Robinson Ash Basin Closure Investigation

Conceptual Closure Planning Update

H.B Robinson Steam Electric Plant, Darlington County, SC

December 2014

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Executive Summary

The purpose of this Conceptual Closure Planning document is to present South Carolina Department of Health and Environmental Control (SCDHEC) with an update of Duke Energy's progress to date on the Robinson Ash Basin Closure Investigation and describe future work activities that will support development of a preferred ash basin closure plan.

Duke Energy conducted a geotechnical and environmental exploration program in and around the H.B. Robinson Steam Electric Plant (Robinson Plant) Unit 1 ash basin and 1960 Fill Area (collectively referred to as the ash management areas) between July and November 2014. The program consisted of soil borings, groundwater monitoring well installation, testing of soil, ash, groundwater and free water, and in-situ hydraulic conductivity testing. A summary of data and information collected as part of the geotechnical and environmental exploration program, along with a summary of results, is provided in this update report. A more detailed description of data collected, methodologies used, and testing results is provided in the companion Robinson Ash Basin Closure Investigation Data Report (HDR 2014).

The data derived from the field investigation program is being evaluated to achieve the following project objectives:

- Determine the amount of coal ash residue in the ash basin and 1960 Fill Area
- Characterize subsurface material within the ash management areas, down-gradient of the ash basin, and in background areas of the site
- Develop a Site Conceptual Model (SCM) to serve as the basis for understanding the hydrogeologic characteristics of the site and ash basin (both existing and under the preferred closure option)
- Use the SCM to develop a conceptual closure plan for the ash management areas that is protective of human health and the environment and acceptable to SCDHEC Bureau of Water

Three potential permanent ash basin closure options are being considered:

- **Hybrid Cap-in-Place** whereby coal ash residue from the 1960 Fill Area would be excavated and placed into the ash basin, ash immediately behind the ash basin embankment would be moved farther west within the basin to allow breaching or removal of the embankment, and consolidated ash within the basin would be capped with an engineered cover system. Potential areas of saturated ash within the basin post-closure (based on SCM modeling) would be reduced or eliminated using appropriate engineering measures (e.g., removal of ash from saturated areas, fixing ash in place via soil mixing and/or injection of stabilizing materials, installation of infiltration cut-off walls on the upstream side of the ash basin, etc.) to prevent or minimize leaching of coal ash constituents to down-gradient areas.
- **On-Site Landfill** whereby coal ash residue from the 1960 Fill Area and ash basin would be excavated and moved to a lined landfill designed to contain coal ash residue. While not thoroughly investigated at this time, an on-site landfill could potentially be located on

the northwest side of Duke Energy's H.B. Robinson/Darlington Electric Power Plant (Darlington County Plant).

- **Off-Site Landfill** whereby coal ash residue from the 1960 Fill Area and ash basin would be excavated and hauled to a lined landfill designed and permitted to receive coal ash residue. This could either be an existing lined landfill with capacity and ability to accept the coal ash residue or a newly constructed lined landfill permitted to accept coal ash residue.

Based on data and information collected between July and November 2014, it appears that up to 18 feet of ash is saturated in the deepest portion of the ash basin (between the transmission line right-of-way and the ash basin embankment). Additional groundwater data collection and completion of a post-closure groundwater model is necessary to precisely predict the post-closure long-term groundwater level in the ash and whether additional mitigation measures are necessary to protect groundwater. This post-closure model will serve to inform decision-making on the three options described above. While the saturated depth of ash diminishes moving away from this area, it is uncertain at this time if the Hybrid Cap-in-Place closure method will reduce the amount of saturated ash in the basin to a point where this option becomes viable.

Further evaluation of data is on-going in support of the development of a preferred closure option. To that end, Duke Energy intends to perform the following work:

- Conduct further analyses of the foundation soils at the ash basin and embankment, for the Hybrid Cap-in-Place option, to determine susceptibility to liquefaction of in-situ soils during seismic events. Such liquefaction could result in differential settlement of a liner or cap and/or induced embankment failure. Analyses may consist of, but would not be limited to, laboratory cyclic triaxial testing of remolded soil samples conducted in conjunction with additional in-situ soil testing. These studies and follow-up finite element analysis will help determine engineering remedies for mitigating potential liquefaction induced differential settlements. The analyses will also be used to develop design criteria for static and post-seismic embankment stability.
- Evaluate potential impacts to the ash basin embankment and ash basin resulting from a postulated 100-year flood event and determine engineering remedies to mitigate for potential impacts
- Evaluate laboratory results from in-basin, near-basin, and background sample locations to determine site-specific coal ash residue constituents of concern
- Develop calculations to evaluate the potential for leaching of coal ash residue constituents of concern from ash into the groundwater
- Conduct three additional rounds of groundwater sampling between January and August 2015 to evaluate potential seasonal variations in groundwater quality data and groundwater surface elevations
- Complete groundwater fate and transport modeling of site-specific coal ash residue constituents of concern to evaluate mobility and concentration gradients over time and evaluate post-closure groundwater elevations in the ash basin as it relates to potential additional groundwater protection measures

The above work activities will be used to evaluate Hybrid Cap-in-Place as a permanent ash basin closure option. If Hybrid Cap-in-Place is not a suitable closure option, the On-Site and Off-Site Landfill closure options will be further investigated to determine which of these options is preferred.

Duke Energy intends to submit a detailed Supplemental Conceptual Closure Plan to SCDHEC Bureau of Water by November 20, 2015. This supplement will provide the analysis for and recommend a preferred permanent closure option for the Robinson Plant ash basin.

1.0 Introduction

1.1 Project Overview

Duke Energy Progress (Duke Energy) owns and operates the H.B. Robinson Steam Electric Plant (Robinson Plant) located near Hartsville in Darlington County, South Carolina (**Figure 1**). The Robinson Plant coal ash management facilities include a former 177-megawatt coal-fired unit (Unit 1), one ash basin located north of the Robinson Plant and west of Lake Robinson, and an older ash storage area (1960 Fill Area) located west of Unit 1 (**Figure 2**). Coal ash residue generated during the coal combustion process at Unit 1 was stored in the 1960 Fill Area from 1960 until the mid-1970s when the approximate 72-acre ash basin was constructed. The ash basin continued to receive coal ash residue until October 2012 when Unit 1 was retired.

Duke Energy retained HDR to develop a Conceptual Closure Plan (Plan) for the Robinson Plant ash basin. To do so, HDR implemented a geotechnical and environmental exploration program between July and November 2014 that consisted of soil boring completion; monitoring well installation; index property testing of soil and ash; constituent testing of soil, ash, groundwater, and free water; and in-situ hydraulic conductivity testing. The data derived from the field program is being evaluated to achieve the following project objectives:

- Determine the amount of coal ash residue in the ash basin and 1960 Fill Area
- Characterize subsurface materials within the ash management areas, down-gradient of the ash basin, and in background areas of the site
- Develop a Site Conceptual Model (SCM) to serve as the basis for understanding the hydrogeologic characteristics of the site and ash basin (both existing and under the preferred closure option)
- Use the SCM to develop a conceptual plan for closure of the ash basin that is protective of human health and the environment and acceptable to SCDHEC Bureau of Water per their guidance *Proper Closeout of Wastewater Treatment Facilities*, *Regulation 61-82*, dated April 11, 1980

The subsurface investigation included completion of 22 environmental soil borings; 11 geotechnical soil borings; installation of 30 groundwater monitoring wells; and subsequent soil, ash, groundwater, and free water sample collection and testing. Soil boring and monitoring well locations are shown on **Figure 3**. Specific details regarding the field exploration program are provided in Section 3.0 of this report.

Closure of the 1960 Fill Area will be regulated under a Consent Agreement between Duke Energy and the SCDHEC Bureau of Solid Waste. However, the final disposition of ash within the 1960 Fill Area will likely be incorporated into closure of the ash basin and is therefore discussed herein.

1.2 Purpose

The purpose of this Conceptual Closure Planning document is to present SCDHEC with an update of Duke Energy's progress to date on the Robinson Ash Basin Closure Investigation and describe future work activities that will support development of a preferred ash basin closure plan. A summary of data and information collected as part of the Robinson Ash Basin Closure Investigation, along with a summary of results, is provided in this update report. A more detailed description of data collected, methodologies used, and testing results is provided in the companion Robinson Ash Basin Closure Investigation Data Report (HDR 2014).

1.3 Report Organization

The report is organized into the following sections:

- Site background, geology, and hydrogeology are provided in Section 2.0
- A summary of the geotechnical and environmental exploration programs is provided in Section 3.0
- Results obtained from the exploration program are provided in Section 4.0
- A review of work completed and pending work is provided in Section 5.0
- Potential closure options are summarized in Section 6.0
- A schedule for refinement of the Plan is provided in Section 7.0
- References are provided in Section 8.0

2.0 Site Background

2.1 Plant Description

The Robinson Plant is a former coal-fired electricity generating facility located approximately 4.5 miles north of Hartsville, Darlington County, South Carolina. The site is bounded by Icy Street to the north, West Old Camden Road to the south, Lake Robinson to the east, and South Carolina Highway 151/West Bobo Newsome Highway to the west.

Development of the Robinson Plant facility began in the late 1950s when Black Creek was impounded to create Lake Robinson. Shortly thereafter, the coal-fired unit (Unit 1) began commercial operation in 1960 until it was retired in October 2012. The 724-megawatt nuclear unit (Unit 2) was brought online in 1971. Duke Energy also owns and operates the H.B. Robinson/Darlington Electric Power Plant (Darlington County Plant) which is located just north of the Robinson Plant and along the western shore of Lake Robinson. The 790-megawatt Darlington County Plant consists of 13 combustion-turbine units fueled by natural gas and oil.

2.2 Ash Management Facilities

The Robinson Plant coal ash management facilities include the coal-fired unit (Unit 1), one ash basin located north of the fossil and nuclear units, and the 1960 Fill Area located west of Units 1 and 2 (**Figure 2**).

The 1960 Fill Area was created in 1960 and received ash from Unit 1 until the ash basin was constructed in the mid-1970s. Between May 2013 and August 2014, Duke Energy contracted AMEC Environment & Infrastructure, Inc. (AMEC) to evaluate the extent and volume of ash stored in this area. Based on data obtained during this assessment, ash was found to cover a surficial area of approximately 25.0 acres with a maximum ash thickness of 16.3 feet. The calculated volume of ash within the 1960 Fill Area is 275,800 cubic yards (cy) (AMEC 2014).

The 72-acre ash basin is comprised of a 49-acre basin and a 23-acre dry ash storage area near the upstream (e.g., western) end of the ash basin. The basin was formed via construction of a dam across an unnamed tributary to Black Creek. The basin began receiving sluiced ash from Unit 1 in the mid-1970s, and continued to receive sluiced ash until Unit 1 was retired in October 2012. Based on data obtained during the current exploration program, ash thickness within the basin ranges from 11 feet along the northern flank of the basin to 53 feet in the middle of the basin. Ash thickness is expected to be greatest within the thalweg (i.e., deepest portion of the channel) of the former tributary to Black Creek.

There are no permitted National Pollutant Discharge Elimination System (NPDES) outfalls from the basin to Lake Robinson. However, the ash basin does have a permitted NPDES outfall to the discharge canal located northeast of the basin. In 2014, Duke Energy submitted an NPDES permit application update to re-route stormwater to the discharge canal. The basin also receives discharge from the Darlington County Plant oil/water separator. There is currently no standing water in the 1960 Fill Area or the ash basin, except for the northeastern most corner of the basin where the basin receives discharge from the Darlington County Plant.

2.3 Regional Geology/Hydrogeology

South Carolina is divided into distinct regions by portions of three physiographic provinces: the Atlantic Coastal Plain, Piedmont, and Blue Ridge (Fenneman 1938). The Coastal Plain is a region of broad, relatively flat terraces of primarily unconsolidated sediments and carbonate rocks. These materials, ranging in age from Cretaceous to Quaternary, were deposited in shallow seas by rivers draining the Blue Ridge and Piedmont provinces.

Within the upper Coastal Plain and extending across the middle of South Carolina is a narrow, irregular band of rolling hills known as the Carolina Sandhills. These rounded, gently sloping hills range in elevation from 250 to 450 feet above sea level and are generally higher than either the adjacent Piedmont or Coastal Plain regions. The Sandhills region varies in width from 5 to 30 miles, although it is absent along some large river systems such as the Congaree River near Columbia, South Carolina, where it has cut completely through the Sandhills deposits to expose the underlying Piedmont rocks.

The Robinson Plant is located within the Pee Dee area of South Carolina. According to the “Preliminary Assessment of the Groundwater in Part of the Pee Dee Region, South Carolina” (SCDHEC 2003), aquifer systems beneath the Pee Dee Region are primarily Late Cretaceous in age and include the Black Creek, Middendorf, and Cape Fear systems. Groundwater is the principal source of potable water in the Pee Dee region and the Middendorf and Middendorf/Cape Fear systems together are the primary source of groundwater for Darlington County, South Carolina. Groundwater is also obtainable from the unconfined surficial aquifer that typically extends from land surface to a depth of approximately 30 to 50 feet below land surface. Groundwater in the surficial aquifer is generally unconfined and recharged primarily from precipitation, losing streams and rivers, and up-flow from underlying aquifers. The surficial aquifer is underlain in the region by fine- to coarse-grained sands with discontinuous layers of sandy clays, kaolins, and gravel. The base of the surficial aquifer typically displays an increase in clay and kaolin and is considered to be the upper confining unit of the Middendorf aquifer. The weathered nature of the sediments in addition to similar parent material makes the exact transition between the surficial aquifer and underlying aquifers very difficult to identify.

The Middendorf aquifer overlies crystalline bedrock and extends from the Fall Line in the upper coastal plain to the Atlantic coast. Sediment within the aquifer is described as sand to gravelly sand with varying degrees of induration. Transmissivity values in the Middendorf aquifer are relatively high with individual supply wells obtaining groundwater from the aquifer producing yields of up to 2,000 gallons per minute. Groundwater in the Middendorf aquifer is under artesian conditions with primary recharge along the outcrop of the aquifer along the Fall Line and minor recharge controlled by differences in hydraulic head with neighboring aquifers. The Middendorf aquifer has reportedly experienced a potentiometric head loss of greater than 195 feet since "predevelopment" in 1927 to current levels. The primary reason for this substantial head loss has been attributed to an increase in groundwater demand in the region (Catlin 2008).

2.4 Site Geology/Hydrogeology

2.4.1 Site Geology

Based on HDR's review of soil boring and monitoring well installation logs provided by Duke Energy for previous work completed on site as well as our observations made during the current subsurface investigation, stratigraphy in the vicinity of the ash basin consists of the following material types: fill, ash, alluvium, Coastal Plain sediments, and bedrock. In general, fill was restricted to borings advanced through the ash basin dam while ash is restricted to the confines of the basin. Alluvium was present beneath ash in several borings advanced into the historic drainage feature that was dammed to create the ash basin. Coastal Plain sediments consisting predominantly of sand with some silt and clay were encountered across the site. Bedrock was reportedly encountered at 398 feet below ground surface during installation of supply Well D in December 2004. Well D is located adjacent to the Unit 2 facility, approximately 4,900 feet south of the ash basin. The general stratigraphic units, in sequence from the ground surface down to boring termination, are defined as follows:

- **Fill** – Fill material generally consisted of re-worked sand and silt that were borrowed from one area of the site and re-distributed to other areas. Based on a 1956 Earth Dam and Spillway drawing provided by Duke Energy, fill was placed around a 12-foot-wide compacted impervious core during construction of the ash basin embankment.
- **Ash** – Ash is present within the ash basin and 1960 Fill Area. Ash has been characterized in the field as gray to dark gray fine- to coarse-grained material.
- **Alluvium** – Alluvium is unconsolidated soil and sediment that has been eroded and re-deposited by streams and rivers. Alluvium may consist of a variety of materials ranging from silts and clays to sands and gravels. Alluvium was present beneath ash in several borings advanced into the historic drainage feature that was dammed to create the ash basin.
- **Coastal Plain Sediments** – Coastal Plain sediments representing fluvial or upper delta-plain depositional environments are found across the site. Based on boring logs reviewed, sediments were characterized as yellow, reddish yellow, pink, pale brown, or brown coarse- to fine-grained sand with gray to white to pink clay lenses and extend to an average depth of greater than 300 feet below ground surface (bgs).
- **Bedrock** – Bedrock was encountered in several historic well borings in the vicinity of the Unit 2 facility. Bedrock was described as "greenish rock" and presumed to represent glauconitic basement rock of the Piedmont. Bedrock was not encountered during the current conceptual closure assessment activities.

Based on the presence of alluvium and unconsolidated sediments beneath the ash basin embankment, Duke Energy will conduct liquefaction analyses during the next phase of work to determine susceptibility to differential settlement resulting from seismic events and determine engineering remedies to mitigate for potential differential settlement.

Boring logs and laboratory reports providing detailed geologic information are provided in the Data Report (HDR 2014). Based on the results of exploration activities as well as review of historical borings, well data, and drawings provided by Duke Energy, HDR developed four cross-sections (A-A' through D-D') to illustrate our interpretation of the hydrostratigraphy of the site. General section descriptions are:

- Section A-A' extends approximately west to east (i.e., longitudinally) through the ash basin
- Section B-B' extends north to south across the ash basin and dry stack area in the western extent of the basin
- Section C-C' extends north to south across the central part of the ash basin
- Section D-D' extends north to south across the eastern extent of the ash basin

The locations of cross-section lines are shown on **Figure 3**. Cross-sections A-A' and B-B' are shown on **Figure 4**. Cross-sections C-C' and D-D' are shown on **Figure 5**. Note that cross-sections are interpretations and that conditions between borings are estimated and/or inferred and were developed in part from historic drawings.

2.4.2 Site Hydrogeology

Groundwater occurrence within and around the ash basin was relatively uniform and generally follows topography across the site. Hydrogeologically, groundwater was encountered under unconfined conditions in the surficial aquifer at depths ranging from 28.44 to 44.69 feet below the top of well casings in shallow wells in the vicinity of the ash basin (excluding well MW-108S as it is located on top of the dry ash stack). The exploration program was developed to include installation of paired monitoring wells in many locations to evaluate groundwater characteristics in the upper and lower portions of the unconfined aquifer. Note that groundwater elevations between paired wells seldom varied by more than 1 foot confirming that the portion of the unconfined aquifer that was the subject of this investigation (shallower than 100 feet) is composed of relatively homogenous material with little or no significant confining layers present.

Subsequent to completion of the well installation program, groundwater elevations in the monitoring wells were measured during a comprehensive gauging event on November 17, 2014. Additional gauging and sampling events are proposed in Section 7.0 of this report to allow for evaluation of groundwater position relative to seasonal variations.

Groundwater elevations measured in shallow monitoring wells installed within the ash basin footprint ranged from 227.82 feet in well MW-110S to 235.53 feet in well MW-108S. Corresponding ground surface elevations at wells MW-110S and MW-108S are 270.17 and 283.97 feet, respectively. Groundwater elevations measured in wells located beyond the ash basin waste boundary ranged from 222.67 in well MW-112S to 236.44 in well MW-107S. Groundwater elevations measured in shallow wells installed within the 1960 Fill Area ranged from 226.30 feet in well MW-118S to 229.25 feet in well MW-117S.

Based on groundwater elevation data collected on November 17, 2014, approximately 18 feet of ash was located below the groundwater table in the vicinity of well pair MW-109S/D. Additional groundwater data collection and post-closure groundwater modeling is necessary to precisely predict the post-closure long term groundwater level in the ash and whether additional mitigation measures are necessary to protect groundwater. Groundwater elevations for monitoring wells installed during the current investigation are presented in **Table 1**. Potentiometric surface maps for shallow and deeper wells, based on groundwater elevations obtained on November 17, 2014, are shown on **Figures 7 and 8**. Groundwater table position is shown in each of the four previously referenced cross-sections.

2.5 Surface Water

The Robinson Plant site is located along the western extent of Lake Robinson. The ash basin was formed via construction of a dam across an unnamed tributary to Black Creek in the mid-1970s. Modifications to the ash basin and ash basin riser barrel in the early 1980s and early 2000s are shown on Carolina Power and Light Drawing D-1777 (May 1982) and Law Engineering and Environmental Services, Stormwater Drainage Improvements, Modifications to Ash Pond (December 2002). The inlet elevation for the upstream riser barrel (Skimmer-005) is 263.87 feet. The 36-inch reinforced concrete pipe (RCP) exiting the riser barrel and embedded in the ash basin embankment enters Catch Basin No. 2, having an inlet elevation of 256.04 feet. The outlet from Catch Basin No. 2 enters new Catch Basin A with an inlet elevation of 243.5 feet. The outlet pipe (36-inch HDPE) from Catch Basin A exits into the discharge canal with an invert elevation of 234.12 feet.

Based on our review of the Site Information drawing prepared by AMEC including the 100-year flood boundary (Federal Emergency Management Agency, Flood Insurance Study, Darlington County, South Carolina, effective February 6, 2013), the ash basin is located within the 100-year flood zone. The 100-year flood level for Lake Robinson adjacent to the ash embankment is shown as 220.96 feet. The crest of the ash basin embankment is 270 feet, which is 49.04 feet higher than the flood level. In addition, the inlet elevation for Catch Basin A located at the downstream toe of the ash pond embankment is 22.54 feet higher than the 100-year flood plain elevation. The historic design drawings provided by Duke Energy (D-1777 and LAW (2002) indicate the ash pond will not flood due to stated riser barrel and catch basin inlet elevations. It appears that the AMEC Site Information drawing shows the intrusion of Lake Robinson's 100-year flood boundary into the ash basin. It is our opinion that the floodplain mapping did not consider the presence of the riser barrel and catch basin configuration, and as such, the ash basin should not be considered to lie within the 100-year floodplain of Lake Robinson. That said, the preferred ash basin closure option will evaluate and mitigate for any potential impacts resulting from the 100-year flood level (i.e., 220.96 feet).

3.0 Field Exploration

The field exploration program was implemented between July and November 2014 to characterize the geotechnical and environmental conditions of the ash basin and 1960 Fill Area. The subsurface investigation included completion of 22 environmental soil borings; 11 geotechnical soil borings; installation of 30 groundwater monitoring wells; and subsequent soil, ash, groundwater, and free water sample collection and testing.

Drilling was conducted by SAEDACCO under the full-time oversight of HDR personnel. Data obtained from the subsurface investigation included boring logs, monitoring well logs, and well construction records. Boring and well survey information are included in the Data Report (HDR 2014). As-built boring and well locations are shown on **Figure 3**.

Field exploration also included a natural resources survey of the site to identify wetlands and the potential for threatened/endangered species whose presence may affect closure of the ash management facilities. A summary of field exploration methods is presented in the following sections.

3.1 Subsurface Exploration

Exploration was conducted by various methods selected for their ability to measure and collect the required data in the field. In general, the geotechnical and environmental exploration programs were implemented independent of one another, although the data collected from those investigations is frequently cross-referenced during evaluation.

3.1.1 Soil Borings

The subsurface investigation consisted of the completion of 22 environmental soil borings and 11 geotechnical soil borings. Of these borings, 10 were completed within the ash basin, 3 were completed within the 1960 Fill Area ash boundary, 4 were completed through the ash basin dike, 11 were completed down- or cross-gradient of the ash management areas, and 5 were completed in background locations as shown in the table below.

Boring Location	**Geotechnical**		**Environmental**	
	Quantity	**Boring IDs**	**Quantity**	**Boring IDs**
Ash Basin	4	AP-2, AP-5, AP-9, AP-10	6	AP-2, AP-5, AP-6, AP-7, AP-9, AP-10
Ash Basin Dike	2	DD-1 and DD-2	2	DD-1 and DD-2
Cross- or Down-Gradient of Ash Basin	4	AP-1, AP-3, AP-4, AP-8	7	AP-1, AP-3, AP-4, AP-8, and CB-1 through CB-3
1960 Fill Area	0	NA	3	LOL-2 through LOL-4
Background	1	AP-11	4	BG-1 through BG-4

Note: NA = Not applicable.

In general, geotechnical soil test borings were completed via hollow stem auger (HSA), cased hole, tricone, and mud rotary drilling techniques using a Diedrich D-50 track rig. Environmental soil borings were completed via HSA using a Diedrich D-50 track rig or via continuous coring using a Geoprobe™ Direct Push Technology (DPT) track rig.

Split-spoon (SPT) and disturbed sampling were performed using a split-spoon sampler driven 18 inches into the ground with an automatic 140-pound hammer. SPT was conducted at 5-foot intervals (3 feet between samples) for ash fill materials and the underlying in-situ soils (e.g., 4–6, 9–11, 14–16, 19–21 feet, etc.) for dual purpose environmental/geotechnical borings.

For borings advanced for geotechnical testing only, SPT was conducted at 2.5-foot intervals (1 foot between samples) to a depth of 20 feet and was then conducted at 5-foot intervals to the boring termination depth. Undisturbed Shelby tube samples were pushed with the hydraulic drill rig 24 inches into the ground to obtain samples at the desired interval. Piston sampler tubes were also taken in selected borings.

For environmental soil borings completed with the DPT rig, continuous soil cores were collected using a macro-core sampler with new polyvinyl chloride (PVC) sample liners.

After collection, the sampler was opened and recovered material was described in the field in accordance with the Unified Soil Classification System (USCS). For geotechnical borings, a selected portion of the sample was transferred into a container, sealed, and transported to the on-site storage area to await laboratory testing assignment. For environmental borings, select samples were transferred to containers provided by a third-party analytical testing laboratory (Pace Analytical Services, Inc.), stored on ice in a laboratory-provided cooler, and shipped to the laboratory under chain-of-custody protocol. Soil samples were obtained from each boring and submitted to independent laboratories for geotechnical and environmental property testing as discussed in Section 4.2.1.

Upon completion, all borings were backfilled with bentonite or grout unless a monitoring well was installed.

3.1.2 Monitoring Well Construction

The subsurface investigation also included installation of 30 groundwater monitoring wells. In general, wells were installed as paired "shallow" and "deep" wells with shallow wells screened across the water table surface and deep wells installed as cased wells screened at depth to evaluate vertical variations in water quality conditions. Of the 30 wells, 17 were installed within and around the ash basin, 8 were installed within and around the 1960 Fill Area, and 5 were installed in background locations up-gradient of the ash basin and 1960 Fill Area as shown in the table below.

Well Location	Quantity	Well IDs
Ash Basin	6	MW-108S, MW-108D, MW-109S, MW-109D, MW-110S, MW-110D
Toe of Ash Basin Dam	2	MW-102D and MW-7D
Cross- or Down-Gradient of Ash Basin	9	MW-107S, MW-107D, MW-111S, MW-111D, MW-112S, MW-113S, MW-113D, MW-114S, MW-114D
1960 Fill Area	4	MW-105S, MW-105D, MW-106S, MW-106D
Cross- or Down-Gradient of 1960 Fill Area	4	MW-117S, MW-117D, MW-118S, MW-118D
Background	5	MW-101D, MW-115S, MW-115D, MW-116S, MW-116D

In general, shallow wells (designated by an “S” qualifier) were installed as Type III wells with 2-inch-diameter Schedule 40 PVC casing and 10-foot well screens set to bracket the water table at the time of installation using HSA drilling techniques. Due to the presence of flowing sands encountered at depth, deep wells were installed using mud rotary drilling techniques. Deeper wells (designated by a “D” qualifier) were completed as cased Type III wells with a 6-inch-diameter Schedule 40 PVC outer casing generally set at least 15 feet below the bottom of the adjacent shallow well screen, and completed with a 2-inch-diameter Schedule 40 PVC casing and 5-foot well screen placed at least 10 feet below the bottom of the outer casing.

Subsequent to completion, all newly installed monitoring wells were developed to create an effective filter pack around the well screen and to remove fine particles within the well. Specific details regarding well development procedures and benchmarks were provided in the Data Report (HDR 2014).

3.1.3 Topographic and As-Built Well Surveys

Between July and November 2014, WSP USA Corp (WSP) completed topographic mapping of an approximate 800-acre area of the site and portions of adjacent properties via aerial and conventional ground run surveying methods. Horizontal and vertical control was tied to existing South Carolina Geodetic Survey NAD83 (2011) and NAVD88 datum. Topography was compiled at a 2-foot contour interval for areas within and adjacent to the ash basin and 1960 Fill Area and at a 4-foot interval for all other areas included in the mapping area.

Subsequent to well completion, WSP also surveyed the locations, ground elevations, and top of casing elevations of the 30 newly installed monitoring wells at an accuracy of less than 0.1 foot.

The topographic and well surveys were conducted to provide a basis for calculating ash volumes, landfill design, and groundwater position as it pertains to the conceptual closure plan proposed herein. Copies of the preliminary surveys prepared by WSP are included as Appendix A.

3.1.4 Water Sampling

Monitoring well sampling was performed by Pace Analytical Services, Inc. (Pace) personnel in August and November 2014. Groundwater samples were collected from 20 newly installed monitoring wells located within and near the ash basin and from 10 newly installed monitoring wells located within and near the 1960 Fill Area to assess groundwater quality. Samples were collected using low-flow sampling techniques in general accordance with USEPA Region 1 Low Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells (revised January 19, 2010).

Free water sampling was performed by Pace personnel in August 2014. One free water sample was collected from the discharge canal using a telescoping cup sampler to assess water quality down-gradient of the ash basin.

3.1.5 Hydraulic Conductivity Testing

Following groundwater sampling, in-situ hydraulic conductivity tests (slug tests) were performed in each of the newly installed monitoring wells. In the absence of specific SCDHEC slug testing guidance, the slug tests were performed to meet the requirements of the North Carolina

Department of Environment and Natural Resources memorandum titled Performance and Analysis of Aquifer Slug Tests and Pumping Tests Policy dated May 31, 2007. Slug testing was conducted to evaluate the horizontal hydraulic conductivity (K) of aquifer materials relative to monitoring well screen position. Hydraulic conductivity is an important parameter needed to understand groundwater movement and how it impacts closure options and design.

3.2 Natural Resources Surveys

On November 13, 2014, HDR biologists conducted an on-site investigation consisting of a delineation of jurisdictional waters of the United States and habitat and individual species surveys for federally protected species within an approximately 660-acre study area on property owned by Duke Energy (**Figure 7**). The purpose of the Natural Resources Survey was to evaluate whether the presence of such features/habits would potentially constrain the preferred closure option. The following sections provide a summary of HDR's methods employed during natural resources survey. Findings of the survey are presented in Section 4.3.

3.2.1 Data Review

HDR conducted a desktop survey of publically available data from federal and state agencies prior to engaging in field reconnaissance surveys. The following sources were reviewed as part of this analysis:

- ESRI ArcGIS online aerial imagery, streets, and basemap information
- National Hydrography Dataset (NHD), U.S. Geological Survey (USGS) (http://nhd.usgs.gov/)
- National Wetland Inventory (NWI), U.S. Fish and Wildlife Service (USFWS) (http://www.fws.gov/wetlands/)
- South Carolina List of At-Risk, Candidate, Endangered, and Threatened Species – Darlington County, USWFS (http://www.fws.gov/charleston/EndangeredSpecies_County.html)
- South Carolina Rare, Threatened and Endangered Species Inventory Quadrangle Search, South Carolina Department of Natural Resources (SCDNR) Heritage Trust Program (https://www.dnr.sc.gov/pls/heritage/species.select_quad_map?pcounty=darlington)
- Soil Survey for Darlington County, Natural Resources Conservation Service (NRCS) (http://www.nrcs.usda.gov/Internet/FSE_MANUSCRIPTS/south_carolina/SC031/0/Darlington.pdf)
- USGS Lake Robinson 24K Quadrangle (**Figure 9**)

3.2.2 Jurisdictional Waters of the U.S.

HDR surveyed the defined study area for jurisdictional waters of the U.S. under Section 404 of the Clean Water Act. The study area was examined according to the methodology described in the U.S. Army Corps of Engineers (USACE) 1987 Wetland Delineation Manual, USACE Post-Rapanos guidance, and the USACE Atlantic and Gulf Coastal Plain Regional Supplement. The North Carolina Division of Water Resource's Methodology for Identification of Intermittent and Perennial Streams and Their Origins (Version 4.11) was used to determine the presence/absence of jurisdictional streams since no stream identification protocol has been established by SCDHEC. Jurisdictional waters were classified in accordance with the Classification of Wetlands and Deepwater Habitats of the United States (Cowardin et al. 1979).

3.2.3 Vegetative Communities

Vegetation community types were documented and categorized based on the Natural Communities of South Carolina Initial Classification and Description developed by Nelson (1986). Dominant species in the canopy, shrub/subcanopy, herbaceous, and vine strata were identified and documented to the lowest taxonomic level based in Radford et al. 1960.

3.2.4 Federally Protected Species

HDR obtained and reviewed a list of federally protected species for Darlington County from the USFWS website which was last updated on October 23, 2013. A summary of these species is provided on the following table.

Common Name	Scientific Name	Federal Status	Habitat Present
	Bird		
Bald eagle	*Haliaeetus leucocephalus*	BGPA	Yes
Red-Cockaded woodpecker	*Picoides borealis*	E	Yes
	Fish		
Atlantic Sturgeon	*Acipenser oxyrinchus*	E	No
Shortnose sturgeon	*Acipenser brevirostrum*	E	No
	Plant		
Rough-leaved loosestrife	*Lysimachia asperulaefolia*	E	No

BGPA – Federally protected under the Bald and Golden Eagle Protection Act
E – Federally Endangered

HDR also reviewed the SCDNR Heritage Trust Program's Rare, Threatened, and Endangered Species Inventory Quadrangle Search for protected species distribution and proximity to the study area.

4.0 Exploration Results

The laboratory testing program was designed to obtain geotechnical and environmental data that can be used to develop an SCM. In turn, the SCM will be used to support the preferred ash pond closure option.

4.1 Geotechnical Testing

Geotechnical laboratory determination of soil index properties included particle size analysis by #200 wash only or #200 wash with hydrometer analysis, Atterberg limit determination, and specific gravity determination. Testing was performed on representative soil and ash samples. Material for testing was obtained from either split-spoon samples, relatively undisturbed Shelby tube samples, or bulk samples obtained at the surface. Additional geotechnical laboratory testing included soil strength determination such as consolidated undrained with pore pressure measurements (CU) testing. Additionally, the hydraulic conductivity of selected samples was also determined. All testing was performed in accordance with the most recently updated American Society for Testing Materials (ASTM) testing standards.

The subsurface exploration has indicated that the majority of on-site soil consists of unconsolidated, loose to medium dense sand with varying degrees of silt and/or clay. Such soils, especially when saturated, may liquefy during a seismic event. Laboratory testing revealed that some of these soils are non-plastic or have a plasticity index < 7, which indicates these soils are susceptible to liquefaction. Since the sandy soils were observed to have varying relative densities at depths within the subsurface horizon, it is reasonable to expect that liquefaction of looser more saturated sand layers could lead to differential settlement of any structures founded above them, such as embankments, liners, and/or caps. Further analyses and modeling will be required to further identify the liquefaction potential of subsurface soils and to develop design criteria for embankments, and impoundment liners, and/or caps.

A summary of the geotechnical laboratory testing program is presented in the table below.

Boring	Depth of Boring	Depth of Fill	Depth of Ash	Depth of Unconsolidated Sediments	No. of Soil Samples[2] Collected	No. of Disturbed Soil Samples Tested	No. of Undisturbed Soil Samples Tested
AP-1	50.0	-	-	50	D=12	1	0
AP-2	100.0	-	56	44	D=8: U=2	2	0
AP-3	50.0	-	-	50	D=12	1	0
AP-4	50.0	-	-	50	D=12	4	0
AP-5	88.8	-	59.5	29.3	D=6; U=1	2	0
AP-8	50.0	-	-	50	D=12	1	0
AP-9	50.0	-	35.5	14.5	D=9	1	0
AP-10	50.0	-	16.5	33.5	D=4; U=1	0	3
AP-11[1]	50.0	-	-	50	D=12; U=2	2	1
DD-1	65.0	22.5	-	42.5	D=15	2	0
DD-2	71.5	41	-	30.5	D=13; U=4	2	2

Notes:
1. Includes Boring AP-11A that was advanced at same location to collect undisturbed samples
2. 2. D = Disturbed Samples
3. 3. U = Undisturbed Samples

The data obtained during implementation of the geotechnical exploration program will be used to support the preferred ash basin closure option as feasibility of the option is further refined. Laboratory results of geotechnical testing are summarized in **Tables 2A and 2B**.

4.2 Environmental Testing

Environmental laboratory testing was performed on soil, ash, ash pore water, groundwater, and free water samples collected from borings, monitoring wells, and the ash basin discharge canal. Samples were analyzed by Pace or their subcontract laboratories in accordance with United States Environmental Protection Agency (USEPA) methods or other applicable standards.

4.2.1 Soil and Ash

A total of 53 soil and ash samples were collected from borings completed within the ash basin, outside of the ash basin, in the 1960 Fill Area, and in background locations. Of the 53 samples, 12 were collected in ash within the ash basin and 4 were collected in ash within the 1960 Fill Area. The remaining samples were collected in soil either beneath ash or outside of ash management areas as presented in the table below.

Soil Boring Location	Soil Boring ID	Type and Quantity of Analyses		
		Soil	Ash	Ash - SPLP
Within Ash Basin	AP-2	--	2	2
	AP-5	--	2	2
	AP-6	1	2	1
	AP-7	1	2	2
	AP-9	1	2	--
	AP-10	1	2	1
Background Ash Basin	BG-1	4	--	--
	BG-2	3	--	--
	BG-3	4	--	--
Cross-gradient of Ash Basin	AP-1	1	--	--
	AP-3	1	--	--
	AP-4	1	--	--
	AP-8	1	--	--
Down-gradient of Ash Basin	DD-1	3	--	--
	DD-2	3	--	--
	CB-1	2	--	--
	CB-2	2	--	--
	CB-3	2	--	--
Within 1960 Fill Area	LOL-2	1	1	1
	LOL-3	1	2	1
	LOL-4	1	1	1
Background1960 Fill Area	BG-4	3	--	--

Note:
1. SPLP = Synthetic Precipitation Leaching Procedure

The 53 samples were submitted to Pace for analysis of total antimony, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, iron, lead, manganese, molybdenum, nickel, selenium, thallium, and zinc using EPA Method 6010; chloride using EPA Method 9056; mercury using EPA Method 7471; and pH using EPA Method 9045. Eleven ash samples were also analyzed for leaching potential of inorganic constituents using the Synthetic Precipitation Leaching Procedure (SPLP) by USEPA Method 6020/1312.

Ash and soil samples collected from within the ash basin were also analyzed for cesium-137 using Method DOE HASL 300, 4.5.2.3/Ga-01-R, and cobalt-60 using Method DOE HASL 300, 4.5.2.3/Ga-01-R, due to the 1998 approved discharge of low-level radioactive boiler cleaning wastewater to the ash basin. This disposal involved boiler chemical metal cleaning wastes that were contaminated at very low levels with Cobalt-60 (CP&L 1998).

The analytical results of the total concentration analyses were compared to Maximum Contaminant Level-based (MCL-based) USEPA Protection of Groundwater Soil Screening Levels (SSLs) and USEPA Industrial SSLs. The site is used for industrial purposes and is not anticipated to be rezoned to residential. Constituents that exceeded the USEPA Protection of Groundwater SSLs in the ash samples collected from within the ash basin and the 1960 Fill Area included antimony, arsenic, barium, beryllium, cadmium, copper, lead, mercury, and selenium. Arsenic was also reported above the USEPA Industrial SSL in the ash samples collected from within the ash basin and the 1960 Fill Area. Constituents that exceeded USEPA Protection of Groundwater SSLs in the soil samples include arsenic and selenium. Arsenic also exceeded the EPA Industrial SSL in one soil sample. Radiological parameters were not detected above the laboratory method detection limit (10.0 pCi/L) in ash or soil samples collected within the ash basin. Laboratory results of soil and ash samples are presented in **Tables 3A, 3B, 3C, and 3D**.

Laboratory results of SPLP analyses were compared to the SCDHEC Primary and Secondary MCLs for drinking water last amended on August 28, 2009. Arsenic was detected at concentrations greater than the Primary and Secondary MCLs in ash samples collected from within the ash basin. Iron and manganese were measured at concentrations greater than the Primary and Secondary MCLs in ash samples collected from within the 1960 Fill Area. Leaching results of select samples of ash are presented in **Table 4**.

The results of environmental soil and ash analyses will be evaluated to derive a list of site-specific constituents of concern (CoC) and to evaluate the leaching potential of those CoC from ash into underlying soils and/or groundwater.

4.2.2 Groundwater

Between August and November 2014, groundwater samples were collected from 20 newly installed monitoring wells located within and near the ash basin and from 10 newly installed monitoring wells located within and near the 1960 Fill Area to assess groundwater water quality.

Samples were collected for both total and dissolved concentration analyses. The samples collected for dissolved concentration analyses were filtered by Pace in a laboratory controlled environment. The samples were submitted to Pace for analysis as follows:

- Antimony, arsenic, barium, beryllium, boron, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, molybdenum, nickel, potassium, selenium, sodium, and zinc using USEPA Method 200.7 (total and dissolved concentrations)

- Mercury using USEPA Method 245.1 (total and dissolved concentrations)
- Thallium using USEPA Method 200.8 (total and dissolved concentrations)
- Alkalinity using SM 2320B
- Bromide, chloride, and sulfate using USEPA Method 300.0
- Ferrous iron using SM 3500-Fe B
- Methane using RSK 175
- Nitrate as nitrogen using USEPA Method 353.2
- Sulfide using SM 4500-S2D
- Total dissolved solids using SM 2540C

Ash pore water and groundwater samples collected from within the ash basin were also analyzed for cesium-137 using Method DOE HASL 300, 4.5.2.3/Ga-01-R, and cobalt-60 using Method DOE HASL 300, 4.5.2.3/Ga-01-R, to evaluate potential impacts from the 1998 approved discharge of low-level radioactive boiler cleaning wastewater to the ash basin.

Constituents detected at concentrations that meet or exceed the Primary and Secondary MCLs in the ash pore water samples include arsenic (samples MW-108S and MW-109S), iron (sample MW-108S), manganese (samples MW-108S and MW-109S), and pH (sample MW-108S). Constituents detected at concentrations that meet or exceed the Primary and Secondary MCLs in the groundwater samples include arsenic (sample MW-7), iron (11 samples), manganese (17 samples), and pH (22 samples). Radiological parameters were not detected above the laboratory reporting limit (10.0 pCi/L) in wells screened within or below ash in the ash basin. Laboratory results of groundwater samples are summarized in **Table 5A** (total inorganics), **Table 5B** (major anions and cations), **Table 5C** (dissolved inorganics), and **Table 5D** (radiological isotopes).

4.2.3 Free Water

One free water sample was collected by Pace personnel in August 2014 from the discharge canal to assess water quality down-gradient from the ash basin. The free water sample was analyzed for total and dissolved concentrations of the same suite of constituents/parameters as the groundwater samples with the exception of radiological parameters. Total and dissolved concentrations of barium, iron, and manganese were detected above their respective laboratory reporting limits in the free water sample. No other constituents were detected above their reporting limits. Laboratory results of the free water sample are summarized in **Table 6**.

The results of water analyses will be evaluated to derive a list of site-specific CoC, to evaluate whether leaching of those CoC from ash into groundwater has occurred, to evaluate the position of groundwater relative to ash, and to evaluate the potential for off-site migration of CoC at concentrations that exceed applicable water standards in support of the of the preferred ash basin closure option as feasibility of the option is further refined.

4.3 Natural Resources Survey

The following sections summarize the findings of the Natural Resources Survey conducted at the Robinson Plant site on November 13, 2014, as described in Section 3.2 of this report.

4.3.1 Jurisdictional Waters of the U.S.

Based on the Classification System of Wetlands and Deepwater Habitats of the United States (Cowardin et al. 1979), identified waters can be described as: deep water Lacustrine; Limnetic; Unconsolidated Bottom; Permanently Flooded; Diked/Impounded (L1UBHh) with adjacent fringe Palustrine; Emergent; Seasonally Flooded; Diked/Impounded (PEMCh) and Palustrine; Scrub-Shrub; Broad-Leaved Deciduous; Seasonally Flooded; and Diked/Impounded (PSS1Ch). No jurisdictional streams were located within the study area.

Jurisdictional waters identified are shown on **Figure 10**. USACE Wetland Determination Data forms are provided in **Appendix B**. A summary of the delineated feature is provided in the table below.

Site Number or Name	Latitude	Longitude	Cowardin Classification	Estimated Amount of Aquatic Resources in Study Area	Class of Aquatic Resources
Open Water	34.41778	-80.15945	L1UBHh	2.81	Section 10 – Non-Tidal

4.3.2 Vegetative Communities

Disturbed/Maintained

Maintained/disturbed areas are scattered throughout the study area and include land north of Icy Street, maintained right-of-ways (ROW), and the 1960 Fill Area. These areas are dominated by immature pines (*Pinus* sp.), asters (*Aster* sp.), black cherry (*Prunus serotina*), blackberry (*Rubus* sp.), big bluestem (*Andropogon gerardii*), Chinese privet (*Ligustrum sinense*), dogfennel (*Eupatorium capillifolium*), fescue (*Fescue* sp.), goldenrods (*Solidago* sp.), Japanese honeysuckle (*Lonicera japonica*), Johnson grass (*Sorghum halepense*), sumac (*Rhus* sp.), and other early successional species.

Pine-Scrub Oak Sandhill

The pine-scrub oak sandhills are located primarily in the western portion of the study area. The canopy is dominated by longleaf pine (*Pinus palustris*) and understory species consist of a high percentage of scrub oaks including bluejack oak (*Quercus incana*), blackjack oak (*Quercus marilandica*), and turkey oak (*Quercus laevis*). Additional understory and shrub species include black cherry, dwarf huckleberry (*Gaylussacia dumosa*), flowering dogwood (*Cornus florida*), highbush blueberry (*Vaccinium stamineum*), mockernut hickory (*Carya tomentosa*), sassafras (*Sassafras albidum*), and sweetgum (*Liquidambar styraciflua*). Herbaceous species included bluestem (*Andropogon* sp.) and bracken fern (*Pteridium aquilinum*).

Mixed Pine/Hardwood Forest

The community located north of the backwater cove below the ash basin does not fall into a distinct natural community type as described by Nelson. The canopy is dominated by loblolly pine (*Pinus taeda*), hickories (*Carya* sp.), and sweetgum. Understory and shrub species consist of American holly (*Ilex opaca*), black cherry, flowering dogwood, highbush blueberry, and wax myrtle. Vine species include Japanese honeysuckle, poison ivy (*Rhus radicans*), and yellow jasmine (*Gelsemium sempervirens*).

4.3.3 Federally Protected Species

The Lake Robinson Quadrangle search revealed several known occurrences of red-cockaded woodpecker located in the Sandhills State Forest approximately 5 miles north of the study area. The following is a summary of biological conclusions for species that are protected under provisions of Section 7 and Section 9 of the Endangered Species Act of 1973 and the Bald and Golden Eagle Protection Act (BGPA).

Bald Eagle (*Haliaeetus leucocephalus*)

The study area is located near open water (Lake Robinson). No known occurrences of bald eagle have been documented nearby. No individuals or nests were noticed within the study area during the on-site investigation. It is recommended that a follow-up survey be conducted should any future on-site activities require Section 7 consultation with United States Fish and Wildlife Service (USFWS).

Red-Cockaded Woodpecker (*Picoides borealis*)

Minimal areas of suitable habitat for the Red-Cockaded Woodpecker exist within the study area. No mature nesting trees were noticed on site. There are a few stands of estimated 20–30 year (estimate) longleaf pines within the study area suitable for foraging; however, the pine stands are not fire maintained and have a thick understory consisting of scrub oaks and other hardwoods which are a limiting factor. Potential foraging habitat for the Red-Cockaded Woodpecker would be restricted to a few areas with mature pines, little or no understory, and abundant herbaceous ground cover within the study area. No individuals or cavity trees were noticed within the study area during the onsite-investigation. It is recommended that a follow-up survey be conducted should any future onsite activities require Section 7 consultation with USFWS.

Atlantic Sturgeon (*Acipenser oxyrinchus*)

No suitable habitats are located within the study area. No known occurrences or historic populations of Atlantic Sturgeon have been recorded in Lake Robinson.

Shortnose Sturgeon (*Acipenser brevirostrum*)

No suitable habitats are located within the study area. No know occurrences or historic populations of Shortnose Sturgeon have been recording in Lake Robinson.

Rough-Leaved Loosestrife (*Lysimachia asperulaefolia*)

The study area does not have suitable ecotone habitat between existing longleaf pine stands and wetter areas that may include pocosins, wet pine savannas, or streamhead seeps. No known occurrences have been documented nearby and this species in now considered to extirpated in Darlington County (NatureServe 2014).

4.3.4 Natural Resources Survey Conclusions

Based on the data reviewed and observations made during the natural resources survey of the site on November 13, 2014, HDR did not identify Jurisdictional Waters of the U.S., wetlands, vegetated communities, or threatened and endangered species in parts of the site that would likely be impacted by closure of the ash basin or movement of ash from the 1960 Fill Area.

5.0 Summary of Completed and On-Going Work

Between July and November 2014, Duke Energy has completed a field exploration program consisting of the following:

- Completion of 22 environmental soil borings and 11 geotechnical soil borings
- Installation, development, and sampling of 30 shallow and deep groundwater monitoring wells
- Hydraulic conductivity testing of 29 newly installed monitoring wells
- Laboratory testing of 18 disturbed and 6 undisturbed soil and ash samples for geotechnical parameters
- Laboratory analysis of 53 soil and ash samples, 30 groundwater samples, and 1 free water sample for potential CoC and natural attenuation indicator parameters

Evaluation of these data is on-going in support of a permanent ash basin closure option that is protective of human health and the environment and acceptable to SCDHEC Bureau of Water per their guidance Proper Closeout of Wastewater Treatment Facilities, Regulation 61-82, dated April 11, 1980. Given the results obtained from the geotechnical and environmental exploration and testing programs thus far, Duke Energy intends to evaluate three potential permanent ash basin closure options (described in more detail in Section 6.0):

- **Hybrid Cap-in-Place** whereby coal ash residue from the 1960 Fill Area would be excavated and placed into the ash basin, ash immediately behind the ash basin embankment would be moved farther west within the basin to allow breaching or removal of the dam, and consolidated ash within the basin would be capped with an engineered cover system. Potential areas of saturated ash within the basin post-closure (based on SCM modeling) would be reduced or eliminated using appropriate engineering measures (e.g., removal of ash from saturated areas, fixing ash in place via soil mixing and/or injection of stabilizing materials, installation of infiltration cut-off walls on the upstream side of the ash basin, etc.) to prevent or minimize leaching of coal ash constituents to down-gradient areas.

- **On-Site Landfill** whereby coal ash residue from the 1960 Fill Area and ash basin would be excavated and moved to a lined landfill designed to contain coal ash residue. While not thoroughly investigated at this time, an on-site landfill could potentially be located on the northwest side of the Darlington County Plant.

- **Off-Site Landfill** whereby coal ash residue from the 1960 Fill Area and ash basin would be excavated and hauled to a lined landfill designed and permitted to receive coal ash residue. This could either be an existing lined landfill with capacity and ability to accept the coal ash residue or a newly constructed lined landfill permitted to accept coal ash residue.

Based on preliminary data analyses, it appears that up to 18 feet of ash is saturated in the deepest portion of the ash basin (between the transmission line right-of-way and the ash basin embankment). Additional groundwater data collection and post-closure groundwater modeling is necessary to precisely predict the post-closure long-term groundwater level in the ash. While the saturated depth of ash diminishes moving away from this area, it is uncertain at this time if the Hybrid Cap-in-Place closure method will reduce the amount of saturated ash in the basin to a point where this option becomes viable. Further evaluation of data is on-going in support of the preferred closure option. To that end, Duke Energy intends to perform the following work:

- Conduct further analyses of the foundation soils at the ash basin and embankments, for the Hybrid Cap-in-Place option, to determine susceptibility to liquefaction of in-situ soils during seismic events. Such liquefaction could result in differential settlement of a liner or cap and/or induced embankment failure. Analyses may consist of, but would not be limited to, laboratory cyclic triaxial testing of remolded soil samples conducted in conjunction with additional in-situ soil testing. These studies and follow-up finite element analysis will help determine engineering remedies for mitigating potential liquefaction induced differential settlements. The analyses will also be used to develop design criteria for static and post-seismic embankment stability.

- Evaluate potential impacts to the ash basin embankment and ash basin resulting from a postulated 100-year flood event; and determine engineering remedies to mitigate for potential impacts

- Evaluate laboratory results from in-basin, near-basin, and background sample locations to determine site-specific coal ash residue CoC and eliminate naturally occurring compounds from future consideration as CoC

- Develop calculations of ash sample SPLP results to evaluate the potential for leaching of coal ash residue CoC from ash into the groundwater

- Conduct three additional rounds of groundwater sampling between January and August 2015 to evaluate potential seasonal variations in groundwater quality data and groundwater surface elevations

- Complete groundwater fate and transport modeling (i.e., SCM) of site-specific coal ash residue CoC to evaluate mobility and concentration gradients over time, and evaluate post-closure groundwater elevations in the ash basin as it relates to potential additional groundwater protection measures

The above work activities will be used to evaluate Hybrid Cap-in-Place as a permanent ash basin closure option. If Hybrid Cap-in-Place is not a suitable closure option, the On-Site and Off-Site Landfill closure options will be further investigated to determine which of these options is preferred.

Duke Energy intends to submit a detailed Supplemental Conceptual Closure Plan to SCDHEC Bureau of Water by November 20, 2015. This supplement will provide the analysis for and recommend a preferred permanent closure option for the Robinson Plant ash basin.

6.0 Potential Ash Basin Closure Options

As described in Section 5.0, Duke Energy intends to evaluate three permanent ash basin closure options for the ash management areas (i.e., ash basin and 1960 Fill Area) at the Robinson Plant site:

- Hybrid Cap-in-Place
- On-Site Landfill
- Off-Site Landfill

Physical and environmental closure approaches for each closure option are discussed in the sections below. Note that the scope of long-term groundwater quality management will be dependent on the results of additional groundwater sampling and subsequent groundwater modeling. Groundwater protection measures will be addressed in the forthcoming Supplemental Conceptual Closure Plan.

6.1 Ash and Earthwork Quantities

The quantities of ash and impacted soil to be consolidated within the ash basin and the quantity of clean cover soil required for cap construction were estimated for the proposed Hybrid Cap-in-Place ash basin closure option. The methods used to calculate the ash and earthwork quantities associated with the various components of the ash basin closure follow. A summary of the calculated quantities is provided in **Table 7**. Unless specifically noted, the quantities are in-place (i.e., bank measure) quantities that do not include swell or shrinkage factors.

6.1.1 1960 Fill Area

Although closure of the 1960 Fill Area will be regulated by the SCDHEC Bureau of Solid Waste, and not by the Bureau of Water, it is assumed that ash removal from the 1960 Fill Area will be handled in conjunction with closure of the ash basin.

The quantity of ash currently within the 1960 Fill Area was previously estimated at approximately 275,800 cy (AMEC 2014). The same reference estimated that approximately 19,600 cy of cover soil had been placed over the ash in the 1960 Fill Area. Due to the relatively thin layer of cover present (typically less than 1 foot) and the length of time the cover has been in-place (since the 1970s), it is assumed that removal and reuse of the cover soil without intermixing with ash will be impractical. In addition, it is assumed that an average of 2 feet of soil has been impacted by the ash beneath the entire 25.0 acre 1960 Fill Area footprint, which is equivalent to 80,800 cy of soil. As a result, the estimated total volume of ash and soil to be removed from the 1960 Fill Area and consolidated within the ash basin is 376,200 cy. Drawing C-01 shows the estimated post-ash excavation grades within the 1960 Fill Area.

6.1.2 Ash Basin Area

The total quantity of ash within the ash basin was estimated by digitizing pre-basin contours obtained from a topographic map of the site (Carolina Power & Light Company, 1981) into CAD format and comparing that surface to a surface generated from a recently developed topographic map of the Robinson site (WSP Transportation and Infrastructure 2014). The quantity of ash within the ash basin area is estimated to be between 3.0 and 3.5 million cy which includes the existing Dry Ash Storage Area located west of the transmission lines that extend over the basin. This volume should be used with caution, however, since it is possible that the ash basin area may have been altered (e.g., by borrow operations to build the ash basin dam or other earthen structures) between the date of the pre-basin topography and when ash began being placed within the basin. Borings conducted within the ash basin as part of the closure investigation appear to support the premise that the grades within the basin were reworked prior to ash disposal since ash was encountered below the aforementioned pre-basin contours. The accuracy of the pre-basin topography is also questionable since information on the original source of the topography is not available and the vertical and horizontal datum is not known. Furthermore, the topographic contours outside of the basin limits deviate between the two surveys. The limits of ash were also estimated based on topographic features and aerial photographs but cannot be determined with a high degree of confidence without field verification. Discrepancies within the limits of ash could also introduce inaccuracy with respect to the total calculated ash volume.

6.1.3 Ash Basin Embankment

The ash basin embankment, located on the east side of the ash basin, was constructed out of general fill materials surrounding a 12-foot-wide compacted impervious core. If the main dam is lowered or removed as part of the overall ash basin closure process, the earthen material could likely be reused as a source of cover soil. The quantity of soil within the dam was estimated by comparing the digitized pre-basin contours to the recent topographic map of the Robinson site as previously described. The upstream profile of the dam, currently overlaid with ash, was estimated based on the original design sections (EBASCO Services Incorporated 1958). The estimated quantity of soil comprising the main dam is 309,400 cy.

6.2 Hybrid Cap-in-Place Closure Option

Duke Energy has performed a preliminary evaluation of a Hybrid Cap-in-Place ash basin closure option for the ash basin and 1960 Fill Area at the Robinson site. The Hybrid Cap-in-Place closure option would consist of the following:

- Consolidate ash and impacted soils from the 1960 Fill Area into the existing ash basin to reduce the closure footprint
- Move ash and impacted soils from immediately behind the ash basin embankment to locations farther west within the basin to allow breaching or removal of the main dam
- Cap-in-Place consolidated portions of ash and impacted soils with an engineered cover system (soil-geosynthetic) designed to isolate and stabilize the ash while providing a physical barrier to the environment
- Re-use embankment soils for closure construction
- Decommission the ash basin and dam embankment from the SCDHEC Dams and Reservoirs Safety Program jurisdiction
- Evaluate monitored natural attenuation (MNA) for environmental closure provided environmental investigation results facilitate MNA as a remedy

- Maintain the current NPDES outfall location for stormwater discharge

Under this strategy, ash and impacted soil from the 1960 Fill Area would be re-located to the footprint of the existing ash basin and closed in-place with an engineered cap system to reduce infiltration through the ash and underlying materials thereby limiting potential for future migration of CoC. Closure would require re-shaping of the basin area to shed stormwater and route to the existing stormwater outfall.

6.2.1 Physical Closure

The closure approach would consider the SCDHEC Regulation 61-82 for Proper Closeout of Wastewater Treatment Facilities, the forthcoming USEPA CCR Rule, and established municipal solid waste landfill closure practices for engineered cover systems.

The Hybrid Cap-in-Place ash basin closure option has the benefits of reducing the closure footprint by approximately 30.5 acres and provides the opportunity to beneficially reuse the soil material in the main dam for engineered cover system construction. The Hybrid Cap-in-Place closure option would require approximately 162,100 cy of soil to provide an 18-inch thick soil cover as part of an engineered cover system. The amount of soil material in the main dam is more than sufficient for this purpose and excess soil could be used to construct stormwater berms and terraces required to promote surface runoff and/or to regrade the excavated 1960 Fill Area. As a result, the engineered cover system would be designed to effectively eliminate the vertical percolation of rainwater into the ash basin.

For the Hybrid Cap-in-Place closure option, approximately 1,128,400 cy of material would be placed into the ash basin including ash and impacted soils from the 1960 Fill Area, ash and impacted soils removed from the upstream face of the ash basin embankment (to allow dam embankment decommissioning), and cover soil from the embankment. This estimated volume assumes compacted ash placed within the basin has a shrinkage factor of approximately 20 percent (based on HDR's experience with coal ash and assuming a minimum dry density of 95 percent of the standard Proctor maximum dry density [ASTM D698]). A shrinkage factor of 12 percent was assumed for impacted soils compacted to a minimum dry density of 95 percent of the standard Proctor maximum dry density. A more detailed breakdown of these quantities is provided in **Table 8**.

The effectiveness of the physical closure would be dependent on the ability of the engineered cover system to lower the groundwater potentiometric surface within the ash basin such that it is below the ash. As shown on the cross sections (**Figure 5 and Figure 6**), the potentiometric surface measured during the field exploration extends up to 18 feet into the ash. If the results of groundwater modeling indicate the potentiometric surface will not be lowered sufficiently within a reasonable length of time, then the effectiveness of the physical closure will be reduced. Continued contact of groundwater with ash could result in a continuing source of release of CoCs into the environment since there would not be a physical barrier to the downgradient flow of impacted groundwater.

Conceptual Closure Geometry

The conceptual closure grades based on the preliminary Hybrid Cap-in-Place design are shown on Drawing C-02 (Appendix C).

As depicted in Drawing C-02, the ash basin will be divided into a West Dry Ash Storage Area and East Dry Ash Storage Area for placement of material from the 1960 Fill Area and material removed from the ash basin during closure construction (i.e., during perimeter channel construction and removal of ash immediately upstream from the main dam). This division is required to avoid interfering with the transmission lines that cross near the center of the ash basin.

Proposed Engineered Cover System

An engineered cover system is proposed as a means of limiting the infiltration of stormwater into the ash and impacted soils after consolidation of materials occurs at the site.

The proposed engineered cover system consists of (from bottom to top): a prepared basegrade comprised of compacted ash and/or impacted soil, a 40-mil textured linear low density polyethylene (LLDPE) geomembrane liner, a geocomposite drainage layer (GDL) consisting of a polyethylene geonet sandwiched between two layers of non-woven geotextile, 18 inches of cover soil (not impacted by ash), and 6 inches of topsoil capable of supporting vegetative growth. This basic design has been used successfully for various closure projects involving coal ash and municipal solid waste and has performed well for many years.

A textured LLDPE geomembrane liner is recommended over a high-density polyethylene liner (HDPE) due to its superior ability to accommodate strain that may result due to differential settlement that may occur due to variable ash and foundation soil properties. The geomembrane should be textured on both sides for veneer stability considerations on the ash basin sideslopes and for safety reasons during construction. The geomembrane provides a virtually impermeable barrier to the vertical percolation of rainwater through the engineered cover system into the ash and impacted soils. The LLDPE geomembrane provides superior performance over a compacted clay liner since it is subject to natural variations in hydraulic conductivity typical of clay deposits and is not subject to cracking over time due to differential settlement or root penetration. A compacted clay liner would require a borrow source classification study to identify a suitable clay source and extensive Construction Quality Assurance (CQA) and Construction Quality Control (CQC) procedures to achieve a high degree of confidence that the project specification requirements are met.

6.2.2 Environmental Closure

The environmental closure is concerned with the short- and long-term soil, groundwater, and surface water quality of the ash management areas. Environmental closure may take one of several pathways depending on the nature, extent, and characteristics of the CoC. For the Hybrid Cap-in-Place closure option, ash and impacted soil beneath ash would largely be left in place. Therefore, the results of leaching analyses and groundwater modeling are critical to understanding whether leaving these materials in place would impact groundwater. To date, CoC have not been established for the ash basin or 1960 Fill Areas, and thus, the preferred environmental closure option is uncertain. Leachability calculations and groundwater modeling will be conducted and included in the Supplemental Conceptual Closure Plan.

6.3 On-Site Landfill Ash Basin Closure Option

Under this option, ash and impacted soil from the ash basin and the 1960 Fill Area would be relocated to the on-site lined ash landfill and closed with an engineered cap system to reduce infiltration through the ash and underlying materials, thereby limiting potential for future migration of CoC. Regrading of the ash basin and 1960 Fill Area would be required after ash and impacted soil removal to ensure that positive drainage is maintained to eliminate ponding and to ensure the final surface can be maintained without excessive erosion. Soil from the decommissioned dam embankment could be used for final grading. Topsoil would also be placed over all regraded areas to encourage the growth of vegetation. Fast-growing vegetative cover consisting of native grasses would initially be established to stabilize the excavated and regraded areas against erosion. Eventually, trees and/or shrubs would be planted or allowed to naturally populate these areas to reduce maintenance requirements.

A potential location for a lined on-site ash landfill for the disposal of ash and impacted soils from the ash basin and the 1960 Fill Area is northwest of the basin as shown on **Drawing G-01**. The natural resource surveys described in Section 3.2 indicate that this area would be suitable for development as a landfill from an ecological standpoint. The suitability of this area from a geotechnical and hydrogeological perspective, however, will need to be confirmed through a subsurface exploration and geotechnical testing program. The on-site landfill ash basin closure option would consist of the following:

- Construct a lined ash landfill with leachate collection system meeting the minimum bottom liner and final cover requirements for a SCDHEC Class 3 landfill within the area shown on **Drawing G-01**
- Consolidate ash and impacted soils from the ash basin and 1960 Fill Area into the on-site landfill
- Construct an engineered cover system (soil-geosynthetic) over the landfill
- Re-use embankment soils from the ash basin dam for engineered cover system construction, if feasible
- Establish a groundwater detection monitoring program for the ash landfill
- Decommission the ash basin and dam embankment from the SCDHEC Dams and Reservoirs Safety Program jurisdiction
- Establish vegetation within the post-closure ash basin area and 1960 Fill Area
- Evaluate monitored natural attenuation (MNA) for environmental closure of the post-closure ash basin area and 1960 Fill Area provided environmental investigation results facilitate MNA as a remedy

6.3.1 Physical Closure

Under this scenario, ash and impacted soils from the ash basin and the 1960 Fill Area would be moved to the lined on-site ash landfill and capped with an engineered cover system designed to isolate and stabilize the ash within the landfill while providing a physical barrier to the environment.

The quantities of ash and impacted soil to be moved to the proposed on-site ash landfill and the quantity of clean cover soil required for cap construction were estimated and are provided in **Table 9**. Estimates of cut and fill required for landfill construction cannot be provided until a hydrogeological investigation is performed at the proposed ash landfill site. For cover soil estimation purposes, the footprint of the on-site landfill was assumed to be 50 acres. Unless specifically noted, the quantities are in-place (i.e., bank measure) quantities that do not include swell or shrinkage factors.

6.3.2 Environmental Closure

In this option, ash and impacted soil beneath the ash will be moved to the lined on-site landfill. As such, the environmental closure then becomes more focused on long-term groundwater quality in the vicinity of the former ash basin. Once CoC are established for groundwater within and beneath the ash basin, groundwater fate and transport modeling can be conducted to:

- Predict concentrations of CoC at the facility's compliance boundary or other locations of interest over time;
- Estimate the groundwater flow and loading to surface water discharge areas; and
- Support the development of a corrective action plan, if required.

6.4 Off-Site Landfill Ash Basin Closure Option

Under this option, ash and impacted soil from the ash basin and the 1960 Fill Area will be re-located to the off-site lined ash landfill which would be closed with an engineered cap system to reduce infiltration through the ash and underlying materials thereby limiting potential for future migration of CoC. Regrading of the ash basin and 1960 Fill Area would be required after ash and impacted soil removal to ensure that positive drainage is maintained to eliminate ponding and to ensure the final surface can be maintained without excessive erosion. Soil from the decommissioned dam embankment could be used for final grading. Topsoil would also be placed over all regraded areas to encourage the growth of vegetation. Fast-growing vegetative cover consisting of native grasses would initially be established to stabilize the excavated and regraded areas against erosion. Eventually, trees and/or shrubs would be planted or allowed to naturally populate these areas to reduce maintenance requirements.

Removal of ash and impacted soils from the ash basin and 1960 Fill Area and placement within an off-site lined ash landfill would be considered as a closure option if the hybrid close-in-place and on-site ash landfill options discussed in Sections 6 and 7, respectively, are determined to be unfeasible. Development of an off-site ash landfill could be pursued either directly by Duke Energy or through an agreement with a private contractor.

The off-site landfill ash basin closure option would consist of the following:

- Identify potential landfill sites within a reasonable haul distance from the Robinson Plant;

- Rank potential landfill sites according to such factors as location, accessibility, cost and ability to be permitted (e.g. presence of wetlands, threatened and endangered species, historic or archeological sites);
- Purchase or obtain options for highest ranking property and perform site suitability study including geotechnical and hydrogeological exploration;
- Complete permitting of site through SCDHEC;
- Construct a lined ash landfill with leachate collection system at site;
- Consolidate ash and impacted soils from the ash basin and 1960 Fill Area by transporting material to the off-site ash landfill;
- Construct an engineered cover system (soil-geosynthetic) over the ash landfill;
- Establish a groundwater detection monitoring program for the ash landfill;
- Decommission the ash basin and dam embankment from the SCDHEC Dams and Reservoirs Safety Program jurisdiction;
- Establish vegetation within the post-closure ash basin area and 1960 Fill Area; and,
- Evaluate monitored natural attenuation (MNA) for environmental closure of the post-closure ash basin area and 1960 Fill Area provided environmental investigation results facilitate MNA as a remedy.

An alternative to developing a new off-site ash landfill would be to identify an existing landfill within a reasonable haul distance from the Robinson Plant that is permitted to accept coal ash and impacted soil. Such a facility would streamline the permitting process and would probably decrease the amount of time required to achieve physical closure of the ash basin and 1960 Fill Area.

6.4.1 Physical Closure

Under this scenario, ash and impacted soils from the ash basin and the 1960 Fill Area would be moved to an off-site ash landfill and capped with an engineered cover system designed to isolate and stabilize the ash within the landfill while providing a physical barrier to the environment.

The quantities of ash and impacted soil to be moved to the proposed off-site ash landfill and the quantity of clean cover soil required for cap construction were estimated and are provided in **Table 9**. Estimates of cut and fill required for landfill construction cannot be provided until a hydrogeological investigation is performed at the proposed ash landfill site. For cover soil estimation purposes, the footprint of the off-site landfill was assumed to be 50 acres. Unless specifically noted, the quantities are in-place (i.e., bank measure) quantities that do not include swell or shrinkage factors.

6.4.2 Environmental Closure

Similar to the on-site landfill option, environmental closure for this option is focused on long-term groundwater quality in the vicinity of the former ash basin. Once CoC are established for groundwater within and beneath the ash basin, groundwater fate and transport modeling can be conducted to:

- Predict concentrations of CoC at the facility's compliance boundary or other locations of interest over time;
- Estimate the groundwater flow and loading to surface water discharge areas; and
- Support the development of a corrective action plan, if required.

7.0 Schedule

As noted in Section 5.0, collection and evaluation of additional data is necessary to fully characterize subsurface conditions, refine the SCM, and predict groundwater flow and quality conditions over time via groundwater modeling. Duke Energy proposes to collect and analyze these data in accordance with the following schedule.

Task	Estimated Duration	Estimated Completion Date
Winter Seasonal Groundwater Sampling	14 days	February 27, 2015
Spring Seasonal Groundwater Sampling	14 days	May 29, 2015
Summer Seasonal Groundwater Sampling	14 days	August 28, 2015
Groundwater Modeling	ongoing	September 25, 2015
Supplemental Conceptual Closure Plan Submittal to SCDHEC	60 days	November 20, 2015

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Figures

Tables

Table 1. Well construction and groundwater elevation data summary

Well Location	Well ID	Well Depth (ft bgs) [1]	Screen Interval (ft bgs) [1]	Ground Elevation (ft)	Top of Casing Elevation (ft)	Depth to Water (ft below TOC)	Water Elevation (ft)
Ash Basin Closure Monitoring Wells	MW-7D	60	55-60	242.94	245.06	18.69	226.37
	MW-101D	71	66-71	265.67	268.19	28.44	239.75
	MW-102D	85	80-85	253.75	256.34	30.09	226.25
	MW-107S	40.5	30.5-40.5	270.32	273.19	36.75	236.44
	MW-107D	67	62-67	270.14	273.14	36.73	236.41
	MW-108S	57	47-57	283.97	286.47	50.94	235.53
	MW-108D	83	78-83	283.85	286.36	51.51	234.85
	MW-109S	45	35-45	268.02	270.33	37.78	232.55
	MW-109D	82	77-82	268.08	270.29	38.87	231.42
	MW-110S	50	40-50	270.17	272.51	44.69	227.82
	MW-110D	75	70-75	270.40	272.37	44.74	227.63
	MW-111S	42	32-42	267.14	269.54	36.24	233.30
	MW-111D	73	68-73	267.38	269.67	36.04	233.63
	MW-112S	25	15-25	240.49	243.73	21.06	222.67
	MW-113S	37	27-37	252.68	255.16	32.09	223.07
	MW-113D	69	64-69	252.76	255.75	32.91	222.84
	MW-114S	37	27-37	254.81	257.53	34.31	223.22
	MW-114D	68	63-68	254.93	257.44	33.71	223.73
	MW-115S	50.5	40.5-50.5	286.19	288.67	49.43	239.24
	MW-115D	77	72-77	286.09	288.73	49.70	239.03
1960 Fill Area Monitoring Wells	MW-105S	35	25-35	254.86	256.86	29.08	227.78
	MW-105D	66	61-66	254.72	256.81	29.16	227.65
	MW-106S	34	24-34	253.53	255.84	29.23	226.61
	MW-106D	65	60-65	253.66	256.13	29.54	226.59
	MW-116S	34	24-34	255.07	257.51	28.82	228.69
	MW-116D	65	60-65	255.17	257.53	29.02	228.51
	MW-117S	32	22-32	252.66	255.33	26.08	229.25
	MW-117D	65	60-65	252.60	255.30	26.36	228.94
	MW-118S	25	15-25	244.71	246.82	20.52	226.30
	MW-118D	54	49-54	244.70	246.98	20.76	226.22
Existing Ash Basin Monitoring Wells [1]	MW-1R	36	26-36	265.25	267.55	27.80	239.75
	MW-2R	42.5	32.5-42.5	254.14	256.85	30.68	226.17
	MW-3R	69	59-69	277.22	280.34	51.56	228.78
	MW-5	39	29-39	--	--	--	--
	MW-6	49	39-49	--	--	--	--
	MW-7	34	24-34	--	--	19.44	--

Notes:

1. Existing ash basin groundwater monitoring well depths and screen intervals are measured from top of casing.
2. ft bgs indicates feet below ground surface.
3. TOC indicates top of well casing.
4. Water elevation measurements for all monitoring wells except MW-5 and MW-6 were gauged by HDR personnel on November 17, 2014.
5. Water elevation measurements for existing monitoring wells MW-5 and MW-6 were gauged by HDR personnel on July 15, 2014.
6. Elevations based on vertical datum NAVD88.

Table 2A. Geotechnical laboratory testing quantities by sample type and test method

Laboratory Test	Standard	Number Of Tests
Sieve Analysis (Mechanical Only)	ASTM D422	17
Sieve Analysis (With Hydrometer)	ASTM D422	7
Specific Gravity	ASTM D854	8
Atterberg Limits	ASTM D4318	10
Natural Moisture Content Determination	ASTM D 2216	18
Cu Triaxial Compression Test (3 Confining Stresses)	ASTM D4767	1
Hydraulic Conductivity	ASTM 5084	4

Table 2B. Geotechnical laboratory results summary – soil classifications

TB #	SAMPLE #	DEPTH (ft)	USCS LABORATORY DESCRIPTION	USCS CLASS	AASHTO CLASS	LL	PL	PI	NMC (%)	Gs	USCS GRAIN SIZE DISTRIBUTION							D60	D50	D30	D10
											GRAVEL		SAND			FINES	FINES				
											3"<%<3/4"	3/4"<%<#4	#4<%<#10	#10<%<#40	#40<%<#200	<#200	<#200				
											COARSE GRAVEL (%)	FINE GRAVEL (%)	COARSE SAND (%)	MED SAND (%)	FINE SAND (%)	SILT (%)	CLAY (%)				
AP-1	S-3	6' - 7.5'	Poorly Graded SAND with Silt	SP-SM	A-2-4(0)	NV	NP	NP	5.3	-	0	0	0.1	29.3	59.7	10.9		0.35	0.29	0.18	-
AP-2	S-4	18.5' - 20'	Poorly Graded SAND with Silt	SP-SM	A-1-b	NV	NP	NP	13.7	-	0	0	0.6	59.9	28.6	10.9		0.63	0.53	0.30	-
	S-8	98.5' - 100'	Fat CLAY	CH	A-7-6(32)	54	24	30	21.7	2.573	0	0	0	1.7	3.7	17.3	77.3	0.00	0.00	-	-
AP-3	S-7	23.5' - 25'	Fat CLAY with Sand	CH	A-7-6(23)	54	25	29	24.0	2.621	0	0	0	7.7	16.7	9.3	66.3	0.00	-	-	-
AP-4	S-4	8.5' - 10'	Poorly Graded SAND with Silt	SP-SM	A-3	NV	NP	NP	5.6	-	0	0	0	27.5	63.5	9		0.30	0.23	0.15	0.08
	S-6	18.5' - 20'	Sandy Lean CLAY	CL	A-6(4)	31	18	13	18.1	2.62	0	0	0.2	8.3	38	24	29.5	0.09	0.07	0.01	-
	S-9	33.5' - 35'	Silty, Clayey SAND	SC-SM	A-2-4(0)	22	15	7	12.8	2.647	0	0	3.4	59.6	23.7	0.5	12.8	0.78	0.62	0.33	-
	S-12	48.5' - 50'	Poorly Graded SAND	SP	A-1-b	NV	NP	NP	16.2	-	0	0	1.3	71.6	24.2	2.9		0.63	0.57	0.44	0.24
AP-5	S-2	63.5' - 65'	Sandy Lean CLAY	CL	A-4(4)	28	18	10	24.0	-	0	0	0.3	28.2	6.9	64.6		-	-	-	-
	S-6	87.4' - 88.8'	Lean CLAY	CL	A-7-6(20)	43	22	21	19.7	2.631	0	0	0	0.1	9	39.8	51.1	0.01	0.00	0.00	-
AP-8	S-2	3.5' - 5'	Poorly Graded SAND with Silt	SP-SM	A-3	NV	NP	NP	2.2	2.631	0	0	0.1	33.4	57.6	8.9		0.36	0.28	0.17	0.08
AP-9	S-4	21' - 22.5'	Silty SAND	SM	A-2-4(0)	NV	NP	NP	4.5	-	0	0	0.1	1.8	85.5	12.6		0.17	0.15	0.12	-
AP-11	S-4	8.5' - 10'	Silty SAND	SM	A-2-4(0)	NV	NP	NP	22.6	-	0	0	0.4	38.1	47.8	13.7		0.41	0.32	0.18	-
	S-11	43.5' - 45'	Poorly Graded SAND with Silt	SP-SM	A-1-b	NV	NP	NP	18.7	-	0	0	0.3	57.6	36.4	5.7		0.55	0.48	0.34	0.17
DD-1	S-9	33.5' - 35'	Silty SAND	SM	A-2-4(0)	NV	NP	NP	13.3	-	0	0	0.3	23.2	43.7	32.8		0.24	0.16	-	-
	S-12	48.5' - 50'	Lean CLAY with Sand	CL	A-4(6)	27	17	10	25.2	2.642	0	0	0	0.7	23.8	50.7	24.8	0.04	0.03	0.01	-
DD-2	S-9	38.5' - 40'	Silty SAND	SM	A-2-4(0)	NV	NP	NP	12.9	-	0	0	0.3	21.5	48.1	30.1		0.23	0.16	-	-
DD-2	S-13	70' - 71.5'	Poorly Graded SAND with Silt	SP-SM	A-1-b	NV	NP	NP	19.8	-	0	0	1.7	77.7	14.8	5.8		0.67	0.61	0.49	0.18
AP-10	UD #2 (top 6")	36' - 38'	Well Graded SAND with Silt	SW-SM	A-1-b	NV	NP	NP	-	-	0	0.2	21.6	58.6	12.6	7		1.43	1.21	0.79	0.15
	UD #2 (middle 6")	36' - 38'	Clayey SAND	SC	A-2-6(0)	37	19	18	-	-	0	0	6.5	64.1	10.2	19.2		1.07	0.90	0.45	-
	UD #2 (bottom 6")	36' - 38'	Lean CLAY with Sand	CL	A-6(7)	31	19	12	-	2.623	0	0	0	4.4	21.2	29.7	44.7	0.02	0.01	0.00	-
AP-11A	UD	18.5' - 20'	Poorly Graded SAND with Silt	SP-SM	A-1-b	NV	NP	NP	-	-	0	0	1.2	83.3	9.6	5.9		0.95	0.82	0.60	0.16
DD-2	UD #1 (top 6")	23' - 24.5'	Poorly Graded SAND	SP					-	-	0	0	3.6	74.8	17.9	3.7		0.82	0.70	0.50	0.28
	UD #1 (bottom 6")	23' - 24.5'	Clayey SAND	SC	A-2-4(0)	22	14	8		-	0	0	1	34	40.9	24.1		0.37	0.27	0.11	-

Table 3A. Soil sampling results – background samples

Parameter	Units	Sample ID and Location														EPA Industrial SSL	MCL-Based EPA Protection of Groundwater SSL
		BG-1 (1-2')	BG-1 (10-11')	BG-1 (20-21')	BG-1 (30-31')	BG-2 (1-2')	BG-2 (10-11')	BG-2 (20-21')	BG-3 (1-2')	BG-3 (10-11')	BG-3 (20-21')	BG-3 (30-31')	BG-4 (1-2')	BG-4 (10-11')	BG-4 (20-21')		
		Northwest of Ash Basin				West of Ash Basin			West-Southwest of Ash Basin				West of Lay of Land Area				
Antimony	mg/kg	< 0.51	< 0.36	< 0.51	< 0.54	< 0.55	< 0.42	< 0.51	< 0.54	< 0.48	< 0.48	< 0.51	< 0.42	< 0.40	< 0.40	470	0.27
Arsenic	mg/kg	< 1.0	**0.81**	**1.2**	< 1.1	**1.2**	**1.4**	**2.1**	< 1.1	**1.8**	< 0.95	**1.1**	**1.3**	< 0.81	< 0.80	3.0	0.29
Barium	mg/kg	2.8	2.7	2.5	6.4	2.6	6.5	1.9	15.8	6.6	1.5	3.1	5.4	0.85	0.62	220,000	82
Beryllium	mg/kg	< 0.10	< 0.073	< 0.10	< 0.11	< 0.11	< 0.085	< 0.10	< 0.11	< 0.096	< 0.095	< 0.099	< 0.083	< 0.081	< 0.080	2,300	3.2
Boron	mg/kg	< 0.84	< 3.94	< 4.37	< 4.19	< 4.18	< 4.35	< 5.31	< 3.77	< 4.17	< 4.27	< 4.25	< 0.72	< 5.10	< 4.01	230,000	NE
Cadmium	mg/kg	< 0.10	< 0.073	< 0.10	< 0.11	< 0.11	< 0.085	< 0.10	< 0.11	< 0.096	< 0.095	< 0.099	< 0.083	< 0.081	< 0.080	NE	0.38
Chloride	mg/kg	< 13	< 11	< 11	< 11	< 10	< 11	< 13	< 10	< 11	< 11	< 11	< 11	< 13	< 10	NE	NE
Chromium	mg/kg	10.9	9.1	14.3	4.2	5.5	7.3	4.8	5.7	14.6	4.8	13.6	5.1	4.2	5.7	NE	180,000
Cobalt	mg/kg	< 0.51	< 0.36	< 0.51	< 0.54	< 0.55	0.48	< 0.51	< 0.54	< 0.48	< 0.48	< 0.5	< 0.42	< 0.40	< 0.40	350	NE
Copper	mg/kg	1.5	2.3	2.3	1.2	1.7	2.5	3.3	1.2	3.3	0.93	2.0	1.6	0.69	< 0.40	47,000	46
Iron	mg/kg	2890	4690	8620	3200	2330	5160	5580	2850	9540	2840	6450	3250	1100	1070	820,000	NE
Lead	mg/kg	1.3	1.2	2.4	1.1	1.1	1.8	1.4	1.7	3.2	1.4	1.3	0.67	< 0.40	0.49	800	14
Manganese	mg/kg	6.6	5.2	3.4	7.7	1.9	83.1	13.6	7.1	12.1	1.6	1.6	20.3	5.8	3.5	26,000	NE
Mercury	mg/kg	0.0050	< 0.0052	0.0097	< 0.0055	0.0070	0.010	0.0063	0.0080	0.015	< 0.0043	0.0082	0.0070	< 0.0029	0.0041	40	0.1
Molybdenum	mg/kg	< 0.51	< 0.36	< 0.51	< 0.54	0.59	< 0.42	< 0.51	< 0.54	0.73	< 0.48	0.53	< 0.42	< 0.40	0.66	5,800	NE
Nickel	mg/kg	2.3	0.44	0.51	< 0.54	< 0.55	1.2	0.62	0.91	1.5	0.52	0.62	1.2	< 0.40	< 0.40	22,000	NE
Selenium	mg/kg	< 1.0	< 0.73	< 1.0	< 1.1	< 1.1	< 0.85	< 1.0	< 1.1	< 0.96	< 0.95	< 1.0	< 0.83	< 0.81	< 0.80	5,800	0.26
Thallium	mg/kg	< 1.0	< 0.73	< 1.0	< 1.1	< 1.1	< 0.85	< 1.0	< 1.1	< 0.96	< 0.95	< 1.0	< 0.83	< 0.81	< 0.80	12	0.14
Zinc	mg/kg	1.3	< 0.73	1.1	< 1.1	1.6	3.3	1.5	1.8	3.0	< 0.95	1.3	2.5	< 0.81	< 0.80	350,000	NE
pH	SU	6.2	5.0	5.1	4.9	5.0	4.3	4.5	4.8	5.0	5.4	5.0	5.2	4.5	5.2	NE	NE

Notes:

1. Concentrations presented in milligrams per kilogram (mg/kg).
2. Screening levels from the Environmental Protection Agency (EPA) Regional Screening Level (RSL) Summary Table (TR=1E-6, HQ=1) dated May 2014.
3. Analytical results obtained from Pace Analytical Services, Inc. laboratory report: Project Duke Robinson 234758.
4. Analytical results with a "<" preceding the result indicates that the parameter was not detected at a concentration which attains or exceeds the laboratory method reporting limit (MRL).
5. NE indicates not established.
6. SU indicates Standard Units.
7. **Bold** indicates a concentration which attains or exceeds the corresponding MCL-based EPA Protection of Groundwater Soil Screening Level (SSL).
8. Sample depth interval (feet below ground surface) is indicated in parentheses of the sample ID.

Table 3B. Ash and soil sampling results – within ash basin boundary

Parameter	Units	Sample ID and Location																EPA Industrial SSL	MCL-Based EPA Protection of Groundwater SSL
		AP-2 (2-3')	AP-2 (40-42')	AP-5 (1-3')	AP-5 (31-34')	AP-6 4-6')	AP-6 (14-16')	AP-6 (24-26')	AP-7 (2-4')	AP-7 (11-13')	AP-7 (17-20')	AP-9 (1-2')	AP-9 (7-10')	AP-9 (13-16')	AP-10 (1-3')	AP-10 (28-30')	AP-10 (36-39')		
		West Portion of Ash Basin		Central Portion of Ash Basin					Southeast Portion of Ash Basin			Northeast Portion of Ash Basin			East Portion of Ash Basin				
Total Inorganics																			
Antimony	mg/kg	< 1.3	0.61	**0.63**	< 0.57	**1.6**	< 0.54	< 0.57	**0.66**	**0.82**	< 0.41	**1.1**	**2.8**	< 0.51	< 0.88	< 0.72	< 0.43	470	0.27
Arsenic	mg/kg	**254**	**195**	**63.7**	**53.9**	**122**	**83.5**	< 1.1	**89.3**	**87.5**	**1.7**	**54.4**	**94.0**	**5.2**	**52.6**	**66.1**	**0.86**	3.0	0.29
Barium	mg/kg	**786**	**342**	**550**	**566**	**429**	**332**	4.6	**389**	**350**	3.0	**149**	**273**	10.2	**696**	**743**	6.5	220,000	82
Beryllium	mg/kg	5.3	4.1	3.1	2.8	**3.8**	**3.3**	< 0.11	**3.9**	**4.2**	< 0.082	2.8	**4.7**	0.23	2.6	**3.2**	< 0.085	2,300	3.2
Boron	mg/kg	16.6	29.5	17.9	19.4	15.8	23.1	< 4.52	22.0	21.0	< 4.06	20.7	19.1	< 4.22	5.99	11.2	< 4.39	230,000	NE
Cadmium	mg/kg	0.90	0.55	0.15	0.17	**0.39**	0.26	< 0.11	0.33	0.31	< 0.082	0.24	0.33	< 0.10	0.29	0.21	< 0.085	NE	0.38
Chloride	mg/kg	< 12	< 16	< 12	< 14	< 14	< 15	< 12	< 14	< 15	< 11	14	< 14	< 11	< 12	< 13	< 11	NE	NE
Chromium	mg/kg	32.6	17.3	11.9	14.7	15.2	18.2	6.0	15.1	18.0	1.4	19.2	31.7	6.3	12.3	21.5	2.0	NE	180,000
Cobalt	mg/kg	NA	NA	7.2	5.9	8.0	7.7	< 0.57	10.0	9.4	< 0.41	11.2	19.3	< 0.51	7.3	6.4	< 0.43	350	NE
Copper	mg/kg	91.1	54.4	29.8	32.3	42.6	37.6	1.9	41.7	44.2	1.0	**51.7**	**81.7**	2.2	41.7	**46.1**	0.99	47,000	46
Iron	mg/kg	19100	7650	8880	9250	6310	5000	2230	6340	5580	595	5460	9960	3430	27500	22900	346	820,000	NE
Lead	mg/kg	30.6	17.4	11.6	10	**14.0**	**15.8**	0.95	**18.9**	**18.8**	0.69	**22.1**	**37.5**	1.4	9.2	10.6	1.7	800	14
Manganese	mg/kg	110	43.5	25.0	50.5	51.9	27.1	0.79	27.9	37.0	1.4	24.2	42.1	7.8	56.3	87.1	1.9	26,000	NE
Mercury	mg/kg	**0.48**	**0.10**	**0.10**	0.095	**0.15**	**0.30**	0.013	**0.18**	**0.26**	0.015	**0.25**	**0.46**	0.0070	0.092	0.050	< 0.0052	40	0.1
Molybdenum	mg/kg	6.4	3.2	3.2	3.4	5.1	2.3	< 0.57	7.5	4.2	1.7	5.4	8.2	2.3	5.9	4.4	2.3	5,800	NE
Nickel	mg/kg	31.1	16.0	13.5	12.8	15.7	15.3	< 0.57	19.0	18.2	< 0.41	22.4	37.8	1.5	17.8	22.2	< 0.43	22,000	NE
Selenium	mg/kg	**12.6**	**6.7**	**11.5**	**10.0**	**12.1**	**9.0**	< 1.1	**15.7**	**13.3**	< 0.82	**10.8**	**17.8**	**1.8**	**4.7**	**12.7**	< 0.85	5,800	0.26
Thallium	mg/kg	< 2.6	< 0.95	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1	< 1.0	< 0.82	< 0.97	< 2.3	< 1.0	< 1.8	< 1.4	< 0.85	12	0.14
Zinc	mg/kg	53.4	26.7	14.8	15.1	22.7	21.2	< 1.1	27.9	26.5	< 0.82	28.6	49.0	4.3	16.2	46.7	< 0.85	350,000	NE
pH	SU	6.2	7.2	6.0	7.4	6.5	7.0	4.7	6.1	6.9	7.0	5.6	5.8	6.8	4.6	7.3	6.9	NE	NE
Radiological																			
Cesium-137	pCi/g	-0.0869 U	-0.069 U	0.0368 U	-0.0405 U	-0.121 U	0.000349 U	-0.0127 U	0.00662 U	0.0186 U	-0.0225 U	-0.0473 U	-0.0359 U	-0.00213 U	-0.00698 U	-0.0826 U	0.00835 U	NE	NE
Cobalt-60	pCi/g	0.082 U	0.0295 U	0.0284 U	-0.0014 U	0.0206 U	0.0135 U	0.00324 U	0.025 U	-0.0151 U	-0.0114 U	-0.00265 U	0.00441 U	0.0244 U	0.028 U	0.0632 U	-0.0284 U	NE	NE

Notes:

1. Concentrations presented in milligrams per kilogram (mg/kg) and pico Curie per gram (pCi/g).
2. Screening levels from the Environmental Protection Agency (EPA) Regional Screening Level (RSL) Summary Table (TR=1E-6, HQ=1) dated May 2014.
3. Analytical results obtained from Pace Analytical Services, Inc. laboratory report: Project Duke Robinson 234758.
4. Analytical results with a "<" preceding the result indicates that the parameter was not detected at a concentration which attains or exceeds the laboratory method reporting limit (MRL).
5. NE indicates not established.
6. SU indicates Standard Units.
7. **Bold** indicates a concentration which attains or exceeds the corresponding MCL-based EPA Protection of Groundwater Soil Screening Level (SSL).
8. **Bold and underline** indicates a concentration which attains or exceeds the corresponding MCL-based EPA Protection of Groundwater SSL and EPA Industrial SSL.
9. Sample depth interval (feet below ground surface) is indicated in parentheses of the sample ID.
10. Grey highlighted columns indicate ash samples.
11. NA indicates not analyzed.
12. U qualifier indicates analyte was analyzed for, but not detected above the MDL, MDA, or LOD.

Table 3C. Soil sampling results – outside ash basin boundary

Parameter	Units	Sample ID and Location																EPA Industrial SSL	MCL-Based EPA Protection of Groundwater SSL
		AP-1 (30-31')	AP-3 (30-31')	AP-4 (30-31')	AP-8 (33-35')	DD-1 (14-15')	DD-1 (34-35')	DD-1 (39-40')	DD-2 (14-15')	DD-2 (39-40')	DD-2 (43-44')	CB-1 (5-6')	CB-1 (12-13')	CB-2 (5-6')	CB-2 (24-25')	CB-3 (5-6')	CB-3 (19-21')		
		Cross Gradient of Ash Basin				Crest of Ash Basin Dam						Downgradient of Ash Basin							
Antimony	mg/kg	< 0.62	< 0.37	< 0.44	< 0.39	< 0.60	< 0.52	< 0.48	< 0.48	< 0.45	< 0.43	< 0.47	< 0.50	< 0.42	< 0.51	< 0.53	< 0.50	470	0.27
Arsenic	mg/kg	< 1.2	< 0.74	< 0.89	< 0.78	< 1.2	**2.2**	< 0.96	< 0.96	**2.7**	< 0.87	< 0.95	< 1.0	**0.98**	< 1.0	< 1.1	< 1.0	3.0	0.29
Barium	mg/kg	0.97	< 0.37	2.0	2.4	7.1	8.2	1.8	1.3	3.0	1.8	0.85	1.7	2.2	< 0.51	6.1	0.75	220,000	82
Beryllium	mg/kg	< 0.12	< 0.074	< 0.089	< 0.078	< 0.12	< 0.10	< 0.096	< 0.096	< 0.090	< 0.087	< 0.095	< 0.10	< 0.084	< 0.10	< 0.11	< 0.10	2,300	3.2
Boron	mg/kg	< 0.84	< 3.79	< 0.90	< 4.20	< 4.26	< 4.12	< 4.22	< 3.95	< 4.48	< 0.86	< 3.75	< 3.90	< 4.02	< 4.06	< 4.12	< 3.95	250,000	NE
Cadmium	mg/kg	< 0.12	< 0.074	< 0.089	< 0.078	< 0.12	< 0.10	< 0.096	< 0.096	< 0.090	< 0.087	< 0.095	< 0.10	< 0.084	< 0.10	< 0.11	< 0.10	NE	0.38
Chloride	mg/kg	< 13	< 10	< 14	< 11	< 11	< 11	< 11	< 10	< 11	< 13	< 10	< 10	< 10	< 10	< 11	< 10	NE	NE
Chromium	mg/kg	2.6	0.70	0.95	5.2	20.8	18.0	1.9	5.7	8.2	2.2	2.3	3.8	9.1	1.0	7.3	1.1	NE	180,000
Cobalt	mg/kg	< 0.62	< 0.37	< 0.44	< 0.39	< 0.60	< 0.52	< 0.48	< 0.48	< 0.45	< 0.43	< 0.47	< 0.50	< 0.42	< 0.51	< 0.53	< 0.50	350	NE
Copper	mg/kg	< 0.62	< 0.37	< 0.44	1.7	3.1	4.2	< 0.48	1.3	1.8	0.64	0.70	0.77	1.7	< 0.51	1.4	< 0.50	47,000	46
Iron	mg/kg	1860	390	175	2710	5220	11700	975	2930	4640	1150	1010	2000	4330	636	3770	590	820,000	NE
Lead	mg/kg	< 0.62	< 0.37	0.71	0.91	1.8	3.0	0.72	1.1	2.0	0.90	< 0.47	0.89	1.2	< 0.51	1.9	< 0.50	800	14
Manganese	mg/kg	0.78	< 0.37	< 0.44	6.2	27.0	5.0	0.64	1.9	5.6	1.9	3.2	1.9	3.5	< 0.51	1.7	1.2	26,000	NE
Mercury	mg/kg	0.0058	< 0.0036	0.0058	0.0080	0.0085	0.028	< 0.0045	< 0.0040	0.013	< 0.0045	< 0.0054	< 0.0049	0.0066	< 0.0047	0.014	< 0.0040	40	0.1
Molybdenum	mg/kg	< 0.62	< 0.37	< 0.44	< 0.39	4.7	0.61	< 0.48	< 0.48	< 0.45	< 0.43	< 0.47	< 0.50	< 0.42	< 0.51	< 0.53	< 0.50	5,800	NE
Nickel	mg/kg	< 0.62	< 0.37	< 0.44	0.76	2.5	1.3	< 0.48	< 0.48	0.45	< 0.43	< 0.47	< 0.50	0.58	< 0.51	< 0.53	< 0.50	22,000	NE
Selenium	mg/kg	< 1.2	< 0.74	< 0.89	< 0.78	< 1.2	< 1.0	< 0.96	< 0.96	< 0.90	< 0.87	< 0.95	< 1.0	< 0.84	< 1.0	< 1.1	< 1.0	5,800	0.26
Thallium	mg/kg	< 1.2	< 0.74	< 0.89	< 0.78	< 1.2	< 1.0	< 0.96	< 0.96	< 0.90	< 0.87	< 0.95	< 1.0	< 0.84	< 1.0	< 1.1	< 1.0	12	0.14
Zinc	mg/kg	< 1.2	< 0.74	< 0.89	< 0.78	6.6	1.3	< 0.96	< 0.96	0.96	< 0.87	1.3	< 1.0	1.6	< 1.0	< 1.1	< 1.0	350,000	NE
pH	SU	4.8	5.0	4.6	5.6	5.6	5.0	5.6	4.8	4.8	5.2	5.2	5.4	4.9	5.4	5.0	4.8	NE	NE

Notes:
1. Concentrations presented in milligrams per kilogram (mg/kg).
2. Screening levels from the Environmental Protection Agency (EPA) Regional Screening Level (RSL) Summary Table (TR=1E-6, HQ=1) dated May 2014.
3. Analytical results obtained from Pace Analytical Services, Inc. laboratory report: Project Duke Robinson 234758.
4. Analytical results with a "<" preceding the result indicates that the parameter was not detected at a concentration which attains or exceeds the laboratory method reporting limit (MRL).
5. NE indicates not established.
6. SU indicates Standard Units.
7. **Bold** indicates a concentration which attains or exceeds the corresponding MCL-based EPA Protection of Groundwater Soil Screening Level (SSL).
8. Sample depth interval (feet below ground surface) is indicated in parentheses of the sample ID.

Table 3D. Ash and soil sampling results – within 1960 Fill Area

Parameter	Units	Sample ID and Location							EPA Industrial SSL	MCL-Based EPA Protection of Groundwater SSL
		LOL - 2 (4-6')	LOL - 2 (9-11')	LOL - 3 (2-4')	LOL - 3 (7-9')	LOL - 3 (11-13')	LOL - 4 (4-6')	LOL - 4 (9-11')		
		Central Portion of 1960 Fill Area		Central Portion of 1960 Fill Area			Southwest Portion of 1960 Fill Area			
Antimony	mg/kg	< 0.66	< 0.51	< 0.52	< 0.58	< 0.48	< 0.59	< 0.44	470	0.27
Arsenic	mg/kg	**37.0**	< 1.0	**39.0**	**38.7**	**11.0**	**58.0**	**1.6**	3.0	0.29
Barium	mg/kg	**828**	10	**385**	**424**	20.5	**526**	12.7	220,000	82
Beryllium	mg/kg	**4.4**	< 0.10	**3.3**	2.1	< 0.097	**4.1**	< 0.088	2,300	3.2
Boron	mg/kg	6.87	< 0.72	9.67	16.9	< 0.9	18.0	< 4.76	230,000	NE
Cadmium	mg/kg	**0.41**	< 0.10	0.21	0.12	< 0.097	0.33	< 0.088	NE	0.38
Chloride	mg/kg	< 13	< 11	< 15	< 17	< 14	< 12	< 13	NE	NE
Chromium	mg/kg	14.1	5.6	12.5	10.4	6.7	15.6	7.1	NE	180,000
Cobalt	mg/kg	6.5	< 0.51	7.0	4.7	< 0.48	8.8	< 0.44	350	NE
Copper	mg/kg	43.8	1.3	31.5	27.4	2.1	44.5	0.91	47,000	46
Iron	mg/kg	12400	3070	5740	10900	4500	7260	2810	820,000	NE
Lead	mg/kg	10.4	1.0	9.2	6.0	1.9	13.7	0.96	800	14
Manganese	mg/kg	208	13.2	49.3	115	13.5	78.6	5.7	26,000	NE
Mercury	mg/kg	0.058	0.0094	0.097	0.067	0.020	0.094	< 0.0035	40	0.1
Molybdenum	mg/kg	1.1	2.1	0.78	1.2	1.3	1.2	< 0.44	5,800	NE
Nickel	mg/kg	15.6	0.61	12.3	9.8	1.2	20.7	0.53	22,000	NE
Selenium	mg/kg	**3.8**	< 1.0	**2.9**	**9.2**	**1.4**	**5.0**	< 0.88	5,800	0.26
Thallium	mg/kg	< 1.3	< 1.0	< 1.0	< 1.3	< 1.2	< 1.2	< 0.88	12	0.14
Zinc	mg/kg	12.0	1.1	13.0	12	8.6	19.1	< 0.88	350,000	NE
pH	SU	6.3	7	5.9	6.3	6.8	6.2	7.1	NE	NE

Notes:
1. Concentrations presented in milligrams per kilogram (mg/kg).
2. Screening levels from the Environmental Protection Agency (EPA) Regional Screening Level (RSL) Summary Table (TR=1E-6, HQ=1) dated May 2014.
3. Analytical results obtained from Pace Analytical Services, Inc. laboratory report: Project Duke Robinson 234758.
4. Analytical results with a "<" preceeding the result indicates that the parameter was not detected at a concentration which attains or exceeds the laboratory method reporting limit (MRL).
5. NE indicates not established.
6. SU indicates Standard Units.
7. **Bold** indicates a concentration which attains or exceeds the corresponding MCL-based EPA Protection of Groundwater Soil Screening Level (SSL).
8. **Bold and underline** indicates a concentration which attains or exceeds the corresponding MCL-based EPA Protection of Groundwater SSL and EPA Industrial SSL.
9. Sample depth interval (feet below ground surface) is indicated in parentheses of the sample ID.
10. Grey highlighted columns indicate ash samples.

Table 4. Ash SPLP leaching results – within ash basin and 1960 Fill Area

Parameter	Units	Sample ID and Location												SC DHEC Primary & Secondary MCLs
		AP-2 (2-3')	AP-2 (40-42')	AP-5 (1-3')	AP-5 (31-34')	AP-6 (4-6')	AP-6 (14-16')	AP-7 (2-4')	AP-7 (11-13')	AP-10 (28-30)	LOL-2 (4-6')	LOL-3 (7-9')	LOL-4 (4-6')	
		West Portion of Ash Basin		Central Portion of Ash Basin				Southeast Portion of Ash Basin		East Portion of Ash Basin	Central Portion of 1960 Fill Area	Central Portion of 1960 Fill Area	Southwest Portion of 1960 Fill Area	
Antimony	µg/L	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	5.9	< 5.0	< 5.0	< 5.0	< 5.0	6
Arsenic	µg/L	**80**	**75**	**14**	**29**	7.9	8.2	6.6	**37**	**11**	3.0	8.9	3.1	10
Barium	µg/L	39	< 10	< 10	74	< 10	< 10	19	< 10	< 10	11	190	26	2000
Beryllium	µg/L	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	4
Boron	µg/L	< 200	< 200	310	< 200	< 200	< 200	< 200	< 200	220	< 200	< 200	< 200	NE
Cadmium	µg/L	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	5
Chloride	mg/L	3.4	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	3.3	< 1.0	4.2	250*
Chromium	µg/L	11	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	100
Cobalt	µg/L	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	NE
Copper	µg/L	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	1000*
Iron	µg/L	1400	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	**330**	300*
Lead	µg/L	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	NE
Manganese	µg/L	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	**110**	< 10	50*
Mercury	µg/L	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	NA	< 0.20	NA	2
Molybdenum	µg/L	13	14	< 10	32	14	< 10	63	54	< 10	< 10	< 10	< 10	NE
Nickel	µg/L	< 40	< 40	< 40	< 40	< 40	< 40	< 40	< 40	< 40	< 40	< 40	< 40	NE
Selenium	µg/L	21	< 20	26	36	27	< 20	42	< 20	< 20	< 20	22	< 20	50
Thallium	µg/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	2
Zinc	µg/L	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	20	< 20	< 20	< 20	5000*
pH	SU	7.4	8.1	7.9	7.3	**8.5**	8.4	**9.6**	**8.5**	**3.4**	**9.8**	6.5	**10**	6.5-8.5

Notes:
1. Concentrations presented in micrograms per liter (µg/L) and milligrams per liter (mg/L).
2. State Primary Drinking Water Regulations: R.61-58 as found in SCDHEC Bureau of Water MCLs, last amended on August 28, 2009.
3. Analytical results obtained from Pace Analytical Services, Inc. laboratory report: Project Duke Robinson 234758.
4. Analytical results with a "<" preceeding the result indicates that the parameter was not detected at a concentration which attains or exceeds the laboratory method reporting limit (MRL).
5. NE indicates not established.
6. SU indicates Standard Units.
7. **Bold** indicates a concentration which attains or exceeds the corresponding Maximum Contaminant Level (MCL).
8. Sample depth interval (feet below ground surface) is indicated in parentheses of the sample ID.
9. NA indicates not analyzed.

Table 5A. Groundwater monitoring well sample results – total inorganics (total concentrations)

Parameter	Units	Sample Location																SC DHEC Primary & Secondary MCLs
		MW-7	MW-7D	MW-101D	MW-102D	MW-105D	MW-105S	MW-106D	MW-106S	MW-107S	MW-107D	MW-108D	MW-108S	MW-109D	MW-109S	MW-110D	MW-110S	
Field Parameters																		
Field pH	SU	7.0	**6.4**	**11.2**	**6.5**	7.6	**5.0**	**6.3**	**4.5**	**5.2**	**11.4**	6.6	**6.5**	6.6	7.8	6.7	**6.1**	6.5-8.5*
Field Specific Conductance	µmhos/cm	308	372	394	52	91	97	136	49	21	669	229	644	208	661	312	369	NE
Field Temperature	°C	22.2	15	20.7	20.9	19	19	19.4	18.5	20.6	20.7	19.2	20.4	21	22.7	23.4	24	NE
Dissolved Oxygen	mg/L	0.1	0.1	8.7	4.8	5	5.3	6.1	8.0	5.8	5.7	8.7	0.1	0	0.6	1.4	3.8	NE
ORP (REDOX)	mV	-135	-101	-2	423	348	490	409	521	281	-58	86.5	-46	-108	-158	-157	366	NE
Total Inorganics																		
Antimony	µg/L	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	6
Arsenic	µg/L	**117**	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	**97.4**	< 10.0	**1100**	< 10.0	< 10.0	10
Barium	µg/L	120	70.0	27.2	7.4	21.2	73.9	13	31.3	7.3	29.0	22.3	118	48.2	342	60.1	125	2000
Beryllium	µg/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	4
Boron	µg/L	774	893	< 50.0	62.3	217	238	< 50	65.0	< 50.0	< 50.0	232	940	441	1550	758	632	NE
Cadmium	µg/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	1.4	< 1.0	< 1.0	5
Chromium	µg/L	< 5.0	12.6	36.4	8.4	3.2	< 5.0	< 5	< 5.0	< 5.0	55.0	6.6	< 5.0	< 5	< 5	< 5	6.9	100
Cobalt	µg/L	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	NE
Copper	µg/L	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	6.0	< 5.0	< 5.0	< 5.0	1000*
Iron	µg/L	**3080**	**8720**	189	105	83.6	< 50.0	250	< 50.0	**339**	61.3	**314**	**6450**	**740**	259	**10700**	**733**	300*
Lead	µg/L	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	NE
Manganese	µg/L	**200**	**177**	< 5.0	8.9	17.6	**68.6**	33.2	11.2	< 5.0	< 5.0	**208**	**1150**	**379**	**94.9**	**340**	**232**	50*
Mercury	µg/L	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	2
Molybdenum	µg/L	17.7	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	10.5	< 5.0	24.1	< 5.0	79.0	< 5.0	12.7	NE
Nickel	µg/L	< 5.0	18.2	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	13.2	7.0	NE
Nitrogen, Nitrate	µg/L	< 20	< 20.0	1140	302	824	426	1900	1850	366	985	562	< 20	< 20	< 20	< 20	< 20	10000
Selenium	µg/L	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	20.8	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	50
Thallium	µg/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	2
Zinc	µg/L	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	11.7	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	5000*

Notes:
1. Concentrations presented in milligrams per liter (mg/L) and micrograms per liter (µg/L).
2. State Primary Drinking Water Regulations: R.61-58 as found in SCDHEC Bureau of Water MCLs, last amended on August 28, 2009.
3. Analytical results obtained from Pace Analytical Services, Inc. laboratory report: Project Duke Robinson 234758.
4. °C Degrees Celsius
5. mV indicates MilliVolts
6. SU indicates Standard Units.
7. umho/cm indicates micromhos per centimeter.
8. NA indicates not analyzed.
9. **Bold** indicates a concentration which attains or exceeds the corresponding Maximum Contaminant Level (MCL).
10. Grey highlighted columns indicate monitoring wells screened in the ash basin.

Table 5A (cont'd.) Groundwater monitoring well sample results - total inorganics (total concentrations)

Parameter	Units	Sample Location															SC DHEC Primary & Secondary MCLs
		MW-111D	MW-111S	MW-112S	MW-113S	MW-113D	MW-114S	MW-114D	MW-115D	MW-115S	MW-116D	MW-116S	MW-117D	MW-117S	MW-118D	MW-118S	
Field Parameters																	
Field pH	SU	**5.4**	**6.3**	**5.0**	**4.1**	**6.1**	8.0	6.6	**12.2**	**5.6**	**6.2**	**5.9**	**6.1**	**5.2**	**6.2**	**6.4**	6.5-8.5*
Field Specific Conductance	µmhos/cm	150	347	89	629	519	451	564	3330	23	90	63	188	92	80	91	NE
Field Temperature	°C	21.1	20.3	21.5	21.7	21.3	21.9	21.9	19.6	19.8	17.8	18.4	17.5	18.6	19.1	21.5	NE
Dissolved Oxygen	mg/L	6.6	0.3	0.5	6.0	1.0	6.4	0.5	5.8	5.8	3.7	6.8	2.9	7.1	5.6	6.1	NE
ORP (REDOX)	mV	375	156	239	407	127	106	66	-80	437	453	353	-1	498	451	341	NE
Total Inorganics																	
Antimony	µg/L	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	6
Arsenic	µg/L	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	10
Barium	µg/L	46.2	67.4	24.4	66.7	32.4	46.7	70	780	7.6	21.0	22.9	84.1	54.2	39.1	14.3	2000
Beryllium	µg/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	4
Boron	µg/L	416	660	210	643	1370	1100	1260	< 50.0	< 50.0	< 50	82.8	394	189	205	75.8	NE
Cadmium	µg/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	5
Chromium	µg/L	< 5	6.6	< 5.0	< 5.0	< 5.0	12.3	< 5.0	51.2	< 5.0	< 5	< 5	7.7	< 5.0	< 5.0	< 5	100
Cobalt	µg/L	< 5.0	< 5.0	< 5.0	11.1	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	NE
Copper	µg/L	< 5.0	< 5.0	< 5.0	13.1	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	1000*
Iron	µg/L	61.3	**2010**	117	252	59.3	70	**300**	< 50.0	**596**	**785**	< 50	94.8	< 50.0	168	228	300*
Lead	µg/L	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	NE
Manganese	µg/L	**165**	**157**	35.1	**328**	**226**	5.0	**75.2**	< 5.0	**100**	**52.4**	**51.4**	**143.0**	**124**	25.8	29.2	50*
Mercury	µg/L	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	2
Molybdenum	µg/L	< 5.0	10.7	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	7.5	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	NE
Nickel	µg/L	< 5.0	< 5.0	6.2	29.5	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	6.1	< 5.0	< 5.0	< 5.0	NE
Nitrogen, Nitrate	µg/L	608	27.1	271	389	197	233	136	1870	392	1600	398	234	808	553	553	10000
Selenium	µg/L	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	10.5	< 10.0	< 10.0	50
Thallium	µg/L	1.1	1.6	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	2
Zinc	µg/L	< 10.0	< 10.0	< 10.0	53.4	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	5000*

Notes:

1. Concentrations presented in milligrams per liter (mg/L) and micrograms per liter (µg/L).
2. State Primary Drinking Water Regulations: R.61-58 as found in SCDHEC Bureau of Water MCLs, last amended on August 28, 2009.
3. Analytical results obtained from Pace Analytical Services, Inc. laboratory report: Project Duke Robinson 234758.
4. °C Degrees Celsius
5. mV indicates MilliVolts
6. SU indicates Standard Units.
7. umho/cm indicates micromhos per centimeter.
8. NA indicates not analyzed.
9. **Bold** indicates a concentration which attains or exceeds the corresponding Maximum Contaminant Level (MCL).
10. Grey highlighted columns indicate monitoring wells screened in the ash basin.

Table 5B. Groundwater monitoring well sample results – major anions and cations

Parameter	Units	Sample Location																SC DHEC Primary & Secondary MCLs
		MW-7D	MW-7	MW-101D	MW-102D	MW-105D	MW-105S	MW-106D	MW-106S	MW-107S	MW-107D	MW-108D	MW-108S	MW-109D	MW-109S	MW-110D	MW-110S	
Alkalinity, Total as CaCO3	mg/L	60.8	106	85.7	16.7	26.1	< 5.0	20.3	< 5.0	< 5.0	150	47.9	312	53.6	238	47.5	71.3	NE
Bromide	mg/L	0.13	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	0.10	< 0.10	0.2	0.1	0.11	NE
Calcium	µg/L	40500	46100	35700	6570	1820	8160	1790	1340	843	58200	7010	77900	20100	106000	38700	53300	NE
Chloride	mg/L	3.0	2.2	1.7	2.1	3.2	2.3	4	4.4	1.9	2.0	2.7	2	2.4	4.2	3.2	3.5	250*
Iron, Ferrous	mg/L	8.2	2.2	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	2.6	0.64	< 0.5	6	< 0.5	NE
Magnesium	µg/L	4950	200	179	267	326	2180	526	1240	175	< 100	1280	19700	2620	10600	3810	4710	NE
Methane	µg/L	30.4	52.4	< 6.6	< 6.6	< 6.6	< 6.6	< 6.6	< 6.6	< 6.6	< 6.6	15.4	62.8	< 6.6	458	< 6.6	13	NE
Nitrogen, Nitrate	µg/L	< 20	< 20	1140	302	824	426	1900	1850	366	985	562	< 20	< 20	< 20	< 20	< 20	10000
Potassium	µg/L	7310	7340	< 5000	< 5000	7640	< 5000	< 5000	< 5000	< 5000	< 5000	6890	< 5000	6220	10900	7930	7410	NE
Sodium	µg/L	6840	< 5000	< 5000	< 5000	11200	< 5000	24400	< 5000	< 5000	10600	29700	26600	11700	9840	< 5000	5180	NE
Sulfate	mg/L	91.7	< 1.0	4.3	1.8	5.9	30.3	27.2	3.2	1.0	18.1	42.5	46	41.5	135	86.4	102	250*
Sulfide	mg/L	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	NE
Total Dissolved Solids	mg/L	232	195	136	49	66	66	99	< 25	< 25	186	151	389	130	442	201	228	500*

Notes:
1. Concentrations presented in milligrams per liter (mg/L) and micrograms per liter (µg/L).
2. State Primary Drinking Water Regulations: R.61-58 as found in SCDHEC Bureau of Water MCLs, last amended on August 28, 2009.
3. Analytical results obtained from Pace Analytical Services, Inc. laboratory report: Project Duke Robinson 234758.
4. °C Degrees Celsius
5. mV indicates MilliVolts
6. SU indicates Standard Units.
7. umho/cm indicates micromhos per centimeter.
8. NA indicates not analyzed.
9. **Bold** indicates a concentration which attains or exceeds the corresponding Maximum Contaminant Level (MCL).
10. Grey highlighted columns indicate monitoring wells screened in the ash basin.

Table 5B (cont'd.) Groundwater monitoring well sample results – major anions and cations

Parameter	Units	Sample Location															SC DHEC Primary & Secondary MCLs
		MW-111D	MW-111S	MW-112S	MW-113S	MW-113D	MW-114S	MW-114D	MW-115D	MW-115S	MW-116D	MW-116S	MW-117D	MW-117S	MW-118D	MW-118S	
Alkalinity, Total as CaCO3	mg/L	< 5.0	134	< 5.0	< 5.0	66.5	126	144	696	< 5.0	14.4	11.4	15.4	< 5.0	14.5	17.8	NE
Bromide	mg/L	< 0.10	< 0.10	< 0.10	0.12	0.15	0.15	0.18	< 0.10	0.12	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	NE
Calcium	µg/L	15900	45300	8250	56500	49400	70200	67300	224000	995	2590	2600	15500	8390	2890	10700	NE
Chloride	mg/L	2.8	2.2	1.3	2.9	3.4	3.2	3.7	3.5	2.7	3.7	2.9	3.4	2.1	3	3.8	250*
Iron, Ferrous	mg/L	< 0.50	2.10	< 0.50	< 0.50	< 0.50	< 0.50	< 0.5	< 0.50	0.7	< 0.5	< 0.5	< 0.50	< 0.50	< 0.50	< 0.5	NE
Magnesium	µg/L	1740	9630	944	4640	8110	5410	8520	< 100	272	708	714	2970	1280	967	814	NE
Methane	µg/L	< 6.6	< 6.6	< 6.6	< 6.6	18.0	< 6.6	11.2	< 6.6	11.7	< 6.6	< 6.6	< 6.6	< 6.6	< 6.6	< 6.6	NE
Nitrogen, Nitrate	µg/L	608	27.1	271	389	197	233	136	1870	392	1600	398	234	808	553	1940	10000
Potassium	µg/L	< 5000	7140	< 5000	7090	< 5000	6620	6700	< 5000	< 5000	< 5000	< 5000	< 5000	< 5000	7020	< 5000	NE
Sodium	µg/L	< 5000	< 5000	< 5000	< 5000	42300	6010	31600	73100	< 5000	14000	7530	8750	< 5000	6420	< 5000	NE
Sulfate	mg/L	50.8	43.7	23.7	**319**	176	99.0	127	3.7	38.7	12.5	8.4	58.0	25.6	12.2	7.1	250*
Sulfide	mg/L	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	NE
Total Dissolved Solids	mg/L	105	214	< 25	167	116	285	346	**670**	32	93	52	136	71	65	46	500*

Notes:
1. Concentrations presented in milligrams per liter (mg/L) and micrograms per liter (µg/L).
2. State Primary Drinking Water Regulations: R.61-58 as found in SCDHEC Bureau of Water MCLs, last amended on August 28, 2009.
3. Analytical results obtained from Pace Analytical Services, Inc. laboratory report: Project Duke Robinson 234758.
4. °C Degrees Celsius
5. mV indicates MilliVolts
6. SU indicates Standard Units.
7. umho/cm indicates micromhos per centimeter.
8. NA indicates not analyzed.
9. **Bold** indicates a concentration which attains or exceeds the corresponding Maximum Contaminant Level (MCL).
10. Grey highlighted columns indicate monitoring wells screened in the ash basin.

Table 5C. Groundwater monitoring well sample results – total inorganics (dissolved concentrations)

Parameter	Units	Sample Location																SC DHEC Primary & Secondary MCLs
		MW-7D	MW-7	MW-101D	MW-102D	MW-105D	MW-105S	MW-106D	MW-106S	MW-107S	MW-107D	MW-108D	MW-108S	MW-109D	MW-109S	MW-110D	MW-110S	
Antimony, Dissolved	µg/L	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	6
Arsenic, Dissolved	µg/L	< 10.0	**77.4**	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	**22.3**	< 10.0	**1040**	< 10.0	< 10.0	10
Barium, Dissolved	µg/L	63.1	102	22.8	6.3	18.4	70.8	9.8	29.3	6.6	27.5	21.1	99.1	44.9	331	54.6	116	2000
Beryllium, Dissolved	µg/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	4
Boron, Dissolved	µg/L	852	682	< 50.0	54.8	196	215	< 50.0	60.4	< 50.0	< 50.0	218	912	435	1570	712	598	NE
Cadmium, Dissolved	µg/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	2.0	< 1.0	< 1.0	5
Chromium, Dissolved	µg/L	< 5.0	< 5.0	21.1	< 5.0	< 5.0	< 5.0	< 5.0	5.8	< 5.0	54.4	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	100
Cobalt, Dissolved	µg/L	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	NE
Copper, Dissolved	µg/L	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	1000*
Iron, Dissolved	µg/L	7050	**1510**	< 50.0	< 50.0	< 50.0	< 50.0	104	< 50.0	< 50.0	< 50.0	< 50.0	**1120**	**537**	ND	**8090**	**482**	300*
Lead, Dissolved	µg/L	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	NE
Manganese, Dissolved	µg/L	**176**	**180**	< 5.0	7.8	15.3	**64.5**	26.9	14.2	< 5.0	< 5.0	**194**	**1060**	**361**	**92.1**	**308**	**212**	50*
Mercury, Dissolved	µg/L	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	2
Molybdenum, Dissolved	µg/L	< 5.0	15.9	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	5.4	< 5.0	22.1	< 5.0	76.2	< 5.0	11.2	NE
Nickel, Dissolved	µg/L	10	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	11.9	< 5.0	NE
Nitrogen, Nitrate	µg/L	< 20.0	< 20	1140	302	824	426	1900	< 10.0	366	985	562	< 20	< 20	ND	< 20	< 20	10000
Selenium, Dissolved	µg/L	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	21.0	< 10.0	29.38	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	50
Thallium, Dissolved	µg/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	2
Zinc, Dissolved	µg/L	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	5000*

Notes:

1. Concentrations presented in micrograms per liter (µg/L).
2. State Primary Drinking Water Regulations: R.61-58 as found in SCDHEC Bureau of Water MCLs, last amended on August 28, 2009.
3. Analytical results obtained from Pace Analytical Services, Inc. laboratory report: Project Duke Robinson 234758.
4. °C Degrees Celsius
5. mV indicates MilliVolts
6. SU indicates Standard Units.
7. umho/cm indicates micromhos per centimeter.
8. NA indicates not analyzed.
9. **Bold** indicates a concentration which attains or exceeds the corresponding SC DEHC Groundwater Standard.
10. Grey highlighted columns indicate monitoring wells screened in the ash basin.

Table 5C (cont'd.) Groundwater monitoring well sample results – total inorganics (dissolved concentrations)

Parameter	Units	Sample Location															SC DHEC Primary & Secondary MCLs
		MW-111D	**MW-111S**	**MW-112S**	**MW-113S**	**MW-113D**	**MW-114S**	**MW-114D**	**MW-115D**	**MW-115S**	**MW-116D**	**MW-116S**	**MW-117D**	**MW-117S**	**MW-118D**	**MW-118S**	
Antimony, Dissolved	µg/L	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	**9.0**	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	6
Arsenic, Dissolved	µg/L	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10	< 10.0	< 10.0	< 10.0	< 10.0	10
Barium, Dissolved	µg/L	42.5	63.4	22.1	63.3	28.5	43.9	63.5	694	6.4	14.8	21	75.6	47.8	35.5	12.7	2000
Beryllium, Dissolved	µg/L	< 1.0	< 1.0	< 1.0	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	4
Boron, Dissolved	µg/L	384	617	168	556	1160	939	1090	< 50.0	< 50.0	< 50	74.5	377	182	190	65.3	NE
Cadmium, Dissolved	µg/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	5
Chromium, Dissolved	µg/L	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	12.6	< 5.0	44.7	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	100
Cobalt, Dissolved	µg/L	< 5.0	< 5.0	< 5.0	11.9	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	NE
Copper, Dissolved	µg/L	< 5.0	< 5.0	< 5.0	11.1	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	1000*
Iron, Dissolved	µg/L	< 50.0	**1830**	76.2	186	< 50.0	< 50.0	< 50.0	< 50.0	**585**	110	< 50	< 50.0	< 50.0	70.1	106	300*
Lead, Dissolved	µg/L	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	NE
Manganese, Dissolved	µg/L	**152**	**147**	33	**312**	**203**	5.8	**68.5**	< 5.0	**103**	33.5	48.6	**152**	**125**	22.5	27.2	50*
Mercury, Dissolved	µg/L	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	2
Molybdenum, Dissolved	µg/L	< 5.0	9.7	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	8.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	NE
Nickel, Dissolved	µg/L	< 5.0	< 5.0	7.1	29.2	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	NE
Nitrogen, Nitrate	µg/L	608	27.1	271	389	197	233	136	1870	392	1600	398	234	808	553	1940	10000
Selenium, Dissolved	µg/L	< 10.0	< 10.0	< 10.0	< 10.0	12.6	< 10.0	10.9	11.3	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	50
Thallium, Dissolved	µg/L	1.1	1.6	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	2
Zinc, Dissolved	µg/L	< 10.0	< 10.0	< 10.0	52.6	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	5000*

Notes:

1. Concentrations presented in micrograms per liter (µg/L).
2. State Primary Drinking Water Regulations: R.61-58 as found in SCDHEC Bureau of Water MCLs, last amended on August 28, 2009.
3. Analytical results obtained from Pace Analytical Services, Inc. laboratory report: Project Duke Robinson 234758.
4. °C Degrees Celsius
5. mV indicates MilliVolts
6. SU indicates Standard Units.
7. umho/cm indicates micromhos per centimeter.
8. NA indicates not analyzed.
9. **Bold** indicates a concentration which attains or exceeds the corresponding SC DEHC Groundwater Standard.
10. Grey highlighted columns indicate monitoring wells screened in the ash basin.

Table 5D. Groundwater monitoring well sample results – radiological isotopes

Parameter	Units	Sample Location								
		MW-7	MW-108S	MW-108D	MW-109S	MW-109D	MW-110S	MW-110D	MW-111S	MW-111D
Cesium - 137	pCi/L	U 0.857	U -0.709	U 0.679	UI 0.00	U 0.885	U -0.367	U -0.589	U 0.388	U -0.862
Cobalt - 60	pCi/L	U -1.53	U 3.67	U 3.08	U -2.21	U -3.21	U -0.0306	U 0.407	U -0.465	U 0.778

Notes:

1. Concentrations presented in picocuries per liter (pCi/L).
2. U indicates that analytes was analyzed for, but not detected above the MDL, MDA, or LOD.
3. UI indicates that uncertain identification via gamma spectroscopy.
4. Analytical results obtained from GEL Laboratories LLC.

Table 6. Free water sample results – total inorganics and anions and cations

Parameter	Units	Sample Location Discharge Canal SS-1
Field Parameters		
Field pH	SU	6.0
Field Specific Conductance	umhos/cm	31.0
Field Temperature	°C	39.1
Dissolved Oxygen	mg/L	7.3
ORP (REDOX)	mV	223
Total Inorganics (Total Concs.)		
Antimony	µg/L	< 5.0
Arsenic	µg/L	< 10.0
Barium	µg/L	10.2
Beryllium	µg/L	< 1.0
Boron	µg/L	< 50.0
Cadmium	µg/L	< 1.0
Chromium	µg/L	< 5.0
Cobalt	µg/L	< 5.0
Copper	µg/L	< 5.0
Iron	µg/L	888
Lead	µg/L	< 5.0
Manganese	µg/L	17.8
Mercury	µg/L	< 0.20
Molybdenum	µg/L	< 5.0
Nickel	µg/L	< 5.0
Nitrogen, Nitrate	µg/L	< 20.0
Selenium	µg/L	< 10.0
Thallium	µg/L	< 1.0
Zinc	µg/L	< 10.0
Anions and Cations		
Alkalinity, Total as CaCO3	mg/L	< 5000
Bromide	mg/L	< 0.10
Calcium	µg/L	1120
Chloride	mg/L	2.8
Iron, Ferrous	mg/L	< 0.50
Magnesium	µg/L	511
Methane	µg/L	13.5
Nitrogen, Nitrate	µg/L	< 20.0
Potassium	µg/L	< 5000
Sodium	µg/L	< 5000
Sulfate	mg/L	2.2
Sulfide	mg/L	< 0.10
Total Dissolved Solids	mg/L	175
Total Inorganics (Dissolved)		
Antimony, Dissolved	µg/L	< 5.0
Arsenic, Dissolved	µg/L	< 10.0
Barium, Dissolved	µg/L	8.2
Beryllium, Dissolved	µg/L	< 1.0
Boron, Dissolved	µg/L	< 50.0
Cadmium, Dissolved	µg/L	< 1.0
Chromium, Dissolved	µg/L	< 5.0
Cobalt, Dissolved	µg/L	< 5.0
Copper, Dissolved	µg/L	< 5.0
Iron, Dissolved	µg/L	592
Lead, Dissolved	µg/L	< 5.0
Manganese, Dissolved	µg/L	13.2
Mercury, Dissolved	µg/L	< 0.20
Molybdenum, Dissolved	µg/L	< 5.0
Nickel, Dissolved	µg/L	< 5.0
Nitrogen, Nitrate	µg/L	< 20.0
Selenium, Dissolved	µg/L	< 10.0
Thallium, Dissolved	µg/L	< 1.0
Zinc, Dissolved	µg/L	< 10.0

Table 7. Conceptual closure ash and earthwork quantities – Hybrid Cap-in-Place Closure Option

Location	Material	Quantity[1] cy
1960 Fill Area	Excavated Ash	275,800[2]
	Excavated Cover Soil	19,600[2]
	Excavated Impacted Soil	80,800[3]
Ash Basin	Excavated Ash Near Dam	510,100[4,6]
	Excavated Impacted Soil Near Dam	17,700[3,6]
	Perimeter Drainage Channel Excavation	429,100[4]
	2' Soil Cover	215,600[5]
	Ash Basin Embankment Fill	309,400[4]

Notes:
1. Quantities are in-place (bank measure) quantities without shrink or swell factors.
2. Source: AMEC, 2014
3. Assumes 2' of impacted soil over location footprint.
4. Volume generated using CAD.
5. Includes 18" soil cover and 6" topsoil.
6. Assumes ash and impacted soils will be removed from a setback of 200' measured from the centerline of the ash basin dam embankment to allow decommissioning.

Table 8. Estimated quantity of material to be placed in ash basin – Hybrid Cap-in-Place Closure Option

Location	Material	Excavated Quantity[1] cy	Compaction Factor	Compacted Quantity cy
1960 Fill Area	Excavated Ash	275,800	20%	220,600
	Excavated Cover Soil	19,600	12%	17,200
	Excavated Impacted Soil	80,800	12%	71,100
Ash Basin	Excavated Ash Near Dam	510,100	20%	408,080
	Excavated Impacted Soil Near Embankment	17,700	12%	15,600
	Perimeter Drainage Channel Excavated Ash	107,300[2]	20%	85,800
	Perimeter Drainage Channel Excavated Impacted Soils	107,300[3]	12%	94,400
	2' Soil Cover	215,600	N/A	215,600
			TOTAL	1,128,400

Notes:
1. See Table 7 for notes.
2. Assumes 25% of material excavated from perimeter drainage channel is ash.
3. Assumes 25% of material excavated from perimeter drainage channel is impacted soil

Table 9. Estimated quantity of material to be placed in ash landfill – On-Site and Off-Site Ash Landfill Closure Options

Location	Material	Excavated Quantity[1] cy	Compaction Factor	Compacted Quantity cy
1960 Fill Area	Excavated Ash	275,800	20%	220,600
	Excavated Cover Soil	19,600	12%	17,200
	Excavated Impacted Soil	80,800	12%	71,100
Ash Basin	Excavated Ash	3,000,000 to 3,500,000	20%	2,400,000 to 2,800,000
	Excavated Impacted Soil	233,300	12%	205,300
	2' Soil Cover[2]	215,600	N/A	161,300
			TOTAL	3,075,500 to 3,475,500

Notes:
1. See Table 7 for notes.
2. Assumes 50 acre landfill footprint.

Appendices

A

Appendix A

Site Survey from WSP

B

Appendix B

Natural Resources Survey Forms

C

Appendix C

Conceptual Design Drawings