Marshall Steam Station Ash Basin

Groundwater Monitoring Program Sampling, Analysis, and Reporting Plan

NPDES Permit NC0004987

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SAMPLING, ANALYSIS, AND REPORTING PLAN

This document has been reviewed for accuracy and quality commensurate with the intended application.

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Section 1 - Introduction

This Groundwater Monitoring Program Sampling, Analysis, and Reporting Plan (Plan) is developed to support the Duke Energy Carolinas, LLC (Duke Energy) requirement for groundwater monitoring around the Marshall Steam Station (MSS) ash basin operated under National Pollutant Discharge Elimination System (NPDES) Permit NC0004987.

This Plan describes the groundwater monitoring network, methodologies of field sampling, record-keeping protocols, laboratory analytical methods, data quality objectives, data validation, and reporting that will be used for the MSS ash basin groundwater monitoring program.
Section 2 - Site Description

2.1 Plant Description
MSS is a coal-fired electricity-generating facility with a capacity of 2,090 megawatts located on the west side of Lake Norman in Catawba County, North Carolina, as shown on Figure 1. MSS is a four-unit station which began commercial operation in 1965.

Lake Norman is part of Duke Energy’s Catawba-Wateree Hydroelectric Project (Federal Energy Regulatory Commission Project No. 2232), has a surface area of approximately 32,475 acres, and provides cooling water for the station.

2.2 Ash Basin Description
The coal ash residue from the coal combustion process has historically been disposed of in the MSS ash basin. The ash basin currently receives waste streams from the MSS wastewater and yard drain sump, coal pile runoff, treated flue gas desulfurization (FGD) wastewater, ash removal system, and stormwater. The discharge from the ash basin is permitted by the North Carolina Department of Environment and Natural Resources (NCDENR) Department of Water Resources (DWR) under NPDES Permit NC0004987.

The ash basin system consists of a single cell impounded by an earthen dike located on the southeast end of the ash basin. The ash basin system was constructed in 1965 and is located approximately 2,000 feet northeast of the power plant. The waste boundary for the ash basin encompasses approximately 382 acres.

The full pond elevation for the MSS ash basin is approximately 790 feet. The normal pond elevation of Lake Norman is approximately 760 feet. Figure 2 is shown with an ash basin elevation at 790 feet.

Due to the nature of MSS operations, inflows to the ash basin are highly variable. The inflows from the station to the ash basin are discharged to the northwest portion of the ash basin. The ash basin pond elevation is controlled by the use of concrete stop logs. The discharge from the ash basin is through a concrete discharge tower located in the eastern portion of the ash basin. The concrete discharge tower drains through a 30-inch-diameter slip-lined corrugated metal pipe which discharges into Lake Norman.
Section 3 - Site Geology and Hydrogeology

3.1 Geologic/Soil Framework
MSS and its associated ash basin system are located in the Kings Mountain Belt of the Piedmont physiographic province of North Carolina (Piedmont). The rocks of the Kings Mountain Belt were formed during the late Proterozoic to Early Paleozoic era. The Kings Mountain Belt bedrock consists of metasedimentary and metavolcanic rocks including schist, phyllite, marble, metavolcanic rock, quartzite, and gneiss (North Carolina Geologic Survey 1996).

The soils that overlie the bedrock in the area have generally formed from the in-place weathering of the parent bedrock. The fractured bedrock is overlain by a mantle of unconsolidated material known as regolith. The regolith, where present, includes the soil zone; a zone of weathered, decomposed bedrock known as saprolite; and alluvium. Saprolite, the product of chemical and mechanical weathering of the underlying bedrock, is typically composed of clay and coarser granular material up to boulder size and may reflect the texture of the rock from which it was formed (LeGrand 2004).

Based on a review of the monitoring well installation logs provided by Duke Energy, the soils comprising the saprolite layer on site were characterized as ranging from micaceous clay to gneissic and granitic partially weathered rock. Bedrock encountered on site consists of biotite gneiss, quartz schist, and granite.

3.2 Hydrogeologic Framework
The groundwater system in the Piedmont Province in most cases is comprised of two interconnected layers or mediums: 1) residuum/saprolite and weathered rock (regolith) overlying, and 2) fractured crystalline bedrock (Heath 1980; Harned and Daniel 1992). Within the regolith layer, a thoroughly weathered and structureless material termed residuum occurs near the ground surface with the degree of weathering decreasing with depth. The residuum grades into a coarser-grained material that retains the structure of the parent bedrock and is termed saprolite. Beneath the saprolite, partially weathered bedrock occurs with depth until sound bedrock is encountered. This mantle of residual soil, saprolite, and weathered rock is a hydrogeologic unit that covers and crosses various types of rock (LeGrand 1988). It provides an intergranular medium through which the recharge and discharge of water from the underlying fractured rock occurs. The bedrock layer consists of fractured, nonporous crystalline bedrock. The fractures control both the hydraulic conductivity and storage capacity of the rock mass.

A transition zone at the base of the regolith has been interpreted to be present in many areas of the Piedmont. The zone consists of partially weathered/fractured bedrock and lesser amounts of saprolite that grades into bedrock and has been described as “being the most permeable part of the system, even slightly more permeable than the soil zone” (Harned and Daniel 1992). The zone thins and thickens within short distances and its boundaries may be difficult to distinguish.
It has been suggested that the zone may serve as a conduit of rapid flow and transmission of contaminated water (Harned and Daniel 1992).

Piedmont topography is characterized by gently rounded sloped hills and valleys. Recharge typically occurs on upland areas and slopes while groundwater discharge is concentrated in surface water bodies and lowland areas. LeGrand’s (1988, 2004) conceptual model of the groundwater setting in the Piedmont incorporates the above two medium systems into an entity that is useful for the description of groundwater conditions. That entity is the surface drainage basin that contains a perennial stream or river (LeGrand 1988). Each basin is similar to adjacent basins and the conditions are generally repetitive from basin to basin. Within a basin, movement of groundwater is generally restricted to the area extending from the drainage divides to a perennial stream or river (Slope-Aquifer System; LeGrand 1988, 2004). Rarely does groundwater move beneath a perennial stream or river to another more distant stream (LeGrand 2004).

Therefore, in most cases in the Piedmont, the groundwater system is a two-medium system (LeGrand 1988) restricted to the local drainage basin. The groundwater occurs in a system composed of two interconnected layers: residuum/saprolite and weathered rock overlying fractured crystalline rock separated by the transition zone. Typically, the residuum/saprolite is partly saturated and the water table fluctuates within it. Water movement is generally through the fractured bedrock. The near-surface fractured crystalline rocks can form extensive aquifers. The character of such aquifers results from the combined effects of the rock type, fracture system, topography, and weathering. Topography exerts an influence on both weathering and the opening of fractures while the weathering of the crystalline rock modifies both transmissive and storage characteristics.

The aquifer system in the Piedmont typically exists in an unconfined or semi-confined condition in the bedrock zone. Under natural conditions, the general direction of groundwater flow can be approximated from the surface topography. Groundwater moves both vertically down through the regolith and parallel to the bedrock surface to areas where groundwater discharges as seepage into streams, lakes, or other surface water bodies.

A surface water divide is located to the west of the MSS ash basin approximately along Sherrills Ford Road to the west of the ash basin (Figure 2). A surface water divide is also located approximately along Island Ford Road to the north of the ash basin. Lake Norman is located to the southeast of the ash basin. The geology/groundwater conditions at the site are expected to be generally consistent with the characteristics of the conceptual groundwater model developed by LeGrand for the Piedmont region.
Section 4 - Monitoring Program

4.1 Regulatory Requirements for Groundwater Monitoring
The NPDES program regulates wastewater discharges to surface waters to ensure that surface water quality standards are maintained. MSS operates under NPDES Permit NC0004987 which authorizes discharge of cooling water and intake screen backwash (Outfall 001), treated wastewater (consisting of metal cleaning wastes, coal pile runoff, ash transport water, domestic wastewater, low volume wastes, and FGD wet scrubber wastewater) (Outfall 002), yard sump overflows (Outfalls 002A and 002B), and non-contact cooling water from the induced draft fan control house (Outfall 003) to the Catawba River (Lake Norman) in accordance with effluent limitations, monitoring requirements, and other conditions set forth in the permit. The NPDES permitting program requires that permits be renewed every 5 years.

The MSS NPDES permit requires groundwater monitoring. Permit Condition A (11) Attachment XX, Version 1.1, dated June 15, 2011, lists the groundwater monitoring wells to be sampled, the parameters and constituents to be measured and analyzed, and the requirements for sampling frequency and results reporting. Attachment XX also provides requirements for well location and well construction. A copy of Attachment XX is included as Appendix B.

The compliance boundary for groundwater quality at the MSS ash basin site is defined in accordance with 15A NCAC 02L .0107(a) as being established at either 500 feet from the waste boundary or at the property boundary, whichever is closer to the source.

Sampling at the compliance groundwater wells commenced in February 2011. Analytical results have been submitted to the NCDENR Department of Water Resources (DWR) before the last day of the month following the date of sampling for all monitoring wells. In the future, analytical results will be submitted to the DWR within 60 days of the date of sampling for all monitoring wells.

4.2 Description of Groundwater Monitoring System
The groundwater monitoring for the MSS ash basin consists of the following monitoring wells: MW-4, MW-4D, MW-10S, MW-10D, MW-11S, MW-11D, MW-12S, MW-12D, MW-13S, MW-13D, MW-14S, and MW-14D. With the exception of monitoring wells MW-4 and MW-4D, the compliance monitoring wells were installed in July and August 2010. Monitoring well MW-4 was installed by Duke Energy in 1989 as part of the Marshall Dry Ash Landfill (Permit No. 1804) groundwater monitoring network. Monitoring well MW-4D was installed by Duke Energy in 2006 prior to the installation of the ash basin compliance monitoring wells as part of a voluntary monitoring system. Based on the locations of monitoring wells MW-4 and MW-4D relative to the ash basin, they were incorporated into the ash basin compliance monitoring network. Well construction data is provided in Table 1. A copy of the boring logs and monitoring well construction records are provided in Appendix A.
The locations for the compliance boundary monitoring wells were selected in consultation with the DWR Aquifer Protection Section. The locations of the monitoring wells, the waste boundary, and the compliance boundary are shown on Figure 2. A summary of the monitoring well location data is included in Appendix C. Based on the slope-aquifer system conceptual model, groundwater at the site is expected to flow downward from the topographic divides along Sherrills Ford Road on the west side of the ash basin and Island Ford Road on the north side of the ash basin. As described below, the wells provide monitoring data on the groundwater adjacent to the ash basin.

Monitoring wells MW-41, MW-10S2, MW-11S, MW-12S, MW-13S, and MW-14S were installed by rotary drilling methods using hollow stem augers, with the well screen installed above auger refusal to monitor the shallow aquifer within the saprolite layer. These wells were installed with screen lengths of either 10 feet or 15 feet. The screens were installed with screen intervals ranging from 3 feet to 18 feet below ground surface (bgs) at MW-13S and 37 feet to 52 feet bgs at MW-11S.

Monitoring wells MW-10D, MW-11D, MW-12D, MW-13D, and MW-14D were installed by rotary drilling methods using hollow stem augers and by rock coring techniques (HQ diameter barrel). Monitoring well MW-4D3 was installed using hollow stem augers and rock coring techniques with an NQ diameter barrel. These monitoring wells were installed in the fractured rock transition zone with screen lengths of 5 feet. The screens were installed with screen intervals ranging from 41.5 feet to 46.5 feet bgs at MW-13D and 90 feet to 95 feet bgs at MW-12D.

The monitoring wells at MSS are equipped with dedicated bladder-type pumps.

Groundwater monitoring wells MW-6S, MW-6D, MW-7S, MW-7D, MW-8S, MW-8D, MW-9S, and MW-9D were installed by Duke Energy in 2006 as part of a voluntary monitoring system. No groundwater samples are currently collected from these wells under the compliance monitoring program.

4.3 Monitoring Frequency
The monitoring wells will be sampled three times per year in February, June, and October.

4.4 Sample Parameters and Methods
The monitoring program consists of sampling and analysis for parameters and constituents identified in Attachment XX of the NPDES permit (Appendix B).

The parameters and constituents and the analytical methods are presented in Table 2.

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2 Wells other than MW-4 and MW-4D have the boring log and well record found in MACTEC’s Ash Basin Monitoring Well Installation Report (MACTEC Project No. 6228-10-5284) dated August 26, 2010.
The analytical results will be compared to the 2L Standards for the parameter or constituent.

4.5 Data Quality Objectives

The overall Quality Assurance (QA) objective is to ensure that reliable data of known and acceptable quality are provided. All measurements will be documented to yield results that are representative of the groundwater quality. Data will be calculated and reported in units as required by the NCDENR.

The analytical QA objectives for precision, accuracy, and completeness have been established by the laboratory(s) in accordance with the Environmental Protection Agency (EPA) or other accepted agencies for each measurement variable where possible. The objectives are outlined in the Duke Energy Analytical Laboratory Procedures Manual and are available upon request.

Appropriate methods have been selected to meet applicable standards for groundwater quality. Instances may occur, however, in which the condition of the sample will not allow detection of the desired limits for various parameters either because of matrix interference or high analyte concentrations requiring sample dilution. The laboratory(s) will provide sufficient documentation with each data package to notify reviewers about any analytical problems with the data, if needed.
Section 5 - Sampling Procedures

5.1 Sampling Equipment
Development, purging, and sampling equipment shall be selected to ensure that materials are compatible with the sample parameters and comply with state and federal regulatory requirements for sampling. Positive-gas-displacement fluorocarbon resin bladder pumps are installed in each monitoring well as dedicated purging and sampling systems.

5.1.1 Equipment Cleaning Procedures
Dedicated sampling equipment has been installed in each monitoring well. In the event non-dedicated equipment is used between monitoring wells, equipment will be cleaned before use and between wells in accordance with standard EPA-approved cleaning procedures for field equipment. This standard is outlined in the Standard Operating Procedures and Quality Assurance Manual, Engineering Support Branch, EPA Region IV, February 1, 1991.

5.2 Groundwater Sampling

5.2.1 Development of Monitoring Wells
All 12 monitoring wells addressed in this sampling plan have been developed. If new monitoring wells are installed, they will be developed prior to initial sampling. Development removes silt that has settled into the bottom of the well following installation and removes fine silt and clay particles from the well screen and sand-pack surrounding the screen. Well development is necessary to eliminate potential clogging and enhance well performance. Development involves removing an estimated ten or more well volumes from the well using a positive-gas-displacement fluorocarbon resin bladder pump with up-and-down agitation to loosen particles from the well screen. After development of a well, a true well depth is recorded referencing the top of well casing (TOC).

5.2.2 Groundwater Level and Total Depth Measurements
Water level measurements shall be collected and recorded to determine the groundwater elevations and groundwater flow direction and to calculate the volume of standing water in the well. All monitoring wells have been surveyed to determine the elevation of the TOC. All depth and water level measurements shall be referencing the TOC and recorded to the nearest one-hundredth of a foot.

Water level measurements shall be made with an electronic measuring device consisting of a spool of dual-conductor wire and sensor. When the sensor comes in contact with water, the circuit is closed and a meter light and/or buzzer are attached to the spool to signal the contact. The sensor is lowered further until it rests on the bottom of the well to determine the total depth of the well referencing the TOC. The depth and water level measurements shall be used to verify that the well has not filled with silt and to calculate the volume of water in the well.

The volume of well water (in gallons) is calculated using the following equation:
\[ V = h \times \pi \times r^2 \times (7.48052 \text{ gal/ft}^3) \]

Where:

- \( V \) = volume of water in the well screen and casing (gallons)
- \( h \) = height of standing water (feet) = total well depth - water level
- \( r \) = radius of well casing (feet)

For example, a 2-inch-diameter casing will have a volume of 0.1631 gallons per foot.

In dedicated sampling systems, an accurate well depth is determined, as indicated above, after development of the well and prior to installation of the dedicated bladder pump. The well depth will be re-measured any time the dedicated sampling system is removed for repair or replacement. The well depth, water level measurement, and calculated well volume are recorded on the Groundwater Monitoring Data Sheet (Figure 4).

### 5.2.3 Well Purging and Sampling

The selection of purging technique is dependent on the hydrogeologic properties of the aquifer and hydraulic characteristics of each well. Hydraulic conductivity, water column, well volume, screen length, and other information are evaluated to select the purging technique to acquire groundwater representative of the aquifer conditions. The Groundwater Monitoring Data Sheet (Figure 4) is used to record purging methods and measurements.

A multi-parameter water quality monitoring instrument is used to measure field stabilization or indicator parameters for determining representative groundwater during purging. These instruments measure pH, specific conductance, temperature, dissolved oxygen (DO), and oxidation-reduction potential (ORP). Instrument calibration must be performed and documented before and after each sampling event. The pH subsystem will be calibrated with two pH standards (pH 7.0 and 4.0) bracketing the expected groundwater pH. The specific conductance subsystem will be calibrated using two standards bracketing the expected groundwater conductivity. Calibration results will be recorded on a Field Sampling Calibration Form (Figure 5).

Various well purging techniques are described below. The purging method utilized at any particular well will be selected after considering the characteristics of the well and the purging method(s) used during previous sampling events.

#### CONVENTIONAL PURGING

This technique entails removing one equivalent well volume and measuring the indicator parameters (temperature, pH, and specific conductance). When the parameters have stabilized to within ±0.2 pH units and ±10 percent for temperature and conductivity over three to five well volumes, representative groundwater has been achieved for sampling. It is acceptable to begin sampling after five complete well volumes have been removed, even when indicator parameters have not stabilized. Groundwater is pumped into a graduated container to measure the volume
of water purged. Under normal rates of recovery, samples should be collected immediately after purging in accordance with EPA guidelines.

For low-yield wells incapable of yielding three to five well volumes in a reasonable amount of time (e.g., 2 hours or less), groundwater is purged to the elevation of the pump intake while measuring indicator parameters. Typically, low-yield wells are evacuated to dryness one time and sampled when sufficient water level recovery occurs. Turbidity is not a required stabilization parameter, but turbidity levels of 10 nephelometric turbidity units (NTU) or less should be targeted.

**LOW-FLOW PURGING**

Low-flow purging and sampling are appropriate when the recharge rate of the well approximates or equals the discharge rate of the pump with minimal drawdown of the water column (≤ 1 foot).

During low-flow purging and sampling, groundwater is pumped into a flow-through chamber at flow rates that minimize or stabilize water level drawdown within the well. Indicator parameters are measured over time (usually at 5-minute intervals). When parameters have stabilized within ±0.2 pH units; ±10 percent for temperature, conductivity, and DO; and ±10 millivolts (mV) for ORP over three consecutive readings; representative groundwater has been achieved for sampling. Turbidity is not a required stabilization parameter, but turbidity levels of 10 NTU or less should be targeted.

**MODIFIED LOW-FLOW PURGING**

This technique is considered a viable option particularly in the Piedmont region due to the likely presence of fine-grained soils where water level drawdown cannot be stabilized while pumping. When the well recharge rate is less than the pump discharge rate, excessive drawdown (>1 foot) of the water column occurs and mixes with stagnant water located above the screened interval. One equivalent well volume is removed initially before measuring indicator parameters. Frequently, removal of the initial well volume reduces the hydraulic head and allows for matching of the recharge rate with the pumping rate providing stabilization of drawdown. Indicator parameters should be measured at 5-minute intervals using a flow-through chamber attached to a multi-parameter water quality instrument. When parameters have stabilized to within ±0.2 pH units; ±10 percent for temperature, conductivity, and DO; and ±10 mV for ORP over three consecutive readings; representative groundwater has been achieved for sampling. Turbidity is not a required stabilization parameter, but turbidity levels of 10 NTU or less should be targeted.

**VERY LOW-YIELD WELL PURGING**

This technique provides the best option for monitoring wells that historically purge to dryness and do not sufficiently recharge to provide adequate volume for sample collection. Wells that yield less than 100 milliliters per minute (mL/min) frequently incur significant drawdown during well purging. Therefore, if the well yield is less than 100 mL/min, the volume of the pumping system (i.e., the pump bladder, tubing, and flow-through chamber) shall be calculated and two pumping system volumes shall be removed. Indicator parameters will be measured and recorded initially, and then sample collection will begin.
5.3 Sample Collection
Groundwater samples are collected after representative groundwater has been determined by purging and stabilizing the indicator parameters.

Sampling personnel wear clean, disposable, non-powdered nitrile gloves at each location. Samples are collected in the order of the volatilization sensitivity of the parameters:

- Metals, metalloids, and selenium
- Sulfate and chloride
- Total dissolved solids

After collection, samples will be preserved and stored according to parameter-specific methods and delivered to the laboratory under proper Chain-of-Custody (COC) procedures. All pertinent notations, water-level measurements, removed well volumes, and indicator parameters shall be documented on the Groundwater Monitoring Data Sheet (Figure 4).

5.4 Sample Containers, Volume, Preservation, and Holding Time
All sample containers supplied by the laboratory for the collection of groundwater samples shall be new and pre-cleaned as approved by EPA procedures appropriate for the parameters of interest. Table 3 summarizes the sample containers, sample volume, preservation procedures, and holding times required for each type of sample and parameter. Sample containers will be kept closed until used. All sample containers will be provided by Duke Energy or vendor laboratories.

5.5 Sample Tracking
The COC procedures allow for tracing the possession and handling of individual samples from the time of field collection through laboratory analysis and report preparation. Samples shall be pre-logged prior to sample collection. This process assigns a unique tracking number for each sample and generates corresponding labels. An example of the COC Record is provided as Figure 6.

5.6 Sample Labeling
Sample containers shall be pre-labeled and organized prior to field activities as part of the pre-sampling staging process. As samples are collected, the sampling personnel shall write the following information directly on the label: sampling date and time, and initials of sample collector. This information is also recorded on the Groundwater Monitoring Data Sheet (Figure 4) and the COC Record (Figure 6).

5.7 Field Documentation
Field documentation from each sampling event is recorded on the Groundwater Monitoring Data Sheets (Figure 4), the Field Sampling Calibration Form (Figure 5), and the Chain-of-Custody Record (Figure 6). Additionally, a Groundwater Sampling Site Checklist (Figure 7) is completed indicating information about the monitoring well such as proper identification (ID) tag and
condition of protective casing and pad. Field notations shall be made during the course of the field work to document the following information as applicable:

- Identification of well
- Well depth
- Static water level depth and measurement technique
- Presence of immiscible layers and detection method
- Well yield – high or low
- Purge volume or pumping rate
- Sample identification numbers
- Well evacuation procedure/equipment
- Sample withdrawal procedure/equipment
- Date and time of collection
- Types of sample containers used
- Identification of replicates or blind samples
- Preservative(s) used
- Parameters requested for analysis
- Field analysis data and methods
- Sample distribution and transporter
- Field observations during sampling event
- Name of sample collector(s)
- Climatic conditions including estimate of air temperature

This field notation information will be entered on the Groundwater Monitoring Data Sheets (Figure 4), the Field Sampling Calibration Form (Figure 5), or the Chain-of-Custody Record and Analysis Request Form (Figure 6) which are filled out for each sampling event. These documents will be arranged and filed by project and date. Recorded entries will be made on electronic forms or on paper forms in indelible ink. Errors on paper documents will be corrected by drawing a line through the error, initialing and dating the correction, and starting a new entry on the next line (if necessary).
5.8 Chain-of-Custody Record
The COC Record (Figure 6) accompanies the sample(s), traces sample possession from time of collection to delivery to the laboratory(s), and clearly identifies which sample containers have been designated for each requested analysis. The record includes the following types of information:

- Sample identification number
- Signature of collector
- Date and time of collection
- Sample type (e.g., groundwater, immiscible layer)
- Identification of well
- Number of containers
- Parameters requested for analysis
- Preservative(s) used
- Signature of persons involved in the chain of possession
- Inclusive dates of possession

5.9 Sample Custody, Shipment, and Laboratory Receipt
For the purpose of these procedures, a sample is considered in custody if it is:

- In actual possession of the responsible person
- In view, after being in physical possession
- Locked or sealed in a manner so that no one can tamper with it after having been in physical custody or in a secured area restricted to authorized personnel

All samples shall be maintained in the custody of the sampling crew during the sampling event. At the end of each sampling day and prior to the transfer of the samples off site, entries shall be completed on the COC form for all samples. Upon transfer of custody, the COC form is signed by a sampling crew member, including the date and time. If outside vendor laboratories are utilized, samples shall be delivered to these facilities by Duke Energy personnel or courier.

All COC forms received by the laboratory(s) shall be signed and dated by the respective supervising scientist(s) or their designee (at the Duke Energy lab) or the laboratory sample custodian (at vendor labs) immediately following receipt by the laboratory.
The analysts at the laboratory(s) maintain a sample tracking record that will follow each sample through all stages of laboratory processing. The sample tracking records show the date of sample extraction or preparation and analysis. These records are used to determine compliance with holding time limits during lab audits and data validation.

Custody procedures followed by Duke Energy laboratory personnel are described in detail in the Duke Energy Laboratory Services Procedures Manual.
Section 6 - Analytical Methods

The main analytical laboratory used in this program is the Duke Energy Laboratory Services Laboratory: N.C. Drinking Water (NC37804) and Wastewater (#248) Certifications. The organizational structure and staff qualifications of the laboratory are discussed in its generic Quality Assurance Program (QAP). The QAP and the Analytical Laboratory Procedures Manual are available for review upon request.

Vendor laboratories that meet EPA and North Carolina certification requirements may be used for analyses with approval by Duke Energy.

The analytical methods used for the samples analyzed for this Groundwater Monitoring Program are listed in Table 2. Specific conductance, field pH, and temperature are measured in the field according to the Duke Energy Groundwater Monitoring and Sample Collection Procedure or the instrument manufacturer instructions.
Section 7 - Internal Quality Control Checks

Internal laboratory QC checks used by the laboratories are described in each laboratory’s generic QAP and procedures manual. Using the internal laboratory QC checks, the laboratories demonstrate the ability to produce acceptable results using the methods specified.

Internal quality control checks for sampling procedures and laboratory analyses will be conducted with each sampling event. These checks will consist of the preparation and submittal of field blanks, trip (travel) blanks, and/or field replicates for analysis of all parameters at frequencies described in the laboratory(s) procedures manuals.

The field QC blanks and replicates that may be included as internal QC checks are described below. The specific type and number of blanks used may vary depending on the sampling event and will be determined by the Duke Energy field sampling personnel:

- **Field Blanks**: A field blank consists of a sample container filled in the field with organic-free, deionized, or distilled water prepared and preserved in the same manner as the samples. The field blank is transported to the laboratory with the samples and analyzed along with the field samples for the constituents of interest to check for contamination imparted to the samples by the sample container, preservative, or other exogenous sources. Field blanks are typically utilized for each sampling event. The field blanks are typically analyzed for major anions, cations, and metals.

- **Trip Blanks**: A trip (travel) blank is a sample container filled with organic-free water in the laboratory that travels unopened with the sample bottles. Trip blanks are typically utilized when sampling for volatile organic compounds. The trip blank is returned to the laboratory with the field samples and analyzed along with the field samples for parameters of interest.

- **Equipment Blanks**: If non-dedicated equipment is used between wells, it is recommended that equipment blanks be collected. The field equipment is cleaned following documented cleaning protocols. An aliquot of the final control rinse water is passed over the cleaned equipment directly into a sample container and submitted for analyses.

- **Field Replicates**: A field replicate is a duplicate sample prepared at the sampling locations from equal portions of all sample aliquots combined to make the sample. Both the field replicate and the sample are collected at the same time, in the same container type, preserved in the same way, and analyzed by the same laboratory as a measure of sampling and analytical precision.
Section 8 - Validation of Field Data Package

The field data package includes all of the field records and measurements developed by the sampling team personnel. The field data package validation will be performed by Duke Energy personnel. The procedure for validation consists of the following:

- A review of field data contained on the Groundwater Monitoring Data Sheets for completeness.

- Verification that equipment blanks, field blanks, and trip blanks were properly prepared, identified, and analyzed.

- A check of the Field Sampling Calibration Form for equipment calibration and instrument conditions.

- A review of the COC Record for proper completion, signatures of field personnel and the laboratory sample custodian, dates and times, and for verification that the correct analyses were specified.
Section 9 - Validation of Laboratory Data

The laboratory will perform a validation review of the submitted samples and analytical results to ensure that the laboratory QA/QC requirements are acceptable.
Section 10 - Report Submittal

A report of the monitoring results for all wells will be submitted to the DWR within 60 days of the date of sampling. The monitoring results will be submitted on NCDENR Form GW-59CCR.

The DWR will be notified in the event that vendor lab analyses have not been completed within this time frame. All Groundwater Monitoring Data Sheets, Field Calibration Forms, Chain-of-Custody Records, Laboratory QA data, and Data Validation Checklists shall be kept on file by Duke Energy and are available upon request.
Section 11 - References


Figures
SITE LAYOUT MAP
DUKE ENERGY CAROLINAS, LLC
MARSHALL STEAM STATION ASH BASIN
NPDES PERMIT #NC0004987
CATAWBA COUNTY, NORTH CAROLINA

NOTES:
1. PARCEL DATA FOR THE SITE WAS OBTAINED FROM DUKE ENERGY REAL ESTATE AND IS APPROXIMATE.
2. ASH WASTE BOUNDARY, STRUCTURAL FILL, AND LANDFILL BOUNDARIES WERE PROVIDED BY DUKE ENERGY AND ARE APPROXIMATE.
3. AS BUILT MONITORING WELL LOCATIONS PROVIDED BY DUKE ENERGY.
4. SHALLOW MONITORING WELLS (SS): WELL SCREEN INSTALLED ACROSS THE SURFICIAL WATER TABLE.
5. DEEP MONITORING WELLS (DS): WELL SCREEN INSTALLED IN THE TRANSITION ZONE BETWEEN COMPETENT BEDROCK AND THE REGOLITH.
6. TOPOGRAPHY DATA FOR THE SITE WAS OBTAINED FROM NC DOT GEOGRAPHIC INFORMATION SYSTEM (GIS) WEB SITE.
7. ORTHOPHOTOGRAPHY WAS OBTAINED FROM NC ONEMAP GIS WEB SITE (DATED 2009).
8. THE ASH BASIN COMPLIANCE BOUNDARY IS ESTABLISHED ACCORDING TO THE DEFINITION FOUND IN 15A NCAC 021 .0307 (a).
Typical Well Construction Details
(no scale)

Aboveground Well Protector
(4 inch x 4 inch x 5 foot steel casing with hinged lockable lid)

Drill ½" diameter vent hole below plug

2'-6" to 3'-0" (Nominal) Stick-up

2" dia. PVC well casing

Ground Surface

Concrete Pad 2 ft x 2 ft Square

6" Min.

Neat cement or neat cement bentonite mix from bentonite seal to ground surface

Boring (8" nominal diameter)

Bentonite Seal 2'-0" (Minimum)

Well Screen (0.010" manufactured slots, typical)

Well packing (Typ. #1 or #2 sand)

Male PVC Plug

Screen length varies (5' to 15' typ.)

6±' of well sand

Information provided by Duke Energy Carolinas, LLC
**FIGURE 4: EXAMPLE GROUNDWATER MONITORING DATA SHEET**

**Marshall Steam Station**

<table>
<thead>
<tr>
<th>SITE NAME</th>
<th>Project Name</th>
<th>PERMIT #</th>
<th>SITE ID</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marshall Steam Station</td>
<td>Ash Basin Groundwater Monitoring</td>
<td>NC0004987</td>
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<td></td>
</tr>
</tbody>
</table>

**MONITORING WELL INFORMATION**

<table>
<thead>
<tr>
<th>WELL DIAMETER (in)</th>
<th>TOC ELEV (ft msl)</th>
<th>MIDDLE OF WETTED SCREEN (ft toc)</th>
<th>PUMP INTAKE DEPTH (ft toc)</th>
<th>SCREEN INTERVAL (ft TOC)</th>
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</thead>
<tbody>
<tr>
<td></td>
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</table>

**EQUIPMENT INFORMATION**

<table>
<thead>
<tr>
<th>LEVEL METER SERIAL#</th>
<th>SAMPLING EQUIPMENT</th>
<th>PURGE METHOD</th>
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<tr>
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</table>

<table>
<thead>
<tr>
<th>PRESSURE (psi)</th>
<th>RECHARGE (sec)</th>
<th>DISCHARGE (sec)</th>
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<td></td>
<td></td>
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</table>

**MONITORING INFORMATION**

<table>
<thead>
<tr>
<th>INITIAL DEPTH TO WATER (ft TOC)</th>
<th>WATER COLUMN (ft)</th>
<th>WELL VOLUME (gal)</th>
</tr>
</thead>
<tbody>
<tr>
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**CONVERSION FACTOR**: 0.1631

**Dissolved Oxygen**: RECALCULATES ON CURRENT WATER LEVEL

**Sample Collected By**: NA

**Sample Collector**: NA

**WELL VOLUME**: WATER COLUMN X CONVERSION FACTOR

**Well Volume**: (Conversion factor dependent on well diameter and selected well volume units)

**Protective Casing**

**Well Pad**

**Well Casing**

**Well Tag**

**Sampling Notes**

**QC By**: NA
**FIELD SAMPLING CALIBRATION FORM**

**STUDY:** Marshall Steam Station Ash Basin Groundwater Monitoring

<table>
<thead>
<tr>
<th>PROCEDURE #:</th>
<th>HYDROLAB 3210.3</th>
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**DATE (s):**

**WEATHER CONDITIONS:**

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<th>DATE:</th>
<th>TIME:</th>
<th>DATE:</th>
<th>TIME:</th>
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</thead>
</table>

<table>
<thead>
<tr>
<th>CALIBRATION INSTRUMENT</th>
<th>STANDARD INSTRUMENT</th>
<th>STANDARD VALUE</th>
<th>STANDARD VALUE</th>
<th>CALIBRATION RESULTS</th>
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<tr>
<td>SPEC. COND. (uS/cm)</td>
<td>SS</td>
<td>0.0</td>
<td>0.0</td>
<td>Instrument Zeroed</td>
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<tr>
<td></td>
<td>SS</td>
<td>350</td>
<td>350</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SS</td>
<td>150</td>
<td>150</td>
<td></td>
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</tbody>
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| pH (units)             | B (7.00)            | 7.00           | 7.00           |                     |
|                       | B (4.00)            | 4.00           | 4.00           |                     |
|                       | B (10.00)           | 10.00          | 10.00          |                     |

| Mid-Day Ck             | B (7.00)            |                |                |                     |

**Time:**

<table>
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<tr>
<th>Parameter</th>
<th>Calibration Date / Time</th>
<th>DATE:</th>
<th>TIME:</th>
<th>BP (mmHg)</th>
<th>Calibration Results</th>
<th>DATE:</th>
<th>TIME:</th>
<th>BP (mmHg)</th>
<th>Calibration Results</th>
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<tbody>
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<td></td>
<td>285</td>
<td>N/A</td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SS (4.00)</td>
<td></td>
<td></td>
<td>462</td>
<td>ORP Temp 25.00</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>DO</td>
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**Temp Cert Device #**

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<th>TIME:</th>
<th>Calibration Results</th>
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<td>Temp</td>
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<td>N/A</td>
<td>N/A</td>
<td>Adjustment Not Available</td>
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<td></td>
<td></td>
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<tr>
<td>AMMONIUM</td>
<td>SS</td>
<td>N/A</td>
<td>N/A</td>
<td></td>
</tr>
</tbody>
</table>

**INSTRUMENT MAINTENANCE**

**Conductance Subsystem**
- Cleaned Electrodes
- Tested - OK

**pH Subsystem**
- Cleaned Electrodes
- Tested - OK

**Dissolved Oxygen Subsystem**
- Replaced Teflon Membrane
- Installed New Electrode
- Cleaned Electrode

**Ammonium Subsystem**
- Tested - OK

**Oxidation Reduction Subsystem**
- Cleaned Electrode
- Cleaned Electrode & Wiper

**Turbidity Subsystem**
- Tested - OK

**Temperature Subsystem**
- Reset / Calibrated

**Depth Subsystem**
- Tested - OK

**Notes:**

**Figure 5: Example Field Sampling Calibration Form**

**Key:**
- B = Buffer
- W = Winkler
- SS = Standard solution
- AW = Average Winkler
- ▬▬► = Adjusted To
- ▬/▬► = Not Adjusted To
- N/A = Not Applicable
<table>
<thead>
<tr>
<th>Customer must complete</th>
</tr>
</thead>
</table>

**CHAIN OF CUSTODY RECORD AND ANALYSIS REQUEST FORM**

<table>
<thead>
<tr>
<th>LIMS #</th>
<th>Samples Originating From</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NC ✓ SC ◊</td>
</tr>
</tbody>
</table>

**Logged By**

**Date & Time**

**SAMPLE PROGRAM**

<table>
<thead>
<tr>
<th>Vendor</th>
<th>Groundwater ✓</th>
<th>NPDES ◊</th>
<th>Drinking Water ◊</th>
<th>UST ◊</th>
<th>RCRA Waste ◊</th>
</tr>
</thead>
</table>

| PO #   | 1=HCL 2=H₂SO₄ 3=HNO₃ 4=ce 5=None |

**MR #**

**Comp.**

**Grab**

**Collection Information**

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Signature</th>
</tr>
</thead>
</table>

**LAB USE ONLY**

**Chem Desktop No.**

**Sample Description or ID**

21) Relinquished By

22) Requested Turnaround

| 14 Days ✓ | 7 Days     | 48 Hr     |

23) Seal/Locked By

24) Comments

**Customer to complete all appropriate, NON-SHADED areas.**

**Customer to sign & date below**

**Total # of Containers**

**Customer important: please indicate desired turnaround.**

21) Relinquished By

22) Requested Turnaround

| 14 Days ✓ | 7 Days     | 48 Hr     |

23) Seal/Locked By

24) Comments

**FIGURE 6 - CHAIN OF CUSTODY RECORD AND ANALYSIS REQUEST FORM**

Customer to complete appropriate columns to right.
### NORTH CAROLINA GROUNDWATER SAMPLING SITE CHECKLIST

**LOCATION / SITE:** Marshall Steam Station / Ash Basin Groundwater Monitoring  
**PERMIT #:** NC0004987  
**SAMPLE DATE:**

**WEATHER:**

**PAGE 1 OF 1**

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<tbody>
<tr>
<td>Casing in good condition</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
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<td>✔️</td>
<td>✔️</td>
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<tr>
<td>Damaged casing / still functional</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
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<tr>
<td>Damaged casing / repair required</td>
<td>✔️</td>
<td>✔️</td>
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<tr>
<td>Minor cracks</td>
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<td>✔️</td>
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<tr>
<td>Major cracks / broken / repair required</td>
<td>✔️</td>
<td>✔️</td>
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<td>Undermined / washing out</td>
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<tr>
<td>Fire ants around concrete pad</td>
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<tr>
<td>Damaged casing / still functional</td>
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</tr>
<tr>
<td>Damaged casing / repair required</td>
<td>✔️</td>
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<td>✔️</td>
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<tr>
<td>Broken hinge on protective lid</td>
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<td>✔️</td>
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<tr>
<td>Wasp nest inside protective casing</td>
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<td>Ants inside protective casing</td>
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<td>Water inside vault</td>
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<td>Vault bolt holes broken or stripped</td>
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<td>Bolts stripped</td>
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<td>Vault lid cracked or broken</td>
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<td>Well tag missing</td>
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<td>Well tag damaged / illegible</td>
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<td>Lacks required information - Driller Reg #</td>
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<td>Lacks required information - Completion date</td>
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<td>Lacks required information - Total well depth</td>
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<tr>
<td>Lacks required information - Depth to screen</td>
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<td>Lacks required information - Non potable tag</td>
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**NOTE:**
Tables
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<tbody>
<tr>
<td>East (ft)</td>
<td>686,723.33</td>
<td>686,715.82</td>
<td>681,328.43</td>
<td>681,327.13</td>
<td>682,062.41</td>
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<td>683,414.08</td>
<td>683,409.20</td>
<td>685,021.83</td>
<td>685,017.16</td>
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<td>Top of PVC Casing Elevation (ft)</td>
<td>1,414,467.78</td>
<td>1,414,462.36</td>
<td>1,418,114.26</td>
<td>1,418,119.07</td>
<td>1,411,706.21</td>
<td>1,411,710.71</td>
<td>1,410,714.04</td>
<td>1,410,712.50</td>
<td>1,410,462.33</td>
<td>1,410,464.23</td>
<td>1,416,995.37</td>
<td>1,416,999.23</td>
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<tr>
<td>Well Diameter</td>
<td>866.42</td>
<td>866.74</td>
<td>772.05</td>
<td>772.04</td>
<td>884.99</td>
<td>884.67</td>
<td>871.86</td>
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<td>847.49</td>
<td>847.05</td>
<td>811.29</td>
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<td>Well Stick-up (ft)</td>
<td>2.16</td>
<td>3.36</td>
<td>2.30</td>
<td>2.04</td>
<td>2.70</td>
<td>2.55</td>
<td>2.63</td>
<td>2.51</td>
<td>2.43</td>
<td>2.52</td>
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<td>Type of Casing</td>
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<tr>
<td>Total Depth below TOC (ft)</td>
<td>50.20</td>
<td>64.18</td>
<td>29.21</td>
<td>87.47</td>
<td>54.12</td>
<td>93.10</td>
<td>25.10</td>
<td>98.30</td>
<td>20.88</td>
<td>48.55</td>
<td>46.87</td>
<td>62.60</td>
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<td>Screen Length (ft)</td>
<td>10</td>
<td>5</td>
<td>15</td>
<td>5</td>
<td>15</td>
<td>5</td>
<td>15</td>
<td>5</td>
<td>15</td>
<td>5</td>
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<tr>
<td>Screen Interval (ft below TOC)</td>
<td>40.20 - 50.20</td>
<td>59.18 - 64.18</td>
<td>14.21 - 29.21</td>
<td>82.47 - 87.47</td>
<td>39.12 - 54.12</td>
<td>88.10 - 93.10</td>
<td>10.10 - 25.10</td>
<td>93.30 - 98.30</td>
<td>5.88 - 20.88</td>
<td>43.55 - 48.55</td>
<td>31.87 - 46.87</td>
<td>57.60 - 62.60</td>
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</tbody>
</table>

Notes:
1. ft indicates feet.
2. TOC indicates top of casing.
3. As-built well coordinates (NAD 83) and top of PVC casing elevations (NAVD 88) provided by Duke Energy.
4. Well diameter, type of casing, and screen lengths were obtained from Well Construction Records provided by Duke Energy.
5. Well total depth below TOC and well stick-up measurements provided by Duke Energy.
## Table 2
Sample Parameters and Analytical Methods
Marshall Steam Station Ash Basin

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>UNITS</th>
<th>ANALYTICAL METHOD</th>
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<tr>
<td><strong>In Situ Parameters</strong></td>
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<tr>
<td>Field pH</td>
<td>pH Units</td>
<td>Hydrolab</td>
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<tr>
<td>Conductivity</td>
<td>µmhos/cm</td>
<td>Hydrolab</td>
</tr>
<tr>
<td>Temperature</td>
<td>°C</td>
<td>Hydrolab</td>
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<tr>
<td>Water Level</td>
<td>ft</td>
<td>Water Level Meter</td>
</tr>
<tr>
<td><strong>Laboratory Analyses</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Antimony</td>
<td>µg/L</td>
<td>TRM / EPA 200.8</td>
</tr>
<tr>
<td>Arsenic</td>
<td>µg/L</td>
<td>TRM / EPA 200.8</td>
</tr>
<tr>
<td>Barium</td>
<td>mg/L</td>
<td>TRM / EPA 200.7</td>
</tr>
<tr>
<td>Boron</td>
<td>mg/L</td>
<td>TRM / EPA 200.7</td>
</tr>
<tr>
<td>Cadmium</td>
<td>µg/L</td>
<td>TRM / EPA 200.8</td>
</tr>
<tr>
<td>Chloride</td>
<td>mg/L</td>
<td>EPA 300.0</td>
</tr>
<tr>
<td>Chromium</td>
<td>mg/L</td>
<td>TRM / EPA 200.7</td>
</tr>
<tr>
<td>Copper</td>
<td>mg/L</td>
<td>TRM / EPA 200.7</td>
</tr>
<tr>
<td>Iron</td>
<td>mg/L</td>
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</tr>
<tr>
<td>Lead</td>
<td>µg/L</td>
<td>TRM / EPA 200.8</td>
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<tr>
<td>Manganese</td>
<td>mg/L</td>
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<tr>
<td>Mercury</td>
<td>µg/L</td>
<td>EPA 245.1</td>
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<tr>
<td>Nickel</td>
<td>mg/L</td>
<td>TRM / EPA 200.7</td>
</tr>
<tr>
<td>Nitrate (as Nitrogen)</td>
<td>mg/L</td>
<td>EPA 300.0</td>
</tr>
<tr>
<td>Selenium</td>
<td>µg/L</td>
<td>TRM / EPA 200.8</td>
</tr>
<tr>
<td>Sulfate</td>
<td>mg/L</td>
<td>EPA 300.0</td>
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<tr>
<td>Thallium</td>
<td>µg/L</td>
<td>TRM / EPA 200.8</td>
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<tr>
<td>Total Dissolved Solids</td>
<td>µg/L</td>
<td>SM 2450C</td>
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<tr>
<td>Zinc</td>
<td>mg/L</td>
<td>TRM / EPA 200.7</td>
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</tbody>
</table>

Notes:
1. µmhos/cm indicates micro-mhos per centimeter.
2. ft indicates feet.
3. µg/L indicates micrograms per liter.
4. mg/L indicates milligrams per liter.
5. TRM indicates total recoverable metals.
6. EPA indicates Environmental Protection Agency.
7. SM indicates Standard Method.
### Table 3
Sample Containers, Preservatives, and Holding Times
Marshall Steam Station Ash Basin

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>CONTAINERS</th>
<th>PRESERVATIVES</th>
<th>HOLDING TIMES</th>
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<td><strong>In Situ Parameters</strong></td>
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<tr>
<td>Field pH</td>
<td>In Situ</td>
<td>None</td>
<td>Analyze Immediately</td>
</tr>
<tr>
<td>Conductivity</td>
<td>In Situ</td>
<td>None</td>
<td>Analyze Immediately</td>
</tr>
<tr>
<td>Temperature</td>
<td>In Situ</td>
<td>None</td>
<td>Analyze Immediately</td>
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<tr>
<td><strong>Laboratory Analyses</strong></td>
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<tr>
<td>Antimony</td>
<td>500 ml HDPE</td>
<td>pH&lt;2 HNO₃</td>
<td>6 months</td>
</tr>
<tr>
<td>Arsenic</td>
<td>500 ml HDPE</td>
<td>pH&lt;2 HNO₃</td>
<td>6 months</td>
</tr>
<tr>
<td>Barium</td>
<td>500 ml HDPE</td>
<td>pH&lt;2 HNO₃</td>
<td>6 months</td>
</tr>
<tr>
<td>Boron</td>
<td>500 ml HDPE</td>
<td>pH&lt;2 HNO₃</td>
<td>6 months</td>
</tr>
<tr>
<td>Cadmium</td>
<td>500 ml HDPE</td>
<td>pH&lt;2 HNO₃</td>
<td>6 months</td>
</tr>
<tr>
<td>Chromium</td>
<td>500 ml HDPE</td>
<td>pH&lt;2 HNO₃</td>
<td>6 months</td>
</tr>
<tr>
<td>Copper</td>
<td>500 ml HDPE</td>
<td>pH&lt;2 HNO₃</td>
<td>6 months</td>
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<tr>
<td>Iron</td>
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<td>pH&lt;2 HNO₃</td>
<td>6 months</td>
</tr>
<tr>
<td>Lead</td>
<td>500 ml HDPE</td>
<td>pH&lt;2 HNO₃</td>
<td>6 months</td>
</tr>
<tr>
<td>Manganese</td>
<td>500 ml HDPE</td>
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<td>6 months</td>
</tr>
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<td>Mercury</td>
<td>500 ml HDPE</td>
<td>pH&lt;2 HNO₃</td>
<td>6 months</td>
</tr>
<tr>
<td>Nickel</td>
<td>500 ml HDPE</td>
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<td>6 months</td>
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<tr>
<td>Nitrate (as Nitrogen)</td>
<td>500 ml HDPE</td>
<td>Cool 4°C</td>
<td>48 hours</td>
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<td>Selenium</td>
<td>500 ml HDPE</td>
<td>pH&lt;2 HNO₃</td>
<td>6 months</td>
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<tr>
<td>Sulfate</td>
<td>500 ml HDPE</td>
<td>Cool 4°C</td>
<td>28 days</td>
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<tr>
<td>Thallium</td>
<td>500 ml HDPE</td>
<td>pH&lt;2 HNO₃</td>
<td>6 months</td>
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<tr>
<td>Total Dissolved Solids</td>
<td>500 ml HDPE</td>
<td>Cool 4°C</td>
<td>7 days</td>
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<tr>
<td>Zinc</td>
<td>500 ml HDPE</td>
<td>pH&lt;2 HNO₃</td>
<td>6 months</td>
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</tbody>
</table>

Notes:
1. ml indicates milliliter.
2. HNO₃ indicates nitric acid.
3. HDPE indicates high density polyethylene.
Appendix A - Boring Logs and Monitoring Well Construction Records
## SOIL TEST BORING FIELD REPORT

**JOB NO.** N/A  
**JOB NAME.** PLYMOUTH LANDFILL ML 15  
**DATE.** 6-29-87  
**WEATHER.** HOT  
**GROUND SURFACE ELEV.** N/A  
**INSPECTOR.** D. DICKSON  
**BORING NO.** ML-4

### SAMPLING

<table>
<thead>
<tr>
<th>SCALE</th>
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<th>SOIL CLASSIFICATION AND REMARKS</th>
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<tbody>
<tr>
<td>0</td>
<td></td>
<td>AD-2 DRILL RIG # 2555</td>
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<tr>
<td>5</td>
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<td>RED MICA. SILTY FINE TO MEDIUM SAND</td>
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<tr>
<td>10</td>
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<td>LT. BROWNISH GRAY MICA. SILTY FINE TO MEDIUM SAND</td>
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<td>LT. BROWNISH GRAY MICA. SILTY FINE TO COARSE SAND</td>
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<td>LT. BROWNISH GRAY MICA. SILTY FINE TO MEDIUM SAND</td>
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<td></td>
<td>LT. BROWNISH GRAY MICA. SILTY FINE TO MEDIUM SAND</td>
</tr>
<tr>
<td>40</td>
<td></td>
<td>LT. BROWNISH GRAY MICA. SILTY FINE TO MEDIUM SAND</td>
</tr>
</tbody>
</table>

### METHOD OF ADVANCING BORING

| POWER AUGER | TO |
| HAND CHOP: W/MUD: W/WATER | TO |
| ROTARY DRILL: W/MUD: W/WATER | TO |
| DIAMOND CORE | TO |

**BORING TERMINATED**  
**BORING REFUSAL**  
**WATER TOB DEPTH**  
**WATER 24 HR. DEPTH**  
**WATER LOSSES**  
**CASING SIZE**  
**LENGTH**

**DRY BORING - SEE ML-4A**
<table>
<thead>
<tr>
<th>SAMPLING</th>
<th>SCALE</th>
<th>UD</th>
<th>SOIL CLASSIFICATION AND REMARKS</th>
</tr>
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<tbody>
<tr>
<td>1ST 6'</td>
<td>4.0</td>
<td>45</td>
<td>CT: GAN MICA: SILTY CLAY TO</td>
</tr>
<tr>
<td>2ND 6'</td>
<td></td>
<td></td>
<td>MEDIUM SAND</td>
</tr>
<tr>
<td>3RD 6'</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>45</td>
<td>4.5</td>
<td></td>
<td>FOR CLASSIFICATION - 44.5 - 45.0</td>
</tr>
<tr>
<td>50</td>
<td></td>
<td></td>
<td>AUGER REFUSAL @ 42' 9&quot;</td>
</tr>
<tr>
<td>55</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>60</td>
<td></td>
<td></td>
<td>DRY BORING - MOVED TO</td>
</tr>
<tr>
<td>65</td>
<td></td>
<td></td>
<td>ALTERNATE BORING SITE</td>
</tr>
<tr>
<td>70</td>
<td></td>
<td></td>
<td># MW - 4A</td>
</tr>
<tr>
<td>80</td>
<td></td>
<td></td>
<td></td>
</tr>
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<td>120</td>
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</table>

BORING TERMINATED
BORING REFUSAL
WATER TOB DEPTH
WATER 24 HR. DEPTH
WATER LOSSES
CASING SIZE

METHOD OF ADVANCING BORING | DEPTH
--------------------------|---
POWER AUGER                | TO
HAND CHOP: W/MUD: W/WATER | TO
ROTARY DRILL: W/MUD: W/WATER | TO
DIAMOND CORE               | TO
## SOIL TEST BORING FIELD REPORT

**JOB NO.** N/A  
**JOB NAME** FLUSH LANDFILL MULTS  
**DATE** 6-30-69  
**WEATHER** H/M  
**STARTING TIME** N/A  
**GROUND SURFACE ELEV.**  
**HRS. DRILLING** N/A  
**HRS. MOVING** N/A  
**INSPECTOR** D. DICKSON  
**BORING NO.** MKI-4A  

### SAMPLING

<table>
<thead>
<tr>
<th>SCALE</th>
<th>UD</th>
<th>SOIL CLASSIFICATION AND REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td><strong>AD-2 DRILL RIG # 2355</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>YELLOWISH RED MICA. SILTY FINE TO</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MEDIUM SAND</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>WHITE MICA. FINE TO COARSE SAND</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>STEEL BROWN MICA. FINE TO</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MEDIUM SANDY SILT.</td>
</tr>
<tr>
<td>15</td>
<td></td>
<td>BROWNISH YELLOW MICA. SILTY FINE</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TO MEDIUM SAND</td>
</tr>
<tr>
<td>20</td>
<td></td>
<td>LT. OLIVE BROWN MICA. SILTY FINE</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TO MEDIUM SAND</td>
</tr>
<tr>
<td>25</td>
<td></td>
<td>OLIVE MICA. SILTY FINE TO</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MEDIUM SAND</td>
</tr>
<tr>
<td>35</td>
<td></td>
<td>OLIVE MICA. SILTY FINE TO</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MEDIUM SAND</td>
</tr>
<tr>
<td>40</td>
<td></td>
<td>OLIVE GRAY MICA. SILTY FINE TO</td>
</tr>
<tr>
<td></td>
<td></td>
<td>COARSE SAND</td>
</tr>
</tbody>
</table>

### BORING TERMINATED

- **METHOD OF ADVANCING BORING**  
  - POWER AUGER
  - HAND CHOP. W. MUD. W. WATER
  - ROTARY DRILL. W. MUD. W. WATER
  - DIAMOND CORE

- **DEPTH**
  - 0 TO 49.1
  - TO —

### BORING REFUSAL

- AUGER @ 49.1'

### WATER TOB DEPTH

- 46.0 on 6-30-69

### WATER 24 HR. DEPTH

- 31.7 on 7-6-69

### WATER LOSSES

- N/A

### CASING SIZE

- N/A

### LENGTH

- 0
### SOIL TEST BORING FIELD REPORT

**Job No.**: A/A

**Job Name**: FLINTSTONE LANDFILL MW’s

**Starting Time**: 5/18

**Ground Surface Elev.**: HRS. DRILLING: A/A HRS. MOVING: A/A

**Date**: 6-3-97

**Weather**: HOT

**Inspector**: D. DICKSON

**Boring No.**: A/A

<table>
<thead>
<tr>
<th>Sampling</th>
<th>Scale</th>
<th>UD</th>
<th>Soil Classification and Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>9 14.2</td>
<td>40</td>
<td>45</td>
<td>OLIVE BROWN MICA, SILITY FINE TO COURSE SAND.</td>
</tr>
<tr>
<td>45.012 50 = 9&quot; 45</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 49.2 49.5 50 = 3&quot; 45</td>
<td></td>
<td></td>
<td>LT. OLIVE GRAY MICA, SILITY FINE TO COURSE SAND.</td>
</tr>
<tr>
<td>49.6 50 = 3&quot; 45</td>
<td></td>
<td></td>
<td>AUGER REFUSAL @ 49.6&quot; BORING TERMINATED</td>
</tr>
<tr>
<td>55</td>
<td></td>
<td></td>
<td>SET MONITOR KNEE PER ATTACHED SKETCH</td>
</tr>
</tbody>
</table>

**Boring Terminated**: 49.6

**Boring Refusal**: AUGER @ 49.6

**Water 24 hr Depth**: 46.0, on 6-30-89

**Water 24 hr: Depth**: 31.7, on 9-6-89

**Water Losses**: A/A

**Casing Size**: A/A

**Length**: 0

**Method of Advancing Boring** | **Depth**
---|---
POWER AUGER | 0 TO 49.6
HAND CHOP: W. MUD: W. WATER | TO
ROTARY DRILL: W. MUD: W. WATER | TO
DIAMOND CORE | TO
DRILLING CONTRACTOR: DUKE POWER CO.  
DRILLER REGISTRATION NUMBER: G21

STATE WELL CONSTRUCTION PERMIT NUMBER: 18-04

1. WELL LOCATION: (Show sketch of the location below)
   Nearest Town: DENVER
   HIGHWAY # 150
   (Road, Community, or Subdivision and Lot No.)

2. OWNER: DUKE POWER CO.
   ADDRESS: P.O. Box 33187
   Street or Route No.: CRISA
   City or Town: NC
   Zip Code: 78242

3. DATE DRILLED: 6-30-89
   USE OF WELL: MONITOR

4. TOTAL DEPTH: 494 ft.  CUTTINGS COLLECTED ☑ Yes ☐ No

5. DOES WELL REPLACE EXISTING WELL? ☑ Yes ☐ No

6. STATIC WATER LEVEL: 35.3 ft.  □ above TOP OF CASING,
   □ below TOP OF CASING IS 2.4 ft. ABOVE LAND SURFACE.

7. YIELD (gpm): N/A  METHOD OF TEST: N/A

8. WATER ZONES (depth): N/A

9. CHLORINATION: Type: N/A  Amount: N/A

10. CASING:

    From 0 To 374 Ft.  6"D.  154 lb./ft.  PVC
    From 374 To 524 Ft.  6"D.  154 lb./ft.  PVC

11. GROUT:

    From 0 To 324 Ft.  MATERIAL: GROUNDWATER
    From 324 To 524 Ft.  N/A

12. SCREEN:

    From 374 To 474 Ft.  6"D.  0.10 in.  PVC
    From 474 To 524 Ft.  6"D.  0.10 in.
    From 524 To 534 Ft.  6"D.  0.10 in.

13. GRAVEL PACK:

    From 35.5 To 49.6 Ft.  MATERIAL: N.E. SAND
    From 49.6 To 52.4 Ft.

14. REMARKS: BENTONITE SEAL Placed FROM 32.5 - 35.5

   I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15 NCAC 2C, WELL CONSTRUCTION
   STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

   SIGNATURE OF CONTRACTOR OR AGENT: [Signature]
   DATE: 7-15-89

Submit original to Division of Environmental Management and copy to well owner.

GW-1 Revised 11/84
**WELL COMPLETION RECORD**

Complete all information requested below for each well installed, and return form to the Department of Human Resources, Solid and Hazardous Waste Management Branch.

**NAME OF SITE:** MARSHALL STEAM STATION

**ADDRESS:** HIGHWAY #130, TERRILL, NC

**PERMIT NO.:** K8-0D4

**OWNER (print):** DUKE POWER CO

**REGISTRATION NO.:** 921

**Casing Type:** BLUE threaded PVC dia. 2 in.  
**Casing Depth:** from 0 to 37.4 ft. - dia. 2 in.  
**Screen Type:** TIGER threaded PVC dia. 2 in.  
**Screen Depth:** from 37.4 to 110 ft. - dia. 2 in. 

**Grout Depth:** from 0 to 32 ft. - dia. 6 in.  
**Bentonite Seal:** from 32.5 to 35 ft. - dia. 6 in.  
**Sand/Gravel PK:** from 35.5 to 49.5 ft. - dia. 6 in.  
**Total Well Depth:** from 0 to 49.5 ft. - dia. 6 in.

**Static Water Level:** 34.3 feet from top of casing  
**Date Measured:** 7/16  
**Yield (gpm):** N/A  
**Method of Testing:** N/A  
**Casing is:** 2.6 feet above land surface

**DRILLING LOG**

<table>
<thead>
<tr>
<th>DEPTH</th>
<th>FROM</th>
<th>TO</th>
<th>FORMATION DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>SEE ATTACHED</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SOIL TEST REPORT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FIELD REPORT FOR WLI - 4</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**LOCATION SKETCH**

(show distance to numbered roads, or other map reference points)

**MARKS:** succeeds is placed in the most hydrologically compatible zone per conversations with Ralph

**DATE:** 7/16 89  
**SIGNATURE:** [Signature]

[Handwritten note: Succeed is placed in the most hydrologically compatible zone per conversations with Ralph, Roberts and Ed Sullivan]
NOTE:
NOT TO SCALE

1. Initial water level rod @ 34.3' from top of pipe on 7-6-59
2. T/L/e/e elev. 15

1/8" VENT HOLE IN RC CAP
LOCULABLE STEEL CAP AND COCK
4" x 4" STEEL PROTECTIVE PIPE
TOP OF GROUND

CONCRETE AROUND

RC STANDPIPE 2" NOM. DIA. (THREADED)
HOLE ABOVE SEAL FILLED WITH CEMENT-BENTONITE GROUT - 5% BENTONITE

BENTONITE SEAL

SLOTTED TRILOC RC 2" 9 NOM. DIA. w/ .01 SLOTS @ 1/8"
RC CAP

CLEAN SATURATED SAND

BOTTOM OF BORING @ 49.6' FROM GROUND SURFACE
# Duke Power-Marshall Steam Station-Ash Basin Monitor Well Installation

**Project:** Duke Power-Marshall Steam Station-Ash Basin Monitor Well Installation

**Location:** Terrell, North Carolina  
**Number:** 1356-06-834

**Boring Depth (ft):** 60.5  
**Elevation (ft):** TBD  
**Driller:** Larry Shrader, NC Cert. No. 3349  
**Date Drilled:** 10/12/06

**Logged By:** Courtney Withers  
**Water Level:** 25.5 ft bsl at 24 hrs  
**Drilling Method:** 4½" H.S.A.

## Material Description

<table>
<thead>
<tr>
<th>Elev. (Feet)</th>
<th>Depth (Feet)</th>
<th>Lithology</th>
<th>Material Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>FILL:</td>
<td>Firm, Red, Slightly Clayey, Silty, Coarse to Fine</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SAND With Rock Fragments</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>SAPROLITE:</td>
<td>Loose, White, Brown, and Orange,</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Micaceous, Silty, Very Fine SAND</td>
</tr>
<tr>
<td>15</td>
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<td>SAPROLITE:</td>
<td>Loose, White and Orange, Micaceous,</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Coarse to Fine SAND</td>
</tr>
<tr>
<td>20</td>
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<td>SAPROLITE:</td>
<td>Firm, Orange, Brown, and White,</td>
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<td></td>
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<td></td>
<td>Micaceous, Coarse to Fine SAND</td>
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<tr>
<td>25</td>
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<td>SAPROLITE:</td>
<td>Firm, Brown, White, and Red, Micaceous,</td>
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<tr>
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<td></td>
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<td>Silty, Very Fine SAND</td>
</tr>
<tr>
<td>30</td>
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<td>SAPROLITE:</td>
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<td></td>
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<td>SAND</td>
<td></td>
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<td>SAPROLITE:</td>
<td>Stiff to Very Hard, Brown, White, and</td>
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<td></td>
<td></td>
<td>Orange, Micaceous, Very Fine Sandy SILT With Course</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>Sand Lenses</td>
</tr>
</tbody>
</table>

## Well Construction

- Penetration Resistance (Blows/Foot):
  - At 25 ft: 12 blows/foot
  - At 30 ft: 11 blows/foot
### Duke Power-Marshall Steam Station-Ash Basin Monitor Well Installation

**Project:** Duke Power-Marshall Steam Station-Ash Basin Monitor Well Installation  
**Location:** Terrell, North Carolina  
**Number:** 1356-06-834  
**Boring No.:** MW-4D

<table>
<thead>
<tr>
<th>Elev. (Feet)</th>
<th>Depth (Feet)</th>
<th>Lithology</th>
<th>Material Description</th>
<th>Well Construction</th>
<th>Penetration Resistance (Blows/Foot)</th>
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</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td>0</td>
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<tr>
<td>19</td>
<td>50</td>
<td></td>
<td></td>
<td>52</td>
<td>50/2</td>
</tr>
<tr>
<td>50/2</td>
<td>60</td>
<td></td>
<td></td>
<td>50</td>
<td>19</td>
</tr>
</tbody>
</table>

**Date Drilled:** 10/12/06  
**Drilling Method:** 4½" H.S.A.

- **Boring Depth (ft):** 60.5  
- **Elevation (ft):** TBD  
- **Logger:** Courtney Withers  
- **Water Level:** 25.5 ft bsl at 24 hrs

**Boring Terminated at 60.5 ft bsl**  
**See Attached Core Picture for Recovery and RQD**

**Notes:**
- **Partially Weathered Rock:** When Sampled Becomes Very Dense, Black and White, Medium to Very Fine SAND
- **Auger Refusal at 50.5 ft bsl**
- **Bedrock:** Fine-Grained Biotite Gneiss

1. **Boring and Sampling IS in Accordance With ASTM D-1586.**  
2. **Penetration (N-Value) is the Number of Blows of 140 lb. Hammer Falling 30 in. Required to Drive 1.4 in. I.D. Sampler 1 ft.**
### MONITORING WELL CONSTRUCTION

**WELL ID:** MW-4D  
**TOTAL DEPTH:** 60.5 ft bls

<table>
<thead>
<tr>
<th>S&amp;ME PROJECT AND NO:</th>
<th>WELL USE / TYPE:</th>
<th>INSTALLATION DATE:</th>
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</thead>
<tbody>
<tr>
<td>Marshall Steam Station, 1356-06-834</td>
<td>Monitoring</td>
<td>10/12/2006</td>
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<table>
<thead>
<tr>
<th>DRILLING CONTRACTOR:</th>
<th>DRILLER AND LICENCE NO.:</th>
<th>DRILLING METHOD:</th>
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<tbody>
<tr>
<td>S&amp;ME, Inc.</td>
<td>Larry Shrader, 3349</td>
<td>4.25 H.S.A.</td>
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<table>
<thead>
<tr>
<th>24-HR WATER LEVEL:</th>
<th>NORTHING:</th>
<th>EASTING:</th>
<th>TOP OF CASING ELEV.:</th>
<th>GROUND SURFACE ELEV.:</th>
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<tbody>
<tr>
<td>25.5 ft bls</td>
<td>TBD</td>
<td>TBD</td>
<td>TBD</td>
<td>TBD</td>
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<table>
<thead>
<tr>
<th>PAD TYPE:</th>
<th>2’x2’ Concrete</th>
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<table>
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<th>PROTECTIVE CASING:</th>
<th>CASING TYPE:</th>
<th>CASING INTERVAL:</th>
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<tbody>
<tr>
<td>4”x4” Lockable Steel</td>
<td>2-inch Sch. 40 PVC</td>
<td>0 to 55.5 ft bls</td>
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</table>

<table>
<thead>
<tr>
<th>SCREEN TYPE:</th>
<th>SCREEN INTERVAL:</th>
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</thead>
<tbody>
<tr>
<td>2-inch 0.010 Slot Sch. 40 PVC</td>
<td>55.5 to 60.5 ft bls</td>
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</table>

<table>
<thead>
<tr>
<th>GROUT TYPE:</th>
<th>GROUT INTERVAL:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neat Cement</td>
<td>0 to 51.5 ft bls</td>
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</table>

<table>
<thead>
<tr>
<th>SEAL TYPE:</th>
<th>SEAL INTERVAL:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bentonite</td>
<td>51.5 to 53.5 ft bls</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>FILTER PACK:</th>
<th>FILTER PACK INTERVAL:</th>
</tr>
</thead>
<tbody>
<tr>
<td>#3 Filter Sand</td>
<td>53.5 to 60.5 ft bls</td>
</tr>
</tbody>
</table>

**DEVELOPMENT:**  
Purged ~35 Gallons

**NOTES:**  
TBD - To Be Determined

For Lithologic Information See Attached Boring Log
WELL CONSTRUCTION RECORD
(MW-4D)
North Carolina - Department of Environment and Natural Resources - Division of Water Quality - Groundwater Section

WELL CONTRACTOR (INDIVIDUAL) NAME (priia) Larry Shrader 
CERTIFICATION # 3349
WELL CONTRACTOR COMPANY NAME S&ME, Inc. 
PHONE # 704-523-4726

1. WELL USE (Check Applicable Box): Residential □ Municipal/Public □ Industrial □ Agricultural □ Monitoring □ Recovery □ Heat Pump Water Injection □ Other □ If Other, List Use

2. WELL LOCATION:
Nearest Town: Terrell County: Iredell
Marshall Steam Station
(Sreet Name, Numbers, Community, Subdivision, Lot No., Zip Code)

3. OWNER: Duke Power
Address: 526 South Church Street
Charlotte, NC 28202
City or Town State Zip Code (704) 373-7900
Area code - Phone Number

4. DATE DRILLED 10/12/2006
5. TOTAL DEPTH 60.5
6. DOES WELL REPLACE EXISTING WELL? YES □ NO ☑
7. STATIC WATER LEVEL Below Top of Casing: 28.5 ft.
(Use "+" if Above Top of Casing)
8. TOP OF CASING IS ~ 3 FT. Above Land Surface*
*Top of casing terminated at/over below land surface requires a
variance in accordance with 15A NCAC 2C.0118.
9. YIELD (gpm) n/a METHOD OF TEST n/a
10. WATER ZONES (depth): n/a
11. DISINFECTION: Type n/a Amount n/a
12. CASING:
<table>
<thead>
<tr>
<th>Depth</th>
<th>Diameter or Weight/Ft.</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>From 0 To 55.5 Ft.</td>
<td>2-inch Sch. 40</td>
<td>PVC</td>
</tr>
<tr>
<td>From 55.5 To 60.5 Ft.</td>
<td>2-inch 0.01 in.</td>
<td>PVC</td>
</tr>
</tbody>
</table>

13. GROUT:
<table>
<thead>
<tr>
<th>Depth</th>
<th>Material</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>From 0 To 51.5 Ft.</td>
<td>Neat Cement</td>
<td>Pour</td>
</tr>
<tr>
<td>From 51.5 To 53.5 Ft.</td>
<td>Bentonite</td>
<td>Pour</td>
</tr>
</tbody>
</table>

14. SCREEN:
<table>
<thead>
<tr>
<th>Depth</th>
<th>Diameter</th>
<th>Slot Size</th>
<th>Material</th>
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<tbody>
<tr>
<td>From 55.5 To 60.5 Ft.</td>
<td>2-inch in.</td>
<td>0.01 in.</td>
<td>PVC</td>
</tr>
</tbody>
</table>

15. SAND/GRAVEL PACK:
<table>
<thead>
<tr>
<th>Depth</th>
<th>Size</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>From 53.5 To 60.5 Ft.</td>
<td>#3</td>
<td>Silica Sand</td>
</tr>
</tbody>
</table>

16. REMARKS:

I DO HERE BY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15A NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER

SIGNATURE OF PERSON CONSTRUCTING THE WELL

DATE

Submit the original to the Division of Water Quality, Groundwater Section, 1636 Mail Service Center - Raleigh, NC 27699-1636 Phone No. (919) 733-3221, within 30 days. GW-1 REV. 07/2001
August 26, 2010

Mr. Jim Lindquist, Engineer
Duke Energy Corporation
Marshall Steam Station
8320 East NC Highway 150
Terrell, North Carolina 28682

Subject: Ash Basin Monitoring Well Installation Report
Marshall Steam Station
Terrell, Catawba County
MACTEC Project No.: 6228-10-5284

Dear Mr. Lindquist:

The purpose of this report is to present the results of monitoring well installation and evaluation activities conducted between July 26 and August 13, 2010 at the above-referenced site (Figure 1). The well installation and testing was conducted in general accordance with the requirements outlined in the Ash Basin Groundwater Monitoring Well Installation Project Work Summary (Work Summary) provided by Duke Energy (Duke) and dated May 21, 2010. The following Figures, Tables and Appendices have been included:

- Figure 1: Site Location Map
- Figure 2: Monitoring Well Location Map
- Table 1: Summary of Well Construction Details
- Table 2: Summary of Slug Test Results
- Appendix A: Rock Core Photographs
- Appendix B: Soil Boring Logs
- Appendix C: Monitoring Well Records
- Appendix D: Monitoring Well Development Records
- Appendix E: Photographs of Completed Well Pairs
- Appendix F: Slug Test Data

Five Type II groundwater monitoring well pairs (a total of 10 wells) were installed between July 26 and August 6, 2010 at the locations shown on Figure 2. The well locations were pre-determined by Duke and marked in the field with wooden stakes and survey flagging. Each well pair consisted of one shallow well (using the identifier “S”) set into overburden soils and one deep well (using the identifier “D) set into bedrock. Standard Penetration Testing (SPT) and split-spoon sampling was performed at five-foot intervals from the surface to bedrock during installation of the deep well at each well pair. Soils observed in the split-spoon samples were logged in the field in accordance with the Unified Soil Classification System (ASTM D2487/D2488). Upon auger refusal, each deep boring was extended a minimum of 10 feet into competent bedrock using HQ-sized rock core techniques.
Rock core samples were logged in the field in accordance with the Field Guide for Rock Core Logging and Fracture Analysis established by Midwest Geosciences. As specified in the Work Summary, split-spoon sampling and rock coring were not performed during installation of the shallow wells. Photographs of rock cores obtained during installation of the five deep wells are included as Appendix A.

Shallow wells were installed using 4.25-inch ID hollow stem augers; deep wells were installed using 4.25-inch ID hollow stem augers to refusal, then HQ-sized rock core approximately 10 feet into competent bedrock. Total depths for shallow wells ranged from 18 feet below ground surface (bgs) in MW-13S to 52 feet bgs in MW-11S. Total depths for bedrock wells ranged from 46.5 feet bgs in MW-13D to 95 feet bgs in MW-12D. Shallow wells were constructed with 15 feet of 0.010-slot 2-inch diameter PVC well screen and riser with well screens set so that 10 feet of screen is below the static water table at the time of installation. Deep wells were constructed with 5-foot well screens set across low-RQD bedrock core intervals in the deep wells to facilitate maximum water flow through each well. Filter sand was placed in the annular space between the augers and the casing from the total depth of the well to approximately 2 feet above the screen. A bentonite seal was placed on top of the filter pack and the well was grouted to the surface. Please note that shallow well depths were typically adjusted after installation, but prior to placement of bentonite, to account for rise in hydraulic head observed at each location. In these instances, additional filter sand was placed between the bottom of the borehole and the bottom of the well. Each well was completed with a stand-up well cover that extends approximately 30 inches above-grade and set into a 2-foot by 2-foot concrete pad. Monitoring well ID tags were secured to the outside of the stand-up covers and well numbers were etched into the wet concrete pad. Soil boring logs and well construction records for the 10 monitoring wells installed in during this work have been included as Appendix B and C, respectively.

Subsequent to installation, each well was developed using a submersible or bladder pump to remove fine-grained material. In general, each well was purged until the development water appeared visually clear, at which time, water quality parameters (temperature, pH, conductivity and turbidity) were recorded in 5-gallon increments until turbidity readings were less than or equal to 10 NTUs. Purge water generated during well development ranged from 60 gallons to 140 gallons and was discharged to the ground surface adjacent to each well. Please note that water quality parameters were not recorded for well MW-12S. However, 140 gallons of water were purged from the well during well development. Monitoring well development records are included as Appendix D. Photographs of the completed monitoring well pairs are included as Appendix E.
Rising head slug tests were performed on each well on August 12 and 13, 2010. Prior to the tests an In-situ Level Troll pressure transducer and 2-foot long stainless steel slug were placed into the well. The water level in the well was recorded as a “Background” test until the well recharged to within 90% of the original measurement. Subsequent to normalization, the rising head test was started, the slug was removed and the change in head versus time was measured using a Rugged-reader data logger. Slug test data was analyzed using Aqtesolv software to estimate hydraulic conductivity in each well. A summary of slug test data is presented in Table 2. Copies of raw data generated during completion of the rising head slug tests are included in Appendix F.

Please contact the undersigned at (704) 357-8600, if you have questions or comments concerning this project.

Sincerely,

MACTEC ENGINEERING AND CONSULTING, INC.

Linda Campbell
Mark P. Filardi, P.G.
Senior Geologist

Enclosures

cc: William M. Miller, PE, PLS, S&ME

For Mark P. Filardi

With Permission

- Site Location

SITE LOCATION MAP
DUKE ENERGY
MARSHALL STEAM STATION
CATAWBA COUNTY, NORTH CAROLINA

PREPARED BY: mFE DATE: 8-20
CHECKED BY: RCF DATE: 5-20-10
JOB NUMBER: 6228-10-5284 FIGURE: 1
MONITORING WELL LOCATIONS
DUKE ENERGY
MARSHALL STEAM STATION
CATAWBA COUNTY, NORTH CAROLINA

TABLES
<table>
<thead>
<tr>
<th>Well Number</th>
<th>Coordinates</th>
<th>Drilling Method</th>
<th>Construction Details</th>
<th>Measured Details</th>
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<tr>
<td></td>
<td>Latitude Longitude</td>
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<td>Well Diameter</td>
<td>Well Depth</td>
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<tr>
<td></td>
<td>(I.D. in.)</td>
<td>Borehole Depth (ft bgs)</td>
<td>Well Depth (ft bgs)</td>
<td>(ft bgs)</td>
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<tr>
<td>MW-105</td>
<td>35°36.36690 80°58.42864</td>
<td>Hollow-stem Auger</td>
<td>2  35.0  27.0</td>
<td>12 - 27</td>
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<tr>
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<td>80.4 - 85.4</td>
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<td>HSA/Rock Core</td>
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<td>HSA/Rock Core</td>
<td>2  60.0  60.0</td>
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ft bgs = feet below ground surface

Prepared by/Date: [Signature]
Checked by/Date: [Signature]
<table>
<thead>
<tr>
<th>Slag Test ID</th>
<th>Test Type</th>
<th>Test Date</th>
<th>Well Diameter (I.D. in.)</th>
<th>Borehole Depth (ft bgs)</th>
<th>Well Depth (ft bgs)</th>
<th>Screen Interval (ft bgs)</th>
<th>Well Depth (ft below TOC)</th>
<th>Depth to Water (ft below TOC)</th>
<th>Water Column Thickness (ft)</th>
<th>TOP of Screen (ft below TOC)</th>
<th>Rising Head Test Results in cm/sec</th>
<th>Average K cm/sec</th>
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<tbody>
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<td>Rising Head</td>
<td>8/16/2010</td>
<td>2</td>
<td>35.0</td>
<td>27.0</td>
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<td>80.4 - 85.4</td>
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<td>37 - 52</td>
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<td>90.5</td>
<td>85.5 - 90.5</td>
<td>93.32</td>
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<td>6.92E-04</td>
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</tbody>
</table>

Notes:
1 - Dagan method applicable to wells screened across the water table.
2 - Barker-Black is a fractured rock method and was not used on saprolite wells.
ft bgs = feet below ground surface
TOC - Top of casing

Prepared by: CHB Date: 8-24-10
Checked by: PC F Date: 8-24-10
APPENDICES
APPENDIX A
ROCK CORE PHOTOGRAPHS
Photo 1: Well MW-10D – Core Run #1 (74.7 – 75.2 ft.)

Photo 2: MW-10D, Core Run #2 (75.2 – 80.4 ft.)
Photo 3: MW-10D, Core Run #2 (75.2 – 80.4 ft.)

Photo 4: MW-10D, Entire Core including Core Run #3 (80.4 – 85.4 ft.)
Photo 5: MW-14D, Core Run #1 (50.0 – 51.3 ft.)

Photo 6: MW-14D, Core Run #2 (51.3 – 56.2 ft.)
Photo 7: MW-14D, Core and Run #3 (56.2 – 60.1 ft.)

Photo 8: MW-11D, Core Run #1 (80.5 – 80.8 ft.)
Photo 9: MW-11D, Core #2 (80.8 – 85.6 ft.)

Photo 10: MW-11D, Core Run #3 (85.6 – 90.6 ft.)
Photo 11: MW-12D, Top of Core Runs #1 (94.0 – 96.2 ft.) and #2 (96.2 – 101.5 ft.)

Photo 12: MW-12D, Bottom of Core Runs #1 (94.0 – 96.2 ft.) and #2 (96.2 – 101.5 ft.)
Photo 13: Top of core Run #3 (101.5 – 106.4 ft.)

Photo 14: Bottom of Core Run #3 (101.5 – 106.4 ft.)
Photo 15: MW-12D, Entire Core

Photo 16: MW-13D, Core Run #1 (36.0 – 40.2 ft.)
Photo 17: MW-13D, Core Run #1 (36.0 – 40.2 ft.) and Top of Core Run #2 (40.2 – 45.1 ft.)

Photo 18: MW-13D, Core Run #2 (40.2 – 45.1 ft.) and top of Core Run #3 (45.1 – 46.4 ft.)
Photo 19: MW-13D, Bottom of Core Run #2 (40.2 – 45.1 ft.)

Photo 20: MW-13D, Entire Core including Run #1 (36.0 – 40.2 ft.), Run #2 (40.2 – 45.1 ft.) and Run #3 (45.1 – 46.4 ft.)
APPENDIX B
SOIL BORING LOGS
SOIL CLASSIFICATION

Red to orange clayey silt (ML); dry.

Tan clay (CH); High silica content

Clay content increase at 6'

Moist at 15'

Boring terminated at 35.0' BGS

REMARKS

DRILLER: Abel McGuire - AE Drilling
EQUIPMENT: CME-750
METHOD: HSA
HOLE DIA.: RVR 8-20-10
REMARKS:

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.
# SOIL CLASSIFICATION

See key symbol sheet for explanation of symbols and abbreviations below.

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Elevation (ft)</th>
<th>Legend</th>
<th>Samples</th>
<th>Remarks</th>
</tr>
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<tbody>
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<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
<td>SS-1</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td></td>
<td></td>
<td>SS-2</td>
<td>Micaceous; Quartz mineral banding (9.5'-10.0')</td>
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<td>20</td>
<td></td>
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<td>SS-3</td>
<td>Micaceous; Mafic mineral banding (14'-15')</td>
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<tr>
<td>25</td>
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<td>SS-4</td>
<td>Micaceous; Coarse quartz sand (19'-20')</td>
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<td>30</td>
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<td>SS-5</td>
<td>Flowing sand (22'-23')</td>
</tr>
<tr>
<td>35</td>
<td></td>
<td></td>
<td>SS-6</td>
<td>Quartz banding with trace Fe stained gravel</td>
</tr>
<tr>
<td>40</td>
<td></td>
<td></td>
<td>SS-7</td>
<td>Vertical quartz band with Fe staining from 29.5'-30.0'</td>
</tr>
<tr>
<td>45</td>
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<td></td>
<td>SS-8</td>
<td>Coarse quartz sand (39.5'-40.0') - possible top of PWR</td>
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<tr>
<td>50</td>
<td></td>
<td></td>
<td>SS-9</td>
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# SOIL TEST BORING RECORD

**PROJECT:** Duke Energy Marshall Steam Station  
**WELL ID:** MW-10D  
**PROJ. NO.:** 6228-10-5284  
**REMARKS:**

This record is a reasonable interpretation of subsurface conditions at the exploration location. Subsurface conditions at other locations and at other times may differ. Transitions between strata may be gradual.
SOIL CLASSIFICATION

SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.

Yellow (10YR 7/6) clayey sand (SC)

Brownish yellow (10YR 6/8) clayey sand (SC)

Very dark grayish brown (2.5Y 3/2) PWR

Yellow (10YR 7/8) PWR

Brownish yellow (10YR 6/8) clayey sand (SC)

Olive yellow (2.4Y 6/6) PWR

Biotite Gneiss; strong, light gray (10YR 7/1) ecodized, gneissic, laminated, slightly disintegrated, unfractured, conformable

Biotite Gneiss; very weak, dark reddishbrown (5YR 3/4), gneissic, laminated, moderately disintegrated, moderately to intensely fractured; 60% - hard drilling

Boring terminated at 85.5' BGS

SAMPLES

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<tr>
<th>IDENT</th>
<th>TYPE</th>
<th>1st 6'</th>
<th>2nd 6'</th>
<th>3rd 6'</th>
<th>N-COUNT</th>
<th>REMARKS</th>
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<tr>
<td>SS-10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1-3-3</td>
<td>Subvertical quartz banding and Fe staining throughout</td>
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<tr>
<td>SS-11</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3-5-7</td>
<td>Coarse quartz sand and abundant Fe staining</td>
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<tr>
<td>SS-12</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>7-14-19</td>
<td>Biotite layering (60'); Fe staining</td>
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<td>SS-13</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10-22-27</td>
<td>Quartz, biotite, k-feldspar</td>
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<td>SS-14</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5-10-17</td>
<td>Quartz, mica, trace Fe staining</td>
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<tr>
<td>SS-15</td>
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<td>50/2</td>
<td></td>
<td></td>
<td></td>
<td>Refusal at 75.0'</td>
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<td>RC-16</td>
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<td></td>
<td></td>
<td>RQD: 0%</td>
<td>Fracture zone (76.4'-76.5')</td>
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<td>RC-17</td>
<td></td>
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<td>RQD: 24%</td>
<td>Shear zones (76.8', 77.15')</td>
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<td>RC-18</td>
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<td></td>
<td>RQD: 28%</td>
<td>Brief H2O loss (79.0'-79.6')</td>
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<tr>
<td>RC-18</td>
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<td></td>
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<td>Hard drilling (80.9')</td>
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DRILLER: Abel McGuire - AE Drilling
EQUIPMENT: CME-750
METHOD: HSA/NQ Rock Core
HOLE DIA:
REMARKS: Rcf 8/20/10

SOIL TEST BORING RECORD

PROJECT: Duke Energy Marshall Steam Station
WELL ID: MW-10D
PROJ. NO.: 6228-10-5284

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.
SOIL CLASSIFICATION

SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.

Red (2.5YR 5/8) clayey silt (ML)

Yellow (2.5YR 3/6) to light yellowish brown (2.5Y 6/3) silty fine sand (SM)

Yellow (10YR 5/8) to light gray (10YR 7/2) clayey fine sand (SW)

REMARKS

Dry

Increasing mica content

Moist at 45' BGW

SOIL TEST BORING RECORD

PROJECT: Duke Energy Marshall Steam Station
WELL ID: MW-11S
PROJ. NO.: 6228-10-5284

July 30, 2010

DRILLER: Abel McGuire - AE Drilling
EQUIPMENT: CME-750
METHOD: HSA
HOLE DIA.:
REMARKS: RCF 5/30/10

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.
**SOIL CLASSIFICATION**

SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.

- Yellow (10YR 5/8) to light gray (10YR 7/2) clayey fine sand (SW)

**SAMPLERS**

<table>
<thead>
<tr>
<th>ELEV (ft)</th>
<th>TYPE</th>
<th>1st 6&quot;</th>
<th>2nd 6&quot;</th>
<th>3rd 6&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**REMARKS**

Boring terminated at 55' BGS

---

**SOIL TEST BORING RECORD**

**PROJECT:** Duke Energy Marshall Steam Station  
**WELL ID:** MW-11S  
**PROJ. NO.:** 6228-10-5284  
**DATE:** July 30, 2010

**DRILLER:** Abel McGuire - AE Drilling  
**EQUIPMENT:** CME-750  
**METHOD:** HSA  
**HOLE DIA.:**  
**REMARKS:** QOF 8/20/10

**NOTE:** THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.
### Soil Classification

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Soil Description</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Red (2.5YR 5/8) clayey silt (ML)</td>
<td>Some mica, dry</td>
</tr>
<tr>
<td>10</td>
<td>Yellow (2.5YR 8/6) fine sand (SW)</td>
<td>Dry; thinly laminated with quartz and Fe stained bands</td>
</tr>
<tr>
<td>15</td>
<td>Light yellowish brown (2.5Y 6/3) silty fine sand (SM)</td>
<td>Micaceous</td>
</tr>
<tr>
<td>20</td>
<td>Yellow (10YR 7/8) clayey fine sand (SC)</td>
<td>Some gravel sized white clay (19.5'-20.0')</td>
</tr>
<tr>
<td>25</td>
<td>Micaceous</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>Increasing secondary mineralization (white clay)</td>
<td>Increasing Fe staining</td>
</tr>
<tr>
<td>35</td>
<td>Micaceous</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>Moist at 40.0'</td>
<td></td>
</tr>
</tbody>
</table>

### Soil Test Boring Record

- **Project:** Duke Energy Marshall Steam Station
- **Well ID:** MW-11D
- **Date:** July 29, 2010
- **Project No.:** 6228-10-5284

---

**Note:** This record is a reasonable interpretation of subsurface conditions at the exploration location. Subsurface conditions at other locations and at other times may differ. Transitions between strata may be gradual.
### Soil Classification

**See Key Symbol Sheet for Explanation of Symbols and Abbreviations Below.**

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Legend</th>
<th>Soil Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>45</td>
<td></td>
<td>Yellow (10YR 7/8) clayey fine sand (SC)</td>
</tr>
<tr>
<td>50</td>
<td></td>
<td>Gray (7.5YR 5/1) clayey medium to fine sand (SC) with quartz gravel</td>
</tr>
<tr>
<td>55</td>
<td></td>
<td>Light gray (10YR 7/2) fine sand (SW); thinly laminated</td>
</tr>
<tr>
<td>60</td>
<td></td>
<td>Quartz Schist; weak, bluish black (Gley 2 2.5/10B), schistose, laminated, moderately decomposed, slightly disintegrated, moderately fractured</td>
</tr>
<tr>
<td>65</td>
<td></td>
<td>Strong, black (Gley 1 2.5/N), gneissic, thinly bedded, slightly decomposed, slightly disintegrated, moderately fractured</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Samples</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS-10</td>
<td>Water dripping from spoon</td>
</tr>
<tr>
<td>SS-11</td>
<td>Some Fe staining</td>
</tr>
<tr>
<td>SS-12</td>
<td>Light gray (10YR 7/1); PWR; foliated (69.5'-70.0')</td>
</tr>
<tr>
<td>SS-13</td>
<td>Refusal at 80.5' DGS</td>
</tr>
<tr>
<td>SS-14</td>
<td>Hard drilling from 80.8'-84.3'; easier to 85.8'</td>
</tr>
<tr>
<td>SS-15</td>
<td>Bedding plane fractures every 0.1'-0.2' inches from 81.2'-81.9'</td>
</tr>
<tr>
<td>SS-16</td>
<td>Bedding plane fractures with Fe staining at 85.9', 87.5' and 89.7'</td>
</tr>
<tr>
<td>SS-17</td>
<td>Fracture zones at 86.1'-86.5', 86.9'-87.1' and 88.0'-88.2'</td>
</tr>
<tr>
<td>SS-18</td>
<td>Near horizontal joints at 86.4', 86.7', 86.9', 87.6', 88.4', 89.2' and 89.3'</td>
</tr>
</tbody>
</table>

### Soil Test Boring Record

**Project:** Duke Energy Marshall Steam Station  
**Well ID:** MW-11D  
**PROJ. NO.:** 6228-10-5284  
**REMARKS:**  

---

*THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.*

---

**DRILLER:** Abel McGuire - AE Drilling  
**EQUIPMENT:** CME-750  
**METHOD:** HSA/NQ Rock Core  
**HOLE DIA.:**  
**REMARKS:**  

---

**DATE:** July 29, 2010  
**PAGE:** 2 OF 3
SOIL CLASSIFICATION

SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.

Boring terminated at 90.6 BGS

SOIL TEST BORING RECORD

PROJECT: Duke Energy Marshall Steam Station
WELL ID: MW-11D
PROJ. NO.: 6228-10-5284

July 29, 2010

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.
### SOIL CLASSIFICATION

**SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.**

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Elevation (ft)</th>
<th>Type</th>
<th>Sample Count</th>
<th>Remarks</th>
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</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td>Light red (2.5YR 6/6) clayey silt (ML)</td>
<td></td>
<td>Dry</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>Yellow (10YR 7/8) clay silt (ML)</td>
<td></td>
<td>Dry, trace gravel</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>Yellowish brown (10YR 5/6) silty clay (CL)</td>
<td></td>
<td>Water on augers at 26'</td>
</tr>
<tr>
<td>30</td>
<td></td>
<td>Boring terminated at 40.0' BGS</td>
<td></td>
<td>Moist</td>
</tr>
<tr>
<td>40</td>
<td></td>
<td></td>
<td></td>
<td>Wet at 38'</td>
</tr>
</tbody>
</table>

**REMARKS:**

- Dry
- Dry, trace gravel
- Water on augers at 26'
- Moist
- Wet at 38'

**SOIL TEST BORING RECORD**

**PROJECT:** Duke Energy Marshall Steam Station  
**WELL ID:** MW-12S  
**PROJ. NO.:** 6228-10-5284  
**August 3, 2010**

**DRILLER:** Abel McGuire - AE Drilling  
**EQUIPMENT:** CME-750  
**METHOD:** HSA  
**HOLE DIA.:**  
**REMARKS:**

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.
<table>
<thead>
<tr>
<th>DEPTH (ft)</th>
<th>SAMPLES</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>SS-1</td>
<td>Dry, layered, hard</td>
</tr>
<tr>
<td>10</td>
<td>SS-2</td>
<td>3-6-15</td>
</tr>
<tr>
<td>15</td>
<td>SS-3</td>
<td>5-8-12</td>
</tr>
<tr>
<td>20</td>
<td>SS-4</td>
<td>5-6-11</td>
</tr>
<tr>
<td>25</td>
<td>SS-5</td>
<td>Some Fe staining</td>
</tr>
<tr>
<td>30</td>
<td>SS-6</td>
<td>Soft at 22.0'</td>
</tr>
<tr>
<td>35</td>
<td>SS-7</td>
<td>Coarse sand to gravel-sized K-feldspar (24.5'-24.6')</td>
</tr>
<tr>
<td>40</td>
<td>SS-8</td>
<td>Wet at 32.0'</td>
</tr>
<tr>
<td>45</td>
<td>SS-9</td>
<td>Coarse sand to gravel (20.5'-20.6')</td>
</tr>
<tr>
<td></td>
<td></td>
<td>White clay (K-feldspar) band (35.0')</td>
</tr>
<tr>
<td></td>
<td></td>
<td>37.0' - 40.0' rig bouncing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Abundant Fe staining</td>
</tr>
</tbody>
</table>

**SOIL TEST BORING RECORD**

**PROJECT:** Duke Energy Marshall Steam Station  
**WELL ID:** MW-12D

August 3, 2010

**PROJ. NO.:** 6228-10-5284  
**PAGE 1 OF 3**

**DRILLER:** Abel McGuire - AE Drilling  
**EQUIPMENT:** CME-750  
**METHOD:** HSA/NQ Rock Core  
**HOLE DIA.:**  
**REMARKS:**

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.
## Soil Classification

See key symbol sheet for explanation of symbols and abbreviations below.

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Sample</th>
<th>Type</th>
<th>1st 6&quot;</th>
<th>2nd 6&quot;</th>
<th>3rd 6&quot;</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>SS-10</td>
<td>X</td>
<td>25-50/4</td>
<td></td>
<td></td>
<td>Abundant Fe staining</td>
</tr>
<tr>
<td>50</td>
<td>SS-11</td>
<td>X</td>
<td>13-22-25</td>
<td></td>
<td></td>
<td>Rig bouncing at 50.0'</td>
</tr>
<tr>
<td>55</td>
<td>SS-12</td>
<td>X</td>
<td>6-7-13</td>
<td></td>
<td></td>
<td>Fe-stained zone (59.3-59.7)</td>
</tr>
<tr>
<td>60</td>
<td>SS-13</td>
<td>X</td>
<td>5-10-13</td>
<td></td>
<td></td>
<td>Abundant Fe staining</td>
</tr>
<tr>
<td>65</td>
<td>SS-14</td>
<td>X</td>
<td>20-32-35</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>70</td>
<td>SS-15</td>
<td>X</td>
<td>30-50/4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>75</td>
<td>SS-16</td>
<td>X</td>
<td>14-50/4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>80</td>
<td>SS-17</td>
<td>X</td>
<td>50/3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>85</td>
<td>SS-18</td>
<td>X</td>
<td>50/4</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Driller:** Abe McGuire - AE Drilling  
**Equipment:** CME-750  
**Method:** HSA/NQ Rock Core  
**Remarks:** *This record is a reasonable interpretation of subsurface conditions at the exploration location. Subsurface conditions at other locations and at other times may differ. Transitions between strata may be gradual.*  

---

**Soil Test Boring Record**  
**Project:** Duke Energy Marshall Steam Station  
**Well ID:** MW-12D  
**Proj. No.:** 6228-10-5284  
**Page 2 of 3**

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**MACTEC**
SOIL CLASSIFICATION

SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.

Variagated white (10YR 8/1) to yellow (10YR 7/8) partially weathered granite

Granite, strong, dark gray (Gleyt 4/N) phaneritic, massive, slightly foliated, slightly decomposed (94.0' to 95.6') to fresh (95.6' to 96.2'), competent, slightly fractured

Foliated Granite: weak, dark gray (Gleyt 4/N), Gneissic, foliated, moderately decomposed, disintegrated, unfractured Chlortite Mica Schist: strong, very dark gray (Gleyt 3/N), shistose, laminated, fresh, competent, unfractured

Boring terminated at 105.4' BGS

REF

REMARKS

SS-19
RC-20
RC-21
RC-22

50/2
RQD: 59%
RQD: 77%
RQD: 69%

Refusal at 94.0' BGS
Bedding plane fracture with Fe staining (95.1')
**SOIL CLASSIFICATION**

SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.

<table>
<thead>
<tr>
<th>DEPTH (ft)</th>
<th>SEMI-LEGEND</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Red (2.5YR 3/8) silt (ML)</td>
<td>Dry</td>
</tr>
<tr>
<td>5</td>
<td>Brownish yellow (10YR 6/6) silty clay (CL)</td>
<td>Dry</td>
</tr>
<tr>
<td>10</td>
<td>Very pale brown (10YR 7/2) medium sand (SP) with gravel</td>
<td>Moist</td>
</tr>
<tr>
<td>15</td>
<td>Light olive brown (2.5Y 5/3) clayey sand (SC)</td>
<td>Dry</td>
</tr>
<tr>
<td>20</td>
<td>Light olive brown (2.5Y 5/3) sandy clay (CL) Boring terminated at 25.5' BDS</td>
<td>Wet, flowing</td>
</tr>
</tbody>
</table>

**SAMPLES**

<table>
<thead>
<tr>
<th>ELEV (ft)</th>
<th>IDENT</th>
<th>TYPE</th>
<th>1st 6'</th>
<th>2nd 6'</th>
<th>3rd 6'</th>
<th>N-COUNT</th>
<th>REMARKS</th>
</tr>
</thead>
</table>

**SOIL TEST BORING RECORD**

PROJECT: Duke Energy Marshall Steam Station

WELL ID: MW-13S

PROJ. NO.: 6228-10-5284

August 6, 2010

DRILLER: Abel McGuire - AE Drilling

EQUIPMENT: CME-750

METHOD: HSA

HOLE DIA.: RGF 8/20/10

REMARKS: THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.
<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Sample</th>
<th>Identification</th>
<th>Type</th>
<th>1st 6&quot;</th>
<th>2nd 6&quot;</th>
<th>3rd 6&quot;</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>SS-1</td>
<td>X</td>
<td></td>
<td>5-6-8</td>
<td></td>
<td></td>
<td>Dry</td>
</tr>
<tr>
<td>10</td>
<td>SS-2</td>
<td>X</td>
<td></td>
<td>-4-15</td>
<td></td>
<td></td>
<td>Moist to wet</td>
</tr>
<tr>
<td>15</td>
<td>SS-3</td>
<td>X</td>
<td>3-4-5</td>
<td></td>
<td></td>
<td></td>
<td>Spoon impeded by quartz gravel (approx. 4 cm); wet</td>
</tr>
<tr>
<td>20</td>
<td>SS-4</td>
<td>X</td>
<td>6-22-32</td>
<td></td>
<td></td>
<td></td>
<td>Hard at 24.0'</td>
</tr>
<tr>
<td>25</td>
<td>SS-5</td>
<td>X</td>
<td>50/4</td>
<td></td>
<td></td>
<td></td>
<td>Flowing sand 27.0'-28.0'</td>
</tr>
<tr>
<td>30</td>
<td>SS-6</td>
<td>X</td>
<td>12-11-15</td>
<td></td>
<td></td>
<td></td>
<td>Quartz banding (29.2')</td>
</tr>
<tr>
<td>35</td>
<td>SS-7</td>
<td>X</td>
<td>50/4</td>
<td></td>
<td></td>
<td></td>
<td>Water in hole</td>
</tr>
<tr>
<td>40</td>
<td>RC-8</td>
<td>X</td>
<td>RQD: 20%</td>
<td></td>
<td></td>
<td></td>
<td>Some Fe staining</td>
</tr>
<tr>
<td>45</td>
<td>RC-9</td>
<td>X</td>
<td>RQD: 13%</td>
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<td></td>
<td></td>
<td>Refusal at 36.0' BGS</td>
</tr>
</tbody>
</table>

This record is a reasonable interpretation of subsurface conditions at the exploration location. Subsurface conditions at other locations and at other times may differ. Transitions between strata may be gradual.

Driller: Abel McGuire - AE Drilling
Equipment: CME-750
Method: HSA/NQ Rock Core
Hole Dia.: RQF 8’/3’

SOIL TEST BORING RECORD

Project: Duke Energy Marshall Steam Station
Well ID: MW-13D

August 4, 2010

6228-10-5284
**SOIL CLASSIFICATION**

**SAMPLES**

<table>
<thead>
<tr>
<th>IDENT</th>
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<th>2nd 6&quot;</th>
<th>3rd 6&quot;</th>
<th>N-COUNT</th>
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<tbody>
<tr>
<td>RC-10</td>
<td>RQD</td>
<td>0%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Boring terminated at 46.6' BGS

---

**SOIL TEST BORING RECORD**

**PROJECT:** Duke Energy Marshall Steam Station  
**WELL ID:** MW-13D  
**PROJ. NO.:** 6228-10-5284  
**August 4, 2010**

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.
SOIL CLASSIFICATION

SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.

Red (2.5YR 5/8) silty sand (SM)

Light brownish yellow (10YR 6/4) silty sand (SM)

DRILLER: Abel McGuire - AE Drilling
EQUIPMENT: CME-750
METHOD: HSA
HOLE DIA.: REMARKS:

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.
### Soil Classification

SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.

- **Light brownish yellow (10YR 6/4) silty sand (SM)**
- **Boring terminated at 49.0' BGS**

### Samples

<table>
<thead>
<tr>
<th>ELEV (ft)</th>
<th>IDENT</th>
<th>TYPE</th>
<th>1st 6&quot;</th>
<th>2nd 6&quot;</th>
<th>3rd 6&quot;</th>
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**Driller:** Abd McGuire - AE Drilling  
**Equipment:** CME-750  
**Method:** HSA  
**Hole Dia.:** RUF 8/2010  
**Remarks:**

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

**Project:** Duke Energy Marshall Steam Station  
**Well ID:** MW-14S  
**Proj. No.:** 6228-10-5284  
**Page 2 of 2**
SOIL CLASSIFICATION

SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.

Red (2.5YR 5/8) silty sand (SM)

Light brownish yellow (10YR 6/4) silty sand (SM)

Gray (Gley 1 5/N) granite rock (RK)

Light yellowish brown (2.5Y 6/4) sand with quartz gravel (SP)

SAMPLES

<table>
<thead>
<tr>
<th>IDENT</th>
<th>TYPE</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS-1</td>
<td>4-5-6</td>
<td>Dry</td>
</tr>
<tr>
<td>SS-2</td>
<td>2-3-4</td>
<td>Micaceous, dry</td>
</tr>
<tr>
<td>SS-3</td>
<td>2-4-4</td>
<td>Trace coarse-grained quartz banding and Fe-staining; dry</td>
</tr>
<tr>
<td>SS-4</td>
<td>4-5-6</td>
<td>Quartz and mafic min banding from 29.8'-30.0'</td>
</tr>
<tr>
<td>SS-5</td>
<td>6-11-12</td>
<td>Coarse-grained to gravel sized quartz and mafic banding (34.5'-35.0')</td>
</tr>
<tr>
<td>SS-6</td>
<td>9-16-20</td>
<td>Fe-stained, weathered</td>
</tr>
<tr>
<td>SS-7</td>
<td>11-20-27</td>
<td></td>
</tr>
<tr>
<td>SS-8</td>
<td>11-25-36</td>
<td></td>
</tr>
<tr>
<td>SS-9</td>
<td>50/4</td>
<td></td>
</tr>
</tbody>
</table>

DRILLER: Abel McGuire - AE Drilling
EQUIPMENT: CME-750
METHOD: HSA/NQ Rock Core
HOLE DIA.: 10" RWP 8.60 ft

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.
SOIL CLASSIFICATION

SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.

LEGEND

DEPTH

ELEV

SAMPLES

ID

TYPE

N-COUNT

REMARKS

Gray (Gley 5/N) granite rock (RK)

54

60

Biotite gneiss: bluish gray (Gley 2.5/1), strong, gneissic, laminated, slightly decomposed, slightly disintegrated, moderately fractured

Granite, white (5YR 8/1) moderate strength, Fe-staining, coarse grained, laminated, moderately decomposed, moderately disintegrated, unfractured

White (5YR 8/1), weak, abundant Fe-staining, gneissic, intensely foliated, intensely disintegrated, intensely fractured

Boring terminated at 60.1' BGS

SS-10

29-50/3

RC-11

RC-12

RC-13

Chlorite vein at 48.7'

Refusal at 50.0' BGS

Bedding plan joint at 50.25', 50.45', 50.9', 51.15' (45°)

Shear at 50.35' with Fe-staining

Fracture zone at 52.0'-52.4'

Bedding plane foliation infilled with quartz

Joints with Fe-staining at 52.2'-52.5'

Fe-stained joint at 53.6'

Joint at 53.75'

Healed bedding plane joint at 57.6' infilled with quartz

Joint with Fe-staining at 58.6'

Joint with Fe-staining at 58.8'

DRILLER: Abel McGuire - AE Drilling
EQUIPMENT: CME-750
METHOD: HSA/NQ Rock Core
HOLE DIA.: RRF 8/20/10

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.
APPENDIX C

MONITORING WELL RECORDS
## Remarks:

**d. Top of Casing is 3 ft. Above Land Surface**

*Top of casing terminated at or below land surface may require a variance in accordance with 15A NCAC 2C.0118.

**e. Yield (gpm):**

METHOD OF TEST: "f//"

**f. Disinfection:** Type "1//7-

Amount "A Z-"

**g. Water Zones (depth):**

<table>
<thead>
<tr>
<th>Thickness/</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Top</td>
<td>Bottom</td>
</tr>
<tr>
<td>Top</td>
<td>Bottom</td>
</tr>
<tr>
<td>Top</td>
<td>Bottom</td>
</tr>
</tbody>
</table>

### Casing: Depth Diameter Weight Material

<table>
<thead>
<tr>
<th>Top 0</th>
<th>Bottom 12 ft. 21 in. 0.125 PVC.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top</td>
<td>Bottom</td>
</tr>
<tr>
<td>Top</td>
<td>Bottom</td>
</tr>
</tbody>
</table>

### Grout: Depth Material Method

<table>
<thead>
<tr>
<th>Top 0</th>
<th>Bottom 9 ft. Concrete Lime</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top</td>
<td>Bottom</td>
</tr>
</tbody>
</table>

### Screen: Depth Diameter Slot Size Material

<table>
<thead>
<tr>
<th>Top 12 ft.</th>
<th>Bottom 27 ft. 2 in.</th>
<th>10 in. NC.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top</td>
<td>Bottom</td>
<td></td>
</tr>
<tr>
<td>Top</td>
<td>Bottom</td>
<td></td>
</tr>
</tbody>
</table>

### Sand/Gravel Pack: Depth Size Material

<table>
<thead>
<tr>
<th>Top 10 ft.</th>
<th>Bottom 27 ft. #1 Sand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top</td>
<td>Bottom</td>
</tr>
</tbody>
</table>

### Drilling Log

<table>
<thead>
<tr>
<th>Top 01 27</th>
<th>Bottom 89 1422</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top</td>
<td>Bottom</td>
</tr>
</tbody>
</table>

### Remarks:

I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15A NCAC 2C, well construction standards, and that a copy of this record has been provided to the well owner.

SIGNATURE OF CERTIFIED WELL CONTRACTOR DATE

PRINTED NAME OF PERSON CONSTRUCTING THE WELL

Submit the original to the Division of Water Quality within 30 days. Attn: Information Mgt., 1617 Mail Service Center – Raleigh, NC 27699-1617 Phone No. (919) 807-6300
1. WELL CONTRACTOR:

A E DRILLING SERVICES, LLC

Well Contractor Company Name

Two United Way

City or Town SC 29607

Street Address Greenville

City or Town State Zip Code

(864) 288-1986 Area code Phone number

2. WELL INFORMATION:

WELL CONSTRUCTION PERMIT #

OTHER ASSOCIATED PERMIT # (if applicable)

SITE WELL ID # (if applicable)

3. WELL USE (Check One Box) Monitoring □ Municipal/Public □
   Industrial/Commercial □ Agricultural □ Recovery □ Injection □
   Irrigation □ Other □ (list use)

DATE DRILLED 7-27-10

4. WELL LOCATION:

(City or Town, State, Zip Code)

CITY: Greenville

COUNTY: SC

TOPOGRAPHIC / LAND SETTING: (check appropriate box)
   □ Slope □ Valley □ Flat □ Ridge □ Other

LATITUDE 35° 35.484' N 35° 35.484' DMS OR 35.5983333333° D D

LONGITUDE 83° 28.07' W 83° 28.07' DMS OR 83.467777777° W

Latitude/longitude source: □ GPS □ Topographic map

(location of well must be shown on a USGS topo map and attached to this form if not using GPS)

5. FACILITY (Name of the business where the well is located.)

Facility Name: Marshall Storm Station

Street Address: 8320 East NC Highway 150

City or Town: Greenville

State Zip Code: 29612

Contact Name: Jim Lunnquist

Mailing Address:

City or Town: Greenville

State Zip Code: 29607

(864) 473-1622 Area code Phone number

6. WELL DETAILS:

MW-10 D

a. TOTAL DEPTH: 85.5'

b. DOES WELL REPLACE EXISTING WELL? YES □ NO □

c. WATER LEVEL Below Top of Casing: 16.23' FT.
   (Use ** if Above Top of Casing)

7. CASING:

Top Bottom Diameter Weight Material

Top Bottom Fl Fl ml ml

8. GROUT:

Top Bottom Material Method

Top Bottom Ft Ft ml

9. SCREEN:

Top Bottom Diameter Slot Size Material

Top Bottom Fl fl In

Top Bottom Fl fl In

10. SAND/GRAVEL PACK:

Top Bottom Size Material

Top Bottom Ft

11. DRILLING LOG:

Formation Description

Top Bottom

0 1 75

12. REMARKS:

I hereby certify that this well was constructed in accordance with 15A NCAC 2C, WELL CONSTRUCTION STANDARDS, and that a copy of this record has been provided to the well owner.

Signature of Certified Well Contractor: Abel McGwire

Printed Name of Person Constructing the Well: Abel McGwire

Submit the original to the Division of Water Quality within 30 days. Attn: Information Mgmt., 1617 Mail Service Center - Raleigh, NC 27699-1817 Phone No. (919) 807-6300

Form GW-1b

Rev. 11/08
# NonResidential Well Construction Record

**North Carolina Department of Environment and Natural Resources - Division of Water Quality**

**WELL CONTRACTOR CERTIFICATION # 3571**

## 1. WELL CONTRACTOR:

- **Facility Name:** A E DRILLING SERVICES, LLC
- **Street Address:** Two United Way
- **City or Town:** Greenville
- **State:** SC
- **Zip Code:** 29607
- **Area code Phone number:** (864) 288-1986

## 2. WELL INFORMATION:

### 2.1. WELL CONSTRUCTION PERMIT#

### 2.2. OTHER ASSOCIATED PERMIT# (if applicable)

### 2.3. SITE WELL ID # (if applicable)

## 3. WELL USE (Check One Box)

- Monitoring
- Municipal/Public
- Industrial/Commercial
- Agricultural
- Recovery
- Injection
- Irrigation
- Other (list use)

### 3.3. DATE DRILLED:

- 7-10-10

## 4. WELL LOCATION:

- **CITY:** AFS
- **COUNTY:** Green
- **TOPOGRAPHIC / LAND SETTING:** Topo
- **GPS:**

## 5. FACILITY (Name of the business where the well is located.)

### 5.1. Contact Name:

### 5.2. Mailing Address:

### 6. WELL DETAILS:

### 6.1. TOTAL DEPTH:

- 35' 35/55

### 6.2. DOES WELL REPLACE EXISTING WELL?

- Yes

### 6.3. WATER LEVEL Below Top of Casing:

- 43.77 FT.

### 6.4. TOP OF CASING IS

- 3' FT. Above Land Surface

### 6.5. TOP OF CASING TERMINATED AT OR BELOW LAND SURFACE MAY REQUIRE A VARIANCE IN ACCORDANCE WITH 15A NCAC 2C .01.18.

### 6.6. YIELD (gpm):

### 6.7. METHOD OF TEST:

### 6.8. DISINFECTION:

- Type:
- Method:

### 6.9. WATER ZONES (depth):

<table>
<thead>
<tr>
<th>Top</th>
<th>Bottom</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 6.10. Casing:

<table>
<thead>
<tr>
<th>Depth</th>
<th>Diameter</th>
<th>Thickness/Weight</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top</td>
<td>Bottom</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 6.11. Grout:

<table>
<thead>
<tr>
<th>Depth</th>
<th>Material</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top</td>
<td>Bottom</td>
<td></td>
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<td></td>
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</tbody>
</table>

### 6.12. Screen:

<table>
<thead>
<tr>
<th>Depth</th>
<th>Diameter</th>
<th>Slot Size</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top</td>
<td>Bottom</td>
<td></td>
<td></td>
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<td></td>
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<td></td>
</tr>
</tbody>
</table>

### 6.13. Sand/Gravel Pack:

<table>
<thead>
<tr>
<th>Depth</th>
<th>Size</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top</td>
<td>Bottom</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 6.14. Drilling Log:

### 6.15. Remarks:

- I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15A NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

### 6.16. SIGNATURE OF CERTIFIED WELL CONTRACTOR:

- Date: 8-7-10
1. WELL CONTRACTOR:

Well Contractor (Individual) Name
A E DRILLING SERVICES, LLC
Well Contractor Company Name
Two United Way
Street Address
Greenville, SC 29607
Area code Phone number

2. WELL INFORMATION: MNL-110

WELL CONSTRUCTION PERMIT# (if applicable)
OTHER ASSOCIATED PERMIT# (if applicable)
SITE WELL ID# (if applicable)

3. WELL USE (Check One Box) Monitoring □ Municipal/Public □ Industrial/Commercial □ Agricultural □ Recovery □ Injection □ Irrigation □ Other □ (list use)

DATE DRILLED 7-30-10

4. WELL LOCATION:

MARS HILL STATION

CITY: Terrell COUNTY: Catawba

TOPOGRAPHIC / LAND SETTING: (check appropriate box)
□ Slope □ Valley □ Flat □ Ridge □ Other

LATITUDE 35° 34' 41.79" N DMS OR 35.XXXXXXXX DD
LONGITUDE 80° 58' 7.1380" W DMS OR 80.XXXXXXXX DD

Latitude/longitude source: [GPS] Topographic map (location of well must be shown on a USGS topo map and attached to this form if not using GPS)

5. FACILITY (Name of the business where the well is located.)

Facility Name
Mars Hill Station
Facility ID# (if applicable)

Street Address
8330 East NC Highway 150
City or Town: Terrell, NC 28682

Contact Name
Jim Longmuir
Mailing Address

Area code Phone number

6. WELL DETAILS: MNL-110

a. TOTAL DEPTH: 90.6'

b. DOES WELL REPLACE EXISTING WELL? YES □ NO □

c. WATER LEVEL Below Top of Casing: 43.40 FT.
(Use "+" if Above Top of Casing)

7. CASING: Depth Diameter Thickness/ Material

Top 85.6 Bottom 68.6 Ft. 2" 0.10 PVC

8. GROUT: Depth Material Method

Top & Bottom 815' Portland Cement Trimix

9. SCREEN: Depth Diameter Slot Size Material

Top 85.6 Bottom 90.6' Ft. 2" 10 in. 8x.40 PVC

10. SAND/GRAVEL PACK: Depth Size Material

Top 80.5 Bottom 90.6' Ft. #2 Sand

11. DRILLING LOG

Form GW-1b
Rev. 11/08
Submit the original to the Division of Water Quality within 30 days. Attn: Information Mgt., 1817 Mail Service Center – Raleigh, NC 27699-1817 Phone No. (919) 807-6300

12. REMARKS:

I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15A NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

SIGNED CERTIFIED WELL CONTRACTOR

PRINTED NAME OF PERSON CONSTRUCTING THE WELL

Form GW-1b
Rev. 11/08
Submit the original to the Division of Water Quality within 30 days. Attn: Information Mgt., 1817 Mail Service Center – Raleigh, NC 27699-1817 Phone No. (919) 807-6300

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PRINTED NAME OF PERSON CONSTRUCTING THE WELL

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SIGNED CERTIFIED WELL CONTRACTOR

PRINTED NAME OF PERSON CONSTRUCTING THE WELL

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12. REMARKS:

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SIGNED CERTIFIED WELL CONTRACTOR

PRINTED NAME OF PERSON CONSTRUCTING THE WELL

Submit the original to the Division of Water Quality within 30 days. Attn: Information Mgt., 1817 Mail Service Center – Raleigh, NC 27699-1817 Phone No. (919) 807-6300
**Non Residential Well Construction Record**

North Carolina Department of Environment and Natural Resources - Division of Water Quality

**Well Contractor Certification #** 5571

1. **Well Contractor:**

   **Well Contractor (Individual) Name:** Abel McQuire

   **Well Contractor Company Name:** A E Drilling Services, LLC

   **Two United Way**

   **Street Address:** Greenville SC 29607

   **City or Town**

   **State**

   **Zip Code**

   **Area code Phone number:** (864) 288-1986

2. **Well Information:**

   **Well Construction Permit#:**

   **Other Associated Permit# (if applicable):**

   **Site Well ID# (if applicable):**

3. **Well Use (Check One Box):**

   - Monitoring
   - Municipal/Public
   - Industrial/Commercial
   - Agricultural
   - Recovery
   - Injection
   - Irrigation
   - Other

   **Date Drilled:** 8-4-10

4. **Well Location:**

   **Facility Name:** Marshall Steam Station

   **Facility ID# (if applicable):**

   **Street Address:** 8330 East N.C. Highway 180

   **City or Town:** Raleigh NC 27682

   **Contact Name:**

   **Mailing Address:**

   **Area code Phone number:** (919) 807-6300

5. **Well Details:**

   **Well Details:** NW - 125

   **Total Depth:** 40' 1/4"

   **Does Well Replace Existing Well?** Yes

   **Water Level Below Top of Casing:** 14.28 ft.

   **Top of Casing:** 3' Above Land Surface

   **Yield (gpm):** 100

   **Method of Test:** 15A NCAC 2C

   **Disinfection:**

   - Type: Non-Residential
   - Amount: 100

   **Water Zones (depth):**

   **Casing:**

   **Depth**

   **Diameter**

   **Weight**

   **Material:**

   **Grout:**

   **Depth**

   **Material**

   **Method:**

   **Screen:**

   **Depth**

   **Diameter**

   **Slot Size**

   **Material:**

   **Sand/Gravel Pack:**

   **Depth**

   **Size**

   **Material:**

   **Drilling Log:**

   **Formation Description:**

   **Remarks:**

   I do hereby certify that this well was constructed in accordance with 15A NCAC 2C, Well Construction Standards, and that a copy of this record has been provided to the well owner.

   **Signature of Certified Well Contractor:**

   **Date:** 8-4-10

   **Printed Name of Person Constructing the Well:**

Submit the original to the Division of Water Quality within 30 days. Attn: Information Mgt, 1617 Mall Service Center - Raleigh, NC 27699-1517 Phone No. (919) 807-6300

Form GW-1b
Rev. 11/08
# NON RESIDENTIAL WELL CONSTRUCTION RECORD

North Carolina Department of Environment and Natural Resources - Division of Water Quality

WELL CONTRACTOR CERTIFICATION # 357

## 1. WELL CONTRACTOR:

**Name:** A E DRILLING SERVICES, LLC

**Company Name:** Two United Way

**Address:**
- Greenville, SC 29607

**Phone Number:** (864) 288-1986

## 2. WELL INFORMATION:

**Permit Information:**
- **Well Construction Permit #:**
- **Other Associated Permit #:**

**Site:**
- **Well ID #:**

## 3. WELL USE:

- **Monitoring:**
- **Municipal/Public:**
- **Industrial/Commercial:**
- **Agricultural:**
- **Recovery:**
- **Injection:**
- **Irrigation:**
- **Other:**

**Date Drilled:** I-3-k

## 4. WELL LOCATION:

**Location:**
- **Street Name:**
- **Numbers:**
- **Community:**
- **Subdivision/Lot No.:**
- **Zip Code:**

**City:**
**County:**

**Topographic/Land Setting:**
- Slope
- Valley
- Flat
- Ridge
- Other

**Latitude/Longitude:**
- **Latitude:** 35° 36' 44.9395" DMS or 35.612988 DD
- **Longitude:** 80° 48' 31.0088" DMS or 80.80831 DD

**Latitude/Longitude Source:**
- NGPS
- Topographic map

## 5. FACILITY:

**Name:** Marshall Steam Station

**Address:**
- **Street:** 8320 East N.C. Highway 150
- **City:** Tarlton, N.C.
- **State:** SC
- **Zip Code:** 28682

**Contact Name:** Jim Luehring

**Mailing Address:**
- **City:**
- **State:**
- **Zip Code:**

## 6. WELL DETAILS:

### a. TOTAL DEPTH:
- 90'

### b. DOES WELL REPLACE EXISTING WELL?
- Yes

### c. WATER LEVEL Below Top of Casing:
- 15.21 ft

## 7. CASING:

**Depth:**
- **Top:**
- **Bottom:**

**Diameter:**
- **Top:**
- **Bottom:**

**Weight:**
- **Top:**
- **Bottom:**

**Material:**
- **Top:**
- **Bottom:**

## 8. GROUT:

**Depth:**
- **Top:**
- **Bottom:**

**Material:**
- **Top:**
- **Bottom:**

**Method:**
- **Top:**
- **Bottom:**

## 9. SCREEN:

**Depth:**
- **Top:**
- **Bottom:**

**Diameter:**
- **Top:**
- **Bottom:**

**Slot Size:**
- **Top:**
- **Bottom:**

**Material:**
- **Top:**
- **Bottom:**

## 10. SAND/GRAVEL PACK:

**Depth:**
- **Top:**
- **Bottom:**

**Size:**
- **Top:**
- **Bottom:**

**Material:**
- **Top:**
- **Bottom:**

## 11. DRILLING LOG:

**Formation:**
- **Top:**
- **Bottom:**

**Description:**
- **Top:**
- **Bottom:**

## 12. REMARKS:

**Signature of Certified Well Contractor:**

**Date:** 8-4-10

**Printed Name of Person Constructing the Well:**

Submit the original to the Division of Water Quality within 30 days. Attn: Information Mgt., 1817 Mali Service Center, Raleigh, NC 27699-1517. Phone No. (919) 807-6300

Form GW-1b
Rev. 11/08
1. WELL CONTRACTOR:
   A E DRILLING SERVICES, LLC
   Two United Way
   Greenville, SC  29607

2. WELL INFORMATION:
   WELL CONSTRUCTION PERMIT:
   OTHER ASSOCIATED PERMIT:
   SITE WELL ID:

3. WELL USE (Check One Box) Monitoring ○ Municipal/Public ○ Industrial/Commercial ○ Agricultural ○ Recovery ○ Injection ○ Irrigation ○ Other ○ (list use)
   DATE DRILLED: 6/4/04

4. WELL LOCATION:
   CITY: Greenville
   COUNTY: Greenville
   TOPOGRAPHIC/LAND SETTING: Flat
   LATITUDE: 35° 36' 54.75" N
   LONGITUDE: 84° 35' 26.25" W
   LAT/Long source: GPS

5. FACILITY (Name of the business where the well is located.)
   Facility Name: Marshall Steam Station
   Facility ID#: 8220 East N.C. Highway 150
   Street Address: 8220 East N.C. Highway 150
   City or Town: Greenville
   State: SC
   Zip Code: 29607

6. WELL DETAILS: M-13.5
   a. TOTAL DEPTH: 25'
   b. DOES WELL REPLACE EXISTING WELL? YES ○ NO
   c. WATER LEVEL Below Top of Casing: 5.70 FT.

7. CASING: Depth Diameter Thickness Weight Material
   Top 0 Bottom 3' 11" 0.10 PVC
   Top 0 Bottom 3' 11" 0.10 PVC

8. GROUT: Depth Material Method
   Top 0 Bottom 1' 6 in. cement
   Top 0 Bottom 1' 6 in. cement

9. SCREEN: Depth Diameter Slot Size Material
   Top 3' Bottom 18' 2.5 in. 10 in. PVC

10. SAND/GRAVEL PACK: Depth Size Material
    Top 2' Bottom 25' 1 in. Sand

11. DRILLING LOG
    Formation Description

12. REMARKS:
    I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15A NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.
    Signature of Certified Well Contractor
    Date: 8-7-10

PRINTED NAME OF PERSON CONSTRUCTING THE WELL

Submit the original to the Division of Water Quality within 30 days. Attn: Information Mgr., 1617 Mail Service Center – Raleigh, NC 27699-1617 Phone No. (919) 807-6500

Form GW-1b
Rev. 11/08
**NonResidential Well Construction Record**

North Carolina Department of Environment and Natural Resources - Division of Water Quality

**WELL CONTRACTOR CERTIFICATION**

I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15A NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS REGISTRATION HAS BEEN PROVIDED TO THE WELL OWNER.

**PRINTED NAME OF PERSON CONSTRUCTING THE WELL**  
Abel McGuire

**WEll CONTRACTOR CERTIFICATION**

A E DRILLING SERVICES, LLC

Two United Way  
Greenville, SC 29607

**WELL INFORMATION**

Well Contractor Company Name  
A E DRILLING SERVICES, LLC

**WELL CONTRACTOR**

Abel McGuire

**WELL CONTRACTOR NAME**

A E DRILLING SERVICES, LLC

**WELL CONTRACTOR COMPANY NAME**

Two United Way  
Greenville, SC 29607

**ADDRESS**

(864) 288-1986

**PHONE NUMBER**

WELL CONTRACTOR CERTIFICATION

# 7/357

**WELL CONTRACTOR CERTIFICATION NUMBER**

1. WELL CONTRACTOR:

Abel McGuire

2. WELL INFORMATION:

WELL CONSTRUCTION PERMIT#

OTHER ASSOCIATED PERMIT# (if applicable)

SITE WELL ID# (if applicable)

3. WELL USE (Check One Box)

- Monitoring
- Municipal/Public
- Industrial/Commercial
- Agricultural
- Recovery
- Injection
- Irrigation
- Other

4. WELL LOCATION:

Marshall Steam Station

5. FACILITY (Name of the business where the well is located.)

Terrell, N.C. 28682

6. WELL DETAILS:

a. TOTAL DEPTH: 46.6'

b. DOES WELL REPLACE EXISTING WELL? YES □ NO □

c. WATER LEVEL Below Top of Casing: 3.59 FT.

7. CASING:

<table>
<thead>
<tr>
<th>Depth</th>
<th>Diameter</th>
<th>Weight</th>
<th>Material</th>
</tr>
</thead>
<tbody>
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8. GROUT:

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<th>Method</th>
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<tr>
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9. SCREEN:

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<th>Slot Size</th>
</tr>
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</tr>
<tr>
<td>Top</td>
<td>Bottom</td>
<td>2'</td>
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</table>

10. SAND/GRAVEL PACK:

<table>
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<th>Depth</th>
<th>Size</th>
<th>Material</th>
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<tbody>
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11. DRILLING LOG:

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12. REMARKS:

I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15A NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

Abel McGuire

SIGNATURE OF CERTIFIED WELL CONTRACTOR DATE 8-20-10

PRINTED NAME OF PERSON CONSTRUCTING THE WELL

Submit the original to the Division of Water Quality within 30 days. Attn: Information Mgt., 1817 Mail Service Center – Raleigh, NC 27699-1617. Phone No. (919) 807-6300

Form GW-1b
Rev. 11/08
## Non Residential Well Construction Record

North Carolina Department of Environment and Natural Resources - Division of Water Quality

WELL CONTRACTOR CERTIFICATION

### 1. WELL CONTRACTOR:

**AAA**

Well Contractor (Individual) Name

**A E DRILLING SERVICES, LLC**

Well Contractor Company Name

**Two United Way**

Street Address

Greenville, SC 29607

City or Town State Zip Code

### 2. WELL INFORMATION:

**WELL CONSTRUCTION PERMIT**

**OTHER ASSOCIATED PERMIT**

**SITE WELL ID**

### 3. WELL USE (Check One Box)

- Municipal/Public
- Industrial/Commercial
- Agricultural
- Recovery
- Injection
- Irrigation
- Other

Date Drilled: 7-29-10

### 4. WELL LOCATION:

(city, state, zip code)

**CITY:**

**COUNTY:**

TOPOGRAPHIC / LAND SETTING:

- Slope
- Valley
- Flat
- Ridge
- Other

Latitude: 35° 36’ 34.10” DMS or 35.609444444 D

Longitude: 80° 0’ 20.92” DMS or 80.005666666 D

Latitude/longitude source: EPS 30 Topographic map

### 5. FACILITY (Name of the business where the well is located.)

**Facility Name:**

**830 East N.C. Highway 60**

**Street Address:**

**Terrell, N.C. 28682**

**City or Town State Zip Code**

**Contact Name**

**Mailing Address**

### 6. WELL DETAILS: MW-140

**TOTAL DEPTH:** 601’

**DOES WELL REPLACE EXISTING WELL?**

- Yes
- No

**WATER LEVEL Below Top of Casing:** 366.98’

(Use “+” if Above Top of Casing)

### 7. CASING: Depth Diameter Thickness/ Weight Material

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<th>Ft.</th>
<th>In.</th>
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### 8. GROUT: Depth Material Method

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### 9. SCREEN: Depth Diameter Slot Size Material

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### 10. SAND/GRAVEL PACK: Depth Size Material

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### 11. DRILLING LOG

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<th>Bottom</th>
<th>Formation Description</th>
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</table>

### 12. REMARKS:

I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15A NCAC 2C. WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

**Signature of Certified Well Contractor:**

**Date:** 8-4-10

**Printed Name of Person Constructing the Well:**

Submit the original to the Division of Water Quality within 30 days. Attn: Information Mgt., 1617 Mail Service Center – Raleigh, NC 27699-1817 Phone No. (919) 807-6300

Form GW-1b

Rev. 11/08
**Non-Residential Well Construction Record**

North Carolina Department of Environment and Natural Resources - Division of Water Quality

**Well Construction Certification #** 3571

1. **Well Contractor:**
   - **Name:** Abi McGuire
   - **Company:** AE Drilling Services, LLC
   - **Address:** Two United Way
   - **City:** Greenville
   - **State:** SC
   - **Zip Code:** 29607
   - **Area Code:** 864
   - **Phone Number:** 288-1986

2. **Well Information:**
   - **Well Construction Permit #**
   - **Other Associated Permit #**
   - **Site Well ID #**

3. **Well Use (Check One Box):**
   - **Monitoring**
   - **Municipal/Public**
   - **Industrial/Commercial**
   - **Agricultural**
   - **Recovery**
   - **Injection**
   - **Irrigation**
   - **Other**

4. **Well Location:**
   - **Street Name:** Marshall Steam Station
   - **City:** Terrel
   - **State:** NC
   - **Zip Code:** 28682
   - **Contact Name:** Jim Langston
   - **Mailing Address:**
   - **City or Town:**
   - **State:**
   - **Zip Code:**
   - **Area Code:** 864
   - **Phone Number:** 478-7622

5. **Well Details:**
   - **Total Depth:** 49 ft
   - **Does Well Replace Existing Well?** Yes
   - **Water Level Below Top of Casing:** 38.75 ft

6. **Top of Casing:** 3 ft above land surface

7. **Casing:**
   - **Material:** PVC
   - **Thickness:** 0.10 in

8. **Grout:**
   - **Material:** Cement
   - **Method:** Injection

9. **Screen:**
   - **Material:** PVC

10. **Sand/Gravel Pack:**
    - **Material:** Sand

11. **Drilling Log:**
    - **Formation Description:**

12. **Remarks:**
    - **Signature of Certified Well Contractor:**
    - **Date:** 8-4-10

Printed Name of Person Constructing the Well: Abi McGuire

Submit the original to the Division of Water Quality within 30 days. Attn: Information Mgr., 1617 Mail Service Center - Raleigh, NC 27699-1617. Phone No. (919) 807-6300

Form GW-1b
Rev. 11/08
APPENDIX D
MONITORING WELL DEVELOPMENT RECORDS
**MONITORING WELL SAMPLING FIELD DATA WORKSHEET**

**MACTEC PROJECT NUMBER** 6228-10-5284  **MONITORING WELL NUMBER** MW-14D  
**SITE NAME** Duke Marshall Steam Station  **DATE**  
**FIELD PERSONNEL** Mark Filardi  **TIME OF SAMPLE** N/A  
**WEATHER CONDITIONS**

**TOTAL WELL DEPTH (TWD)** 62.85  **FT** (measured well tag / drillers log – circle one)  
**SCREENED INTERVAL** 55-60 bgs  **MEASURING POINT FOR DEPTH** Top of casing  
**DEPTH TO GROUNDWATER (DGW)** 36.98  
**LENGTH OF WATER COLUMN (LWC) = TWD – DGW =** 25.87  
**CASING DIAMETER** 2 IN.  
**ONE STANDING WELL VOLUME =** 4.22 gal.  
(NOTE ½” = 0.0102G/FT; ¾” = 0.023 G/FT; 1” = 0.041 G/FT; 2” = 0.163 G/FT; 4” = 0.653 G/FT; 6” = 1.46 G/FT)  
**THREE STANDING WELL VOLUMES =** 12.65  **FIVE STANDING WELL VOLUMES =** 21.10  
**METHOD OF WELL EVACUATION:** BAILER / PUMP / OTHER:  
**TYPE**  
**TOTAL VOLUME OF WATER REMOVED:** 70 GAL.  
**WELL TYPE:** FLUSH MOUNT / ABOVE GRADE  
**COMMENTS**  
No sample collected/purged for development only  

<table>
<thead>
<tr>
<th>Time</th>
<th>Volume</th>
<th>pH</th>
<th>Temp (°C)</th>
<th>Cond. (µS/cm)</th>
<th>Dis. O₂ (mg/L)</th>
<th>Turbidity (NTU)</th>
<th>ORP (mV)</th>
<th>Notes</th>
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</table>
MONITORING WELL SAMPLING FIELD DATA WORKSHEET

MACTEC PROJECT NUMBER 6228-10-5284 MONITORING WELL NUMBER MW-13S
SITE NAME Duke Marshall Steam Station DATE ______________ TIME OF SAMPLE N/A
FIELD PERSONNEL Mark Filardi WEATHER CONDITIONS ______________

TOTAL WELL DEPTH (TWD) 21.12 FT (measured well tag / drillers log – circle one)
SCREENED INTERVAL 3-18 bgs. MEASURING POINT FOR DEPTH Top of casing
DEPTH TO GROUNDWATER (DGW) 5.70
LENGTH OF WATER COLUMN (LWC) = TWD – DGW = 15.42
CASING DIAMETER 2 IN.
ONE STANDING WELL VOLUME = 2.51 gal.
(NOTE ½” = 0.0102 G/FT; ¾” = 0.023 G/FT; 1” = 0.041 G/FT; 2” = 0.163 G/FT; 4” = 0.653 G/FT; 6” = 1.46 G/FT)
THREE STANDING WELL VOLUMES = 7.54 FIVE STANDING WELL VOLUMES = 12.55
METHOD OF WELL EVACUATION: BAILER PUMP OTHER: TYPE ______________
TOTAL VOLUME OF WATER REMOVED: 60 GAL.
WELL TYPE: FLUSH MOUNT ABOVE GRADE
COMMENTS ______________
LOCKING CAP YES X NO ______________ No sample collected/purged for
PROTECTIVE POST/ABUTMENT YES NO X ______________ development only
NONPOTABLE LABEL YES X NO ______________
ID PLATE YES X NO ______________
WELL INTEGRITY SATISFACTORY YES X NO ______________
WELL YIELD LOW MODERATE HIGH X

<table>
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<th>Time</th>
<th>Volume</th>
<th>pH</th>
<th>Temp (°C)</th>
<th>Cond. (µS/cm)</th>
<th>Dis. O₂ (mg/L)</th>
<th>Turbidity (NTU)</th>
<th>ORP (mV)</th>
<th>Notes</th>
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MONITORING WELL SAMPLING FIELD DATA WORKSHEET

MACTEC PROJECT NUMBER 6228-10-5284 MONITORING WELL NUMBER MW-13D
SITE NAME Duke Marshall Steam Station DATE N/A TIME OF SAMPLE N/A
FIELD PERSONNEL Mark Filardi WEATHER CONDITIONS

TOTAL WELL DEPTH (TWD) 48.61 FT. measured: well tag / drillers log – circle one
SCREENED INTERVAL 41.5-46.5 bgs MEASURING POINT FOR DEPTH Top of Casing
DEPTH TO GROUNDWATER (DGW) 3.59
LENGTH OF WATER COLUMN (LWC) = TWD – DGW = 45.02
CASING DIAMETER 2 IN.
ONE STANDING WELL VOLUME = 7.34 gal.
(NOTE ½" = 0.0102G/FT: ¾" = 0.023 G/FT: 1" = 0.041G/FT: 2" = 0.163 G/FT: 4" = 0.653 G/FT: 6" = 1.46 G/FT)
THREE STANDING WELL VOLUMES = 22.01 FIVE STANDING WELL VOLUMES = 36.70
METHOD OF WELL EVACUATION: BAILER, PUMP OTHER: TYPE
TOTAL VOLUME OF WATER REMOVED: 85 GAL.
WELL TYPE: FLUSH MOUNT ABOVE GRADE COMMENTS
LOCKING CAP YES X NO No sample collected/purged for development only
PROTECTIVE POST/ABUTMENT YES NO X NONPOTABLE LABEL YES X NO
ID PLATE YES X NO
WELL INTEGRITY SATISFACTORY YES X NO
WELL YIELD LOW MODERATE HIGH X

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<tr>
<th>Time</th>
<th>Volume</th>
<th>pH</th>
<th>Temp (°C)</th>
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MONITORING WELL SAMPLING FIELD DATA WORKSHEET

MACTEC PROJECT NUMBER 6228-10-5284

MONITORING WELL NUMBER MW-12S

SITE NAME Duke Marshall Steam Station

DATE

TIME OF SAMPLE N/A

FIELD PERSONNEL Mark Filardi

WEATHER CONDITIONS

TOTAL WELL DEPTH (TWD) 25.32 FT (measured - well tag / drillers log – circle one)

SCREENED INTERVAL 7-22 MEASURING POINT FOR DEPTH Top of casing

DEPTH TO GROUNDWATER (DGW) 14.28

LENGTH OF WATER COLUMN (LWC) = TWD – DGW = 11.04

CASING DIAMETER 2 IN.

ONE STANDING WELL VOLUME = 1.80 gal.

(NOTE ½" = 0.0102G/FT; ¾" = 0.023 G/FT; 1" = 0.041G/FT; 2" = 0.163 G/FT; 4" = 0.653 G/FT; 6" = 1.46 G/FT)

THREE STANDING WELL VOLUMES = 5.40 FIVE STANDING WELL VOLUMES = 9.00

METHOD OF WELL EVACUATION: BAILER PUMP OTHER: TYPE

TOTAL VOLUME OF WATER REMOVED: GAL.

WELL TYPE: FLUSH MOUNT ABOVE GRADE

COMMENTS No sample collected/purged for development only

LOCKING CAP YES X NO 

PROTECTIVE POST/ABUTMENT YES NO X

NONPOTABLE LABEL YES X NO

ID PLATE YES X NO

WELL INTEGRITY SATISFACTORY YES X NO

WELL YIELD LOW MODERATE HIGH X

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MONITORING WELL SAMPLING FIELD DATA WORKSHEET

MACTEC PROJECT NUMBER_ 6228-10-5284_ MONITORING WELL NUMBER_ MW-12D_

SITE NAME_ Duke Marshall Steam Station_ DATE_ TIME OF SAMPLE_ N/A

FIELD PERSONNEL_ Mark Filardi_ WEATHER CONDITIONS_

TOTAL WELL DEPTH (TWD) 98.59 FT (measured tag / drillers log – circle one)

SCREENED INTERVAL 90-95 ft MEASURING POINT FOR DEPTH Top of casing

DEPTH TO GROUNDWATER (DGW) 15.21

LENGTH OF WATER COLUMN (LWC) = TWD – DGW = 83.38

Casing Diameter 2 IN.

ONE STANDING WELL VOLUME = 13.59 gal.

(Note ½" = 0.0102G/FT; ¾" = 0.023 G/FT; 1" = 0.041G/FT; 2" = 0.163 G/FT; 4" = 0.653 G/FT; 6" = 1.46 G/FT)

THREE STANDING WELL VOLUMES = 40.77 FIVE STANDING WELL VOLUMES = 67.95

METHOD OF WELL EVACUATION: BAILER, PUMP OTHER: TYPE_

TOTAL VOLUME OF WATER REMOVED: 85 GAL.

WELL TYPE: FLUSH MOUNT ABOVE GRADE

LOCKING CAP YES X NO_ COMMENTS_ No sample collected/purged for development only

PROTECTIVE POST/ABUTMENT YES _ NO _ X

NONPOTABLE LABEL YES _ X _ NO

ID PLATE YES _ X _ NO

WELL INTEGRITY SATISFACTORY YES _ X _ NO

WELL YIELD LOW _ MODERATE _ HIGH _ X

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TOTAL WELL DEPTH (TWD) 54.38 FT (measured well tag / drillers log – **circle one**)
SCREENED INTERVAL 37-52 bgs
MEASURING POINT FOR DEPTH Top of casing
DEPTH TO GROUNDWATER (DGW) 43.77
LENGTH OF WATER COLUMN (LWC) = TWD – DGW = 10.61
CASING DIAMETER 2 IN.
ONE STANDING WELL VOLUME = 1.73 gal.
(NOTE ½" = 0.0102G/FT; ¾" = 0.023 G/FT; 1" = 0.041G/FT; 2" = 0.163 G/FT; 4" = 0.653 G/FT; 6" = 1.46 G/FT)
THREE STANDING WELL VOLUMES = 5.19
FIVE STANDING WELL VOLUMES = 8.65
METHOD OF WELL EVACUATION: BAILEY/PUMP/OTHER: TYPE
TOTAL VOLUME OF WATER REMOVED: 60 GAL.
WELL TYPE: FLUSH MOUNT **ABOVE GRADE**
LOCKING CAP YES X NO
PROTECTIVE POST/ABUTMENT YES X NO
NONPOTABLE LABEL YES X NO
ID PLATE YES X NO
WELL INTEGRITY SATISFACTORY YES X NO
WELL YIELD LOW MODESTE MODERATE HIGH X

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COMMENTS
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No sample collected/purged for development only.

Notes
MONITORING WELL SAMPLING FIELD DATA WORKSHEET

MACTEC PROJECT NUMBER 6228-10-5284 MONITORING WELL NUMBER MW-11D

SITE NAME Duke Marshall Steam Station DATE N/A TIME OF SAMPLE N/A

FIELD PERSONNEL Mark Filardi WEATHER CONDITIONS

TOTAL WELL DEPTH (TWD) 93.32 FT. measured / well tag / drillers log – circle one

SCREENED INTERVAL 85.5-90.5 bgs MEASURING POINT FOR DEPTH Top of casing

DEPTH TO GROUNDWATER (DGW) 43.40’

LENGTH OF WATER COLUMN (LWC) = TWD – DGW = 49.92’

CASING DIAMETER 2 IN.

ONE STANDING WELL VOLUME = 8.14 gal.

(NOTE ½” = 0.0102G/FT; ¾” = 0.023 G/FT; 1” = 0.041G/FT; 2” = 0.163 G/FT; 4” = 0.653 G/FT; 6” = 1.46 G/FT)

THREE STANDING WELL VOLUMES = 24.41 FIVE STANDING WELL VOLUMES = 40.70

METHOD OF WELL EVACUATION: BAILER / PUMP / OTHER: TYPE

TOTAL VOLUME OF WATER REMOVED: 60 GAL.

WELL TYPE: FLUSH MOUNT ABOVE GRADE

LOCKING CAP YES X NO COMMENTS No sample collected/purged for development only

PROTECTIVE POST/ABUTMENT YES X NO

NONPOTABLE LABEL YES X NO

ID PLATE YES X NO

WELL INTEGRITY SATISFACTORY YES X NO

WELL YIELD LOW MODERATE X HIGH

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MONITORING WELL SAMPLING FIELD DATA WORKSHEET

MACTEC PROJECT NUMBER 6228-10-5284 MONITORING WELL NUMBER MW-10S
SITE NAME Duke Marshall Steam Station DATE N/A
FIELD PERSONNEL Mark Filardi WEATHER CONDITIONS

TOTAL WELL DEPTH (TWD) 29.44 FT. (measured / well tag / drillers log = circle one)
SCREENED INTERVAL 12-27 bgs MEASURING POINT FOR DEPTH top of casing
DEPTH TO GROUNDWATER (DGW) 16.64 below TOC
LENGTH OF WATER COLUMN (LWC) = TWD - DGW = 12.80
CASING DIAMETER 2 IN.
ONE STANDING WELL VOLUME = 2.09 gal.
(NOTE ½" = 0.0102G/FT; ¾" = 0.023 G/FT; 1" = 0.041G/FT; 2" = 0.163 G/FT; 4" = 0.653 G/FT; 6" = 1.46 G/FT)
THREE STANDING WELL VOLUMES = 6.26 FIVE STANDING WELL VOLUMES = 10.45

METHOD OF WELL EVACUATION: BAILER / PUMP / OTHER: TYPE
TOTAL VOLUME OF WATER REMOVED: 60 GAL.
WELL TYPE: FLUSH MOUNT / ABOVE GRADE

LOCKING CAP PROTECTIVE POST/ABUTMENT NONPOTABLE LABEL ID PLATE WELL INTEGRITY SATISFACTORY
YES X NO YES X NO YES X NO YES X NO

WELL YIELD LOW MODERATE HIGH X

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COMMENTS

No sample collected/purged for development only
MACTEC ENGINEERING AND CONSULTING, INC.

MONITORING WELL SAMPLING FIELD DATA WORKSHEET

MACTEC PROJECT NUMBER 6228-10-5284 MONITORING WELL NUMBER MW-10D

SITE NAME Duke Marshall Steam Station DATE __________ TIME OF SAMPLE N/A
FIELD PERSONNEL Mark Filardi WEATHER CONDITIONS ____________________________________________________________

TOTAL WELL DEPTH (TWD) 87.69 FT (measured from well tag / drillers log – circle one)
SCREENED INTERVAL 80.4 – 85.4 bgs MEASURING POINT FOR DEPTH Top of casing
DEPTH TO GROUNDWATER (DGW) 16.23
LENGTH OF WATER COLUMN (LWC) = TWD – DGW = 71.46
CASING DIAMETER __2__ IN.

ONE STANDING WELL VOLUME = 11.65 gal.
(NOTE ½” = 0.0102G/FT; ¾” = 0.023 G/FT; 1”= 0.041G/FT; 2” = 0.163 G/FT; 4” = 0.653 G/FT; 6” = 1.46 G/FT)
THREE STANDING WELL VOLUMES = 39.94 FIVE STANDING WELL VOLUMES = 58.25

METHOD OF WELL EVACUATION: BAILER / PUMP / OTHER: TYPE _______________
TOTAL VOLUME OF WATER REMOVED = 80 GAL.

WELL TYPE: FLUSH MOUNT ABOVE GRADE

LOCKING CAP YES X NO ________________ COMMENTS ____________________
PROTECTIVE POST/ABUTMENT YES ____ NO ____ X ________________
NONPOTABLE LABEL YES X NO ________________
ID PLATE YES X NO ________________
WELL INTEGRITY SATISFACTORY YES X NO ________________

WELL YIELD LOW ____ MODERATE ____ HIGH ____ X ________________

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MACTEC ENGINEERING AND CONSULTING, INC.

MONITORING WELL SAMPLING FIELD DATA WORKSHEET

MACTEC PROJECT NUMBER  6228-10-5284  MONITORING WELL NUMBER  MW-14S
SITE NAME  Duke Marshall Steam Station  DATE  TIME OF SAMPLE  N/A
FIELD PERSONNEL  Mark Filardi  WEATHER CONDITIONS 

TOTAL WELL DEPTH (TWD)  47.13 FT (measured well tag / drillers log – circle one)
SCREENED INTERVAL  28-43 bgs MEASURING POINT FOR DEPTH  Top of casing
DEPTH TO GROUNDWATER (DGW)  36.36
LENGTH OF WATER COLUMN (LWC) = TWD – DGW = 10.77
CASING DIAMETER  2 IN.

ONE STANDING WELL VOLUME = 1.76 gal.
(NOTE ¾" = 0.0102G/FT; ¾" = 0.023 G/FT; 1" = 0.041G/FT; 2" = 0.163 G/FT; 4" = 0.653 G/FT; 6" = 1.46 G/FT)
THREE STANDING WELL VOLUMES = 5.27 FIVE STANDING WELL VOLUMES = 8.80

METHOD OF WELL EVACUATION:  BAILEY PUMP  OTHER:  TYPE 
TOTAL VOLUME OF WATER REMOVED:  90 GAL.
WELL TYPE:  FLUSH MOUNTABLE  ABOVE GRADE

LOCKING CAP  YES  X  NO
PROTECTIVE POST/ABUTMENT  YES  NO  X
NONPOTABLE LABEL  YES  X  NO
ID PLATE  YES  X  NO
WELL INTEGRITY SATISFACTORY  YES  X  NO

WELL YIELD  LOW  MODERATE  HIGH  X

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<th>Temp (°C)</th>
<th>Cond. (μS/cm)</th>
<th>Dis. O₂ (mg/L)</th>
<th>Turbidity (NTU)</th>
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COMMENTS  No sample collected/purged for development only
APPENDIX E
PHOTOGRAPHS OF COMPLETED WELL PAIRS
Photo 1: Well pair MW-13S (Right) and MW-13D (Left)

Photo 2: Well pair MW-12S (Right) and MW-12D (Left)
Photo 3: Well pair MW-14S (Left) and MW-14D (Right)

Photo 4: Well pair MW-11S (Left) and MW-11D (Right)
Photo 5: Well pair MW-10S (Right) and MW-10D (Left)
APPENDIX F
SLUG TEST DATA
RISING HEAD TEST

PROJECT INFORMATION

Company: MACTEC
Client: Duke Energy
Project: 6228-10-5284
Location: Marshall Steam Station
Test Well: MW-14S
Test Date: 8/16/2010

AQUIFER DATA

Saturated Thickness: 10.77 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-14S)

Initial Displacement: 1.06 ft
Total Well Penetration Depth: 10.77 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 10.77 ft
Screen Length: 10.77 ft
Well Radius: 0.26 ft
Gravel Pack Porosity: 0.28

SOLUTION

Aquifer Model: Unconfined
Solution Method: Dagan
\[ K = 0.0008911 \text{ cm/sec} \]
\[ y_0 = 0.5161 \text{ ft} \]
RISING HEAD TEST

PROJECT INFORMATION

Company: MACTEC
Client: Duke Energy
Project: 6228-10-5284
Location: Marshall Steam Station
Test Well: MW-14S
Test Date: 8/16/2010

AQUIFER DATA

Saturated Thickness: 10.77 ft
Anisotropy Ratio (Kz/Kr): 1

WELL DATA (MW-14S)

Initial Displacement: 1.06 ft
Total Well Penetration Depth: 10.77 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 10.77 ft
Screen Length: 10.77 ft
Well Radius: 0.26 ft
Gravel Pack Porosity: 0.28

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.0009566 cm/sec
y0 = 0.6086 ft
## PROJECT INFORMATION

Company: MACTEC  
Client: Duke Energy  
Project: 6228-10-5284  
Location: Marshall Steam Station  
Test Well: MW-14D  
Test Date: 8/16/2010

## AQUIFER DATA

Saturated Thickness: 25.87 ft  
Anisotropy Ratio (Kz/Kr): 1.

## WELL DATA (MW-14D)

| Initial Displacement: 1.111 ft | Static Water Column Height: 25.87 ft |
| Total Well Penetration Depth: 25.87 ft | Screen Length: 5. ft |
| Casing Radius: 0.0833 ft | Well Radius: 0.157 ft |
| Gravel Pack Porosity: 0.28 |

## SOLUTION

| Aquifer Model: Unconfined | Solution Method: Hvorslev |
| K = 0.0006479 cm/sec | y0 = 0.8376 ft |
RISING HEAD TEST

PROJECT INFORMATION

Company: MACTEC
Client: Duke Energy
Project: 6228-10-5284
Location: Marshall Steam Station
Test Well: MW-14D
Test Date: 8/16/2010

AQUIFER DATA

Saturated Thickness: 25.87 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-14D)

Initial Displacement: 1.111 ft
Total Well Penetration Depth: 25.87 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 25.87 ft
Screen Length: 5. ft
Well Radius: 0.157 ft
Gravel Pack Porosity: 0.28

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.0006015 cm/sec
y0 = 0.9218 ft
RISING HEAD TEST

PROJECT INFORMATION

Company: MACTEC
Client: Duke Energy
Project: 6228-10-5284
Location: Marshall Steam Station
Test Well: MW-13S
Test Date: 8/16/2010

AQUIFER DATA

Saturated Thickness: 15.42 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-13S)

Initial Displacement: 0.954 ft
Total Well Penetration Depth: 15.42 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 15.42 ft
Screen Length: 15. ft
Well Radius: 0.26 ft
Gravel Pack Porosity: 0.28

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev
K = 0.0002725 cm/sec
y₀ = 0.4048 ft
RISING HEAD TEST

PROJECT INFORMATION

Company: MACTEC
Client: Duke Energy
Project: 6228-09-5100
Location: Marshall Steam Station
Test Well: MW-13S
Test Date: 8/16/2010

AQUIFER DATA

Saturated Thickness: 15.42 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-13S)

Initial Displacement: 0.954 ft
Total Well Penetration Depth: 15.42 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 15.42 ft
Screen Length: 15 ft
Well Radius: 0.0833 ft
Gravel Pack Porosity: 0.28

SOLUTION

Aquifer Model: Unconfined
Solution Method: Dagan
K = 7.376E-5 cm/sec
y0 = 0.4439 ft
**RISING HEAD TEST**

**PROJECT INFORMATION**

Company: MACTEC  
Client: Duke Energy  
Project: 6228-10-5284  
Location: Marshall Steam Station  
Test Well: MW-13S  
Test Date: 8/16/2010

**AQUIFER DATA**

Saturated Thickness: 15.42 ft  
Anisotropy Ratio (Kz/Kr): 1.

**WELL DATA (MW-13S)**

Initial Displacement: 0.954 ft  
Total Well Penetration Depth: 15.42 ft  
Casing Radius: 0.0833 ft  
Static Water Column Height: 15.42 ft  
Screen Length: 15. ft  
Well Radius: 0.26 ft  
Gravel Pack Porosity: 0.28

**SOLUTION**

Aquifer Model: Unconfined  
Solution Method: Bouwer-Rice  
$K = 0.0002399 \text{ cm/sec}$  
$y_0 = 0.5024 \text{ ft}$
**RISING HEAD TEST**

**PROJECT INFORMATION**

- **Company:** MACTEC
- **Client:** Duke Energy
- **Project:** 6228-10-5284
- **Location:** Marshall Steam Station
- **Test Well:** MW-13D
- **Test Date:** 8/16/2010

**AQUIFER DATA**

- **Saturated Thickness:** 45.02 ft
- **Anisotropy Ratio (Kz/Kr):** 1.

**WELL DATA (MW-13D)**

- **Initial Displacement:** 0.837 ft
- **Total Well Penetration Depth:** 45.02 ft
- **Casing Radius:** 0.0833 ft
- **Static Water Column Height:** 45.02 ft
- **Screen Length:** 5 ft
- **Well Radius:** 0.157 ft
- **Gravel Pack Porosity:** 0.28

**SOLUTION**

- **Aquifer Model:** Unconfined
- **Solution Method:** Hvorslev
- **K:** 0.0007045 cm/sec
- **y0:** 0.5309 ft
RISING HEAD TEST

PROJECT INFORMATION

Company: MACTEC
Client: Duke Energy
Project: 6228-10-5284
Location: Marshall Steam Station
Test Well: MW-13D
Test Date: 8/16/2010

AQUIFER DATA

Saturated Thickness: 45.02 ft
Anisotropy Ratio (Kz/Kr): 1

WELL DATA (MW-13D)

Initial Displacement: 0.837 ft
Total Well Penetration Depth: 45.02 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 45.02 ft
Screen Length: 5 ft
Well Radius: 0.157 ft
Gravel Pack Porosity: 0.28

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.0007923 cm/sec
y0 = 0.6391 ft
### RISING HEAD TEST

### PROJECT INFORMATION

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### AQUIFER DATA

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### WELL DATA (MW-12S)

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<td>Well Radius:</td>
<td>0.26 ft</td>
</tr>
<tr>
<td>Gravel Pack Porosity:</td>
<td>0.28</td>
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### SOLUTION

- Aquifer Model: Unconfined
- Solution Method: Hvorslev
- \( K = 0.001445 \text{ cm/sec} \)
- \( y_0 = 0.3676 \text{ ft} \)
# RISING HEAD TEST

## PROJECT INFORMATION

| Company:  | MACTEC |
| Client:   | Duke Energy |
| Project:  | 6228-10-5284 |
| Location: | Marshall Steam Station |
| Test Well:  | MW-12S |
| Test Date:  | 8/16/2010 |

## AQUIFER DATA

| Saturated Thickness:  | 11.04 ft |
| Anisotropy Ratio (Kz/Kr):  | 1 |

## WELL DATA (MW-12S)

| Initial Displacement:  | 1.257 ft |
| Total Well Penetration Depth:  | 11.04 ft |
| Casing Radius:  | 0.0833 ft |
| Static Water Column Height:  | 11.04 ft |
| Screen Length:  | 11.04 ft |
| Well Radius:  | 0.26 ft |
| Gravel Pack Porosity:  | 0.28 |

## SOLUTION

| Aquifer Model:  | Unconfined |
| Solution Method:  | Dagan |
| K =  | 0.001787 cm/sec |
| y0 =  | 0.4844 ft |
### PROJECT INFORMATION

Company: MACTEC  
Client: Duke Energy  
Project: 6228-10-5284  
Location: Marshall Steam Station  
Test Well: MW-12S  
Test Date: 8/16/2010

### AQUIFER DATA

- Saturated Thickness: **11.04 ft**  
- Anisotropy Ratio (Kz/Kr): _1_

### WELL DATA (MW-12S)

- Initial Displacement: **1.257 ft**  
- Total Well Penetration Depth: **11.04 ft**  
- Casing Radius: **0.0833 ft**  
- Static Water Column Height: **11.04 ft**  
- Screen Length: **11.04 ft**  
- Well Radius: **0.26 ft**  
- Gravel Pack Porosity: **0.28**

### SOLUTION

- Aquifer Model: **Unconfined**  
- Solution Method: **Bouwer-Rice**  
- $K = 0.001557 \text{ cm/sec}$  
- $y_0 = 0.4443 \text{ ft}$
RISING HEAD TEST

PROJECT INFORMATION

Company: MACTEC
Client: Duke Energy
Project: 6228-10-5284
Location: Marshall Steam Station
Test Well: MW-12D
Test Date: 8/16/2010

AQUIFER DATA

Saturated Thickness: 83.38 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-12D)

Initial Displacement: 1. ft
Total Well Penetration Depth: 83.38 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 83.38 ft
Screen Length: 5. ft
Well Radius: 0.157 ft
Gravel Pack Porosity: 0.28

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev
K = 0.0001302 cm/sec
y0 = 0.8428 ft
RISING HEAD TEST

PROJECT INFORMATION
Company: MACTEC
Client: Duke Energy
Project: 6228-10-5284
Location: Marshall Steam Station
Test Well: MW-12D
Test Date: 8/16/2010

AQUIFER DATA
Saturated Thickness: 83.38 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-12D)
Initial Displacement: 1. ft
Total Well Penetration Depth: 83.38 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 83.38 ft
Screen Length: 5. ft
Well Radius: 0.157 ft
Gravel Pack Porosity: 0.28

SOLUTION
Aquifer Model: Unconfined
K = 0.0001336 cm/sec
y0 = 0.8583 ft
Solution Method: Bouwer-Rice
### RISING HEAD TEST

### PROJECT INFORMATION

- **Company:** MACTEC
- **Client:** Duke Energy
- **Project:** 6228-10-5284
- **Location:** Marshall Steam Station
- **Test Well:** MW-11S
- **Test Date:** 8/16/2010

### AQUIFER DATA

- **Saturated Thickness:** 10.61 ft
- **Anisotropy Ratio (Kz/Kr):** 1

### WELL DATA (MW-11S)

- **Initial Displacement:** 0.955 ft
- **Total Well Penetration Depth:** 10.61 ft
- **Casing Radius:** 0.0833 ft
- **Static Water Column Height:** 10.61 ft
- **Screen Length:** 10.61 ft
- **Well Radius:** 0.26 ft
- **Gravel Pack Porosity:** 0.28

### SOLUTION

- **Aquifer Model:** Unconfined
- **Solution Method:** Hvorslev
- **K:** 0.002047 cm/sec
- **y0:** 0.3804 ft
RISING HEAD TEST

PROJECT INFORMATION
Company: MACTEC
Client: Duke Energy
Project: 6228-10-5284
Location: Marshall Steam Station
Test Well: MW-11S
Test Date: 8/16/2010

AQUIFER DATA
Saturated Thickness: 10.61 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-11S)
Initial Displacement: 0.955 ft
Total Well Penetration Depth: 10.61 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 10.61 ft
Screen Length: 10.61 ft
Well Radius: 0.26 ft
Gravel Pack Porosity: 0.28

SOLUTION
Aquifer Model: Unconfined
K = 0.001285 cm/sec
y0 = 0.387 ft

Solution Method: Dagan
RISING HEAD TEST

PROJECT INFORMATION

Company: MACTEC
Client: Duke Energy
Project: 6228-10-5284
Location: Marshall Steam Station
Test Well: MW-11S
Test Date: 8/16/2010

AQUIFER DATA

Saturated Thickness: 10.61 ft
Anisotropy Ratio (Kz/Kr): 1

WELL DATA (MW-11S)

Initial Displacement: 0.955 ft
Total Well Penetration Depth: 10.61 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 10.61 ft
Screen Length: 10.61 ft
Well Radius: 0.26 ft
Gravel Pack Porosity: 0.28

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

\[ K = 0.00154 \text{ cm/sec} \]
\[ y_0 = 0.4687 \text{ ft} \]
### RISING HEAD TEST

### PROJECT INFORMATION

- **Company**: MACTEC
- **Client**: Duke Energy
- **Project**: 6228-10-5284
- **Location**: Marshall Steam Station
- **Test Well**: MW-11D
- **Test Date**: 8/16/2010

### AQUIFER DATA

- **Saturated Thickness**: 49.92 ft
- **Anisotropy Ratio (Kz/Kr)**: 1

### WELL DATA (MW-11D)

- **Initial Displacement**: 2.627 ft
- **Total Well Penetration Depth**: 49.92 ft
- **Casing Radius**: 0.0833 ft
- **Static Water Column Height**: 49.92 ft
- **Screen Length**: 5 ft
- **Well Radius**: 0.157 ft
- **Gravel Pack Porosity**: 0.28

### SOLUTION

- **Aquifer Model**: Unconfined
- **Solution Method**: Hvorslev
- **K** = 3.448E-5 cm/sec
- **y0** = 1.08 ft
RISING HEAD TEST

PROJECT INFORMATION
Company: MACTEC
Client: Duke Energy
Project: 6228-10-5284
Location: Marshall Steam Station
Test Well: MW-11D
Test Date: 8/16/2010

AQUIFER DATA
Saturated Thickness: 49.92 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-11D)
Initial Displacement: 2.627 ft
Total Well Penetration Depth: 49.92 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 49.92 ft
Screen Length: 5 ft
Well Radius: 0.157 ft
Gravel Pack Porosity: 0.28

SOLUTION
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
\[ K = 3.428 \times 10^{-5} \text{ cm/sec} \]
\[ y_0 = 1.1 \text{ ft} \]
RISING HEAD TEST

PROJECT INFORMATION

Company: MACTEC  
Client: Duke Energy  
Project: 6228-10-5284  
Location: Marshall Steam Station  
Test Well: MW-10S  
Test Date: 8/16/2010

AQUIFER DATA

- Saturated Thickness: 12.8 ft  
- Anisotropy Ratio (Kz/Kr): 1

WELL DATA (MW-10S)

- Initial Displacement: 1.506 ft  
- Total Well Penetration Depth: 12.8 ft  
- Casing Radius: 0.0833 ft  
- Static Water Column Height: 12.8 ft  
- Screen Length: 12.8 ft  
- Well Radius: 0.26 ft  
- Gravel Pack Porosity: 0.28

SOLUTION

- Aquifer Model: Unconfined  
- Solution Method: Hvorslev  
- $K = 0.001361$ cm/sec  
- $y_0 = 0.7673$ ft
RISING HEAD TEST

PROJECT INFORMATION

Company: MACTEC
Client: Duke Energy
Project: 6228-10-5284
Location: Marshall Steam Station
Test Well: MW-10S
Test Date: 8/16/2010

AQUIFER DATA

Saturated Thickness: 12.8 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-10S)

Initial Displacement: 1.506 ft
Total Well Penetration Depth: 12.8 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 12.8 ft
Screen Length: 12.8 ft
Well Radius: 0.26 ft
Gravel Pack Porosity: 0.28

SOLUTION

Aquifer Model: Unconfined
K = 0.0009221 cm/sec

Solution Method: Dagan
y0 = 0.7748 ft
### RISING HEAD TEST

### PROJECT INFORMATION

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<th>Client: Duke Energy</th>
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<td>Location: Marshall Steam Station</td>
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<tr>
<td>Test Well: MW-10S</td>
<td>Test Date: 8/16/2010</td>
</tr>
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### AQUIFER DATA

| Saturated Thickness: 12.8 ft | Anisotropy Ratio (Kz/Kr): 1 |

### WELL DATA (MW-10S)

| Initial Displacement: 1.506 ft | Static Water Column Height: 12.8 ft |
| Total Well Penetration Depth: 12.8 ft | Screen Length: 12.8 ft |
| Casing Radius: 0.0833 ft | Well Radius: 0.26 ft |
| Gravel Pack Porosity: 0.28 |

### SOLUTION

| Aquifer Model: Unconfined | Solution Method: Bouwer-Rice |
| K = 0.000749 cm/sec | y0 = 0.7498 ft |
RISING HEAD TEST

PROJECT INFORMATION

Company: MACTEC
Client: Duke Energy
Project: 6228-10-5284
Location: Marshall Steam Station
Test Well: MW-10D
Test Date: 8/16/2010

AQUIFER DATA

Saturated Thickness: 71.46 ft
Anisotropy Ratio (Kz/Kr): 1

WELL DATA (MW-10D)

Initial Displacement: 1.148 ft
Total Well Penetration Depth: 87.69 ft
Casing Radius: 0.0833 ft
Screen Length: 5 ft
Well Radius: 0.157 ft
Gravel Pack Porosity: 0.28

STATIC WATER COLUMN HEIGHT: 71.46 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev
K = 0.0001192 cm/sec
y0 = 0.856 ft
RISING HEAD TEST

PROJECT INFORMATION
Company: MACTEC
Client: Duke Energy
Project: 6228-10-5284
Location: Marshall Steam Station
Test Well: MW-10D
Test Date: 8/16/2010

AQUIFER DATA
Saturated Thickness: 71.46 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-10D)
Initial Displacement: 1.148 ft
Total Well Penetration Depth: 87.69 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 71.46 ft
Screen Length: 5. ft
Well Radius: 0.157 ft
Gravel Pack Porosity: 0.28

SOLUTION
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
\( K = 0.0001129 \) cm/sec
\( y_0 = 0.8209 \) ft
**RISING HEAD TEST**

**PROJECT INFORMATION**

Company: MACTEC  
Client: Duke Energy  
Project: 6228-10-5284  
Location: Marshall Steam Station  
Test Well: MW-14S  
Test Date: 8/16/2010

**AQUIFER DATA**

Saturated Thickness: 10.77 ft  
Anisotropy Ratio (Kz/Kr): 1.

**WELL DATA (MW-14S)**

Initial Displacement: 1.06 ft  
Total Well Penetration Depth: 10.77 ft  
Casing Radius: 0.0833 ft  
Static Water Column Height: 10.77 ft  
Screen Length: 10.77 ft  
Well Radius: 0.26 ft  
Gravel Pack Porosity: 0.28

**SOLUTION**

Aquifer Model: Unconfined  
\[ K = 0.001007 \text{ cm/sec} \]  
Solution Method: Hvorslev  
\[ y_0 = 0.4034 \text{ ft} \]
A. (6) GROUNDWATER MONITORING WELL CONSTRUCTION AND SAMPLING

1. The permittee shall conduct groundwater monitoring as may be required to determine the compliance of this NPDES permitted facility with the current groundwater Standards found under 15A NCAC 2L .0200

2. WELL CONSTRUCTION. Within 120 days of permit issuance, monitoring wells, as proposed on Attachment XX, shall be installed to monitor groundwater quality.
   a. Monitoring wells shall be constructed in accordance with 15A NCAC 02C .0108 (Standards of Construction for Wells Other than Water Supply) and any other jurisdictional laws and regulations pertaining to well construction. The general locations for all monitoring wells are indicated on Attachment XX.
   b. Within 30 days of completion of well construction, a completed Well Construction Record (Form GW-1) must be submitted for each monitoring well to Division of Water Quality, Aquifer Protection Section, 1636 Mail Service Center, Raleigh, NC 27699-1636.
   c. The Mooresville Regional Office, telephone number (704) 663-1699, shall approve the location of new monitoring wells prior to installation. The regional office shall be notified at least 48 hours prior to the construction of any monitoring well and such notification to the Aquifer Protection Section’s regional supervisor shall be made from 8:00 a.m. until 5:00 p.m. on Monday through Friday, excluding State Holidays.
   d. Within 60 days of completion of the monitoring wells, the Permittee shall submit two original copies of a site map with a scale no greater than 1-inch equals 500 feet. At a minimum, the map shall include the following information:
      i. The location and identity of each monitoring well.
      ii. The location of major components of the waste disposal system.
      iii. The location of property boundaries within 500 feet of the disposal areas.
      iv. The latitude and longitude of the established horizontal control monument.
      v. The elevation of the top of the well casing (i.e., measuring point) relative to a common datum.
      vi. The depth of water below the measuring point at the time the measuring point is established.
      vii. The location of compliance and review boundaries.
      viii. The date the map is prepared and/or revised.
      ix. Topographic contours in no more than ten (10) foot intervals
   e. The above information should be overlaid on the most recent aerial photograph taken of the site. Control monuments shall be installed in such a manner and made of such materials that the monument will not be destroyed due to activities taking place on the property. The map and any supporting documentation shall be sent to the Division of Water Quality, Aquifer Protection Section, 1636 Mail Service Center, Raleigh, NC 27699-1636.
   f. The well(s) must be constructed by a North Carolina Certified Well Contractor, the property owner, or the property lessee according to General Statutes 87-98.4. If the construction is not performed by a certified well contractor, the property owner or lessee, provided they are a natural person, must physically perform the actual well construction activities.
g. The monitoring wells shall be regularly maintained. Such maintenance shall include ensuring that the well caps are rust-free and locked at all times, the outer casing is upright and undamaged, and the well does not serve as a conduit for contamination.

3. GROUNDWATER SAMPLING AND COMPLIANCE. Monitoring wells shall be sampled after construction and thereafter at the frequencies and for the parameters as specified in Attachment XX. All maps, well construction forms, well abandonment forms and monitoring data shall refer to the permit number and the well nomenclature as provided on Attachment XX.
   a. Per 15A NCAC 02H .0800, a Division certified laboratory shall conduct all laboratory analyses for the required effluent, groundwater or surface water parameters.
   b. The measurement of water levels shall be made prior to purging the wells. The depth to water in each well shall be measured from the surveyed point on the top of the casing. The measurement of pH shall be made after purging and prior to sampling for the remaining parameters.
   c. The measuring points (top of well casing) of all monitoring wells shall be surveyed to provide the relative elevation of the measuring point for each monitoring well. The measuring points (top of casing) of all monitoring wells shall be surveyed relative to a common datum.
   d. For monitoring wells that are not located at the Compliance Boundary, the Compliance Monitoring Form (GW-59CCR) is not required. However, predictive calculations or modeling shall be submitted to the Regional Office annually (i.e. 12 months after permit issuance) demonstrating groundwater quality standards at the Compliance Boundary.
   e. Two copies of the monitoring well sampling shall be submitted on a Compliance Monitoring Form (GW-59CCR), and received no later than the last working day of the month following the sampling month. Copies of the laboratory analyses shall be kept on site, and made available upon request. The Compliance Monitoring Form (GW-59CCR) shall include this permit number and the appropriate well identification number. All information shall be submitted to the following address:

      Division of Water Quality
      Information Processing Unit
      1617 Mail Service Center
      Raleigh, North Carolina 27699-1617

f. For groundwater samples that exceed the ground water quality standards in 15A NCAC 02L .0202, the Regional Office shall be contacted within 30 days after submission of the groundwater monitoring report; an evaluation may be required to determine the impact of the waste disposal activities. Failure to do so may subject the permittee to a Notice of Violation, fines, and/or penalties.
4. COMPLIANCE BOUNDARY. The compliance boundary for the disposal system shall be specified in accordance with 15A NCAC 02L .0107(a). This disposal system was individually permitted prior to December 30, 1983; therefore, the compliance boundary is established at either 500 feet from the effluent disposal area, or at the property boundary, whichever is closest to the effluent disposal area. An exceedance of groundwater standards at or beyond the compliance boundary is subject to remediation action according to 15A NCAC 02L .0106(c) as well as enforcement actions in accordance with North Carolina General Statute 143-215.6A through 143-215.6C.
ATTACHMENT XX – GROUNDWATER MONITORING PLAN

Permit Number: **NC0004987**

Version 1.1

<table>
<thead>
<tr>
<th>WELL NOMENCLATURE</th>
<th>PARAMETER DESCRIPTION</th>
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<td>February, June, October</td>
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Note 1: For locations of monitoring wells, see attached map.

Note 2: Monitoring revisions may be considered, as applicable, if there are no significant detections prior to permit renewal.
Appendix C - Monitoring Well Locations
<table>
<thead>
<tr>
<th>Description</th>
<th>Northing</th>
<th>Easting</th>
<th>Elevation</th>
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<th>Elevation</th>
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Note1: Coordinates shown are based on the North Carolina State Plane Coordinate System
Note2: Horizontal Datum of NC Grid NAD 1983 (NSRS 2007)
Note3: Elevations shown are referenced to the NAVD 88 vertical datum
Note4: Coordinates and elevations shown are in U.S. Survey Foot
Note5: Coordinates and elevations shown only for as-built wells as requested by NCDENR
Note6: Mag nails set in concrete base of each well for future elevation checks
Note7: Survey information provided by Duke Energy