIC PIPING MATERIALS SPECIFICATIONS 15052 ATTACHMENT 2, REV 4, 5/11/2007.
- CONTRACTOR IS RESPONSIBLE FOR PROVIDING ROAD PLATES, LIGHTED TRAFFIC CONTROLS, AND ANY MAINTENANCE OF TRAFFIC CONTROLS, NEEDED TO KEEP ALL ROADWAYS OPEN DURING CONSTRUCTION.(4 ROAD CROSSINGS, 30 FT WIDE)
- ARCADIS WILL COLLECT SAMPLES FROM EXCAVATED SOIL DURING TRENCHING ACTIVITIES PRIOR TO USING NATIVE SOIL AS BACKFILL.
- NATIVE SOIL NOT SUITABLE FOR BACKFILL MATERIAL WILL BE STOCKPILED ON VISQUEEN AND COVERED AT ALL TIMES.
- CERTIFIED CLEAN TYPE III MATERIAL IS REQUIRED FOR REPLACING ANY NATIVE SOIL NOT SUITABLE FOR USE AS BACKFILL.

Professional Engineer

P.E.'s Number | State AL | Date Signed

NOT TO SCALE

THIS BAR REPRESENTS ONE INCH ON THE ORIGINAL DRAWING: USE TO VERIFY FIGURE REPRODUCTION SCALE

| No. | Date | Revisions | By | Ckd |
|---|---|---|---|---|
| Rev 4 | 8/12/14 | Add additional notes | ALH | KMW |
| Rev 5 | 10/24/14 | Add cross section D | ALH | KMW |
| Rev 7 | 12/16/14 | Add storm drain detail | ALH | KMW |
| Rev 8 | 1/26/15 | Add section E, F, G, edit piping distances | ALH | KMW |

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Project Mgr. (AE) | Designed by (KMW) | Drawn by (ALH) | Checked by (KMW)

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# Pipe Trenching Cross Section

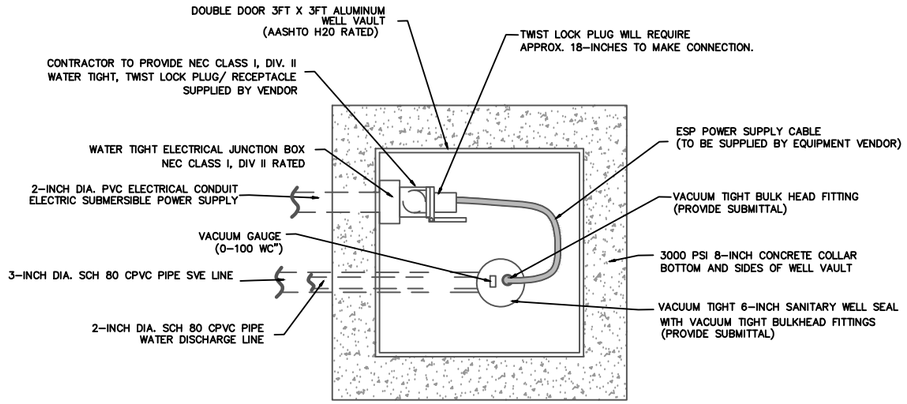
ARCADIS Project No. 13283007.0000

Date October 2014

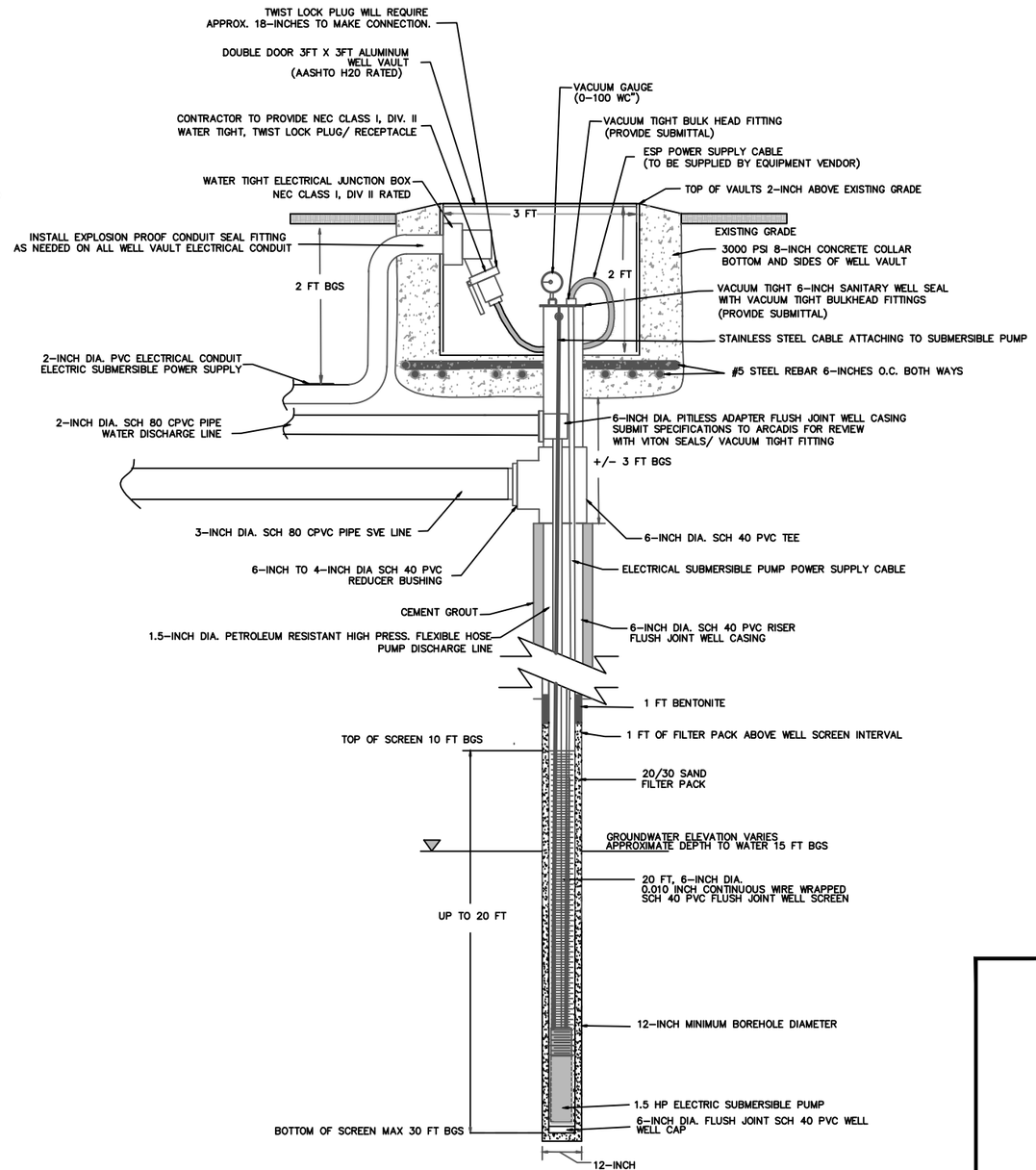
ARCADIS
3522 Thomasville Rd
Tallahassee, FL 32309

5

CITY: DIV/GROUP: DB: LD: PIC: PM: TM: LYR:ON=*;OFF=*REF*
G:\ENVCAD\Tallahassee-FL\ACT\13283007\13283007 RAC 1_26_15 Rev8.dwg LAYOUT: SHEET 5 SAVED: 1/27/2015 6:00 AM ACADVER: 18.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: GRAYSCALE.CTB PLOTTED: 1/27/2015 6:02 AM BY: HOFMEISTER, AUSTIN
PROJECTNAME---- XREFS:




**TOP VIEW**
**EXTRACTION WELL (TYP.)**
NOT TO SCALE
**(PW-1 THROUGH PW-3)**




**EXTRACTION WELL (TYP.)**
NOT TO SCALE
**(PW-1 THROUGH PW-3)**

NOTES:

- WELLS TO BE INSTALLED BY OTHER CONTRACTOR.
- ELECTRICAL SUBMERSIBLE PUMP, LEADS, HOSE, STEEL CABLE AND CONNECTIONS TO BE SUPPLIED BY EQUIPMENT VENDOR.
- CONTRACTOR IS RESPONSIBLE FOR INSTALLING ALL EQUIPMENT SUPPLIED BY EQUIPMENT VENDOR.
- CONTRACTOR TO USE ALL NEC CLASS I, DIV II ELECTRICAL CONNECTIONS IN VAULTS.
- CONTRACTOR IS RESPONSIBLE FOR ALL ELECTRICAL CONNECTIONS NEEDED TO WIRE AND INSTALL EXTRACTION WELL PUMPS.
- EXTRACTION WELL PUMPS REQUIRE 3 PHASE, 480 VAC SERVICE FOR A 1.5 HP MOTOR.
- ELECTRICAL WIRE AWG SIZING TO BE APPROVED BY ARCADIS AND SABIC PRIOR TO INSTALLATION.
- PW–4 EXTRACTION WELL WILL NOT BE CONNECTED TO THE SVE SYSTEM.
- CONTRACTOR IS RESPONSIBLE FOR THE PROPER INSTALLATION OF EXTRACTION WELL PUMPS.
- CONTRACTOR TO PROVIDE SUBMITTALS FOR SANITARY WELL SEAL, PITTLESS ADAPTER, BULKHEAD FITTINGS, AND VACUUM GAUGES FOR THE INSTALLATION OF EXTRACTION WELL PUMPS AND WELL VAULT CONSTRUCTION.
- CONTRACTOR IS RESPONSIBLE TO PROVIDE SUBMITTALS FOR ALL ADHESIVES, GLUES AND GASKETS USED FOR THE CONSTRUCTION OF EXTRACTION WELLS.
- CONTRACTOR IS RESPONSIBLE FOR REMOVING ALL PVC CUTTINGS AND DEBRIS BY FLUSHING ALL WATER AND SVE LINES PRIOR TO FINAL CONNECTIONS TO SYSTEM OR WELLS.
- EXTRACTION WELL PUMPS TO BE SET AT APPROX. 28 FT BGS INSIDE EXTRACTION WELLS.

Professional Engineer

| P.E.'s Number | State AL | Date Signed |
|---|---|---|
| | | |

NOT TO SCALE

THIS BAR REPRESENTS ONE INCH ON THE ORIGINAL DRAWING: USE TO VERIFY FIGURE REPRODUCTION SCALE

| No. | Date | Revisions | By | Ckd |
|---|---|---|---|---|
| Rev 2 | 7/24/14 | Change plug to NEC Class I, Div II, Add Top View Detail | ALH | KMW |
| Rev 3 | 7/30/14 | Add/ Edit Notes | ALH | KMW |
| Rev 4 | 8/12/14 | Add/ Edit Notes, add water bleed/ drain line to wells | ALH | KMW |
| Rev 8 | 1/26/15 | Remove water drain line from well | ALH | KMW |

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Project Mgr. (AE)
Designed by (KMW)
Drawn by (ALH)
Checked by (KMW)

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# Groundwater Extraction Well Detail

ARCADIS Project No. 13283007.0000
Date October 2014
ARCADIS 3522 Thomasville Rd Tallahassee, FL 32309

6

CITY: DIV/GROUP: DB: LD: PIC: PM: TM: LYR:ON=*;OFF=*REF*
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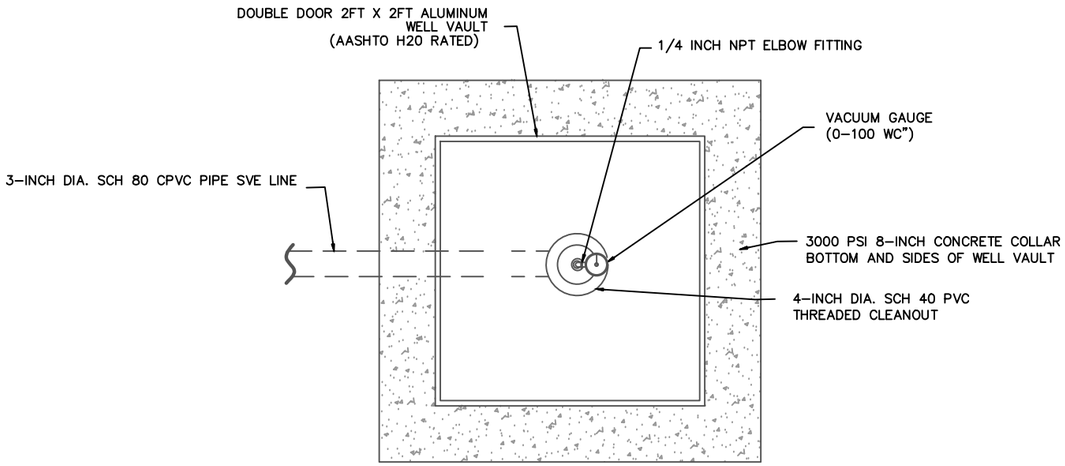
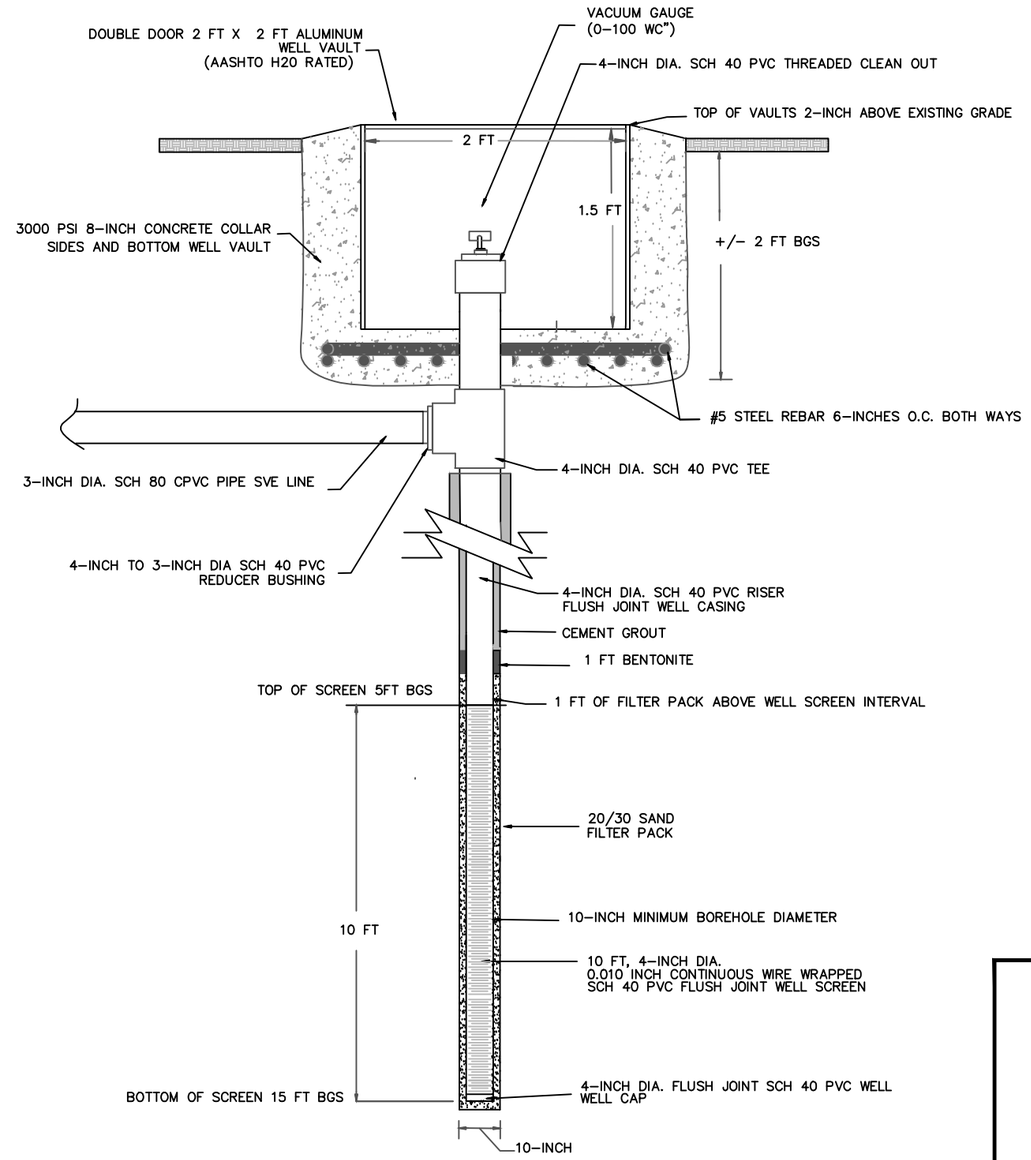
XREFS: PROJECTNAME:




**TOP VIEW**
**SVE WELL (TYP.)**
NOT TO SCALE
**(SVE-1)**




**SOIL VAPOR EXTRACTION WELL (TYP.)**
NOT TO SCALE
**(SVE-1)**

NOTES:

- WELLS TO BE INSTALLED BY OTHER CONTRACTOR
- CONTRACTOR IS RESPONSIBLE TO PROVIDE SUBMITTALS FOR ALL ADHESIVES, GLUES AND GASKETS USED FOR THE CONSTRUCTION OF SVE WELLS.
- CONTRACTOR IS RESPONSIBLE FOR REMOVING ALL PVC CUTTINGS AND DEBRIS BY FLUSHING ALL SVE LINES PRIOR TO FINAL CONNECTIONS TO SYSTEM OR WELLS.

Professional Engineer

| P.E.'s Number | State | Date Signed |
|---|---|---|
| | AL | |

NOT TO SCALE

THIS BAR REPRESENTS ONE INCH ON THE ORIGINAL DRAWING: USE TO VERIFY FIGURE REPRODUCTION SCALE

| No. | Date | Revisions | By | Ckd |
|---|---|---|---|---|
| Rev 3 | 7/30/14 | Add/ Edit Notes | ALH | KMW |
| Rev 6 | 10/30/14 | Add Top View, add notes | | |

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Project Mgr. (AE)
Designed by (KMW)
Drawn by (ALH)
Checked by (KMW)

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ARCADIS U.S., INC.

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SABIC CONSTRUCTION DRAWINGS

# Soil Vapor Extraction Well Detail

ARCADIS Project No. 13283007.0000
Date October 2014
ARCADIS 3522 Thomasville Rd Tallahassee, FL 32309

7

CITY: DIV/GROUP: DB: LD: PIC: PM: TM: LYR:ON=*;OFF=*REF*
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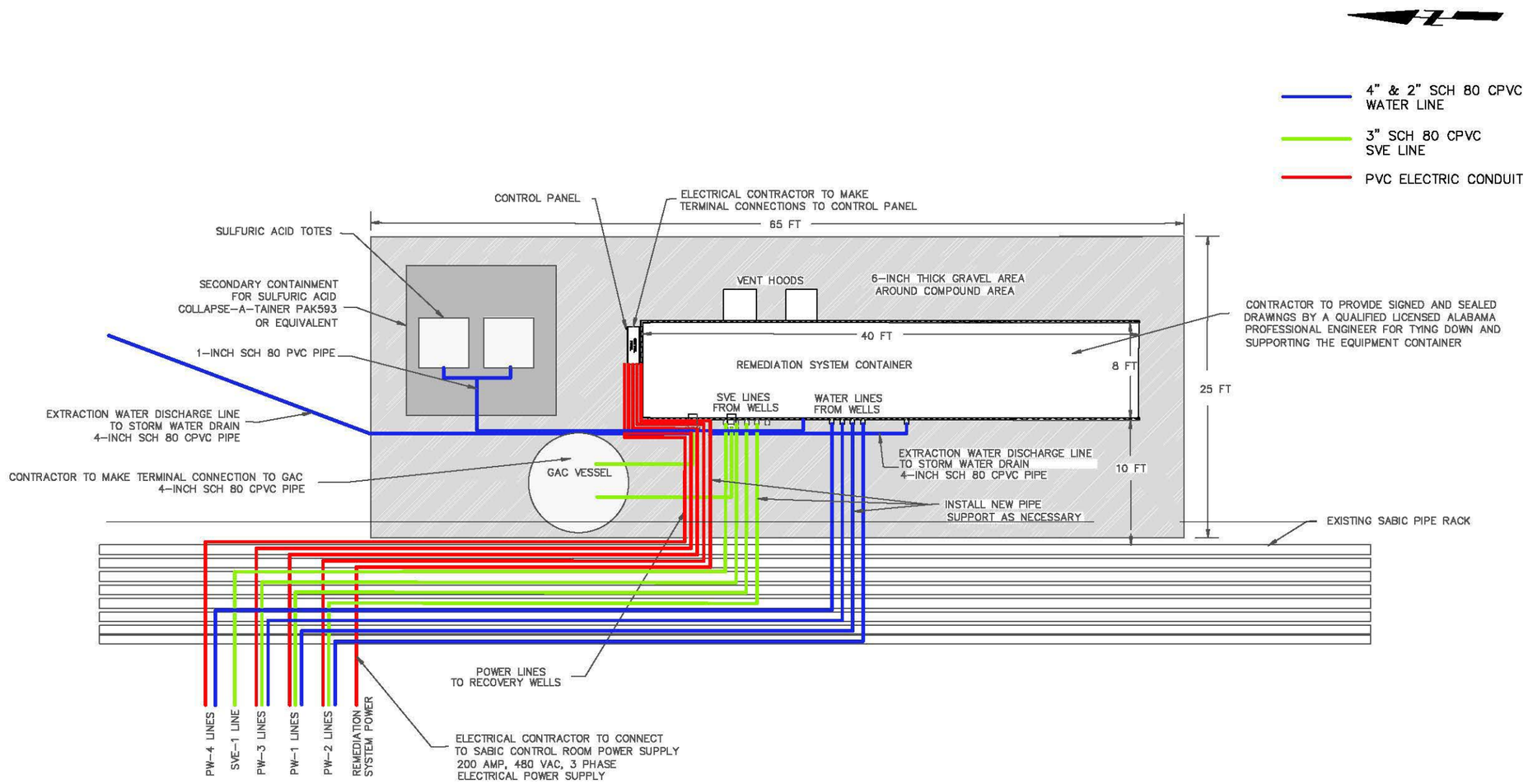
XREFS:
PROJECT NAME:




NOTES:

- CONTRACTOR TO MAKE CONNECTIONS AS NEEDED BY EQUIPMENT VENDOR.
- SET EQUIPMENT CONTAINER IN PLACE WITH A CRANE. LEVEL AS NECESSARY.
- SET GAC IN PLACE WITH CRANE, LEVEL AS NECESSARY.
- CONTRACTOR TO COORDINATE EQUIPMENT DELIVERY WITH VENDOR, ARCADIS, AND SABIC.
- CONTRACTOR TO PROVIDE SIGNED AND SEALED DRAWINGS BY A QUALIFIED LICENSED ALABAMA PROFESSIONAL ENGINEER FOR TYING DOWN AND SUPPORTING THE EQUIPMENT CONTAINER.
- CONTRACTOR TO SUPPLY AND INSTALL TIE DOWN CONNECTIONS.
- CONTRACTOR RESPONSIBLE FOR ELECTRICAL CONNECTIONS TO THE SYSTEM AND TO RECOVERY WELLS
- CONTRACTOR IS RESPONSIBLE FOR ALL PIPING AND CONNECTIONS TO THE SYSTEM AND CARBON VESSEL.
- ELECTRICAL WIRE AWG SIZING TO BE APPROVED BY ARCADIS AND SABIC PRIOR TO INSTALLATION.
- ALL PIPING, WIRING AND CONNECTIONS TO BE COMPLETED AFTER THE SYSTEM HAS BEEN INSTALLED.
- CONTRACTOR RESPONSIBLE FOR SUPPLYING AND INSTALLING A 55FT x 25FT AREA OF GRAVEL 8-INCHES IN DEPTH, AROUND THE REMEDIATION SYSTEM.
- SVE LINES WILL BE CONNECTED TO THE SYSTEM MANIFOLD USING PVC FLEX HOSE AND CAMLOCK FITTINGS. CONTRACTOR TO PROVIDE SUBBITAL FOR HOSE.

ALL PIPING AND PIPING SUPPORTS WILL COMPLY WITH THE SABIC DESIGN GUIDE SPECIFICATION SPEC#1840.05 REVISION 1, 7/28/14

ALL PIPING MATERIALS WILL COMPLY WITH THE SABIC PIPING MATERIALS SPECIFICATIONS 15052 ATTACHMENT 2, REV 4, 5/11/2007

Professional Engineer

| P.E.'s Number | State AL | Date Signed |
|---|---|---|
| | | |

0 5' 10' 20'
SCALE IN FEET

THIS BAR REPRESENTS ONE INCH ON THE ORIGINAL DRAWING: USE TO VERIFY FIGURE REPRODUCTION SCALE

| No. | Date | Revisions | By | Ckd |
|---|---|---|---|---|
| Rev 2 | 7/24/14 | Move system to the East side of Pipe rack | ALH | KMW |
| Rev 3 | 7/30/14 | Add/ Edit Notes | ALH | KMW |
| Rev 4 | 8/12/14 | Add/ Edit Notes, move equipment locations | ALH | KMW |
| Rev 5 | 10/24/14 | Add Sulfuric acid tanks, move system power | ALH | KMW |

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Project Mgr. (AE)
Designed by (KMW)
Drawn by (ALH)
Checked by (KMW)

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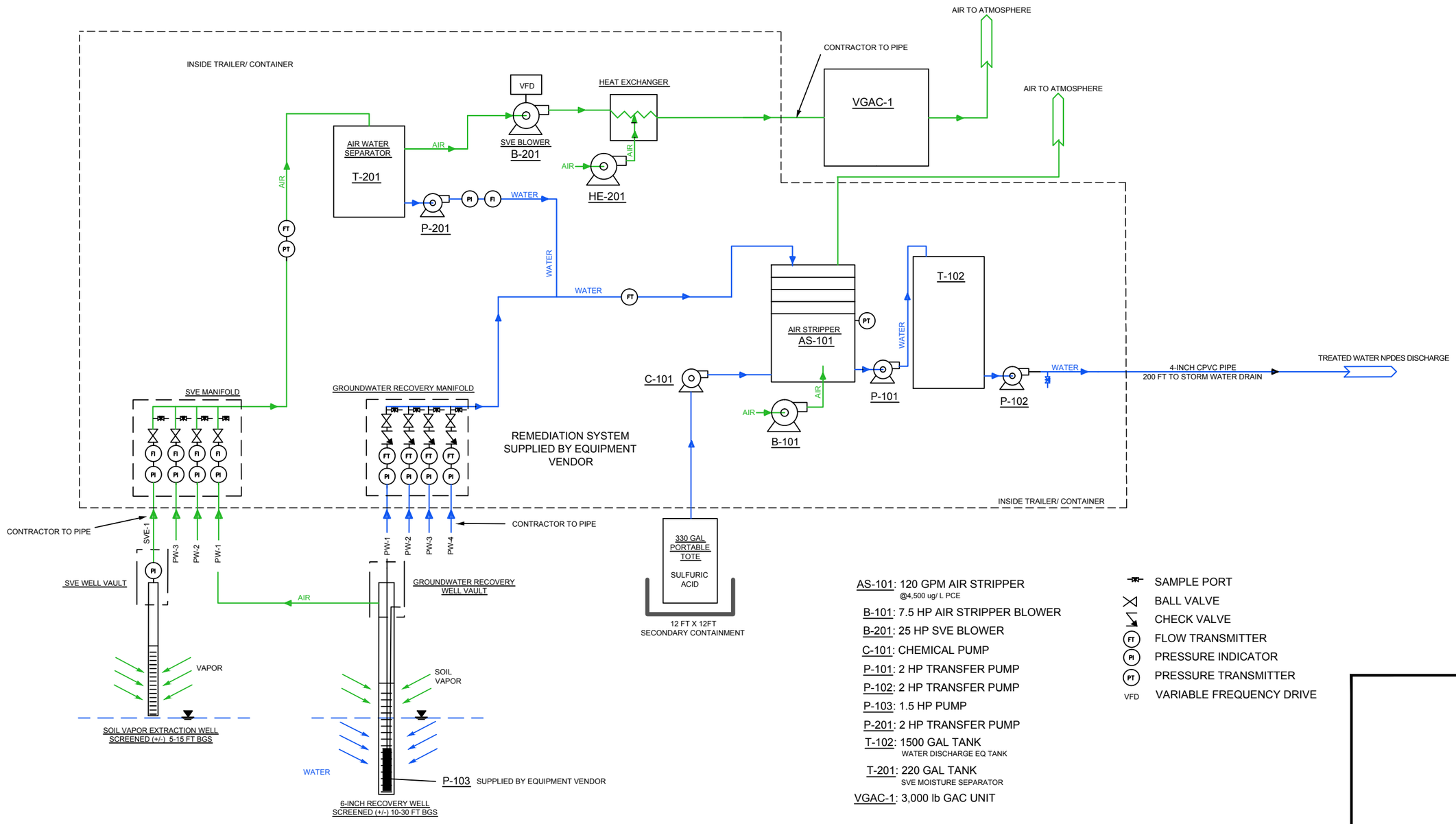
# Remediation System Compound Layout

ARCADIS Project No. 13283007.0000
Date August 2014
ARCADIS 3522 Thomasville Rd Tallahassee, FL 32309

8

CITY: DIV/GROUP: DB: LD: PIC: PM: TM: LYR:ON=*;OFF=*REF*
G:\ENVCAD\Tallahassee-FL\ACT\13283007\13283007 RAC 1_26_15 Rev8.dwg LAYOUT: SHEET 8 SAVED: 1/27/2015 6:00 AM ACADVER: 18.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: GRAYSCALE.CTB PLOTTED: 1/27/2015 6:03 AM BY: HOFMEISTER, AUSTIN
PROJECT NAME:
XREFS:




AS-101: 120 GPM AIR STRIPPER
@4,500 ug/ L PCE

B-101: 7.5 HP AIR STRIPPER BLOWER

B-201: 25 HP SVE BLOWER

C-101: CHEMICAL PUMP

P-101: 2 HP TRANSFER PUMP

P-102: 2 HP TRANSFER PUMP

P-103: 1.5 HP PUMP

P-201: 2 HP TRANSFER PUMP

T-102: 1500 GAL TANK
WATER DISCHARGE EQ TANK

T-201: 220 GAL TANK
SVE MOISTURE SEPARATOR

VGAC-1: 3,000 lb GAC UNIT

SAMPLE PORT
BALL VALVE
CHECK VALVE
FT FLOW TRANSMITTER
PI PRESSURE INDICATOR
PT PRESSURE TRANSMITTER
VFD VARIABLE FREQUENCY DRIVE

Professional Engineer

| P.E.'s Number | State AL | Date Signed |
|---|---|---|
| | | |

NOT TO SCALE

THIS BAR REPRESENTS ONE INCH ON THE ORIGINAL DRAWING: USE TO VERIFY FIGURE REPRODUCTION SCALE

| No. | Date | Revisions | By | Ckd |
|---|---|---|---|---|
| Rev 4 | 7/24/14 | Add Notes, remove spare SVE line | ALH | KMW |
| Rev 5 | 10/24/14 | Add Sulfuric acid | ALH | KMW |

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Project Mgr. (AE)
Designed by (KMW)
Drawn by (ALH)
Checked by (KMW)

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ARCADIS U.S., INC.

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SABIC CONSTRUCTION DRAWINGS

# Process Flow Diagram

ARCADIS Project No. 13283007.0000
Date oCTOBER 2014
ARCADIS
3522 Thomasville Rd
Tallahassee, FL 32309

9

CITY: DIV/GROUP: DB: LD: PIC: PM: TM: LYR:ON=*;OFF=*REF*
G:\ENVCAD\Tallahassee-FL\ACT\13283007\13283007 RAC 1_26_15 Rev8.dwg LAYOUT: SHEET 9 SAVED: 1/27/2015 6:00 AM ACADVER: 18.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ---- PLOTTED: 1/27/2015 6:03 AM BY: HOFMEISTER, AUSTIN
XREFS:
PROJECTNAME:

**Appendix B**

Pumping Extraction Well
Construction Logs

# Log of Boring
## & Well Construction

BOREHOLE NO.: **PW-01**

TOTAL DEPTH: **32'**

| PROJECT INFORMATION | | DRILLING INFORMATION | |
|---|---|---|---|
| PROJECT: | **SABIC** | DRILLING CO.: | **Boart-Longyear** |
| SITE LOCATION: | **Burkville, AL** | DRILLER: | **Jeremy Tripke** |
| JOB NO.: | **13283006.0000** | RIG TYPE: | **Boart Longyear MiniSonic** |
| LOGGED BY: | **Jason Hughes** | METHOD OF DRILLING: | **10" Sonic** |
| PROJECT MANAGER: | **Andrew Eversull** | TOC ELEVATION: | **233.47'** |
| DATE(S) DRILLED: | **6-23-13** | GROUND ELEVATION: | **234.21'** |

▼ Water level in completed well ▽ Water level during drilling

| ELEVATION | SOIL SYMBOLS | DEPTH | SOIL DESCRIPTION | BORING COMPLETION | WELL DESCRIPTION |
|---|---|---|---|---|---|
| 230 | | 0 | CLAY; low to medium plasticity; no dilatancy; dry; orange-red brown. | | Surface Casing |
| | | -5 | | | Cap |
| | | | | | Grout |
| | | | | | Bentonite Seal |
| 225 | | -10 | | | |
| 220 | | -15 | CLAY AND SAND; low to medium plasticity; sand very fine to fine; no dilatancy; moist @15; orange-red-brown. NOTE: Sand increasing with depth. | | |
| | | | | | Sand Pack-20/30 |
| 215 | | -20 | SAND AND PEBBLES; sand very fine to medium, pebbles small to very large @19-22; poorly sorted; moist to wet @18; light brown-brown. NOTE: Sand coarsens with depth, pebbles decrease with depth, quartz pebbles, interval is hot to the touch @17-20. | | Screen |
| 210 | | -25 | | | |
| 205 | | -30 | CLAY; low to medium plasticity; slow dilatancy; stiff; light brown-gray. | | Bentonite Fill |
| | | | CHALK; hard; dry; dark gray-gray. | | |

# Log of Boring
## & Well Construction

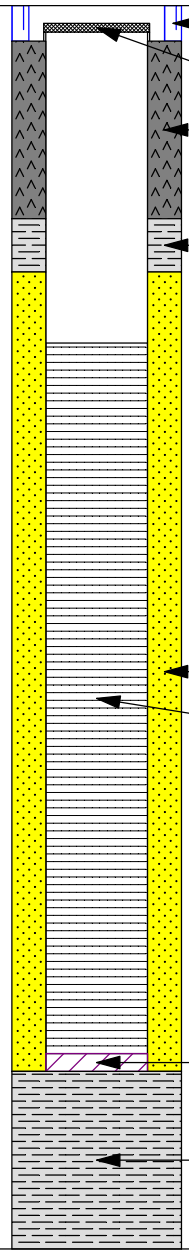
BOREHOLE NO.: **PW-2**

TOTAL DEPTH: **31'**

| PROJECT INFORMATION | | DRILLING INFORMATION | |
|---|---|---|---|
| PROJECT: | **SABIC** | DRILLING CO.: | **Boart Longyear** |
| SITE LOCATION: | **Burkville, AL** | DRILLER: | **Jeremy Tripke** |
| JOB NO.: | **13283011.0000** | RIG TYPE: | **Boart-Longyear Minisonic** |
| LOGGED BY: | **Cole Pace** | METHOD OF DRILLING: | **10" Sonic** |
| PROJECT MANAGER: | **Andrew Eversull** | TOC ELEVATION: | |
| DATE(S) DRILLED: | **9/10/14 - 9/12/14** | GROUND ELEVATION: | |

▽ Water level during drilling ▼ Water level in completed well

| Elevation | SOIL SYMBOLS | DEPTH | SOIL DESCRIPTION |
|---|---|---|---|
| 0 | | 0 | CLAY AND GRAVEL; medium gravel 40%; dry; hard; red-brown. |
| | | | CLAY; low to medium plasticity; no dilatancy; dark red. NOTE: No gravel. |
| -5 | | 5 | CLAY; no plasticity; no dilatancy; stiff to very stiff; hard; dry; dark red-brown. |
| -10 | | 10 | |
| | | | CLAY AND SAND; no plasticity; stiff; dry; red-yellow. NOTE: No gravel. |
| -15 | | 15 | SAND; coarse to very soarse; poorly sorted; angular to subangular; moist; light red-brown. NOTE: No gravel. |
| -20 | | 20 | SAND; medium to fine grain; well sorted; subrounded to subangular; very moist to wet; red-brown. NOTE: No gravel. |
| | | | SAND AND GRAVEL; coarse to very coarse , small gravel up to 40%; subrounded to rounded; wet; light brown. NOTE: Gravel increasing with depth. |
| -25 | | 25 | SAND AND GRAVEL; very coarse , poorly sorted; small gravel up to 40%; subrounded to rounded; wet; light brown. NOTE: Gravel increasing with depth. NOTE: Black nodules observed @ 29-30; no odor; some smearing. |
| -30 | | 30 | CLAY; very low plasticity; stiff to very stiff; wet; light brown. |
| -35 | | 35 | CHALK; hard; dry; dark gray. |



# Log of Boring
## & Well Construction

BOREHOLE NO.: **PW-3**

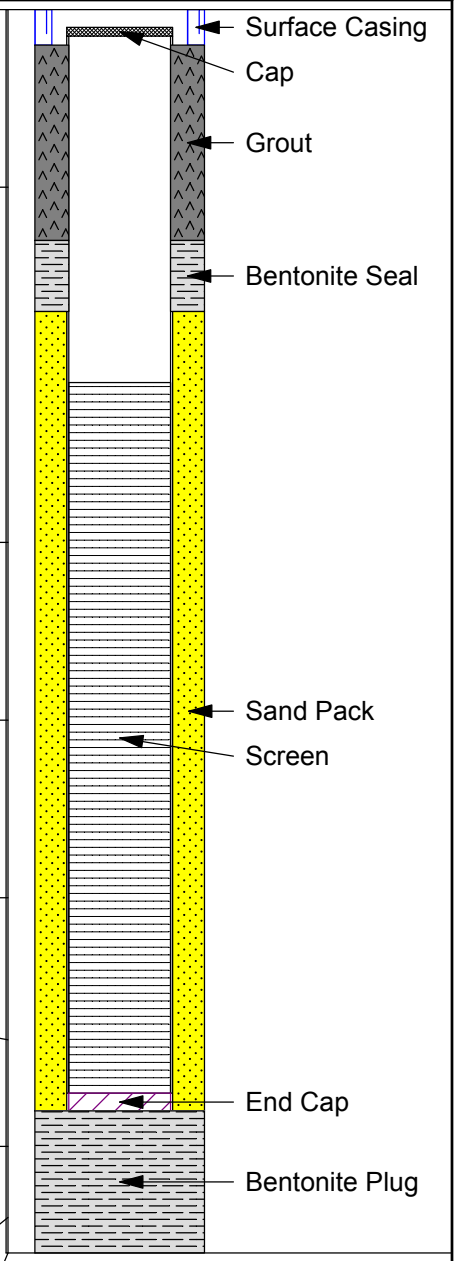
TOTAL DEPTH: **31'**

| PROJECT INFORMATION | | DRILLING INFORMATION | |
|---|---|---|---|
| PROJECT: | **SABIC** | DRILLING CO.: | **Boart Longyear** |
| SITE LOCATION: | **Burkville, AL** | DRILLER: | **Jeremy Tripke** |
| JOB NO.: | **13283011.0000** | RIG TYPE: | **Boart-Longyear Minisonic** |
| LOGGED BY: | **Cole Pace** | METHOD OF DRILLING: | **10" Sonic** |
| PROJECT MANAGER: | **Andrew Eversull** | TOC ELEVATION: | |
| DATE(S) DRILLED: | **09/13/14** | GROUND ELEVATION: | |

▽ Water level during drilling ▼ Water level in completed well

| Elevation | SOIL SYMBOLS | DEPTH | SOIL DESCRIPTION |
|---|---|---|---|
| 0 | | 0 | CLAY; no dilatancy; stiff; hard; dry; dark red-brown. |
| -5 | | 5 | CLAY; low to medium plasticity; no dilatancy; stiff; moist; red-brown. |
| -10 | | 10 | |
| -15 | | 15 | CLAY AND SAND; low plasticity; sand very fine to fine; subangular to subrounded; moist; orange to red-brown. NOTE: Sand increasing with depth. |
| -20 | | 20 | SAND AND GRAVEL; medium to fine grained; samll to medium pebbles 30-40%; light brown to gray-red. NOTE: Sand tightly packed; loosens with depth; coarsens with depth. |
| -25 | | 25 | SAND; some gravel; fine to very fine grained; well sorted; subround to round; medium gravel 20%; light brown. NOTE: Sand loosely packed. |
| -30 | | 30 | SAND AND GRAVEL; coarse to very coarse; subround to subangular; medium to large gravel 30-40%; red-yellow. |
| | | | CLAY; low to no plasticity; no dilatancy; stiff to very stiff; light brown. |
| -35 | | 35 | CHALK; hard; dry; dark gray. |

BORING COMPLETION / WELL DESCRIPTION

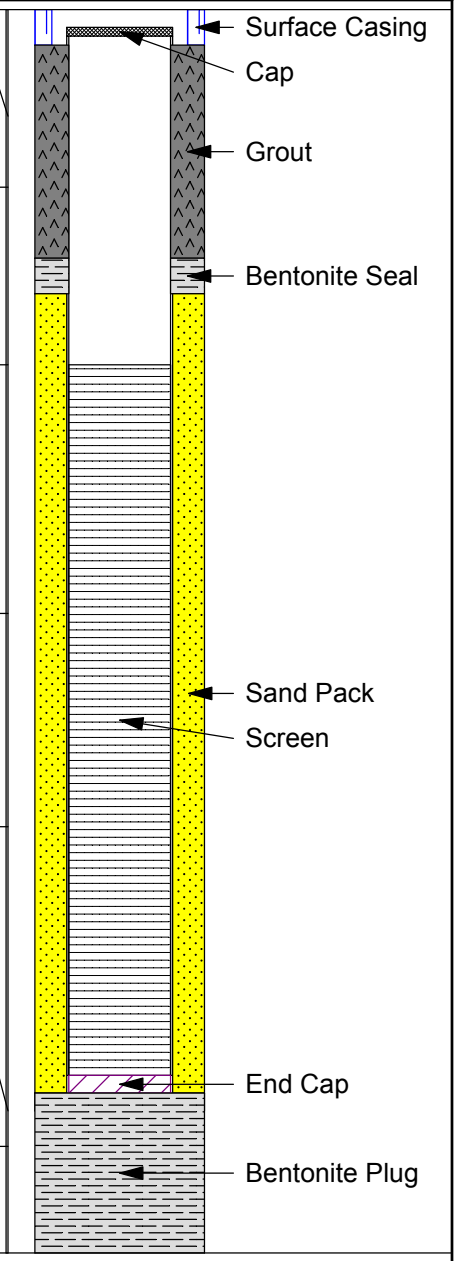


# Log of Boring
## & Well Construction

BOREHOLE NO.: **PW-4**

TOTAL DEPTH: **Total Depth**

| PROJECT INFORMATION | | DRILLING INFORMATION | |
|---|---|---|---|
| PROJECT: | **SABIC** | DRILLING CO.: | **Boart Longyear** |
| SITE LOCATION: | **Burkville, AL** | DRILLER: | **Jeremy Tripke** |
| JOB NO.: | **13283011.0000** | RIG TYPE: | **Boart-Longyear Minisonic** |
| LOGGED BY: | **Cole Pace** | METHOD OF DRILLING: | **10" Sonic** |
| PROJECT MANAGER: | **Andrew Eversull** | TOC ELEVATION: | |
| DATE(S) DRILLED: | **09/09/14 - 09/11/2014** | GROUND ELEVATION: | |

Water level during drilling  Water level in completed well

| Elevation | SOIL SYMBOLS | DEPTH | SOIL DESCRIPTION |
|---|---|---|---|
| 0 | | 0 | CLAY AND SAND; large gravel 40%; dry; red-brown. |
| | | | CLAY AND GRAVEL; medium plasticity; no dilatancy; very large gravel 30-40%; moist; dark red-brown. |
| -5 | | 5 | CLAY; low to no plasticity; no dilatancy; stiff to very stiff; dry; dark red-brown. |
| -10 | | 10 | CLAY AND SAND; low to medium plasticity; stiff; dry; yellow-red and gray. |
| -15 | | 15 | |
| -20 | | 20 | SAND; very fine to medium; well sorted; subrounded to subangular; moist to wet; yellow-brown. NOTE: Coarsens with depth. |
| -25 | | 25 | SAND AND PEBBLES; fine to coarse; poorly sorted; quartz pebbles 20-30%; pebbles small to very large; light brown-brown. NOTE: Sand coarsens with depth. |
| -30 | | 30 | CLAY; low to no plasticity; no dilatancy; stiff to very stiff; light brown. |
| | | | CHALK; hard; dry; dark gray. |
| -35 | | 35 | |