GROUNDWATER ASSESSMENT WORK PLAN

FOR

ROXBORO STEAM ELECTRIC PLANT
1700 DUNNAWAY ROAD
SEMORA, NORTH CAROLINA 27343
NPDES PERMIT #NC0003425
N 36.484825/W -79.072315

PREPARED FOR

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EXECUTIVE SUMMARY

Duke Energy Progress, Inc. (Duke Energy) owns and operates the Roxboro Steam Electric Plant (Roxboro Plant) located near Semora, in Person County, North Carolina. The Roxboro Plant began operations in the 1960s and continued to add capacity through the 1980s. Currently, the Plant operates four coal-fired units. Coal combustion residues (CCR) have historically been managed at the Plant's on-site ash basins: the semi-active East Ash Basin (operated from the mid-1960s to present) and the active West Ash Basin (operated from the early 1970s to present).

Wastewater discharges from the ash basins is permitted by the North Carolina Department of Environment and Natural Resources (NCDENR) Division of Water Resources (DWR) under National Pollution Discharge Elimination System (NPDES) Permit NC0003425.

In a letter dated August 13, 2014, the DWR requested that Duke Energy prepare a Groundwater Assessment Plan to identify the source and cause of contamination, any imminent hazards to public health and safety, all receptors and significant exposure pathways for the site. In addition, the plan should be designed to determine the horizontal and vertical extent of soil and groundwater contamination and all significant factors affecting contaminant transport and the geological and hydrogeological features influencing the movement, chemical, and physical character of the contaminants.

The following assessment plan anticipates:

- Implementation of a receptor survey to identify public and private water supply wells (including irrigation wells and unused or abandoned wells), surface water features, and wellhead protection areas (if present) within a 0.5 mile radius of the Roxboro Plant compliance boundary;
- Installation of borings within the ash basins for chemical and geotechnical analysis of residuals and in-place soils;
- Installation of background soil borings;
- Installation of monitoring wells and piezometers;
- Collection and analysis of groundwater samples from existing site wells and newly installed monitoring wells;
- Statistical evaluation of groundwater analytical data; and

- Development of a groundwater model to evaluate the long term fate and transport of constituents of concern in groundwater associated with the ash management units.

The information obtained through this Work Plan will be utilized to prepare a Comprehensive Site Assessment (CSA) report in accordance with the Notice of Regulatory Requirements (NORR). In addition to the components listed above, a human health and ecological risk assessment will be conducted. This assessment will include the preparation of a conceptual site model illustrating potential pathways from the source to possible receptors.

During the CSA process if additional investigations are required NCDENR, will be notified.

1.0 INTRODUCTION

Duke Energy Progress, Inc. (Duke Energy) owns and operates the Roxboro Steam Electric Plant (Roxboro Plant) located near Semora, in Person County, North Carolina (**Figure 1**). The Roxboro Plant began operations in the 1960s and continued to add capacity through the 1980s. Currently, the Plant operates four coal-fired units.

Coal combustion residues (CCR) have historically been managed at the Plant's on-site ash basins: the semi-active East Ash Basin (operated from the mid-1960s to present) and the active West Ash Basin (operated from the early 1970s to present; **Figure 2**). An unlined landfill was constructed on top of the semi-active East Ash Basin in the late 1980s for the placement of dry fly ash (DFA). A lined landfill was constructed over the unlined landfill around 2004. The discharges from the ash basins are permitted by the North Carolina Department of Environment and Natural Resources (NCDENR) Division of Water Resources (DWR) under the National Pollution Discharge Elimination System (NPDES).

Groundwater monitoring has been performed in accordance with the conditions of NPDES Permit #NC0003425. The current groundwater compliance monitoring plan for the Roxboro Plant includes the sampling of eight (8) wells. These eight wells include one background well and seven (7) downgradient wells.

In addition to the eight wells monitored as part of the NPDES permit, the Roxboro Plant samples six monitoring wells and collects landfill leachate samples from four locations associated with the lined DFA landfill in accordance with a permit issued by NCDENR's Solid Waste Section.

The compliance boundary for the Plant is defined in accordance with NCAC Title 15A Chapter 02L.0107(a) as being established at either 500 feet from the waste boundary or at the property boundary.

In a Notice of Regulatory Requirement (NORR) letter dated August 13, 2014, the DWR of the NCDENR requested that Duke Energy prepare a Groundwater Assessment Plan to conduct a Comprehensive Site Assessment (CSA) in accordance with 15A NCAC 02L .0106(g) to address groundwater constituents that have been detected at elevated levels greater than the 2L Standard at the compliance boundary. A summary of these constituents is provided in **Table 1** and a copy of the DWR letter is provided in **Appendix A**.

SynTerra has prepared this Groundwater Assessment Work Plan on behalf of Duke Energy to fulfill the DWR letter request and to satisfy the requirements of NC Senate Bill 729 as ratified August 2014.

Specifically, this document describes the plans to meet the requirements of 15A NCAC 02L .0106(g) including;

- Identify the source and cause of contamination;
- Identify any imminent hazards to public health and safety and actions taken to mitigate them in accordance to 15A NCAC 02L .0106(f);
- Identify receptors and significant exposure pathways;
- Determine the horizontal and vertical extent of soil and groundwater contamination and significant factors affecting contaminant transport; and
- Determine geological and hydrogeological features influencing the movement, chemical, and physical character of the contaminants.

The information obtained through this Work Plan will be utilized to prepare a CSA report in accordance with the requirements of the NORR. In addition to the components listed above, a human health and ecological risk assessment will be conducted. This assessment will include the preparation of a conceptual site model illustrating potential pathways from the source to possible receptors.

During the CSA process if additional investigations are required, NCDENR will be notified.

2.0 SITE HISTORY AND SOURCE CHARACTERIZATION

2.1 Plant Description

Duke Energy Progress, Inc. owns and operates the Roxboro Plant located in north-central North Carolina near Semora, North Carolina. A large part of the Plant area encompasses Hyco Lake. The Roxboro Plant is located in Person County along the east bank of Hyco Lake north of Roxboro, NC and west of McGhees Mill Road. The site location is shown on **Figure 1**.

The Roxboro Plant began operations in the 1960s and continued to add capacity through the 1980s. The Roxboro Plant uses coal-fired units to produce steam. Ash generated from coal combustion has been stored on-site in ash basins.

The Plant is located on Dunnaway Road, approximately 10 miles northwest of the city of Roxboro, North Carolina. The Plant is situated on the south side of Hyco Lake, a lake formed from the impoundment of the Hyco River. The Plant property is roughly bounded by Hyco Lake to the north and west, NC Highway 57 (Semora Road) to the south and west, and State Highway 1336 (McGhees Mill Road) to the east. The overall topography of the Plant generally slopes toward the north (Hyco Lake).

2.2 Ash Management Areas

Ash generated from coal combustion has been stored in on-site ash basins and lined landfill. Ash has been sluiced to the ash basins or conveyed in its dry form to the lined landfill. Two ash basins areas have been used at the Roxboro Plant and are referenced using the date of construction and relative location: the 1966 semi-active East Ash Basin and the 1973 active West Ash Basin. The East Ash Basin is located southeast of the plant, and the West Ash Basin is located south of the plant. An unlined landfill was constructed on the East Ash Basin in the late 1980s. A lined landfill was subsequently constructed over the unlined landfill around 2004.

The ash basins are impounded by earthen dams. Surface water runoff from the East Ash basin and the lined landfill are routed into the West Ash Basin to allow settling. A 500-foot compliance boundary encircles both ash basins. The ash basins are indicated on **Figure 2**.

Currently, the East Ash Basin and lined landfill are covered with vegetation where the landfill is not active (grasses and shrubs). The West Ash Basin has some grass cover and ponded water, mostly along the southern and eastern edges of the basin.

Wastewater discharges from the facility are permitted by the North Carolina Department of Environment and Natural Resources (NCDENR) Division of Water

Resources (DWR) under National Pollution Discharge Elimination System (NPDES) Permit NC0003425.

2.3 Groundwater Monitoring System

The current groundwater compliance monitoring program for the Roxboro Plant includes the sampling of eight wells surrounding the compliance boundary. These eight wells include one background well and seven downgradient wells. The locations of the monitoring wells, the waste boundary, and the compliance boundary are shown on **Figure 2**.

In addition to the eight wells monitored as part of the NPDES permit, the Roxboro Plant samples six monitoring wells and collects landfill leachate samples from four locations associated with the active lined landfill in accordance with a permit issued by NCDENR's solid waste section. The locations of landfill monitoring points are shown on **Figure 2.**

The compliance monitoring network includes one background monitoring well, BG-1, plus seven monitoring wells located in side-gradient and downgradient positions along the compliance boundary.

The monitoring network at the lined landfill includes six monitoring wells located in side gradient and down gradient positions as permitted by NCDENR's solid waste section. Semi-annual groundwater monitoring is conducted for the landfill monitoring wells. Groundwater analytical results from these monitoring events will be reviewed and included in the assessment.

Wells CW-3D and CW-4D were installed in the upper bedrock and were paired with shallow wells CW-3 and CW-4, which were installed above the bedrock, to monitor the vertical hydraulic gradient in the area and aquifer conditions within the shallow bedrock. The remainder of the compliance boundary wells were installed in the saprolite or residuum, above bedrock.

In accordance with the current NPDES permit, the ash basins compliance monitoring wells are sampled three times per year in April, July, and November. The analytical results for the compliance monitoring program are compared to the 2L Standards or site-specific background concentrations. A summary of the NPDES monitoring requirements is provided below.

It is proposed that monitoring for aluminum be discontinued. Aluminum is a very common, naturally-occurring element in soil and rocks of the area. A preliminary statistical evaluation indicates that aluminum concentrations in downgradient compliance monitoring wells are not statistically significant increases (SSIs) over the background well data set for the most recent sampling event. Further, aluminum is not consistently monitored across the entirety of Duke Energy facilities, and there is no 2L Standard for aluminum.

NPDES Groundwater Monitoring Requirements

Well Nomenclature	Parameter Description				Frequency
Monitoring Wells CW-1, CW-2, CW-2D, CW-3, CW-3D, CW-4, CW-5, BG-1	Aluminum	Chloride	Mercury	TDS	April, July, November
	Antimony	Chromium	Nickel	Thallium	
	Arsenic	Copper	Nitrate	Zinc	
	Barium	Iron	pH		
	Boron	Lead	Selenium		
	Cadmium	Manganese	Sulfate		

3.0 RECEPTOR INFORMATION

The August 13, 2014 NORR states:

> *No later than October 14th, 2014 as authorized pursuant to 15A NCAC 02L.0106(g), the DWR is requesting that Duke perform a receptor survey at each of the subject facilities and submitted to the DWR. The receptor survey is required by 15A NCAC 02L .0106(g) and shall include identification of all receptors within a radius of 2,640 feet (one-half mile) from the established compliance boundary identified in the respective National Pollutant Discharge Elimination System (NPDES) permits. Receptors shall include, but shall not be limited to, public and private water supply wells (including irrigation wells and unused or abandoned wells) and surface water features within one-half mile of the facility compliance boundary. For those facilities for which Duke has already submitted a receptor survey, please update your submittals to ensure they meet the requirements stated in this letter and referenced attachments and submit them with the others. If they do not meet these requirements, you must modify and resubmit the plans.*
>
> *The results of the receptor survey shall be presented on a sufficiently scaled map. The map shall show the coal ash facility location, the facility property boundary, the waste and compliance boundaries, and all monitoring wells listed in the respective NPDES permits. Any identified water supply wells shall be located on the map and shall have the well owner's name and location address listed on a separate table that can be matched to its location on the map.*

In accordance with the requirements of the NORR, SynTerra is in the process of completing a receptor survey for the Roxboro Plant to identify all receptors within a 0.5-mile radius (2,640 feet) of the Roxboro Plant ash basin compliance boundary. The compliance boundary for groundwater quality, in relation to the ash basin, 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. The receptors include public and private water supply wells (including irrigation wells and unused or abandoned wells) and surface water features within a 0.5-mile radius of the Roxboro Plant ash basin compliance boundary.

The survey consists of a review of publicly available data from NCDENR Department of Environmental Health (DEH), NC OneMap GeoSpatial Portal, DWR Source Water Assessment Program (SWAP) online database, county GIS, Environmental Data Resources, Inc. (EDR) Records Review, the USGS National Hydrography Dataset

(NHD), as well as a vehicular survey along public roads located within 0.5 mile radius of the compliance boundary.

Additional receptor information will be collected as part of the anticipated assessment to comply with the CSA guidelines (NCDENR, August 2014).

4.0 REGIONAL GEOLOGY AND HYDROGEOLOGY

The Roxboro Plant is situated in the eastern Piedmont Region of north-central North Carolina. The Piedmont is characterized by well-rounded hills and rolling ridges cut by small streams and drainages. Elevations in the area of the Roxboro Plant range between 410 feet above mean sea level (msl) during full pool at Hyco Lake to 570 feet msl near the Dunnaway Road and McGhees Mill Road intersection southeast of the Plant.

Geologically, the Plant is located near the contact of two regional geologic zones: the Inner Piedmont zone and the Carolina zone. Both zones are generally comprised of igneous and metamorphosed igneous and sedimentary rocks of Paleozoic age. In general, the rocks are highly fractured and folded and have been subjected to long periods of physical and chemical weathering. The origination, genesis, and characteristics of the rocks of the region have been the focus of detailed study by researchers for many years. These investigations have resulted in a number of interpretations and periodic refinements to the overall geological model of the region.

Rocks of the region, except where exposed in road cuts, stream channels, and steep hillsides, are covered with unconsolidated material formed from the in-situ chemical and physical breakdown of the bedrock. This unconsolidated material is referred to as saprolite or residuum. Direct observations at the Roxboro Plant confirm the presence of residuum, developed above the bedrock, which is generally 10 to 30 feet thick. The residuum extends from the ground surface (soil zones) downward, transitioning through a zone comprised of unconsolidated silt and sand, downward through a transition zone of partially weathered rock in a silt/sand matrix, down to the contact with competent bedrock.

The *Geologic Map of North Carolina* (1985) places the rocks of the Plant area in the Charlotte Terrane: a belt of metamorphic rock trending generally southwest to northeast characterized by strongly foliated felsic mica gneiss and schist and metamorphosed intrusive rocks (**Figure 3**). The rocks of the area near the Plant are described as biotite gneiss and schist with abundant potassic feldspar and garnet, and interlayered and gradational with calc-silicate rock, silliminite-mica schist and amphibolite. The gneiss contains small masses of granite rock. The felsic mica gneiss of the Charlotte Terrane is described as being interlayered with biotite and hornblende schist. Later mapping generally confirms these observations and places the Roxboro Plant near the contact between the Inner Piedmont zone, characterized by the presence of biotite gneiss and schist, and the Charlotte Belt (or Charlotte Terrane), characterized by felsic mica gneiss (USGS, 2007).

Other researchers have conducted detailed investigations of the area and have provided additional description of the geology in detailed tectonic, structural, and litho-stratigraphic terms (Wilkins, Shell and Hibbard, 1995; Hibbard, et. al., 2002). One of the most important interpretations concerning the geologic nature of the region is the discovery and description of the Hyco shear zone, a tectonic boundary comprised of a ductile shear zone that sharply separates contrasting rocks of the Charlotte (Milton) and Carolina Terranes in north-central North Carolina and southern Virginia (Hibbard, et. al., 1998). The Hyco shear zone was mapped as directly underlying Hyco Lake.

Groundwater within the area exists under unconfined, or water table, conditions within the residuum and/or saprolite zone and in fractures and joints of the underlying bedrock. The water table and bedrock aquifers are interconnected. The residuum acts as a reservoir for supplying groundwater to the fractures and joints in the bedrock. Shallow groundwater generally flows from local recharge zones in topographically high areas, such as ridges, toward groundwater discharge zones, such as stream valleys. Ridge and topographic high areas serve as groundwater recharge zones, and groundwater flow patterns in recharge areas tend to develop a somewhat radial pattern from the center of the recharge area outward toward the discharge areas and are expected to mimic surface topography.

5.0 SITE GEOLOGY AND HYDROGEOLOGY

Field activities at the Roxboro Plant document the bedrock of the northwestern portion of the compliance boundary as mafic granitic gneiss and the remainder of the site as felsic gneiss and hornblende gneiss. Based on available well logs, subsurface lithology beneath the Plant area is comprised of tan to olive brown sandy silt and fine to coarse sands grading into partially weathered rock and then competent bedrock.

Groundwater beneath the Plant area occurs within the residuum/partially weathered rock or competent bedrock at depths ranging from three to 20 feet below land surface (bls) along the downgradient compliance boundary and greater than 35 feet bls upgradient of the ash basin. Routine water level measurements and corresponding elevations from the compliance monitoring well network indicate that groundwater generally flows from upland areas along the south, west, and eastern boundaries towards the north and Hyco Lake. Groundwater generally flows from the south to the north along the western portion of the property and from the southeast to the northwest across the remainder of the property. The approximate groundwater gradient along the western portion of the property for July 2014 data was 85.04 feet (vertical change) over 530 feet (horizontal distance) or 16 feet/100 feet as measured from upgradient background well BG-1 to downgradient well CW-2. The approximate groundwater gradient along the northern compliance boundary for July 2014 was slightly less at 76.64 feet (vertical change) over 570 feet (horizontal distance) or 13.4 feet over 100 feet as measured from well CW-1 to downgradient well CW-2. Groundwater elevation data collected from the two well pairs indicate the vertical gradient tends to be upward or neutral between the transition zone and upper bedrock near surface water bodies.

6.0 GROUNDWATER MONITORING RESULTS

6.1 Groundwater Analytical Results

July 2014 was the twelfth compliance monitoring event conducted in accordance with the NPDES Permit. The routine analytical data indicates that chromium, iron, manganese, sulfate, total dissolved solids (TDS), and pH have been elevated relative to the 2L Standard. The concentration ranges for the constituents which have elevated values greater than the 2L Standard are provided in **Table 1**.

- Chromium tends to be detected greater than the 2L Standard in background well BG-1 and compliance boundary wells CW-1, CW-2D, and CW-4.
- Iron tends to be detected greater than the 2L Standard in background well BG-1 and compliance boundary wells CW-1, CW-2, CW-2D, CW-3, CW-3D, and CW-4.
- Manganese tends to be detected greater than the 2L Standard in compliance boundary wells CW-1, CW-2, and CW-3D.
- Sulfate tends to be detected greater than the 2L Standard in compliance boundary well CW-5.
- TDS tends to be detected greater than the 2L Standard in compliance boundary wells CW-2, CW-3, CW-4, and CW-5.
- In general, the groundwater pH tends to be slightly below 6.5 Standard Units (SU), which is below the lower end of the 2L Standard range, at background and compliance wells for the ash basins.

6.2 Preliminary Statistical Evaluation Results

As a preliminary evaluation tool, statistical analysis was conducted on the groundwater analytical data collected between November 2010 and July 2014. The statistical analysis was conducted in accordance with US EPA, *Statistical Training Course for Ground Water Monitoring Data Analysis*, EPA530-R-93-003, 1992 and US EPA's *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities; Unified Guidance* EPA 530/R-09-007, *March 2009.*

An inter-well prediction interval statistical analysis was utilized to evaluate the groundwater data. The inter-well prediction interval statistical evaluation involves comparing background well data to the results for the most recent sample date from compliance boundary wells.

Monitoring well BG-1 is the upgradient background well and monitoring wells CW-1, CW-2, CW-2D, CW-3, CW-3D, CW-4, and CW-5 are considered downgradient compliance boundary wells. Statistical analysis was performed on the inorganic constituents with detectable concentrations for the most recent routine sampling event (July 2014).

The statistical analysis indicated statistically significant increases (SSIs) over background concentrations for the following:

- CW-1 sulfate and TDS (however, the concentrations of both constituents are consistently much less than the 2L Standard);
- CW-2 barium, sulfate, and TDS (however, barium and sulfate concentrations are consistently much less than the 2L Standard and TDS has occasionally been detected at elevated concentrations greater than the 2L Standard);
- CW-2D barium, sulfate, and TDS (however, the concentrations of each of the three constituents are consistently much less than the 2L Standard);
- CW-3 barium, chloride, sulfate, and TDS (however, only TDS concentrations have been consistently detected at concentrations greater than the 2L Standard);
- CW-3D chloride, manganese, sulfate, and TDS (manganese has consistently been detected at concentrations greater than the 2L Standard while chloride, sulfate and TDS are consistently much less than the 2L Standard);
- CW-4 barium, chloride, and sulfate (however, the concentrations of each of three constituents are consistently much less than the 2L Standard);
- CW-5 boron, chloride, sulfate, and TDS (however, only sulfate and TDS concentrations have been consistently detected at concentrations greater than the 2L Standard).

A more robust statistical analysis will be completed as part of the CSA using data from additional wells.

7.0 ASSESSMENT WORK PLAN

The scope of work discussed in this plan is designed to meet the requirements of 15A NCAC 02L .0106(g) and to;

- Identify the source and cause of contamination;
- Identify any imminent hazards to public health and safety and actions taken to mitigate them in accordance to 15A NCAC 02L .0106(f);
- Identify all receptors and significant exposure pathways;
- Determine the horizontal and vertical extent of soil and groundwater contamination and all significant factors affecting contaminant transport; and
- Determine geological and hydrogeological features influencing the movement, chemical, and physical character of the contaminants.

The following sections generally describe anticipated assessment activities to fill data gaps associated with the source, vertical and horizontal extent, in soil and groundwater, for the constituents that have exceeded the 2L Standards. The assessment may be iterative with possible additional assessment activities prior to the preparation of the CSA. Groundwater samples collected will generally be analyzed for the constituents listed in **Table 2**. The following activities are anticipated at this time.

7.1 Anticipated Ash Basin Boring Locations

Five borings are anticipated within the West Ash Basin to determine the thickness of ash as well as to determine the current residual saturation. The anticipated boring locations are shown on **Figure 4**.

The borings may be conducted using Direct Push Technology (DPT) or Roto-Sonic drilling (or similar methods), to provide continuous soil cores through ash and into the underlying native soil. Drilling will be extended to approximately 20 feet below the bottom of the ash (or to refusal) to allow for characterization of the underlying native soil.

Ash samples will be collected for laboratory analysis of total and SPLP metals. To characterize the variation in ash composition, two samples, a shallow and a deep, are anticipated at each location, if the ash thickness is less than 20 feet. If the thickness is greater than 20 feet, three samples (shallow, intermediate, and deep), may be collected.

A summary of the boring details is provided in **Table 3**. The depths at which the samples are collected will be noted on sample IDs.

7.2 Anticipated Soil Boring Locations

7.2.1 Inside Ash Basins

As discussed above, continuous soil sample drilling techniques may be used to conduct borings within the West Ash Basin. These borings are anticipated to extend to a depth of approximately 20 feet below the ash (or to refusal) to characterize the native material below the ash basin. No soil borings are anticipated within the East Ash Basin based on available data from previous investigations.

Soil samples are anticipated to be collected at each of the boring locations immediately below the ash and at the bottom of the borings to provide information on the vertical distribution of metals beneath the basin. The soil samples will be analyzed for total metals, SPLP metals, and geotechnical parameters. A summary of the anticipated boring details is provided in **Table 3**.

Following soil sample collection, the borings will be abandoned by filling with a bentonite-grout mixture or will be converted to a piezometer to measure groundwater fluctuations beneath the West Ash Basin.

7.2.2 Outside Ash Basins

Soil samples are anticipated to be collected during installation of monitoring well pairs for metals analysis at all wells to further assess concentrations across the site. Geotechnical parameters pertinent to developing the computer model will be collected from AW-1, AW-2, AW-3, AW-5, and AW-6. Soil samples are anticipated at each of the boring locations immediately above the water table and within the transition zone. The soil samples will be analyzed for total metals, SPLP metals, and geotechnical parameters. A summary of the anticipated boring details is provided in **Table 3**.

7.3 Anticipated Sediment and Surface Water Locations

Surface water and sediment samples are not anticipated at this time. Data associated with recent seep sampling will be used to infer preferential pathways and migration from groundwater to surface water in various areas of the plant. Seep data analysis may be used to guide the collection of additional sediment or surface water data in the future.

7.4 Anticipated Groundwater Monitoring Wells and Piezometers

A number of monitoring wells and piezometers are present at the site. These existing wells will be supplemented with additional wells to complete the CSA.

7.4.1 General Construction, Development, Aquifer Testing

Monitoring wells and piezometers will be constructed by North Carolina-licensed well drillers. Drilling equipment will be decontaminated prior to use at each location using a high pressure steam cleaner.

Monitoring wells will be constructed of 2-inch ID, National Sanitation Foundation (NSF) grade polyvinyl chloride (PVC) (ASTM 2012a,b) schedule 40 flush-joint threaded casing and 0.010-inch machine-slotted pre-packed screens appropriately sized sand for a gravel pack around the screen. Piezometers will be constructed of 1-inch ID, NSF Schedule 40 PVC flush-joint threaded casing and pre-packed screens.

At each monitoring well location specified on **Figure 4** with a "S" qualifier (ex. AW-1S) a Type II well will be constructed. Each well will have a 10 foot screen set approximately 5 feet below the water table.

Should the Roto-Sonic drilling technique not be technically feasible at deeper bedrock wells the construction of Type III wells may be necessary. In these instances, a cased Type III well will be constructed with a 6-inch diameter PVC outer casing and a 2-inch diameter PVC inner casing and well screen. The purpose of installing cased wells at the site is to restrict vertical mixing within the shallow and deeper portions of the unconfined aquifer during well installation. Outer well casings (6-inch casing) will be advanced to auger refusal and set approximately 2-feet into competent rock. Note that location specific subsurface geology will dictate actual casing depths on a per-well basis. Air rotary drilling (or other appropriate drilling method) will be used to advance the borehole a minimum of 15 – 20 feet into competent bedrock with the intent of setting a 10-foot well screen at least 10 feet below the bottom of the casing.

The deeper of the paired wells will be installed first. The monitoring well will be constructed in accordance with 15A NCAC 02C (Well Construction Standards).

The monitoring wells will be completed with either steel above ground protective casings with locking caps or steel flush-mount manholes with locking expansion caps, and well tags. The protective covers will be secured and completed in a concrete collar and 2-foot square concrete pad.

Additional piezometers are not planned at this time, however, after a thorough review of available data is completed, one or more piezometers may be completed to address data gaps, if identified. Piezometers may be installed in a similar manner, but with 1-inch ID, NSF Schedule 40 PVC flush-joint threaded casing and pre-packed screens. A pelletized bentonite seal will be placed above the filter pack and the remainder of the annular space will be filled with a neat cement grout from the top of the upper bentonite seal to near ground surface. The piezometers will be completed with either steel above ground protective casings with locking caps or steel flush-mount manholes with locking expansion caps, and well tags. The protective covers will be secured and completed in a concrete collar and 1-foot square concrete pad.

Following installation, the monitoring wells will be developed in order to remove drill fluids, clay, silt, sand, and other fines which may have been introduced into the formation or sand pack during drilling and well installation, and to establish communication of the well with the aquifer. Well development will be performed using a portable submersible pump, which will be repeatedly moved up and down the well screen interval until the water obtained is relatively clear. Development will be continued by sustained pumping until monitoring parameters (e.g., conductivity, pH, temperature) are generally stabilized; estimated quantities of drilling fluids, if used, are removed; and, turbidity decreases to acceptable levels.

After the wells have been developed, hydraulic conductivity tests (rising head slug tests) will be conducted on each of the wells. The slug tests will be performed in general accordance with ASTM D4044-96 Standard Test Method (Field Procedure) for Instantaneous Change in Head (Slug) Tests for Determining Hydraulic Properties of Aquifers and NCDENR *Performance and Analysis of Aquifer Slug Tests and Pumping Test Policy*, dated May 31, 2007.

The data obtained during the slug tests will be reduced and analyzed using AQTESOLV™ for Windows, version 4.5, software to determine the hydraulic conductivity of the soils in the vicinity of wells.

7.4.2 Background Wells

Existing background well BG-1 is positioned to provide representative data for comparison with background groundwater conditions. Additional background well data will be useful to broaden the range of potential background groundwater concentrations. Therefore, two additional background well pairs BW-2S/BW-2D and BW-3S/BW-3D, along with one bedrock well (BW-1D), installed adjacent to transition background well BG-1 are anticipated at the locations shown on **Figure 4.** BW-1D will be installed adjacent to existing background well BG-1, but will be installed as a deep well, since BG-1 is installed within the transition zone. BW-2S/D will be installed southeast of the West Ash Basin between the end of Daisy Thompson Road and Sargents Creek. BW-3S/3D will be installed southeast of the East Ash Basin to the east of the unnamed pond. A summary of the boring details is provided in **Table 3**.

7.4.3 Ash Basins Area

A number of piezometer and groundwater monitoring wells are present in and around both ash basin areas. Further, the semi-active east ash basin is partially covered by a liner and a landfill. Therefore, no permanent piezometers or monitoring wells are proposed for installation inside the ash basin areas.

7.4.4 Downgradient Assessment Areas

A preliminary review of site data and existing monitoring well locations indicate that horizontal and vertical coverage around the compliance boundary is mostly adequate to complete a CSA of the Roxboro Plant with the following exceptions.

At the western corner of the West Ash Basin, a well pair will be installed across the Sargents Creek canal to monitor groundwater conditions in the deeper portion of the surficial aquifer at this location. A deep monitoring well will also be installed adjacent to compliance boundary well CW-4 to monitor groundwater conditions in the deeper portion of the surficial aquifer at this location.

Two additional well pairs (AW-7S/D and AW8S/D) will be installed to the west of the active ash basin between the basin and Hyco Lake to refine the flow regime and provide additional geochemical data in this area.

To the north of the West Ash Basin an additional well pair (AW-6S/D) is anticipated to refine groundwater flow north of the basin and provide additional groundwater chemistry data north of CW-5. Wells AW-2S/D and AW-5S/D are anticipated to be located between the West Ash Basin and the East Ash Basin to refine groundwater flow between the basins and provide additional groundwater geochemical data in this area. An additional well pair (AW-3S/D) is anticipated to be located near the northeast corner of the gypsum pad. This pair will further refine groundwater flow and provide additional groundwater geochemistry area between the East Ash Basin and canal to the north.

The approximate locations of the additional monitoring wells are shown on **Figure 4.** A summary of the boring details is provided in **Table 3**.

7.4.5 Groundwater Sampling

It is anticipated that groundwater samples will be collected using a low-flow sampling technique consistent with compliance monitoring well sampling protocol. The groundwater samples will be analyzed for the parameters listed in **Table 2**. Total and dissolved metals analysis will be conducted. A summary of the anticipated groundwater samples is included in **Table 3**.

During groundwater sampling activities, water level measurements will be made at the existing site monitoring wells, observation wells, and piezometers, along with the new wells. The data will be used to generate water table and potentiometric maps of the upper and lower portions of the surficial aquifer zones, as well as to determine the degree of residual saturation beneath the ash basins.

7.5 Influence of Pumping Wells on Groundwater System

No pumping or production wells have been reported onsite. Potentially, one production well exists at a neighboring industry within 0.25 mile of the East Ash Basin. This well is located across the canal from the Plant and is not expected to substantially influence the groundwater flow system near the ash basins. Preliminary information indicates 57 potential private water supply wells may be located within a 0.5 mile radius of the compliance boundary. The wells are located upgradient from the ash basins. It is anticipated that due to the distance from the ash basins and likely limited withdrawal rates, the use of the off-site wells should not substantially affect the groundwater flow system near the ash basins. Additional information on the potential off-site water supply wells will also be collected as part of the assessment.

7.6 Site Conceptual Model

Existing and new hydrogeological data will be used to develop a Site Conceptual Model (SCM). The SCM will be developed in accordance with "*Evaluating Metals in Groundwater at DWR Permitted Facilities*" (July 2012) and the May 31, 2007 NCDENR Memorandum entitled *Hydrogeologic Investigation and Reporting Policy*. The SCM will define the groundwater flow systems at the site, horizontally and vertically, and provide a better understanding of the fate and transport of constituents of concern in groundwater. This information will be used to develop a groundwater computer model. **Figure 4** shows the proposed locations for Geologic Cross Sections anticipated for the SCM.

7.7 Development of Groundwater Computer Model

Data from existing and new monitoring wells will be used to develop a groundwater computer model of the system. The groundwater modeling will be conducted in accordance with the requirements of the May 31, 2007 NCDENR Memorandum entitled *Groundwater Modeling Policy*.

At this time, it is anticipated that a numerical groundwater flow model will be developed using the MODFLOW finite difference model that was developed by the USGS and is one of the most widely accepted and widely used groundwater flow models. The MODFLOW model will be created as a multi-layer flow model to better determine the vertical flow component of the aquifer system which will allow for more accurate fate and transport modeling. Once the model is created, it will be calibrated to site conditions by modifying model inputs, such as hydraulic conductivity, within established limits based on actual site data, until a reasonable match between the model and actual site conditions is accomplished.

After the MODFLOW model is calibrated, the modeled flow data will be imported into MT3D or RT3D and a fate and transport model will be created. MT3D and RT3D are three-dimensional numerical solute fate and transport model, which will be used to predict the short and long-term movement of the constituents of interest in groundwater at the site and under the various predictive scenarios discussed above.

Due to the data requirements of the computer modeling, the computer model will be completed after the majority of the groundwater assessment activities. The results of the groundwater modeling are anticipated as an appendix to the CSA Report.

8.0 IMPLEMENTATION SCHEDULE AND REPORT SUBMITTAL

Implementation will take place immediately following approval of this Groundwater Assessment Plan by DWR. The anticipated schedule of activities and project completion following plan approval is provided below.

- 10 days to begin field activities upon approval of plan
  (Including, but not limited to, notification of public utility locate services, road access clearing, container requests from laboratories for the soil and groundwater samples, assemble information on existing site wells and piezometers in addition to compliance boundary well information)

- 60 days to complete field activities
  - Complete drilling activities
  - Conduct slug tests
  - Survey soil borings, wells, and other assessment locations
  - Collect groundwater and other assessment samples
  - Collect site-wide water levels
  - Setup groundwater computer model

- 30 days after completion of field activities receive analytical data

- 60 days after receipt of analytical data evaluate results, conduct statistical evaluation, prepare summary tables, develop CSM, and calibrate computer model.

- 20 days to complete Assessment Report, per NC Senate Bill 729, August 2014.

- 90 days (up to 180 days) to complete computer modeling and Corrective Action Plan, per NC Senate Bill 729, August 2014.

- Conduct additional work as may be required to complete the CSA.

- 90 days to complete CSA preparation, review, and submittal, in accordance with NCDENR guidance (August 2014).

Project Assumptions Include:

- No more than one iterative assessment step will be required;
- DEP will make a diligent effort to collect all receptor information in accordance with NCDENR guidance (August 2014); however, it is anticipated that all such information may not be available;
- If off-site water supply wells sampling is deemed necessary, NCDENR staff may be requested to assist with access;
- No special permitting is anticipated; and
- Data may not reflect all seasonal or extreme hydrologic conditions.
- During the CSA process if additional investigations are required NCDENR, will be notified.
- In addition to the components listed above, a human health and ecological risk assessment will be conducted.

9.0 REFERENCES

ASTM D4044-96 Standard Test Method (Field Procedure) for Instantaneous Change in Head (Slug) Tests for Determining Hydraulic Properties of Aquifers

Hibbard, James P., Glenn S. Shell, Phillip J. Bradley, Scott D. Samson, and Greg L. Wortman, February 1998, *The Hyco shear zone in North Carolina and southern Virginia: Implications for the Piedmont Zone-Carolina Zone boundary in the southern Appalachians*. American Journal of Science, V. 298, p. 85 – 107.

Hibbard, James P., Edward F. Stoddard, Donald T. Secor, and Allen J. Dennis, 2002, *The Carolina Zone: overview of Neoproterozoic to Early Paleozoic peri-Gondwanan terranes along the eastern Flank of the southern Appalachians*: Earth Science Reviews, v. 57.

NCDENR Document, "Hydrogeologic Investigation and Reporting Policy Memorandum", dated May 31, 2007.

NCDENR Document, "Groundwater Modeling Policy Memorandum", dated May 31, 2007.

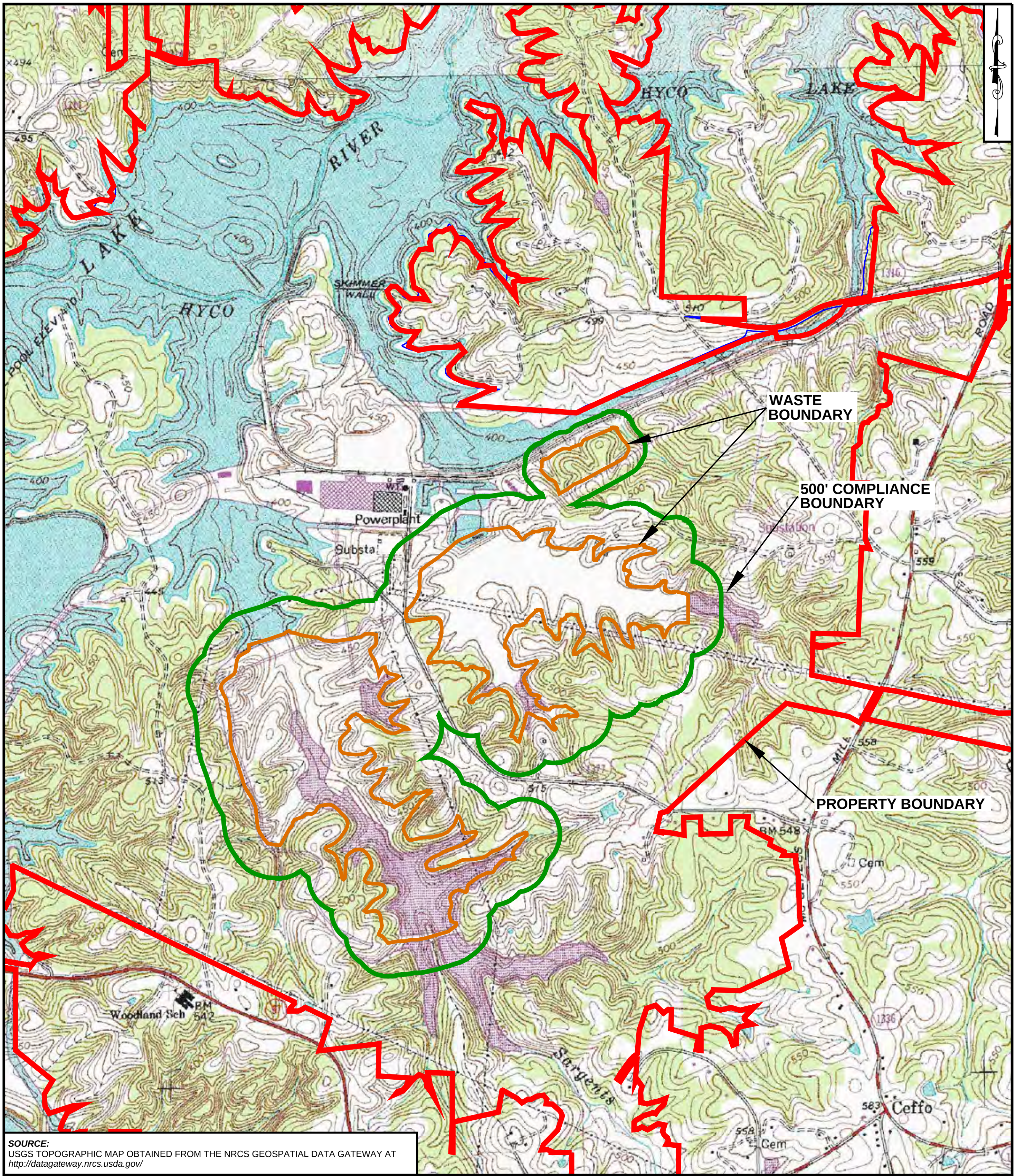
NCDENR Document, "Performance and Analysis of Aquifer Slug Tests and Pumping Test Policy", dated May 31, 2007.

North Carolina Geological Survey, 1985, *Geologic map of North Carolina*: North Carolina Geological Survey, General Geologic Map , scale 1:500000.

USGS, December 2007, *Preliminary integrated geologic map databases for the United States: Alabama, Florida, Georgia, Mississippi, North Carolina, and South Carolina.* United States Geological Survey Open-File Report 2005-1323, Version 1.1.

Wilkins, James K., Glenn S. Shell, and James P. Hibbard, 1995, *Geologic contrasts across the central Piedmont Suture in north-central North Carolina*. South Carolina Geology, V. 37, p. 25 – 32.

FIGURES



SOURCE:
USGS TOPOGRAPHIC MAP OBTAINED FROM THE NRCS GEOSPATIAL DATA GATEWAY AT
http://datagateway.nrcs.usda.gov/

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GREENVILLE, SOUTH CAROLINA
PHONE 864-421-9999
www.synterracorp.com

ROXBORO POWER PLANT
PERSON COUNTY

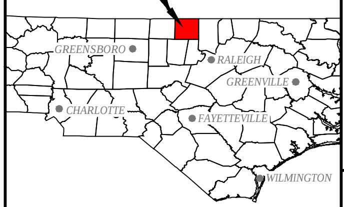

FIGURE 1
SITE LOCATION MAP
DUKE ENERGY PROGRESS
ROXBORO STEAM ELECTRIC PLANT
1700 DUNWAY RD
SEMORA, NORTH CAROLINA
OLIVE HILL, NC QUADRANGLE

DRAWN BY: S. ARLEDGE
PROJECT MANAGER: KATHY WEBB
LAYOUT: FIG 1 (USGS SITE LOCATION)

DATE: 2014-09-25
CONTOUR INTERVAL: 10ft
MAP DATE: 1994

GRAPHIC SCALE
1000 0 1000 2000
IN FEET

LEGEND

- BG-1 — BACKGROUND MONITORING WELL (SURVEYED)
- CW-1 — COMPLIANCE MONITORING WELL (SURVEYED)
- CMW-8 — LANDFILL MONITORING WELL (SURVEYED)
- DUKE ENERGY PROGRESS ROXBORO PLANT
- 500 ft COMPLIANCE BOUNDARY
- WASTE BOUNDARY
- LEACHATE MONITORING LOCATION

SOURCES:

1. 2012 AERIAL PHOTOGRAPH OF PERSON COUNTY, NORTH CAROLINA WAS OBTAINED FROM THE USGS EARTH EXPLORER WEB SITE AT *http://earthexplorer.usgs.gov/*
2. WELL SURVEY INFORMATION, PROPERTY LINE, LANDFILL LIMITS AND BOUNDARIES ARE FROM ARCGIS FILES PROVIDED BY S&ME AND PROGRESS ENERGY.
3. 2014 AERIAL PHOTOGRAPH WAS OBTAINED FROM WSP FLOWN ON APRIL 17, 2014.
4. DRAWING HAS BEEN SET WITH A PROJECTION OF NORTH CAROLINA STATE PLANE COORDINATE SYSTEM FIPS 3200 (NAD 83).

GRAPHIC SCALE
500 0 500 1000
IN FEET

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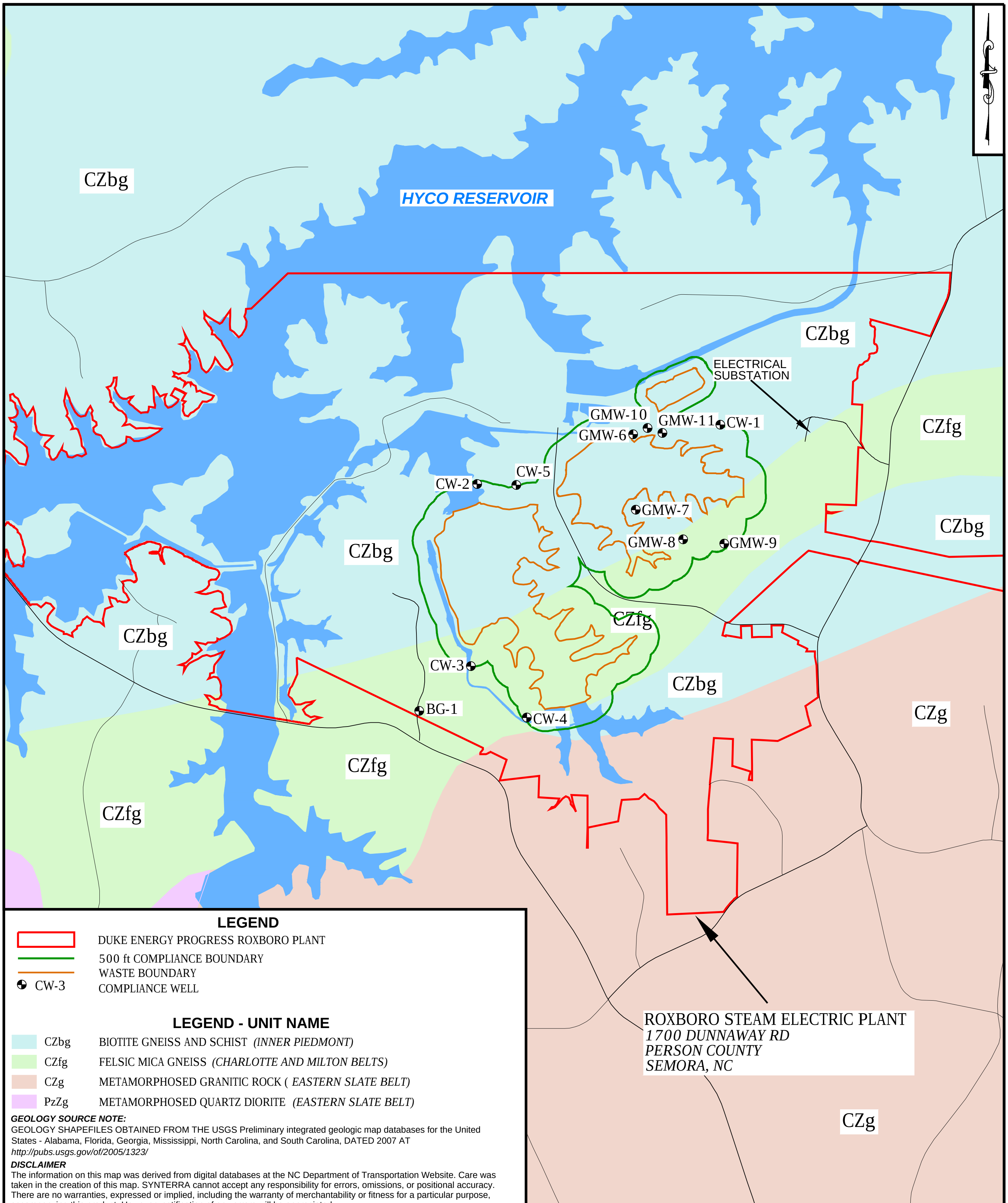
864-421-9999
www.synterracorp.com

DRAWN BY: S. ARLEDGE	DATE: 2014-09-25
CHECKED BY: J. WYLIE	DATE: 2014-09-25
PROJECT MANAGER: K. WEBB	
LAYOUT NAME: FIG 2 (SITE LAYOUT)	

DUKE ENERGY PROGRESS

ROXBORO STEAM ELECTRIC PLANT
1700 DUNNAWAY RD
SEMORA, NORTH CAROLINA

FIGURE 2
SITE LAYOUT



LEGEND

DUKE ENERGY PROGRESS ROXBORO PLANT
500 ft COMPLIANCE BOUNDARY
WASTE BOUNDARY
CW-3 COMPLIANCE WELL

LEGEND - UNIT NAME

CZbg	BIOTITE GNEISS AND SCHIST	*(INNER PIEDMONT)*
CZfg	FELSIC MICA GNEISS	*(CHARLOTTE AND MILTON BELTS)*
CZg	METAMORPHOSED GRANITIC ROCK (	*EASTERN SLATE BELT)*
PzZg	METAMORPHOSED QUARTZ DIORITE	*(EASTERN SLATE BELT)*

GEOLOGY SOURCE NOTE:
GEOLOGY SHAPEFILES OBTAINED FROM THE USGS Preliminary integrated geologic map databases for the United States - Alabama, Florida, Georgia, Mississippi, North Carolina, and South Carolina, DATED 2007 AT *http://pubs.usgs.gov/of/2005/1323/*

DISCLAIMER
The information on this map was derived from digital databases at the NC Department of Transportation Website. Care was taken in the creation of this map. SYNTERRA cannot accept any responsibility for errors, omissions, or positional accuracy. There are no warranties, expressed or implied, including the warranty of merchantability or fitness for a particular purpose, accompanying this product. However, notification of any errors will be appreciated.

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GRAPHIC SCALE
1500 0 1500 3000
IN FEET

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www.synterracorp.com

DRAWN BY: S. ARLEDGE DATE: 2014-09-25
PROJECT MANAGER: KATHY WEBB
LAYOUT: FIG 3 (GEOLOGY MAP)

FIGURE 3
GEOLOGY MAP
DUKE ENERGY PROGRESS
ROXBORO STEAM ELECTRIC PLANT
1700 DUNNAWAY RD
SEMORA, NORTH CAROLINA

LEGEND

BG-1	BACKGROUND MONITORING WELL (SURVEYED)
CW-1	COMPLIANCE MONITORING WELL (SURVEYED)
CMW-8	LANDFILL MONITORING WELL (SURVEYED)
MW-1	EXISTING MONITORING WELLS / PIEZOMETERS / SOIL BORINGS (APPROXIMATE)
P-2	ASH LANDFILL LEACHATE MONITORING LOCATION (APPROXIMATE)
	DUKE ENERGY PROGRESS ROXBORO PLANT
	500 ft COMPLIANCE BOUNDARY
	WASTE BOUNDARY
	PARCEL LINE (PERSON CO GIS)
120	2007 LiDAR CONTOUR MAJOR
	FLOW DIRECTION
	GENERALIZED GROUNDWATER FLOW DIRECTION • SUPPORTED BY GROUNDWATER ELEVATION DATA OR TOPOGRAPHIC DATA
AW-3S	ANTICIPATED MONITORING WELL LOCATION
AB-4	ANTICIPATED ASH/SOIL BORING LOCATION
A - - - - A'	ANTICIPATED GEOLOGIC CROSS SECTION

SOURCES:

1. 2012 AERIAL PHOTOGRAPH OF PERSON COUNTY, NORTH CAROLINA WAS OBTAINED FROM THE USGS EARTH EXPLORER WEB SITE AT *http://earthexplorer.usgs.gov/*
2. WELL SURVEY INFORMATION, PROPERTY LINE, LANDFILL LIMITS AND BOUNDARIES ARE FROM ARCGIS FILES PROVIDED BY S&ME AND PROGRESS ENERGY.
3. PARCEL BOUNDARIES WERE OBTAINED FROM PERSON COUNTY (NC) GIS DATA AT *http://gis.personcounty.net*
4. 2014 AERIAL PHOTOGRAPH WAS OBTAINED FROM WSP FLOWN ON APRIL 17, 2014.
5. DRAWING HAS BEEN SET WITH A PROJECTION OF NORTH CAROLINA STATE PLANE COORDINATE SYSTEM FIPS 3200 (NAD 83).
6. 10ft CONTOUR INTERVALS FROM NCDOT LIDAR DATED 2007 *https://connect.ncdot.gov/resources/gis/pages/cont-elev_v2.aspx*

NOTE:

1. CONTOUR LINES ARE USED FOR REPRESENTATIVE PURPOSES ONLY AND ARE NOT TO BE USED FOR DESIGN OR CONSTRUCTION PURPOSES.

GRAPHIC SCALE
700 0 700 1400
IN FEET

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864-421-9999
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DRAWN BY: S. ARLEDGE	DATE: 2014-09-25
CHECKED BY: J. WYLIE	DATE: 2014-09-25
PROJECT MANAGER: K. WEBB	
LAYOUT NAME: FIG 4 (CROSS SECTIONS)(11X17)	

DUKE ENERGY PROGRESS

ROXBORO STEAM ELECTRIC PLANT
1700 DUNNAWAY RD
SEMORA, NORTH CAROLINA

FIGURE 4
ANTICIPATED SAMPLE LOCATIONS

TABLES

TABLE 1
SUMMARY OF CONCENTRATION RANGES FOR CONSTITUENTS
DETECTED GREATER THAN 2L STANDARDS
ROXBORO STEAM ELECTRIC PLANT
DUKE ENERGY PROGRESS, INC., ROXBORO, NORTH CAROLINA

	PARAMETER	CHROMIUM	IRON	MANGANESE	SULFATE	TDS	pH
	2L STANDARD (eff. 4/1/2013)	10	300	50	250	500	6.5 - 8.5
	Units	(ug/l)	(ug/l)	(ug/l)	(mg/l)	(mg/l)	SU
Well ID	Well Location Relative to Compliance Boundary	Concentration Range					
BG-1	Background	6 - 42.7	113 - 881	<2L	<2L	<2L	6.3 - 6.8
CW-1	CB	<5 - 16.9	30 - 2290	5 - 180	<2L	<2L	6.2 - 6.9
CW-2	CB	<2L	55.3 - 1190	5 - 52.9	<2L	385 - 520	<2L
CW-2D	CB	<5 - 18.6	11 - 382	<2L	<2L	<2L	<2L
CW-3	CB	<2L	26 - 1030	<2L	<2L	120 - 652	5.6 - 6.9
CW-3D	CB	<2L	53.6 - 844	48 - 416	<2L	<2L	<2L
CW-4	CB	18.9 - 29.6	15 - 391 B	<2L	<2L	323 B - 612	<2L
CW-5	CB	<2L	<2L	<2L	81.2 - 873	292 - 1510	6.4 - 6.7

Notes:

Prepared by: RBI Checked by: BER

B - Data flagged due to detection in field blank
CB - Compliance Boundary
<2L - Constituent has not been detected above 2L Standard or beyond range for pH
Shown concentration ranges only include concentrations detected above the laboratory's reporting limit

TABLE 2
ASSESSMENT PARAMETER LIST
ROXBORO STEAM ELECTRIC PLANT
DUKE ENERGY PROGRESS, INC., ROXBORO, NORTH CAROLINA

PARAMETER	UNITS	FIELD EQUIPMENT / LAB METHOD
Field Parameters		
pH	SU	YSI Professional Plus or YSI 556 MPS
Specific Conductivity	µS/cm	YSI Professional Plus or YSI 556 MPS
Temperature	C°	YSI Professional Plus or YSI 556 MPS
ORP	mV	YSI Professional Plus or YSI 556 MPS
Dissolved Oxygen	mg/L	YSI Professional Plus or YSI 556 MPS
Turbidity	NTU	Hach 2100Q
Lab Parameters - Inorganics (Total & Dissolved)		
Antimony	µg/L	EPA 200.8
Arsenic	µg/L	EPA 200.8
Barium	mg/L	EPA 200.7
Boron	mg/L	EPA 200.7
Cadmium	µg/L	EPA 200.8
Chromium	µg/L	EPA 200.8
Copper	mg/L	EPA 200.7
Iron	mg/L	EPA 200.7
Lead	µg/L	EPA 200.8
Manganese	mg/L	EPA 200.7
Mercury	µg/L	EPA 245.1
Molydbenum	µg/L	EPA 200.8
Nickel	µg/L	EPA 200.8
Selenium	µg/L	EPA 200.8
Thallium (low level)	µg/L	EPA 200.8
Zinc	mg/L	EPA 200.7
Lab Parameters - Anions/Cations		
Nitrate as Nitrogen	mg-N/L	EPA 300.0
Ferrous Iron	mg/L	(Field Test Kit)
Sulfate	mg/L	EPA 300.0
Sulfide	mg/L	SM 4500 Sd
Methane	mg/L	RSK 175
Chloride	mg/L	EPA 300.0
Calcium	mg/L	EPA 200.7
Magnesium	mg/L	EPA 200.7
Sodium	mg/L	EPA 200.7
Potassium	mg/L	EPA 200.7
Bromide	mg/L	EPA 300.1
Total Organic Carbon	mg/l	EPA 5310
Alkalinity (as CaCO3)	mg/L	SM 2320B
Total Dissolved Solids	mg/L	SM 2540C

Prepared by: RBI Checked by: JAW

Notes:

SU - Standard Units
µS/cm - microsiemens per centimeter
C° - degrees Celsius
mV - millivolts
mg/L - milligrams per liter
NTU - Nephelometric Turbidity Units
µg/L - micrograms per liter
mg-N/L - milligrams nitrate (as nitrogen) per liter

TABLE 3
ASSESSMENT SAMPLING PLAN
ROXBORO STEAM ELECTRIC PLANT
DUKE ENERGY PROGRESS, INC., SEMORA, NORTH CAROLINA

ASH MANAGEMENT AREA	BORING / WELL ID	ESTIMATED BORING DEPTH (ft bgs)	ESTIMATED NO. OF SAMPLES	SAMPLE MEDIA	SAMPLE DEPTHS/INTERVALS/ TARGET ZONES	LAB ANALYSIS	PURPOSE/NOTES
Ash Basin	AB-1	40	4-5	Ash Ash Ash Soil Soil	1-2' Intermediate (if >20' thick) Above ash/soil contact 2' Below ash/soil contact Bottom of boring	Total metals + SPLP Total metals + SPLP Total metals + SPLP Total metals + Geotech Total metals + Geotech	Refine ash thickness, determine residual saturation of ash, characterize ash chemistry and leachability, characterize soil chemistry beneath ash, geologic cross section, groundwater modeling
	AB-2	40	4-5	Ash Ash Ash Soil Soil	1-2' Intermediate (if >20' thick) Above ash/soil contact 2' Below ash/soil contact Bottom of boring	Total metals + SPLP Total metals + SPLP Total metals + SPLP Total metals + Geotech Total metals + Geotech	Refine ash thickness, determine residual saturation of ash, characterize ash chemistry and leachability, characterize soil chemistry beneath ash, geologic cross section, groundwater modeling
	AB-3	40	4-5	Ash Ash Ash Soil Soil	1-2' Intermediate (if >20' thick) Above ash/soil contact 2' Below ash/soil contact Bottom of boring	Total metals + SPLP Total metals + SPLP Total metals + SPLP Total metals + Geotech Total metals + Geotech	Refine ash thickness, determine residual saturation of ash, characterize ash chemistry and leachability, characterize soil chemistry beneath ash, geologic cross section, groundwater modeling
	AB-4	40	4-5	Ash Ash Ash Soil Soil	1-2' Intermediate (if >20' thick) Above ash/soil contact 2' Below ash/soil contact Bottom of boring	Total metals + SPLP Total metals + SPLP Total metals + SPLP Total metals + Geotech Total metals + Geotech	Refine ash thickness, determine residual saturation of ash, characterize ash chemistry and leachability, characterize soil chemistry beneath ash, geologic cross section, groundwater modeling
	AB-5	40	4-5	Ash Ash Ash Soil Soil	1-2' Intermediate (if >20' thick) Above ash/soil contact 2' Below ash/soil contact Bottom of boring	Total metals + SPLP Total metals + SPLP Total metals + SPLP Total metals + Geotech Total metals + Geotech	Refine ash thickness, determine residual saturation of ash, characterize ash chemistry and leachability, characterize soil chemistry beneath ash, geologic cross section, groundwater modeling
New Monitoring Wells	BW-1D	100	3	Soil Soil Water	Just above the water table Within transition zone Screened interval	Total metals Total metals Table 2 List Table 2 List	Groundwater modeling, statistical evaluation, and sentinel well
	BW-2S/D	50 100	4	Soil Soil Water Water	Just above the water table Within transition zone Screened interval Screened interval	Total metals Total metals Table 2 List Table 2 List	Groundwater modeling, statistical evaluation, and sentinel well
	BW-3S/D	50 100	4	Soil Soil Water Water	Just above the water table Within transition zone Screened interval Screened interval	Total metals Total metals Table 2 List Table 2 List	Groundwater modeling, statistical evaluation, and sentinel well
	AW-1S/D	20 50	4	Soil Soil Water Water	Just above the water table Within transition zone Screened interval Screened interval	Total metals + Geotech Total metals + Geotech Table 2 List Table 2 List	Groundwater modeling and horizontal and vertical extent
	AW-2S/D	20 50	4	Soil Soil Water Water	Just above the water table Within transition zone Screened interval Screened interval	Total metals + Geotech Total metals + Geotech Table 2 List Table 2 List	Groundwater modeling and horizontal and vertical extent
	AW-3S/D	20 50	4	Soil Soil Water Water	Just above the water table Within transition zone Screened interval Screened interval	Total metals + Geotech Total metals + Geotech Table 2 List Table 2 List	Groundwater modeling and horizontal and vertical extent
	AW-4D	100	3	Soil Soil Water	Just above the water table Within transition zone Screened interval	Total metals Total metals Table 2 List Table 2 List	Groundwater modeling and horizontal and vertical extent
	AW-5S/D	50 100	4	Soil Soil Water Water	Just above the water table Within transition zone Screened interval Screened interval	Total metals + Geotech Total metals + Geotech Table 2 List Table 2 List	Groundwater modeling and horizontal and vertical extent
	AW-6S/D	50 100	4	Soil Soil Water Water	Just above the water table Within transition zone Screened interval Screened interval	Total metals + Geotech Total metals + Geotech Table 2 List Table 2 List	Groundwater modeling and horizontal and vertical extent
	AW-7S/D	50 100	4	Soil Soil Water Water	Just above the water table Within transition zone Screened interval Screened interval	Total metals + Geotech Total metals + Geotech Table 2 List Table 2 List	Groundwater modeling and horizontal and vertical extent
	AW-8S/D	20 50	4	Soil Soil Water Water	Just above the water table Within transition zone Screened interval Screened interval	Total metals + Geotech Total metals + Geotech Table 2 List Table 2 List	Groundwater modeling and horizontal and vertical extent
Existing Monitoring Wells	Existing Monitoring Wells	TBD	Variable	TBD	Water	Well Screen Interval (variable)	Table 2 List

Prepared by: TDP Checked by: JAW

Notes:

Total Metals - As, B, Ba, Cd, Cr, Cu, Fe, Hg, Mn,Mo, Ni, Pb, Sb, Se, Tl, and Zn.
SPLP (Synthetic Preciptation Leaching Procedure) Metals - As, B, Ba, Cd, Cr, Cu, Fe, Hg, Mn,Mo, Ni, Pb, Sb, Se, Tl, and Zn.
Geotech - Geotechnical parameters include moisture content, particle size distribution, Atterberg limits, specific gravity, and permeability.
Table 2 List - Parameter list presented in Table 2 of this document.
ft bgs - Feet below ground surface.
TBD - To be determined.

APPENDIX A

NCDENR LETTER OF AUGUST 13, 2014

NCDENR
North Carolina Department of Environment and Natural Resources

Pat McCrory
Governor

John E. Skvarla, III
Secretary

August 13, 2014

CERTIFIED MAIL 7004 2510 0000 3651 1168
RETURN RECEIPT REQUESTED

Paul Newton
Duke Energy
526 South Church Street
Charlotte, NC 28202

Subject: Notice of Regulatory Requirements
Title 15A North Carolina Administrative Code (NCAC) 02L .0106
14 Coal Ash Facilities in North Carolina

Dear Mr. Newton:

Chapter 143, North Carolina General Statutes, authorizes and directs the Environmental Management Commission of the Department of Environment and Natural Resources to protect and preserve the water and air resources of the State. The Division of Water Resources (DWR) has the delegated authority to enforce adopted pollution control rules.

Rule 15A NCAC 02L .0103(d) states that no person shall conduct or cause to be conducted any activity which causes the concentration of any substance to exceed that specified in 15A NCAC 02L .0202. As of the date of this letter, exceedances of the groundwater quality standards at 15A NCAC 02L .0200 Classifications and Water Quality Standards Applicable to the Groundwaters of North Carolina have been reported at each of the subject coal ash facilities owned and operated by Duke Energy (herein referred to as Duke).

Groundwater Assessment Plans

No later than September, 26 2014 Duke Energy shall submit to the Division of Water Resources plans establishing proposed site assessment activities and schedules for the implementation, completion, and submission of a comprehensive site assessment (CSA) report for each of the following facilities in accordance with 15A NCAC 02L .0106(g):

Asheville Steam Electric Generating Plant
Belews Creek Steam Station
Buck Steam Station
Cape Fear Steam Electric Generating Plant
Cliffside Steam Station

Dan River Combined Cycle Station
H.F. Lee Steam Electric Plant
Marshall Steam Station
Mayo Steam Electric Generating Plant
Plant Allen Steam Station
Riverbend Steam Station
Roxboro Steam Electric Generating Plant
L.V. Sutton Electric Plant
Weatherspoon Steam Electric Plant

The site assessment plans shall include a description of the activities proposed to be completed by Duke that are necessary to meet the requirements of 15A NCAC 02L .0106(g) and to provide information concerning the following:

(1) the source and cause of contamination;
(2) any imminent hazards to public health and safety and actions taken to mitigate them in accordance to 15A NCAC 02L .0106(f);
(3) all receptors and significant exposure pathways;
(4) the horizontal and vertical extent of soil and groundwater contamination and all significant factors affecting contaminant transport; and
(5) geological and hydrogeological features influencing the movement, chemical, and physical character of the contaminants.

For your convenience, we have attached guidelines detailing the information necessary for the preparation of a CSA report. The DWR will review the plans and provide Duke with review comments, either approving the plans or noting any deficiencies to be corrected, and a date by which a corrected plan is to be submitted for further review and comment or approval. For those facilities for which Duke has already submitted groundwater assessment plans, please update your submittals to ensure they meet the requirements stated in this letter and referenced attachments and submit them with the others.

<u>Receptor Survey</u>

No later than October 14th, 2104 as authorized pursuant to 15A NCAC 02L .0106(g), the DWR is requesting that Duke perform a receptor survey at each of the subject facilities and submitted to the DWR. The receptor survey is required by 15A NCAC 02L .0106(g) and shall include identification of all receptors within a radius of 2,640 feet (one-half mile) from the established compliance boundary identified in the respective National Pollutant Discharge Elimination System (NPDES) permits. Receptors shall include, but shall not be limited to, public and private water supply wells (including irrigation wells and unused or abandoned wells) and surface water features within one-half mile of the facility compliance boundary. For those facilities for which Duke has already submitted a receptor survey, please update your submittals to ensure they meet the requirements stated in this letter and referenced attachments and submit them with the others. If they do not meet these requirements, you must modify and resubmit the plans.

The results of the receptor survey shall be presented on a sufficiently scaled map. The map shall show the coal ash facility location, the facility property boundary, the waste and compliance boundaries, and all monitoring wells listed in the respective NPDES permits. Any identified water supply wells shall be located on the map and shall have the well owner's name and location address listed on a separate table that can be matched to its location on the map.

Failure to comply with the State's rules in the manner and time specified may result in the assessment of civil penalties and/or the use of other enforcement mechanisms available to the State.

We appreciate your attention and prompt response in this matter. If you have any questions, please feel free to contact S. Jay Zimmerman, Water Quality Regional Operations Section Chief, at (919) 807-6351.

Sincerely,

John E. Skvarla, III

Attachment enclosed

cc: Thomas A. Reeder, Director, Division of Water Resources
Regional Offices – WQROS
File Copy

GUIDELINES FOR COMPREHENSIVE SITE ASSESSMENT

This document provides guidelines for those involved in the investigation of contaminated soil and/or groundwater, where the source of contamination is from:

- Incidents caused by activities subject to permitting under G.S. 143-215.1
- Incidents caused by activities subject to permitting under G.S. 87-88
- Incidents arising from agricultural operations, including application of agricultural chemicals, but not including unlawful discharges, spills or disposal of such chemicals

Comprehensive Site Assessment (CSA)

NOTE: *Regional Offices may request additional information in support of the CSA to aid in their review and will not approve the CSA if any of the elements specified below have not been included or have not been sufficiently addressed*

Minimum Elements of the Comprehensive Site Assessment Report:

A. Title Page

- Site name, location and Groundwater Incident number (if assigned) and Permit Number ;
- Date of report;
- Responsible Party and/or permittee, including address and phone number;
- Current property owner including address and phone number;
- Consultant/contractor information including address and phone number;
- Latitude and longitude of the facility; and
- Seal and signature of certifying P.E. or P.G., as appropriate.

B. Executive Summary

The Executive Summary should provide a brief overview of the pertinent site information (i.e., provide sufficient information to acquaint the reader with the who, what, when, where, why and how for site activities to date).

1. Source information:
    - Type of contaminants
2. Initial abatement/emergency response information.

3. Receptor information:
    - Water supply wells;
    - Public water supplies (wells, surface water intakes);
    - Surface water bodies;
    - Wellhead protection areas;
    - Deep aquifers in the Coastal Plain physiographic region;
    - Subsurface structures; and
    - Land use.
4. Sampling/investigation results:
    - Nature and extent of contamination;
    - Maximum contaminant concentrations;
    - Site hydrogeology.
5. Conclusions and recommendations.

C. Table of Contents

- First page number for each section listed.
- List of figures (all referenced by number and placed in a single section following contents text).
- List of tables (all referenced by number and placed in a single section following contents text).
- List of appendices.

D. Site History and Source Characterization

- Provide a history of property ownership and use. Indicate dates of ownership, uses of the site, and potential sources of contaminants.
- Discuss the source(s) of contamination, including primary and secondary sources.
- For permitted activities, describe nature of activity, permitted waste, application of all instances of over-application/irrigation of wastes or water
- Summarize assessment activities and corrective actions performed to date including emergency response, initial abatement, primary and secondary source removal.
- Discuss geographical setting and present/future surrounding land uses.

E. Receptor Information

- Provide a site map showing labeled well locations within a minimum of 1500 feet of the known extent of contamination. Key to the table and maps described.

NOTE: *As the known extent of contamination changes, the receptor survey must be updated to reflect the change. This applies throughout the Receptor Information section.*

- In table format, list all water supply wells, public or private, including irrigation wells and unused wells, (omit those that have been properly abandoned in accordance with 15A NCAC 2C .0100) within a minimum of 1500 feet of the known extent of contamination. Note whether well users are also served by a municipal water supply.
- For each well, include well number, well owner and user names, addresses and telephone numbers, use of the well, well depth, well casing depth, well screen interval, and distance from source of contamination;

NOTE: *It will often be necessary to conduct any or all of the following in order to ensure reliability in a water supply well survey:*

  - *Call the city/county water department to inquire about city water connections;*
  - *Visit door-to-door (make sure that you introduce yourself and state your purpose to residents prior to examining their property) to obtain accurate description of water usage, and if some residents are not at home, ask surrounding neighbors who are home about the water usage at those residences. Even if a public water line is available, some residents still use their well water and are not connected to the public water system; and*
  - *Search for water meters and well houses.*

- Site map showing location of subsurface structures (e.g., sewers, utility lines, conduits, basements, septic tanks, drain fields, etc.) within a minimum of 1,500 feet of the known extent of contamination;
- Table of surrounding property owner addresses;
- Discuss the availability of public water supplies within a minimum of 1,500 feet of the source area, including the distance and location to the nearest public water lines and the source(s) of the public water supply;

- Identify all surface water bodies (e.g., ditch, pond, stream, lake, river) within a minimum of 1,500 feet of the source of contamination;
- Determine the location of any designated wellhead protection areas as defined in 42 USC 300h-7(e) within a minimum of 1,500 feet of the source of contamination. Identify and discuss the location of the water supply well(s) for which the area was designated a wellhead protection area, and the extent of the protected area. Include information about the well owner, well-construction specifications (especially at screened intervals), pumping rate and pumping schedule. Information regarding designated wellhead protection areas may be obtained by contacting the Public Water Supply Section at (919) 707-9083;
- Discuss the uses and activities (involving possible human exposure to contamination) that could occur at the site and adjacent properties. Examples of such activities and uses include but are not limited to use of a property for an office, manufacturing operation, residence, store, school, gardening or farming activities, recreational activities, or undeveloped land;
- Determine whether the contaminated area is located in an area where there is recharge to an unconfined or semi-confined deeper aquifer that is being used or may be used as a source of drinking water. Based on a review of scientific literature on the regional hydrogeology and well construction records and lithological logs for deeper wells in the area, identify and describe the deep aquifers underlying the source of contamination. Include information on the depth of the deep aquifer in relation to the surficial saturated zone, the lithology and hydraulic conductivity of the strata between the surficial aquifer and the deeper aquifer, and the difference in groundwater head between the surficial aquifer and the deeper aquifer. Discuss the local and regional usage of the deep aquifer and the draw down from major pumping influences. Also, specify the distance from the source of contamination to major discharge areas such as streams and rivers. Cite all sources and references used for this discussion.

NOTE: *This requirement (last bullet) only pertains to* *contamination sources in the Coastal Plain physiographic region as designated on a map entitled "Geology of North Carolina" published by the Department in 1985. However, recharge/discharge, hydraulic conductivity, lithology, head difference, etc. is also important information at mountains and piedmont sites.*

F. Regional Geology and Hydrogeology

Provide a brief description of the regional geology and hydrogeology. Cite all references.

G. Site Geology and Hydrogeology

- Describe the soil and geology encountered at the site. Use the information obtained during assessment activities (e.g., lithological descriptions made during drilling, probe surveys, etc.). This information should correspond to the geologic cross sections required in N. below; and
- Based on the results of the groundwater investigation, describe the site hydrogeology, including a discussion of groundwater flow direction, hydraulic gradient, hydraulic conductivity and groundwater velocity. Discuss the effects of the geologic and hydrogeological characteristics on the migration, retardation, and attenuation of contaminants.

H. Soil Sampling Results

Using figures and tables to the extent possible, describe all soil sampling performed to date and provide the rationale for sample locations, number of samples collected, etc. Include the following information:

- Location of soil samples;
- Date of sampling;
- Type of soil samples (from excavation, borehole, Geoprobe, etc.);
- Soil sample collection procedures (split spoon, grab, hand auger, etc.)
- Depth of soil samples below land surface;
- Soil sample identification
- Soil sample analyses;
- Soil sample analytical results (list any contaminant detected above the method detection limit); and

- Identify any sample analytical results that exceed the applicable cleanup levels.

NOTE: *Information related to H. above should correspond to the sampling location and sampling results maps required in N. below.*

I . Groundwater Sampling Results

Using figures and tables to the extent possible describe the groundwater sampling performed to date and provide the rationale for sample locations (based on source and contaminant type), number of samples collected, etc. Include the following information:

- Location of groundwater samples and monitoring wells;
- Date of sampling;
- Groundwater sample collection procedures (bailer, pump, etc.);
- Groundwater sample identification and whether samples were collected during initial abatement, CSA, etc.;
- Groundwater sample analyses;
- Groundwater sample analytical results (list any contaminant detected above the method detection limit; and
- Identify all sample analytical results that exceed 15A NCAC 2L or interim standards.

NOTE: *Information related to I. above should correspond to the sampling location and sampling results maps required in N. below.*

J. Hydrogeological Investigation

Describe the hydrogeological investigation performed including all methods, procedures and calculations used to characterize site hydrogeological conditions. The following information should be discussed and should correspond to the maps and figures required below:

- Groundwater flow direction;
- Hydraulic gradient (horizontal and vertical);
- Hydraulic conductivity;
- Groundwater velocity;
- Contaminant velocity;
- Slug test results; *
- Aquifer test results; *
- Plume's physical and chemical characterization; and
- Fracture trace study if groundwater in bedrock is impacted. *

** Check with the Regional Office prior to performing these tests and study to see if necessary for the site.*

K. Groundwater Modeling Results

Groundwater modeling or predictive calculations may be necessary at some sites (source area proximate to surface water, source area located within wellhead protection area or source area overlying semi-confined or unconfined deeper Coastal Plain aquifer) to verify, based on site specific hydrogeological conditions, whether groundwater contamination poses a risk to receptors. For contamination shown to pose a risk to receptors, groundwater modeling may be necessary to determine an appropriate cleanup level for contaminated groundwater. Modeling should illustrate the input data used to complete the model and will generally be required for natural attenuation proposals (see *Groundwater Modeling Policy* at http://portal.ncdenr.org/web/wq/aps/gwpro/policy).

NOTE: *Input data for models should be derived from site specific information with limited assumptions or estimates. All assumptions and estimated values including biodegradation rates must be conservative (predict reasonable worst-case scenarios) and must be well documented.*

L. Discussion

- Nature and extent of contamination, including primary and secondary source areas, and impacted groundwater and surface water resources;
- Maximum contaminant concentrations;
- Contaminant migration and potentially affected receptors

M. Conclusions and Recommendations

If corrective action will be necessary, provide a preliminary evaluation of remediation alternatives appropriate for the site. Discuss the remediation alternatives likely to be selected. Note that for impacts to groundwater associated with permitted activities, corrective action pursuant to 15A NCAC 2L .0106(k), (l) and (m) is not applicable, unless provided for pursuant to 15A NCAC 2L .0106(c) and (e) or through a variance from the Environmental Management Commission (EMC).

N. Figures

- 71/2 minute USGS topographic quadrangle map showing an area within a minimum of a 1,500-foot radius of the source of contamination and depicting the site location, all water supply wells, public water supplies, surface water intakes, surface water bodies, designated well head protection areas, and areas of recharge to deeper aquifers in the Coastal Plain that are or may be used as a source for drinking water;

- Site map locating source areas, site boundaries, buildings, all water supply wells within a minimum of 1,500 feet, named roads/easements/right-of-ways, subsurface utilities, product or chemical storage areas, basements and adjacent properties, scale and north arrow;

- At least two geologic cross sections through the saturated and unsaturated zones intersecting at or near right angles through the contaminated area using a reasonable vertical exaggeration. Indicate monitoring well/sample boring/sample locations and analytical results for soil samples. Identify the depth to the water table. Provide a site plan showing the locations of the cross sections;

- Site map(s) showing the results of all soil sampling conducted. Indicate sampling identifications, sampling depths, locations and analytical results;

- Site map(s) showing the results of all groundwater sampling conducted. Indicate sampling locations, monitoring well identifications, sample identifications, and analytical results;

- Separate groundwater contaminant iso-concentration contour maps showing total volatile organic compound concentrations, total semi-volatile organic compound concentrations and concentrations for the most extensive contaminant. Maps should depict the horizontal and vertical extent. Contour line for applicable 2L standard should be shown in bold;

- Site map(s) showing the elevation of groundwater in the monitoring wells and the direction of groundwater flow. Contour the groundwater elevations. Identify and locate the datum (arbitrary

100', USGS, NGVD) or benchmark. Indicate the dates that water level measurements were made. There should be one map for each series of water level measurements obtained;

- Groundwater contaminant iso-concentration contour cross-section; and

- Site map(s) showing the monitoring wells.

NOTE: *If possible, use a single base map to prepare site maps using a map scale of 1 inch = 40 feet (or a smaller scale for large sites, if necessary). Maps and figures should include conventional symbols, notations, labeling, legends, scales, and north arrows and should conform to generally accepted practices of map presentation such as those enumerated in the US Geological Survey pamphlet, "Topographic Maps".*

O. Tables

- List all water supply wells , public or private, including irrigation wells and unused wells, (omit those that have been properly abandoned in accordance with 15A NCAC 2C .0100) within a minimum of 1500 feet of the known extent of contamination For each well, include the well number (may use the tax map number), well owner and user names, addresses and telephone numbers, use of the well, well depth, well casing depth, well screen interval and distance from the source of contamination;

- List the names and addresses of property owners and occupants within or contiguous to the area containing contamination and all property owners and occupants within or contiguous to the area where the contamination is expected to migrate;

- List the results for groundwater samples collected including sample location; date of sampling; sample collection procedures (bailer, pump, etc.); sample identifications; sample analyses; and sample analytical results (list any contaminant detected above the method detection limit in bold); and

- List for each monitoring well, the monitoring well identification numbers, date water levels were obtained, elevations of the water levels, the land surface, top of the well casing, screened interval and bottom of the well.

P Appendices

- Boring logs and lithological descriptions;
- Well construction records;
- Standard procedures used at site for sampling, field equipment decontamination, field screening, etc.;
- Laboratory reports and chain-of-custody documents;
- Copies of any permits or certificates obtained, permit number, permitting agency, and
- Modeling data and results;
- Slug/pumping test data; and
- Certification form for CSA

DIVISION OF WATER RESOURCES

Certification for the Submittal of a Comprehensive Site Assessment

Responsible Party and/or Permittee: ____________________________
Contact Person: ____________________________
Address: ____________________________
City: ________________ **State:** ________ **Zip Code:** ________
Site Name: ____________________________
Address: ____________________________
City: ________________ **State:** ________ **Zip Code:** ________
Groundwater Incident Number (applicable): __________

I, ________________________, a Professional Engineer/Professional Geologist (circle one) for ____________________________(firm or company of employment) do hereby certify that the information indicated below is enclosed as part of the required Comprehensive Site Assessment (CSA) and that to the best of my knowledge the data, assessments, conclusions, recommendations and other associated materials are correct, complete and accurate.

(Each item must be initialed by the certifying licensed professional)

1. __________The source of the contamination has been identified. A list of all potential sources of the contamination are attached.

2. __________Imminent hazards to public health and safety have been identified.

3. __________Potential receptors and significant exposure pathways have been identified.

4. __________Geological and hydrogeological features influencing the movement of groundwater have been identified. The chemical and physical character of the contaminants have been identified.

5. __________The CSA sufficiently characterizes the cause, significance and extent of groundwater and soil contamination such that a Corrective Action Plan can be developed. If any of the above statements have been altered or items not initialed, provide a detailed explanation. Failure to initial any item or to provide written justification for the lack thereof will result in immediate return of the CSA to the responsible party.

(Please Affix Seal and Signature)