WORK PLAN FOR ADDITIONAL INVESTIGATION

PINE STREET MANUFACTURED GAS PLANT SITE
SPARTANBURG, SOUTH CAROLINA

SCDHEC Site ID: 56553

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Acronym List

AMEC	AMEC Environment & Infrastructure, Inc.
ASTM	American Society of Testing and Materials
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and xylenes
COC	contaminant of concern
CSM	conceptual site model
Declaration	Declaration of Covenants and Restrictions
DNAPL	dense, non-aqueous phase liquid
DO	dissolved oxygen
DOT	Department of Transportation
DRO	diesel range organics
DPT	direct push technology
Duke	Duke Energy
EPA	Environmental Protection Agency (United States)
FFS	Focused Feasibility Study
foc	fractional organic carbon
ft^2	square feet
GRO	gasoline range organics
HASP	Health and Safety Plan
HSA	hollow stem auger
ID	inside diameter
IDW	investigative derived waste
ISCO	in-situ chemical oxidation
lb	pound
MCL	maximum contaminant level
MDL	method detection limit
mg/kg	milligrams per kilogram
MGP	manufactured gas plant
mL	milliliter
MNA	monitored natural attenuation
mV	millivolts
NAPL	non-aqueous phase liquid
NTU	nephelometric turbidity unit

OD	outside diameter
ORP	oxidation-reduction potential
PAH	polycyclic aromatic hydrocarbons
PID	photoionization detector
PNG	Piedmont Natural Gas Company
ppm	parts per million
PVC	polyvinyl chloride
PWR	partially weathered rock
QC	quality control
RBSL	risk based screening level
SCDHEC	South Carolina Department of Health and Environmental Control
site	former Spartanburg Pine Street MGP Plant
SVOC	semivolatile organic compound
TPAH	total polycyclic aromatic hydrocarbons
TPH	total petroleum hydrocarbon
UIC	Underground Injection Control
VOC	volatile organic compound
QC	quality control

1.0 INTRODUCTION

The former Spartanburg Pine Street Manufactured Gas Plant (Site) was located at 684 North Pine Street in Spartanburg, South Carolina and encompasses a total area of approximately 7.4 acres (Figure 1). Manufactured Gas Plant (MGP) operations were conducted at the Site from the early 1900s to the mid-1950s. MGPs were industrial facilities that produced gas from coal, oil, or similar feedstocks. The primary wastes from the process were coal tar, emulsions of tar, oil and water, ash, and purifier wastes (lime and iron oxides). During historical operations, these materials were often released to the subsurface at various points of the process including the gas holders, tar separators, and tar wells. Materials that have limited solubility and a density greater than water that migrate in the subsurface in a non-dissolved phase are referred to as dense non-aqueous phase liquids (DNAPL). The subsurface flow paths of these materials are generally not influenced by ambient hydraulic gradients, but are affected by interfacial tensions and the presence of subsurface low permeability layers.

In 2003 and 2004, soils at the Site were characterized by widespread grid sampling and analyses using standard United States Environmental Protection Agency (EPA) volatile organic compound (VOC) and semivolatile organic compound (SVOC) methods. That characterization data was used to design remedial excavation which was implemented in three phases. The areas at the site addressed by the three phases of excavation are shown in Figure 2. Although the excavation was extensive, all potentially impacted soils were not removed due to physical site constraints that included, but were not limited to, building foundations, property boundaries, railroad and utility right-of-way limits, and the presence of residuals below the water table.

Post excavation monitoring of on-site wells screened in the overburden and upper bedrock zone indicated hydrocarbons at concentrations above South Carolina Department of Health and Environmental Control's (SCDHEC) Risk Based Screening Levels (RBSLs). Based on these results, SCDHEC requested that Duke Energy (Duke) consider additional remedial alternatives relative to the shallow groundwater. Duke submitted a Focused Feasibility Study (FFS) for the Site to SCDHEC in 2008 (ENSR, 2008) that evaluated monitored natural attenuation (MNA), gas inFusion technology, in-situ chemical oxidation (ISCO), soil stabilization, and saturated zone excavation. Duke and SCDHEC agreed upon ISCO as the preferred alternative for shallow groundwater at the Site. Both parties agreed that pilot testing should be conducted prior to full-scale implementation.

A *Chemical Oxidation Pilot Test Work Plan* was prepared in May 2012 and approved by SCDHEC on June 26, 2012. The pilot test work plan was implemented in 2012 and 2013 and the results are summarized in the *Chemical Oxidation Pilot Test Report* dated September 30, 2014. The ISCO Pilot Study demonstrated that the technology has the potential to significantly reduce contaminant mass by 65% to 99%. However, historical data suggest that portions of the site may have greater residual contaminant concentrations than were present in the Pilot Study area. Therefore, following the pilot test, it was concluded that additional investigation is necessary prior to remedy selection.

The existing well network does not adequately define the potential extent of groundwater contamination in portions of the site. Additionally, the only monitoring wells screened in the PWR are MW-13ISOC and the PWR pilot study monitoring wells. Additional monitoring wells need to be installed to close these data gaps.

Although MNA was evaluated in the 2008 FFS, fate and transport modeling was not performed to determine the timeframes to attain the cleanup goals. Therefore, additional soil and groundwater data will be obtained in the northern portion of the Phase 1 Area to evaluate whether MCLs may be obtained through natural attenuation in a reasonable timeframe. Combining technologies, including MNA following an active technology, was also not evaluated. Certain hydrogeologic data such as hydraulic conductivities and fraction organic carbon of the soils are needed to complete fate and transport calculations.

This Work Plan has been prepared to guide the execution of field sampling activities, laboratory analysis, sample data collection activities, and data reporting for the Additional Investigation to support revision of the FFS. All field work will be performed in accordance with the health and safety procedures of AMEC Environment & Infrastructure, Inc. (AMEC) and a site-specific health and safety plan (HASP). This document presents the site sampling and analysis procedures. AMEC's field forms that will be used to support the sampling are provided in Appendix A.

2.0 SITE BACKGROUND

2.1 Site Description

The Site is located at 684 North Pine Street in Spartanburg, South Carolina. North Pine Street (US Highway 176) bounds the property to the west, and Norfolk Southern Railway mainline tracks form its northern boundary (Figure 2). The Site is bounded by other commercial/industrial property to its east and by Linder Street to the south. Piedmont Natural Gas Company (PNG) presently owns the majority of the former MGP property which is located in a predominately commercial and industrial section of Spartanburg. The remainder of the Site is owned by Duke.

Chinquapin Creek flows through the approximate center of the Site, entering the Site from the northwest through a culvert beneath the Norfolk Southern Railway system railroad embankment (Figure 2). The creek flows southeasterly, then turns east and eventually flows beneath Fairview Avenue. A tributary of Chinquapin Creek enters the Site from the west through a culvert beneath North Pine Street and intersects with Chinquapin Creek. Chinquapin Creek eventually flows into Lawson Fork Creek approximately 3,600 feet from the Site.

2.2 Geologic Setting

The Site is in the Piedmont physiographic province of South Carolina. This region extends from Alabama into Georgia, the Carolinas, Virginia, Maryland, Pennsylvania, and southeastern New Jersey. The rock formations of this region consist primarily of metamorphic rock formations, generally consisting of gneisses and schists of Precambrian age.

Residual soils are products of physical and chemical weathering of the underlying bedrock. Depending on the degree of weathering, the soil can retain much of the fabric, or structural features, of the parent rock. Weathering generally decreases with depth. However, there is often no well-defined boundary between soil and rock.

The shallow geology within the Spartanburg area is generally comprised of igneous and metamorphic crystalline rocks that are generally foliated and fractured. The percolation of water downward through the fractures has resulted in the formation of a layer of residual weathered material (saprolite) and soil at the land surface. The saprolite unit retains the relict structure of the parent rock. Although its strength resembles that of soil, it is considered a semi-permeable bed which may store and recharge water to the underlying bedrock aquifer.

Groundwater occurs within several zones beneath the Site: a shallow unconfined zone within the saprolite and a thin semi-confined zone within the PWR. Groundwater occurs within the saprolite and residuum between the clay, silt, and sand grains from approximately from 5.3 to 13 feet below ground surface (bgs). A potentiometric map for the shallow aquifer is provided in Figure 3.

PWR occurs at depths of about 15 to 24 feet bgs. Groundwater flow also occurs within the PWR and underlying fractured bedrock along secondary features, joints, and planes of weakness.

Vertical gradients are generally from the overlying overburden or saprolite to the bedrock. Some well pairs exhibit weak variations between vertical upward and downward gradients. However, vertical upward gradients are consistently exhibited at well pairs MW-14S/14D and MW-16S/16D.

2.3 Site Operational History

MGP operations were conducted at the Site from the early 1900s to the mid-1950s. MGPs were industrial facilities that produced gas from coal, oil, or similar feedstocks. The majority of the facilities produced gas from coal which was used in the same manner as natural gas is used today. The coal gas manufacturing process generally consisted of the following steps:

- Coal was heated in retorts with little to no air;
- During heating, steam was injected which resulted in formation of water gas (a mixture of methane and carbon monoxide);
- Heating also volatilized light hydrocarbons which were subsequently condensed and either re-injected into the coal retort or collected for other uses; and
- A portion of the light hydrocarbons that were re-injected cracked to methane which increased the heating potential of the water gas.

Primary by-products or wastes from the process were coal tar, emulsions of tar, oil and water, ash, and purifier wastes (lime and iron oxides). MGP byproducts or coal tar contain aliphatic hydrocarbons, alcohols, and esters not quantified in EPA Methods 8260 (VOCs) or 8270 (SVOCs). Normalized analyses indicate that coal tars are composed of approximately 27% aliphatics, 53% aromatics, 10% polar compounds (phenols, cresols, napthols), and 10% higher molecular weight esters.

The coal tars are highly viscous materials that have limited solubility and a density slightly greater than water. Materials that have limited solubility and a density greater than water that migrate in the subsurface in a non-dissolved phase are referred to as DNAPL. Historically, these materials were released to the subsurface at various points of the process.

The original plant had two gasholders and two tar wells. An additional gasholder and an aboveground tank were constructed on site around 1950. By 1960, all three gasholders and the two tar wells were demolished. All equipment associated with the gas plant had been removed by 1964.

2.4 Summary of Remedial Activities

The Spartanburg MGP Site was extensively characterized by grid sampling of soils for VOCs and SVOCs to support remedial excavation in 2003 and 2004. Remedial excavation, performed in three phases from February 2003 to March 2004, removed approximately 67,596 tons of contaminated soil and debris from the Site. Due to site constraints such as building foundations, property boundaries, railroad and utility right-of-way limits, and the presence of residuals below the water table, not all potentially impacted material was removed from the subsurface.

A Trespasser Focused Risk Evaluation Report in 2004 determined that current site conditions do not pose unacceptable risks for industrial/commercial use scenarios. In 2006, a Declaration of Covenants and Restrictions (Declaration) was executed by PNG that restricted use of the property for residential, agricultural, recreational, child day care, schools, and elderly care facilities. Additionally, the institutional controls prohibit the use of groundwater for drinking or irrigation purposes without the approval of SCDHEC.

Post excavation monitoring of on-site wells screened in the overburden and upper bedrock zone indicated hydrocarbons at concentrations above SCDHEC's RBSLs. Groundwater monitoring results from the deeper bedrock well at the Site (MW-1DR) screened at approximately 40 feet below the top of bedrock have not indicated any hydrocarbon contamination. Based on the post excavation monitoring results, SCDHEC requested that Duke consider additional remedial alternatives relative to the shallow groundwater.

Duke submitted a FFS for the site to SCDHEC in 2008 (ENSR, 2008). The conceptual site model (CSM) presented in the FFS indicated that DNAPL and adsorbed hydrocarbons in the saturated zone soils and PWR were the primary sources of impacts to shallow overburden and bedrock groundwater. The 2008 FFS evaluated MNA, gas inFusion technology, ISCO, soil stabilization, and saturated zone excavation as groundwater remedial technologies. Duke and SCDHEC agreed upon ISCO as the preferred alternative for shallow groundwater at the site and that pilot testing should be conducted prior to full-scale implementation.

A *Chemical Oxidation Pilot Test Work Plan* was prepared in May 2012 and approved by SCDHEC on June 26, 2012 (AMEC, 2012). SCDHEC issued an Underground Injection Control (UIC) permit to operate on October 5, 2012. Shallow zone pilot injections were initiated in December 2012 and completed in January 2013. Injections in the PWR were initiated in March 2013, but were temporarily suspended prior to completion based on certain unexpected geochemical measurements during the initial weeks. Pilot Study PWR injections were re-initiated in August 2013 using a different activator chemistry. The Pilot Study PWR injections were completed in September 2013. Figure 2 depicts the pilot test area and layout of the pilot test injection and monitoring wells. The ISCO Pilot Study results are described in the *Chemical Oxidation Pilot Test Report* dated September 30, 2014.

3.0 IDENTIFICATION OF DATA GAPS

Although considerable data has been generated concerning site characteristics, some additional information is needed to further evaluate the technical and financial practicality of ISCO. Additional information is also required to evaluate other remedial technologies that were not considered in the FFS and combinations of remedial technologies for their potential to achieve reasonable contaminant mass reduction that promotes long-term natural attenuation in an acceptable timeframe. Data gaps exist with respect to the extent of COC contamination in the soils in the Phase 1 excavation area, distribution of COCs in groundwater in the Phase 1 area, and hydrogeologic transport properties.

3.1 Phase 1 Excavation Area Soils

Confirmation sampling conducted with the excavation suggests the potential for elevated concentrations of PAHs in several areas of the site. Residual contamination remains throughout the Phase 1 excavation zone. As indicated in Figure 4 and described in the *Chemical Oxidation Pilot Test Report*, elevated TPAH concentrations may remain in the Phase 1 excavation area at borings ARB-13 (43,075 mg/kg), GP-33 (10,640 mg/kg), GP-30 (9,630 mg/kg), ARB-43 (2,233 mg/kg), and GP-55 (2,580 mg/kg). These concentrations indicate the presence of residual DNAPL at the site. Where residual DNAPL is present at a site, multiple remedial techniques may be required. Based on the existing data, full scale implementation of ISCO may be technically and financially impractical as a single remedy. Application of multiple remedial techniques may be required to attain practical reduction in contaminant mass for the site.

The five historical Phase 1 borings that infer potentially impractical treatment requirements (ARB-13, GP-33, GP-30, ARB-43, and GP-55) are widely spaced over a 200-foot by 70-foot area. Other historical borings between these locations and to their north exhibit lesser concentrations. However, the existing data are not sufficient to clearly delineate the extent of residual contamination or if the residual contamination is present in several small isolated “hot spots”. Accordingly, further evaluation of the contaminant concentrations in the Phase 1 area is needed to define the lateral extent of TPAH contamination and if that residual contamination may exist in hot spots.

3.2 Phase 2 Excavation Area Soils

In the Phase 2 area, the pre-excavation TPAH concentrations at boring GP-78 (0 to 4 feet bgs) and GP-64 (0 to 4 feet bgs) were greater than 20,000 mg/kg and above 2,000 mg/kg, respectively. Excavation was reportedly conducted to 3.5 feet in the area represented by GP-78 and GP-64. Additionally pre-excavation boring GP-88 had a TPAH concentration of 3,461 mg/kg with a sampling interval to a depth of 12 feet bgs. In this portion of the Phase 2 zone, excavation was reportedly conducted to a depth of 11.5 feet bgs. Monitoring wells MW-11S/MW-11D have not routinely shown impacts which suggests that TPAH contamination may have been excavated and is not impacting groundwater quality at these wells.

3.3 Phase 1 Area Groundwater

Although wells MW-12S/MW-12D are located between borings with potentially elevated TPAH concentrations (GP-33 and ARB-13), these wells have not routinely shown impacts. The absence of impacts in these wells may result from the well pair being slightly upgradient of the potentially impacted borings. In the Phase 1 area north of the road, there are not overburden monitoring wells located downgradient of the borings with the potentially most elevated residual TPAH concentrations. Therefore, additional monitoring wells are needed in this area to define potential groundwater impacts that may result from the potentially impacted soils.

The only monitoring well north of the Pilot Study Area is MW-17S which is upgradient of the area that may have potentially impacted soils (GP-18, GP-22, and ARB-13). Therefore, there is an absence of data concerning the potential for contaminant transport from the upgradient area into the pilot study area where successful treatment has been achieved. If significant contaminant transport from the upgradient area occurs, the reduction in COC concentrations observed in the pilot study area would eventually be negated. Therefore, additional groundwater monitoring is needed in this portion of the Phase 1 area.

Additionally, the only monitoring well screened in the PWR is MW-13ISOC and the PWR pilot study monitoring wells. Additional PWR monitoring wells are needed in the Phase 1 area to support evaluation of remedial technologies in conjunction with MNA.

MNA was evaluated in the 2008 FFS, but fate and transport modeling was not performed to determine the timeframes for attenuation to achieve the remedial action objective. Hydrogeologic data including hydraulic conductivities and fraction organic carbon for the soils in the Phase 1 area are needed to complete fate and transport calculations.

4.0 OBJECTIVE

A subsurface soil assessment in the Phase 1 excavation area will be conducted to verify and define residual concentrations of MGP contaminants in the overburden soils and PWR. The primary objective of this subsurface assessment is to refine the areas and volumes of media that may require remediation within a potential treatment zone. Additionally data will be obtained concerning overburden physical properties for use in fate and transport calculations.

Eight groundwater monitoring wells will be installed in the Phase 1 excavation area to collect contaminant data in the overburden and PWR aquifers. The primary objectives of the expanded groundwater monitoring network are to (1) determine COC concentrations and mass flux in the area where very elevated residual TPAH concentrations may remain, (2) determine COC concentrations and mass flux from areas north of the road into the pilot study area and areas to the east, and (3) obtain characterization data in the PWR.

The data obtained from the Additional Investigation will be used to evaluate the technical and financial practicality of ISCO and other remedial technologies in a revised FFS. Additionally, these data will be used to evaluate whether MNA, alone or in combination with active remediation, can achieve cleanup goals in a reasonable timeframe.

5.0 FIELD METHODS AND PROCEDURES

This section discusses the field sampling methods, sample handling protocols, and documentation requirements necessary to meet the objectives of this investigation.

5.1 Utilities

Prior to any intrusive work, the proposed soil sampling and monitoring well locations will be clearly marked and the location of existing underground utilities at the Site will be located and marked by the utility owner representatives. During soil sampling or monitoring well installation, any location within a two-foot radius of an underground utility shall be initially excavated to 5 feet below the ground surface using hand-held shovels or hand augers to avoid damaging the underground utilities.

No work is to be conducted within 50 feet of overhead power lines without first contacting the utility company to determine the voltage of the system. No aspect of any piece of equipment is to be operated within 50 feet of overhead power lines without first making this determination. Table 1 provides the required separation distances for work in the vicinity of overhead power lines.

Table 1 Minimum Distances from Power Lines

Power Lines Nominal System (Kv)	Minimum Required Distance (Feet)
0-50	10
51-100	12
101-200	15
201-300	20
301-500	25
501-750	35
751-1000	45

Note: Kv = kilovolt

5.2 Phase 1 Excavation Area DPT Sampling

Much of the site was excavated in 2003-2004, and native soils were replaced with fills and thermally treated soils. The pilot study was conducted in the prior Phase 1 excavation area, northeast of Chinquapin Creek. Cross sections from the vicinity of MW-13S and much of the area north of the access road that would be targeted for remediation by ISCO show both fill and native alluvium in the saturated zone. A layer of residual saprolite soil is also present in the saturated interval in the northeast portion of the Phase 1 excavation area. Residual contamination may remain throughout the Phase 1 excavation zone. Interpolation of the currently available soil data suggests that nearly 1 acre north of the road may exhibit total PAH concentrations greater than 500 mg/kg. An area of approximately 6,300 ft^2 north of the road may exhibit TPAH concentrations greater than 10,000 mg/kg. However, this area is potentially overestimated since there is no northern or southern boundary data. The area of soil in excess of 10,000 mg/kg is generally driven by three significantly high data points (SOD-6, ARB-13, and GP-33).

5.2.1 Sample Locations and Depth Intervals

A preliminary estimate of soil boring locations using direct push technology (DPT) methods was based on the distribution of existing data points across the investigation area. Based on data from Phase 1 Assessment (Duke, 2002) and Final Soil Excavation Summary Report (Duke, 2006), the soil samples will be concentrated in areas of potential residual contamination and to the north of historical soil samples TAS-002, ARB-13, ARB-43, and GP-33 to develop bounding data. Soil boring data will confirm the depth where affected soils may be present and provide horizontal delineation to refine the areas and volumes of the potential treatment zone.

Twenty borings will be drilled for soil sample collection from 15 DPT soil borings and 5 monitoring well installation borings (Figure 5). Samples from the DPT borings will be obtained between the fill/native material interface (~10 to 13 feet bgs) and above the overburden/PWR interface (~15 feet bgs). The DPT sampling is summarized below and the monitoring well boring soil sampling is summarized in Section 5.3.

5.2.2 DPT Soil Sampling Procedures

All field operations will be supervised by personnel experienced in site assessment and sampling activities. Soil will be collected in a disposable acetate liner inside of a macrocore sampler. The macrocore sampler will be advanced by a DPT rig in 5-foot sample intervals to an approximate depth of 15 feet bgs. Soil cores will be described in a dedicated logbook in the field using the Unified Soil Classification System in accordance with American Society of Testing and Materials (ASTM) Standard D-2488, *Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)*. An AMEC field geologist will oversee the drilling and will be responsible for generating boring logs. Boring logs generated for geologic and hydrogeologic interpretation of the site will be reviewed by a Senior Geologist.

Head space samples and analytical samples will be collected from below the fill/native material interface (which occurs at approximately 10 to 13 feet bgs) every 2 feet and at suspect intervals where MGP contamination is evident using visual and olfactory senses. The AMEC field geologist will field screen soil cores for VOCs using a photoionization detector (PID). No samples will be collected of the fill material.

One grab sample for VOCs and up to two composite samples per boring will be collected for laboratory analysis based on visual and olfactory senses and/or highest PID field screening. The composite samples will be analyzed for PAHs, TPH-GRO, and TPH-DRO. The grab sample for VOCs will be collected from the 2-foot sample interval with the highest PID (greater than 15 parts per million [ppm]) or obvious MGP contamination.

A composite sample will be generated for each 2-foot interval between the fill/native material interface and approximately 15 feet. For example:

- if the fill/native material interface occurs at 11 feet bgs, a composite sample will be collected from the 11- to 13-foot and 13- to 15-foot intervals, or
- if the fill/native material interface occurs at 13 feet bgs, a composite sample will be collected from the 13- to 15-foot interval.

Sample collection intervals, the type of sample and analytical parameters are summarized in Table 2.

Table 2 Phase 1 Excavation Area DPT Soil Sampling

Number of DPT Borings	Estimated DPT Boring Depth (ft bgs)	DPT Boring IDs	Sampling Depth (ft bgs)	Matrix	Description and Identification of Soils	Analysis	Method	Laboratory Samples
15	15	ISOC-1-3, 5-7, 9-14, 16, 17, 19	0 to ~10	fill	Yes	NA		
			10-12	fill/native interface[1]	Yes	headspace	PID	1 grab sample for VOCs, up to 2 composite samples for PAHs, TPH-GRO and TPH-DRO at highest PID (>15 ppm) or obvious MGP contamination
			12-14	native soil	Yes	headspace	PID	
			14-15	native soil	Yes	headspace	PID	

[1] Head space samples and analytical samples will be collected from below the fill/native material interface (which occurs at approximately 10 to 13 feet bgs) every 2 feet and at suspect intervals where MGP contamination is evident using visual and olfactory senses. For this matrix 10 ft bgs is arbitrarily chosen and depths should be adjusted based on field observations.

Notes: DRO = diesel range organics
ft bgs = feet below ground surface
GRO = gasoline range organics
MGP = manufactured gas plant
NA = not available
PAH = polynuclear aromatic hydrocarbon
PID = photoionization detector
ppm = parts per million
TPH = total petroleum hydrocarbons
VOC = volatile organic compound

Samples collected will be analyzed for VOCs (EPA Method 8260), PAHs (EPA Method 8270), and TPH-GRO and TPH-DRO (Method 8015B). Upon completion of the borehole, soil generated during sampling, will be placed back into the borehole. Soils will be tamped every 2 feet or more if needed to ensure minimal voids in backfilling. If additional soils are needed, coarse bentonite chips will be added and hydrated to complete the borehole to grade.

5.3 Monitoring Well Installation Procedures

Monitoring well borings will be advanced at five locations using hollow stem auger (HSA) methods (Figure 5). Five monitoring wells (three overburden wells and two PWR wells) will be installed at three locations north of the road within the Phase 1 area to close data gaps concerning groundwater impacts between MW-17S, MW-13S/D, and MW-18S/D from areas with potentially elevated TPAH levels in soils. One of these wells will be located upgradient to provide boundary condition data. Three monitoring wells (two overburden wells and one PWR well) will be installed south of the road in order to define contaminant transport from the upgradient area toward the pilot study area and assess the lateral extent of COC contamination to its east. At locations designated for both overburden and PWR wells the wells will be installed in separate borings. As subsequently described, soil samples will be collected for laboratory analyses of COCs during HSA drilling to install the wells.

The monitoring wells will be installed following all applicable requirements of the South Carolina Well Standards R.61-71 and guided by ASTM D5784-95 (2006). Soil samples will be collected in continuous intervals from each borehole using a standard split spoon sampler, or equivalent device, depending on field conditions. Standard penetration test N values will be recorded at each sample point. Retrieved soil samples will be field screened for VOCs using a PID and visually examined to assess subsurface conditions and physical properties of the strata. These properties include color, moisture content, and visual evidence of discoloration. Each newly installed well will be surveyed by a South Carolina licensed surveyor, labeled with a unique well identification number, and a Water Well Record Form 1903 will be completed and submitted to the SCDHEC within 30 days after well completion.

5.3.1 Overburden Monitoring Wells (Five Locations)

Five overburden monitoring wells (ISOC-4, ISOC-8, ISOC-15, ISOC-18, and ISOC-20) will be installed to the top of the PWR (an approximate depth of 15 feet bgs) by advancing a nominal 8-inch outside diameter (OD) X 4.25-inch inside diameter (ID) borehole to the approximate target depth. The overburden monitoring wells will be constructed using 2-inch-diameter, flush-joint, schedule 40 polyvinyl chloride (PVC) riser pipe and 5-foot factory slotted well screen (0.010-inch) with bottom cap. Before the well screen and casings are placed on the bottom of the borehole, at least 6 inches of filter material should be placed at the bottom of the borehole to serve as a firm footing. The string of well screen and casings should then be placed into the borehole and plumbed. The filter pack material will consist of a clean, rounded to well-rounded, quartz silica sand of 10/30 sieve size (i.e., between 1/10 and 1/30 inch in size). The augers should be slowly extracted as the filter pack is tremied into place using a 1-inch PVC tremie pipe lowered between the screen/casing and the augers. The gradual extraction of the augers allows the materials being placed in the augers to flow out of the bottom of the augers into borehole. The filter pack will be extended a minimum of 1 foot and a maximum of 2 feet above the top of the well screen. A bentonite seal of a minimum 1-foot vertical thickness, but no more than 2-foot thickness consisting of medium grade crushed (1/4 to 3/8-inch) bentonite will be placed above the sand pack and hydrated with clean water. Following seal hydration (minimum 2 hours), the remaining annulus will be filled with a 95/5 ratio neat cement grout. The neat cement grout should consist of a mixture of 94 pounds of cement and no more than 6 gallons of clean water. Bentonite will not exceed 5% of the total mixture. The grout will be installed in a manner to prevent bridging of the annulus between the outside of the well casing and the borehole from the top of the bentonite seal to the ground surface. The monitoring wells will be completed with a 2-foot by 2-foot concrete pad sloped to drain outwards and a 6-inch PVC well protector (stickup). The PVC well heads will be secured with a locking cap. Figure 6 provides a representative schematic of the overburden monitoring well construction.

At each of the monitoring well locations, a sample of the native soil (below the fill/native material interface at approximately 10 to 13 feet bgs) will be collected for analyses of VOCs, PAHs, TPH-GRO, TPH-DRO, and fraction of organic carbon (foc). The 2-foot sample interval with the highest PID (greater than 15 ppm) or obvious MGP contamination will be selected for sampling. In the absence of elevated PID reading or visual evidence of MGP contamination, the sample will be collected from the 2-foot interval that corresponds to the middle of the screened interval. Sample collection intervals, the type of sample, and analytical parameters are summarized in Table 3.

5.3.2 PWR Monitoring Wells (Three Locations)

Three PWR wells will be installed at locations ISOC-4, ISOC-15, and ISOC-18 to provide site-wide groundwater data in the PWR. These wells will be installed by advancing a nominal 8-inch OD X 4.25-inch ID borehole to the top of competent rock (approximately 25 feet bgs), and each 2-inch diameter flush-joint Schedule 40 PVC well screen and riser pipe will then be set through the augers at the target depths. As previously described, three overburden monitoring wells will also be installed in separate boreholes to the top of the PWR (an approximate depth of 15 feet bgs) at these locations.

The monitoring wells will be constructed as described above in Section 5.3.1. Figure 7 provides a representative schematic of the PWR monitoring well construction.

At each of the monitoring well locations, a sample of the native soil (below approximately 10 to 13 feet bgs) and if possible the PWR material (approximately 15 to 20 feet bgs) will be collected for analyses of VOCs, PAHs, TPH-GRO, TPH-DRO, and foc.

At locations where both an overburden and PWR well will be installed (ISOC-4, ISOC-15, and ISOC-18), the deeper interval well (PWR monitoring well) at that location will be drilled first and soil and weathered rock samples will be collected as indicated. If during shallow well drilling either a higher PID result (exceeding 15 ppm) occurs or obvious MGP contamination is encountered that was not encountered in the PWR well borehole, then the soil samples from shallow well borehole will be selected for analyses and the soil samples from the PWR borehole will be discarded. Criteria for selecting the sampling interval were provided in Section 5.3.1 and Table 3.

Table 3 Monitoring Well Installation Soil Sampling (HSA)

Well ID	Estimated Boring Depth (ft bgs)	Sampling Depth (ft bgs)	Sampling Method	Matrix	Description and Identification of Soils	Analysis	Method	Laboratory Samples
ISOC-4S	15	0 to ~10	SS - 5 ft center	fill	Yes	NA		
		10-12	SS - 2 ft center	fill/native interface[1]	Yes	headspace	PID	1 sample for VOCs, PAHs, foc, select metals, TPH-GRO and TPH-DRO at highest PID (>15 ppm) or obvious MGP contamination[3]
		12-14	SS - 2 ft center, ST	native soil	Yes	headspace	PID	
		14-15	SS - 2 ft center	native soil/PWR interface[2]	Yes	headspace	PID	
ISOC-4D[4]	25	0 to ~10	SS - 5 ft center	fill	Yes	NA		
		10-12	SS - 2 ft center	fill/native interface[1]	Yes	headspace	PID	1 sample for VOCs, PAHs, foc, select metals, TPH-GRO and TPH-DRO at highest PID (>15 ppm) or obvious MGP contamination[3]
		12-14	SS - 2 ft center, ST	native soil	Yes	headspace	PID	
		14-15	SS - 2 ft center	native soil/PWR interface[2]	Yes	headspace	PID	
		15-17	SS - 2 ft center	PWR	Yes	headspace	PID	1 sample for VOCs, PAHs, foc, select metals, TPH-GRO and TPH-DRO at highest PID (>15 ppm) or obvious MGP contamination[3]
		17-19	SS - 2 ft center, ST	PWR	Yes	headspace	PID	
		19-20	SS - 2 ft center	PWR	Yes	headspace	PID	
		20-25	SS - 2 ft center	PWR	Yes	NA		
ISOC-8	15	0 to ~10	SS - 5 ft center	fill	Yes	NA		
		10-12	SS - 2 ft center	fill/native interface[1]	Yes	headspace	PID	1 sample for VOCs, PAHs, foc, select metals, TPH-GRO and TPH-DRO at highest PID (>15 ppm) or obvious MGP contamination[3]
		12-14	SS - 2 ft center	native soil	Yes	headspace	PID	
		14-15	SS - 2 ft center	native soil/PWR interface[2]	Yes	headspace	PID	
ISOC-15S	15	0 to ~10	SS - 5 ft center	fill	Yes	NA		
		10-12	SS - 2 ft center	fill/native interface[1]	Yes	headspace	PID	1 sample for VOCs, PAHs, foc, select metals, TPH-GRO and TPH-DRO at highest PID (>15 ppm) or obvious MGP contamination[3]
		12-14	SS - 2 ft center	native soil	Yes	headspace	PID	
		14-15	SS - 2 ft center	native soil/PWR interface[2]	Yes	headspace	PID	
ISOC-15D[4]	25	0 to ~10	SS - 5 ft center	fill	Yes	NA		
		10-12	SS - 2 ft center	fill/native interface[1]	Yes	headspace	PID	1 sample for VOCs, PAHs, foc, select metals, TPH-GRO and TPH-DRO at highest PID (>15 ppm) or obvious MGP contamination[3]
		12-14	SS - 2 ft center	native soil	Yes	headspace	PID	
		14-15	SS - 2 ft center	native soil/PWR interface[2]	Yes	headspace	PID	
		15-17	SS - 2 ft center	PWR	Yes	headspace	PID	1 sample for VOCs, PAHs, foc, select metals, TPH-GRO and TPH-DRO at highest PID (>15 ppm) or obvious MGP contamination[3]
		17-19	SS - 2 ft center, ST	PWR	Yes	headspace	PID	
		19-20	SS - 2 ft center	PWR	Yes	headspace	PID	
		20-25	SS - 2 ft center	PWR	Yes	NA		

Table 3 Monitoring Well Installation Soil Sampling (HSA) (Continued)

Well ID	Estimated Boring Depth (ft bgs)	Sampling Depth (ft bgs)	Sampling Method	Matrix	Description and Identification of Soils	Analysis	Method	Laboratory Samples
ISOC-18S	15	0 to ~10	SS - 5 ft center	fill	Yes	NA		
		10-12	SS - 2 ft center	fill/native interface[1]	Yes	headspace	PID	1 sample for VOCs, PAHs, foc, select metals, TPH-GRO and TPH-DRO at highest PID (>15 ppm) or obvious MGP contamination[3]
		12-14	SS - 2 ft center, ST	native soil	Yes	headspace	PID	
		14-15	SS - 2 ft center	native soil/PWR interface[2]	Yes	headspace	PID	
ISOC-18D[4]	25	0 to ~10	SS - 5 ft center	fill	Yes	NA		
		10-12	SS - 2 ft center	fill/native interface[1]	Yes	headspace	PID	1 sample for VOCs, PAHs, foc, select metals, TPH-GRO and TPH-DRO at highest PID (>15 ppm) or obvious MGP contamination[3]
		12-14	SS - 2 ft center, ST	native soil	Yes	headspace	PID	
		14-15	SS - 2 ft center	native soil/PWR interface[2]	Yes	headspace	PID	
		15-17	SS - 2 ft center	PWR	Yes	headspace	PID	1 sample for VOCs, PAHs, foc, select metals, TPH-GRO and TPH-DRO at highest PID (>15 ppm) or obvious MGP contamination[3]
		17-19	SS - 2 ft center, ST	PWR	Yes	headspace	PID	
		19-20	SS - 2 ft center	PWR	Yes	headspace	PID	
		20-25	SS - 2 ft center	PWR	Yes	NA		
ISOC-20	15	0 to ~10	SS - 5 ft center	fill	Yes	NA		
		10-12	SS - 2 ft center	fill/native interface[1]	Yes	headspace	PID	1 sample for VOCs, PAHs, foc, select metals, TPH-GRO and TPH-DRO at highest PID (>15 ppm) or obvious MGP contamination[3]
		12-14	SS - 2 ft center, ST	native soil	Yes	headspace	PID	
		14-15	SS - 2 ft center	native soil/PWR interface[2]	Yes	headspace	PID	

[1] Head space samples and analytical samples will be collected from below the fill/native material interface (which occurs at approximately 10 to 13 feet bgs) every 2 feet and at suspect intervals where MGP contamination is evident using visual and olfactory senses. For this matrix 10 ft bgs is arbitrarily chosen and depths should be adjusted based on field observations.

[2] Head space samples and analytical samples will be collected from below the native soil/PWR interface (which occurs at approximately 15 feet bgs) every 2 feet and at suspect intervals where MGP contamination is evident using visual and olfactory senses. For this matrix 15 ft bgs is arbitrarily chosen and depths should be adjusted based on field observations.

[3] In the absence of elevated PID reading or visual evidence of MGP contamination, the sample will be collected from the 2-foot interval that corresponds to the middle of the screened interval.

[4] The deeper interval well at the overburden/PWR monitoring well location will be drilled first and a sample collected as indicated. If during shallow well drilling, either higher PID (greater than 15 ppm) results or obvious MGP contamination is encountered, then the soil samples from the shallow well borehole will be selected for analyses and the soil samples from the PWR borehole will be discarded.

Notes: bgs = below ground surface
DRO = diesel range organics
foc = fraction of organic carbon
ft = feet
GRO = gasoline range organics
MGP = manufactured gas plant
NA = not available
PAH = polynuclear aromatic hydrocarbon
PID = photoionization detector
ppm = parts per million
SS = split spoon PWR = partially weathered rock
ST = shelby tube
TPH = total petroleum hydrocarbons
VOC = volatile organic compound

5.3.3 Physical Property Sampling

At ISOC-4, ISOC-18, and ISOC-20 (Figure 5), physical property samples will be obtained to provide a cross section of the site's soil physical properties. These three locations will be sampled with split spoon and Shelby tube samplers. Overburden soil physical property testing will consist of grain size distribution, air permeability, hydraulic conductivity, water-filled and total porosity, and dry bulk density (ASTM D6836). Physical property data (grain size distribution, vertical conductivity, porosity) are needed for retardation calculations in fate and transport modeling. Soil samples will also be analyzed to obtain data concerning foc which is needed for phase distribution calculations. As subsequently described, slug testing will also be performed in the monitoring wells installed for this investigation to provide horizontal hydraulic conductivity data. Samples collected in the PWR will be analyzed for the same components as above with the exception of vertical hydraulic conductivity.

5.3.4 Monitoring Well Development Procedure

At least 24 hours after the completion, the monitoring wells will be developed to ensure removal of fine grained sediments from the vicinity of the well screen in general accordance with EPA and ASTM protocols. During development, the well will be pumped until the water runs clear containing a minimum amount of sediment and three successive readings (taken at 5-minute intervals) of pH, temperature, turbidity, and specific conductivity have stabilized. Water produced by development will be containerized in 55-gallon drums staged on pallets.

5.3.5 Monitoring Well Groundwater Sampling

The eight newly installed monitoring wells will be sampled in conjunction with the semi-annual groundwater sampling activities in accordance with EPA low flow purging and sampling methods. Prior to sample collection, the monitoring well identification, water level, time, and date will be recorded in the field logbook and on the respective groundwater sampling field form.

Water quality measurements will be made in general accordance with EPA Region IV standard operating procedures for field sampling. Field measurements will include pH, conductivity, temperature, turbidity, dissolved oxygen (DO), and oxidation-reduction potential (ORP), which will be made using the YSI Model 6920 multi-parameter sonde with a Model 650 MDS display or similar appropriate meter. The meter will be calibrated daily prior to sampling using the manufacturer's instructions and appropriate reference solutions. Measurements of all physical properties will be obtained during purging of the monitoring well. To make the water property measurements, the discharge tubing from the pump will be attached to a flow chamber, and the measurement sonde will be placed in the flow chamber. A parameter will be considered stable when readings taken for three separate, successive volumes of water in the flow-through cell are within a certain range. The acceptable stability ranges are ±0.1 for pH, ±3% for conductivity, ±10 millivolts (mV) for ORP, ≤10 nephelometric turbidity units (NTU) for turbidity, and ±0.5 milligrams per liter for DO.

Groundwater samples will be collected during semi-annual sampling events. Groundwater samples will be analyzed for TPH-DRO, TPH-GRO, VOCs (EPA Method 8260), PAHs (EPA Method 8270), and select metals: iron, manganese, vanadium, chromium, arsenic, and lead (EPA Method 6010C) will be collected from each monitoring well when the well stabilization criteria have been met.

After the new wells have been sampled, each well, if practicable, will undergo a slug test to determine in-situ properties of the respective water-bearing formation (overburden or PWR). These tests will determine transmissivity, hydraulic conductivity, storativity, connection between saturated zones, and identification of boundary conditions.

6.0 ANALYTICAL METHODS AND FIELD QUALITY CONTROL PROCEDURES

This section describes the analytical methods, sample containers, preservatives, holding time requirements, and field quality control (QC) samples.

6.1 Analytical Methods

All DPT soil samples will be submitted for laboratory analysis of VOCs (SW-846 Method 8260B), PAHs (SW-846 Method 8270D), TPH-GRO (SW-846 Method 8015C), and TPH-DRO (SW-846 Method 8015C).

All soil samples collected during the installation of monitoring wells will be submitted for laboratory analysis of VOCs (SW-846 Method 8260B), PAHs (SW-846 Method 8270D), TPH-GRO (SW-846 Method 8015C), TPH-DRO (SW-846 Method 8015C), and foc (Lloyd-Kahn/SW-846 Method 9060). Overburden soil physical property testing will consist of grain size distribution, air permeability, hydraulic conductivity, water-filled and total porosity, and dry bulk density (ASTM D6836). Samples collected in the PWR will be analyzed for the same components as above with the exception of hydraulic conductivity.

Groundwater samples collected during semi-annual sampling will also be analyzed for VOCs (SW-846 Method 8260B), PAHs (SW-846 Method 8270D), TPH-GRO (SW-846 Method 8015C), TPH-DRO (SW-846 Method 8015C), and select metals: iron, manganese, vanadium, chromium, arsenic, and lead (SW-846 Method 6010C).

6.2 Sample Containers, Preservatives, and Holding Time Requirements

Pre-cleaned sample containers will be obtained from the analytical laboratory, container requirements vary according to the analyte. Samples collected for VOC analyses will use Encore samplers or 40 milliliter (mL) amber volatile organic analysis vials pre-preserved with methanol. Sample material for PAH, TPH-GRO, and TPH-DRO analyses shall be packaged in 4-ounce amber glass jars.

Samples will be preserved according to the requirements of the specific analytical methods to be employed, and all samples will be extracted and analyzed within method-specified holding times. All samples will be handled in accordance with chain-of-custody procedures. Analyses will be performed by Test America in Nashville, Tennessee.

6.3 Field Quality Control Procedures

The following field QC samples will be required during sampling. All QC samples will be analyzed for VOCs, PAHs, TPH-GRO, and TPH-DRO (with the exception of the trip blanks to be submitted for VOC analysis only). A maximum of 32 samples will be submitted to the laboratory from the borings. Therefore, QC samples will consist of approximately three duplicates, four rinsate blanks, and four trip blanks.

Field QC samples for groundwater samples will be collected in accordance with the procedures for semi-annual sampling.

6.3.1 Field Duplicate

This type of field duplicate measures the total system variability (field and laboratory variance), including the variability component resulting from the inherent heterogeneity of the soil. Soil duplicates will be collected in separate containers, but from the same location as the original primary samples. The duplicate samples will be analyzed as a separate sample from the primary samples. Field duplicates will be collected at a frequency of one per ten primary soil samples (since there is a maximum of 32 primary soil samples no more than 3 duplicates are anticipated during this project).

Duplicate samples for groundwater will be collected in accordance with the procedures for semi-annual sampling.

6.3.2 Equipment Rinsate Blank

This QC sample serves as a check for effectiveness of the decontamination process. An equipment rinsate blank will be prepared and submitted for analysis at a frequency of one per day. The equipment rinsate blank will consist of analyte-free water used to rinse sampling equipment as the last step in the decontamination process. Equipment rinsates for groundwater samples will be collected in accordance with the procedures for semi-annual sampling.

6.3.3 Trip blank

Trip blanks consisting of target analyte-free water will be provided by the laboratory. The trip blank is a sealed container that accompanies the samples from collection at the site through shipment. This QC sample serves as a check for cross-contamination of VOCs as part of sampling, handling, and shipment. Trip blanks will be submitted to the laboratory at a frequency of one per cooler for VOC analysis.

7.0 DECONTAMINATION

Equipment decontamination minimizes the risk of cross-contamination of samples and ensures the collection of representative samples. All reusable or non-dedicated field equipment (e.g., sampling spoons, mixing bowls, groundwater sampling pump) will be decontaminated prior to reuse between locations, but will not be decontaminated between subsample collection at one location. All non-dedicated sampling equipment will be thoroughly decontaminated between sample locations using a solution of anionic soap (e.g., Liquinox®) and deionized water followed by a "clean" rinse using deionized water. Equipment will be allowed to air dry to the extent possible after being cleaned. All liquids generated during decontamination procedures will be containerized in new or reconditioned Department of Transportation (DOT)-approved 55-gallon drums. Disposable equipment intended for one-time use will not be decontaminated, but will be packaged for appropriate disposal.

8.0 INVESTIGATIVE DERIVED WASTE (IDW) MANAGEMENT

As IDW is generated, it will be stored on site in a designated area and remain in that location until characterized. IDW will be placed in new or reconditioned, DOT-approved 55-gallon drums. Drums will be in good condition and suitable for transportation. IDW drums will be placed in a configuration that allows room for inspections, operations and maintenance, and handling. Each drum will be labeled with the following information: contents, name of generator, and date. Drums will be staged on pallets. IDW containers will be routinely inspected to ensure that all containers remain in serviceable condition and to ensure good housekeeping practices. Container inspections will be used to identify any problems associated with drum usage, such as bulging, leaking, or improper/missing labels. Any problems will be addressed immediately upon discovery.

Incidental trash generated during this investigation (including discarded nitrile gloves, aluminum foil, paper towels, and disposable equipment) will be placed in plastic trash bags and disposed of as solid waste.

9.0 EROSION AND SEDIMENT CONTROLS

Drilling activities are anticipated to result in limited disturbance to the area near Chinquapin Creek and will require temporary erosion and sediment controls. During well installation, the driller will be instructed to take necessary actions such as a temporary silt fence or straw bales placed on the stream bank parallel to the creek to minimize sedimentation. Drilling activities are not anticipated to occur below the top of the stream bank. To prevent runoff, soil cuttings will be immediately transferred to a DOT-approved 55-gallon drum for storage. As previously described, drums will be routinely inspected to ensure proper storage. While drilling activities are occurring, daily checks of the controls and the stream for evidence of runoff will be performed. Any problems will be addressed immediately upon discovery. The impacted area will be restored by sowing grass seed and covering in straw once drilling activities have finished.

10.0 SCHEDULE

The proposed schedule for the Additional Investigation is provided below.

Task	Task Description	Task Time
	Work Plan Approval	0
1	Project Coordination, Procurement, HASP, Utility Locate	3 weeks
2	Field Preparation	1 weeks
3	Field Implementation	2 weeks
4	Analytical Results from Soil and Groundwater Investigation	3 weeks
5	Data Review, Tabulation, Figure Preparation	2 weeks
6	2D Modelling and Draft of Revised FFS	3 weeks
7	Final Report of Revised FFS	2 weeks
	Submittal – Total Time	16 weeks

11.0 REFERENCES

AMEC, 2012. *Chemical Oxidation Pilot Test Work Plan* (May).

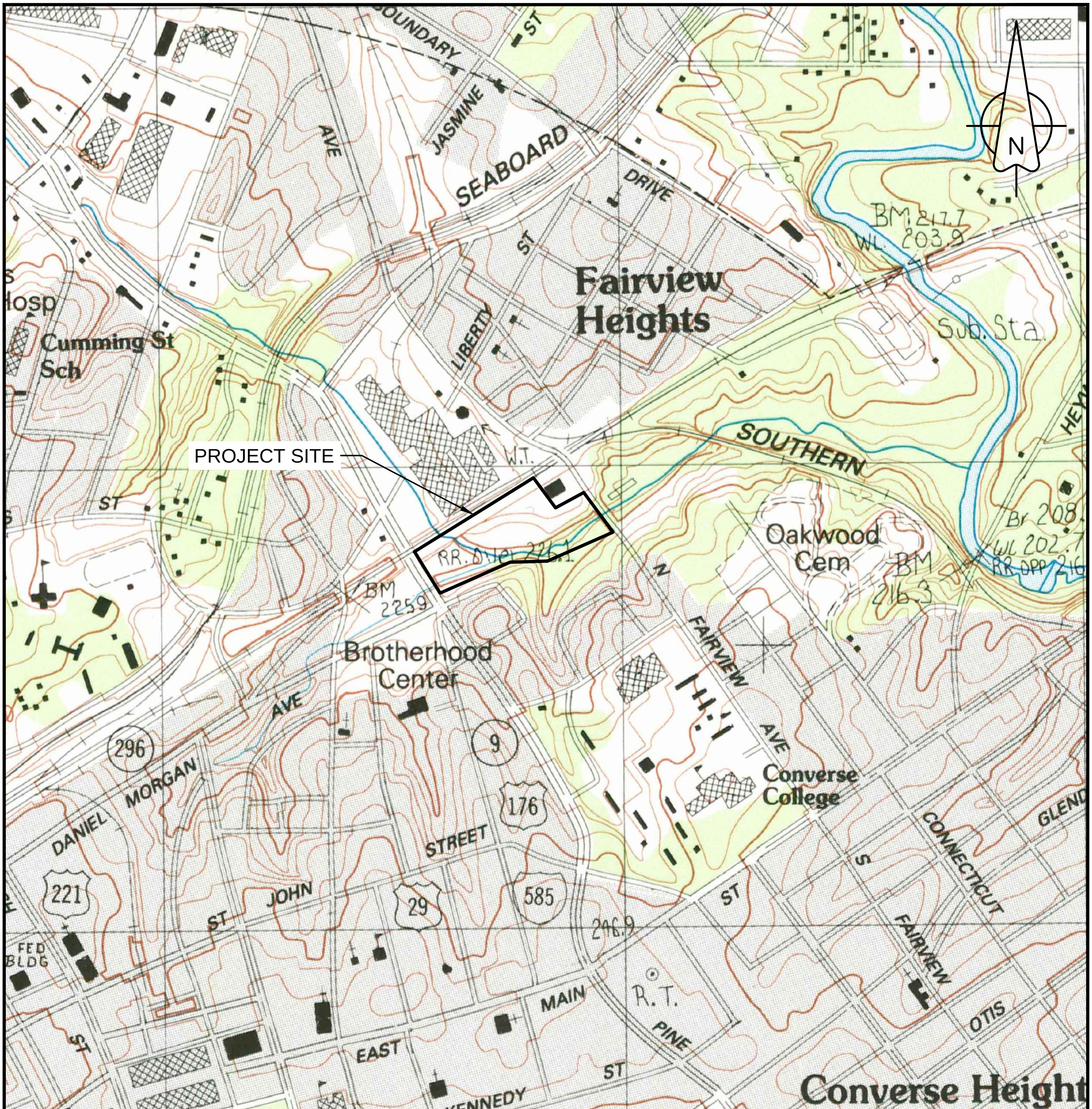
Duke, 2002. *Remedial Investigation Plan & Phase I Results for Spartanburg Manufactured Gas Plant (Pine Street)* (February 20).

Duke, 2006. *Final Soil Excavation Summary Report, Spartanburg – Pine Street MGP Site* (June 6).

ENSR, 2008. *Remedial Alternatives Focused Feasibility Study, Spartanburg Former Manufactured Gas Plant Site, Spartanburg, South Carolina*. Prepared for Duke Energy Corporation, Charlotte, North Carolina, Document No. 02355180-400 (May 22).

SCDHEC, 2012. Letter approval of *Chemical Oxidation Pilot Test Work Plan* (June 26).

FIGURES



NOTES:

BASE MAP TAKEN FROM USGS 7.5 MIN. SPARTANBURG, SOUTH CAROLINA QUADRANGLE.

0' 500' 1000' 1500'

1" = 1000'

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CLIENT:

DUKE ENERGY

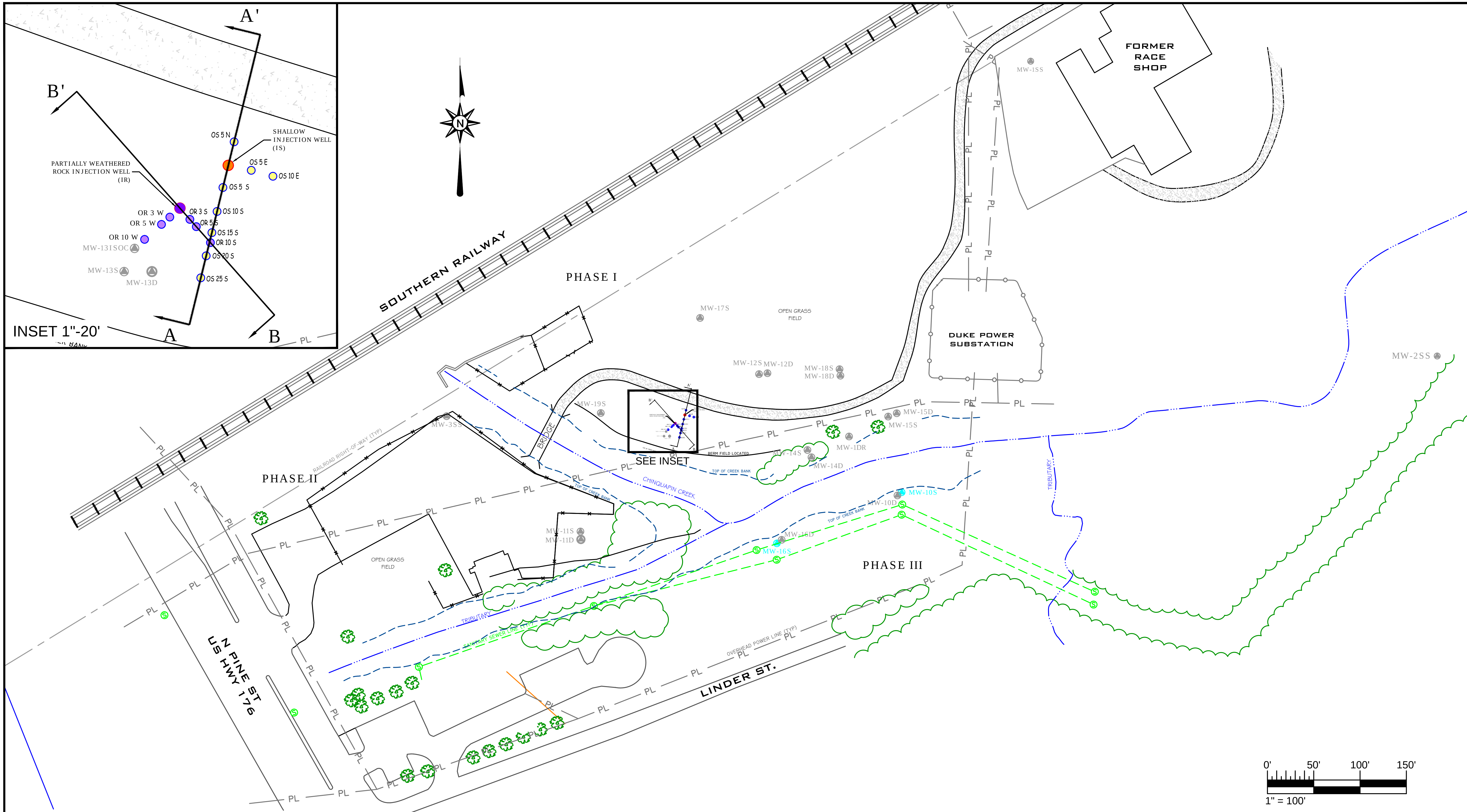
TITLE:

SITE VICINITY MAP

DUKE ENERGY PINE STREET MGP SITE

SPARTANBURG, SOUTH CAROLINA

DR: APT	REV: WPT	PROJ. NO.: 6228140195
CHK: ALA	DATE: 10-17-2014	DWG NO. NA
SCALE:	AS SHOWN	FIGURE 1



P:\CADD\Projects\6228\6228140195 Duke Spartanburg SC\F 02 Site Layout.dwg Jan. 08, 2015 william.wiers

LEGEND

- SHALLOW WELL
- PARTIALLY WEATHERED ROCK MONITORING WELL
- SHALLOW INJECTION WELL
- PARTIALLY WEATHERED ROCK INJECTION WELL
- SANITARY SEWER MANHOLE
- PREVIOUS EXISTING MONITORING WELL LOCATION

- PROPERTY BOUNDARY LINE
- RAILROAD RIGHT-OF-WAY
- CREEK/TRIBUTARY
- FENCE
- PL — OVERHEAD POWER
- UNDERGROUND SANITARY SEWER

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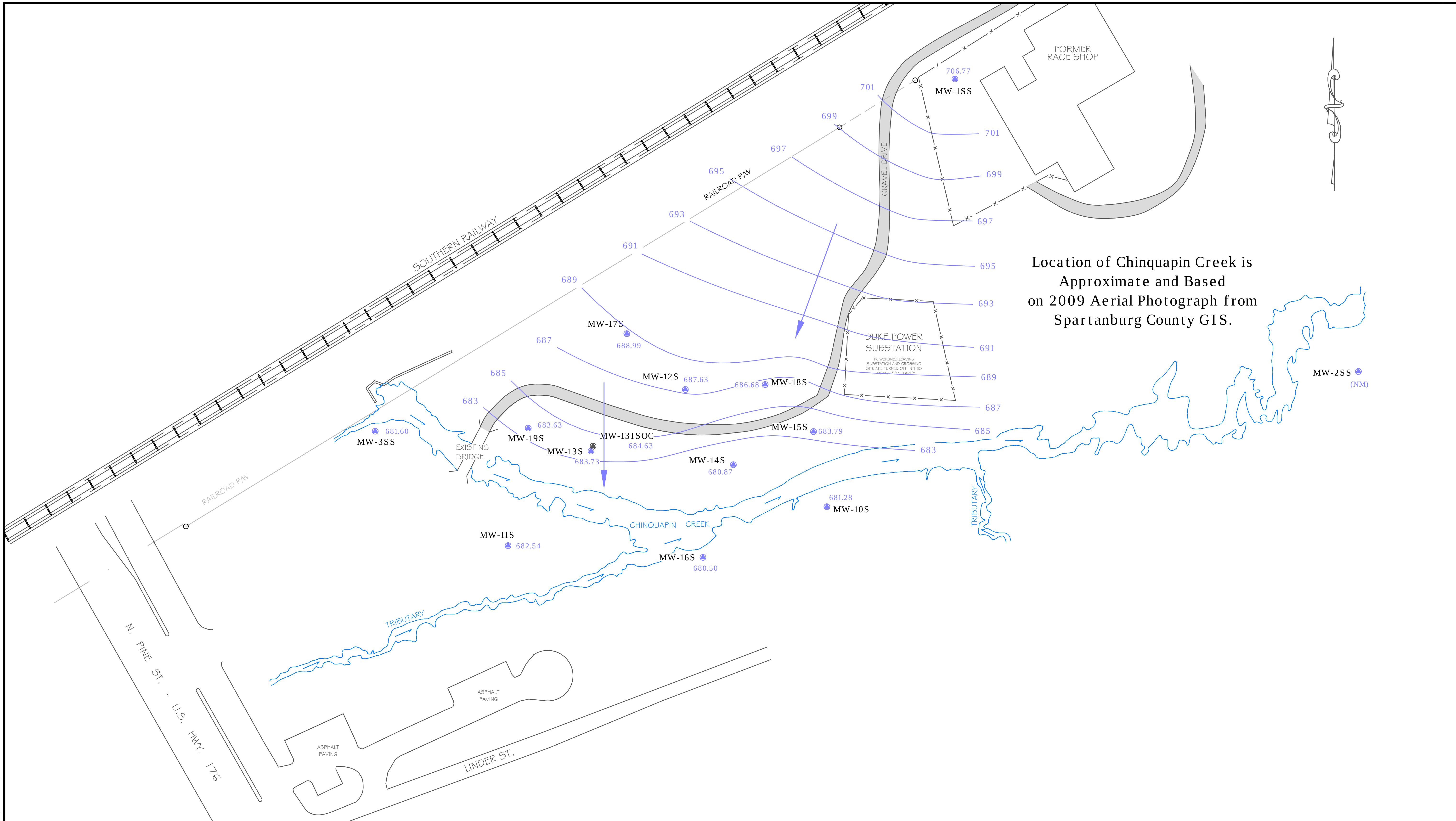
CLIENT: DUKE ENERGY

TITLE: SITE LAYOUT & PILOT TEST AREA
DUKE ENERGY PINE STREET MGP SITE
SPARTANBURG, SOUTH CAROLINA

DR: APT	REV: WPT	PROJ. NO.: 6228140195
CHK: ALA	DATE: 10-17-2014	DWG NO. NA
SCALE:	AS SHOWN	FIGURE NO.: FIGURE 2



LEGEND

MW-10S	SAPROLITE GROUNDWATER WELL
680.40	WATER LEVEL ELEVATION (feet msl)
	SAPROLITE GROUNDWATER CONTOUR
(NM)	NOT MEASURED
	GROUNDWATER FLOW DIRECTION
	SURFACE WATER FLOW DIRECTION

Wells South of Chinquapin Creek Were Not Contoured

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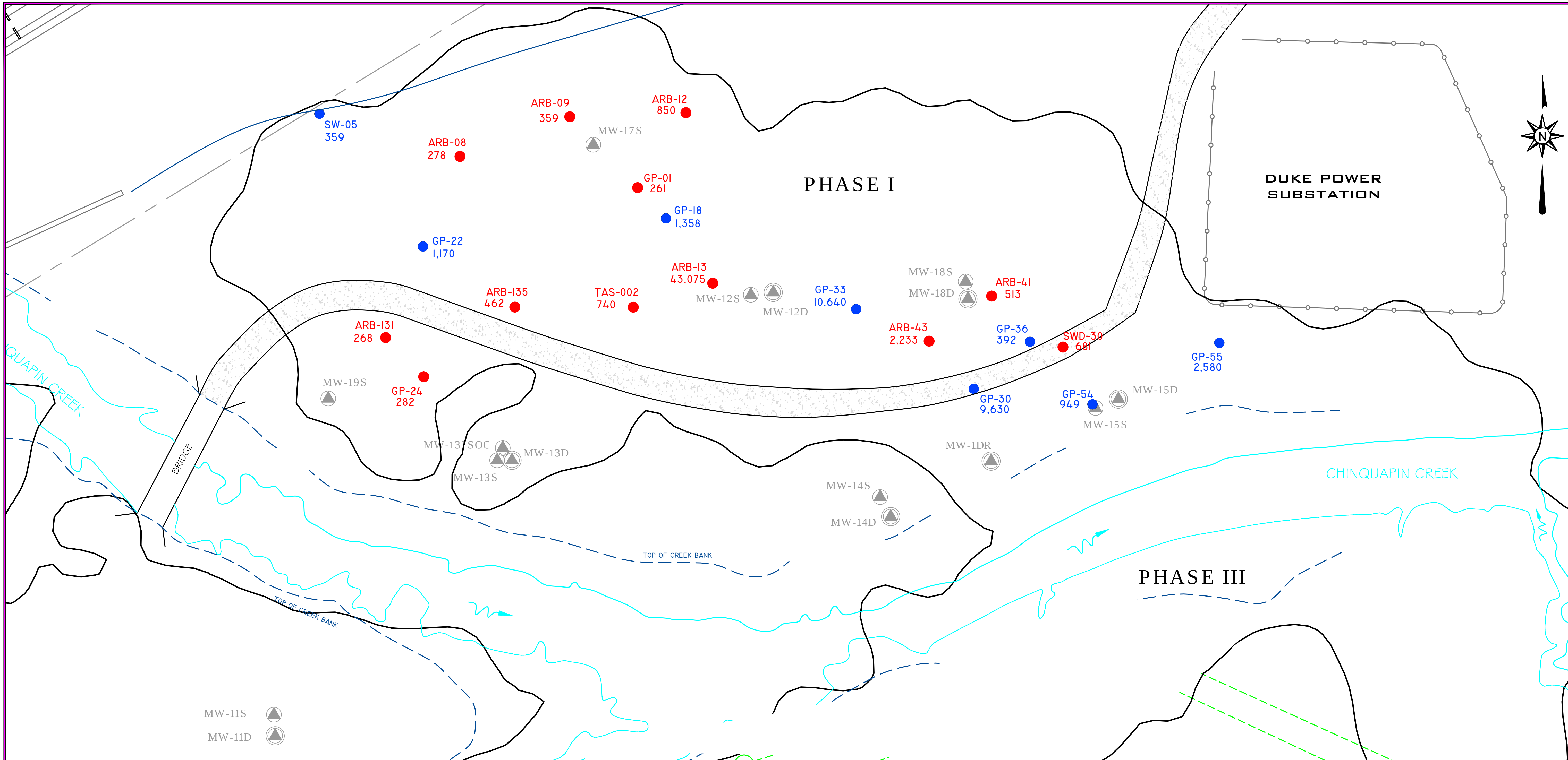
CLIENT: DUKE ENERGY

TITLE: GROUNDWATER ELEVATIONS IN SHALLOW WELLS - JULY/AUGUST 2013
DUKE ENERGY PINE STREET MGP SITE
SPARTANBURG, SOUTH CAROLINA

DR: WRW	REV: WPT	PROJ. NO.: 6228-1-0195
CHK: ALA	DATE: 10-17-2014	DWG NO. NA
SCALE: 0' 100'		FIGURE. NO.: FIGURE 3



LEGEND:

MW-13S	OVERBURDEN GROUNDWATER MONITORING WELL
MW-13D	BEDROCK GROUNDWATER MONITORING WELL
MW-13ISOC	PARTIALLY WEATHERED ROCK GROUNDWATER MONITORING WELL
	APPROXIMATE LIMITS OF EXCAVATION REMEDIATION
GP-84	SAMPLE LOCATION, DESIGNATION, AND TPAH CONCENTRATION >250 mg/kg. REMEDIATION DOCUMENTATION SUGGESTS SAMPLE MAY LIKELY HAVE BEEN EXCAVATED DURING REMEDIATION, BUT IS NOT CONCLUSIVE.
ARB-58	SAMPLE LOCATION, DESIGNATION, AND TPAH CONCENTRATION >250 mg/kg. REMEDIATION DOCUMENTATION SUPPORTS THAT MEDIA WAS NOT EXCAVATED AND REMOVED DURING REMEDIATION, AND REMAINS IN-PLACE.

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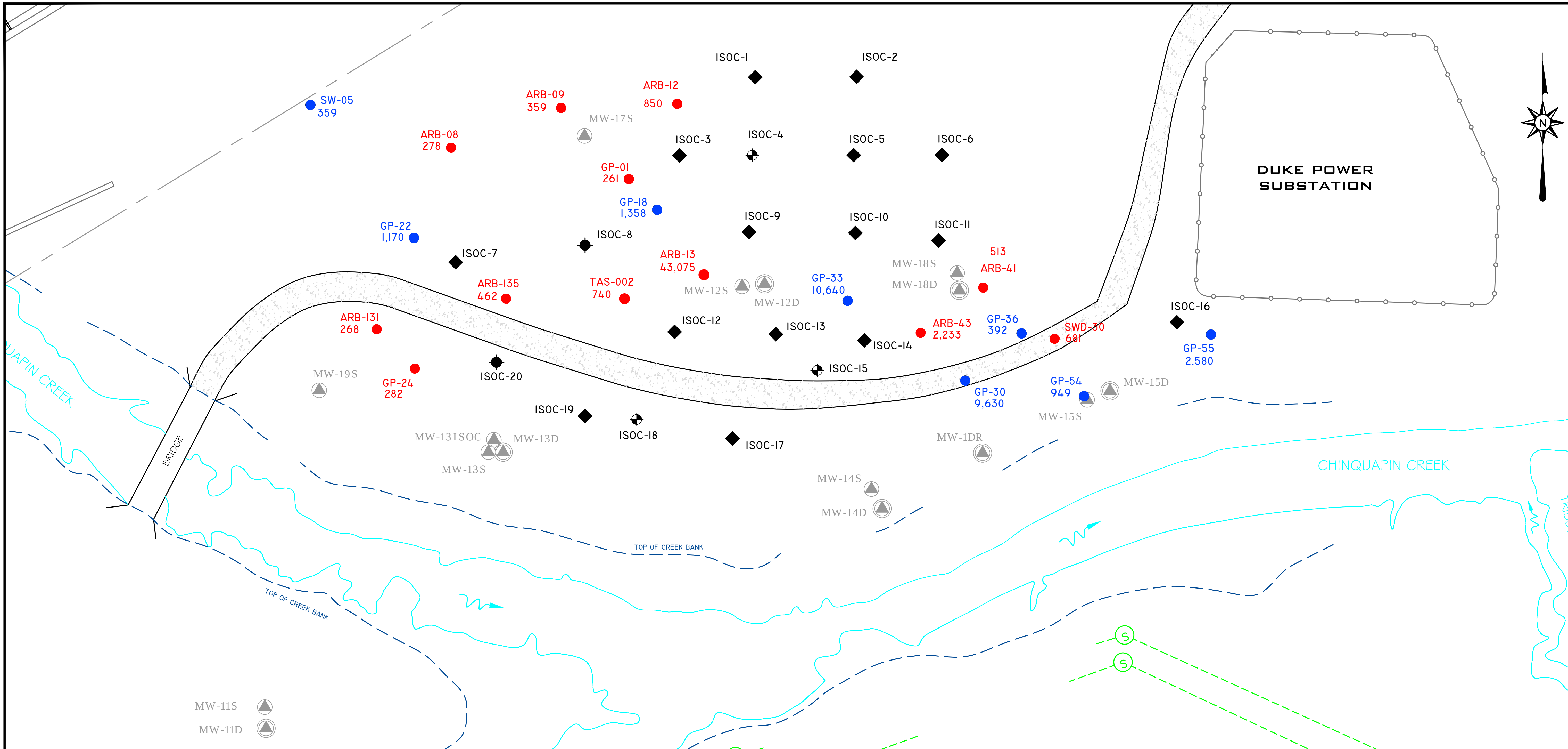
CLIENT: DUKE ENERGY

TITLE: PHASE I AREA TOTAL TPAH > 250 mg/kg REMAINING AFTER EXCAVATION
DUKE ENERGY PINE STREET MGP SITE
SPARTANBURG, SOUTH CAROLINA

DR: WRW	REV: WPT	PROJ. NO.: 6228-14-0195
CHK: ALA	DATE: 10-17-2014	DWG NO. NA
SCALE: 0' 40'		FIGURE NO.: FIGURE 4



LEGEND:

- MW-13S — OVERBURDEN GROUNDWATER MONITORING WELL
- MW-13D — BEDROCK GROUNDWATER MONITORING WELL
- MW-13ISOC — PARTIALLY WEATHERED ROCK GROUNDWATER MONITORING WELL
- GP-84 — SAMPLE LOCATION, DESIGNATION, AND TPAH CONCENTRATION >250 mg/kg. REMEDIATION DOCUMENTATION SUGGESTS SAMPLE MAY LIKELY HAVE BEEN EXCAVATED DURING REMEDIATION, BUT IS NOT CONCLUSIVE.
- ARB-58 — SAMPLE LOCATION, DESIGNATION, AND TPAH CONCENTRATION >250 mg/kg. REMEDIATION DOCUMENTATION SUPPORTS THAT MEDIA WAS NOT EXCAVATED AND REMOVED DURING REMEDIATION, AND REMAINS IN-PLACE.
- ISOC-4 — HSA SOIL BORINGS WITH OVERBURDEN WELL INSTALLED
- ISOC-8 — PAIRED HSA SOIL BORINGS WITH OVERBURDEN AND PWR WELL INSTALLED
- ISOC-1 — SOIL BORINGS

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CLIENT: DUKE ENERGY

TITLE: PHASE I AREA PROPOSED SAMPLE LOCATIONS TO SUPPORT REVISION OF THE FOCUSED FEASIBILITY STUDY
DUKE ENERGY PINE STREET MGP SITE
SPARTANBURG, SOUTH CAROLINA

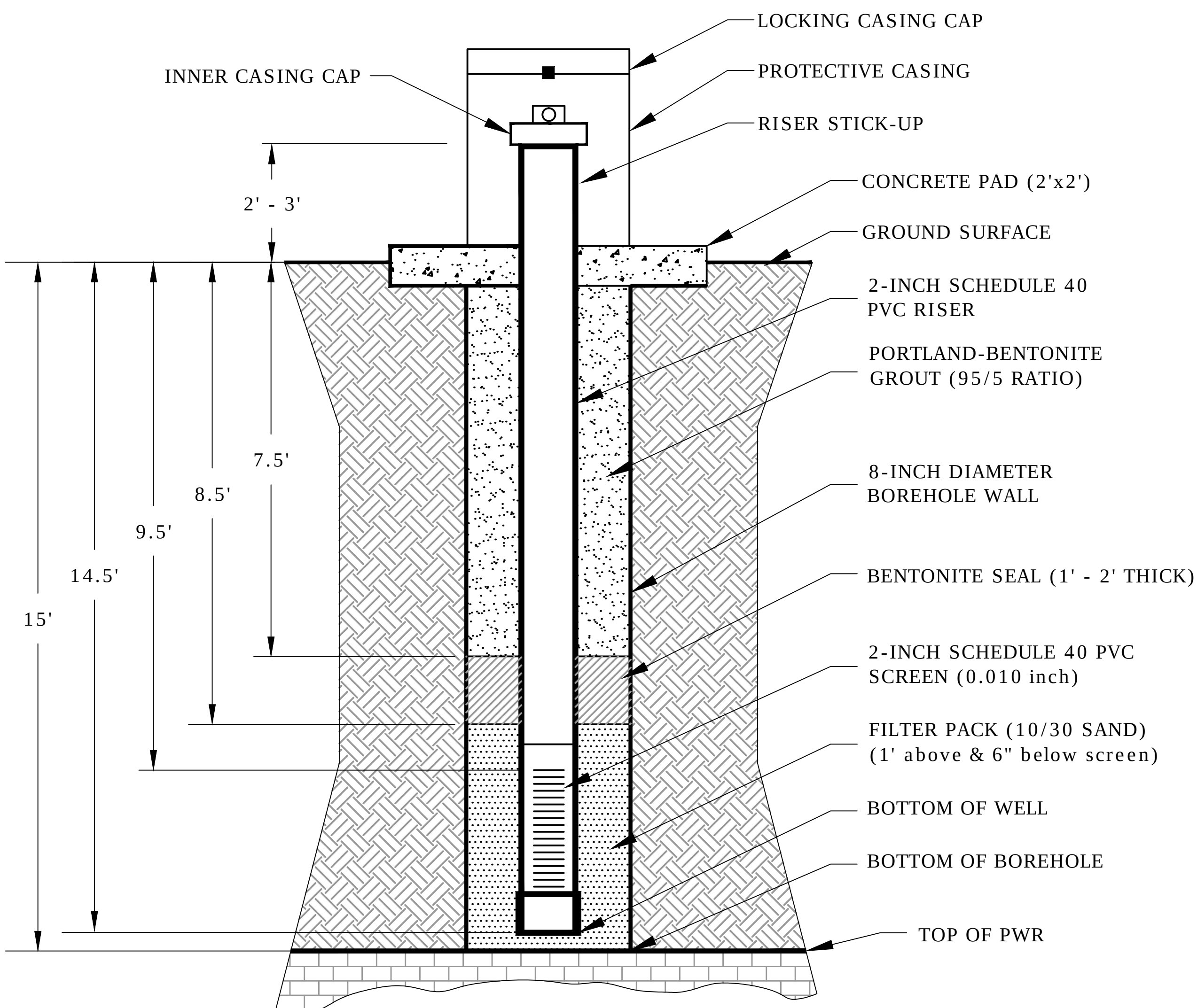
DR: APT	REV: WPT	PROJ. NO.: 6228140195
CHK: ALA	DATE: 10-17-2014	DWG NO. NA
SCALE: 0' 40'		FIGURE 5

P:\CADD\Projects\6228\6228140195 Duke Spartanburg SC\F 05 Soil Sample Locations.dwg Jan. 08, 2015 william.wiers

PROPOSED MONITORING WELL CONSTRUCTION

JOB NAME: DUKE ENERGY PINE STREET MGP SITE
WELL NUMBER: TBD
BOREHOLE DIAMETER: ~8"
TOTAL DEPTH: ~15

RISER/SCREEN MATERIAL: SCHEDULE 40 PVC
DIAMETER: 2 INCH
SLOT SIZE: 0.010 INCH



(NOT TO SCALE)

amec foster wheeler

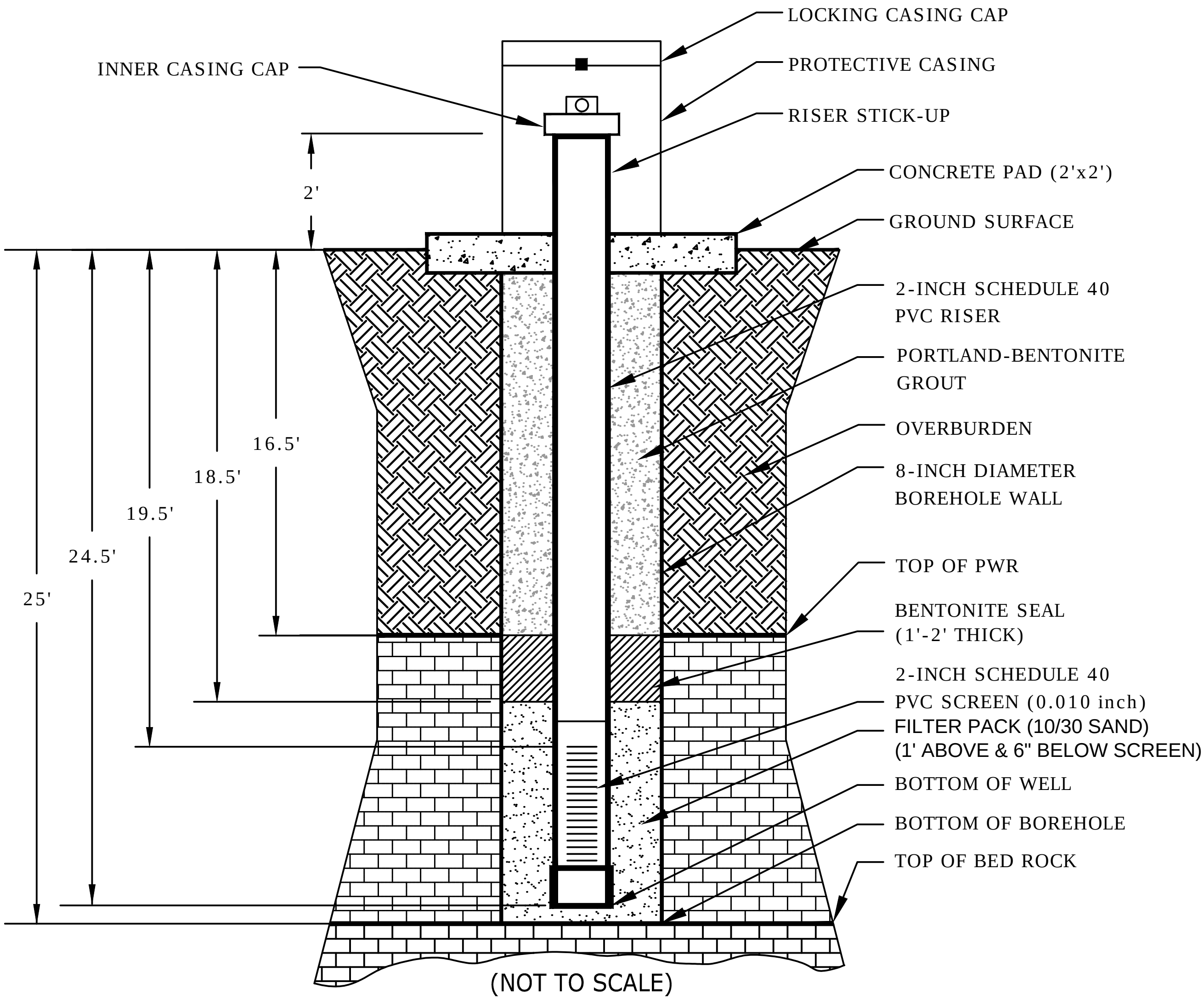
CLIENT: DUKE ENERGY

TITLE: TYPICAL CONSTRUCTION FOR OVERBURDEN MONITORING WELL
DUKE ENERGY PINE STREET MGP SITE
SPARTANBURG, SOUTH CAROLINA

DR: APT	REV: WPT	PROJ. NO.: 6228140195
CHK: ALA	DATE: 10-17-2014	DWG NO. NA
SCALE: AS SHOWN		FIGURE 6

PROPOSED MONITORING WELL CONSTRUCTION

JOB NAME	DUKE ENERGY PINE STREET MGP SITE	RISER/SCREEN MATERIAL:	SCHEDULE 40 PVC
WELL NUMBER	TBD	DIAMETER:	2 INCH
BOREHOLE DIAMETER	~8"	SLOT SIZE:	0.010 INCH
TOTAL DEPTH	~25		



(NOT TO SCALE)

amec foster wheeler

CLIENT: DUKE ENERGY

TITLE: TYPICAL CONSTRUCTION FOR PWR MONITORING WELL
DUKE ENERGY PINE STREET MGP SITE
SPARTANBURG, SOUTH CAROLINA

DR: APT	REV: WPT	PROJ. NO.: 6228140195
CHK: ALA	DATE: 10-17-2014	DWG NO. NA
SCALE: AS SHOWN		FIGURE 7

APPENDIX A

FIELD FORMS

WELL DEVELOPMENT LOG

Project Name:	
Client/AMEC Proj No:	
Location:	
Well ID No.:	
Sample Technician:	
Date:	
Initial Measurements:	Well Total Depth (TOC): ft. Water Level (TOC): ft.
Calculated Well Volume:	Gallons Well Diameter: in.

WELL PURGING ACTIVITIES

Water Level Prior to Purging (TOC): ft.

Time	Flow Rate (ml/min)	Turbidity (NTUs)	Temp (^{o}C)	Cond. (mS/Cm)	pH	Salinity (%)	Dissolved Oxygen (mg/l)	ORP	Total Gallons Pumped	Comments
Results At End Of Purging:										

Purging Method		Flow rate		Units	ml/min		gal/min			
Grundfos pump										
Bladder pump										
Whale pump										
Bailer										

COMMENTS:

NM = Not Measured

Boring Log

Boring Log	Project Name:	Boring No.:
	Location:	Sequence No.: -
	Client/AMEC Project Number:	Page 1 of 1

Logged By:	Surface Elevation:	Excavation Depths [ft.]
Drilling Subcontractor:	Drilling Equipment &/or Method:	Rock:
		Completion:
Driller:		Groundwater Depths [ft.]
Laborer:	Miscellaneous Information:	First:
Start Date:		Completion:
Completion Date:		_____ Hours:

Geoprobe Run	USCS	% Recovery	Sample No.	Sample Type	Graphic Log	Depth (ft)	Soil/Rock Description	Notes
						0.5		
1						1.0		
						1.5		
						2.0		
						2.5		
2						3.0		
						3.5		
						4.0		
						4.5		
3						5.0		
						5.5		
						6.0		
						6.5		
4						7.0		
						7.5		
						8.0		
						8.5		
5						9.0		
						9.5		
						10.0		
						10.5		
6						11.0		
						11.5		
						12.0		
						12.5		
7						13.0		
						13.5		
						14.0		
						14.5		
						15.0		
						15.5		
						16.0		
						16.5		
						17.0		

DRILLING LOG

HOLE NUMBER	IR
SHEET / SHEETS	1 of 1
DRILL SUBCONTRACTOR	SAEDACCO
PROJECT	Duke Energy Former Pine Street MGP
LOCATION	Spartanburg, SC
NAME OF DRILLER(S)	Richy Lemire
MANUFACTURER'S DESIGN OF DRILL	
SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	4.25 inch HSA
HOLE LOCATION	IR
SURFACE ELEVATION	
DATE STARTED	9/25/2012
DATE COMPLETED	9/25/2012
OVERBURDEN THICKNESS	26'
DEPTH DRILLED INTO ROCK	NA
TOTAL DEPTH OF HOLE	26'
DEPTH OF GROUNDWATER ENCOUNTERED	10'
DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	9.5'
OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	
GEOTECHNICAL SAMPLES	NA
DISTURBED	NA
UNDISTURBED	NA
TOTAL NUMBER OF CORE BOXES	NA
SAMPLES FOR CHEMICAL ANALYSIS	
VOC	
METALS	
OTHER (SPECIFY)	
OTHER (SPECIFY)	
OTHER (SPECIFY)	
TOTAL CORE RECOVERY	
DISPOSITION OF HOLE	2" injection well installed
BACKFILLED	
MONITORING WELL	IR
OTHER (SPECIFY)	
GEOLOGIST	Mike Flanik
LOCATION SKETCH/COMMENTS	
SCALE	Not to Scale

0-1: Gray/black silty medium sand, with trace organics (SM)
1-3: Black silty fine-medium sand, few gravel (SM)
3-4: Gray silty medium sand (SM)
4-5: Black and red brown silty fine sand, trace slag (SM)-FILL
5-10: Tan brown silty fine-very fine sand (SM)

10-14: Gray silty sand (black staining), wet, coal tar present with odor (SM)-ALLUVIUM

14-15: Dark gray sandy/clayey silt, moderate elasticity, wet, odor
15-26: White and gray layered weathered rock, silty sand with few quartz gravel-SAPROLITE