CORRECTIVE ACTION PLAN UPDATE

Site Name and Location:	**Allen Steam Station** **253 Plant Allen Road** **Belmont, NC 28012-8845**
Groundwater Incident No.:	Not Assigned
NPDES Permit No.:	NC0004979
NCDEQ CCR Impoundment Ranking:	Low-Risk
Date of Report:	December 31, 2019
Permittee and Current Property Owner:	Duke Energy Carolinas, LLC 526 South Church Street Charlotte, NC 28202-1803 (855) 355-7042
Consultant Information:	SynTerra Corporation 148 River Street, Suite 220 Greenville, SC 29601-2567 (864) 421-9999
Latitude and Longitude of Facility:	N 35.186944 / W -81.012500

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12/23/2019
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Note to the Reader from Duke Energy

Duke Energy Carolinas, LLC (Duke Energy) is pleased to submit this groundwater Corrective Action Plan (CAP) for the Allen Steam Station (Allen) located in Gaston County, North Carolina. Since 2004, Duke Energy has been engaged in extensive site investigation activities to comprehensively characterize environmental conditions in soil, groundwater, surface water, and sediments associated with the presence of coal combustion residuals (CCR) in and around the Allen coal ash basins and coal piles. Activities have been performed in compliance with the North Carolina Coal Ash Management Act of 2014, as amended (CAMA), as well as the United States Environmental Protection Agency's (USEPA) CCR Rule. In 2018, the North Carolina Department of Environmental Quality (NCDEQ) ranked the ash basins at Allen as low-risk pursuant to CAMA.

Thousands of multi-media samples have been collected at the Allen yielding over 191,000 individual analyte results. All of this work has been coordinated with the NCDEQ, which has provided review, comments, and approvals of plans and reports related to these activities. This CAP provides the results of these extensive assessment activities, and presents a robust corrective action program to address groundwater conditions where concentrations of constituents of interest (COI) are above applicable regulatory criteria. Closure plan(s) to address the ash basin source areas are submitted separately.

As detailed in this CAP, we have begun to implement, and will continue implementing, source control measures at the site, including (i) complete decanting of the ash basins to remove the hydraulic head, thereby reducing hydraulic gradients, groundwater seepage velocities, and COI transport potential; and (ii) complete closure of the ash basins. In addition, we intend to implement a robust groundwater remediation program that includes actively addressing COI in groundwater above applicable standards at or beyond the compliance boundary using groundwater extraction combined with clean water infiltration and removal of the low pH area source proximate to the coal pile area. These corrective action measures will most effectively achieve remediation of the groundwater through the use of extraction wells to the north, northeast, and east of the ash basins and coal piles, and strategically located clean water infiltration wells. Significantly, groundwater modeling simulations indicate (i) these measures will control COI at or beyond the compliance boundary; and (ii) at such time the site-specific considerations detailed within this CAP have been satisfied, including, but not limited to, securing all required state approvals, installing the necessary equipment, and commencing full-scale system operation, COI at or beyond the compliance boundary will meet the remedial objectives in nine years.

This CAP contains over 2,500 pages of technical information that we believe represents one of the most detailed and well supported corrective action plans ever submitted to the NCDEQ and forms the basis of the robust groundwater remediation approach described above. Thousands of labor hours by PhD-level scientists, engineers, and geologists have been performed to obtain and evaluate the large amount of data generated at Allen and inform this CAP. This combined effort has enabled a comprehensive understanding of site conditions, creation of a highly detailed three-dimensional groundwater flow and solute transport model used to simulate remediation scenarios, and evaluation and selection of a site-specific corrective action program for Allen. Duke Energy believes it is also important to provide a science-based perspective on these extensive studies, which include the following key findings:

- **The human health and ecological risk assessments performed for Allen using USEPA guidance demonstrate that risks to potential human health and ecological receptors associated with the coal ash basins are not measurably greater than risks posed by naturally occurring background conditions.**
- **Ash basin- and coal pile-related constituents have not affected, nor are they predicted to affect, off-site water supply wells. This has been confirmed by analytical results from groundwater samples and water level measurements collected from over 211 monitoring wells over 31 separate monitoring events, and performing over 175 groundwater and geochemical modeling simulations.**
- **An additional 23 monitoring wells were installed in late 2019 to further assess the low pH area and coal pile area.**

In addition, even though no off-site wells were impacted, Duke Energy has already provided owners of surrounding properties within 0.5-mile radius of the ash basin compliance boundary with either connections to water supplied by the City of Belmont or water filtration systems under a program approved by the NCDEQ. These alternate water supplies provide additional peace of mind for our neighbors. Importantly, ongoing multi-media sampling of the nearby surface water aquatic system, the Catawba River (Lake Wylie), confirms that this surface water system is healthy with a robust fish population.

Duke Energy looks forward to proactively implementing this CAP.

EXECUTIVE SUMMARY

(CAP Content Section Executive Summary)

ES.1 Introduction

SynTerra prepared this groundwater Corrective Action Plan (CAP) Update on behalf of Duke Energy Carolinas, LLC (Duke Energy). The plan pertains to the Allen Steam Station (Allen, Site, or Station) coal combustion residuals (CCR) ash basins and coal piles. The Site is located in Gaston County, North Carolina (**Figure ES-1**). At Allen, the coal piles are adjacent to and downgradient of the ash basins. The coal piles, therefore, are considered a component of this CAP Update.

This CAP Update addresses the requirements of Section 130A-309.211(b) of the North Carolina General Statutes (G.S.), as amended by Coal Ash Management Act (CAMA) of 2014. The CAP Update is consistent with North Carolina Administrative Code (NCAC), Title 15A, Subchapter 02L .0106 corrective action requirements, and with the CAP guidance provided by the North Carolina Department of Environmental Quality (NCDEQ) in a letter to Duke Energy, dated April 27, 2018, and adjusted on September 10, 2019 (**Appendix A**).

This CAP Update evaluates remedies for constituents of interest (COIs) in groundwater associated with the Allen ash basins and coal piles, which are considered sources of COIs. The ash basins include the active ash basin (AAB) and the retired ash basin (RAB).

Specifically, this CAP Update focuses on constituents detected at concentrations greater than applicable North Carolina groundwater standards [NCAC, Title 15A, Subchapter 02L, Groundwater Classification and Standards (02L); Interim Maximum Allowable Concentrations (IMAC); or background values, whichever is greater] at or beyond the compliance boundary. The COIs were detected in the following areas:

- North and northeast of the RAB and the coal piles
- East of the AAB and RAB

In accordance with G.S. requirements, a CAP for Allen was previously submitted to the NCDEQ in two parts, as follows:

- *Corrective Action Plan Part 1 – Allen Steam Station Ash Basins* (HDR, 2015b)
- *Corrective Action Plan Part 2 (included CSA Supplement 1 as Appendix A) – Allen Steam Station Ash Basins* (HDR, 2016a)

This CAP Update considers data collected through June 2019, with the exception of data collected through October 2019 related to additional assessment of the coal piles and the "low pH area", an area where low pH conditions are present within and downgradient of the RAB.

Ash basin closure is detailed in a separate document prepared by AECOM. Closure scenarios evaluated in this CAP include closure-in-place and closure-by-excavation. Therefore, the groundwater remediation alternatives evaluated and recommended in this CAP Update consider the closure-in-place scenario and closure-by-excavation scenario. Groundwater modeling simulations consistently indicate the closure-in-place and closure-by-excavation scenarios have a similar effect on COI concentrations in groundwater.

Summary of CAP Approach

As stated above, this CAP Update meets the corrective action requirements under G.S. and Subchapter 02L .0106. The preferred groundwater remediation approach assumes source control under the ash basin closure-in-place or closure-by-excavation scenarios. Both closure scenarios provide similar source control by reducing and/or eliminating further releases of COIs to groundwater. The groundwater remediation approach presented in this CAP Update can be implemented under either ash basin closure scenario and can achieve 02L .0202 groundwater quality standards based on groundwater modeling simulations. The focus of groundwater corrective action at Allen is reducing COIs to concentrations less than applicable criteria at or beyond the compliance boundary consistent with Subchapter 02L .0106(e)(4) and to address Subchapter 02L .106(j). Applicable criteria in this case are defined as the 02L groundwater standard, IMAC, or background, whichever is greatest, defined as the COI criterion. If a COI does not have an 02L standard or IMAC, then the background value defines the COI criteria.

Duke Energy has implemented, or plans to implement, the following multi-component Corrective Action Plan at Allen:

Source Control Measures

- Completion of ash basin decanting is currently underway and will reduce the hydraulic head in the dam area, thereby significantly reducing the hydraulic driving force for potential COI migration in groundwater downgradient of the basin. As of December 1, 2019, 53,300,000 gallons of water have been removed from the AAB and the water elevation has decreased by 14.1 feet. Completion of decanting is projected to occur on or before June 30, 2020.

Groundwater modeling indicates that the average linear velocity of groundwater in the vicinity of the AAB dam will decrease from 0.1–5.0 feet per day (ft/day) pre-decanting to 0.01–0.5 ft/day post-decanting.

- Removal of the coal piles when the Station is decommissioned.

Groundwater Remediation Measures

- A robust groundwater remediation approach for Allen is planned. The approach includes actively addressing COIs in groundwater with concentrations greater than applicable standards at or beyond the compliance boundary using groundwater extraction combined with groundwater infiltration and treatment. Site data and groundwater models were used to evaluate and optimize an effective remedial approach to reduce COI concentrations north, northeast, and east of the source areas. The following is a summary of components of the preferred remediation system that would be installed in areas north, northeast, and east of the ash basins and coal piles:
    - 87 vertical extraction wells
    - 76 clean water vertical infiltration wells or 48 clean water vertical infiltration wells combined with 22 clean water horizontal infiltration wells

Effectiveness Monitoring Plan (EMP)

- Duke Energy has prepared an effectiveness groundwater monitoring plan as discussed in **Section 6.8** and provided in **Appendix O** of this CAP Update. The EMP includes an optimized groundwater monitoring network for the ash basins and coal piles based on Site-specific COI mobility and distribution. The EMP is also designed to be adaptable and targets key areas where changes to groundwater conditions are most likely to occur during corrective action implementation or basin closure activities. The monitoring plan includes provisions for a post-closure monitoring program in accordance with G.S. Section 130A-309.214(a)(4)k.2 upon completion of basin closure activities.

Details and supporting rationale for these CAP activities are provided in the following sections.

ES.2 Background

Plant Operations

Operations began at Allen in 1957. Five coal-fired units are operated at the Station. CCR materials, composed primarily of fly ash and bottom ash, were initially hydraulically sluiced to the RAB, also referred to as the inactive ash basin, until the AAB was constructed and placed into operation in 1973. CCR materials were hydraulically sluiced to the AAB from 1973 to 2019. In 2008, hydraulic sluicing of fly ash was discontinued and was replaced with a dry fly ash (DFA) handling system. In 2019, Duke Energy converted to dry handling of bottom ash, and coal ash is no longer placed in either basin. The Allen ash basins have been operated under a National Pollution Discharge Elimination System (NPDES) Permit issued by the NCDEQ Division of Water Resources (DWR).

Pursuant to N.C. General Statute § 130A-309.213(d)(1), a November 13, 2018 letter from NCDEQ to Duke Energy, documented the classification of the CCR surface impoundment at Allen as low-risk (**Appendix A**). The letter cited that Duke Energy has "established permanent water supplies as required by NCGS 130A-309.211(cl)" and has "rectified any deficiencies identified by, and otherwise complied with the requirements of, any dam safety order issued by the Environmental Management Commission…pursuant to NCGS 143-215.32." The relevant closure requirements for low-risk impoundments are in N.C. General Statute § 130A-309.214(a)(3), which states that low-risk impoundments shall be closed as soon as practicable, but no later than December 31, 2029.

Source Areas

The RAB and AAB are the primary source areas evaluated in this CAP. General information is provided below for the coal pile area as an additional source area. The coal pile is adjacent to the RAB, and therefore, the source areas (the AAB, RAB, and coal pile area) are evaluated together as Source Area 1 within this CAP Update.

Ash Basins

The RAB includes two ash storage areas, two structural fills, and the double-lined RAB Ash Landfill. Pyrite-rich rocks known as "clinkers" or "mill rejects" have also been observed to be mixed with ash within in the north-northeast portion of the RAB. Clinkers were mixed with coal but not combusted as part of the power-generation process. Pyrite within the clinkers has caused low pH conditions in the subsurface within and downgradient of the north-northeast portion of the RAB. The area containing the clinkers and areas downgradient extending toward the main coal pile are referred to as the "low pH area." The AAB includes three areas of ponded water known as primary ponds 1, 2, and 3. Each of the ponds were constructed atop ash and separated with divider dikes. These features within the RAB and AAB are not considered separate sources but are considered collectively as part of the ash basins within the corrective action approach.

Mechanical decanting of the AAB was initiated on June 5, 2019. The former operating elevation of the ash basin ponded water was approximately 635 feet. As of December 1, 2019 approximately 53,300,000 gallons of water have been pumped from the AAB with a corresponding reduction in hydraulic head of 14.1 feet in elevation. Ash basin decanting, as part of the ash basin closure process, is scheduled to be complete on or before June 30, 2020.

Coal Piles

The coal piles are an additional source area evaluated in this CAP.

Coal has been stored north and northeast of the RAB within two separate piles. Collectively, the coal piles are referred to in this CAP Update as the coal pile area. The coal pile area is downgradient of the RAB. The live coal pile, located adjacent to the Catawba River (Lake Wylie), encompasses approximately 2 acres. The main coal pile is located west of the live coal pile and northeast of the RAB. The main coal pile encompasses approximately 15 acres. The approximate locations of the coal piles have remained consistent throughout the operating history of the Site. Minor changes to the footprint occur depending upon the volume of coal stockpiled on Site, which can vary substantially throughout the year. Coal is not waste, therefore, the coal piles do not have waste or compliance boundaries. However, a portion of the main coal pile lies within the ash basin compliance boundary. The coal piles are not lined. However, in 2018, a lined holding basin was built in the southeast corner of the main coal pile footprint as part of a water redirect project. It is anticipated that the coal piles will remain in place until the Station is retired, currently planned for 2024 for Units 1, 2, and 3 and 2028 for Units 4 and 5.

Data from monitoring wells installed downgradient of the coal piles indicate concentrations of COIs, primarily concentrations of sulfate and total dissolved solids (TDS), are greater than applicable comparative criteria. Between the RAB and the coal pile, sulfate and TDS concentrations are less than concentrations in areas downgradient of the coal piles. This indicates the coal pile area is a separate source of COIs in groundwater. Therefore, the coal pile area is included as a component of this CAP.

Pre-Basin Closure Activities

Initial ash basin closure efforts included ceasing all wastewater flows to the ash basins. To accommodate closure of the ash basins, mechanical decanting (removal) of free water from the AAB began on June 5, 2019, as required by a Special Order by Consent (SOC) issued through the North Carolina Environmental Management Commission (EMC) on April 25, 2018 (EMC SOC WQ S17-009) (Appendix B of **Appendix J**). The SOC requires completion of decanting by June 30, 2020. Decanting of free, ponded water from the ash basin before closure will reduce or eliminate seepage from constructed or non-constructed seeps. Constructed seeps are seeps on or within the dam structure that convey wastewater via a pipe or constructed channel to an NPDES-regulated receiving water. Seeps that do not meet the constructed seep definition are considered non-constructed seeps. Decanting is considered an important component of the corrective action strategy because it will significantly reduce the hydraulic head and gradients, thereby reducing the groundwater flow velocity and COI migration potential associated with the ash basin. As of December 1, 2019, 53,300,000 gallons of water had been removed from the AAB and the water elevation had decreased by 14.1 feet.

Basis for CAP Development

A substantial amount of data related to the ash basins, coal pile area, and the general Allen Site has been collected to date. A summary of the Allen assessment documentation used to prepare this CAP Update is presented in **Table ES-1.**

TABLE ES-1
SUMMARY OF ALLEN ASSESSMENT DOCUMENTATION

Comprehensive Site Assessment Report - Allen Steam Station Ash Basin [HDR Engineering, Inc. of the Carolinas (HDR, 2015a)].
Corrective Action Plan Part 1 - Allen Steam Station Ash Basin (HDR, 2015b).
Corrective Action Plan Part 2 (included CSA Supplement 1 as Appendix A) - *Allen Steam Station Ash Basin* (HDR, 2016a).
Comprehensive Site Assessment Supplement 1 - (included in CAP 2 as Appendix A) – *Allen Steam Station Ash Basin* (HDR, 2016b).
Comprehensive Site Assessment Supplement 2 – Allen Steam Station Ash Basin (HDR, 2016c).
2018 Comprehensive Site Assessment Update - Allen Steam Station (SynTerra, 2018a).
Preliminary Updated Groundwater Flow and Transport Modeling Report - Allen Steam Station (FRx, Inc., Falta Environmental, and SynTerra, 2018).
Human Health and Ecological Risk Assessment Summary Update - Allen Steam Station (SynTerra, 2018b).
Allen Steam Station HB 630 Completion (Duke Energy, 2018).
Ash Basin Pumping Test Report - Allen Steam Station (SynTerra, 2019a).
Surface Water Evaluation to Assess 15A NCAC 02B .0200 Compliance for Implementation of Corrective Action Under 15A NCAC 02L .0106 (k) and (l) - Allen Steam Station (SynTerra, 2019b).
2018 CAMA Annual Interim Monitoring Report (SynTerra, 2019c).
Community Impact Analysis of Ash Basin Closure Options at the Allen Steam Station (Exponent, 2018).
Allen Steam Station Ash Basin Closure Options Analysis – Summary Report (AECOM, 2018).
Updated Background Threshold Values for Groundwater (SynTerra, 2019d).

Prepared by: LWD Checked by: CJS

NCDEQ reviewed the January 31, 2018 Comprehensive Site Assessment (CSA) Update report, and in a June 11, 2018 letter to Duke Energy, NCDEQ stated that sufficient information was provided to allow preparation of this CAP Update (**Appendix A**).

The assessment work referenced in the documents listed in **Table ES-1** has resulted in a very large dataset that has informed the development of this CAP Update. The following site assessment-related activities have been completed and are summarized in **Table ES-2.** The table is current as of June 2019 and does not include additional wells or sampling events for assessment of the low pH area and coal pile area. However, data related to these areas are evaluated and included within this CAP Update.

TABLE ES-2
SUMMARY OF ALLEN ASSESSMENT ACTIVITIES

Tasks	Total
Total Monitoring Wells Installed (CAMA and CCR Wells around basins)	211
Groundwater Monitoring Events	31
Groundwater Samples Collected	3,233
Individual Analyte Results	191,551
Off-site Water Supply Well Sampling (Total inorganic analysis) - Number of Analyses	8,410
Ash Pore Water - Number of Analyses (Total and dissolved)	20,513
Ash Pore Water Sampling Events	27
Surface Water Monitoring Events	13
Surface Water Sample Locations	33
Area of Wetness Sample Events	33
Ash Samples (Within ash basins analyzed for SPLP)	11
Soil Samples Collected	249
Soil Sample Locations	82
Sediment Sample Locations	19
Geotechnical Soil Sample Locations	84
Geochemical Ash, Soil, Partially Weathered Rock, Whole Rock Samples	101
Hydraulic Conductivity Tests (Slug Tests, Pumping Tests, Packer Tests, FLASH Analysis of Bedrock HPF Data)	186
Groundwater Flow and Transport Simulations	93
PHREEQC Geochemical Simulations	82

Prepared by: LWD Checked by: CJS

Notes:
Data available to SynTerra as of June 2019
FLASH – Flow-Log Analysis of Single Holes
HPF – Heat Pulse Flow
SPLP – Synthetic Precipitation Leaching Procedure
PHREEQC – pH Redox Equilibrium in computer code C

A COI management process was developed by Duke Energy at the request of NCDEQ to gain understanding of the COI behavior and distribution in groundwater and to aid in selection of the appropriate remedial approach. The COI management process consists of three steps:

1. Performing a detailed review of the applicable regulatory requirements of NCAC, Title 15A, Subchapter 02L
2. Acquiring an understanding of the potential mobility of Site-related COIs in groundwater based on Site hydrogeology and geochemical conditions
3. Determining the COI distribution related to the ash basins and coal piles under current or predicted future conditions.

This COI management process is supported by multiple lines of technical evidence, including empirical data collected at the Site, geochemical modeling, and groundwater flow and transport modeling. This approach has been used to understand and predict COI behavior in the subsurface related to the ash basins and coal piles, or to identify COIs that are naturally occurring. COIs that have migrated at or beyond the compliance boundary at concentrations greater than 02L, IMAC, and background values that are related to the ash basins or coal piles would be subject to corrective action. COIs that are naturally occurring at concentrations greater than the 02L standard do not require corrective action. Details on the COI management approach are presented in **Section 6**.

Groundwater

In conformance with requirements of G.S. Section 130A-309.211, groundwater corrective action is the main focus of this CAP Update. Groundwater COIs to be addressed with corrective action are those detected in groundwater at or beyond the compliance boundary greater than the 02L standard, IMAC, or background concentrations, whichever is greater.

Soil

Data indicate unsaturated soil COI concentrations are generally consistent with background concentrations or are less than regulatory screening values. In the few instances where unsaturated soil COI concentrations are greater than Preliminary Soil Remediation Goal (PSRG) Protection of Groundwater (POG) standards or background values, either COI concentrations are generally within the range of the background dataset concentrations or there are no mechanisms by which the COI could have been transported from the ash basins to the unsaturated soils. One exception is at a location north of the coal pile where iron was detected at a concentration at an isolated depth interval of 2 to 3 feet below ground surface that might indicate potential effects from the coal pile. However, iron is prevalent naturally in saprolitic soils, so the detected concentration might be a natural variation in concentration within the subsurface. Furthermore, iron concentrations at deeper unsaturated soils are less than PSRG POG; the iron in soil at the 2- to 3-foot interval is not considered a significant source of COIs in groundwater. Therefore, this CAP Update focuses on remediation of COIs in groundwater derived from the ash basins and the coal piles.

Risk Assessment

The human health and ecological risk assessments, prepared based on state and federal guidance, demonstrated no measurable difference in modeled risks to potential human or ecological receptors compared with background concentrations. The updated risk assessments of the Allen ash basins and coal piles are presented in **Section 6** of this CAP Update. Data from former water supply wells and the Catawba River (Lake Wylie) indicate no evidence of risk posed by groundwater migration associated with the ash basins or coal piles based on evaluation of concentrations of CCR constituents in environmental media and potential receptors.

Risk Ranking

Also, in accordance with G.S. Section 130A-309.211(c1) of House Bill 630 (2016), Duke Energy:

- Connected 191 households to the City of Belmont water supply (nine of those households were already connected to the city of Belmont water supply)
- Installed 10 water treatment systems
- Abandoned three public water supply wells that served 77 households

Of the remaining 12 households/properties that were initially considered eligible by being within a 0.5-mile radius of the ash basin compliance boundary:

- Two households either opted out of the option to connect to a water treatment system or did not respond to the offer.
- One household was demolished, but that property will be connected at a future date.
- Six locations were deemed not eligible because the property did not contain a household.

- Three additional locations were associated with a business, church, or school, which are not eligible for the HB 630 provisions.

Additionally, Duke Energy voluntarily connected two businesses and 23 households to the City of Belmont water supply that were otherwise not eligible per G.S. Section 130A-309.211(c1).

Connection of households to City of Belmont water supply and installation of water supply filtration systems, along with certain improvements to the ash basin dams completed by Duke Energy, resulted in the ash basins being ranked as low-risk.

ES.3 CSM Overview

The Conceptual Site Model (CSM) is a written and graphical representation of the hydrogeologic conditions and COI interactions specific to the Site and is critical to understanding the subsurface conditions related to the ash basins and coal pile area. The updated CSM developed for Allen included in this CAP Update is based on a United States Environmental Protection Agency (USEPA) document titled "Environmental Cleanup Best Management Practices: Effective Use of the Project Life Cycle Conceptual Site Model" (USEPA, 2011). This document describes six CSM stages for a project life cycle. The CSM is an iterative tool designed to assist in the decision-making process for Site characterization and remediation as the Site progresses through the project life cycle and new data becomes available. The current Allen CSM is consistent with Stage 4 "Design CSM", which allows for iterative improvement of the Site CSM during design of the remedy while supporting development of remedy design basis (USEPA, 2011).

Multiple lines of evidence have been used to develop the CSM based on the large data set generated for Allen. The remedial action evaluation to meet the effectiveness criteria in the CAP guidance provided by NCDEQ is also based on the updated CSM (NCDEQ, 2018).

The following provides an overview of the updated CSM for the Allen ash basins and coal piles which forms the basis of this CAP Update. Supporting details for the CSM are presented in **Section 5.0**.

Key conclusions of the CSM include the following:

- **No material increases in risk to human health related to the ash basins or coal piles have been identified. The Site-specific risk assessments of the ash basins and coal pile indicate no measurable difference between evaluated Site-related risks and risks imposed by background concentrations.** Site-specific risk assessments indicate there is no evidence of unacceptable risks to human and ecological receptors exposed to environmental media potentially impacted by CCR constituents at Allen.
- **The ash basins and coal pile area do not increase risks to ecological receptors.** The assessment did not indicate an increase of risks to ecological receptors (benthic invertebrates, fish, mallard, great blue heron, killdeer bird, muskrat, river otter, robin, red-tailed hawk, meadow vole, and red fox) that might access surface water and sediments downgradient of the ash basins and coal pile.
- **Groundwater from the ash basins and coal pile area has not and does not flow toward any water supply wells. That conclusion is based on groundwater flow patterns of over 30 monitoring events using data from 234 monitoring wells and the upgradient or side-gradient wells relative to the location of water supply wells in the area.** Groundwater data from water supply wells and on-Site monitoring wells, groundwater elevation measurements from 31 monitoring events, and groundwater flow and transport modeling results all indicate that Site COIs are not affecting, and have not affected, water supply wells, most of which are no longer in use or are abandoned.
- **The permanent water solution program implemented by Duke Energy provided city water connections or water filtration systems to owners of surrounding properties with water supply wells within a 0.5-mile radius of the ash basin compliance boundary.** The hydrogeologic data collected at Allen confirms that Site-related COIs are not affecting off-Site water supply users. Modeling predicts that Site-related COIs will not, affect off-Site water supply users. Nevertheless, in accordance with General Statutes 130A-309.211(c1), Duke Energy connected 191 households to the City of Belmont water supply (nine of the 191 households were connected to the City of Belmont water supply prior to HB 630); installed 10 water treatment systems, and abandoned three public water supply wells that served 77 households. Of the remaining 12 water supply wells within a 0.5-mile radius of the ash basin compliance boundary; two (2) households opted out or were non-responsive to Duke Energy's offer of a permanent water solution; one (1) household was demolished but would be connected at a future date; six (6) locations were deemed not eligible because the

property did not contain a household; and three (3) locations were associated with a business, church, or school which are not eligible for the HB 630 (2016). Furthermore, Duke Energy voluntarily connected two businesses and 23 households to the City of Belmont water supply that were otherwise not eligible per G.S. Section 130A-309.211(c1).

- **The hydrogeologic setting of the Allen ash basins and coal pile area limits COI transport.** The Site, located in the Piedmont Physiographic Province, conforms to the general hydrogeologic framework for sites in the Blue Ridge/Piedmont area, which are characterized by groundwater flow in a slope-aquifer system within a local drainage basin with a perennial stream (LeGrand 2004). Predictive groundwater flow and transport model simulations indicate that ash basin decanting will affect groundwater flow patterns within the basin by lowering hydraulic heads in and around the ash basin dam, which will reduce the rate of COI transport, and provide source control prior to completion of basin closure. As of December 1, 2019, 53,300,000 gallons water had been removed from the AAB and the water elevation had decreased by 14.1 feet.
- **The physical setting and hydraulic processes control the COI flow pattern within the ash basins, underlying groundwater system, and downgradient areas.** The ash basins are predominantly a horizontal water flow-through system. Groundwater enters the upgradient side of the ash basins; it is supplemented by rainfall infiltration and flows laterally through the middle of the ash basins under a low horizontal gradient, and then flows downward near the dam. This flow system results in limited downward migration of COIs into the underlying soils and saprolite upgradient from the dams. Near the dam, COIs in water either discharge through the NPDES-permitted outfall or flow downward out of the basin and under the dam. Beyond the dam, groundwater flows upward toward the Catawba River (Lake Wylie) discharge zone, limiting downward migration of COIs to the area proximate to the dam. The exception is near the northern portion of the RAB, where a relatively small component of the groundwater flow system flows in a similar manner, but toward the discharge canal within Duke Energy property. Bedrock wells installed at various depths within the basin footprint and downgradient of the dam structure support the flow characteristics and limited COI distribution.
- **Horizontal distribution of COIs in groundwater proximate to the basins and coal pile area is limited to the north and east.** The physical extent of constituent migration north and east of the basins and coal pile area is controlled by

hydrologic divides, dilution from unaffected groundwater, and the groundwater-to-surface water discharge zones.

- **Geochemical processes stabilize and limit certain constituent migration along the flow path.** Each COI exhibits a unique geochemical behavior related to the specific constituent partition coefficient (K_d), response to changing geochemical parameters (*i.e.*, pH and E_h), and sorption capacity of the soil and/or rock. Based on geochemical modeling:
  - Non-conservative, reactive COIs (*e.g.*, strontium) will remain in mineral phase assemblages that are stable under variable Site conditions north and east of the basins, demonstrating sorption as an effective attenuation mechanism. Strontium reactivity is less in the deep and bedrock flow zones and can be more mobile under lower pH conditions, due to both the lower sorption affinity of strontium at lower pH values as well as the increased concentration of other divalent ions (e.g., Ca+2, Mg+2, Co+2, Mn+2) that might compete with strontium for ion exchange sites.
  - Variably reactive COIs (*e.g.*, cobalt, iron, and manganese) can exhibit mobility, depending on geochemical conditions and availability of sorption sites.
  - Conservative, non-reactive COIs (*e.g.*, boron, sulfate, and TDS) migrate in groundwater as soluble species and are not strongly attenuated by reactions with solids but are reduced in concentration with distance primarily by physical processes such as mechanical mixing (dispersion), dilution, and diffusion into less permeable zones. Sorption of boron to clay particles might occur, especially for groundwater with slight alkaline to alkaline pH values. Maximum boron sorption occurs at pH values from about 7.5 standard units (S.U.) to 10 S.U., then decreases at pH values greater than 10 S.U. (EPRI 2005, ATSDR 2010).

  The groundwater corrective action strategies evaluated herein consider the potential for dynamic geochemical conditions under basin closure scenarios, currently under appeal, and account for potential mobilization of COIs.

- **COIs in groundwater are contained within Duke Energy's property.** COI distribution extends from the ash basins toward the Catawba River (Lake Wylie). In addition to the station property, Duke Energy owns and operates the Catawba-Wateree Project (Federal Energy Regulatory Commission Project Number 2232), which includes the Lake Wylie reservoir. The plume associated with the ash basins has been characterized and is stable to decreasing.

- **Groundwater/surface water interaction has not caused and is not predicted to cause, COIs at concentrations greater than NCAC, Title 15A Subchapter 02B, Surface Water and Wetland Standards (02B).** Analytical results for surface water samples collected from the Catawba River (Lake Wylie) indicate that this water body meets 02B criteria under current conditions. An evaluation of future surface water quality conditions of basin-related jurisdictional streams was conducted using a surface water mixing model with closure option model simulation inputs. The evaluation indicates that no future groundwater COI migration would result in constituent concentrations greater than applicable 02B surface water criteria.
- **The aquatic systems of the Catawba River adjacent to the Site are healthy based on multiple lines of evidence including robust fish populations, species variety and other indicators derived from years of sampling data**. Ongoing sampling and analysis of the Catawba River confirm that the surface waters have been environmentally healthy and functioning ecosystems for many years. This finding combined with results of the ecological risk assessment, indicate that there are no adverse ecological effects to the main surface water systems proximate to the ash basins or coal pile area.
- **Most of the COIs identified in the CSA Update occur naturally in groundwater, some at concentrations greater than the 02L standard or IMAC.** Groundwater at Allen naturally contains antimony, chromium, cobalt, iron, manganese, and vanadium at concentrations greater than 02L and/or IMAC standards. The occurrence of inorganic constituents in groundwater from the Piedmont Physiographic Province is well documented in the literature. For example, vanadium has natural background concentrations in all flow zones at the Site greater than its IMAC value, and iron and manganese have natural background concentrations in the shallow and deep flow zones greater than respective 02L values. For the Allen CAP Update, these constituents and others are evaluated based on Site-specific statistically derived background values, and on additional lines of evidence to determine whether constituent concentrations represent migration from the ash basins and the coal pile area, or are naturally occurring.

These CSM aspects, combined with the updated human health and ecological risk assessments, provide the basis for the CAP Update pertaining to the Allen ash basins and the adjacent coal piles.

ES.4 Corrective Action Approach

Corrective Action Objectives and Zones Requiring Corrective Action

Migration of COIs related to the ash basins and coal piles in groundwater at or beyond the ash basin compliance boundary occurs in areas to the north, northeast, and east of the ash basins and coal piles. To satisfy G.S. and maintain compliance with 02L, the corrective action approach planned for the Site focuses on restoring ash basin-affected and coal pile-affected groundwater at or beyond the compliance boundary. The following remedial objectives address the regulatory requirements of NCAC Title 15A Subchapter 02L for the Allen CAP Update:

- Restore groundwater quality at or beyond the compliance boundary by returning COIs to the 02L/IMAC groundwater quality standards, or applicable background concentrations (whichever are greater), or as closely thereto as is economically and technologically feasible consistent with Subchapter 02L. 0106(a).
- Use a phased CAP approach that includes initial active remediation with effectiveness monitoring of remedy implementation followed by monitored natural attenuation (MNA) as provided in Subchapters 02L. 0106(j) and (l).
- If appropriate given future Site conditions, Duke Energy may seek approval of an alternate plan that does not require meeting groundwater 02L/IMAC/applicable background concentration values after satisfying the requirements set out in Subchapter 02L .0106(k).

The compliance boundary extent is shown on **Figure ES-1**. Groundwater concentrations greater than 02L/IMAC/applicable background concentration values occur locally beyond the compliance boundary north, northeast, and east of the ash basins. There is no waste or compliance boundary associated with the coal piles and it is not subject to CAMA. COI concentrations are less than 02B surface water standards within the Catawba River (Lake Wylie), which is adjacent to and downgradient of the compliance boundary.

The area proposed for corrective action is shown on **Figure ES-2.**

Summary of Source Control and Corrective Measures

It is critical to take into account all of the various activities Duke Energy has performed and will perform to improve subsurface conditions at Allen related to the ash basins and coal piles. The remedial program incorporates source control by basin decanting and closure, coal pile removal, active groundwater remediation, and effectiveness monitoring. **Table ES-3** summarizes the discrete components of the planned corrective action for COI-affected groundwater.

TABLE ES-3
COMPONENTS OF SOURCE CONTROL, ACTIVE REMEDIATION, AND MONITORING

Groundwater Remedy Component	Rationale
Source Control Activities	
Ash Basin Decanting	Active source remediation by removing ponded water in the AAB. Decanting will lower the hydraulic head within the AAB and reduce hydraulic gradients, reducing groundwater seepage velocities and COI transport potential. Decanting will return the groundwater flow system to its approximate natural condition, flowing toward the axis of the perennial stream valley, then east. Mechanical decanting was initiated on June 5, 2019. As of December 1, 2019, 53,300,000 gallons of water had been pumped from the AAB, with a corresponding reduction in hydraulic head of 14.1 feet in elevation. Completion of decanting is projected to occur on or before June 30, 2020. In addition, ash basin decanting will be effective in reducing or eliminating seeps identified under the Special Order by Consent.
Ash Basin Closure	The ash basin closure-in-place or by closure-by-excavation scenarios are considered source control activities. Extensive groundwater modeling indicates that either method results in similar effects with respect to groundwater remediation. Closure would include management of the ash storage areas, structural fills and low pH area within the RAB, and locations of ponded water within the AAB.
Holding Basin Construction	Construction of the holding basin between the main and live coal piles has improved control of stormwater runoff that has had contact with the coal pile. This stormwater is captured and initially treated for total suspended solids and pH within the lined holding basin and then pumped to the lined retention basin for final treatment prior to discharge at NPDES Outfall 006.
Coal Pile Decommissioning	As part of the decommissioning process, coal will be removed from the Site, mitigating a potential source of certain COIs associated with the coal pile, such as sulfate.

TABLE ES-3
COMPONENTS OF SOURCE CONTROL, ACTIVE REMEDIATION, AND MONITORING

Groundwater Remedy Component	Rationale
Active Groundwater Remediation Activities	
Active Groundwater Remediation	Groundwater remediation focused on meeting the stated remedial objectives at and beyond the compliance boundary is planned. These efforts will focus on areas downgradient (north, northeast and east) of the ash basins and coal pile area where COIs are present at concentrations greater than applicable criteria. To meet the above-referenced CAP objectives, approximately 87 extraction wells and approximately 76 clean water vertical infiltration wells or approximately 48 clean water vertical infiltration wells combined with approximately 22 clean water horizontal infiltration wells are planned for placement in areas to reduce COI concentrations based on actual Site data and groundwater modeling simulations.
Institutional Controls and Monitoring	
Permanent Water Solution for Water Supply Well Users within a 0.5-mile radius of the Ash Basin Compliance Boundary and Associated Water Filtration System Maintenance	Groundwater data at the Site indicate that surrounding water supply wells have not been affected by Site-related COIs. Nevertheless, Duke Energy connected 191 households to public water supply and installed and maintains 10 water filtration systems for occupied households. Duke Energy also abandoned three public water supply wells. Duke Energy’s actions were approved by the NCDEQ, which addressed stakeholder concerns. Duke Energy maintains these systems on behalf of the property owners.
Maintain Ownership and Institutional Controls (ICs) Consisting of a Land Use Restriction	ICs in the form of a Declaration of Perpetual Land Use Restrictions may be requested in the future based on the results of the groundwater remediation activities.

TABLE ES-3
COMPONENTS OF SOURCE CONTROL, ACTIVE REMEDIATION, AND MONITORING

Groundwater Remedy Component	Rationale
Effectiveness Groundwater Monitoring	Duke Energy plans to monitor the groundwater to confirm the corrective action objectives are met and maintained over time. This monitoring program includes provisions for monitoring COIs within the compliance boundary as required under NCAC Title 15A. 0107(k)(2). Flow and transport plus geochemical modeling have been conducted to predict future groundwater conditions after closure. Effectiveness monitoring will provide data to validate modeling or provide input for model refinement in the future. The CAP Update includes a comprehensive review of groundwater data collected through June 2019 (with additional data through October 2019) and a plan to optimize the monitoring program. Within 30 days of CAP approval, Duke Energy would implement the effectiveness monitoring program.
Provision for Adaptive Management of Groundwater Remedies	The Allen ash basins, coal pile area, and surrounding areas constituent a complex site; therefore, Duke Energy believes it is important to allow for an adaptive approach during implementation of this CAP Update. This approach is consistent with the Interstate Technology and Regulatory Council (ITRC) document titled *Remediation Management of Complex Sites* (ITRC, 2017). This approach may include (i) adjustments to the groundwater remedy, if necessary, based on new data, or if conditions change; or (ii) an alternate groundwater standard for boron of 4,000 µg/L (USEPA tap water regional screening level) pursuant to NCDEQ's authority under 15A NCAC 02L .0106(k).

Prepared by: LWD Checked by: CJS

Corrective Action at Remediation Zones

The area proposed for groundwater remediation in accordance with 02L requirements is to the north, northeast, and east of the basins at or beyond the compliance boundary (**Figure ES-2**). Multiple potential groundwater remedial technologies were initially screened as part of the CAP Update to identify the most applicable remedial methods based on Site-specific hydrogeologic conditions and COIs distribution in groundwater. After initial screening, the following remedial alternatives were further evaluated in detail:

- Remedial Alternative 1: Monitored Natural Attenuation
- Remedial Alternative 2: Groundwater Extraction and Treatment
- Remedial Alternative 3: Groundwater Extraction Combined with Targeted Clean Water Infiltration and Treatment

These remedial alternatives were screened against the following criteria outlined in Section 6.D.iv. (1-10) of the CAP guidance (NCDEQ, 2018):

- Protection of human health and the environment
- Compliance with applicable federal, state, and local regulations
- Long-term effectiveness and permanence
- Reduction of COI toxicity and mobility, and volume of COI-affected groundwater
- Short-term effectiveness at minimizing effects on the environment and local community
- Technical and logistical feasibility
- Time required to initiate
- Predicted time required to meet remediation goals
- Cost
- Sustainability
- Community acceptance

Groundwater modeling simulations were performed to evaluate the effectiveness of the alternatives and to develop the most effective approach. The results of the analysis indicate that groundwater remedial Alternative 3: Groundwater Extraction Combined with Targeted Clean Water Infiltration and Treatment will most effectively achieve the remedial objectives presented above. This alternative would include installation of a system located north, northeast and east of the ash basins and coal pile area consisting of:

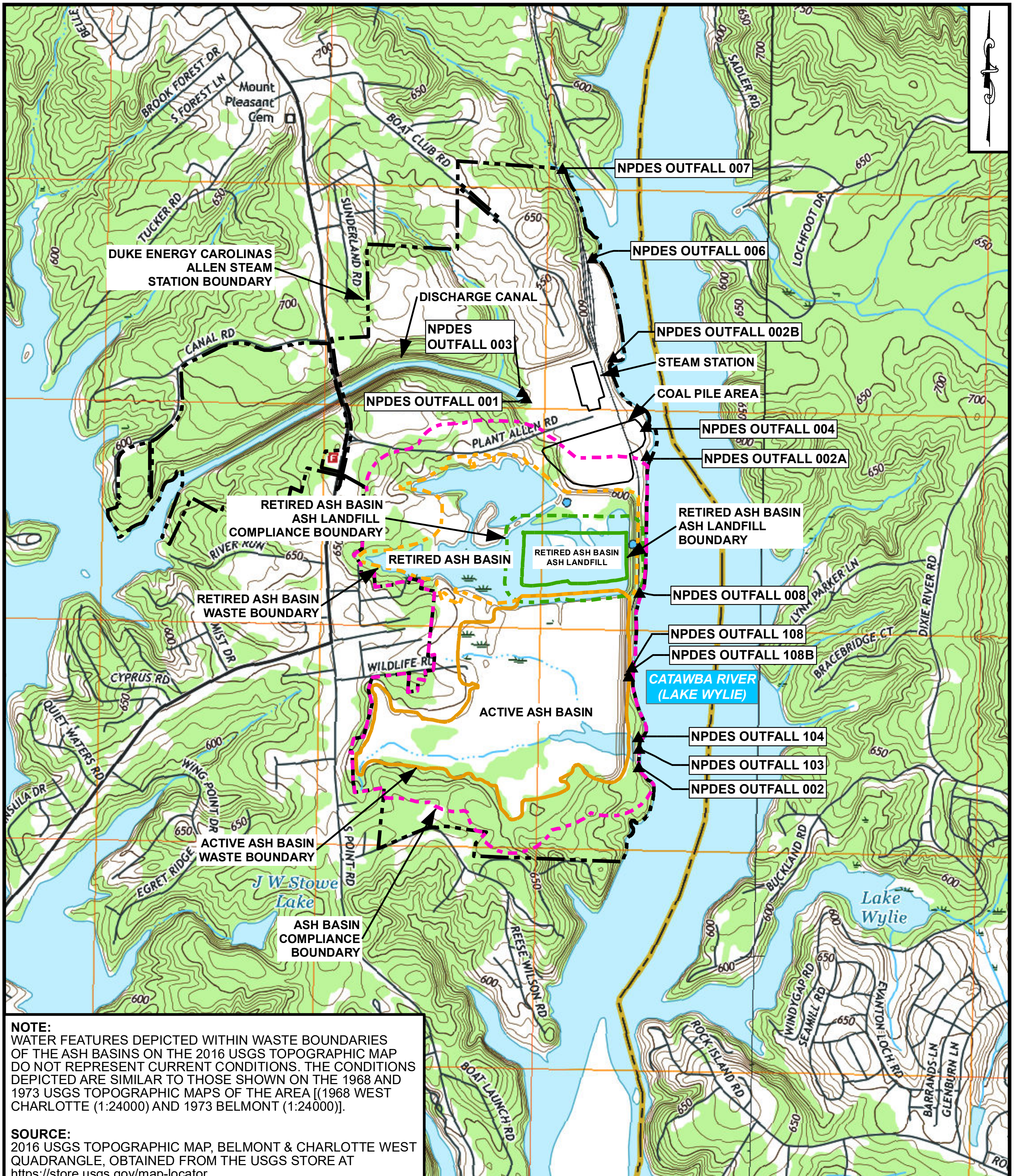
- 87 extraction wells
- 76 clean water vertical infiltration wells or 48 clean water vertical infiltration wells combined with 22 clean water horizontal infiltration wells

The proposed well layouts are depicted on **Figure ES-3a** (with vertical wells only) and **Figure ES-3b** (with horizontal and vertical wells). It is anticipated the extraction wells will be screened within the shallow, deep, and bedrock flow zones, with depths ranging from approximately 65 feet below ground surface (bgs) to 395 feet bgs. It is anticipated that clean water infiltration vertical wells will be installed in the shallow and transition zones at depths ranging from 75 feet bgs to 140 feet bgs. If clean water infiltration horizontal wells are used, they would be installed as overlapping pairs with a deeper well installed to approximately 80 feet bgs and a shallower well installed to 20 feet bgs.

Raw water from the existing fire suppression system would go through a proposed treatment process to produce clean infiltration water. The clean infiltration water would be stored in a proposed tank for conveyance to the infiltration wells via proposed distribution piping.

The flow and transport model predicts the remediation system will have a total groundwater extraction flow rate of approximately 970 gallons per minute (gpm). It is planned that the extracted water will be treated and then discharged through an existing permitted NPDES outfall location, either Outfall 002 or Outfall 006. Details of this approach are presented in **Section 6.**

It is recommended that prior to implementation, pilot testing of the proposed alternative will be conducted at the areas north, northeast, and east of the ash basins and coal piles. Pilot testing and treatment tests to be conducted include: 1) groundwater extraction and clean water infiltration, 2) treatment testing of extraction and clean water infiltration water. Pilot study results will inform the design of the full-scale system. Pilot test work plan(s) would be submitted to NCDEQ within 30 days of CAP approval to fulfill G.S. Section 130A-309.211(b)(3), amended by CAMA. Remedial performance monitoring will be performed to evaluate remedy effectiveness as described in **Section 6.8** of this CAP Update.



NOTE:
WATER FEATURES DEPICTED WITHIN WASTE BOUNDARIES OF THE ASH BASINS ON THE 2016 USGS TOPOGRAPHIC MAP DO NOT REPRESENT CURRENT CONDITIONS. THE CONDITIONS DEPICTED ARE SIMILAR TO THOSE SHOWN ON THE 1968 AND 1973 USGS TOPOGRAPHIC MAPS OF THE AREA [(1968 WEST CHARLOTTE (1:24000) AND 1973 BELMONT (1:24000)].

SOURCE:
2016 USGS TOPOGRAPHIC MAP, BELMONT & CHARLOTTE WEST QUADRANGLE, OBTAINED FROM THE USGS STORE AT https://store.usgs.gov/map-locator.

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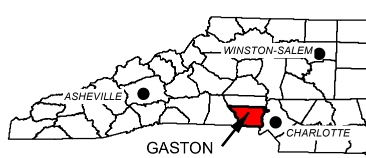

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FIGURE ES-1
USGS LOCATION MAP
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA

DRAWN BY: B. YOUNG	DATE: 05/02/2019
REVISED BY: C. WYATT	DATE: 12/08/2019
CHECKED BY: L. DRAGO	DATE: 12/08/2019
APPROVED BY: L. DRAGO	DATE: 12/08/2019
PROJECT MANAGER: C. SUTTELL	

GRAPHIC SCALE
1,000 0 1,000 2,000
(IN FEET)

NOTES:

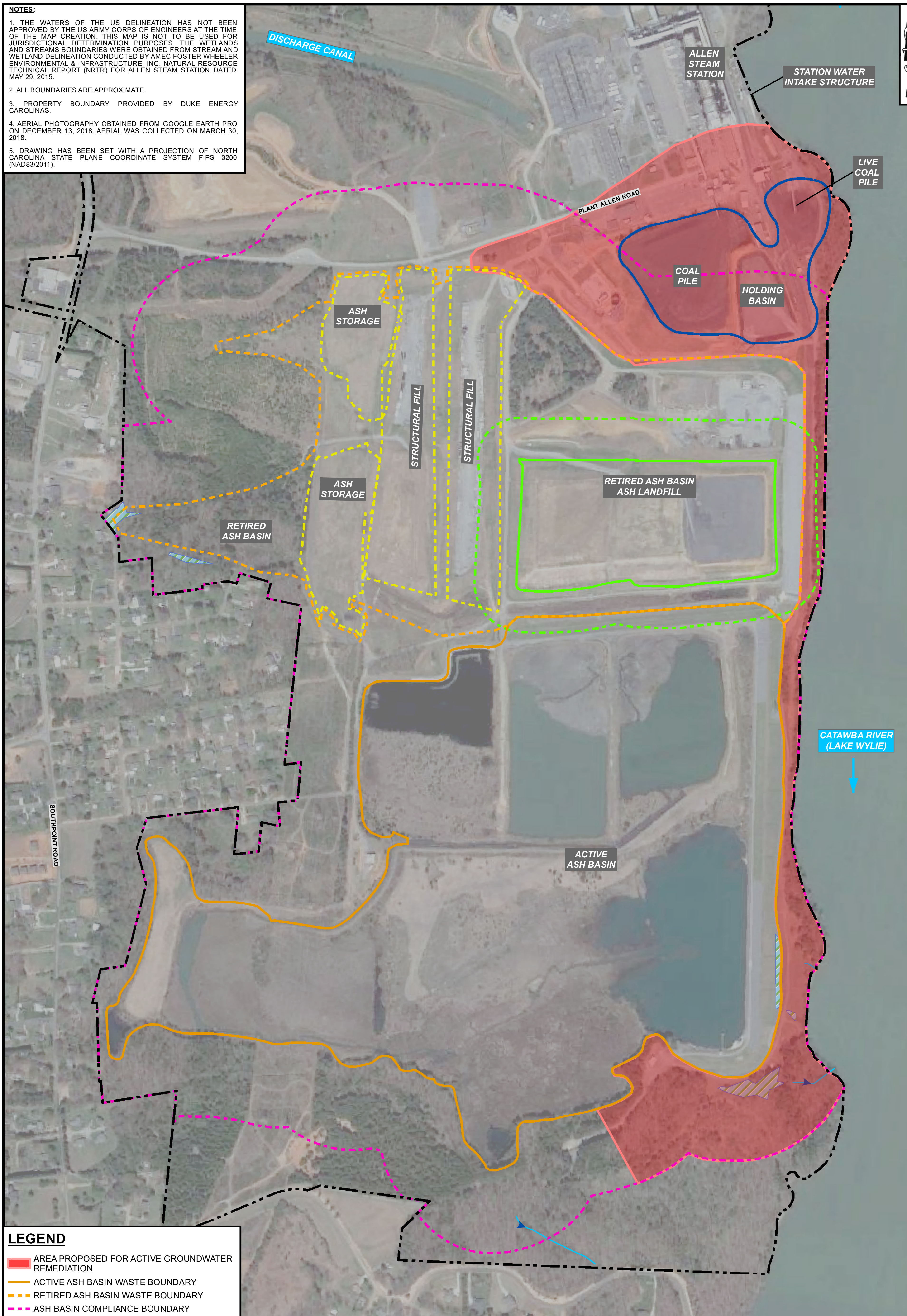
1. THE WATERS OF THE US DELINEATION HAS NOT BEEN APPROVED BY THE US ARMY CORPS OF ENGINEERS AT THE TIME OF THE MAP CREATION. THIS MAP IS NOT TO BE USED FOR JURISDICTIONAL DETERMINATION PURPOSES. THE WETLANDS AND STREAMS BOUNDARIES WERE OBTAINED FROM STREAM AND WETLAND DELINEATION CONDUCTED BY AMEC FOSTER WHEELER ENVIRONMENTAL & INFRASTRUCTURE, INC. NATURAL RESOURCE TECHNICAL REPORT (NRTR) FOR ALLEN STEAM STATION DATED MAY 29, 2015.

2. ALL BOUNDARIES ARE APPROXIMATE.

3. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.

4. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON DECEMBER 13, 2018. AERIAL WAS COLLECTED ON MARCH 30, 2018.

5. DRAWING HAS BEEN SET WITH A PROJECTION OF NORTH CAROLINA STATE PLANE COORDINATE SYSTEM FIPS 3200 (NAD83/2011).



LEGEND

- AREA PROPOSED FOR ACTIVE GROUNDWATER REMEDIATION
- ACTIVE ASH BASIN WASTE BOUNDARY
- RETIRED ASH BASIN WASTE BOUNDARY
- ASH BASIN COMPLIANCE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL WASTE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL COMPLIANCE BOUNDARY
- DORS FILLS BOUNDARIES
- SITE FEATURE
- DUKE ENERGY CAROLINAS PROPERTY LINE
- STREAM (AMEC NRTR 2015)
- WETLAND (AMEC NRTR 2015)

DUKE ENERGY. CAROLINAS

synTerra

GRAPHIC SCALE
250 0 250 500
(IN FEET)

DRAWN BY: K. KING DATE: 06/19/2019
REVISED BY: J. KIRTZ DATE: 12/19/2019
APPROVED BY: L. DRAGO DATE: 12/19/2019
CHECKED BY: L. DRAGO DATE: 12/19/2019
PROGRAM MANAGER: C. SUTTELL

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FIGURE ES-2
AREA PROPOSED FOR CORRECTIVE ACTION
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA

Figure ES-3a

Proposed Corrective Action Approach Well System Layout (Vertical Wells Only)

Provided in separate electronic figure file as a large sheet size

ES-3b

Proposed Corrective Action Approach Well System Layout (Vertical and Horizontal Wells)

Provided in separate electronic figure file as a large sheet size

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LIST OF FIGURES (CONTINUED)

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LIST OF TABLES (CONTINUED)

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LIST OF ACRONYMS

02B	NCDEQ Title 15A, Subchapter 02B. Surface Water and Wetland Standards
02L	NCDEQ Title 15A, Subchapter 02L. Groundwater Classification and Standards
AAB	Active Ash Basin
Allen	Allen Steam Station
AOW	Area of Wetness
ASTM	American Society for Testing and Materials
BGS	Below Ground Surface
BTV	Background Threshold Value
CAMA	Coal Ash Management Act
CAP	Corrective Action Plan
CBD	Citrate-Bicarbonate-Dithionite
CCR	Coal Combustion Residuals
CFR	Code of Federal Register
COI	Constituent of Interest
CSA	Comprehensive Site Assessment
CSM	Conceptual Site Model
CY	Cubic Yards
DFA	Dry Fly Ash
DORS	Distribution of Residual Solids
Duke Energy	Duke Energy Carolinas, LLC
DWR	Division of Water Resources
Eh	Oxidation Reduction Potential
EMC	Environmental Management Commission
EMP	Effectiveness Monitoring Program
EPRI	Electric Power Research Institute
FERC	Federal Energy Regulatory Commission
FGD	Flue Gas Desulfurization
G.S.	General Statutes
GPM	Gallons per Minute
HAO	Hydrous Aluminum Oxide
HFO	Hydrous Ferric Oxide
IMAC	Interim Maximum Allowable Concentration
IMP	Interim Monitoring Plan
ISV	In-situ Vitrification
K_d	Partition Coefficient

LIST OF ACRONYMS (CONTINUED)

LEAF	Leaching Environmental Assessment Framework
LRB	Lined Retention Basin
MAROS	Monitoring and Remediation Optimization System
Mg/L	Milligrams per liter
MGD	Million of Gallons per Day
mm	Millimeter
MNA	Monitored Natural Attenuation
NAVD 88	North American Vertical Datum of 1988
NCAC	North Carolina Administrative Code
NCDENR	North Carolina Department of Environment and Natural Resources
NCDEQ	North Carolina Department of Environmental Quality
NORR	Notice of Regulatory Requirements
NPDES	National Pollutant Discharge Elimination System
NRTR	National Resource Technical Report
NTU	Nephelometric Turbidity Units
ORP	Oxidation Reduction Potential
OSWER	Office of Solid Waste and Emergency Response
POG	Protection of Groundwater
PRB	Permeable Reactive Barrier
PSRG	Preliminary Soil Remediation Goal
RAB	Retired Ash Basin
S.U.	Standard Units
SB	Soil Boring
Site	Allen Steam Station
SOC	Special Order by Consent
SPLP	Synthetic Precipitation Leaching Procedure
Station	Allen Steam Station
TDS	Total Dissolved Solids
TOC	Total Organic Carbon
USEPA	United States Environmental Protection Agency
μg/L	Micrograms per Liter

1.0 INTRODUCTION

(CAP Content Section 1)

SynTerra prepared this groundwater corrective action plan (CAP) update on behalf of Duke Energy Carolinas, LLC (Duke Energy). The plan pertains to the Allen Steam Station (Allen, Site, or Station) coal combustion residual (CCR) ash basins and adjacent coal piles. Duke Energy owns and operates Allen, located in Belmont, Gaston County, North Carolina (**Figure 1-1**).

In accordance with Section 130A-309.211(b) of North Carolina General Statutes (G.S.), as enacted by Coal Ash Management Act (CAMA), Duke Energy is submitting this groundwater CAP Update to prescribe methods and materials to restore groundwater quality associated with CAMA-regulated units. This CAP Update considers constituent concentrations detected greater than applicable North Carolina groundwater standards [NC Administrative Code, Title 15A, Subchapter 02L, Groundwater Classification and Standards (02L); Interim Maximum Allowable Concentrations (IMAC); or background values], whichever is greater, at or beyond the compliance boundary.

In accordance with G.S. requirements, a CAP for Allen was previously submitted to the North Carolina Department of Environmental Quality (NCDEQ) in two parts:

- *Corrective Action Plan Part 1 – Allen Steam Station Ash Basin* (HDR, 2015b)
- *Corrective Action Plan Part 2– Allen Steam Station Ash Basin* (HDR, 2016a)

This CAP Update is being submitted to NCDEQ as originally requested in a June 2, 2017 letter from NCDEQ to Duke Energy. In an April 5, 2019 letter to Duke Energy, NCDEQ issued revised deliverable schedules and requested assessment of additional potential sources of constituents to groundwater at Allen stating that sources hydrologically connected to the ash basins are to be assessed and included in an updated CAP. The coal pile was included as additional source hydrologically connected to the ash basin.

In addition to the CAP Update, Duke Energy is required to submit a CCR Surface Impoundment Closure Plan to NCDEQ on/before December 31, 2019. Duke Energy is required to submit final closure plan consistent with the detailed requirements of the CAMA which is provided under separate cover. This CAP Update has been developed to be effective with the various closure scenarios determined for the Site.

The CAP content is in accordance with subsequent correspondence between NCDEQ and Duke Energy, including CAP content guidance issued by NCDEQ on April 27, 2018 and adjusted on September 10, 2019. This CAP Update includes section references to the document titled *Corrective Action Plan Content for Duke Energy Coal Ash Facilities* (provided in **Appendix A**), beneath the report section headings and within the text in parentheses to facilitate the review process.

1.1 Background

(CAP Content Section 1.A)

A substantial amount of assessment data has been collected for the Allen ash basins, which include the active ash basin (AAB) and the retired ash basin (RAB), and the adjacent coal piles to support this CAP Update. Site assessment was performed and the Allen Comprehensive Site Assessment (CSA) Update Report (SynTerra, 2018a) was prepared and submitted in accordance with requirements in Subchapter 02L.0106 (g). The CSA:

- Identified the source(s) and causes of constituent of interest (COIs) in groundwater.
- Found no imminent hazards to public health and safety.
- Identified receptors and potential exposure pathways.
- Sufficiently determined the horizontal and vertical extent of COIs in soil and groundwater.
- Determined the geological and hydrogeologic features influencing the movement, chemical makeup, and physical characteristics of COIs.

NCDEQ provided review of the CSA Update to Duke Energy in a letter dated June 11, 2018 and stated the information provided sufficiently warranted preparation of this CAP Update (**Appendix A**). This CAP Update builds on the previous documents to provide a CAP for addressing the requirements in Subchapter 02L .0106 for corrective action and the restoration of groundwater quality.

Detailed descriptions of Site operational history, the conceptual Site model (CSM), physical setting and features, geology/hydrogeology, and findings of the CSA and other CAMA-related work are documented in the following reports:

- *Comprehensive Site Assessment Report – Allen Steam Station Ash Basin* (HDR Engineering, Inc. of the Carolinas (HDR, 2015a)
- *Corrective Action Plan Part 1 – Allen Steam Station Ash Basin* (HDR, 2015b)
- *Corrective Action Plan Part 2 (included CSA Supplement 1 as Appendix A) – Allen Steam Station Ash Basin* (HDR, 2016a)

- *Comprehensive Site Assessment Supplement 1 – Allen Steam Station Ash Basin* (HDR, 2016b)
- *Comprehensive Site Assessment Supplement 2 – Allen Steam Station Ash Basin* (HDR, 2016c)
- *Comprehensive Site Assessment Update – Allen Steam Station* (SynTerra, 2018a)
- *Ash Basin Pumping Test Report – Allen Steam Station* (SynTerra, 2019a)
- *Surface Water Evaluation to Assess 15A NCAC 02B.0200 Compliance for Implementation of Corrective Action Under 15A NCAC 02L.0106 (k) and (l) – Allen Steam Station* (SynTerra, 2019b)
- *2018 CAMA Annual Interim Monitoring Report* (SynTerra, 2019c)

1.2 Purpose and Scope

(CAP Content Section 1.B)

The purposes of this corrective action approach are the following:

- Restore groundwater affected by the ash basins and coal piles at or beyond the ash basin compliance boundary to the applicable groundwater standards or as close to the standards as is economically and technically feasible, consistent with Subchapter 02L .0106(a).
- Address response requirements contained within 15A North Carolina Administrative Code (NCAC) 02L .0107(k) for exceedances of standards (1) in adjoining classified groundwater, (2) presenting an imminent hazard to public health and safety, and/or (3) in bedrock groundwater that might potentially affect a water supply well.
- Meet the requirements for corrective action plans specified in G.S. Section 130A-309.211(b).

The scope of the CAP and this CAP Update is defined by G.S. Section 130A-309.211, amended by CAMA. The legislation required, among other items, assessment of groundwater at coal combustion residual impoundments and corrective action in conformance with the requirements of Subchapter 02L. These corrective action for restoration of groundwater quality requirements were codified into G.S. Section 130A-309.211, which was further amended by House Bill 630 to require a provision for alternate water supply for receptors within 0.5-mile downgradient from the established compliance boundary.

Based on conditions and the results from the Site investigations, this CAP Update develops and compares alternative methods for corrective action and presents the recommended plan. This CAP Update presents a holistic, multi-component corrective action approach for groundwater COIs associated with the ash basins and coal piles at or beyond the compliance boundary north, northeast, and east of the ash basins and coal piles. Design information and steps necessary for implementation are included in the CAP Update. Once the CAP is approved by NCDEQ, implementation is planned to begin within 30 days, as required by the G.S..

1.3 Regulatory Basis for Corrective Action

(CAP Content Section 1.C)

Comprehensive groundwater assessment activities, conducted in accordance with a Notice of Regulatory Requirements (NORR) issued to Duke Energy on August 13, 2014 by the North Carolina Department of Environment and Natural Resources (NCDENR) (**Appendix A**), indicate the coal ash basins and the related contiguous units - the coal piles - have demonstrated that constituent concentrations greater than applicable regulatory standards are contained within the compliance boundary of the ash basins with the exception of the areas east of the AAB and north, northeast and east of the RAB and coal piles.

The regulatory requirements for corrective action at coal combustion residuals surface impoundments under CAMA are in G.S. Section 130A-309.211(b), (c), and (c1). Section (b) of G.S. Section 130A-309.211 requires that the CAP shall provide for groundwater restoration in conformance with the requirements of Subchapter L of Chapter 2 of Title 15A of the North Carolina Administrative Code (15A NCAC Subchapter 02L). In accordance with G.S. Section 130A-309.211(b)(1), the groundwater CAP shall include, at a minimum, the following (*CAP Content Section 1.C.a*):

- A description of all exceedances of the groundwater quality standards, including any exceedances that the owner asserts are the result of natural background conditions
- A description of the methods for restoring groundwater in conformance with the requirements of Subchapter L of Chapter 2 of Title 15A of the NCAC and a detailed explanation of the reasons for selecting these methods
- Specific plans, including engineering details, for restoring groundwater quality
- A schedule for implementation of the groundwater corrective action plan
- A monitoring plan for evaluating the effectiveness of the proposed corrective action and detecting movement of any constituent plumes

- Any other information related to groundwater assessment required by NCDEQ

In addition to CAMA, requirements for CAPs are also contained in Subchapter 02L .0106(e), (h) and (i).

Section 02L .0106(e)(4) requires implementation of an approved CAP for restoration of groundwater quality at or beyond the compliance boundary in accordance with a schedule established by the Secretary.

To comply with 02L .0106(h), CAPs must include (*CAP Content Section 1.C.b***):**

- A description of the proposed corrective action and reasons for its selection
- Specific plans, including engineering details where applicable, for restoring groundwater quality
- A schedule for the implementation and operation of the proposed plan
- A monitoring plan for evaluating the effectiveness of the proposed corrective action and the movement of the constituent plume

This CAP Update presents an evaluation of the options available for corrective action under Subchapter 02L .0106(j), (k), and (l).

- Under paragraph (j), corrective action would be implemented using remedial technology for restoration of groundwater quality to the standards (02L).
- Under paragraph (k), a request for approval of a corrective action plan may be submitted without requiring groundwater remediation to the standards (02L) if the requirements in (k) are met.
- Under paragraph (l), a request for approval of a corrective action plan may be submitted based on natural processes of degradation and attenuation if the requirements in (l) are met.

This CAP Update has been prepared in general accordance with the NCDEQ guidance document titled *Corrective Action Plan Content for Duke Energy Coal Ash Facilities* which provides an outline of the technical content and format presented in the NCDEQ's letter dated September 10, 2019, provided in **Appendix A** (*CAP Content Section 1.C.c*).

In addition to this groundwater CAP, the Allen ash basins are subject to closure requirements under CAMA. Basin closure activities will provide source control within the ash basin and are considered a component of the overall corrective action for the site. The Allen ash basins meet the low-risk classification criteria set forth in CAMA for

CCR surface impoundments. On October 12, 2018, the NCDEQ confirmed that Duke Energy satisfactorily completed the alternate water provision under CAMA, G.S. Section 130A-309.211(c1). On November 14, 2018, the NCDEQ confirmed that Duke Energy rectified certain dam safety deficiencies, reclassifying the ash basins from their prior draft ranking of “intermediate” to “low-risk”. Under CAMA, a low-risk coal combustion residuals surface impoundment may be closed by excavation, closure-in-place, or a hybrid approach.

On April 1, 2019, the NCDEQ issued a determination that the Allen coal ash basins are to be closed using the excavation approach (**Appendix A**). This decision was subsequently appealed by Duke Energy. The CAP approach described herein can be implemented under either scenario.

1.4 List of Considerations by the Secretary for Evaluation of Corrective Action Plans

(CAP Content Section 1.D.a through g)

Potential targeted active remedial alternatives were developed using the criteria included in the NCDEQ’s CAP Guidance (NCDEQ, 2018). An evaluation of remedial alternatives was performed based on the following criteria:

- Protection of human health and the environment
- Compliance with applicable federal, state, and local regulations
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, and volume
- Short-term effectiveness at minimizing impact on the environment and local community
- Technical and logistical feasibility
- Time required to initiate
- Predicted time required to meet remediation goals
- Cost
- Community acceptance

In the evaluation of CAPs as specified in 02L .0106(i), the criteria includes:

- A consideration of the extent of any violations
- The extent of any threat to human health or safety

- The extent of damage or potential adverse impact to the environment
- Technology available to accomplish restoration
- The potential for degradation of the constituents in the environment
- The time and costs estimated to achieve groundwater quality restoration
- The public and economic benefits to be derived from groundwater quality restoration

These 02L .0106(i) criteria form the basis for defining the screening criteria outlined in **Section 6.6** for use in evaluating remedial alternatives in **Section 6.7**.

In addition, institutional controls [(provided by the restricted designation (RS)] may be proposed by Duke Energy to limit access to groundwater use (Subchapter 02L .0104). The RS designation may be requested for areas outside of an established compliance boundary when groundwater may not be suitable for use as drinking water supply without treatment. RS designation is a temporary designation and removed by the NCDEQ Director upon a determination that the quality of the groundwater has been restored to the applicable standards or when the groundwater has been reclassified by the NCDEQ. NCDEQ is authorized to designate existing or potential drinking water (Class GA groundwater) as RS where the Director has approved a CAP, or the termination of corrective action, that will not result in the immediate restoration of such groundwater to the standards established in 02L.

1.5 Facility Description

(CAP Content Section 1.E)

1.5.1 Location and History of Land Use

(CAP Content Section 1.E.a)

Allen is located on the west bank of the Catawba River on Lake Wylie in Belmont, Gaston County, North Carolina (**Figure 1-1**). Allen is a five-unit coal-fired electricity generating station with a combined capacity of 1,155 megawatts. The station began commercial operations in 1957 with Units 1 and 2, which have a capacity of 330 megawatts total. Unit 3 (275 megawatts) was placed into commercial operation in 1959, followed by Unit 4 (275 megawatts) in 1960, and Unit 5 (275 megawatts) in 1961. Cooling water for Allen is provided by the Catawba River (Lake Wylie).

The area surrounding Allen generally consists of residential properties, undeveloped land, and the Catawba River (Lake Wylie) (**Figure 1-2**). Topography at the Site ranges from an approximate high elevation of 680 feet

North American Vertical Datum of 1988 (NAVD 88) near the west and southwest boundaries of the Site to an approximate low elevation of 570 feet at the shoreline of the Catawba River (Lake Wylie). The elevation of the Catawba River (Lake Wylie) near the Site is approximately 565 feet.

The station and supporting facilities lie within a 1,009-acre parcel owned by Duke Energy. Duke Energy also owns property along the Discharge Canal to the east and west of South Point Road (NC 273), as shown on **Figure 1-1**. In addition to the station property, Duke Energy owns and operates the Catawba-Wateree Project (Federal Energy Regulatory Commission [FERC] Project Number 2232). Lake Wylie reservoir is part of the Catawba-Wateree Project and is used for hydroelectric generation, municipal water supply, and recreation. Based on a review of available historical aerial photography, the Site consisted of a combination of agricultural land, rural residential, and woodlands prior to the development of the Station. **Figure 1-3** presents an aerial photograph from 1948 prior to development of the Site.

The ash basins are located south of the power block and are generally bounded by earthen dams to the east, a natural ridge to the west, north and south, and an earthen divider dike separating the two basins oriented east-west (**Figure 1-2)**. A topographic ridge that acts as a groundwater divide that affects regional groundwater flow is located west of the Site and partially within the western portions of the Site. South Point Road (NC Highway 273) is situated along parts of this topographical ridge in the vicinity of the Site. The ridge curves eastward around the basins to the north and south. Topography to the east of the ridge generally slopes downward toward the Catawba River (Lake Wylie) to the east. One exception is in the north central portions of the Station where topography (including areas north of the RAB) slopes toward the discharge canal. The discharge canal ultimately flows to the South Fork Catawba River (also known as the South Fork River). Topography to the west of the topographic ridge generally slopes downward toward the South Fork River to the west and, locally, toward the discharge canal.

1.5.2 Operations and Waste Streams Coincident with the Ash Basins

(CAP Content Section 1.E.b)

Coal-Related Operational Storage and Waste Streams Coincident with the Ash Basins

Coal is a highly combustible sedimentary or metamorphic rock typically dark in coloration and present in rock strata known as coal beds or seams. Coal is predominantly made up of carbon and other elements such as hydrogen, oxygen, nitrogen, and sulfur as well as trace metals. The composition of coal makes it useful as a fossil fuel for combustion processes. Coal results from the conversion of dead vegetative matter into peat and lignite. The exact composition of coal varies depending on the environmental and temporal factors associated with its formation.

The historical specific coal sources used at Allen are bituminous coal from Northern Appalachia and Central Appalachia. Coal has been delivered to Allen through rail transportation since operations began. Coal is conveyed via transfer belts to the station where it is pulverized before being utilized in the powerhouse boilers.

Coal storage has historically occurred at two separate piles located immediately south of the power block and north-northeast of the RAB. The live coal pile, located adjacent to the Catawba River, encompasses approximately 2 acres. The live coal pile is where coal is staged to feed the boilers within the power block. The main coal pile is located west of the live coal pile and north and northeast of the RAB. The main coal pile encompasses approximately 15 acres. The main coal pile is where coal is stockpiled for longer-term storage. Both coal piles are unlined and remain active. In 2018, a lined holding basin was built in the eastern footprint of the main coal pile as part of a water redirect project. Collectively, the coal piles are referred to in this CAP Update as the coal pile area.

Assessment and corrective action of the coal pile area is within the scope of this CAP Update. The coal piles are located within the groundwater drainage area of the ash basins and are downgradient of the RAB (**Figure 1-2**). Therefore, the corrective action approach for the coal pile area is included with the corrective action approach for the ash basins.

Coal ash and other CCR are produced as a result of coal combustion. The smaller ash particles (fly ash) are carried upward in the flue gas and are captured by air pollution control devices, including an electrostatic precipitator. The larger ash particles (bottom ash) fall to the bottom of the boiler.

Approximately 70 to 80 percent of ash produced during coal combustion is fly ash (EPRI, 1995). Typically, 65 to 90 percent of fly ash has particle sizes that are less than 0.010 millimeter (mm). In general, fly ash has a grain size distribution similar to that of silt. The remaining 20 to 30 percent of ash produced is considered bottom ash. Bottom ash consists of angular particles with a porous surface and is normally gray to black in color. Bottom ash particle diameters can vary from approximately 38 mm to 0.05 mm. In general, bottom ash has a grain size distribution similar to that of fine gravel to medium sand (EPRI, 1995).

Coal “mill rejects” or “clinkers” have been observed mixed with ash within the northern portion of the RAB. “Clinkers” or “mill rejects” are rocks that were mixed with coal that was not combusted as part of the power generation process. This material at Allen is typically dark gray to black, with angular to subangular grains ranging in size from coarse sand to pebbles and often contains vugs. Clinkers can be rich in pyrite and can cause low pH subsurface conditions.

Non-Coal-Related Operational Storage and Waste Streams Coincident with the Ash Basins

Environmental incidents at Allen have occurred only in the vicinity of the Station power block area. Incidents that initiated notifications to NCDEQ and subsequent remediation under NCDEQ’s Division of Waste Management mainly consisted of petroleum or tetrachloroethene (PCE). A summary of the historical environmental incidents at Allen is provided in **Table 1-1**. None of these incidents had an effect on the ash basins and coal pile COI distribution in groundwater because the Station power block is located in an area considered downgradient of the ash basin or coal piles (**Figure 1-2**).

Beneath the powerhouse generating units within the power block, fuel oil constituents in groundwater related to NCDEQ Incident Number 11186 may overlap with or lie just beyond the extent of COIs related to the ash basins and coal piles. A Notice of No Further Action (NFA) was issued by the North Carolina Department of Waste Management on June 30, 2017 (**Appendix A**). The letter indicated that groundwater in the area is not suitable for use as a water supply. The NFA was conditional upon filing of a Notice of Residual Petroleum with the Register of Deeds and deed restriction enforced that prohibits groundwater for use as water supply within the area of affected groundwater. A *December 2018 Free Product Recovery Report* prepared by Anchor QEA, included in

Appendix A, provides additional detail regarding NCDEQ Incident Number 11186 (Anchor QEA, 2019). Like other releases, constituents related to the fuel oil have been managed by Duke Energy in cooperation with NCDEQ. For Incident Number 11186, a pump-and-treat recovery system was operated that consisted of five recovery wells. NCDEQ approved decommissioning of the pump-and-treat system in August 2018. Data from that recovery system was considered as part of this CAP Update, although, remaining components of that system are not included as part of the remedy included in this CAP Update related to the ash basins or coal pile. However, caution would be used in the area during implementation and operation of the remedial system associated with the ash basins and coal piles.

No non-coal-related operations or environmental incidents (releases that initiated notification to NCDEQ) were identified to have occurred in the vicinity of or coincident to the source areas of the ash basins or coal piles. Therefore, no environmental incidents at the Allen, including incident number 11186, are relevant to this CAP Update and are not included as components of this CAP Update.

1.5.3 Overview of Existing Permits and Special Orders by Consent

(CAP Content Section 1.E.c)

NPDES Permit

Duke Energy is authorized to discharge wastewater from the Allen ash basin to the Catawba River (Lake Wylie) (Outfall 002) in accordance with National Pollutant Discharge Elimination System (NPDES) Permit NC0004979, which issued by NCDEQ on August 1, 2018. The sources of wastewater for these outfalls include non-contact cooling water, ash basin discharge, sanitary waste, cleansing and polishing water, low volume wastes, and storm water from process areas.

The facility operates the following outfalls (except where subsequently noted, descriptions of each outfall are quoted from the NPDES permit):

- ***Outfall 001***: *Once through cooling water.* [Subsequent note: this outfall discharges to the discharge canal]
- ***Outfall 002:*** *Ash Basin discharge. This outfall includes domestic wastewater, storm water from the coal pile area, miscellaneous storm water flows, ash sluice, wastewater from turbine non-destructive testing, landfill leachate, flue gas*

desulfurization (FGD) blowdown, yard drain sump, water treatment filter backwash, treated groundwater, laboratory wastes, and the power house sump at Unit 5. The domestic waste is pretreated by a septic tank. Outfall 002 wastewater is treated using chemical coagulation, settling, and pH neutralization. <u>Outfall 002 and Outfall 006 might be operational at the same time during the transition period</u>. [Subsequent notes: Outfall 002 will remain active until the ash basin system is decanted and dewatered. Outfall 002 currently only receives water that has been treated for pH within the water treatment plant. Flows to the AAB ceased on February 9, 2019. Outfall 002 is active during decanting and would be active during dewatering. This outfall discharges to the Catawba River.]

- ***Outfall 002A:*** *Coal yard sump overflow (discharge from coal handling and storage areas).*
- ***Outfall 002B:*** *Powerhouse sump overflow (floor wash water, boiler blowdown, water treatment waste, condensates, equipment cooling water, sealing water and miscellaneous leakage).*
- ***Outfall 003:*** *Miscellaneous equipment non-contact cooling and sealing water*
- ***Outfall 004:*** *Miscellaneous non-contact cooling water, vehicle wash water, and intake screen backwash*
- ***Outfall 006:*** *Upon completion of construction of the Retention Basin, discharge domestic wastewater, storm water from the coal pile area, miscellaneous storm water flows, ash sluice, wastewater from turbine non-destructive testing, landfill leachate, FGD blowdown, yard drain sump, water treatment filter backwash, treated groundwater, laboratory wastes, and the power house sump at Unit 5. The domestic waste is pre-treated by a septic tank. Outfall 006 wastewater is treated using chemical coagulation, settling, and pH neutralization. <u>Outfall 002 and Outfall 006 might be operational at the same time during the transition period.</u>* [Subsequent note: Outfall 006 will remain active after the ash basin system is decanted and dewatered.]
- ***Outfall 007:*** *the emergency spillway of the new Retention Basin. The spillway is designed for a flood greater than 100-year event. Sampling of this spillway is waived due to unsafe conditions associated with sampling during an overflow event.*
- ***Outfall 008:*** *the emergency spillway of the retired Ash Pond. The spillway is designed for a flood greater than 100-year event. Sampling of this spillway is*

waived due to unsafe conditions associated with sampling during an overflow event.

- ***Toe Drain Outfalls:* *103*** *(lat. - 35°10.512'; long. -81°0.360'),* ***104*** *(lat. - 35°10.541'; long. - 81°0.364'),* ***108*** *(lat. - 35°10.710'; long - 81°0.384 '), and* ***108B*** *(lat. - 35°10.689'; long - 81°0.391'): 4 potentially contaminated toe drains.*

With the exception of internal outfalls and Outfall 001, each outfall discharges toward the Catawba River. Outfall 001 discharges to the discharge canal which flows toward the South Fork River. Outfall 003 discharges in the vicinity of Outfall 001.

Special Order by Consent

A Special Order by Consent (SOC) was issued to Duke Energy on April 25, 2018, to address the elimination of seeps from Duke Energy's coal ash basins during the separate and independent process of ash basin closure (Appendix B of **Appendix J**). The SOC provided definition for constructed seeps [seeps that (1) are on or within the dam structures and (2) convey wastewater via a pipe or constructed channel directly to a receiving water] or non-constructed seeps (seeps that do not meet the "constructed seep" definition). Ash basin decanting now underway is expected to substantially reduce or eliminate the seeps.

The SOC requires Duke Energy to accelerate ash basin decanting. After completion of decanting, remaining seeps, if not dispositioned in accordance with the SOC, are to be characterized. After post-decanting seep characterization, an amendment to the CAP and/or Closure Plan, may be required to address remaining seeps. The SOC terminates 180 days after decanting or 30 days after approval of the amended CAP. Mechanical decanting of the AAB at Allen began on June 5, 2019. As of December 1, 2019, 53,300,000 gallons water have been removed from the AAB and the water elevation has decreased by 14.1 feet. The SOC requires completion of decanting by June 30, 2020.

Permitted Solid Waste Facilities

The RAB Ash Landfill is under the active NCDENR Division of Water Resources (DWR) Solid Waste Section Permit No. 3612-INDUS. The RAB Ash Landfill is a double-lined landfill located within the footprint of the RAB, south of the power block (**Figure 1-2**).

Additional Permits

In addition to NPDES wastewater discharge permit NC0004979, the facility also holds air permit #03757T45 and a hazardous waste permit NCD043678937 as a RCRA small quantity generator. Duke Energy is permitted to discharge storm water to the Catawba River (Lake Wylie) and South Fork River in accordance with NPDES Permit NCS000546.

The facility held a Distribution of Residual Solids (DORS) Fills Permit No. WQ0000452, which authorized placement of wastewater residuals (i.e., ash) on land for certain beneficial uses. Permit No. WQ0000452 was rescinded on September 2, 2015, but that did not affect the status of DORS projects that had already been completed. The DORS fills are located within the footprint of the RAB, west of the RAB Ash Landfill and southwest of the powerhouse (**Figure 1-2**).

Erosion and sediment control (E&SC) permits are required for construction and excavation related activities including general construction projects and environmental assessment and remediation projects if the area of disturbance is greater than one acre. Multiple E&SC permits have been obtained for various projects implemented at the Station, including environmental related projects, such as well installation and access road construction. Most of the E&SC permits are closed as the related projects are completed. E&SC permits will continue to be obtained prior to implementation of additional construction projects, as appropriate.

2.0 RESPONSE TO CSA UPDATE COMMENTS

(CAP Content Section 2)

2.1 Facility-Specific Comprehensive Site Assessment (CSA) Comment Letter

(CAP Content Section 2.A)

On January 31, 2018, Duke Energy submitted a CSA Update to NCDEQ. In a letter from NCDEQ to Duke Energy dated June 11, 2018, NCDEQ stated that sufficient information had been provided in the 2018 CSA Update to allow preparation for the CAP Update. The letter also provided a number of CSA-related comments and items required to be addressed prior to or as part of the CAP Update submittal (**Appendix A**).

2.2 Duke Energy's Response to DEQ Letter

(CAP Content Section 2.B and 2.B.a)

Responses to all NCDEQ comments within the June 11, 2018 letter are summarized in **Appendix B**. Additional content related to NCDEQ's comments is either included within sections of this CAP Update or as standalone appendices to this CAP Update, such as the groundwater modeling reports and surface water evaluation reports.

Activities that directly addressed NCDEQ comments include:

- Additional monitoring wells were installed within the shallow flow layer beneath the retired and active ash basins to assess vertical distribution of COIs within the footprint of the basins. Discussion of data acquired from the monitoring wells beneath the ash basins is presented in **Section 6.1**.
- Groundwater samples continued to be collected on a quarterly basis as part of the Allen Interim Monitoring Plan (IMP) after CSA Update submittal. Additional sampling results augmented the groundwater quality database. Comprehensive groundwater analytical data are included in **Appendix C**, Table 1.
- Additional groundwater and soil samples were collected in the vicinity of the coal piles to assess COI distribution in these areas. Discussion of groundwater and soil assessment results is presented in **Sections 6.1.2** and **6.1.4** and assessment activities are detailed in **Appendix P**.
- Additional soil assessment downgradient of the source areas was performed to further delineate COI distribution. Discussion of soil assessment results is presented in **Section 6.1.4**.
- Additional assessment of the Catawba River (Lake Wylie) surface water and sediment downgradient of the Allen source areas was performed in August 2018.

Results determined that groundwater migration from beneath the ash basins and coal pile area has not resulted in exceedances of the NCAC, Title 15A Subchapter 02B, Surface Water and Wetland Standards (02B) in the Catawba River (Lake Wylie). A report summarizing the sampling, results, evaluation, and conclusions of the surface water evaluation was submitted to NCDEQ in March 2019 and is included in **Appendix J**.

- An evaluation of potential groundwater migration and associated impacts to surface water under future conditions was conducted. Based on the evaluation, future groundwater discharge to the Catawba River from areas potentially affected by the ash basins and coal pile area is not predicted cause COI concentrations in surface water greater than 02B surface water standards. The evaluation is presented in **Appendix J**.
- Background groundwater and soil datasets and background values were updated to include data through December 2018. Information about background determinations is presented in **Section 4.0**. Updated soil background threshold values (BTVs) are listed on **Table 4-2**, and updated groundwater BTVs are listed on **Table 4-3**.
- The Allen flow and transport model and geochemical model were updated to incorporate additional assessment data and information. The additional data helped refine the models so the models better represent current Site conditions and predict future Site conditions. The flow and transport model report is provided as **Appendix G**. The geochemical model report is provided as **Appendix H**.
- The Allen CSM was updated to improve understanding of Site conditions and to support remedy design based upon updated Site data, assessment results, and model predictions. The updated CSM is presented in **Section 5.0**.

3.0 OVERVIEW OF SOURCE AREAS BEING PROPOSED FOR CORRECTIVE ACTION

(CAP Content Section 3)

The ash basins (RAB and AAB) are the only CAMA-regulated units at the Site. The RAB and AAB are the primary sources of COIs to groundwater. The only secondary source located within or adjacent to the ash basins addressed under this CAP Update are the coal piles. **Figure 1-2** shows the location of the ash basins waste boundary and the coal piles (*CAP Content Section 3.A and 3.A.a*).

Included within the footprint of the RAB are two ash storage areas, a two structural fills, the double-lined RAB Ash Landfill. Pyrite rich rocks known as "clinkers" or "mill rejects" have also been observed to be mixed with ash within in the north-northeast portion of the RAB. Pyrite within the clinkers has caused low pH conditions in the subsurface within and downgradient of the north-northeast portion of the RAB. Clinkers have not been observed outside of the RAB waste boundary. The area containing the clinkers and areas downgradient extending toward the main coal pile are referred to as the "low pH area". The AAB includes three ponds known as primary ponds 1, 2, and 3. These features within the ash basins are comprised of primarily of ash and therefore, are not considered separate sources but are considered collectively as part of the ash basins within the corrective action approach.

Other facilities at the Site are not part of the source area addressed herein. A consensus was reached with the NCDEQ DWR regarding sources not considered for corrective action as part of this CAP Update was provided in a letter from NCDEQ to Duke Energy dated April 5, 2019 (**Appendix A**). Brief descriptions of these facilities, their status of inclusion or exclusion as part of the source area, and the rationale for inclusion or exclusion is provided in the **Table 3-1** (*CAP Content Section 3.B*). Corrective action approach for the ash basins and coal piles is discussed in detail in **Section 6.0**.

4.0 SUMMARY OF BACKGROUND DETERMINATIONS

(CAP Content Section 4)

Metals and inorganic constituents, typically associated with CCR material, are naturally occurring and present in the Piedmont physiographic province of north-central North Carolina. The metals and inorganic constituents can occur in soil, groundwater, surface water, and sediment. Background analytical results are used to compare detected constituent concentration ranges from the source area relative to native conditions.

The statistically derived background values for the site are used for screening of assessment data collected in areas of potential migration of COIs from a source area. If the assessment data concentrations are less than background, it is likely COI migration has not occurred in the area. If the assessment data concentrations are greater than background, additional lines of evidence are used to determine whether the concentrations represent migration from a source area. Additional lines of evidence include, but may not be limited to:

- Evaluation of whether the concentration is within the range concentrations detected at the Site, or within the range for the region
- Evaluation of whether there is a migration mechanism through the use and interpretation of hydraulic mapping (across multiple flow zones), flow and transport modeling, and understanding of the CSM
- Do the concentration patterns represent a discernable plume or migration pattern
- Natural variations in Site geology or geochemical conditions between upgradient (background locations) and downgradient area
- Are other COIs present at concentrations greater than background.

Allen and nine other Duke Energy facilities (Belews Creek Steam Station, Buck Steam Station, Cape Fear Steam Electric Plant, Cliffside Steam Station, Dan River Steam Station, Marshall Steam Station, Mayo Steam Electric Plant, Riverbend Steam Station, and Roxboro Steam Electric Plant) are situated in the Piedmont physiographic province of north-central North Carolina. The nine Duke Energy facilities are located within a 150-mile radius from Allen. Statistically derived background values from these facilities provide a geographic regional background range for comparison. Generally background values derived from the Piedmont facilities are similar, with some exceptions.

As more background data become available, the background values may be updated to continue to refine the understanding of background conditions. However, these multiple lines of evidence, and additional steps in the evaluation process, will continue to be important tools to distinguish between background conditions and areas affected by constituent migration.

Background sample locations were selected to be in areas that represent native conditions, not affected by the coal ash basins or additional source areas. A map showing the background locations for all media including groundwater, surface water, soil, and sediments are shown in **Figure 4-1** (*CAP Content Section 4.A*). Tables referenced in this section present the background datasets for each media, statistically calculated BTVs for soil and groundwater, and background dataset ranges for surface water and sediment.

Background soil and groundwater locations approved by NCDEQ, as well as statistically derived BTVs, are detailed in **Sections 4.1** and **4.2**. BTVs were not calculated for surface water and sediment; however, background locations for surface water and sediment were approved by NCDEQ as part of the evaluation of potential groundwater to surface water impacts (**Appendix J**) and are detailed in **Sections 4.3** and **4.4**. The background surface water and sediment samples were collected at locations at least 1,000 feet upstream of the source areas and associated permitted outfalls.

4.1 Background Concentrations for Soil

The locations of the background soil borings are shown on **Figure 4-1**. The soil background dataset with the appropriate protection of groundwater (POG) preliminary soil remediation goals (PSRGs) and BTVs are included in **Appendix C,** Table 4 (*CAP Content Section 4.B*). Background soils samples were collected from multiple unsaturated depth intervals (**Table 4-1**). All samples were collected from depth intervals greater than one foot above the seasonal high water table. The Allen background soil boring locations, unsaturated soil depth interval and number of discrete samples collected from the unsaturated soil depth interval are included in **Table 4-1**.

The suitability of each of these locations for evaluating background conditions was addressed in a technical memorandum (May 26, 2017). In a response letter dated July 7, 2017, NCDEQ approved use of the soil data for determination of BTVs (**Appendix A**). Soil BTVs were calculated using data from background unsaturated soil samples collected February 2015 to August 2017 and in accordance with the *Revised Statistical Methods for Developing Reference Background Concentrations for Groundwater and Soil at Coal Ash Facilities* (HDR and SynTerra, 2017).

Calculated soil BTVs were submitted to NCDEQ in the *Comprehensive Site Assessment Update – Allen Steam Station*, dated January 31, 2018. NCDEQ DWR provided comments and approval of BTVs in a response letter dated May 14, 2018 (**Appendix A**). Soil BTVs for Allen were updated in 2019 and are provided, along with the original soil BTVs from 2018 for comparison and North Carolina Piedmont soil BTV ranges for comparison, in **Table 4-2** (*CAP Content Section 4.B*).

The updated BTVs were calculated using data from background unsaturated soil samples collected February 2015 to August 2017 but the 2019 dataset retained extreme outlier concentrations when data validation and geochemical analysis of background groundwater concentrations indicated that those outlying concentrations did not result from sampling error or laboratory analytical error. The approach used to evaluate whether extreme outlier concentrations should be retained in background soil datasets is presented the technical memorandum prepared by Arcadis titled, "*Background Threshold Value Statistical Outlier Evaluation – Allen, Belews Creek, Cliffside, Marshall, Mayo, and Roxboro Sites"* which was included as an attachment to the *Updated Background Threshold Values for Constituent Concentrations in Groundwater* (SynTerra, 2019d). The updated BTVs were calculated in accordance with the *Revised Statistical Methods for Developing Reference Background Concentrations for Groundwater and Soil at Coal Ash Facilities* (HDR and SynTerra, 2017).

4.2 Background Concentrations for Groundwater

The groundwater system beneath the Site is divided into the following three layers to distinguish the interconnected groundwater system: the shallow flow layer, deep (transition zone) flow layer, and the bedrock flow layer. The Allen flow zones and background groundwater monitoring wells installed within each flow layer include:

- Shallow flow zone: AB-12S, BG-1S, BG-2S, BG-3S, BG-4S, CCR-BG-1S, GWA-16S, GWA-19S, GWA-21S, GWA-23S, GWA-26S
- Deep flow zone: AB-12D, BG-1DA, BG-2D, BG-3D, BG-4D, CCR-BG-1DA, GWA-16D, GWA-19D, GWA-21DA, GWA-23D, GWA-26D
- Bedrock flow zone: BG-1BR, BG-2BRA-2, BG-4BR, GWA-21BR

The locations of the background monitoring wells are shown on **Figure 4-1**. The groundwater background dataset with the appropriate 02L standards, IMAC, and BTVs is included in **Appendix C**, Table 1 (*CAP Content Section 4.C*). The suitability of each of these locations for background purposes was evaluated in the *Updated Background Threshold* technical memorandum (May 26, 2017). Identified groundwater data appropriate for inclusion in the statistical analysis to determine BTVs was approved by

NCDEQ in a response letter dated July 7, 2017 (**Appendix A**). NCDEQ DWR provided further comments and approval of BTVs in a response letter dated October 11, 2017, provided in **Appendix A**.

Groundwater BTVs for each groundwater flow zone at Allen were updated in 2019 with the inclusion of five additional background monitoring wells (BG-1BR, CCR-BG-1S, CCR-BG-1DA, GWA-19D, and GWA-23D) and are provided, along with the original 2018 groundwater BTVs and North Carolina Piedmont groundwater BTV ranges for comparison, in **Table 4-3** (*CAP Content Section 4.C*).

The updated background datasets were calculated using concentration data from background groundwater samples collected from March 2011 to December 2018. Background values were calculated in accordance with the *Revised Statistical Methods for Developing Reference Background Concentrations for Groundwater and Soil at Coal Ash Facilities* (HDR and SynTerra, 2017). The updated background datasets for each flow system used to statistically assess naturally occurring concentrations of inorganic constituents in groundwater are presented in the report *Updated Background Threshold Values for Constituent Concentrations in Groundwater* (SynTerra, 2019d) provided to NCDEQ on June 13, 2019. The updated background dataset for each hydrogeologic flow zone consists of an aggregate of total (non-filtered) concentration data pooled across background monitoring wells installed within that flow layer. The use of groundwater BTVs is currently under appeal.

4.3 Background Concentrations for Surface Water

Background surface water sample locations collected from the Catawba River (Lake Wylie) are located upstream, or outside potential groundwater impact from the source area to surface water. Surface water background sample locations are outside of future groundwater to surface water migration pathways as determined by groundwater predictive modeling results (**Appendix J**).

Background surface water sample locations include five locations from the Catawba River (Lake Wylie), J_2_UP, SW-BG-01, SW-BG-02, SW-BG-03, and SW-U1. Background surface water sample locations are located upgradient of potential groundwater influence from the ash basins and other potential source areas, as well as NPDES Outfall 002. Background surface water sample locations are shown on **Figure 4-1**.

Background surface water data are used for general comparative purposes. The analytical results provide a comparative range of naturally occurring constituent concentrations present at background locations. Background surface water analytical dataset ranges compared to 02B and United States Environmental Protection Agency

(USEPA) criteria are included in **Table 4-4** (*CAP Content Section 4.D*). The surface water background dataset with the appropriate 02B standards is included in **Appendix C**, Table 2 (*CAP Content Section 4.D*).

Background data sets include at most five samples collected from each location. Surface water samples from background locations have been collected in accordance with NCDEQ guidance as part of periodic sampling events, which include the comprehensive sampling event in August 2018 used to assess surface water compliance for implementation of corrective action under Subchapter 02L .0106 (k) and (l). Analytical results from background surface water sample locations indicate COI concentrations are less than 02B standards.

4.4 Background Concentrations for Sediment

All background sediment sample locations are co-located with background surface water sample locations in the Catawba River (Lake Wylie). Background sediment sample locations are located upstream, or outside potential groundwater migration from source areas to sediment. Sediment background sample locations remain outside of future migration areas as determined by groundwater predictive modeling.

Background sediment sample locations from the Catawba River (Lake Wylie) shoreline include SW-BG-01, SW-BG-02, and SW-BG-03. Background sediment sample locations are shown on **Figure 4-1**.

Background sediment data are used for general comparative purposes. The analytical results provide a comparative range of naturally occurring constituent concentrations present at background locations. Background sediment analytical dataset ranges are presented in **Table 4-5** (*CAP Content Section 4.E*). The sediment background dataset with the appropriate 02B standards is included in **Appendix C**, Table 5 (*CAP Content Section 4.E*).

Background data sets include one sample collected from each location. Sediment samples were collected concurrently with a background surface water sample.

5.0 CONCEPTUAL SITE MODEL

(CAP Content Section 5)

The conceptual site model is a descriptive and illustrative representation of the hydrogeologic conditions and COI interactions specific to the Site. The purpose of the CSM pertaining to the Allen ash basins and coal pile area is to provide a current understanding of the distribution of constituents with regard to the Site-specific geology/hydrogeology and geochemical processes that control the transport and potential presence of COIs in various media. This information is also considered with respect to exposure pathways to potential human and ecological receptors.

The CSM is presented in this section is based on a USEPA document titled *Environmental Cleanup Best Management Practices: Effective Use of the Project Life Cycle Conceptual Site Model* (USEPA, 2011). That document describes six CSM stages for an environmental project life cycle and is an iterative tool to assist the decision process for characterization and remediation during the life cycle of a project as new data become available. The six CSM stages for an environmental project life cycle are described below:

1. **Preliminary CSM Stage** – Site representation based on existing data; conducted prior to systematic planning efforts.
2. **Baseline CSM Stage** – Site representation used to gain stakeholder consensus or disagreement, identifies data gaps and uncertainties; conducted as part of the systematic planning process.
3. **Characterization CSM Stage** – Continual updating of the CSM as new data or information is received during investigations; supports remedy decision making.
4. **Design CSM Stage** – Targeted updating of the CSM to support remedy design.
5. **Remediation/Mitigation CSM Stage** – Continual updating of the CSM during remedy implementation; and providing the basis for demonstrating the attainment of cleanup objectives.
6. **Post Remedy CSM Stage** – The CSM at this stage is used to support reuse planning and placement of institutional controls if warranted.

The current Allen CSM is consistent with Stage 4, "Design CSM", which allows for iterative improvement of the Site CSM during design of the remedy while supporting development of remedy design basis (USEPA, 2011). A three-dimensional depiction of the CSM under conditions prior to decanting and basin closure is presented as **Figure 5-1**.

Anticipated changes to Site conditions, such as with decanting and basin closure, have been incorporated into the CSM based on groundwater modeling simulations. Predicted and observed effects will be compared on an ongoing basis to further refine the CSM.

5.1 Site Geologic and Hydrogeologic Setting

(CAP Content Section 5.A.a)

5.1.1 Site Geologic Setting

(CAP Content Section 5.A.a)

The groundwater system at the ash basins and coal piles is divided into the following three flow zones to distinguish the interconnected groundwater system: the shallow flow zone, deep (transition zone) flow zone, and the bedrock flow zone. The following is a summary of the natural hydrostratigraphic unit assessment observations:

- **Shallow flow zone:** Shallow soil includes fill, alluvium, regolith, and saprolite. Fill material was used in the construction of the ash basin dams and dikes and generally consists of reworked silts, clays, and sands. Alluvium consists primarily of gravel with clay and sand, sand with gravel, and silt. The regolith or residuum is in-place weathered soil that consists primarily of silt with sand, clayey sand, sandy clay, clay with gravel, and clayey silts. Saprolite is soil developed by in-place weathering of rock that retains remnant bedrock structure (such as a planar fabric associated with relic foliation). Saprolite consists primarily of medium dense to very dense silty sand, sand silt, sand, sand with gravel, sand with clay, clay with sand, and clay. Sand particle size ranges from fine to coarse-grained. Much of the saprolite is micaceous. Shallow zone material is present across the Site, including background locations. The vertical thickness of shallow zone material observed ranged from approximately 15 feet to more than 130 feet. Shallow flow layer wells are typically labeled with an "S," "SA," "PWS," or "SS" designation, although there are some exceptions where "S" wells are screened in ash.
- **Deep flow zone**: The deep flow zone (transition zone) consists of a relatively transmissive zone of partially weathered bedrock encountered below the shallow zone. Observations of core recovered from this zone included rock fragments, unconsolidated material, and highly oxidized

bedrock material. The transition zone thickness ranges from approximately 0 feet to 15 feet. Deep flow layer wells are typically labeled with a “D,” “DA,” or “BRU” designation.

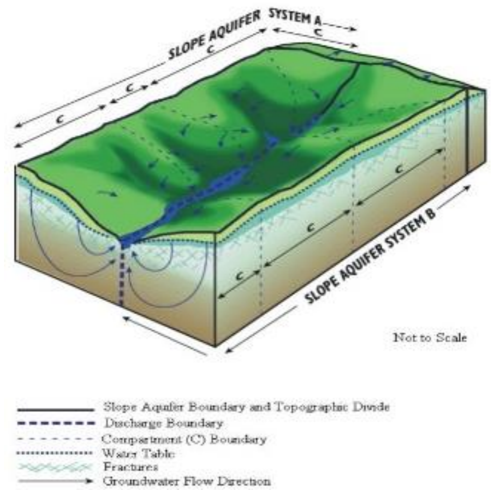
- **Bedrock flow zone**: Bedrock is defined as lithified solid rock, based on sample recovery and/or drilling resistance, that is generally slightly weathered to unweathered and fractured to varying degrees. The primary types of rock at the Site include quartz-diorite and hornblende andesite (often referred to as Diabase in boring logs and previous reports) (**Appendix F**). Quartz-diorite, the predominant rock type at the Site, is very light gray to dark gray, fine- to coarse-grained, non-foliated and massive to foliated. Hornblende andesite is greenish black to very dark greenish gray, is mostly non-foliated, and is noted as aphanitic to fine-grained, although it is described as fine- to course-grained in some boring logs. The principal minerals are plagioclase, quartz, biotite, and amphibole (**Appendix F,** Attachment D). Groundwater movement in the bedrock flow zone occurs in secondary porosity represented by fractures. Based on the orientations of lineaments and open bedrock fractures near the ash basins and coal pile area at Allen, horizontal groundwater flow within the bedrock should occur approximately parallel to the hydraulic gradient, with no preferential flow direction (*i.e.*, no expected, significant anisotropy). Allen bedrock fracture orientation and flow profile characterization data sets support overall fracturing and fracture aperture decreases with increasing depth, and a general decline in hydraulic conductivity with increasing depth below the top of bedrock (**Appendix F**). Groundwater flow in bedrock fractures is anisotropic and difficult to predict, and velocities change as groundwater moves between fractures of varying orientations, gradients, pressure, and size. Bedrock wells are typically labeled with a “BR”, “BRA”, “BRL” or “BRLL” designation. However, a few wells (GWA-5D, CCR-16D and CCR-17D) were identified with a “D” designation that were initially characterized as deep zone wells were reevaluated and reclassified as bedrock wells. A detailed evaluation of bedrock conditions is located in **Appendix F** (*CAP Content Section 5.A.a.iv*).

5.1.2 Site Hydrogeologic Setting

(CAP Content Section 5.A.a)

The groundwater system in the natural materials (shallow/deep/bedrock) at Allen is consistent with the regolith-fractured rock system and is characterized as an unconfined, interconnected groundwater system indicative of the Piedmont physiographic province.

FIGURE 5-2
LEGRAND SLOPE AQUIFER SYSTEM



A conceptual model of groundwater flow in the Piedmont, which applies to the Site, was developed by LeGrand (1988, 1989) and Daniel and Dahlen (2002) (**Figure 5-2**). The model assumes a regolith and bedrock drainage basin with a perennial stream. The model describes conditions before ash basin construction, but the general groundwater flow directions are still relevant under current conditions. Groundwater is recharged by rainfall infiltration in the upland areas followed by discharge to the perennial stream. Flow in the regolith follows porous media principals, while flow in bedrock occurs in fractures. Rarely does groundwater move beneath a perennial stream to another more distant stream or across drainage divides (LeGrand 1989).

Topographic drainage divides represent natural groundwater divides within the slope-aquifer system. The areas between the topographic divides are flow compartments that are open-ended down slope. Compartmented groundwater flow, applicable to the Allen ash basin and coal pile areas, is described in detail in *A Master Conceptual Model for Hydrogeological Site Characterization in the Piedmont and Mountain Region of North Carolina* (LeGrand, 2004).

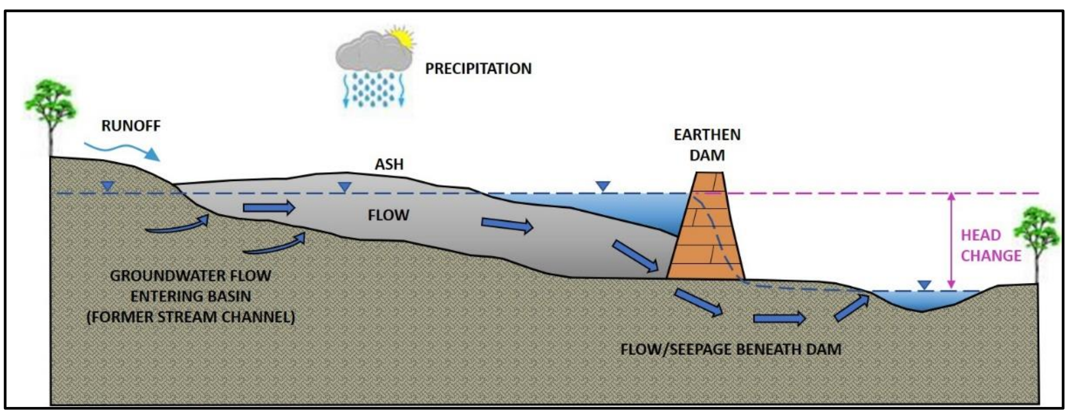
5.1.2.1 Groundwater Flow Direction

(CAP Guidance Section 5.A.a.i)

A groundwater divide located primarily west of the Site and roughly follows topography along South Point Rd and topographic highs north of the RAB along Plant Allen Road to the discharge canal and south of the AAB, near Reese Wilson Road. Groundwater on the basin side of the ridge flows east toward the basins and the Catawba River (Lake Wylie), while groundwater on the west side of the ridge flows west, away from the basins toward the South Fork River or the discharge canal. The hydraulic divides provides natural hydraulic control of ash basin constituent migration within the stream valley system. Groundwater flow and transport modeling indicates that ash basin decanting and basin closure will make the groundwater divide more pronounced to the west of the Site (**Appendix G**).

The ash basins were constructed within former perennial stream valleys. The ash basin's physical settings are horizontal flow-through water systems characterized by groundwater movement into the upgradient ends, flowing generally east through the middle regions, and downward near the dams and dikes (**Figure 5-3**). Near the dams, vertical hydraulic gradients, imposed by hydraulic pressure of water impounded within the basins, promote downward vertical gradients in the groundwater system. Beyond the dams, groundwater flows upward. Generally, the physical setting of the ash basins within former perennial stream valleys limit the horizontal and vertical migration of constituents to areas near and directly downgradient of the basin dams. The primary flow path of the groundwater remains in the stream valley systems that encompass the ash basins. Therefore, areas upgradient and side-gradient of the basins have groundwater divides that limit groundwater flow in these directions.

FIGURE 5-3
GENERALIZED PROFILE OF ASH BASIN PRE-DECANTING FLOW CONDITIONS IN THE PIEDMONT



Note:
Drawing is not to scale

Water level maps for each groundwater flow zone were constructed from pre-decanting groundwater elevations, obtained in March 2019 (**Figures 5-4a, 5-4b,** and **5-4c**). March 2019 water level measurements and elevations are presented in **Table 5-1a**. General groundwater flow directions can be inferred from the water-level contours. The groundwater flow direction for each flow zone associated with the basins and coal piles is generally from west to east toward the Catawba River (Lake Wylie) along with a small component that flows north toward the discharge canal. **Figures 5-4e, 5-4d and 5-4f** present water level maps focusing on the low pH area and coal pile area based on water levels from wells installed in late 2019 and supplemented with existing wells in the vicinity of these areas (**Table 5-1b**).

Predictive flow and transport model simulations indicate that the cessation of sluicing and subsequent decanting in the AAB will reduce the potential for COI transport prior to complete closure of the basins. Model simulations predict downward migration of groundwater below the dams and dikes will be limited without the presence of ponded water in the AAB.

The following are conclusions from the groundwater modeling results and empirical data pertaining to groundwater flow beneath the Site:

- Horizontal groundwater flow velocities in areas with free ponded water within the AAB are less than those seen upgradient of the ash basins and below the ash basin dams.
- Downward vertical gradients occur just upstream of the ash basin dams.
- Upward vertical gradients occur beyond or downstream of the dams, which is the main groundwater discharge zone toward the Catawba River (Lake Wylie).

Empirical Site data from over 30 monitoring events over multiple seasonal variations and groundwater flow and transport modeling simulations support groundwater flow is away from water supply wells and that there are no exposure pathways between the source areas and the pumping wells used for water supply in the vicinity of the Site. Domestic and public water supply wells now connected to water supply from the City of Belmont or connected to a filtration system are outside, or upgradient of the groundwater flow system containing the ash basins and coal piles. Domestic and public water supply wells are not affected by constituents released from the ash basins and coal piles or by the different closure scenarios, according to groundwater flow and transport model simulations.

5.1.2.2 Groundwater Seepage Velocities

(CAP Content Section 5.A.a.i)

Groundwater seepage velocities were calculated for current conditions using horizontal hydraulic gradients determined from measurements collected in March 2019 (**Table 5-1a**). Hydraulic conductivity and effective porosity (n_e) values were taken from the updated flow and transport model (**Appendix G**). Calibrated hydraulic conductivity and porosity values for each flow zone were used to align velocity calculations with model predictions.

The flow and transport model provided subdivided hydraulic conductivity zones and a calibrated hydraulic conductivity (K) for each zone and model flow layer. Simulated hydraulic conductivity values range from 0.01 to 115 feet per day (feet/day) for the shallow flow zone, from 0.04 to 280 feet/day for the deep flow zone, and from 0.00001 to 11 feet/day for the bedrock flow zone. Hydraulic conductivity values used in calculating seepage velocity were selected based on area's location within or proximity to subdivided hydraulic conductivity zones. The flow and transport model uses estimated effective porosity values of 20 percent for the shallow flow zone, 10 percent for the deep flow zone, and 5 percent for the bedrock flow zone (**Appendix G**).

The horizontal groundwater seepage flow velocity (v_s) can be estimated using a modified form of the Darcy Equation:

$$v_s = \frac{K}{n_e}(\frac{dh}{dl})$$

Using the March 2019 groundwater elevation data, the horizontal groundwater flow velocity in the vicinity of the AAB was:

- 0.08 ft/day [(27.9 feet per year (ft/yr)] in the shallow flow zone
- 0.15 ft/day (56.0 ft/yr) in the deep flow zone
- 0.04 ft/day (15.0 ft/yr) in the bedrock flow zone

Using the March 2019 groundwater elevation data, the horizontal groundwater flow velocity in the vicinity of the RAB was:

- 0.07 ft/day (24.6 ft/yr) in the shallow flow zone

- 0.09 ft/day (34.2 ft/yr) in the deep flow zone
- 0.02 ft/day (7.5 ft/yr) in the bedrock flow zone

Groundwater modeling predicts groundwater elevation changes associated with closure activities will change flow velocities and result in a more pronounced groundwater divide upgradient of the ash basins. As of December 1, 2019, 53,300,000 gallons of water have been removed from the AAB. The water elevation in the AAB has decreased by 14.1 feet in response to decanting, indicating significant water level changes in the AAB have already occurred. For visualization, velocity vector maps of groundwater under pre-decanting and future conditions were developed. The pre-decanting conditions map was created from comprehensive Site data incorporated into the calibrated flow and transport model. The closure condition maps were created using predicted flow fields for the closure-by-excavation or closure-in-place scenarios. Saturated conditions in the shallow zone are relatively constant across the Site; therefore, the shallow flow zone was selected for the velocity vector maps.

- Velocity vector map for groundwater in the shallow flow zone under pre-decanting conditions - **Figure 5-5a**
- Velocity vector map for groundwater in the shallow flow zone under Closure-By-Excavation - **Figure 5-5b**
- Velocity vector map for groundwater in the shallow flow zone under Closure-In-Place scenario - **Figure 5-5c**

These depictions illustrate potential future changes in groundwater flow compared with pre-decanting groundwater flow throughout the Site. Key conclusions from the predictive model simulation of future ash basin closure conditions include:

- Hydraulic heads decline.
- Small streams are predicted to return to the former perennial stream channels beneath both the RAB and AAB.
- Groundwater flow patterns change in response to the newly developed drainage system that includes the reformed stream channels. Flow directions within the basins are more prominently eastward compared to pre-decanting conditions.

- The groundwater divide shifts westward compared to pre-decanting conditions. Specifically in the AAB, the groundwater divide moves approximately 1,000 feet to the west and groundwater flow directions are eastward across the compliance boundary, toward the Site, along the western portion of the AAB.
- East of the AAB, velocity vectors under pre-decanting conditions indicate groundwater velocity is greatest (1-5 ft/day) beneath and immediately downstream of the dam and flows predominantly east (**Figure 5-5a**). Under the closure-by-excavation scenario, the velocity vectors in that area are greatly reduced (0.1-0.2 ft/day). In the southern portion of the AAB, the velocity vector directions turn inward within the AAB, simulating the natural funneling system of the historical stream valley (**Figure 5-5b**).
- Velocity vector depictions for current and future conditions indicate that groundwater flow from the ash basin does not flow in the direction of residential areas and water supply wells to the west. The exception is where a few arrows indicate eastward flow from an area of ponded water in the southwest tip of the AAB which receives storm water runoff from areas upgradient of the AAB.

5.1.2.3 Hydraulic Gradients

(CAP Content Section 5.A.a.i)

Horizontal hydraulic gradients at the Site were calculated from water levels collected from various wells located in the vicinity of the source areas. The water level elevations collected in March 2019 are summarized in **Table 5-1a**. Based on hydraulic gradient calculations using March 2019 groundwater elevation data, the average horizontal hydraulic gradients [measured in feet per foot (ft/ft)] for each flow zone along flow paths are: 0.02 ft/ft (shallow flow zone), 0.02 ft/ft (deep flow zone), and 0.02 ft/ft (bedrock flow zone). The flow paths used are roughly depicted by generalized cross-sections B-B′, C-C′, and E-E′ (**Figures 6-3, 6-4,** and **6-6**). Hydraulic gradients are circum-neutral and relatively flat across large areas of the ash basins due to the influence of standing water.

Vertical hydraulic gradients were calculated at clustered wells from the water level data and the midpoint elevations of the well screens. Within the AAB, a small upward vertical gradient was observed between the ash pore water and the deep flow zone at well cluster AB-20S/D (-0.01 ft/ft). Farther to the east, a small upward vertical gradient was observed between the ash pore water and the deep flow zone at well cluster AB-21S/D (0.00 ft/ft). At the AAB dam, upward gradients were observed at AB-22S/D (-0.07 ft/ft), AB-22D/BR (-0.01 ft/ft), and AB-22BR/BRL (-0.12). A downward vertical gradient is indicated in the shallow, deep, and bedrock flow zones on the upstream side of the ash basin dams based on the groundwater flow and transport modeling results, which are supported by data from the 234 monitoring wells present at Allen.

Downgradient of the ash basin dams, upward or approximately neutral gradients are observed at well cluster GWA-3 [GWA-3S/D (-0.01 ft/ft), GWA-3D/BRA (0.00 ft/ft)]. Artesian conditions are observed in bedrock well GWA-3BRL. The upward component of groundwater flow to the groundwater discharge zone minimizes the horizontal extent of constituent migration downgradient of the ash basins.

Exceptions regarding the CSM flow-through system exist near earthen dikes found within the basins. Earthen dikes are present in the AAB (separating the primary ponds), the RAB (separating the RAB from the coal pile area), and separating the AAB from the RAB. The earthen dikes have a similar effect on hydraulic heads as the dams do, forcing flow downward rather than flowing laterally within the basins.

5.1.2.4 Particle Tracking Results

(CAP Content Section 5.A.a.ii)

Particle tracking is not available for Allen.

5.1.2.5 Subsurface Heterogeneities

(CAP Content Section 5.A.a.iii)

The nature of groundwater flow across the Site is based on the character and configuration of the ash basins relative to specific Site features such as manmade and natural drainage features, engineered drains, streams, and lakes, hydraulic boundary conditions, and subsurface media properties.

Natural subsurface heterogeneities at the Site are represented by three flow zones that distinguish the interconnected groundwater system: the shallow flow zone, deep flow zone, and the bedrock flow zone. The shallow flow zone is composed of residual soil/saprolite. Typically, the residual soil/saprolite is partially saturated and the water table fluctuates within it. Water movement is generally preferential through the weathered/fractured and fractured bedrock of the transition zone where permeability and seepage velocity is enhanced. Groundwater within the Site area exists under unconfined, or water table, conditions within the saprolite, transition zone and in fractures and joints of the underlying bedrock. The saprolite, where saturated thickness is sufficient, acts as a reservoir for supplying groundwater to the fractures and joints in the bedrock. The shallow water table and upper bedrock water-bearing zones are typically interconnected. However, artesian conditions were observed within the deep/lower bedrock at GWA-3BRL and indicating some fracture zones are not directly interconnected with overlying material. At CP-2, no fractures were observed in bedrock that would yield sufficient water for monitoring.

NORR CSA guidance requires a "site map showing location of subsurface structures (e.g., sewers, utility lines, conduits, basements, septic tanks, drain fields, etc.) within a minimum of 1,500 feet of the known extent of contamination" in order to evaluate the potential for preferential pathways. Identification of piping near and around the ash basins was conducted by Stantec in 2014 and 2015, and utilities at the Site were also included on a 2015 topographic map by WSP USA, Inc. (SynTerra, 2018a).

Based on groundwater flow direction at the Site and identified subsurface underground utilities present at the site, there are no potential preferential pathways for constituent migration through underground utility corridors.

5.1.2.6 Bedrock Matrix Diffusion and Flow

(CAP Content Section 5.A.a.iv)

Matrix Diffusion Principles

When solute plumes migrate through fractures, a solute concentration gradient occurs between the plume within the fracture versus the initially clean groundwater in the unfractured bedrock matrix next to the fracture. If the matrix has pore spaces connected to the fracture, a portion of the solute mass will move by molecular diffusion from the fracture into the matrix. This mass is therefore removed, at least temporarily, from the flow regime in the open fracture. This effect is known as matrix diffusion (Freeze and Cherry 1979). When the plume concentrations later decline in the fractures (e.g., during plume attenuation and/or remediation), the concentration gradient reverses and solute mass that has diffused into the matrix begins to diffuse back out into the fractures. This effect is sometimes referred to as reverse diffusion.

Matrix diffusion causes the bulk mass of the advancing solute plume in the fracture to advance slower than would occur in the absence of mass transfer into the matrix. This effect retards the advance of any solute, including relatively non-reactive solutes like boron, sulfate, and total dissolved solids (TDS). The magnitude of plume retardation increases with increasing plume length, because longer plumes have more contact for diffusion to transfer solute mass from the fracture to the matrix (Lipson et al, 2005). The magnitude of plume retardation also increases with increasing matrix porosity.

If the solute sorbs to solids, the retarding effect increases. Sorption of solutes that have diffused into the matrix within the matrix occurs on a much larger surface area than would be the case if the solute mass remained entirely within the fracture. The combined effect of adsorption on the fracture surface and adsorption in the matrix further enhances plume retardation relative to the advance that would occur in the absence of adsorption. If sorption is reversible, when reverse diffusion occurs the sorbed mass can desorb and transfer back into the aqueous phase and diffuse back to the fractures. Solute mass that has been converted into stable mineral species would not undergo desorption.

Site-Specific Data Pertaining to Matrix Diffusion

Overall, the bedrock hydraulic conductivity and calculated fracture apertures decrease with increasing depth below the top of rock (**Appendix F**). The observed decline in bedrock hydraulic conductivity and hydraulic aperture with increasing depth is consistent with expectations based on the literature (Gale, 1982, Neretnieks, 1985 and Snow, 1968), and indicates that the overall volumetric rate of groundwater flow in the bedrock decreases with depth (**Appendix F**).

The available data do not indicate any predominant bedrock fracture sets at Allen. Overall, a wide range of open fracture dip angles and dip directions is observed. Based on the orientations of lineaments and open bedrock fractures, horizontal groundwater flow within the bedrock should occur approximately parallel to the hydraulic gradient, with no preferential flow direction (i.e., no expected, significant anisotropy) (**Appendix F**). Consistent with this interpretation, the current groundwater flow model for Allen does not simulate plan-view anisotropy.

Rock core samples from bedrock locations which represent areas of affected groundwater migration, north, northeast and east of the ash basins and coal pile area, and are interpreted to coincide with zones of preferential groundwater flow were analyzed for porosity, bulk density and thin section petrography.

The reported matrix porosity values ranged from 0.49 percent to 5.16 percent with an average of 1.88 percent. Bulk density ranged from 2.65 grams per cubic centimeter (g/cm^3) to 2.95 g/cm^3 with an average of 2.78 g/cm^3 (**Appendix F**). Petrographic evaluation classified all seven samples as igneous rocks. Five samples are intrusive and two are extrusive. The plutonic igneous rocks are classified as quartz diorite and tonalite, while the volcanic igneous rocks are classified as hornblende andesite. The principal minerals are plagioclase, quartz, biotite, and amphibole. Accessory minerals include K-feldspar, epidote, pyrite, magnetite, apatite, and sphene. Many plagioclase crystals have been altered into sericite/illitic clays. Biotite and amphibole crystals are locally altered into chlorite (**Appendix F**).

The reported matrix porosity values are within the range of those reported for crystalline rocks in the literature (Freeze and Cherry, 1979; Löfgren, 2004; Zhou and others, 2008; Ademeso and others, 2012). The presence of measurable matrix porosity suggests that matrix diffusion contributes to plume retardation at the Site (Lipson and others, 2005). In addition, the identification of sericite (a mixture of muscovite, illite, or paragonite produced by hydrothermal alteration of feldspars) in all of the samples indicates the bedrock has some capacity to sorb boron and other elements associated with coal ash. The influences of matrix diffusion and sorption are implicitly included in the groundwater fate and transport model as a component of the specific constituent partition coefficient (K_d) term used for the bedrock layers model.

5.1.2.7 Onsite and Offsite Pumping Influences

(CAP Content Section 5.A.a.v)

No on-Site pumping of groundwater occurs at the Site. Water used at the Site is derived from the Catawba River (Lake Wylie). Decanting was initiated on June 6, 2019. As of December 1, 2019, 53,300,000 gallons of water have been removed from the AAB and the water elevation has decreased by 14.1 feet.

Because much of the area surrounding the ash basin is either residential properties or undeveloped land, potential off-Site pumping influences would be limited to domestic and public water supply wells. Water supply wells are outside, upgradient, or side-gradient of the groundwater flow system containing the ash basins and coal piles. Flow and transport modeling indicated private water wells within the model area remove only a small amount of water from the overall hydrologic system (**Appendix G**).

5.1.2.8 Ash Basin Groundwater Water Balance

(CAP Content Section 5.A.a.vi)

The groundwater system flows from a groundwater divide toward the Catawba River (Lake Wylie). The groundwater divide is primarily west of the Site and roughly follows topography along South Point Rd and topographic highs north of the RAB along Plant Allen Road and south of the AAB, near Reese Wilson Road. The location of the groundwater divides defining the edge of the watershed change due to decanting and closure activities because of changing hydraulic conditions. The flow and transport model was used to evaluate the ash basins hydraulic conditions prior to decanting, post-decanting, and post-closure (both closure-in-place and closure-by-excavation). Each scenario water balance was developed using the results from the flow and transport model under current and predicted groundwater simulations (**Appendix G**). The approximate groundwater flow budget in the ash basin watershed under each simulated scenario is summarized in **Table 5-2**.

Pre-Decanting Conditions Groundwater Water Balance

Under pre-decanting conditions, the watershed area that contributes groundwater flow toward the basins is estimated at approximately 429 acres.

- Groundwater recharge from the 429-acre watershed is estimated to be 138 gallons per minute (gpm).
- Groundwater recharge from the ash basin ponds is estimated to be 428 gpm, and is the primary water balance component for groundwater recharge under pre-decanting conditions.
- Groundwater recharge and discharge associated with wells and septic returns from outside the ash basins are estimated to be 12 gpm each.

- Groundwater flow to drainages inside and outside of the ash basins are estimated to be 66 gpm.
- Groundwater that flows through and immediately under the dam, toward the southeast of the active ash basin, and north to the discharge canal and coal pile area is estimated to be a total of 340 gpm. The majority of this total is derived from the flow through and immediately under the dam (estimated 293 gpm).

Post-Decanting Conditions Groundwater Water Balance

The flow and transport model (**Appendix G**) was used to evaluate the ash basins and coal piles hydraulic conditions that would occur after decanting of the AAB. A water balance was developed for the simulated groundwater system under post-decanting conditions.

The extent of the watershed and location of groundwater divides during decanting is expected to remain the same as under pre-decanting conditions. Under simulated post-decanting conditions, the watershed area contributing flow towards the basins is estimated at approximately 429 acres.

- Groundwater recharge from the watershed recharge area is estimated to be 172 gpm. This includes 60 gpm from outside of the ash basins and 112 gpm from the ash basins.
- With minimal changes between pre- and post-decanting conditions, groundwater recharge associated with wells and septic returns from outside the ash basins is estimated to be 12 gpm. Discharge associated with wells and septic returns from outside the ash basins is estimated to be 13 gpm.
- Groundwater flow to drainages inside and outside of the ash basins are estimated to be 29 gpm.
- Groundwater that flows through and immediately under the dam, toward the southeast of the active ash basin, and north to the discharge canal and coal pile area is estimated to be a total of 137 gpm. The majority of this total is derived from the flow through and immediately under the dam (estimated 110 gpm).

Decanting the AAB has a large impact on the water balance, reducing the total groundwater flow through and under the dam to the east by more than 180 gpm compared to pre-decanting conditions.

Post-Closure Conditions Groundwater Water Balances

The flow and transport model (**Appendix G**) was used to evaluate the ash basins and coal piles hydraulic conditions that would occur after two ash basin closure options: closure-in-place and closure-by-excavation. A water balance was developed for the simulated groundwater system under post-closure conditions.

The extent of the watershed under post closure conditions is expected to be slightly larger than post-decanting conditions. Under closure-in-place conditions, the location of the groundwater divide to the west of the Site shifts to the west approximately 300 feet. Under closure-by-removal conditions, the location of the groundwater divide to the west of the Site shifts to the west approximately 700 feet.

- Groundwater recharge from the watershed recharge area is estimated to be 92 gpm for closure-in-place or 172 gpm for closure-by-excavation.
- Groundwater recharge associated with wells and septic returns from outside the ash basins is estimated to be 15 gpm for closure-in-place or 17 gpm for closure-by-excavation. Discharge associated with wells and septic returns from outside the ash basins is estimated to be 15 gpm for closure-in-place or 18 gpm for closure-by-excavation.
- Groundwater discharge from the ash basin ponds is estimated to be 20 gpm for closure-in-place or 129 gpm for closure-by-excavation.
- Groundwater discharge to drainages outside of the ash basins are estimated to be 6 gpm.
- Groundwater recharge that flows toward the coal pile area is estimated to be 1 gpm for closure-in-place or 5 gpm for closure-by-removal.
- Groundwater discharge that flows through and immediately under the dam, or towards the coal pile area is estimated to be a total of 66 gpm for closure-in-place. For closure-by-excavation, discharge in these areas is estimated to be a total of 33 gpm.

5.1.2.9 Effects of Naturally Occurring Constituents

(CAP Content Section 5.A.a.vii)

Metals and inorganic constituents, typically associated with CCR material, are naturally occurring and present in the Piedmont physiographic province of North Carolina. The metals and inorganic constituents occur in soil, bedrock, groundwater, surface water, and sediment. During the Allen CSA efforts, samples of soil and rock were collected during drilling activities and analyzed for metals and inorganic constituents. Results indicate that soil and rock at Allen contain naturally occurring constituents that are also typically related to CCR material and likely effect the chemistry of groundwater at the Site. Chromium, cobalt, iron, and manganese are commonly present in background soil and rock samples at concentrations greater than the PSRG POG values. Although less common, boron, selenium, and thallium are present in background soil and rock samples at concentrations greater than the PSRG POG values (**Appendix C**, Table 4 and **Table 4-2**). Analytical results for groundwater at background locations indicate that antimony, chromium, cobalt, iron, manganese, and vanadium are present at concentrations greater than 02L/IMAC standards (**Appendix C**, Table 1 and **Table 4-3**).

These results suggest that antimony, chromium, cobalt, iron, manganese, selenium, thallium, and vanadium may occur naturally in soil, rock, and groundwater at the Site. Therefore, when applicable, the concentrations of these constituents at the Site are compared to background values.

5.2 Source Area Location

(CAP Content Section 5.A.b)

The ash basins, located south of the Station, are generally bounded by a natural ridge to the west and earthen dams and dikes to the north, south, and east (**Figure 1-2**). The coal piles, also located south of the Station, are bounded by the RAB to the west and south, and the Catawba River (Lake Wylie) to the east. South Point Road, located along a topographic ridge, represents a hydrogeologic divide that affects groundwater flow within an area approximately 0.5 miles west of the ash basins. Topography to the west of South Point Road generally slopes downward toward the South Fork Catawba River to the west and discharge canal to the north.

5.3 Summary of Potential Receptors

(CAP Content Section 5.A.c)

G.S. Section 130A-309.201(13) defines receptor as "*any human, plant, animal, or structure which is, or has the potential to be, affected by the release or migration of contaminants. Any well constructed for the purpose of monitoring groundwater and contaminant concentrations shall not be considered a receptor.*" In accordance with the NORR CSA guidance, receptors cited in this section refer to public and private water supply wells and surface water features.

The Site-specific risk assessment conducted for the ash basins and coal piles indicates no measurable difference between evaluated Site-related risks imposed by background concentrations (**Appendix E**). It is determined that there is no identified material increases in risks to human health related to the ash basins and coal piles. Additionally, multiple lines of evidence support that groundwater from the ash basin and/or coal pile area has not and does not flow towards any water supply wells based on groundwater flow patterns and the location of water supply wells in the area. However, Duke Energy has implemented a permanent water solution which provides owners of the surrounding properties with water supply wells within a 0.5-mile radius of the ash compliance boundary with access to an alternate water supply.

The Site-specific risk assessment conducted for the ash basins and coal piles also indicates that there is no increase in risks to ecological receptors. The Catawba River (Lake Wylie) aquatic system that is adjacent to Allen is healthy based on multiple lines of evidence including robust fish populations, species variety, and other indicators based on years of sampling data.

5.3.1 Surface Water

The Site is located in the Catawba River watershed. The ash basins and coal piles are located along the west bank of the Catawba River (Lake Wylie). The South Fork River is located west of the Site, beyond a topographic and hydrogeologic divide. Associated North Carolina surface water classifications for the Catawba River (Lake Wylie) and the South Fork Catawba River are summarized in **Table 5-3**.

An on-Site surface water intake is used to pump water from the Catawba River (Lake Wylie) for Station operations (**Figure 5-6**).

A depiction of surface water features - including wetlands, ponds, unnamed tributaries, seeps, streams, lakes, and rivers - within a 0.5-mile radius of the ash basin compliance boundary is provided in **Figure 5-6**. The surface water information is provided by the Natural Resources Technical Report (NRTR) prepared by AMEC Foster Wheeler (Wheeler, 2015). In addition, permitted outfalls under the NPDES and SOC locations are shown on **Figure 5-6**. Non-constructed and dispositioned seep sample locations between the ash basin and the Catawba River (Lake Wylie) are managed by the SOC and are subject to the monitoring and evaluation requirements contained in the SOC.

5.3.1.1 Environmental Assessment of Lake Wylie

The NPDES permit for Lake Wylie and the Allen Steam Station (NPDES No. NC0004979) requires Duke Energy to conduct weekly to monthly outfall and instream water quality monitoring at 14 locations including within Lake Wylie. Trace elements (arsenic, selenium) monitoring in fish muscle tissue is also conducted annually in accordance with a study plan approved by NCDEQ.

Lake Wylie has been monitored by Duke Energy since 1959. Over the years, specific assessments have been conducted for water quality and chemistry as well as abundance and species composition of phytoplankton, zooplankton, macroinvertebrates, aquatic macrophytes, fish, and aquatic wildlife. These assessments have all demonstrated that Lake Wylie has been an environmentally healthy and functioning ecosystem, and ongoing sampling programs have been established to ensure the health of these systems will continue. Furthermore, these data indicate that there have been no significant effects to the local aquatic systems related to coal ash constituents over the last 50 years. More information related environmental health assessments conducted for Lake Wylie, including sampling programs, water quality and fish community assessments, and fish tissue analysis, can be found in **Appendix E**.

5.3.2 Availability of Public Water Supply

Residential potable water supply lines are available to residents within a 0.5-mile radius of the ash basin compliance boundary. The nearest available residential water supply line to the Site, provided by the City of Belmont, is located west of the Site on Southpoint Drive. **Section 6.2.2** has a more detailed discussion regarding water supply within a 0.5-mile radius of the ash basin compliance boundary.

5.3.3 Water Supply Wells

No public or private drinking water wells or wellhead protection areas were found to be located downgradient of the ash basins. A total of 290 eligible households for permanent water supply were identified within the 0.5-mile radius of the ash basin compliance boundary. These eligible households are located northwest, west, southwest, and south of the ash basins (**Figures 5-7a and 5-7b).** Discussion, with supporting material and data, of alternative water supply provisions (water filtration systems) provided by Duke Energy for surrounding occupied residences and findings of the drinking water supply well survey are included in **Section 6.2.2**.

5.3.4 Surrounding Land Use

Land use within the 0.5-mile radius of the ash basin compliance boundary generally consists of residential properties and undeveloped land in Gaston County to the north, west and south, and residential properties and undeveloped land in Mecklenburg County to the east and southeast across the Catawba River (Lake Wylie). The Catawba River (Lake Wylie) bounds the Site to the east.

5.3.5 Future Groundwater Use Area

Duke Energy owns the land and controls the use of groundwater on the land downgradient of the ash basins and coal piles at and beyond the predicted area of potential affected groundwater. Therefore, no future groundwater use areas are anticipated downgradient of the basins and coal piles.

Under G.S. Section 130A-309.211(c1) (added by House Bill 630), Duke Energy provided permanent water solutions to all eligible households within a 0.5-mile radius of the ash basin compliance boundary. It is anticipated that residences within a 0.5-mile of the ash basin compliance boundary will continue to rely on groundwater resources for water supply for the foreseeable future. Duke Energy has a performance monitoring plan in place, with details of the plan outlined in the *Permanent Water Supply – Water Treatment Systems* document. Duke Energy will provide quarterly maintenance of the water treatment systems to include replenishing expendables (salt for brine tank and neutralizer media) and providing system checks and needed adjustments. Laboratory samples of pre-treated and treated water will be collected annually to coincide with system installation, unless there is evidence the system is not performing properly, in which case samples will be collected more frequently.

5.4 Human Health and Ecological Risk Assessment Results

(CAP Content Section 5.A.d)

A human health and ecological risk assessment pertaining to Allen was prepared and is included in **Appendix E**. The risk assessment focuses on the potential impacts of CCR constituents from the Allen ash basins and coal piles on groundwater, surface water, and sediment. Groundwater flow information was used to focus the risk assessment on areas where exposure of humans and wildlife to CCR constituents could occur. Primary conclusions of the risk assessment include: 1) there is no evidence of risks to on-Site or off-Site human receptors potentially exposed to CCR constituents that may have migrated from the ash basin; and 2) there is no evidence of risks to ecological receptors potentially exposed to CCR constituents that may have migrated from the ash basin. This risk assessment uses analytical results from groundwater, surface water, and sediment samples collected March 2015 through June 2019.

Evaluation of risks associated with area of wetness (AOW) locations and soil beneath the ash basin are not subject to this assessment and will be evaluated independent from the CAP Update. Consistent with the iterative risk assessment process and guidance, updates to the risk assessment have been made to the original 2016 risk assessment (HDR, 2016c) in order to incorporate new site data and refine conceptual site models. The original risk assessment was prepared in accordance with a work plan for risk assessment of CCR-affected media at Duke Energy sites (Haley & Aldrich, 2015).

The following risk assessment reports have been prepared:

1. *Baseline Human Health and Ecological Risk Assessment*, Appendix F of the *CAP Part 2* (HDR, 2016a)
2. *Comprehensive Site Assessment (CSA) Update* (SynTerra, 2018a)
3. *Human Health and Ecological Risk Assessment Summary Update for Allen Steam Station*, Appendix B of *Community Impact Analysis of Ash Basin Closure Options at the Allen Steam Station* (Exponent, 2018)

To help evaluate options for groundwater corrective action, this risk assessment characterized potential effects on human health and the environment related to naturally occurring elements, associated with coal ash, present in environmental media. This risk assessment follows the methods of the 2016 risk assessment (HDR, 2016c) and is based on NCDENR, NCDEQ, and USEPA risk assessment guidance (NCDENR, 2003; NCDEQ, 2017; USEPA, 1989; 1991; 1998).

Human health and ecological CSMs were developed and further refined to guide identification of exposure pathways, exposure routes, and potential receptors for evaluation. Additional information regarding groundwater flow and the treatment of source areas other than the ash basin was incorporated into the refinement of CSMs presented in **Appendix E**.

Environmental data evaluated in the risk assessment were compared to human health and ecological screening values. Risk assessment constituents of potential concern (COPCs) are different than COIs in that COPC are those elements in which the maximum detected concentration exceeded human health or ecological screening values. COPCs are carried forward for further evaluation in the deterministic risk assessment. **Appendix E** contains the results of the screening assessment.

No unacceptable risks from exposure to environmental media were identified. Results of the human health risk assessment indicate the following:

- On-Site groundwater poses no unacceptable risk for the construction worker under these exposure scenarios.
- On-Site surface water, and sediment pose no unacceptable risk for the trespasser under these exposure scenarios.
- Exposure to CCR constituents by current and future commercial/industrial worker, residences is incomplete.
- No evidence of carcinogenic or non-carcinogenic risks associated with the recreational swimmer, wader, or boater exposure scenarios was identified.
- No evidence of carcinogenic or non-carcinogenic risks associated with the recreational fisher exposure scenario was identified.
- There is no increase in estimated risks for the subsistence fisher exposure scenario attributable to the ash basins. Hexavalent chromium concentrations in upstream surface water samples also resulted in estimated values within USEPA's range for excess lifetime cancer risk (ELCR). The modeled concentration of hexavalent chromium in fish tissue is likely overestimated.

Findings of the baseline ecological risk assessment include the following:

Ecological Exposure Area 1:

- No hazard quotients (HQs) based on no observed adverse effects levels (NOAELs) or lowest observed adverse effects levels (LOAELs) were greater than unity for the mallard duck, great blue heron, and river otter exposed to surface water and sediments in the Catawba River adjacent to the site (Exposure Area 1).
- Two endpoints, the killdeer and muskrat, had modeled risk results greater than unity for aluminum and lead based on modeled NOAEL and LOAEL based HQs. The killdeer had limited modeled (NOAEL based) risk results greater than unity for copper. The modeled risks are considered negligible based on natural and background conditions. The exposure models likely overstate risks to aluminum and lead.

Ecological Exposure Area 4:

- No HQs based on NOAELS or LOAELs were greater than unity for the American robin, red-tailed hawk, and red fox exposed to surface water and sediments located west of the AAB in Exposure Area 4.
- One endpoint, meadow vole, had limited modeled (NOAEL based) risk results greater than unity for aluminum. The modeled risks are considered negligible based on natural and background conditions. The exposure models likely overstate risks to aluminum. The modeled risks are considered negligible based on natural and background conditions. The exposure models likely overstate risks to aluminum, lead, and copper.

In summary, there is no evidence of unacceptable risks to human and ecological receptors exposed to environmental media potentially affected by CCR constituents at Allen. This conclusion is further supported by multiple water quality and biological assessments conducted by Duke Energy as part of the NDPES monitoring program.

5.5 CSM Summary

The Allen CSM presented herein describes and illustrates geologic and hydrogeologic conditions and constituent interactions specific to the Site. The CSM presents an understanding of the distribution of constituents with regard to the Site-specific geologic/hydrogeologic and geochemical processes that control the transport and potential impacts of constituents in various media and potential exposure pathways to human and ecological receptors.

In summary, the ash basins and coal piles were constructed within former perennial stream valleys in the Piedmont of North Carolina, and exhibit limited horizontal and vertical constituent migration, with the predominant area of migration occurring near and downgradient of the ash basin dams. The upward flow of water into the basins minimizes downward vertical constituent migration to groundwater immediately underlying saturated ash in the upgradient ends of the basins. Due to the prevailing horizontal flow within the ash basins, there is limited vertical flow of ash basin pore water into the underlying groundwater. The elevated constituent concentrations found in groundwater near the dams is due to the operating hydraulic head in the basin. The ponded water in the basin is the most important factor contributing to constituent migration in groundwater.

Groundwater flow is away from water supply wells and there are no exposure pathways between ash basins and the pumping wells used for water supply in the vicinity of the Site, based on empirical Site data from over 30 monitoring events over multiple seasonal variations and groundwater flow and transport modeling simulations. Risk assessment results conclude that there is no identified material increases in risks to human health related to the ash basins and/or coal piles.

Through ash basin decanting and closure, the hydraulic head and the rate of constituent migration from the AAB to the groundwater system will be reduced based on basin hydrogeology described above. Either closure option considered by Duke Energy will significantly reduce infiltration to the remaining ash, reducing the rate of constituent migration. Based on future predicted groundwater flow patterns, under post ash basin closure conditions, and the location of water supply wells in the area, groundwater flow direction from the ash basins is expected to be further contained within the stream valleys and continue flowing east of the ash basin footprint, and therefore will not flow towards any water supply wells.

Multiple lines of evidence have been used to develop this CSM based on the large data set generated for Allen. This CSM provides the basis for this CAP Update developed for the Allen ash basins and coal piles to comply with G.S. Section 130A-309.211, enacted by CAMA.

6.0 CORRECTIVE ACTION APPROACH FOR SOURCE AREA 1 (ASH BASINS AND COAL PILE AREA)

(CAP Content Section 6)

Groundwater contains varying concentrations of naturally occurring inorganic constituents. Constituents in groundwater with sporadic and low concentrations greater than the corresponding standard (02L/IMAC/background value, as applicable) do not necessarily demonstrate horizontal or vertical distribution of COI-affected groundwater migration from source areas. Constituents with concentrations greater than corresponding standards were evaluated to determine if the level of concentration is present due to source areas. COIs are those constituents identified from the "constituent management process" described below. This evaluation assisted in identifying if a unit is subject to corrective action under G.S. Section 130A-309.211 and 15A NCAC 02L .0106.

A COI Management Plan was developed at the request of NCDEQ to evaluate and summarize COI concentrations in groundwater at the Site (**Appendix H**). Results of this COI Management Plan are used to identify areas that may require corrective action and to determine appropriate Site-specific mapping of COI concentrations on figures based on the actual distribution of each COI in Site groundwater.

- Groundwater COIs to be addressed with corrective action are those which exhibit concentrations in groundwater at or beyond the compliance boundary greater than the 02L standard, IMAC, or BTV, whichever is highest. **Table 6-6** presents the COI management matrix for determining COIs subject to corrective action at Allen.
- The COI Management Plan is also used to discern constituents at naturally occurring concentrations greater than 02L that would not be subject to corrective action. Examples include naturally occurring COIs that do not exhibit a discernable plume or COIs that have no correlation with other soluble constituents associated with coal ash or another primary source (e.g., boron or sulfate).

A three-step process was utilized in the COI Management Plan approach:

- An evaluation of the applicable regulatory context
- An evaluation of the mobility of target constituents
- A determination of the distribution of constituents within Site groundwater

The primary goal of the COI Management Plan is to utilize science-based evidence to determine the realistic distribution and behavior of coal ash-related constituents in groundwater. The COI Management Plan presents multiple lines of evidence used to understand the actual COI presence in the subsurface at the Site, uses results from the COI Management Plan approach to identify Site-specific COIs for inclusion for corrective action planning, and presents the COI mapping approach for the CAP. The COI Management Plan approach is described in detail in (**Appendix H**) and summarized below.

Numerous Site-assessment activities have been completed to date and support the CSM, as described in **Section 5**. Data generated from these Site assessment activities have been considered within the COI Management Plan approach. Components of the Site assessment activities and data evaluations utilized within the COI Management Plan include the hydrogeologic setting, groundwater hydraulics, constituent concentrations, groundwater flow and transport modeling results, geochemical modeling results, and groundwater geochemical conditions.

Step 1: Regulatory Review

Step 1 of the COI Management Plan process considers the relevant regulatory references listed in **Appendix H**. The regulatory analysis starts with the current COI list identified in the CSA Update (SynTerra, 2018a) and 2019 IMP submitted by Duke Energy, March 20, 2019, and approved by NCDEQ April 4, 2019 (**Appendix A**). COI concentrations were screened against their respective COI criterion defined as the maximum of the 02L groundwater quality standard, IMAC, and background. COI concentrations were screened against their respective COI criterion for groundwater monitoring locations at or beyond the compliance boundary. Groundwater COI concentrations used in the screening are based on a calculated central tendency value (mean) including data from 2018 through the 2nd quarter of 2019. Arithmetic mean COI concentrations were calculated when the range in COI concentrations was less than one order of magnitude. A geometric mean COI concentration was calculated when the range in COI concentrations was greater than one order of magnitude.

NCDEQ recommended use of a lower confidence limit (LCL95) concentration rather than the central tendency value (**Appendix H**). LCL95 concentrations were calculated for each COI and the LCL95 concentration for the sample with the highest COI LCL95 concentration is provided in Table 1 of the COI Management Approach (**Appendix H)** for comparison to the maximum COI mean concentration. Table 2 of the COI Management Approach (**Appendix H**) provides a comparison of the maximum COI central tendency concentrations compared with the maximum COI LCL95 concentration for wells located at or beyond the compliance boundary for the Allen Steam Station, Belews Creek Steam Station, Cliffside Steam Station, Marshall Steam Station, Mayo Steam Electric Plant, and Roxboro Steam Electric Plant Sites. The COI LCL95 concentrations were typically lower than the COI central tendency value with very few exceptions. The number of wells exceeding COI criteria using the COI LCL95 concentration was typically equal to or less than the number of wells exceeding COI criteria using the COI central tendency concentration. There were no increases in the number of wells exceeding COI criteria for the Site when comparing the LCL95 to the COI criterion and the number of exceedances was typically less for LCL95. Use of the COI central tendency concentrations in the COI Management Plan process provides conservative estimate of the extent of COI in Site groundwater.

Step 2: COI Mobility

Step 2 of the COI Management Plan process evaluates the COI mobility to identify hydrogeologic and geochemical conditions and relative COI mobility based on:

- Review of regulatory agency and peer-reviewed literature to identify general geochemical characteristics of COI,
- Analysis of empirical data and results from geochemical and flow and transport modeling conducted for the Site, and
- Identification of COI-specific mobility as conservative (non-reactive), non-conservative (reactive), or variably reactive COIs based on results from geochemical modeling (Appendix H).

Site-specific groundwater geochemical conditions that may affect COI transport and distribution are described in Table 1 of the COI Management Approach (**Appendix H**).

Step 3: COI Distribution

Step 3 of the COI Management Plan process evaluates the relative presence of COI in Site groundwater. Descriptions of the horizontal and vertical distribution of COI with mean concentrations above their respective COI criterion at and beyond the compliance boundary are summarized in Table 1 of the COI Management Approach (**Appendix H**) and provided in more detail in **Table 6-6**. The COI Management Plan approach considers the distribution of COI on a Site-wide basis. These distributions are used for planning appropriate corrective action as well as determining which COI to map on figures.

Primary descriptions of COI distributions include plume-like distributions for relatively mobile COI such as boron and sulfate and isolated location(s) for COI that do not exhibit plume-like distributions. Boron and sulfate are the COIs with the most plume-like distributions. Some COIs with isolated exceedances of COI criteria are not associated with the boron plume and these exceedances are described in more detail in **Table 6-6** to place these exceedances within the context of the Site CSM.

Rationale for inclusion or exclusion of COI from mapping on figures in the 2019 CAP Update is based on the horizontal and vertical distribution of COI with concentrations greater than their respective COI criterion. All wells that have COI mean concentration(s) greater than the COI criterion are listed in **Table 6-6**.

Outcome of COI Management Plan Process

Constituents with concentrations greater than the COI criterion beyond the compliance boundary were grouped by geochemical behavior and mobility. A comprehensive evaluation (i.e., means and groupings) of available data was used to demonstrate constituent distribution and correlation with other soluble constituents associated with coal ash, and to evaluate the spatial occurrence with a discernable COI plume in the direction of groundwater flow downgradient of the source area. This evaluation emphasizes the depiction of those constituents that have migrated downgradient of the source area, in the direction of groundwater flow at concentrations greater than the COI criterion with a discernable plume that correlates with other soluble constituents.

COI were assigned to mobility categories based on geochemical modeling results and information derived from peer-reviewed literature. COI mobility categories are based on the concept of conservative versus non-conservative COI introduced by NCDEQ in the January 23, 2019 CAP content guidance document. The use of three mobility categories for COI was first introduced during in-person COI Management meetings held with NCDEQ in September 2019 for the Allen, Marshall, Mayo, and Roxboro Sites. Based on geochemical modeling results, COI mobility categories were expanded from conservative versus non-conservative to include the following:

- Conservative, Non-Reactive COI: Antimony, boron, sulfate, TDS. Geochemical model simulations support that these constituents would transport conservatively (K_d values <1 liter per kilogram [L/kg]) as soluble species under most conditions, and that the mobility of these COIs will not change significantly due to current geochemical conditions or potential geochemical changes related to remedial actions.
- Non-Conservative, Reactive COI: Beryllium, cadmium, total chromium, strontium, vanadium. Geochemical model simulations support that these constituents are subject to significant attenuation in most cases and have high K_d values indicating the mobility of these COIs is unlikely to be geochemically affected by current geochemical conditions or potential geochemical changes related to remedial actions.
- Variably Reactive COI: Arsenic, cobalt, hexavalent chromium, iron, manganese, molybdenum, nickel, selenium, thallium. Geochemical model simulations, and resulting K_d values, support these constituents may be non-reactive or reactive in relation to geochemical changes and are dependent on the pH and oxidation reduction potential (Eh) of the system. The sensitivity of these COIs to the groundwater pH and Eh indicates that these constituents could respond to natural changes, such as water level fluctuations imposed by seasonality, or decanting and source control activities that have the potential to change the groundwater pH or Eh.

As discussed in the CSA Update (SynTerra, 2018a) and the 2018 CAMA Annual Interim Monitoring Report (SynTerra, 2019c), not all constituents with results greater than background values can be attributed to the ash basin or another source area. Naturally occurring groundwater contains varying concentrations of inorganic constituents. Sporadic and low-concentration occurrences of these constituents in the groundwater data do not necessarily demonstrate horizontal or vertical distribution of COI-affected groundwater migration from the ash basin [and other source areas, as appropriate].

COI Management Plan Summary

A three-step process was utilized for the COI Management Plan approach considering the regulatory context, the mobility of constituents, and the distribution of constituents within Site groundwater. A comprehensive, multiple lines of evidence approach was followed utilizing extensive Site data. The COI Management Plan approach incorporated numerous components of the Site CSM in a holistic manner. Clear rationale was provided for every step of the COI Management process.

For the regulatory review portion of the COI Management Plan, mean COI concentrations were compared with COI criteria to identify COI that exceeded their respective COI criterion. Use of the COI central tendency concentrations in the COI Management Plan process was shown to provide a conservative estimate of the extent of COI in Site groundwater. Exceedance ratio values indicate COI concentrations that exceed COI criteria are typically within one order of magnitude (ER <10) to two orders of magnitude (ER <100) above the COI criterion.

Results of the COI Management Plan evaluation were used to identify COI for mapping on figures in the CAP Update. COIs to be mapped include boron, cobalt, iron, manganese, strontium, sulfate, and total dissolved solids. The following COIs have no exceedances of COI criteria or have isolated exceedances without a discernable plume, at or beyond the compliance boundary: antimony, arsenic, beryllium, cadmium, total chromium, hexavalent chromium, lithium, molybdenum, nickel, selenium, thallium, and vanadium. These constituents will not be mapped on figures in the 2019 CAP Update.

Results of the COI Management Plan evaluation were also used to identify areas that require groundwater corrective action as described in **Section 6.1.3** based on the actual distribution of each COI in Site groundwater.

6.1 Extent of Constituent Distribution

(CAP Content Section 6.A)

This section provides an in-depth review of constituent characteristics associated with source area 1 (the ash basins and coal piles) and the mobility, distribution, and extent of constituent migration within, at, and beyond the point of compliance.

6.1.1 Source Material within the Waste Boundary

(CAP Content Section 6.A.a)

Waste boundaries are shown on **Figure 1-2**. An overview of the material within the ash basins is presented in the following subsections. Although there is no waste boundary associated with the coal piles, a description of material within the coal piles is included in **Section 6.1.1.7**.

6.1.1.1 Description of Waste Material and History of Placement

(CAP Content Section 6.A.a.i)

The ash basins consist of two impoundments created with the construction of the dike located north of the RAB, the dam located along the west bank of the Catawba River (Lake Wylie), and the dike located between the RAB and AAB. The RAB was constructed in 1957 and encompasses approximately 132 acres. The AAB was constructed in 1973 and encompasses approximately 169 acres. The Allen ash basins have been operated under a NPDES Permit issued by the NCDEQ DWR.

CCR materials, composed primarily of fly ash and bottom ash, were initially deposited in the unlined RAB (south of the Station) via sluice lines. A water/ash slurry was discharged from sluice lines in the northern portion of the RAB. Pyrite-rich rocks known as “clinkers” or “mill rejects” have been observed within the north-northeast portion of the RAB. Clinkers were mixed with coal but were not combusted as part of the power generation process. Although documentation was not available, this material was likely historically managed with ash and placed in the RAB via sluicing. Pyrite within the clinkers has caused low pH conditions in the subsurface within and downgradient of the north-northeast portion of the RAB, and this area is referred to as the “low pH area” further discussed in **Section 6.1.1.7**.

Due to the RAB’s diminishing capacity, the AAB was constructed south of the RAB. After the AAB began operation in 1973, coal ash was sluiced there and no longer deposited in the RAB.

Duke Energy excavated ash from the northern portion of the AAB to provide capacity for sluiced ash and the future construction of the primary ponds. Approximately 300,000 cubic yards of ash was excavated and placed in unlined ash storage and structural fill areas, which are located within the footprint of the RAB (**Figure 1-2**). The ash storage and structural fill areas were constructed under Duke Energy’s DORS Permit issued by NCDENR DWQ.

The double-lined RAB Ash Landfill (Solid Waste Section Permit No. 3612-INDUS) was constructed on top of the RAB. The RAB Ash Landfill is located east of the DORS fills, along the east dam and north of the dike between the RAB and AAB. The landfill is permitted to receive CCR materials, including fly ash, bottom ash, boiler slag, mill rejects, and FGD waste. In addition to these CCR materials, the landfill is permitted to receive non-hazardous sandblast material, limestone, coal, carbon, sulfur pellets, cation and anion resins, sediment from sumps, and cooling tower sludge. The approximate boundary of the RAB Ash Landfill is shown on **Figure 1-2**.

The unlined AAB, located in the southern portion of the Site, received CCR materials from 1973 to 2019. While it was operating, sluice lines discharged a water/ash slurry into the northern portion of the basin. Primary ponds 1, 2, and 3 were constructed in 2004. Primary ponds 2 and 3 have been used for settling purposes. Ponded water occurs in three general areas in the AAB:

- Primary ponds 1, 2, and 3
- Southwest portion of the AAB
- Southeast portion of the AAB

Allen was modified for dry fly ash (DFA) handling in 2008. Since DFA handling began at Allen, only *de minimus* quantities of fly ash were sent to the AAB on occasion upon system start-up. Bottom ash was sluiced to the AAB until January 2019 when the facility converted to a dry bottom ash collection system. In February 2019, all sluicing to the AAB was stopped. Removal of free water, known as decanting or mechanical decanting, of the AAB began June 5, 2019 and has continued.

6.1.1.2 Specific Waste Characteristics of Source Material
(CAP Content Section 6.A.a.ii)

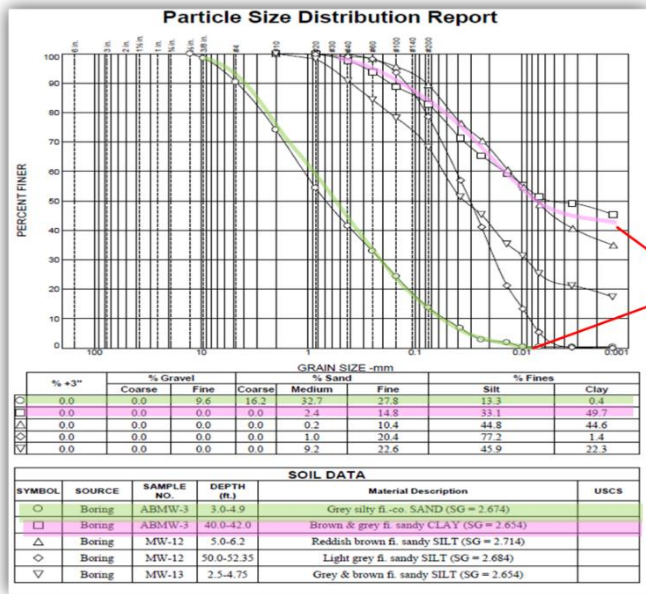
Source characterization was performed through the completion of soil borings, installation of monitoring wells, and collection and analysis of associated solid matrix and aqueous samples. Source characterization was performed to identify the physical and chemical properties of the ash in the source areas. The source characterization involved determining physical properties of ash, identifying the constituents present in ash, measuring concentrations of constituents in the ash pore water, and performing laboratory analyses to estimate constituent concentrations from leaching of ash.

Thirty-three (33) borings (AB-20S/D, AB-21D, AB-23BRU, AB-24D, AB-25SL, AB-27D, AB-28D, AB-29D, AB-30D, AB-33D, AB-34D, AB-35D, AB-36D, AB-37D, AB-38D, AB-39S, SB-1, SB-3, SB-4, SB-5, SB-6, SB-8, SB-9, and SB-10 through SB-18) were advanced within the ash basin waste boundaries to obtain ash samples for chemical analyses (**Figure 1-2**). Wells clusters AB-40 through AB-44 were co-located with adjacent borings SB-10, SB-11, SB-12, SB-17, and SB-18). Borings were advanced through the main earthen dams (AB-22D, AB-26D, AB-31D, and AB-32S) without encountering ash, and three borings at the AB-9 location drilled through the dike (one of which was advanced into bedrock) did not encounter ash. Ash was not observed in borings outside the ash basin waste boundaries.

The hydraulically sluiced deposits of ash consisted of interbedded fine- to coarse-grained fly ash and bottom ash materials. Ash was generally described as gray to dark gray, non-plastic, loose to medium density, dry to wet, fine- to coarse-grained sandy silt texture. Physical properties analyses (grain size, specific gravity, and moisture content) were performed on ash samples from the ash basins and measured using American Society for Testing and Materials (ASTM) methods. Ash is generally characterized as a non-plastic silty (medium to fine) sand or silt. Ash exhibits a lower specific gravity compared to soil, with six values reported ranging from 1.9 (AB-25BR) to 2.4 (AB-35S). Moisture content of the ash samples ranges from 22.3 percent to 57.8 percent.

Within an ash basin, ash typically contains interbedded layers of fly ash and bottom ash as a result of the varying rates and pathways of bottom ash and fly ash settlement. A depiction of the typical interbedded nature of fly ash and bottom ash within an ash basin, as seen from an ash boring photograph (**Figure 6-1**). Layers of bottom ash are typically more permeable than layers of fly ash due to the coarser grain size of bottom ash.

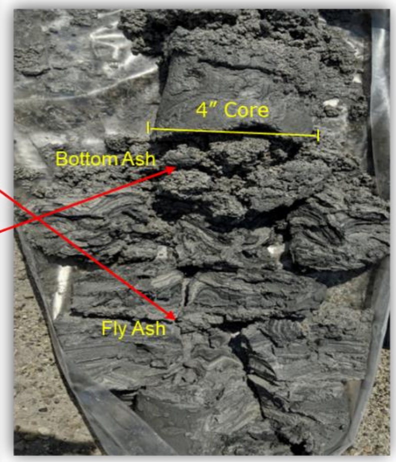
FIGURE 6-1
FLY ASH AND BOTTOM ASH INTERBEDDED DEPICTION



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	9.6	16.2	32.7	27.8	13.3	0.4
□	0.0	0.0	0.0	0.0	2.4	14.8	33.1	49.7
△	0.0	0.0	0.0	0.0	0.2	10.4	44.8	44.6
◇	0.0	0.0	0.0	0.0	1.0	20.4	77.2	1.4
▽	0.0	0.0	0.0	0.0	9.2	22.6	45.9	22.3

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	Boring	ABMW-3	3.0-4.9	Grey silty fi.-co. SAND (SG = 2.674)	
□	Boring	ABMW-3	40.0-42.0	Brown & grey fi. sandy CLAY (SG = 2.654)	
△	Boring	MW-12	5.0-6.2	Reddish brown fi. sandy SILT (SG = 2.714)	
◇	Boring	MW-12	50.0-52.35	Light grey fi. sandy SILT (SG = 2.684)	
▽	Boring	MW-13	2.5-4.75	Grey & brown fi. sandy SILT (SG = 2.654)	



6.1.1.3 Volume and Physical Horizontal and Vertical Extent of Source Material

(CAP Content Section 6.A.a.iii)

Based on CCR inventory data provided by Duke Energy as of July 31, 2019 and upon a surface comparison calculation, performed within AutoCAD Civil 3D, comparing the approximate pre-development topography to the existing topographic and bathymetric survey, the approximate volume of source material in the basins 16,231,500 tons, or 13,526,250 cubic yards. This estimate includes the DORS Fills, but excludes the double-lined RAB Ash Landfill. Based on borings located within the RAB and AAB, the maximum depth of CCR within the ash basins is estimated to be approximately 58 feet which was observed within a boring (AB-35) on an elevated structural fill area within the RAB. Volume and physical horizontal and vertical extent of ash material within the basins under pre-decanting conditions as cross-section transects, from west to east, are presented in **Figures 6-2** through **6-6**. The horizontal limits of source material is depicted by the waste boundaries as shown on **Figure 1-2**.

The live coal pile encompasses approximately 2 acres. The main coal pile encompasses approximately 15 acres. While the footprint of the coal piles remains relatively constant, the volume of coal changes due to the on-going operations of the Station.

6.1.1.4 Volume and Physical Horizontal and Vertical Extent of Anticipated Saturated Source Material

(CAP Content Section 6.A.a.iv)

Volume and physical horizontal and vertical extent of saturated ash material under pre-decanting conditions, within the basins in plan-view is presented in **Figure 6-7**. Water levels of ash pore water wells under pre-decanting conditions ranged from 0.5 feet to 39 feet below grade surface in the RAB, and 5 feet to 8 feet below grade surface in the AAB. The large discrepancy in water levels in the RAB and AAB is due to the wells installed within the DORS Fills. The maximum saturated ash thickness under pre-decanting conditions was estimated to be 40 feet in the RAB and 70 feet in the AAB. The estimates use the approximated bottom of ash from the flow and transport model simulation (**Appendix G**) and simulated hydraulic heads. Due to ponded water being present in the AAB, estimates of saturated ash in the eastern portion of the AAB are likely overestimated. The greatest volume of saturated ash follows the former stream valleys in the central portions of the basins (**Figure 6-7**).

Decanting of the AAB was initiated in June 2019. As of December 1, 2019, 53,300,000 gallons of water has been decanted and the corresponding pond water elevation has decreased by 14.1 feet, significantly reducing areas of saturated ash. Under closure-in-place conditions, the range of potential saturated ash thickness in the RAB is estimated to be between 0 feet to 20 feet and between 0 feet to 20 feet in the AAB. The estimates use the approximated bottom of ash from the flow and transport model simulation (**Appendix G**) and simulated hydraulic heads. The greatest volume of saturated ash remains within the former stream valleys in the central portions of the basins, as it was under pre-decanting conditions (**Figure 6-7**). Under closure-in-place conditions, the ash/source material within the low pH area is estimated to be unsaturated.

Under the closure-by-excavation option, all of the ash in the ash basins would be excavated, and therefore, no saturated ash would remain in the ash basin footprints.

6.1.1.5 Saturated Ash and Groundwater

(CAP Content Section 6.A.a.v)

Based on the trend analysis results, the thickness of saturated ash remaining in place following closure (closure-in-place only) will have limited to no adverse effect on future groundwater quality. Layered ash within the basin has resulted in relatively low vertical hydraulic conductivity, reducing the potential for downward flow of pore water into underlying residual material. The CSM indicates that the flow-through ash basin system should result in low to non-detectable COI concentrations in groundwater underlying saturated ash within the basin except near the dam where downward vertical hydraulic gradients are observed. Boron is the CCR constituent most indicative of COI transport in groundwater from the source area as it has a minimal K_d value and has a discernable plume pattern. Using boron data to indicate COI distribution potentially related to the ash basins, the generalized flow-through system is consistent with Site-specific data as summarized in the **Table 6-1**.

Of the 15 well locations within the RAB, 12 demonstrate minimal (less than 700 μg/L and below the 02L groundwater standard) to non-detectable boron concentrations consistent with the flow-through system, which suggests there is no correlation between the thickness of saturated ash and the underlying groundwater quality. As shown in **Table 6-1**, and discussed in **Section 5.0**, exceptions to the CSM are near earthen dikes found within the basins (AB-25, AB-27, and AB-33). The earthen dikes have a similar effect on hydraulic heads as the dams, forcing flow downward rather than flowing laterally within the basin.

A technical memorandum, titled *Saturated Ash Thickness and Underlying Groundwater Boron Concentrations – Allen, Belews Creek, Cliffside, Marshall, Mayo, and Roxboro Sites (*Arcadis, 2019a*)*, conducted linear regression analyses to evaluate the relationships between saturated ash thickness and concentrations of boron in ash pore water and underlying groundwater. The linear regression analysis was conducted using analytical data from Piedmont ash basins, including data from Allen.

The statistical evaluation was performed using a dataset which included 88 monitoring wells completed in shallow, transition, and bedrock groundwater zones directly beneath ash basins and 57 ash pore water monitoring wells completed in saturated ash. Linear regression results indicated that 86% of the groundwater monitoring locations below saturated ash locations have less than 02L concentrations of boron in groundwater. Exceptions to this relationship occur for select groundwater wells located near ash basin dikes and dams. This is due to the downward vertical hydraulic gradient in these areas, which enhances migration of COIs.

Under pre-decanting conditions, the analysis demonstrates saturated ash and ash pore water are not significantly contributing COI concentrations to underlying groundwater except near dikes and dams, where downward vertical gradients exist. Pre-decanting conditions represent the greatest opportunity for COI migration to occur, not because of the volume of saturated ash, but because of the existing ash basin hydraulic head and the downward vertical hydraulic gradient near the dam. Under post-decanting, the hydraulic head of the ash basin will be reduced, therefore reducing the downward vertical gradient occurring near the dam and the rate of constituent migration from the ash basin to the groundwater system. Decanting the basin to reduce the vertical hydraulic gradient is the most important factor to limit further constituent migration in groundwater.

6.1.1.6 Chemistry within Waste Boundary

(CAP Content Section 6.A.a.vi)

Analytical sampling results associated with material from within the ash basin waste boundary are included in the following appendix tables or appendices:

- Ash solid phase: **Appendix C**, Table 4 *(CAP Content Section 6.A.a.vi.1.1)*
- Ash and soil synthetic precipitation leaching procedures (SPLP): **Appendix C**, Table 6 *(CAP Content Section 6.A.a.vi.1.2)*
- Ash Leaching Environmental Assessment Framework: **Appendix H,** Attachment C *(CAP Content Section 6.A.a.vi.1.3)*
- Soil: **Appendix C**, Table 4 *(CAP Content Section 6.A.a.vi 1.4)*
- Ash pore water: **Appendix C**, Table 1 *(CAP Content Section 6.A.a.vi.1.6)*

Ash Solid Phase and Synthetic Precipitation Leaching Potential

(CAP Content Section 6.A.a.vi.1.1 and 6.A.a.vi.1.2)

Ash samples collected inside the ash basin waste boundaries were analyzed for total extractable inorganics using EPA Methods 6010/6020. For information purposes, ash samples were compared to soil background values and PSRGs for POG. The ash analytical data do not represent soil conditions outside of or beneath the ash basins. Concentrations of arsenic, barium, boron, chromium, and selenium were greater than soil background concentrations and the PSRG POGs (**Appendix C**, Table 4)**.**

In addition, 35 ash samples collected from borings completed within the ash basins were analyzed for leachable inorganics using SPLP EPA Method 1312 (**Appendix C**, Table 6). The purpose of the SPLP testing is to evaluate the potential for leaching of constituents that might result in concentrations greater than the 02L standards or IMACs. SPLP analytical results are compared with the 02L standard or IMAC comparative values to evaluate potential source contribution; the data do not represent groundwater conditions.

The results of the SPLP analyses indicated antimony, arsenic, chromium, cobalt, iron, manganese, selenium, thallium, and vanadium have the potential to leach at concentrations greater than the 02L/IMAC or shallow groundwater background values, which are not comparative criteria for ash pore water, but comparing these results to these values may indicate potential to affect the shallow flow zone beneath the ash.

In the low pH area of the RAB, 22 of the 35 ash samples were collected from five of nine borings for laboratory analysis including SPLP. SPLP results from sample in this area were similar to other locations within the ash basins, however, cadmium and nickel were additional constituents detected to have the potential to leach at concentrations greater than the 02L/IMAC or shallow groundwater background values in one or more samples. These additional constituents are also detected within the compliance boundary in groundwater immediately downgradient of the low pH area. Low pH conditions and abundant sulfate concentrations in this area are contributing to the leaching potential of solids in this area. Notably, SPLP results from soil samples collected beneath indicate the that only cobalt, manganese and nickel at SB-17 have potential to leach to groundwater at concentrations greater than 02L/IMAC or shallow groundwater background. Additional detail regarding the analysis of and leaching potential of constituents in this area is included in the geochemical model **(Appendix H)**. Additional discussion of the investigation of the low pH area conducted in the third quarter of 2019 are included in **Appendix P** and subsequent sections of this CAP Update.

Ash Leaching Environmental Assessment Framework

(CAP Content Section 6.A.a.vi.1.3)

Ash samples were analyzed for extractable inorganics, including hydrous ferric oxide (HFO)/hydrous aluminum oxide (HAO), using the Citrate-Bicarbonate-Dithionite (CBD) method. Leaching environmental assessment framework (LEAF) is a leaching evaluation framework for estimating constituent release from solid materials. Leaching studies of consolidated ash samples from the Allen ash basins were conducted using two LEAF tests, EPA methods 1313 and 1316. The data are presented and discussed in the geochemical modeling report in **Appendix H.**

Leaching test results, using USEPA LEAF method 1316, indicate that, even for conservative COIs such as boron, the leachable concentration of boron present in ash from Allen is considerably lower than the total boron concentration (**Appendix H,** Attachment C). Allen data indicate that there is a process by which the COIs might become stable within the ash and would make the COI unavailable for leaching. The exact mechanisms of this process are unknown, however, literature suggests that incorporating COIs, such as boron, into the silicate mineral phases is a potential mechanism (**Appendix H**, Attachment C). The leaching behavior of several COIs as a function of pH, examined using USEPA LEAF method 1313, demonstrated that for anionic COIs, the leaching increased with increasing pH and the cationic COIs showed the opposite trend (**Appendix H,** Attachment C).

Soil Beneath Ash

(CAP Content Section 6.A.a.vi 1.4 and 6.A.a.vi 1.5)

Soil samples within the ash basin waste boundaries include samples collected from beneath the ash basins and samples collected from the fill material within the ash basin dams and dikes. Soil samples beneath the ash basin were both mostly saturated. Unsaturated soil samples within the waste boundaries were collected at eight locations. Temporary soil borings

(SB) were used for soil sample collection purposes (*i.e.*, no monitoring wells were installed at these locations).

Constituents considered for soil evaluation were limited to constituents identified as COIs for Allen source areas since soil impacts would be related to the interactions from the source areas to the underlying soils and groundwater, which may migrate beyond the source areas. The range of constituent concentrations in soils within the waste boundary, along with a comparison with soil background values and North Carolina PSRG POG standards, whichever is greater, is provided in **Appendix C**, Table 4. For constituents lacking an established target concentration for soil remediation (*i.e.,* sulfate), the following equation was used in general accordance with the references in Subchapter 02L .0202 to calculate a POG value.

$$C_{soil} = C_{gw}\,[k_d + (\theta_w + \theta_a H')/P_b]df$$

Where necessary, the PSRG POG values were calculated using laboratory testing and physical soil data for effective porosity (0.3) and dry bulk density (1.6 kg/L) prepared in part for flow and transport modeling for the Site. Soil water partition coefficients (K_d) were obtained from the *Groundwater Quality Signatures for Assessing Potential Impacts from Coal Combustion Product Leachate* (EPRI, 2012). Soil PSRG POG standard equation parameters and values used in the equation above are outlined on **Table 6-2**. The resulting PSRG POG calculated value for sulfate was 1,438 mg/kg (**Appendix C**, Table 4).

Saturated soil and rock is considered a component of the groundwater flow system and can serve as a source for groundwater COIs at the Site. The potential leaching and sorption of constituents in the saturated zone is included in the flow and transport and geochemical model evaluations (**Appendix G** and **H**) by continuously tracking the COI concentrations over time in the saprolite, transition zone, and bedrock materials throughout the models. Historical transport models simulate the migration of COIs through the soil and rock from the ash basins and coal piles, and these results are used as the starting concentrations for the predictive simulations.

Unsaturated soil and rock is considered a potential secondary source to groundwater. Constituents present in unsaturated soil or partially saturated soil (vadose zone) have the potential to leach into the groundwater system if exposed to favorable geochemical conditions for chemical dissolution to occur. Unsaturated fill and/or soil within the waste boundaries were collected from borings associated with AB-22, AB-26, AB-31, AB-32, AB-34, SB-1, SB-2, and SB-4 (**Figure 6-8**).

Analytical results for unsaturated soil data within the waste boundary can be found on **Table 6-3.** Unsaturated soil sample AB-32S (33.5-35) has concentrations of cobalt (82.3 mg/kg) greater than PSRG for POG or background values, whichever is greater. Unsaturated soil sample AB-34D (14-14) has concentrations of arsenic (39.8 mg/kg) and selenium (3.7 mg/kg) greater than PSRG for POG or background values, whichever is greater. Unsaturated soil sample SB-1 (3-5) is stratigraphically above the ash, but has concentrations of arsenic (44.5 mg/kg) greater than PSRG for POG or background values, whichever is greater. Unsaturated soil sample SB-4 (25-26.5) has concentrations of boron (45.7 mg/kg) greater than PSRG for POG or background values, whichever is greater. While these values are greater than PSRG for POG or background values, they all fall within the Piedmont background range (**Table 4-2**) with the exception of the cobalt concentrations at AB-32S (33.5-35) and arsenic concentrations at SB-1 (3-5). The maximum detected cobalt concentration at from an NCDEQ-approved background location at a Piedmont site is 81.68 mg/kg and the maximum detected arsenic concentration at from an approved background location at a Piedmont site is 43.13 mg/kg. The exceedances at AB-32S (33.5-35) and SB-1 (3-5) are negligibly (3%) greater than the Piedmont background range. Additionally, source control and ash basin closure activities will lower water elevation in these areas, reducing the potential for leaching constituents into the groundwater system. No other unsaturated soil samples within the waste boundaries had concentrations greater than PSRG POG or background values.

One unsaturated soil sample within the waste boundaries has been analyzed for leachable inorganics using SPLP procedures EPA Method 1312. SB-1 (3-5), classified as fill in the boring log, is located in the ash storage area of the RAB stratigraphically above the ash. Several COIs have the potential to leach at concentrations greater than the 02L/IMAC. However, wells downgradient (AB-35 cluster) of SB-1 do not exceed 02L/IMAC or Site-wide background values for any COIs.

Ash Pore Water

(CAP Content Section 6.A.a.vi.1.6 and 6.A.a.vi.3)

The ash basins are wastewater treatment systems. Water within the ash basins is not groundwater; therefore, comparison to 02L/IMAC/background values is not appropriate. Ash pore water data is provided for general purposes only in **Appendix C**, Table 1. **Figures 6-9a** through **6-13c** represent ash pore water constituent distribution in cross-section from west to east. For further discussion of geochemical trends within the ash pore water, see **Appendix H**, Section 2. All ash pore water sample locations are shown on **Figure 1-2,** and analytical results are provided in **Appendix C**, Table 1.

One ash pore water monitoring well and three groundwater monitoring wells located in areas that could be sensitive to changing conditions from ash basin closure activities, including decanting, were selected for monitoring water elevation and geochemical parameters. Water elevations are monitored with pressure transducers and geochemical parameters, including pH, oxidation reduction potential (ORP) and specific conductivity, are monitored using multi parameter (or geochemical) sondes. Locations monitored with multi parameter sondes are depicted on **Figure 6-14**, and include:

- AB-21SL: ash pore water monitoring well located in the southern portion of the AAB (data has not been retrieved from transducers at this location as access became restricted due safety concerns with ash stability after decanting began)
- AB-21SS: shallow flow zone monitoring well located in the southern portion of the AAB, stratigraphically below ash pore water monitoring well AB-21SL (data has not been retrieved from transducers at this location as access became restricted due safety concerns with ash stability after decanting began)

- AB-26S: shallow flow zone monitoring well located within the dam of the AAB, downgradient of primary pond 3
- GWA-3S: shallow flow zone monitoring well located downgradient of the AAB and primary pond 3

Hydrographs and geochemical water quality parameter time series plots for each location are included on **Figure 6-14**. Observations of water elevation and multi parameter records from monitored locations include:

- Ash pore water and shallow flow zone monitoring wells within the waste boundary show a response to ash basin decanting by reduced water elevation levels (**Figure 6-14)**.
- Shallow flow zone monitoring wells within the AAB dam and directly downgradient of the AAB dam show a response to ash basin decanting by reduced groundwater elevation levels (**Figure 6-14**).
- Geochemical parameters located within the waste boundary (AB-21SL and AB-21SS) are generally stable and do not show significant shifts or variability in records since ash basin decanting commenced (**Figure 6-14**). This suggests geochemical conditions have remained stable under changing conditions at locations within the waste boundary. Data spikes seem to occur around dates where samples were collected or data retrieval/maintenance was conducted on the geochemical sondes.
- Geochemical parameters located at or beyond the waste boundary (AB-26S and GWA-3S) show somewhat sporadic results potentially due to on-going sampling efforts or data retrieval/sonde maintenance at the Site, as previously mentioned (**Figure 6-14**). Clear trends in the data are not yet apparent, with the exception of a slight increase in conductivity values at GWA-3S. The increasing trend appears to be consistent with the trends prior to reduction of water levels, therefore it is unlikely related to ash basin decanting and could reflect natural variability.

In general ash pore water and groundwater geochemical parameters appear stable under changing site conditions. Ash pore water pH and ORP do not appear to be significantly affected by lowering the ash basin pond's water level, and therefore represent stable conditions in which an increase in constituent dissolution and mobility is unlikely to occur. Additionally, groundwater pH and ORP, monitored beneath and downgradient of the ash basin, are unaffected by even larger reductions in water levels, indicating stable geochemical conditions in which constituent dissolution and mobility are unlikely to occur.

Ash Pore Water Piper Diagrams

(CAP Content Section 6.A.a.vi.2)

Piper diagrams can be used to differentiate water sources in hydrogeology (Domenico and Schwartz 1998). Piper diagrams of ash pore water monitoring data (**Figures 6-15a** and **6-15b**) are used to assess the relative abundance of major cations (*e.g*., calcium, magnesium, potassium, and sodium) and major anions (*e.g*., chloride, sulfate, bicarbonate, and carbonate). Data used for the piper diagrams include ash pore water data between January 2018 and June 2019 with a charge balance between -10 and 10 percent. Additional data collected as recent as October 2019 were included on the piper diagrams on **Figure 6-15b** to include the recently installed low pH area and coal pile area assessment wells.

- The Piper diagrams indicate ash pore water is characterized by two water types, calcium-bicarbonate to calcium sulfate and that ash pore water is similar within the RAB and AAB. These results are similar to findings in a 2006 Electric Power Research Institute (EPRI) study of 40 ash leachate water samples collected from 20 different coal ash landfills and impoundments which characterized bituminous coal ash leachate as calcium-magnesium-sulfate water type (EPRI, 2006).
- Ash pore water samples at Allen are not sodium-rich, which is different than typical subbituminous coal ash leachate evaluated by EPRI which was found to be a sodium-calcium-sulfate water type (EPRI, 2012).

6.1.1.7 Other Potential Source Material

(CAP Content Section 6.A.a.vii)

Other potential source material is coal within the coal piles and pyrite-rich rocks observed to be mixed with ash in the north-northeast portion of the RAB. The pyrite rich rocks are known as “clinkers” or “mill rejects” that were mixed with coal but not combusted as part of the power generation process and placed with ash within the RAB. Pyrite within the clinkers has caused low pH conditions in the subsurface within and downgradient of the north-northeast portion of the RAB, and this area is referred to as the "low pH area".

A focused investigation into these two areas was performed in 2019 to further evaluate previous assessment results that indicated potential influence to groundwater from these source areas. Details of the 2019 investigation into these areas, including boring logs, screening results, and sampling techniques, are included in **Appendix P.** Evaluation of the results are included within this CAP Update.

Low pH Area

The "low pH area" is a wooded area within the northern portion of RAB waste boundary directly upgradient (west) of the main coal pile (**Figure 1-2**). In this area, ash, ash pore water, and groundwater pH values are approximately 4.2 standard units (S.U.) or less, which is less than other areas of the Site, including within ash pore water in other areas within the AAB and RAB. Ash pore water and groundwater elsewhere at the Site typically ranges from approximately 5 S.U. to 8 S.U. Based on field screening of pH, the area where low pH conditions are present encompasses approximately 3-acres within a wooded tract of land within the northern portion of RAB waste boundary directly upgradient (west) of the main coal pile. Boring logs and groundwater quality data from wells installed in this area indicate coal "mill rejects" or "clinkers" were placed in this area within the RAB. Clinkers have not been identified beyond the RAB waste boundary.

A focused investigation into the low pH area was conducted voluntarily in the third quarter of 2019. The investigation included the installation of nine borings and 13 monitoring wells. Details of the investigation of the low pH area, including the executed sampling plan, field screening results, well construction details and boring logs are provided in **Appendix P**. Laboratory analytical results are included in **Appendix C**, Table 1. Based on field screening, 22 samples from 5 borings were collected for laboratory analysis. Low pH conditions are isolated to areas generally near the waste boundary, specifically at borings SB-11, SB-12, SB-14 through SB-17. Horizontally, this area encompasses approximately 130,000 square feet. Vertically, this area extends to an average depth of approximately 20 feet below ground surface.

The low pH conditions within the RAB are causing low pH conditions in groundwater immediately downgradient of the low pH area source area as indicated by measurements from monitoring wells GWA-6S, CCR-4S, CCR-5S and CCR-6S. As a result, several constituents not typically detected in other areas of the Site, have solubilized and been transported, primarily within the shallow flow zone groundwater. Lesser effects of the low pH conditions have been observed in the deep flow zone and groundwater data indicates that the bedrock flow zone has not been affected by the low pH area.

Constituents likely caused by the low pH conditions include arsenic, beryllium, cadmium, calcium, nickel, selenium, and thallium. These constituents are not detected in groundwater at concentrations greater than applicable regulatory or background values elsewhere at the Site. These listed constituents are not detected beyond the compliance boundary. Monitoring wells upgradient, side-gradient, and farther downgradient of the low pH area have pH values ranging from 5 to 6.5 S.U. Concentrations of the aforementioned constituents in upgradient and side-gradient wells are orders of magnitude less than respective concentrations found immediately downgradient of the low pH area and the concentrations of these constituents are less than applicable regulatory values (02L, IMAC, or background). Several of these constituents would otherwise be less mobile under pH conditions observed elsewhere on the Site. Sulfate concentrations observed in wells downgradient of the low pH area may also be derived from the pyrite-rich clinkers.

Coal Pile Area

Coal stored on-Site is a not a waste product and therefore, is not regulated under G.S. Section 130A-309.211, enacted by CAMA. Therefore, no compliance or waste boundaries are associated with the coal piles, although a portion of the RAB compliance boundary encompasses the southwest portion of the main coal pile.

In an April 5, 2019, letter to Duke Energy, NCDEQ listed and requested assessment of additional potential sources of constituents to groundwater at Allen stating that sources hydrologically connected to the ash basins (including the ash basins) are to be assessed and included in an updated CAP. The coal pile area was included as an additional source hydrologically connected to the ash basins. The coal pile area is adjacent to, and downgradient of, the RAB.

Coal has been stored on-Site within the same general footprint since operations began in 1957. There are two adjacent but separate coal storage areas. The "live coal pile", located adjacent to the Catawba River (Lake Wylie), encompasses approximately 2 acres. The "main coal pile" is located west of the active coal pile and north-northeast of the RAB. The main coal pile encompasses approximately 15 acres.

The volume of coal within the coal piles fluctuates. Typically more coal is stored on-Site when demand for power is greater and the Station is producing power. However, other factors such as logistics and economics can determine how much coal is stored on-Site at any given time. Volume within the live coal pile is more consistent than the main coal pile. Typically the volume of coal in the live coal pile is approximately 9,800 cubic yards (cy) (assuming a radius of 25 yards stacked conically 15 yards high). The volume of coal within the main coal pile is notably greater, but much more variable.

The base of the coal piles are unlined, at land surface grade, and drain water away from the piles. Historical storm water runoff in the vicinity of the coal piles was channelized between the RAB and the south end of the main coal pile to a ponded area and managed through capture within a coal yard sump and yard drain sump. The storm water was then pumped from the sumps to the AAB for treatment and discharge through NPDES Outfall 002. To improve storm water management in the area of the coal piles, a lined holding basin was constructed in 2018 within the eastern footprint of the main coal pile and west of the live coal pile. Construction of the holding basin was associated with a water redirect project which is a component of ash basin closure (**Figure 1-2**). Storm water runoff in this area is now captured within the holding basin for pretreatment and then pumped to the lined retention basin for further treatment before discharge through NPDES Outfall 006.

To facilitate construction of the holding basin, temporary extraction wells were used to lower the water table. Extraction well pumping rates and water levels were monitored in select wells in the vicinity of the holding basin during construction. Results of these monitoring activities are considered in the flow and transport model and were considered in the development of this CAP Update. Transducers were installed to monitor water levels in 24 monitoring wells in the vicinity of the holding basin. The extraction well network was already functioning at the time of transducer installation. Dewatering data (*i.e.*, gallons treated) was provided by Duke Energy. Hydrographs depicting the impact the extraction wells had on the surrounding monitoring wells are included as **Figures 6-18a** and **6-18b**. As anticipated, monitoring wells located at CCR-7, CCR-8, and CCR-9 were the most responsive to the dewatering activities.

The coal piles at Allen are exposed to erosion, oxidation, and precipitation. An estimated 50-95% of precipitation becomes runoff from coal piles (Davis and Boegly, 1981). Leachate from coal piles tend to be acidic, with pH values as low as 2 to 3 S.U. At Allen, acidic conditions occur upgradient of the coal piles in the area of the AB-40 cluster to the GWA-6 and CCR-6 clusters, likely due in part to the mill rejects associated with the low pH area. Downgradient of the coal piles at Allen, low pH conditions are not observed. Chemical reactions occur at coal piles when water and oxygen is introduced to pyrite commonly in coal. The chemical reaction typically results in iron and sulfate in solution, which is consistent with the values seen in monitoring wells in the vicinity of the coal piles at Allen. Sulfate and low pH are potential indicator constituents of coal pile impact (EPRI, 2019). Sulfate, a conservative constituent at Allen, is observed above 02L in the low pH area and in the area of the coal piles. Other constituents of note commonly associated with coal piles are aluminum, calcium, magnesium, potassium, and sodium (EPRI, 2019). These constituents have been observed in monitoring wells downgradient of the coal piles at concentrations greater than background and are within the footprint of the sulfate plume. The remedial actions put forth in this CAP Update address sulfate as well as the constituents listed above.

Sulfate concentrations are greatest upgradient/southwest of the coal pile area at well CCR-06S, near the low pH area. Sidegradient of the main coal pile, and farther downgradient of the low pH area at CP-01S, sulfate concentrations are less than at CCR-06S. Farther downgradient, at CP-02S, sulfate concentrations are greater than at CP-01S. Similarly, sulfate concentrations at GWA-30S, located at the upgradient edge of the main coal pile, are less than concentrations at CP-2S. This distribution of COI concentrations from the low pH area and areas upgradient of the coal piles to areas downgradient of coal piles indicates the coal piles are an additional source of COIs, separate from the low pH area. However, there is overlap of areas where groundwater has been affected by the RAB and the coal piles and therefore these areas are grouped together as a single source area with this CAP Update.

The coal piles are anticipated to be used until the Station is decommissioned. Decommissioning may play an important role in the corrective action, as coal pile removal would not only eliminate the coal piles as a source, but also would improve access for implementation of an active remedy within the footprint of the coal piles.

6.1.1.8 Interim Response Actions

(CAP Content Section 6.A.a.viii)

Interim response actions to date include ash basin decanting, source area stabilization, and construction of the lined holding basin as summarized in **Table 6-4.**

Ash Basin Decanting

(CAP Content Section 6.A.a.viii.1)

Ash basin decanting commenced on June 6, 2019 and is expected to be ongoing through June 2020. Decanting is a form of active source remediation by removing ponded water in the AAB, which is considered a critical component of reducing constituent migration from the ash basins. Reduction of constituent migration occurs through decanting by significantly reducing the hydraulic head and gradients, thereby reducing the groundwater seepage velocity and COI transport potential.

Prior to ash basin closure, the operating level of ponded water in the AAB was maintained at approximately 634 feet. Flow and transport modeling simulations indicate decanting will lower hydraulic heads within and around the ash basins, flow directions within the basins will be more prominently eastward, and flow velocities will be reduced.

Four ponded water points from the AAB and 42 monitoring well locations in the vicinity of the AAB were selected for monitoring water elevations using pressure transducers to record changing site conditions from ash basin decanting (**Figure 6-16**). Ponded water, ash pore water, and groundwater decanting network hydrographs, using water elevations recorded between March 2019 (May 2019 for ponded water) through

August 2019 (September for miscellaneous monitoring wells and ponded water locations) are depicted on **Figures 6-17a** through **6-17d**. Observations from hydrographs include:

- By mid-August 2019, no ponded water was present within primary pond 1. Primary pond 1 is primarily a stormwater retention pond.
- Primary ponds 2 and 3 appear to by hydrologically connected with each other and the main ash basin pond in the AAB.
- The ponded water in the southwestern finger of the AAB appears to be more influenced by precipitation than decanting. However, the levels of all surface waters associated with the AAB have decreased since the start of decanting efforts at Allen.
- By December 2019, water level in the ash basin pond has decreased by 14.1 feet since decanting started. Note the water elevations displayed on **Figure 6-17d** are not current to December 1, 2019.
- All groundwater monitoring locations show a response to ash basin decanting by reduced groundwater elevation levels (**Figures 6-17a** through **6-17d**, with the exception of AB-10. This is likely due to the close proximity of the AB-10 well cluster to the Catawba River (Lake Wylie).
- Groundwater monitoring wells south of the ash basin (*e.g.* CCR-20S/D, CCR-21S, and CCR-22S) and within the ash basin (*e.g.* AB-20S/D, AB-21S/SL/SS/BR, AB-22S/D/BR, and AB-26S/D) show the largest degree of response from decanting by greatest reduction in water (**Figures 6-17a** through **6-17d**).

Source Area Stabilization

(CAP Content Section, 6.A.a.viii.2)

In an August 22, 2016 correspondence, NCDEQ provided a notice of deficiencies related to the ash basin dams including the need for spillway repair, installation of a new principal spillway, vegetation/tree removal, and slope repair (**Appendix A**). In response, Duke Energy undertook activities in 2016 to correct the deficiencies. In letters provided in **Appendix A**, repairs and deficiencies were approved by NCDEQ.

Lined Holding Basin Construction

In the fourth quarter of 2018, Duke Energy installed extraction wells to dewater the area between the main and live coal piles for construction of the lined holding basin. Dewatering continued until construction was completed in the first quarter of 2019. Water level measurements were recorded during dewatering from several nearby wells. Measurements collected from nearby wells are included as **Figures 6-18a** and **6-18b**. The results indicate that monitoring wells in the vicinity of the dewatering system were affected by dewatering activities. The results of the dewatering activities were used to calibrate the flow and transport model based on observed extraction rates and cone of depression areas.

The holding basin has an area of approximately 3.5 acres and is 5 feet deep. The basin was constructed with approximately 8 feet thick concrete walls and lined with HDPE. The holding basin receives water from the coal yard and sump in the live coal pile and then is pumped to the lined retention basin for further treatment before discharge via NPDES Outfall 006.

Control and management of storm water runoff from the coal pile area was improved by construction of a lined holding basin between the main and live coal piles. Improved handling of the storm water in this area impedes migration of COIs potentially derived from contact with the coal stored in this area.

6.1.2 Extent of Constituent Migration beyond the Compliance Boundary

(CAP Content Section 6.A.b)

This section is an overview of COI occurrences beyond the point of compliance. The point of compliance at Allen is the ash basin compliance boundary (**Figure 1-2**). The compliance boundary for groundwater quality at the Site is defined in accordance with Title Subchapter 02L .0107(a) as being established at either 500 feet from the waste boundary or at the property boundary, whichever is closer to the waste. The coal piles do not have an associated waste boundary or compliance boundary.

Analytical sampling results associated with the source areas (ash basins and coal piles) for each media are included in the following tables and appendix tables:

- Soil: **Appendix C**, Table 4 and **Table 6-3** *(CAP Content Section 6.A.b.ii.1)*
- Groundwater: **Appendix C**, Table 1 and **Table 6-5** *(CAP Content Section 6.A.b.ii.2)*
- Seeps: **Appendix C**, Table 3 and **Table 6-8** *(CAP Content Section 6.A.b.ii.3)*

- Surface water: **Appendix C**, Table 2 and **Appendix J** *(CAP Content Section 6.A.b.ii.4)*
- Sediment: **Appendix C**, Table 5 *(CAP Content Section 6.A.b.ii.5)*

Soil Constituent Extent

(CAP Content Section 6.A.b.ii.1)
Data indicate unsaturated soil COI concentrations at or beyond the compliance boundary are generally consistent with background concentrations. In the few instances where unsaturated soil COI concentrations are greater than PSRG POG standards or Site-specific background values, either COI concentrations are generally within range of concentrations represented by larger background dataset that includes 16 other Duke Energy sites across the Piedmont or there are no mechanisms by which the COI could have been transported from the ash basin to the unsaturated soils. Adjacent to the coal pile, one sample at CP-2 from 2 to 3 feet below ground surface had an iron concentration that may indicate effects from the coal pile. However, iron is prevalent naturally in saprolitic soils, so the detected concentration at the location adjacent to the coal piles may be natural variations in concentrations within the subsurface (**Table 6-3, Figure 6-8**). Horizontal and vertical extent of COI concentrations in soil is discussed further in **Section 6.1.4**.

Groundwater Constituent Extent

(CAP Content Section 6.A.b.ii.2)
The ash basin compliance boundary extends 500 feet beyond the ash basin waste boundary, or to the property boundary, whichever is closer. Groundwater concentrations greater than 02L/IMAC/applicable background concentration values occur locally at or beyond the compliance boundary in two general areas:

1. North and northeast of the RAB and coal piles
2. East of the ash basin dams

The Catawba River (Lake Wylie) bounds the Site to the east. The Catawba River (Lake Wylie) is a groundwater discharge zone that limits the horizontal transport of constituents downgradient of the source areas. And due to the limited presence and mobility of most constituents in the groundwater system, COI concentrations in groundwater have not caused, and will not cause, current surface water quality standards to be exceeded (**Appendix J**).

The maximum extent of COI-affected groundwater migration for all flow zones is represented by boron and sulfate concentrations greater than the 02L standard. Boron has migrated from the ash basins to areas east of the basins at concentrations greater than the 02L standard, at or beyond the compliance boundary. The boron plume is bounded by the Catawba River (Lake Wylie), which is the approximately 100 to 200 feet beyond the RAB waste boundary, and approximately 100 to 200 feet beyond the AAB waste boundary. Boron has not migrated at or beyond the point of compliance in any other areas.

Sulfate has migrated from the ash basins and coal piles to areas north and northeast of these source areas at concentrations greater than the 02L standard, at or beyond the compliance boundary. Like boron, the sulfate plume is also bounded by the Catawba River (Lake Wylie) to the east of the ash basins and coal piles. To the north of the RAB and coal piles, sulfate concentrations are greater than applicable regulatory or background values in the shallow, deep, and bedrock flow zones. Bedrock wells were among the wells installed in the third quarter of 2019 downgradient of the coal pile area. However, at CP-2BR, only minor fractures were observed throughout the borehole to a depth of 275 feet below ground surface. Packer tests and slug tests were performed at several depth intervals during drilling. None of the fractures yielded sufficient water for monitoring. Therefore, the borehole was abandoned and COIs are considered delineated at the base of the transition (deep) zone in this area. Sulfate and TDS concentrations greater than 02L standards detected in the initial round of sampling in October 2019 from newly installed well clusters GWA-27, GWA-28S, and GWA-29 confirm the distribution of sulfate and TDS simulated in the groundwater flow and transport models (**Appendix G**). The model simulates that sulfate and TDS concentrations in groundwater greater than 02L standards downgradient of GWA-28 and GWA-29 wells are limited to areas beneath the power block units and adjacent switchyard and bound by the discharge canal and Catawba River (Lake Wylie).

Other constituents, including cobalt, iron, manganese, strontium, and TDS, have concentrations greater than their respective groundwater regulatory standards at or beyond the compliance boundary. Of these constituents, concentrations greater than regulatory standards are at locations where boron and/or sulfate concentrations are greater than 02L standards. Several COIs (cadmium beryllium, nickel, selenium and thallium) are only observed at concentrations greater than 02L/IMAC or background in the vicinity of the low pH area west of the main coal pile. Elsewhere, COIs (*i.e.*, chromium) at concentrations greater than applicable comparative values are isolated and do not exhibit a discernable plume with other occurrences of the same COIs at concentrations greater than applicable comparative values.

Section 6.1.3 includes a detailed matrix evaluation and rationale of groundwater constituents requiring corrective action, and **Section 6.1.4** provides isoconcentration maps and cross sections depicting groundwater flow and constituent distribution in groundwater at or beyond the compliance boundary *(CAP Content Section 6.A.b.i)*.

Seep Constituent Extent

(CAP Content Section 6.A.b.ii.3)
Seeps at Allen are subject to the monitoring and evaluation requirements contained in the SOC. The SOC states that the effects from non-constructed seeps should be monitored. Attachment A to the SOC identifies the following seeps:

- Non-constructed seeps to be monitored — S-2, S-5, S-6, S-7, and S-10
- Non-constructed seeps dispositioned — S-1 and S-9
- Constructed seeps to be monitored per terms of the NPDES Permit – S-3, S-4, S-8, and S-8B

The SOC defines dispositioned:

1. The seep is dry for at least three consecutive quarters;
2. The seep does not flow to waters of the State;
3. The coal ash basin no longer impacts the seep for all COIs over four consecutive sampling events;
4. An engineering solution has eliminated the seep.

Table 6-8 provides a summary of seep general location and approximate flow rate. Seeps at Allen are contained within well-defined channels or pipes. Therefore, potential COIs related seep flow are constrained in localized areas along the channel or at the discharge of pipes. Surface water sampling conducted downstream of seep channels, near the point where the channels confluence with the Catawba River, demonstrated that flow from seeps has not caused constituent concentrations greater than 02B standards in the river. Surface water samples that were collected near the confluence of the seeps with the Catawba River are shown on **Figure 1-2** and included SW-AB-3 (located upgradient of the seeps), SW-AB-4 (located between S-8 and S-8B), SW-AB-5 (located between S-7 and S-6), SW-AB-6 (located downgradient of S-5), SW-AB-7 (located upgradient of S-3 and S-4), and SW-D1 and SW-DG-1 (located downgradient of S-2, S-3, and S-4). Analytical results for these samples are included in **Appendix C**, Table 2 and evaluated in **Appendix J**.

Surface Water COI Extent

(CAP Content Section 6.A.b.ii.4)

Surface water samples have been collected from NCDEQ-approved locations from the Catawba River (Lake Wylie) to confirm groundwater downgradient of the source areas has not resulted in surface water concentrations greater than 02B water quality standards. Surface water samples were collected to evaluate acute and chronic water quality values. Surface water samples were also collected at background locations (upgradient of potential migration areas) within the Catawba River (Lake Wylie). Analytical results were evaluated with respect to 02B water quality standards and background data. All of this data confirms that there are no surface water quality exceedances related to the Allen ash basins or coal piles. Surface water conditions is further discussed in **Section 6.2.1** and the full report for Allen surface water current conditions can be found in **Appendix J**.

Additionally, environmental assessments of Lake Wylie have all demonstrated that Lake Wylie has been an environmentally healthy and functioning ecosystem, and ongoing sampling programs have been established to ensure the health of this system will continue. Furthermore, these data indicate that there have been no significant effects to the local aquatic systems related to coal ash constituents over the last 50 years. More information related environmental health assessments conducted for Lake Wylie, including sampling programs, water quality and fish community assessments, and fish tissue analysis, can be found in **Appendix E.**

Sediment Constituent Extent

(CAP Content Section 6.A.b.ii.5)

Each sediment sample location is co-located with surface water or tributary stream seep sample locations (**Figure 1-2**). Similar to saturated soils and groundwater, sediment is considered a component of the surface water system, and the potential leaching and sorption of constituents in the saturated zone is related to water quality. Because no regulatory standards are established for sediment inorganic constituents, both background sediment COI concentration ranges and co-located surface water sample results are considered in this sediment evaluation. **Table 4-5** presents constituent ranges of background sediment datasets. Analytical results for sediment samples are provided in **Appendix C**, Table 5.

Assessment of COIs in sediment from surface waters, including the Catawba River (Lake Wylie) and seeps, was conducted through a comparison evaluation between sediment sample COI analytical results, from one-time grab samples, and COI concentration ranges from background sediment datasets. Samples collected from the Catawba River (Lake Wylie) were compared with background dataset ranges from the Catawba River (Lake Wylie). No background sediment locations from tributary streams available, therefore maximum COI concentrations from the Catawba River (Lake Wylie) background sediment results are used to compare sediment sample results collected from tributary streams.

Eleven sediment samples have been collected from the Catawba River (Lake Wylie). Downstream sediment sample locations (**Figure 1-2**) include eight locations downstream of the source areas, along the bank of the Catawba River (Lake Wylie) (SW-AB-1, SW-AB-2, SW-AB-5, SW-AB-7, SW-CP-2, SW-DG-2, SW-IAB-1, and SW-IAB-4).

Of the eight sediment samples co-located with surface water sample locations in the Catawba River (Lake Wylie), six samples had at least one COI concentration greater than the maximum detected concentrations in background sediment. COI concentrations from the Catawba River (Lake Wylie) downstream sediment samples greater than background concentrations include boron, cobalt, iron, manganese, strontium, and sulfate. Surface water samples co-located with the sediment samples collected from the Catawba River (Lake Wylie) have COI concentrations less than 02B surface water standards and are generally within surface water background COI concentration ranges. A summary of the results is provided below:

- Sediment sample SW-CP-2, located east of the live coal pile, had cobalt, iron, manganese, and strontium concentrations greater than background. The cobalt, iron, manganese, and strontium concentrations in sediment are less than background values for soil. Therefore, it is likely that the COI concentrations observed in sediment at SW-CP-2 occur naturally. Furthermore, sediment sample SW-IAB-1, collected downstream of SW-

CP-2, had no COI concentrations greater than background indicating constituent concentrations at SW-CP-2 are localized.

- Sediment sample SW-AB-1, located east of primary pond 3, has COI concentrations greater than background concentrations of boron, cobalt, iron, manganese, strontium, and sulfate. Each of these concentrations are less than soil background values, except for iron, which is a common element in the Piedmont. This indicates these COI concentrations observed at SW-AB-1 are likely attributable to background. Sediment sample SW-IAB-4, collected upstream of SW-AB-1, has a strontium concentration slightly greater than Site background concentrations, but less than soil background values. This indicates that strontium concentrations at SW-IAB-4 are likely naturally occurring and further indicates that strontium concentrations at SW-AB-1 are also naturally occurring. Sediment sample SW-AB-2, collected downstream of SW-AB-1, has an iron concentration slightly greater than Site background concentrations, but less than background soil values. This indicates that iron concentrations at SW-AB-2 are likely naturally occurring and that iron concentrations greater than background values at SW-AB-1 are localized.
- Sediment sample SW-AB-7, located east of the AAB ponded water, has an iron concentration slightly greater than background concentrations, but less than background soil values. This indicates that iron concentrations at SW-AB-7 are likely naturally occurring. Furthermore, sediment sample SW-AB-5, collected upstream of SW-AB-7, and SW-DG-2, collected downstream of SW-AB-7, have no COI concentrations greater than background concentrations. This indicates the iron concentration observed at SW-AB-7 greater than background is localized.

As evaluated in the risk assessment (**Appendix E**), there is no evidence that sediments in the Catawba River adjacent to the Site pose an increased risk to on-Site or off-Site human receptors or ecological receptors. Additionally, Duke Energy has monitored Lake Wylie since 1959. Assessments such as water quality, chemistry, and general species composition have demonstrated that Lake Wylie is an environmentally healthy and functioning ecosystem. These assessments indicated that there have been no significant effects to Lake Wylie related to coal ash constituents over the last 50 years. Therefore, no corrective action for sediment in the Catawba River is planned at this time.

Sediment Collected from Seeps

Sediment samples were collected at seven locations within flow paths or channels at seep sample locations (**Figure 1-2**). Of the seven sediment samples (S-1 through S-7), four samples have at least one COI concentration greater than the maximum detected concentrations in background sediment. Constituents in seep sediment samples detected greater than background concentrations include boron, cobalt, manganese, and strontium. A summary of the results is provided below:

- Sediment sample S-1 had a concentration of manganese detected greater than background concentrations, but less than background soil values. As stated in the SOC, no CCR impacts were noted via sampling of surface water flow and Seep S-1 has been dispositioned per the SOC. Therefore, the observed manganese concentration is likely naturally occurring.

- Sediment sample S-2 had concentrations of boron, cobalt, manganese, and strontium detected greater than background sediment concentrations. Seep S-2 is regulated by the SOC and flow ceased in response to decanting. Therefore flow across the sediments at S-2 has been minimized to occasional storm water. Therefore, the S-2 is now soil. Boron, cobalt, manganese, and strontium concentrations at S-2 are less than background values for soil. This indicates these constituent concentrations are attributable to background. Furthermore, samples collected downstream of S-2 in the Catawba River do not indicate influence from the sediment or soil. Sediment sample SW-S-2, collected within the channelized seep downgradient from S-2, was part of the groundwater to surface water assessment. Sediment sample SW-S-2 has concentrations of cobalt, manganese, and strontium detected greater than sediment background concentrations, but less than soil background values. This indicates these constituent concentrations may be attributable to background. As previously mentioned, seep S-2 is regulated by the SOC. Flow has ceased at S-2 due to decanting. Sediments collected downstream within the Catawba River do not indicate influence from the sediments at SW-S-2.

- Sediment sample S-3 has a concentration of strontium detected greater than sediment background concentrations, but less than background soil values. This indicates strontium concentrations may be attributable to background. Seep S-3 is included in the NPDES Permit as Toe Drain Outfall 103 and is monitored under the NPDES permit.

- Sediment sample S-4 has concentrations of boron, cobalt, manganese, and strontium detected greater than sediment background concentrations, but less than soil background values. This indicates these constituent concentrations may be attributable to background. Seep S-4 is included in the NPDES Permit as Toe Drain Outfall 104 and is monitored under the NPDES permit.

- Sediment samples S-5, S-6, and S-7 have no COI concentrations detected greater than background concentrations. Seeps S-5, S-6, and S-7 are managed by the SOC.

After completion of decanting, seeps covered by the SOC, are to be characterized for determination of seep disposition. The SOC defines dispositioned: 1) the seep is dry for at least three consecutive quarters; 2) the seep does not flow to waters of the State; 3) the coal ash basin no longer impacts the seep for all COIs over four consecutive sampling events; 4) an engineering solution has eliminated the seep. After seep characterization, an amendment to the CAP, may be required to address non-dispositioned seeps. Additional discussion of potential correct action for seeps is included in **Section 6.8.1**.

6.1.2.1 Piper Diagrams

(CAP Content Section 6.A.b.iii)

Piper diagrams can be used to differentiate water sources in hydrogeology by assessing the relative abundance of major cations (*i.e.*, calcium, magnesium, potassium, and sodium) and major anions (*i.e.*, chloride, sulfate, bicarbonate, and carbonate) in water.

Groundwater Piper Diagrams

Piper diagrams of groundwater monitoring data from shallow, deep, and bedrock flow zones are included on **Figures 6-15a** and **6-15b.** Monitoring locations included on **Figures 6-15a** and **6-15b** include upgradient/background locations, locations within the waste boundary, and locations downgradient of the source areas. Data used for the piper diagrams on **Figure 6-15a** include groundwater data between January 2018 and April 2019 with a charge balance between -10 and 10%. Additional data collected as recent as October 2019 was included on the piper diagrams on

Figure 6-15b to include the recently installed low pH area and coal pile area assessment wells. Evaluation of the piper diagrams indicates the following:

- Background groundwater at Allen is generally low in chloride and sulfate and bicarbonate rich, and classified as a range from calcium-bicarbonate to calcium-sodium plus potassium-bicarbonate type water. Background groundwater has a lesser proportion of bicarbonate, calcium and sulfate proportions and a larger range of chloride proportions compared to ash pore water.
- Shallow groundwater tends have a broader range of calcium, chloride, bicarbonate, and sodium plus potassium compared to deep and bedrock groundwater.
- Groundwater samples from downgradient locations generally fall between calcium-bicarbonate type water and calcium-sulfate type water and have a broader range of bicarbonate proportion compared to background locations.
- Groundwater at downgradient locations that plot similarly to background are typically at locations where boron is detected at concentrations less than the 02L or background, such as the wells south of the AAB and in deep and bedrock flow zones on the western side of the basins.
- Groundwater downgradient of the basins where boron concentrations are greater than or, close to the 02L, plot on the piper diagrams similar to ash pore water and are more sulfate- and calcium-rich, and with a wider range of bicarbonate. This indicates influence from the ash basins by mixing of groundwater and ash pore water.
- Wells GWA-7D and GWA-6BR plot similar to typical ash pore water, however boron is not detected in these locations. This indicates groundwater may be influenced by another source, such as the coal pile. Piper diagrams could not be made for GWA-6S and GWA-6D due to charge balance differences beyond acceptable limits (10%).
- Groundwater samples from within and downgradient of the low pH area (**Figure 6-15b**) tend to group based on flow zone. Shallow flow zone samples generally plot in the 'affected' or 'potential mixing' zones. Deep flow zone samples plot relatively evenly throughout the

three zones, 'affected', 'potential mixing', and 'generally unaffected'. Bedrock flow zone samples plot in either 'generally unaffected' or 'potential mixing', with CP-6BR as the exception (plots in 'affected').

- Groundwater samples from the deep flow zone within the low pH area (**Figure 6-15b)** plot as generally unaffected, which agrees with the data (**Table 6-5**) and the CSM.
- As noted above, CP-6BR plots in the 'affected' area of the Piper diagram. Data indicate CP-6BR is unimpacted by the source areas, with strontium as the only exceedance of comparative criteria. Concentrations of strontium at CP-6BR are within the Site background range.

Seep and Surface Water Piper Diagrams

(CAP Content Section 6.A.b.iii)

Piper diagrams of seep and Catawba River (Lake Wylie) surface water monitoring data (**Figure 6-26**) are used to assess the relative abundance of major cations (*e.g.*, calcium, magnesium, potassium, and sodium) and major anions (*e.g.*, chloride, sulfate, bicarbonate, and carbonate) in surface water. Data used for the piper diagrams include most recent available seep and surface water data (**Appendix C**, Tables 2 and 3) with a charge balance between -10 and 10 percent. From ash pore water and groundwater piper diagrams (**Figures 6-15a** and **6-15b**), areas identified where ash pore water tends to plot is noted as "affected"; areas that show potential mixing with affected water is noted as "potential mixing", and areas that are similar to background (or native) water quality are noted as "generally unaffected". Based on sample location, the samples group predictably.

- Seeps and surface waters at the Site are predominantly characterized as calcium-sulfate waters with a few seep samples plotting between calcium-sulfate and calcium-bicarbonate.
- Free water within the AAB tends to plot with higher proportions of sulfate, chloride, calcium, and magnesium, just as ash pore water generally does.
- Seeps downgradient of the ash basins are primarily characterized by two water types, calcium-bicarbonate to calcium-sulfate, similar to ash pore water.

- A seep located southeast of the AAB (S-02) is magnesium-chloride type water. This indicates mixing of background water with ash basin-influenced water within the wet area downgradient of seepage from the AAB.
- A seep located south of the AAB (S-01) plots as calcium-bicarbonate, which suggests background groundwater influence. This seep has been dispositioned because water quality samples do not indicate influence from the ash basin.
- Samples from the Catawba River (Lake Wylie) plot between calcium-sodium plus potassium-bicarbonate and calcium-chloride waters. These results plot similar to surface water samples analyzed from Lake Norman in Iredell County, North Carolina upstream of Allen (USGS, 2008).

6.1.3 Constituents of Interest (COIs)

(CAP Content Section 6.A.c)

This CAP Update evaluates the extent of and remedies for COIs associated with the Allen ash basins and coal piles that are at or beyond the compliance boundary to the north, northeast, and east of the source areas detected at concentrations greater than regulatory criteria or background values, whichever is greater.

Site-specific COIs were developed by evaluating groundwater sampling results with respect at concentrations greater than regulatory criteria or background values, whichever is greater and additional regulatory input/requirements. The distribution of constituents in relation to the source areas, co-occurrence with CCR indicator constituents such as boron and sulfate, and migration directions based on groundwater flow direction are considered in determination of COIs.

The following list of COIs was developed as part of the CSA Update for Allen (SynTerra, 2018a):

- Antimony
- Arsenic
- Beryllium
- Boron
- Cadmium
- Molybdenum
- Nickel
- pH
- Selenium
- Strontium

- Chromium (Hexavalent)
- Chromium (Total)
- Cobalt
- Iron
- Manganese
- Sulfate
- Thallium
- TDS
- Vanadium

Subsequent sampling and analysis for USEPA CCR Rule compliance indicated lithium is an additional COI at Allen. Hexavalent chromium was included as a COI in the CSA Update at the request of NCDEQ (**Appendix A**).

Soil

(CAP Content Section 6.A.c.i.1)

Unsaturated soil at or near the compliance boundary is considered a potential secondary source to groundwater. Constituents, if present in unsaturated soil or partially saturated soil (vadose zone), have the potential to leach into the groundwater system if exposed to favorable geochemical conditions for chemical dissolution to occur. Constituents considered for unsaturated soil evaluation were the same constituents identified as COIs for the ash basins and coal piles, since soil impacts, if present, would be related to ash pore water interaction to the underlying soils within the basins, groundwater migration at or beyond the ash basins, and coal pile runoff.

Allen samples of background soil and rock media at Allen indicate that some naturally occurring constituents that are also typically related to CCR material and likely affect the chemistry of groundwater at the Site, are present at concentrations greater than the PSRGs POG values (**Table 4-2**). Constituents with background values greater than PSRGs POG values include total chromium, cobalt, iron, manganese, selenium, and thallium.

Data indicate unsaturated soil COI concentrations are generally consistent with background concentrations or are less than regulatory screening values (**Table 6-3**). In the few instances where unsaturated soil COI concentrations are greater than PSRG POG standards or background values, COI concentrations are within range of background dataset concentrations or there are no mechanisms by which the COI could have been transported from the ash basin to the unsaturated soils. Horizontal and vertical extent of COI concentrations in soil, and reasons why no necessary corrective action for soils is identified at the Site, is discussed further in **Section 6.1.4**.

Groundwater

(CAP Content Section 6.A.c.i.2)

A measure of central tendency analysis (means analysis) of groundwater constituent data (January 2018 to June 2019) was conducted and means were calculated to support the analysis of groundwater conditions and to provide a basis for defining the extent of the COI migration beyond the compliance boundary. The mean analysis method was selected to capture the central tendency (arithmetic mean, geometric mean, and median) of constituent concentrations, which may vary over orders of magnitude. A single sample result might not be an accurate representation of the concentrations observed over several months to years of groundwater monitoring. Evaluating constituent plume geometries with central tendency data minimizes the potential for incorporating occasions when COIs are reported at concentrations outside of the typical concentration range, and potentially greater, or substantially less than enforceable groundwater standards. Previous Site assessment mapping based on single COI concentrations for each well might have overrepresented or underrepresented areas affected by the ash basins by posting a single data set on maps and cross-sections that might have included isolated data anomalies.

NCDEQ (October 24, 2019, **Appendix A**) recommended the use of a lower confidence limit (LCL95) rather than the central tendency value. LCL95 concentrations were calculated for each COI. The LCL95 concentration for the sample with the highest COI LCL95 concentration is provided for comparison to the COI mean concentration in Table 1 of the technical memorandum titled *COI Management Plan Approach – Allen Creek Steam Station* (Arcadis, 2019b) included within **Appendix H**. The mean COI concentration is typically higher than the LCL95 concentration, and therefore, is more conservative for comparison to the COI criterion.

The mean of up to six quarters of valid data was calculated for each identified COI to analyze groundwater conditions and define the extent of COI migration beyond the compliance boundary. At a minimum, four quarters of valid data were used for calculating means, however, if fewer than four quarters of valid data were available, the most recent valid sample result was reported. For use in calculating means, non-detect values were assigned the laboratory reporting limit and estimated (J-flag) values were treated as the value reported. Procedures for excluding data from calculating means are based on USEPA's National Functional Guidelines (USEPA, 2017), published research about leaching of elements from coal combustion fly ash (Izquierdo and others, 2012), and professional judgement.

The following steps outline the approach followed in calculating central tendency values for constituent concentrations in groundwater:

1. If the maximum analytical value divided by the minimum value for each constituent was greater than or equal to 10 (*i.e.* the data set ranges over an order of magnitude), the geometric mean of the analytical values was used.
2. If the maximum analytical value divided by the minimum value for each constituent was less than 10 (*i.e.* the data set range is within an order of magnitude), the arithmetic mean was used.
3. The median of the data was used for records that contain zeros or negative values (*e.g.*, total radium). Negative values were set to zero prior to calculating the median concentration.
4. If the dataset mode (most common) was equal to the RL, and the geometric mean or mean value was less than or equal to the dataset's mode, the value was reported as "<RL" (*e.g*. the reporting limit for boron is 50 μg/L; for wells with geometric mean or mean analysis concentrations less than 50 μg/L the mean analysis result would be shown as "<50").

Sample results were excluded from calculations for the following conditions:

- Duplicate sampling events for a given location and date. The parent (CAMA) sample was retained
- Turbidity was greater than 10 Nephelometric Turbidity Units (NTUs)
- pH was greater than 10 S.U. Data with pH greater than 10 S.U. might suggest well grout impacts
- Data flagged as unusable (R0 qualified)
- Data reported as non-detect with a reporting limit greater than the normal laboratory reporting limit

Table 6-5 presents the mean analysis results of the COI data using groundwater monitoring sampling results from January 2018 to June 2019. Where means could not be calculated, the most recent valid sample was evaluated to determine whether the sample result is an appropriate representation of the historical dataset. Data from **Table 6-5** are used in evaluating COI plume geometry in the vicinity of the ash basins and coal pile area.

Constituent Management Approach

As discussed in the beginning of **Section 6**, a 'COI management process' was developed by Duke Energy at the request of NCDEQ to gain understanding of the COI behavior and distribution in groundwater distribution and to select the appropriate remedial approach. Details of the COI management approach are provided in **Appendix H**. In general, the COI management process consists of three steps:

1. Performing a detailed review of the applicable regulatory requirements of NCAC, Title 15A, Subchapter 02L
2. Understand the potential mobility of site-related COIs in groundwater based on Site hydrogeology and geochemical conditions
3. Determine the COI distribution related to the ash basins and coal piles under current or predicted future conditions.

The management process uses a matrix evaluation [**Table 6-6** (*CAP Content Section 6.A.c.i.2*)]

This COI management process is supported by multiple lines of evidence including empirical data collected at the Site, geochemical modeling, and groundwater flow and transport modeling. This approach has been used to understand and predict COI behavior in the subsurface related to the ash basins and coal pile area or COIs that are naturally occurring. COIs that have migrated beyond the compliance boundary at concentrations greater than 02L, IMAC and background that are related to an ash basin would be subject to corrective action. COIs that are naturally occurring at concentrations greater than 02L, IMAC and background do not require corrective action.

Using the constituent management process, 12 of the 19 inorganic groundwater constituents (not including pH) identified in the CSA (CSA Update, 2018a), exhibit mean concentrations that are currently less than background values, the 02L standard, or IMAC at or beyond the compliance boundary, or have few concentrations greater than comparison criteria but with no discernable COI plume characteristics (*e.g.* antimony in the deep flow zone). These 12 constituents include:

- Antimony
- Chromium
- Arsenic
- Beryllium
- Cadmium
- Chromium
- Chromium VI
- Lithium
- Molybdenum
- Nickel
- Selenium
- Thallium
- Vanadium

These constituents are not expected to migrate distances that would present risk to potential receptors or beyond the compliance boundary, and are predicted, based on geochemical modeling, to remain at stable concentrations, typically less than background values, the 02L standard, or IMAC. Arsenic, beryllium, cadmium, lithium, nickel, selenium, thallium and vanadium are not detected at locations beyond the compliance boundary. Of these, arsenic, beryllium, cadmium, calcium, nickel, selenium, and thallium are only detected in the low pH area.

As shown in **Table 6-6**, concentrations of antimony, hexavalent chromium, total chromium, and molybdenum occur at or beyond the compliance boundary greater than comparative criteria in one or more groundwater monitoring wells. Antimony, hexavalent chromium, total chromium, and molybdenum are not considered corrective action COIs due to the following rationale:

- Antimony at concentrations greater than comparative criteria at or beyond the compliance boundary is present in only one groundwater monitoring well, CP-1D. Therefore there is no discernable plume of antimony. Furthermore, antimony concentrations at CP-1D do not exceed the Site-specific background value ranges at Allen, indicating the antimony concentration is attributable to background and not the source areas.
- Hexavalent chromium is not detected in ash pore water at concentrations greater than comparative criteria at Allen, therefore, the ash basins are not a source of groundwater concentrations detected in areas in the vicinity of the Site. None of the wells surrounding the coal pile have concentrations greater than applicable criteria for hexavalent chromium, indicating the coal pile is not a source of hexavalent chromium in groundwater. Additionally, of the 13 monitoring wells (AB-1R, AB-2D, AB-6A/R, AB-10D, AB-11D, GWA-1D, GWA-2D, GWA-7S/D, GWA-8S, and CCR-

26D/BR) where hexavalent chromium was detected at concentrations greater than comparative criteria, the concentrations were less than the range of hexavalent chromium concentrations within the background dataset that includes 16 other Duke Energy sites across the Piedmont province. Further, numerous water supply wells upgradient and beyond a hydrologic divide exceed comparative criteria for hexavalent chromium. Therefore, the detected concentrations in these 13 wells are likely attributable to naturally occurring concentrations and natural variation within the region and not the ash basins and coal piles.

- Total chromium is not found in ash pore water above comparative criteria and therefore, is considered not attributable to the ash basins at Allen. None of the wells surrounding the coal pile have concentrations greater than applicable criteria for total chromium, indicating the coal pile is not a source of total chromium in groundwater. Total chromium has been detected in only one monitoring well (AB-6A) at or beyond the compliance boundary at concentrations greater than the comparative criteria for total chromium. However, the concentrations are less than the flow zone specific background value range at Allen, therefore there is no discernable plume attributable to the ash basin or coal piles.
- Molybdenum at concentrations greater than comparative criteria at or beyond the compliance boundary is present in only two groundwater monitoring wells (CCR-11S and GWA-4BRL). Although the these two well clusters are adjacent to one another, the wells with detections greater than comparative values are in separate flow zones indicating there is no discernable plume of molybdenum attributable to the adjacent ash basins. Furthermore, none of the wells surrounding the coal pile have concentrations greater than applicable criteria for molybdenum, indicating the coal pile is not a source of molybdenum in groundwater. While greater than the comparative criteria, molybdenum concentrations at CCR-11S and GWA-4BRL are less than the Site specific background value ranges at Allen. Therefore, the detected concentrations of molybdenum in these two wells are likely attributable to naturally occurring concentrations and natural variation within the region and not the ash basins and coal piles.

Radionuclides radium and uranium have been monitored periodically since 2016. Uranium has not been detected in any wells at a concentration greater than the EPA MCL of 0.03 micrograms per milliliter (μg/ml). Total radium has not been detected in recently any current wells at a concentration greater than the EPA MCL of 5 picocuries per liter (pCi/L). Historical sample results from wells CCR-3D, CCR-3DA, and CCR-11D had total radium concentrations greater than 5 pCi/L. Of these wells, CCR-3D and CCR-11D were replaced because elevated pH values likely due to grout impacts from well installation, and the analytical results were inconsistent, indicating those results are not reliable. The remaining location, CCR-3DA, which replaced CCR-3D, had a single detection of total radium greater than 5 pCi/L in April 2017, but concentrations have since been less than 5 pCi/L after seven additional monitoring events. Therefore, radium and uranium, if present in groundwater at Allen, are at concentrations less than applicable regulatory criteria and not considered COIs.

The remaining seven COIs exhibit mean concentrations greater than background values, 02L standards, or IMACs with plume characteristics downgradient of the ash basins and coal pile area at or beyond the compliance boundary. These constituents are as follows:

- Boron
- Cobalt
- Iron
- Manganese
- Strontium
- Sulfate
- TDS

As discussed in the CSA Update (SynTerra, 2018a), and the 2018 CAMA Annual Interim Monitoring Report (SynTerra, 2019c), not all constituents with results greater than background values can be attributed to the ash basins or coal piles. Naturally occurring groundwater contains varying concentrations of inorganic constituents. Sporadic and low-concentration occurrences of constituents in groundwater data do not necessarily demonstrate horizontal or vertical distribution of COI-affected groundwater migration from the ash basins or coal pile area.

6.1.4 Horizontal and Vertical Extent of COIs

(CAP Content Section 6.A.d)

The COIs at Allen have been sufficiently delineated horizontally and vertically in groundwater based on sampling and analysis data collected from 234 monitoring wells present at the site and flow and transport modeling. The majority of COIs are either present below their applicable standards, do not exhibit discernable plumes, or have migrated a limited distance from the ash basins and coal piles in groundwater. In fact, the presence of COIs downgradient of the ash basins waste boundary is limited to between approximately 50 and 1,600 feet and approximately 500 feet from the coal piles. Furthermore, an evaluation of site data indicates that COI presence in groundwater decreases with depth. Supporting information for these findings are presented in the COI management evaluation presented in **Section 6.1.3** and in **Appendix H**.

Boron, a conservative (non-reactive) constituent, is the main COI that is present in Site groundwater in a discernable plume related to the ash basins, although boron concentrations decline below its 02L standard within approximately 500 feet beyond the ash basins waste boundary. Boron typically has greater concentrations in CCR than in native soil and is relatively soluble and mobile in groundwater (Chu, 2017). Sulfate, also a conservative constituent that is relatively soluble in groundwater, is the main COI that is present in Site groundwater in a discernable plume related primarily to the coal piles, although sulfate concentrations are modeled to decline below its 2L standard within approximately 750 feet beyond the coal piles. Non-conservative and variable constituents have smaller, and generally isolated, plume geometries relative to boron and sulfate because of their high K_d values and reactivity, which reduce their mobility. Therefore, the maximum extent of the 02L boron plume (700 μg/L) and sulfate plume [250 milligrams per liter (mg/L)] was used to determine the maximum extent of COI-affected groundwater migration. Additional constituent concentrations identified as being greater than their respective groundwater regulatory standards or background values, and are associated with COI-affected groundwater migration from the ash basins and coal pile area, are confined within the extent of the 02L boron and sulfate plume at the Site. Therefore, the boron (700 μg/L) and sulfate (250 mg/L) plumes were used to define the maximum extent of COI-affected groundwater migration.

Since naturally occurring COIs might be present at concentrations greater than Site-specific background values, isoconcentration maps of primary CCR indicator COIs (*e.g.*, boron, sulfate, and TDS) are most representative of the groundwater COI plume extent in three-dimensional space. The horizontal extent of COI-affected groundwater migration in each flow layer is depicted by the boron (**Figures 6-19a** through **6-19c**), sulfate (**Figures 6-20a** through **6-20c**), and TDS (**Figures 6-21a** through **6-21c**) isoconcentration maps. The background and 02L boron, sulfate, and TDS plumes generally represent the maximum extent of COI-affected groundwater migration in each flow layer.

Isoconcentration maps and cross-sections use groundwater analytical data to spatially and visually define areas where groundwater COI concentrations are greater than the respective constituent background values and/or 02L/IMAC. In areas where data is not available, flow and transport model results for boron, sulfate, and TDS were interpreted and included within the isoconcentration maps. The model predictions are conservative; the model over-predicts the actual groundwater concentrations in some isolated areas.

Mean data of groundwater COI monitoring sampling results from January 2018 to June 2019 provide an understanding of groundwater flow dynamics and direction to define the horizontal and vertical extent of the COI plume. Horizontal extent of the COI plume is depicted on isoconcentration maps for boron (**Figures 6-19a** through **6-19c**), sulfate (**Figures 6-20a** through **6-20c**), TDS (**Figures 6-21a** through **6-21c**), strontium (**Figures 6-22a** through **6-22c**), cobalt (**Figures 6-23a** through **6-23c**), iron (**Figures 6-24a** and **6-24b**), and manganese (**Figures 6-25a** through **6-25c**). COI concentrations for COIs representative of each geochemical grouping (conservative, non-conservative, and variable) discussed in **Section 6.1.5** are shown on five cross-sectional depictions of the Site. Cross-section A-A′ (**Figures 6-9a** through **6-9c**) is oriented north to south and displays the areas downgradient of the coal pile area and ash basins. Cross-section B-B′ (**Figures 6-10a** through **6-10c**) is oriented west to east and displays the RAB footprint, coal pile area, topography, and depth of saturated ash in the RAB. Cross-section C-C′ (**Figures 6-11a** through **6-11c**) is oriented west to east and displays the RAB footprint, topography, and depth of saturated ash in the RAB. Cross-section D-D′ (**Figures 6-12a** through **6-12c)** is oriented west to east and displays the northern AAB footprint, topography, free water in the primary ponds, and depth of saturated ash in the basin. Cross-section E-E′ (**Figures 6-13a** through **6-13c**) is oriented west to east and displays the southern portion of the AAB footprint, topography, depth of saturated ash in the basin, and free water near the dam.

Beyond the compliance boundary, the maximum extent of COI-groundwater affected by the ash basins and coal pile area occurs north, northeast, and east of the ash basins and coal piles.

6.1.4.1 COIs in Unsaturated Soil

(CAP Content Section 6.A.d.i)

Unsaturated soil at or beyond the compliance boundary has potential to be a secondary source to groundwater. Constituents present in unsaturated soil or partially saturated soil (vadose zone) have the potential to leach into the groundwater system if exposed to favorable geochemical conditions for chemical dissolution to occur. Therefore, constituents considered for unsaturated soil evaluation as related to the ash basins and coal piles were the same constituents identified as COIs in groundwater related to the ash basins and coal piles.

Unsaturated soil samples at or beyond the compliance boundary were collected from well installation activities and an additional soil sampling event in April 2018. The sampling event in April 2018 was conducted to further delineate unsaturated soils based on CSA Update comments made by NCDEQ (**Appendix A**). Unsaturated soils samples at or beyond the compliance boundary include samples collected from AB-9, AB-10, AB-11, CCR-23, CCR-26, CP-1, CP-2, CP-3, CP-4, GWA-1, GWA-2, GWA-3, GWA-5, GWA-6, GWA-9, GWA-9, GWA-15, GWA-28, and GWA-29 (**Figure 6-8**). An evaluation of the potential nature and extent of COIs in unsaturated soil at or beyond the waste boundary was conducted by comparing unsaturated soil concentrations with PSRG POG or background values, whichever is greater [(**Table 6-3**) (*CAP Content Section 6.A.d.i*)]. PSRG POG standards were calculated for sulfate (1,438 mg/kg) (**Table 6-3**).

Data indicate unsaturated soil COI concentrations are generally consistent with background concentrations or are less than regulatory screening values. In the few instances where unsaturated soil COI concentrations are greater than PSRG POG or background values, COI concentrations are generally within the range of the background dataset compiled from Piedmont sites or there are no mechanisms by which the COI could have been transported from the ash basins to the unsaturated soils, indicating the observed concentrations occur naturally.

At two locations and at isolated depth intervals at GWA-27 and CP-2, iron (and manganese at CP-2) concentrations in soil are greater than PSRG POG, Site-specific background values and the larger range of background concentrations from the dataset that includes other sites within the Piedmont. However, the iron and manganese concentrations in these isolated areas may further indicate natural variability in concentrations for these COIs. The concentrations isolated to the specific depth intervals at these locations do not reveal concentration trends indicating clear affects from the source areas, with the potential exception of iron detected at CP-2 from 2 to 3 feet below ground surface (bgs).

At GWA-27, iron concentrations detected slightly greater than the Piedmont background range were detected in samples from 14-15 feet bgs and 19-20 feet bgs. However, concentrations in shallower soil from 10-11 feet bgs are less than PSRG POG or background values. This indicates there is not a source of constituents from a shallow source near the surface, which could be indicative of Station operations or waste management. Furthermore, iron concentrations in groundwater at this location are less than regulatory criteria. This indicates that relatively little iron is being transported with groundwater that has passed beneath the RAB and that iron in groundwater is not, and has not been, the source of iron in soil at the depth intervals of 14-15 feet and 19-20 feet bgs, even if groundwater levels in this area were to have fluctuated as high as 14 feet historically. Therefore, it is likely that the iron concentrations detected at 14-15 feet bgs and 19-20 feet bgs at GWA-27 are naturally occurring.

At CP-2, iron concentrations detected at a depth interval of 2-3 feet bgs may be a result of runoff from the coal pile or other historical operations. However, iron is prevalent naturally in saprolitic soils, so the detected concentration may be a natural variation in concentration within the subsurface. Furthermore, the iron at concentrations greater than Piedmont background is isolated to this shallow depth interval and is, therefore, not considered a significant source of COIs in groundwater. Manganese detected at a concentration greater than the Piedmont background at CP-2 is isolated to a depth interval from 5 to 6 feet bgs. Manganese, like iron, is prevalent naturally in saprolitic soils, so the detected concentration may be a natural variation in concentration within the subsurface. Similar to iron concentrations at GWA-27, the isolated depth interval of manganese concentrations at CP-2 indicates there is not a source of constituents from a shallow source near the surface, which could be indicative of Station operations or waste or coal management. Manganese concentrations in unsaturated soil at depths below 6 feet are less than background concentrations. This indicates groundwater transport of manganese from depths below to the 5- to 6-foot interval is not the mechanism for the presence of manganese at CP-2, even if historical water levels were higher than they are currently. Because there is no mechanism for transport of manganese to the 5- to 6-foot depth interval at CP-2 from potential source areas, the manganese at this location and depth interval is likely naturally occurring.

Active remediation is planned along with source control measures and decommissioning in the areas of both GWA-27 and CP-2. The contingency plan generally describes an adaptive approach to address unsaturated soil in the future, if needed, following decommissioning and closure that could address iron concentrations at CP-2, if necessary. Therefore, no corrective action for soils is planned at this time and this CAP Update focuses on remediation of COIs in groundwater derived from the ash basins and the coal piles.

6.1.4.2 Horizontal and Vertical Extent of Groundwater in Need of Restoration

(CAP Content Section 6.A.d.ii)

This section discusses the horizontal and vertical extent of groundwater in need of restoration in areas north, northeast, and east of the source areas. Groundwater is not in need of restoration adjacent to the ash basins to the northwest, west, and south due to the lack of COI concentrations greater than applicable standards in these areas.

Eastern Extent of COI-Affected Groundwater

East of the dam along the Catawba River (Lake Wylie), downgradient of the ash basins, the COI plume at or near the compliance boundary is defined by boron at concentrations greater than 02L (**Figures 6-19a** through **6-19c**). The extent of affected groundwater transport related to hydraulic conditions is supported by the following observations (**Figures 6-9a** through **6-13c**, **Figures 6-19a** through **6-25c**):

- Mean analysis of boron from groundwater monitoring wells in the western portion of the ash basins indicates concentrations are generally less than background (non-detect), suggesting the influx of background groundwater from upgradient. This supports the flow-through setting of the CSM.
- Mean analysis of boron from groundwater monitoring wells along a flow transect within the AAB at AB-25S (ash pore water), AB-25SL (ash pore water), and AB-25SS (shallow flow zone) indicate concentrations are greater than 02L in all three wells. These wells are located on a basin divider dike between primary pond 2 and primary

pond 3. As discussed in the CSM, downward migration of COIs is observed at the ash basin dams and at these divider dikes.

- Mean analysis of boron from groundwater monitoring wells AB-22S and AB-32S indicates concentrations are less than background (<50 μg/L). Groundwater monitoring wells AB-22S and AB-32S are located in the dam east of the basins, centrally located within the groundwater plume. These wells are located in areas with downward (positive) vertical gradients due to the dams effect on groundwater. Due to the vertical gradients, shallow wells in these areas are generally unaffected by COIs as flow is downward below the dams. The deep and upper bedrock flow zones in these areas generally indicate boron values greater than the 02L standard. This observation is consistent with the CSM. However, boron concentrations in deep/lower bedrock wells are less than 02L, indicating limited downward migration of COIs.
- Boron concentrations are greater than 02L east of the dam along the Catawba River (Lake Wylie) in some locations. Installation of monitoring wells farther downgradient is not possible due the proximity of the river. The flow and transport model indicates boron concentrations at these locations extend beneath the river approximately 200 feet from the shoreline.
- Deep and bedrock flow zones have similar plume geometries east of the ash basins. Generally, COI concentrations decrease with depth, depicting the upward gradient downstream of the dams as groundwater discharges to the Catawba River, as detailed in **Section 5.0**.
- Mean analysis of boron concentrations north of the RAB beyond the compliance boundary are delineated by CP-5S for the shallow zone, CP-04D for the deep zone, and CP-6BR for the bedrock zone.
- Mean analysis of boron from groundwater monitoring wells GWA-02S/D indicate concentrations are less than background values. These wells delineate the boron plume horizontally and vertically to the south.
- The deep/lower bedrock wells GWA-3BRL, GWA-4BRL, GWA-5BRL, GWA-5BRL and AB-10BRL have delineated the boron plume downgradient of the ash basins.

- Surface water sampling from the Catawba River (Lake Wylie) adjacent to the Site confirms that there are no surface water quality exceedances related to the Allen ash basins or coal piles.

Northern and Northeastern Extent of COI-Affected Groundwater

North, northeast, and east of the RAB and coal pile area, the COI plume at or beyond the compliance boundary is defined by sulfate and TDS at concentrations greater than 02L. This area encompasses northern portions of the RAB (including the low pH area) and the coal pile area. Boron is also present at concentrations greater than the 02L beyond the compliance boundary north of the RAB, but to lesser extents than sulfate and TDS. The extent of affected groundwater transport related to hydraulic conditions is supported by the following observations and shown on **Figures 6-20a** through **6-21c**:

- The sulfate and TDS plume is delineated horizontally to the east as it is bound by the Catawba River (Lake Wylie).
- The sulfate and TDS plume is delineated horizontally and vertically to the south by wells located at CCR-7S/D and CP-6S/D/BR. Notably, the plume associated with sulfate concentrations greater than 02L comingles minimally with the plume associated with boron to the south.
- Sulfate and TDS detected at concentrations greater than 02L standards in the shallow, deep, and bedrock flow zones north of the RAB and coal piles confirm the distribution of sulfate and TDS simulated in the groundwater flow and transport models (**Appendix G**). The model indicates these constituents at concentrations greater than 02L are limited to the north to areas beneath the power block units and adjacent switchyard and bound by the discharge canal to the west and Catawba River (Lake Wylie) to the east.
- Flow and transport model simulations indicate the sulfate and TDS transport north of the RAB and coal piles is limited due to advective flow from upgradient areas north of the power block where topography is higher and groundwater flow is east southeast toward the power block and Catawba River (Lake Wylie).
- Shallow, deep and bedrock flow zones have similar sulfate and TDS plume geometries north and northeast of the RAB and coal piles.

This indicates a well-connected, unconfined flow system between the flow zones. However, at CP-2BR, no significant fractures in bedrock were encountered which indicates limited to no potential for COIs to be transported into bedrock in this area. The minor fractures that were encountered yielded insufficient water for monitoring. Therefore, COIs are considered delineated at the base of the transition (deep) zone in the area surrounding the CP-2 well cluster. Additionally, sulfate and TDS are not detected at concentrations greater than 02L values in bedrock groundwater immediately north and northeast of the RAB at GWA-6BRA or GWA-6BRL. This indicates limited interconnection of the shallow and deep flow zones with bedrock groundwater in this area but that downward transport of COIs occurs farther downgradient from the ash basins. This also indicates sulfate and TDS concentrations north and northeast of the RAB and coal pile are derived, in part, from the coal piles.

- Based on available data, the plume characterized by sulfate, TDS and boron is stable and bound within the Site.
- Other COIs detected at concentrations greater than applicable regulatory criteria in this area are within the footprint of sulfate and TDS plumes, although cobalt concentrations in the shallow and deep flow zones extend slightly more westerly than sulfate, but remain within the bounds of the Site.
- Surface water sampling from the Catawba River (Lake Wylie) adjacent to the Site confirms that there are no surface water quality exceedances related to the Allen ash basins or coal piles.

6.1.5 COI Distribution in Groundwater

(CAP Content Section 6.A.e)

As part of the COI management process and geochemical modeling (**Appendix H**) constituents with concentrations greater than the 02L standard, IMAC, or background values beyond the compliance boundary were grouped by geochemical behavior and mobility. A comprehensive evaluation (*i.e.* mean analysis and groupings) of available data was used to demonstrate constituent distribution in groundwater to evaluate the spatial occurrence with a discernable plume in the direction of groundwater flow downgradient of the ash basins and coal pile area. The groupings of constituents that were mapped and are considered for corrective action are as follows:

- **Conservative, non-reactive constituents:** boron, sulfate, and TDS. Geochemical model simulations support that these constituents would transport conservatively (K_d values <1 L/kg) as soluble species under most conditions, and that the mobility of these COIs will not change significantly due to current geochemical conditions or potential geochemical changes related to remedial actions.
- **Non-conservative, reactive constituent:** strontium. Geochemical model simulations support that this constituent is subject to significant attenuation in most cases, especially in the shallow flow zone and has high K_d values indicating the mobility of this COI is unlikely to be geochemically affected by current geochemical conditions or potential geochemical changes related to remedial actions. Strontium reactivity is less in the deep and bedrock flow zones and can be more mobile under lower pH conditions, due to both the lower sorption affinity of strontium at lower pH values as well as the increased concentration of other divalent ions (e.g., Ca+2, Mg+2, Co+2, Mn+2) that may compete with strontium for ion exchange sites.
- **Variably reactive constituents:** cobalt, iron, and manganese. Geochemical model simulations, and resulting K_d values, support these constituents may be non-reactive or reactive in relation to geochemical changes and are dependent on the pH and Eh of the system. The sensitivity of these COI to the groundwater pH and Eh indicates that these constituents could respond to natural changes under current conditions, such as water level fluctuations imposed by seasonality, and decanting or source control activities that have the potential to change the groundwater pH or Eh.

COIs identified in the CSA that are not mapped in this CAP Update are not only limited within the compliance boundary, but are further limited to isolated areas within the compliance boundary. In fact, several COIs (cadmium beryllium, nickel, selenium and thallium) are only observed at concentrations greater than 02L/IMAC or background in the vicinity of the low pH area west of the main coal pile.

6.1.5.1 Conservative Constituents

(CAP Content Section 6.A.e.i)

Boron, sulfate, and TDS mean isoconcentration maps, cross sections and groundwater flow and transport modeling support the following observations regarding the extent of COI-affected groundwater represented by these conservative (non-reactive) constituents (**Figures 6-9a, 6-10a, 6-11a, 6-12a, 6-13a,** and **6-19a** through **6-21c**; **Appendix G)**:

- Shallow, deep, and to a lesser extent bedrock flow zone groundwater COI plumes east and north of the ash basins and coal pile area extend to or beyond the compliance boundary, and to the Catawba River (Lake Wylie). However, there are no COI concentrations in surface water within the Catawba River (Lake Wylie) greater than applicable 02B standards. Furthermore, model simulations indicate boron concentration decline to less than the 02L within approximately 600 feet of the ash basin waste boundary and sulfate and TDS concentrations decline to less than applicable groundwater standards within approximately 1,900 feet of the ash basins waste boundary and 750 feet of the coal piles.
- Shallow and deep flow zone groundwater COI plumes have relatively similar COI plume geometries. This supports a connected, unconfined flow system between the shallow and deep flow zones.
- Bedrock groundwater with concentrations greater than applicable regulatory criteria is limited to the upper fracture zones and to areas adjacent to the Catawba River (Lake Wylie) near and beneath the ash basin dams, within, at, and/or beyond the compliance boundary. Bedrock groundwater is less connected to the upper flow zones, as indicated by unique COI plume geometry compared with COI plume geometry of the shallow and deep flow zones.
- The maximum extent of COI-affected groundwater migration for all flow zones is represented by boron, sulfate, and TDS and the distribution of other constituents are limited to smaller areas within the boron, sulfate, and TDS plumes.

Plume Behavior and Stability

(CAP Content Section 6.A.e.i.1)

Mann-Kendall trend analysis was performed using conservative constituent (boron, sulfate, and TDS) datasets for ash pore water and groundwater wells within the waste boundary, between the waste boundary and compliance boundary, and downgradient the source area, at or beyond the compliance boundary (**Table 6-7**). Trend analysis and results were prepared by Arcadis U.S. Inc. and are included as Attachment A in **Appendix I**.

The analysis was performed using analytical results for samples collected from 2004 through 2019, for COIs identified in the 2018 CSA Update (**Table 6-7**). Trend analysis results are presented where at least four samples were available and frequency of detection was greater than 50%. Statistically significant trends are reported at the 95% confidence level. The analysis of constituent concentrations through time produced six possible results:

1. Statistically significant, decreasing concentration trend (D)
2. Statistically significant, increasing concentration trend (I)
3. Greater than 50% of concentrations were non-detect (ND).
4. Insufficient number of samples to evaluate trend (n < 4) (NE)
5. No significant trend, and variability is high (NT)
6. Stable. No significant trend, and variability is low (S)

A total of 2,540 data sets were evaluated for trends. Excluding the NE trends described above, 90% of the remaining data sets had statistically significant decreasing trends, stable trends, no trends, or greater than 50% non-detect concentrations. Only 10% of the trends were statistically increasing. Excluding both NE and ND trends described above, 86% of the remaining data sets had statistically significant decreasing trends, stable trends, or no trends. (**Appendix I**).

Ash pore water and groundwater wells within the waste boundary generally have no trends, stable trends, or decreasing trends, suggesting limited changing conditions and the plume is stable. Mann-Kendall results for ash pore water and groundwater within the waste boundary indicate the following:

- Approximately 80% of ash pore water trend results indicate stable trends, no trends, non-detect, or decreasing trends for conservative constituents (boron, sulfate, TDS) (**Table 6-7**).
- Approximately 65% of groundwater trend results indicate stable trends, no trends, non-detect, or decreasing trends for conservative constituents (**Table 6-7**).
- In the shallow flow zone, increasing trends for conservative constituents are limited to AB-25SS, which is located on an earthen

dike (**Table 6-7**). **Section 5.0** details the exceptions to the CSM regarding earthen dams/dikes.

- Similar to the shallow flow zone, increasing trends for conservative constituents in the deep and bedrock flow zones is generally limited to locations within earthen dams/dikes (**Table 6-7**).
- The data indicate overall stability and improvement in groundwater COI concentrations within the ash basins.

Trend analyses of groundwater monitoring wells north, east, and south of the source areas near or beyond the compliance boundary indicate the following:

- Approximately 65% of trends results for groundwater wells at or beyond the compliance boundary indicate stable trends, no trends, non-detect, or decreasing trends for conservative constituents (**Table 6-7**).
- Only 17% of trend results for groundwater wells at or beyond the compliance boundary have increasing trends for conservative constituents (**Table 6-7**).

Wells with increasing COI concentration trends are generally located east of the source areas, along the Catawba River (Lake Wylie). The areas with increasing COI concentration trends are generally located within the areas planned for groundwater remedial actions (**Section 6.8**)

6.1.5.2 Non-Conservative Constituents

(CAP Content Section 6.A.e.ii)

Strontium isoconcentration maps, cross sections and the geochemical model support the following observations regarding the extent of COI-affected groundwater represented by this non-conservative (reactive) constituent, for which there is no 02L standard or IMAC value (**Figures 6-9b, 6-10b, 6-11b, 6-12b, 6-13b,** and **6-22a** through **6-22c**; **Appendix H**):

- Strontium within all flow zones exhibits a plume-like distribution of concentrations greater than background similar to the vertical and horizontal extent of conservative constituents at the Site. However, there are no COI concentrations in surface water within the Catawba River (Lake Wylie) greater than applicable 02B standards.

- The extent of strontium at concentrations greater than background north of the RAB and coal pile is likely localized to areas beneath the power block and the switchyard and bound by the discharge canal to the west and Catawba River (Lake Wylie) to the east. The limits of strontium extents in this area are likely due to the same factors limiting the extent of sulfate and TDS concentrations which is advective flow from upgradient areas north of the power block where topography is higher and groundwater flow is east southeast toward the power block and Catawba River (Lake Wylie).
- Strontium is unlike other COIs in that the broadest distribution across the monitoring well network is within the bedrock flow zone. Strontium concentrations are less than background in shallow wells in the vicinity of the AAB, but are greater than background in the deep and bedrock flow zones. Strontium concentrations are also less than background in the shallow zone in the western portion of the RAB but concentrations are greater than background in the deep and bedrock flow zones in this area. Furthermore, strontium has a more limited distribution of concentrations greater than background northeast of the RAB and coal piles compared to the deep and bedrock flow zones in this area. This indicates the distribution of strontium at concentrations greater than background in each flow zone is not likely derived, at least entirely, from the ash basins and/or coal piles because there is no clear concentration gradient from greater to lesser from the source areas to deeper flow zones. The distribution of strontium in the vicinity of the AAB may be entirely naturally occurring. This also indicates that site-specific background comparative values are not representative of the range of naturally occurring strontium concentrations.

6.1.5.3 Variably Conservative Constituents

Cobalt, iron, and manganese isoconcentration maps, cross sections, and the geochemical model support the following observations regarding the extent of COI-affected groundwater represented by these variable constituents (**Figures 6-9c, 6-10c, 6-11c, 6-12c, 6-13c,** and **6-23a** through **6-25c**; **Appendix H**):

- Localized plume-like distributions of cobalt, iron, and manganese above the IMAC standard and/or background values occur in shallow and deep flow layers north and northeast of the RAB and southeast of the AAB. The variably reactive constituent plumes are located within localized areas of the footprint of the conservative constituent plumes. The distribution of these constituents is limited to the eastern portion of the ash basins along the Catawba River and north and northeast of the RAB and coal pile area. Concentrations to west of these areas are less then applicable comparative values (IMAC or background). Furthermore, there are no COI concentrations in surface water within the Catawba River (Lake Wylie) greater than applicable 02B standards.

- Variable constituents at concentrations greater than comparative criteria in bedrock are limited to cobalt detected at three locations, AB-04BR, GWA-06BRA, GWA-29BR and manganese, also at GWA-29BR. At AB-04BR, multiple water level measurements and sample analytical results indicate that cobalt concentrations slightly greater than the IMAC in bedrock are naturally occurring and not derived from the ash basins because the well is upgradient of the ash basins; are in an area where upward vertical hydraulic gradients are observed, consistent with the CSM; and concentrations in the shallow and deep flow zones are less than the shallower flow zones so there is no concentration gradient trend that indicates cobalt is migrating, or has migrated, from the ash basins downward through, the shallow and deep flow zones to bedrock. At GWA-6BRA, cobalt concentrations greater than the IMAC are also likely naturally occurring. Although cobalt concentrations in the shallow zone at this location (GWA-06S) are notably greater than IMAC and concentrations within bedrock, due to influence from the RAB/low pH area, cobalt concentrations in the deep zone (between the shallow and bedrock) are less than the IMAC. This indicates cobalt may not be migrating from the shallow zone downward through the deep zone into bedrock at this location and that the cobalt occurs naturally at the observed concentrations. Cobalt concentrations within the lower bedrock well at this location (GWA-06BRL) are less than the IMAC, which indicates that cobalt concentrations greater than IMAC in bedrock are limited to the upper bedrock. At GWA-29BR, initial sample results indicate cobalt and manganese concentrations slightly greater than applicable comparative values may be a result of transport from the coal pile area as cobalt and manganese concentrations in the shallow and deep flow zones are also greater than applicable comparative values.

6.2 Potential Receptors Associated with Source Area

(CAP Content Section 6.B)

CSA and ongoing monitoring data confirm that affected groundwater is limited to between 50 to 1,300 feet immediately downgradient of the ash basins and coal pile area and COI-affected groundwater is limited to Duke Energy property. COI-affected groundwater from the ash basins and coal pile area does not reach any water supply wells, and modeling indicates this will remain the case in the future, although a portion of the simulated boron plume extends beneath the western portion of Catawba River (Lake Wylie). Therefore, potential receptors are limited to the Catawba River (Lake Wylie).

6.2.1 Surface Waters – Downgradient Within a 0.5-Mile Radius of the Waste Boundary

(CAP Content Section 6.B.a)

A depiction of surface water features — including wetlands, ponds, unnamed tributaries, seeps, streams, lakes, and rivers — within a 0.5-mile radius of the ash basin compliance boundary, along with permitted outfalls under the NPDES and the SOC locations are shown on **Figure 5-6** (*CAP Content Section 6.B.a.i and 6.B.a.ii*). The 0.5-mile radius from the ash basin compliance boundary, for which data is evaluated and depicted on figures including surface water, is greater than the required 0.5-mile radius from the waste boundary and is consistent with the drinking water well and receptor surveys. The ash basins and coal piles are located along the west bank of the Catawba River (Lake Wylie). The South Fork River is located west of the Site, beyond a topographic and hydrogeologic divide. Associated North Carolina surface water classifications for the Catawba River (Lake Wylie) and the South Fork Catawba River are summarized in **Section 5.3.1** and **Table 5-3** (*CAP Content Section 6.B.a.iii*).

For groundwater corrective action to be implemented under 15A NCAC .02L .0106(k), groundwater discharge to surface water cannot result in exceedances of standards for surface waters contained in 02B. Surface water constituents with 02B standards include: arsenic, barium, beryllium, cadmium, chloride, chromium (hexavalent and trivalent), copper, fluoride, lead, mercury, nickel, nitrate and nitrite, selenium, silver, sulfate, total dissolved solids, thallium, total hardness, and zinc.

Surface water samples were collected from the Catawba River. Samples were also collected from a small channel that flows from a seep-fed wet area southeast of the AAB (seep/AOW S-2). Decanting has since resulted in no flow being present within that channel. The samples were collected to confirm groundwater downgradient of the ash basins and coal piles has not resulted in surface water concentrations greater than 02B water quality standards. A map of surface water sample locations for groundwater discharge to surface water evaluation is included in **Appendix K** (*CAP Content Section 6.B.a.iv*). Surface water samples were collected, using division approved protocols, to evaluate acute and chronic water quality values. Surface water samples were also collected at background locations (upgradient of potential migration areas) within the Catawba River. Analytical results were evaluated with respect to 02B water quality standards and background data.

Comparisons of surface water data with the applicable USEPA National Recommended Water Quality Criteria for Protection of Aquatic Life, Human Health and/or Water Supply (USEPA, 2015; 2017a; 2017b) was also conducted on surface water samples from the Catawba River. As stated by the USEPA, these criteria are not a regulation, nor do they impose a legally-binding requirement. Therefore, comparisons with these criteria are only for situational context. The constituents that have corresponding USEPA criteria but do not have 02B criteria are alkalinity, aluminum, antimony, iron and manganese. All concentrations of alkalinity, aluminum, antimony, iron and manganese in downstream samples were either non-detect (*i.e.* antimony) or concentrations were generally comparable to background concentrations.

The surface water samples were collected in accordance with NCDEQ DWR Internal Technical Guidance: Evaluating Impacts to Surface Water from Discharging Groundwater Plumes - October 31, 2017. The full report for Allen groundwater discharge to surface water and the evaluation of surface waters to evaluate compliance with 15A NCAC 02B .0200 was submitted to NCDEQ in March 2019. Surface water data has been reevaluated as a result of surface water quality standards updated by NCDEQ on June 6, 2019. The revised report is provided in **Appendix J**.

General findings of the evaluation of current surface water quality conditions at Allen include:

- Groundwater migration from beneath the ash basins and coal pile area has not resulted in exceedances of the 02B surface water quality standards in the Catawba River.
- Previously identified seeps are deemed covered by North Carolina Environmental Management Commission (EMC) SOC WQ S17-009.

Surface Water - Future Conditions Evaluation

An evaluation of potential future groundwater migration to surface water was conducted to identify areas where further evaluation might be warranted. For areas of potential future groundwater migration to surface water, a mixing model approach was used for the evaluation of future surface water quality conditions. Flow and transport modeling results were used to determine where groundwater migration from the ash basins might intersect surface water in the future. Predictive groundwater modeling using boron as a proxy for COI plume migration demonstrated areas within the Catawba River east of the ash basins could potentially be influenced by future groundwater migration. A groundwater to surface water mixing model approach was used to determine the potential surface water quality in the future groundwater discharge zones. Constituents assessed in the predictive model include those that were identified as COIs in the 2018 CSA Update (SynTerra, 2018a) with 02B standards. The full report for Allen groundwater discharge to surface water under future conditions can be found in **Appendix J**.

General findings of the evaluation of future surface water conditions in potential groundwater discharge areas include:

- The surface water mixing model evaluation confirms that predicted resultant constituent concentrations in applicable surface waters are less than 02B surface water standards. Therefore, the criteria for compliance with 02B is met, allowing potential corrective action under 15A NCAC 02L .0106 (k), (l), or (m).
- Modeling scenarios illustrate the maximum extent of the affected groundwater plume occurs under current conditions. Simulations of future conditions indicate the plume extent will continue to decrease as unaffected groundwater migrates from the upgradient direction.

- The current and predicted transport extent of COIs potentially derived from the ash basins does not extend toward the South Fork Catawba River. That conclusion is based on groundwater sample results, water level elevation measurements used to determine groundwater flow direction, and groundwater modeling simulation.
- As future hydraulic head elevations decline, groundwater flow velocities slow and resemble a pre-ash basin flow direction and magnitude.

Seeps currently governed by the SOC that remain and are not dispositioned 90 days after completion of decanting would be characterized for determination of corrective action applicability. Where applicable, and accounting for seep jurisdictional status, corrective action planning at that time would occur.

The full report for Allen groundwater discharge to surface water under future conditions can be found in **Appendix J.**

Based on current and future surface water evaluations, along with relevant media assessments, no COIs require remediation in surface water at Allen.

6.2.2 Water Supply Wells

(CAP Content Section 6.B.b)

A total of 290 eligible households for permanent water supply were identified within the 0.5-mile radius of the ash basin compliance boundary. These eligible households are located northwest, west, southwest, and south of the ash basins (**Figures 5-7a** and **5-7b).** All of the private water supply wells are located either upgradient or side-gradient of the ash basins and coal pile area.

No public or private drinking water wells or wellhead protection areas were found to be located downgradient of the ash basins as discussed in **Section 5.3.3**. This finding has been supported by sampling and evaluation of results from several water supply wells (**Table 6-9** and **Figure 5-7a**), over 30 groundwater sampling events of monitoring wells on-Site (**Appendix C,** Table 1), a review of public records, an evaluation of historical groundwater flow direction data, and results of groundwater flow and transport modeling (**Appendix G**). The location and information pertaining to water wells located upgradient or side-gradient of the Site, within 0.5 miles of the ash basin compliance boundary, were included in drinking water supply well survey reports (HDR, 2014a; 2014b).

6.2.2.1 Provision of Alternative Water Supply

(CAP Content Section 6.B.b.i)

Although results from local water supply well testing do not indicate effects from the source areas at Allen, water supply wells identified within the 0.5-mile radius from ash basin compliance boundary have been offered alternate water supply, per G.S. Section 130A-309.211(c1) requirements.

A property eligibility was contingent that the property did not include:

- A business
- A church
- A school
- An empty lot

As of August 1, 2018, Duke Energy:

- connected 191 households to the City of Belmont water supply (nine of those households were already connected to the city of Belmont water supply),
- installed 10 water treatment systems, and
- abandoned three public water supply wells that served 77 households in accordance with G.S. Section 130A-309.211(c1) of HB 630 (2016).

Water supply wells were abandoned if requested by the property owner after the home was connected to the municipal water supply. If the owner wanted to keep the well for non-potable use, a spigot was installed per City of Belmont and Gaston County regulations. City of Belmont required a backflow prevention device be installed for each home that kept their well, so a large number of owners decided to have their well abandoned. No wells were abandoned due to necessity related to water quality. Abandonment was done solely at the owner's request. Water supply well abandonment records are provided in **Appendix D**.

Of the remaining 12 households that were initially considered eligible by being within a 0.5-mile radius of the ash basin compliance boundary:

- two either opted out of the option to connect to a water treatment system or did not respond to the offer,
- one household was demolished but will be connected at a future date,
- six locations were deemed not eligible because the property did not contain a household, and
- three additional locations were associated with a business, church, or school which are not eligible for the HB630.

City of Belmont water supply lines were installed along the following roadways:

- Michael Dominick Drive
- Reese Wilson Road
- Reese Wilson Road Extension
- Nutall Oak Lane
- Sawtooth Oak Lane
- Bell Post Road
- Dana Michelle Court
- Wing Point Drive
- Shorewood Place
- Egret Ridge
- White Ibis Lane
- Wildlife Road
- Idlewood Lane
- Midwood Lane
- Warren Drive
- Southpoint Drive
- Mitchell Street
- Lake Mist Drive
- Lake Breeze Lane
- Canal Road

Additionally, Duke Energy voluntarily connected two businesses and 23 households to the City of Belmont water supply that were otherwise not eligible per G.S. Section 130A-309.211(c1).

On August 1, 2018, Duke Energy provided completion documentation to NCDEQ to fulfill the requirements of HB 630. NCDEQ provided correspondence, dated October 11, 2018, to confirm that Duke Energy satisfactorily completed the alternate water provision under CAMA, G.S. Section 130A-309.211(c1) at Allen. Both documents are provided in **Appendix D**.

Figure 5-7b (*CAP Content Section 6.B.b.i*) shows the private and public water supply well locations with reference to water treatments systems installed and to be installed, along with vacant parcels and residential properties that have decided to either opt out of the water treatment system program or did not respond to the offer. Where provided, Duke Energy maintains the systems on behalf of the property owners.

6.2.2.2 Findings of Drinking Water Supply Well Surveys

(CAP Content Section 6.B.b.ii)

The location and relevant information pertaining to water wells located upgradient or side-gradient of the facility, within 0.5-miles of the compliance boundary, were included in the survey reports. Results from surveys conducted to identify potential receptors for groundwater, including public and private water supply wells and surface water features within a 0.5-mile radius of the ash basin compliance boundary, have been reported to NCDEQ:

- *Drinking Water Well and Receptor Survey – Allen Steam Station Ash Basin* (HDR, 2014a)
- *Supplement to Drinking Water Well and Receptor Survey – Allen Steam Station Ash Basin* (HDR, 2014b)
- *Comprehensive Site Assessment Report – Allen Steam Station Ash Basin,* (HDR, 2015a)

The surveys identified four public supply wells within 0.5-mile radius of the ash basin compliance boundary (**Figures 5-7a** and **5-7b**). The three public water supply wells closest to the ash basins were abandoned in 2018. Two of the public water supply wells (Heather Glen/Highland) were located approximately 0.35 miles west and upgradient of the ash basins. These wells were located in the vicinity of a groundwater divide. One public water supply well (South Point Landing) was located approximately 0.2 miles west and beyond the groundwater divide from the ash basins. The farthest public water supply well (River Lakes S/D) from the ash basins is located approximately 0.5 miles west of the ash basins and beyond a groundwater divide (South Point Road). This well was not abandoned and remains in use.

As documented in the 2018 CSA Update, NCDEQ arranged for independent analytical laboratories to collect and analyze water samples in the first part of 2015 from private wells identified during the well survey, if the owner agreed to have their well sampled. NCDEQ collected and analyzed a total of 216 samples from 159 private monitoring wells within a 0.5-mile radius of the Allen ash basin compliance boundary from 2015 through 2017.

Table 6-9 (*CAP Content Section 6.B.b.ii*) provides tabulated results for the NCDEQ sampling results as well as identified exceedances of 02L Standards, IMACs, and bedrock background values, as well as a well-by-well summary of COI exceedances and characterization. The exceedance evaluation compares bedrock background values since it is assumed area water supply wells are installed within the bedrock, which is typical for water supply wells in the Piedmont. Although some of the water supply wells may be installed in the lower transition zone. Groundwater concentrations of boron and sulfate, which are constituents that conservatively indicate influence from the ash basins or coal pile, are not detected in the vicinity of the water supply wells and are only detected in bedrock monitoring wells at locations adjacent to the Catawba River, and approximately 2,500 feet from the closest water supply well.

Major findings from the water supply well evaluation include:

- All water supply wells are outside of the boron and sulfate plumes as defined on the conservative isoconcentration contour maps for all flow zones (**Figures 6-19a** through **Figure 6-21c**).
- All water supply wells to the west, northwest, and south are upgradient or sidegradient of the ash basins (**Figures 5-7a** and **5-7b**).
- Groundwater modeling simulations indicate that as source control (decanting) continues, the hydraulic divide will be more pronounced to the west of the basins, therefore the water supply wells west of the ash basins will become further isolated from the basins (**Figure 5-5a** through **5-5c, Appendix G).**
- Five of the seven COIs that have been identified as useful for mapping to indicate areas for corrective action were present in water supply wells at values greater than 02L/IMAC or background, whichever is greater including: cobalt, iron, strontium, sulfate, and TDS; however, the presence of these COIs in the water supply wells are not associated with the ash basins or coal piles based on the local hydrogeology and distribution of COIs described above.

- 95 water supply wells sampled demonstrated concentrations of chromium (VI) greater than background values. No discernable plume associated with the ash basins or coal piles was identified. This finding has been confirmed by more than 30 consecutive groundwater monitoring events.
- 75 water supply wells sampled demonstrated concentrations of strontium greater than background values. No discernable plume associated with the ash basins or coal piles was identified. This finding has been confirmed by more than 30 consecutive groundwater monitoring events.
- Six water supply wells sampled demonstrated concentrations of vanadium greater than background values. No discernable plume associated with the ash basins or coal piles was identified. This finding has been confirmed by more than 30 consecutive groundwater monitoring events.
- One public water supply well sampled demonstrated a concentrations of cobalt greater than IMAC, iron background values, sulfate 02L, thallium IMAC, and TDS 02L. No discernable plumes associated with the ash basins or coal piles were identified. This finding has been confirmed by more than 30 consecutive groundwater monitoring events.

6.2.3 Future Groundwater Use Areas

(CAP Content Section 6.B.c)

Duke Energy owns the land and controls the use of groundwater on the land downgradient of the ash basins and coal pile area within and beyond the predicted area of potential groundwater COI influence. Therefore, no future groundwater use areas are anticipated downgradient of the basins or coal pile area.

Based on future predicted groundwater flow patterns, under post ash basin closure conditions, and the location of water supply wells in the area, groundwater flow direction from the ash basin is expected to be further contained within the stream valley and continue flowing east of the ash basin footprint, and therefore will not flow towards any water supply wells [(**Appendix G**) *(CAP Content Section 6.B.c.ii)*].

6.3 Human and Ecological Risks

(CAP Content Section 6.C)

Updated human health and ecological risk assessments were prepared for Allen consistent with the CAP content guidance. The updated risk assessments incorporate results from surface water, sediments, and groundwater samples collected March 2015 through June 2019. Primary conclusions from the risk assessments include:

1. there is no evidence of risks to on-Site or off-Site human receptors potentially exposed to CCR-related constituents that may have migrated from the ash basins or coal pile area; an
2. there is no evidence of risks to ecological receptors potentially exposed to CCR-related constituents that have migrated from the ash basins or coal pile area.

These conclusions are further supported by multiple water quality and biological assessments conducted by Duke Energy as part of the NDPES monitoring program. A more detailed discussion regarding human health and ecological risk associated with the ash basins and coal piles can be found in **Section 5.4**. An update to the Allen human health and ecological risk assessment is included in **Appendix E**.

6.4 Description of Remediation Technologies

This section provides supplemental information beyond CAP Content guidance to introduce groundwater remediation technologies and considers a range of individual groundwater remediation technologies that may be used to formulate comprehensive groundwater remediation alternatives for consideration at Allen. The most feasible remedial options identified will form the basis, in whole or in part, for the remedial alternatives evaluated in **Section 6.7**. Groundwater remediation technologies will be evaluated based upon two primary criterion:

- Can a technology be effective when addressing one or more Site-specific COI?
- Can a technology be feasibly implemented under Site-specific conditions and be effective?

The remedial alternative screening includes the criteria in the NCDEQ CAP Guidance (April 27, 2018). Technologies that are clearly not workable under Site conditions will not be carried forward. Technologies that have potential application will be retained for further consideration. Technologies retained for further consideration might be used to formulate comprehensive groundwater remedial alternatives in **Section 6.5**.

6.4.1 Monitored Natural Attenuation

Monitored natural attenuation (MNA) is a groundwater remedy that relies on natural processes to reduce constituent concentrations in groundwater over time. The primary objective of an MNA strategy is to identify and quantify natural attenuation processes specific to a site and demonstrate that those processes will reduce constituent concentrations in groundwater to levels that are less than regulatory standards (USEPA, 1999; NCDEQ, 2017).

MNA processes potentially applicable to inorganic constituents include:

- Dispersion
- Dilution
- Transformation
- Sorption
- Radioactive decay
- Phyto-attenuation
- Biological stabilization
- Chemical stabilization

Dilution from recharge to groundwater, mineral precipitation, and COI adsorption will occur over time and distance from the source area, thereby, reducing COI concentrations through attenuation. MNA can be used in combination with other remediation technologies such as source control. Routine monitoring of select locations for COI concentrations is used to confirm the effectiveness of the approach.

The USEPA does not consider MNA to be a "no action" option. Source control and long-term monitoring are fundamental components of any MNA remedy. Furthermore, MNA is an alternative means of achieving remediation objectives that might be appropriate for specific, well-documented site circumstances where its use will satisfy applicable statutory and regulatory requirements (USEPA, 1999).

The USEPA, as shown below, considers MNA to be in-situ (USEPA, 1999):

> *The term "monitored natural attenuation", as used in this Directive, refers to the reliance on natural attenuation processes (within the context of a carefully controlled and monitored site cleanup approach) to achieve site-specific remediation objectives within a time frame that is reasonable compared to that offered by other more active methods. The "natural attenuation processes" that are at work in such a remediation approach include a variety of physical, chemical, or biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or*

> *concentration of contaminants in soil or groundwater. These in-situ processes include biodegradation; dispersion; dilution; sorption; volatilization…"*

MNA is compared with other viable remediation methods during the remedy selection process. MNA should be selected only if it will meet site remediation objectives within a timeframe that is reasonable compared to that offered by other methods (USEPA, 1999). A contingency remedy should be proposed at the time MNA is selected to be a site remedy (NCDWM, 2000).

The NCDEQ and USEPA have guidance documents that prescribe the investigative and analytical processes required for an MNA demonstration. NCAC 02L provides additional requirements for MNA implementation. USEPA developed a tiered approach to support evaluation and, if appropriate, selection of MNA as a remedial technique (USEPA, 2007*).* Three decision tiers require progressively greater site information and data to assess the potential effectiveness of MNA as a remedy for inorganic constituents in groundwater.

MNA will be retained for further consideration at Allen, as groundwater COIs do not pose an unacceptable risk to human health or the environment under conservative exposure scenarios and a source control measure will be implemented that eliminate or mitigate the source of CCR constituents in groundwater. The MNA evaluation for the technical applicability at Allen is provided in **Appendix I**.

6.4.2 In-Situ Technologies

Groundwater remediation technologies that are implemented in-situ, or in place, are discussed here.

Low Permeability Barriers

When used for the purpose of groundwater remediation, low permeability barriers (LPBs) are structures constructed in-situ to redirect or contain groundwater flow. Materials used to construct LPBs are either impermeable (*e.g.*, steel sheet pile) or have a permeability that is at least two orders of magnitude less than the permeability of the saturated media that comprises a targeted groundwater flow path. For this reason, LPBs are typically keyed into a natural barrier to groundwater flow such as a competent confining unit (*e.g.*, aquitard) or bedrock to prevent groundwater from flowing under the LPB.

LPBs can be used to redirect groundwater away from a potential receptor, redirect groundwater away from a source area, or redirect COI laden groundwater towards a groundwater extraction system or in-situ groundwater treatment system (*e.g*., permeable reactor barrier). The design and technique used to construct a LPB typically depends upon the length of the LPB, the depth to a competent confining layer or bedrock, and cost considerations. Sheet piling, trenching, and vertical drilling are the most common means to construct a LPB. Sheet piling and trenching are typically limited to depths of approximately 50 feet whereas installation of a LPB using drilling techniques can achieve depths greater than 50 feet. For this reason, construction of a LPB at Allen would involve installation by means of drilling because bedrock is approximately 100 feet below ground surface downgradient of the ash basins.

Construction of a LPB at Allen would involve drilling to competent bedrock and injecting bentonite or grout into fractured bedrock, the transition zone, and possibly into saprolite flow zones. Keying the LPB into a natural barrier to groundwater flow such as a competent confining unit (*e.g*., aquitard) or bedrock cannot be achieved with certainty due to the complex Piedmont geology present at Allen. Installation of an effective low permeability barrier to depths approaching 100 feet is technically feasible but would be technically challenging and costly. For these reasons, LPB technology was not retained for further consideration.

Groundwater Infiltration and Flushing

Groundwater flushing by infiltration can be accomplished by many methods including vertical wells, horizontal wells, and infiltration galleries.

In-situ groundwater flushing involves infiltration or injection of clean water into groundwater to accelerate flushing of target constituents. Constituents mobilized by flushing would be captured by an extraction well. Flushing can enhance natural constituent transport mechanisms such as advection, dispersion, and molecular diffusion. This technology is potentially applicable to a broad range of constituents. Furthermore, in-situ flushing has potential applicability at almost any depth. However, successful implementation is site-specific. Factors affecting the effectiveness include the degree of subsurface heterogeneity, the variability of hydraulic conductivity, and the organic content of soil. Suitability testing of the clean water source and pre-design collection of data is important for most sites where this technology might be considered.

Flushing of relatively mobile and unreactive constituents like boron can be accomplished using clean water.

In-situ infiltration can also be used to enhance conventional pump and treat technology at locations with limited natural recharge or low permeability. The introduction of clean water into groundwater enhances groundwater flow by increasing the hydraulic gradient between the point of injection and the point of extraction or discharge. Addition of clean water can mobilize COIs, such as boron, and enhance the hydraulic gradient to improve hydraulic capture of COIs (USEPA, 1996).

Groundwater flushing is a technology that has possible application at Allen to enhance the capture of mobile constituents. Furthermore, groundwater flushing can be used to facilitate the addition of amendments for treating groundwater that is acidic when compared to the pH range of groundwater in site background wells. Increasing the pH of locally acidic groundwater towards neutrality might also immobilize some constituents that are soluble under acidic conditions. Groundwater flushing will be retained for further consideration.

Encapsulation

Encapsulation technologies act to prevent waste materials and constituents from coming into contact with potential leaching agents such as water. Materials used to encapsulate a waste must be both chemically compatible with the waste and inert to common environmental conditions such as rain infiltration, groundwater flow, and freeze/thaw cycles (USEPA, 2002). Waste materials can generally be encapsulated in three ways: microencapsulation, macroencapsulation or in-situ vitrification (ISV).

Microencapsulation involves mixing the waste together with the encasing material before solidification occurs. Macroencapsulation involves pouring the encasing material over and around a larger mass of waste, thereby enclosing it in a solidified block. Grout, sulfur polymer stabilization/solidification, chemically bonded phosphate ceramic encapsulation, and polyethylene encapsulation are examples of the techniques that have used to improve the long-term stability of waste materials (USEPA, 2002). ISV involves the use of electrical power to heat and melt constituent laden soil and buried wastes (*e.g.*, ash). ISV uses an array of electrodes inserted into the ground. Electrical power is applied to the electrodes which establishes an electric current through the soil. The electric current generates sufficient heat (>2500^{o}F) to melt subsurface soil and waste materials. The molten material cools to form a hard monolithic, chemically inert crystalline glass-like product with low leaching characteristics (USEPA, 1994).

Encapsulation technologies are not carried forward for further evaluation for the following reasons:

- The area and depth requiring groundwater remediation is greater than feasible for this technology, which is best implemented in areas of limited size or extent.
- The varied geological conditions pose the unlikelihood that the performance of an implemented technology will be uniform.

Permeable Reactive Barrier

The USEPA defines a permeable reactive barrier (PRB) as being:

> *An emplacement of reactive media in the subsurface designed to intercept a contaminant plume, provide a flow path through the reactive media, and transform the contaminant(s) into environmentally acceptable forms to attain remediation concentration goals down-gradient of the barrier* (USEPA, 1997).

Construction of PRBs involves emplacement of reactive media below the ground surface for the purpose of treating groundwater containing dissolved COIs. The PRB media is designed to be more hydraulically conductive than the saturated media surrounding the PRB so that groundwater will flow through the PRB media with little resistance. The depth and breadth of PRBs are oriented perpendicular to groundwater flow direction so that the PRB will intercept groundwater targeted for treatment. Design of the PRB thickness takes into account groundwater velocity and the need to provide sufficient groundwater residence and contact time for constituents to react with PRB media. PRBs can be installed as permanent or semi-permanent treatment units. The PRB reactive media in a permanent treatment unit is designed to remain emplaced over the needed timeframe whereas the reactive media in a semi-permanent treatment unit is designed to be replaced periodically once it is spent.

Two of the most common PRB designs are the continuous wall and the "funnel and gate". The continuous wall design involves the installation of a trench downgradient of a constituent plume that is oriented perpendicular to groundwater flow. The funnel and gate configuration involves construction of two LPBs that redirect groundwater flow towards the PRB. This allows for a smaller PRB design and treatment of a greater volume of groundwater. A design factor for both designs is the ability for the PRB be keyed in a low permeability confining layer or in bedrock to minimize the potential for groundwater underflow beneath the PRB.

Media commonly used in PRBs for the treatment of inorganic COIs includes zero-valence iron (ZVI), apatite, zeolites, and materials used to affect groundwater pH. The mechanisms that take inorganic constituents out of solution includes adsorption, ion exchange, oxidation-reduction, or precipitation.

ZVI (Fe^0) is an effective reducing agent; donates an electron ($Fe^0 \rightarrow Fe^{+2} + 2e^-$). ZVI particles can remove divalent metallic cations through reductive precipitation, surface adsorption, complexation, or co-precipitation with iron oxyhydroxides. ZVI has been used to treat cationic metals such mercury (Hg^{+2}), nickel (Ni^{+2}), cadmium (Cd^{+2}), and lead (Pb^{+2}) (USEPA, 2009).

Apatite is a media used in PRBs to treat groundwater for the removal of certain metals in solution including lead, cadmium, and zinc. Apatite refers to a group of crystalline phosphate minerals; namely, hydroxylapatite, fluorapatite and chlorapatite. Apatite II™ is an amorphous form of a carbonated hydroxy-apatite that has random nanocrystals of apatite embedded in it. The apatite nanocrystals are capable of precipitating various phosphate phases of metals and radionuclides. Apatite II is also an efficient non-specific surface adsorber (Wright et al., 2003).

Zeolite is any of a large group of minerals consisting of hydrated aluminosilicates of sodium, potassium, calcium, and barium. Zeolites have large internal surface areas capable of treating inorganics by both adsorption and cation exchange.

Limestone and materials containing limestone such as recycled cement can be used as a PRB medium for raising the pH of acidic groundwater like that are found in mine runoff (Indraratna et al., 2010).

Sulfate reduction facilitated by naturally occurring bacteria has been shown to effectively treat acidic to net alkaline groundwater containing dissolved heavy metals, including aluminum, in a variety of situations. The chemical reactions are facilitated by the bacteria *desulfovibrio*. This is a well-proven technology often used to treat acidic runoff from historic mining operations.

The ability to maintain adequate reactive reagent concentrations at depth over an extended period of time is a significant operational and performance consideration. Permeable reactive barriers are not carried forward. Reasons include:

- Detected concentrations of aluminum, iron, and manganese dissolved in groundwater could react with, and clog, treatment areas, diminishing the hydraulic conductivity through the PRB.
- There is recent favorable data suggesting that the technology might be effective in reducing some coal ash-related constituents, however, PRB technology is not well suited to treat boron.
- It would not be economically, or in some areas technically, feasible to construct a PRB along the entire length and depth of the affected areas beyond the compliance boundary.

6.4.3 Groundwater Extraction

Groundwater extraction is often used when remediating mobile constituents in groundwater. Groundwater extraction can be used to withdraw affected groundwater from the subsurface for the purpose of reducing the mass of one or more target constituent(s) in an aquifer. Groundwater extraction can be used to hydraulically contain affected groundwater and mitigate groundwater constituent migration. Groundwater extraction can be conducted using a variety of methods that are discussed in the following sub-sections.

Vertical Extraction Wells

A vertical well is the most common design for groundwater extraction. Drilling techniques used to install vertical groundwater extraction wells range from direct push technology, to hollow stem auger, mud rotary, air rotary, sonic drill rigs, and other methods. Groundwater extraction wells can be designed and screened in unconsolidated saturated media such as sand, saprolite, alluvium, transition zone, fractured bedrock, silts, and clays. Alternatively, groundwater extraction wells installed in bedrock can be completed as open-hole borings.

Low yielding aquifers can be problematic for vertical extraction wells. Relatively close spacing of vertical wells might be necessary to capture a constituent plume if the aquifer yield is low. Enhanced yield can be accomplished through injection or infiltration of water upgradient of the wells to increase the availability of water and hydraulic head, or fracking. Alternatively, low yielding wells can be effective through intermittent pumping to remove sorbed constituents with each pump cycle.

Pump options include submersible pumps and centrifugal pumps depending upon the anticipated yield, depth to water and well diameter. Shallow centrifugal pumps (shallow well jet pumps) can be used in small diameter wells where the groundwater level and desired pumping level is relatively shallow (less than 25 to 30 feet below the ground surface). Submersible pumps or 'deep well jet pumps' can be used to extract groundwater from larger diameter wells with deeper groundwater levels. Deep well jet pumps have the advantage of mechanical equipment above grade and power only needs to be provided to a few pump stations rather than to every well as with submersible pump systems. All require routine maintenance of the pumps, vaults, piping and well screens to sustain desired performance.

Groundwater modeling conducted at Allen indicates that vertical groundwater extraction wells can produce sufficient yield for effective constituent mass removal without supplemental measures. Pilot testing could be used to verify and adapt the design to accommodate actual flow rates. Therefore, the use of vertical groundwater extraction wells is retained for further consideration.

Horizontal/Angular Extraction Wells

Horizontal groundwater extraction wells offer advantages over vertical groundwater extraction wells when access is difficult or to reduce the number of system elements requiring maintenance. For example, horizontal wells can be installed below buried utilities, buildings, and similar surface or near surface features. Also, horizontal wells can be more efficient and effective when remediating constituent plumes distributed over a large area within a relatively thin flow zone. Fewer horizontal wells would be required under this scenario compared with the number of vertical wells that might be required to achieve similar remediation goals. Furthermore, recovery efficiency might be increased relative to vertical wells due to the ability of a single horizontal well to contact a larger horizontal area, particularly where the horizontal aquifer transmissivity is greater than the vertical transmissivity.

Installation of a directionally drilled well involves the use of an auger bit that can be steered in three dimensions. The progress of direction boring installations is precisely monitored to avoid subsurface obstructions and to install the well as designed. Tracking accuracy generally decreases with increasing depth of installation. Site hydrogeologic and geologic conditions can also affect tracking accuracy.

Directionally drilled horizontal wells can be completed as blind holes (single-end completion) or surface-to-surface holes (double-end completion). Single-end holes involve one drill opening, with drilling and well installation taking place through this single opening. Borehole collapse might be more likely in single-ended drilling since the hole is left unprotected between drilling and reaming and between reaming and casing installation. An additional complication associated with single-ended completion involves the precise steering of reaming tools required to match the original borehole path. In contrast, double-end holes are typically easier to install since reaming tools and well casing can be pulled backward from the opposite opening, and the hole does not have to be left open.

Materials used for horizontal wells are typically the same or similar as those used for vertical wells. Factors to consider in the choice of the well screen and casing materials to be used with horizontal wells include axial strength, tensile strength, and flexibility (Miller, 1996).

Angle drilled wells are constructed in the same way as a vertical well with the exception that the drill rig mast is positioned at an angle that is purposely not plumb. The drilling mast angle and the targeted drilling depth will determine horizontal offset of the well screen and submersible pump from the location where drilling was initiated. Otherwise, angled wells function in the same manner as vertical wells.

Groundwater modeling conducted at Allen indicates that groundwater vertical extraction wells can produce sufficient yield for purposes of hydraulic containment and/or constituent mass removal. Vertical extraction wells are deemed more cost effective. The use of horizontal or angular groundwater extraction wells is not retained for further consideration.

Extraction Trenches

Shallow horizontal groundwater extraction (collection or intercept) trenches can be installed in areas near surface waters where groundwater might discharge. These trenches can be utilized to prevent groundwater from discharging into surface waters and can be effective in lowering or managing the water table.

Trenches might be used as temporary installations to intercept and monitor subsurface flow or can be retained as a permanent installation. Trenches must be deep enough to tap and provide an outlet for ground water that is in shallow, permeable strata or in water-bearing sand. The spacing of trenches varies with soil permeability and drainage requirements.

Extraction trenches function similar to horizontal wells but are installed with excavation techniques. They can be cost-effective to construct at shallow depths (less than or equal to 35 feet below ground surface) using conventional equipment. Trenches can be installed to depths of approximately 50 feet below ground surface using specialty equipment. Horizontal collection trenches are usually not cost-effective for deeper installations or bedrock applications. Horizontal collection trenches do have the advantage of generally having lower operations and maintenance costs compared with the costs of multiple vertical wells.

Extraction trenches will not be considered at Allen because the thickness of saprolite between the ash basin dams and the Catawba River is approximately 100 feet and effectiveness would be limited.

Hydraulic Fracturing

The effectiveness of groundwater extraction systems can sometimes be improved in low permeability formations, including bedrock, with the use of fracturing techniques.

Pneumatic fracturing involves injection of highly pressurized air into consolidated sediments to extend existing fractures and create a secondary network of fissures and channels. Similarly, hydraulic fracturing involves the use of high pressure water to extend existing fractures and create a secondary network of fissures and channels.

Hydraulic fracturing generally involves the application of high pressures to propagate existing fractures or to create fractures following fracture nucleation. When hydraulic fracturing is applied to unconsolidated materials, a disk-shaped notch that serves as the starting point for the fracture is created using high pressure water to cut into the formation. This is followed by pumping a slurry of water, sand, and a thick gel at high pressure into the borehole to propagate the fracture. The residual gel biodegrades and the resultant fracture is a highly permeable sand-filled lens that might be as large as 60 feet in diameter (USEPA, 1995).

The presence of COIs in the bedrock groundwater at Allen is limited compared to the distribution and concentrations of COIs in saprolite and transition zone groundwater. The use of hydraulic fracturing to enhance remediation of bedrock groundwater is not considered further because the extent of COIs in bedrock groundwater is limited and COIs in bedrock groundwater might be addressed as effectively using more conventional means.

Phytoremediation

Phytoremediation involves the use of plants and trees as a means to extract groundwater. Water uptake by trees is used for plant growth and metabolism. Water uptake by plants and trees is ultimately released into the atmosphere via the pore-like structures on the leaves called stoma. Water on the leaves evaporates into the atmosphere. The loss of water by plants and trees is called transpiration. The amount of water transpired by plants, and therefore water uptake by plants, is a function of:

- **Plant type:** Plants that are native to arid regions must conserve water and therefore transpire less than plants that are native to wet regions.
- **Temperature:** Transpiration rates increase with increasing temperature and decrease with decreasing temperatures.
- **Relative humidity:** Transpired water on plant leaves evaporate at a faster rate when the relative humidity is low and that results in a correspondingly higher transpiration rate. The opposite is true when the relative humidity is high.
- **Wind and air movement:** Increased movement of air around a plant will increase the rate of transpiration by plants
- **Availability of soil moisture:** Plants can sense when soil moisture is lacking and will reduce their transpiration rate.

The growth rate of selected plant species and the growing season can be limiting factors for the effectiveness of this technique. Maintenance can be long term and require, in most cases, fertilizing, regular monitoring, and harvesting.

Phytoremediation using TreeWell® technology involves the installation of a 3 to 5 foot diameter boring to a target depth, typically a flow zone containing COIs. A Root Sleeve™ liner and aeration tubing are installed from ground surface to target depth. The boring is backfilled with soil that might include reactive media. If filled with reactive media, the tree well would serve as a PRB as well as a means to promote phytoremediation.

A tree is planted within the tree well followed by placement of plastic cover over the soil surrounding the tree. The plastic cover minimizes infiltration of precipitation into the tree well. The tree well design forces the tree to draw water from the targeted depth via the Root Sleeve™ liner. Groundwater is also drawn through reactive media, if present. Consequently, the tree and the tree well are capable of uptake of some COIs and serve as a means of groundwater treatment and enhanced natural attenuation.

Ground cover plants stabilize soil/sediment and control hydraulics. In addition, densely rooted groundcover plants and grasses can also be used to remediate constituents. Phytoremediation groundcovers are one of the more widely used applications and have been applied at various bench- to full-scale remediation projects. Furthermore, in the context of this document, phytoremediation groundcovers are vegetated systems typically applied to surface soils as opposed to TreeWells which are targeted to deep soil and/or groundwater. The typical range of effectiveness for phytoremediation groundcovers is 1–2 feet bgs; however, depths down to 5 feet have been reported as within the range of influence under some situations (ITRC, 2009)

Constructed treatment wetlands are manmade wetlands built to remove various types of pollutants that may be present in water that flows through them. They are constructed to recreate, to the extent possible, the structure and function of natural wetlands, which is to act as filters. Wetlands are ideally suited to this role. They possess a rich microbial community in the sediment to effect the biochemical transformation of pollutants, they are biologically productive, and most importantly, they are self-sustaining.

Metals are removed in constructed wetlands by a variety of mechanisms including the following. Settling and sedimentation achieve efficient removal of particulate matter and suspended solids. The chemical process that results in short-term retention or long-term immobilization of constituents is sorption. Sorption includes the combined processes of adsorption and absorption. Chemical precipitation involves the conversion of metals in the influent stream to an insoluble solid form that settles out. (ITRC, 2003)

Phytoremediation technology can be also be used as a means to treat extracted groundwater. Aquaculture treatment technologies have been applied to the treatment of water. Those using aquatic plants, have been demonstrated capable treatment of metals and other non-metal elements including boron and arsenic (USEPA, 1982).

Phytoremediation technology can be used to extract groundwater; however, phytoremediation is not capable of achieving extraction rates necessary to achieve groundwater remediation within reasonable timeframes. Although, phytoremediation is not retained for consideration for groundwater corrective action, phytoremediation could be an effective surface water protection supplement to a groundwater management system. At Allen, phytoremediation technology could be applied as corrective measure to address low flowing seeps east and southeast of the ash basin dam, if those seeps are not dispositioned after completion of decanting. The use of phytoremediation is retained for further consideration for potential seep remediation.

6.4.4 Groundwater Treatment

Several technologies exist for treatment of extracted groundwater to remove or immobilize constituents ex-situ, or above ground. The following technologies are used for treatment of extracted groundwater. These groundwater treatment technologies are scalable for small to large flow rates.

pH Adjustment

Adjustment of the pH of extracted groundwater, if required prior to discharge, is a proven technology. NPDES permitted discharges will impose specific limits on the pH of discharged wastewater. The existing NPDES permitted outfalls at Allen maintain a pH between 6.0 and 9.0 S.U. Facilities and equipment to adjust the pH of wastewater to satisfy NPDES discharge requirements are in-place at Allen.

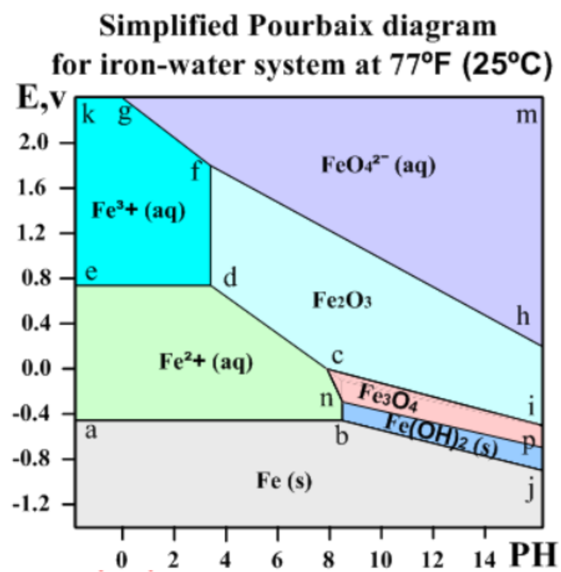
The pH adjustment of extracted groundwater is anticipated. Background values for pH in shallow (saprolite) groundwater at the Allen Site have been reported as low as 4.5 S.U. Also, field measured pH of groundwater samples collected from 58 downgradient groundwater monitoring wells were less than 6.0 S.U. during 2018 and 2019. This treatment technology will be retained for further consideration.

Precipitation

Precipitation of metals and other inorganic constituents has been used extensively to treat extracted groundwater. The process involves the conversion of soluble (dissolved) constituents to insoluble particulates that will precipitate.

The insoluble particles are subsequently removed by physical methods such as clarification or filtration. The process might involve adjustment of the wastewater pH and/or reduction-oxidation (redox) potential or Eh (volts). The stability of soluble and insoluble metals and metal complexes is commonly illustrated in Pourbaix diagrams (pH vs Eh).

FIGURE 6-27
POURBAIX DIAGRAM FOR IRON-WATER SYSTEM



https://rsteyn.wordpress.com/pourbaix-diagrams

As illustrated in the Pourbaix diagram (**Figure 6-27**) at right, iron is soluble (aqueous or aq) at a pH of approximately 3.5 S.U. or less under aerobic conditions (Eh > 0 V). If the pH is increased, ferric (Fe+3) iron will react to form insoluble (solid or s) complexes and precipitate out of solution, provided that the Eh remains between 0.75 and 1.5 V. Adjustment of groundwater pH and Eh can be used to remove other metals including cadmium, chromium, copper, nickel, and zinc. Flocculation is another method that can be used to remove inorganics from an aqueous waste stream.

Precipitation technology might be warranted to treat, or pretreat, extracted groundwater to satisfy NPDES permitted discharge limits. Precipitation technologies are retained for further consideration. Dissolved constituent precipitation technology equipment is readily available.

Ion Exchange

Ion exchange processes are reversible chemical reactions that can be used for the removal of dissolved ions from solution and replacing them with other similarly charged ions. The ion exchange medium might consist of a naturally occurring material such as zeolites or a synthetic resin with a mobile ion attached to an immobile functional acid or base group. Mobile ions held by the ion exchange resin are exchanged with solute or target ions in the waste stream having a stronger affinity to the functional group.

Ion exchange resins can be cation resins or anion resins of varying strength. Ion exchange resins are generally classified as being:

- Strong acid cation (SAC) resins.
- Weak acid cation (WAC) resins.
- Strong base anion (SBA) resins.
- Weak base anion (WBA) resins.

Over time, a resin can become saturated with the targeted or competing ions. Breakthrough might occur when a resin becomes saturated. The possibility of breakthrough is evident when effluent concentrations of the targeted metal ion steadily increases over time and approach influent concentrations. Ion resins should be replaced or regenerated before breakthrough occurs. Ion selective born resins are available and do not have the same competition considerations. However, capacity and regeneration are still potential limitations and key design parameters.

Regeneration is laborious and requires safe handling of concentrated chemical reagents and waste. The first step in the co-flow regeneration process (regenerant is introduced via ion exchange bed influent) is to backwash the system with water. The regenerant solution is introduced to drive off ions and restores the resin capacity to about 60 to 80 percent of the total resin ion exchange capacity. Sodium hydroxide is a commonly used regenerant for WBA resins; weaker alkalis such as ammonia (NH_3) and sodium carbonate (Na_2CO_3) can also be used (SAMCO, 2019).

When sufficient contact time has passed, a slow water rinse is applied to the resin bed to push the regenerant solution throughout the resin and subsequently remove the regenerant from the system. The regenerant should be retained for proper management. The slow rinse is followed by a fast "raw" water rinse to verify water quality requirements are being met.

A limitation of this technology is that there must be a feasible and economical method to dispose of the regeneration effluent. An additional challenge could be groundwater influent streams that might have geochemical characteristics that result in interference in the ion exchange process. Because of these challenges ion exchange is not retained for further consideration.

Membrane Filtration

There are a number of permeable membrane filtration technologies that can be utilized to remove metals and other constituents from extracted groundwater. The most common is reverse osmosis. Microfiltration, ultrafiltration, and nanofiltration are also permeable membrane filtration technologies that are used less frequently.

All four technologies use pressure to force influent water through a permeable membrane. Permeable membrane filtration technologies are selected and designed so that influent water can pass through the membrane while target constituents are filtered (retained) by the membrane. The permeable membrane filtration technologies discussed differ in the size of the molecules filtered and the pressures needed to allow permeate to pass through the membranes.

Permeable membrane filtration technologies can filter one or more target constituents simultaneously and achieve low effluent concentrations. However, permeable membrane filtration technologies are also very susceptible to fouling and often require a pretreatment step. They can also generate a high concentration reject effluent which might require additional treatment prior to management. These technologies typically have high capital costs.

Membrane filtration at Allen is not carried forward for further evaluation for the following reasons:

- Extracted groundwater is not expected to be greater than permit discharge limits.
- Pretreatment and a high volume of reject effluent that requires additional treatment prior to management make this technology costly and high maintenance.

6.4.5 Groundwater Management

Extracted groundwater must be managed or used as supplemental process water prior to discharge. The disposition of extracted groundwater is discussed in the following sections.

National Pollutant Discharge Elimination System (NPDES) Permitted Discharge

The Allen Steam Station has an NPDES permit (NC0004979) that authorizes the discharge of specific waste streams to the Catawba River via NPDES Outfalls 002 and 006. Outfalls 002 and 006 are authorized to discharge storm water from the coal pile area, miscellaneous storm water flows, ash sluice water, landfill leachate, yard drain sump, treated groundwater and other waste streams. When necessary, these waste streams are treated using chemical coagulation, settling, and/or pH neutralization to satisfy Outfall 002 and 006 NPDES discharge requirements, which are summarized on **Table 6-10**. Outfall 002 is located in the southern end of the Site east of the AAB. Outfall 006 is on the north end of the plant and receives the discharge from the lined retention basin (LRB). Both of these outfalls will be considered for the management of extracted groundwater.

Management of extracted groundwater utilizing the NPDES discharge system will be retained for further consideration.

Publicly Owned Treatment Works (POTW)

This groundwater management option involves the discharge of extracted groundwater to a sewer that discharges to the local POTW. The feasibility of this management option depends on a number of factors including:

- The proximity of the nearest sewer line relative to the groundwater extraction system.
- The available capacity of a POTW to accept a new waste stream.
- The suitability of a groundwater waste stream on POTW operations.
- Capital costs, pretreatment requirements, and management fees.

The City of Belmont wastewater treatment plant (WWTP) is located at 298 Parkdale Drive in Belmont, NC 28012 or about 2.5 miles north of Allen on the western shoreline of the Catawba River. The City of Belmont Water Distribution and Sewer Collections Department is responsible for sewer distribution lines to the Belmont WWTP. A sewer line that discharges to the Belmont WWTP extends to Plant Allen Road (Miller, 2019a).

The City of Belmont WWTP has the following limits on their influent (Miller, 2019b):

- Daily flow rate: 5 million of gallons per day (MGD).
- pH: minimum 6.00 S.U. maximum 9.00 S.U.

The maximum monthly influent flow rate is 2.226 MGD. Consequently, it appears that the City of Belmont WWTP has approximately 2.0 MGD of available treatment capacity. However, the Belmont sewer use ordinance (SUO) states that the City of Belmont WWTP will not accept groundwater unless specifically authorized by the POTW director (SUO §52.060(b)(13)). Total flow rates required for treatment may be greater than 1.3 MGD as discussed in **Section 6.8.2**. It is unlikely that the City of Belmont WWTP will allocate most of its available capacity to a single industrial user.

Discharge of extracted groundwater to the City of Belmont WWTP is not retained for further consideration at this time. Management of extracted groundwater via NPDES Outfall 002 or through the lined retention basin and NPDES Outfall 006 are considered better options.

Non-Discharge Permit/Infiltration Gallery

Disposition of treated groundwater by way of infiltration into underlying groundwater involves the construction of an infiltration gallery to receive and distribute the treatment effluent or wastewater. Discharge of wastewater by way of an infiltration gallery must not result in a violation of 02L groundwater standards. Consequently, groundwater treatment must reliably produce an effluent waste stream that does not result in groundwater violation set by the 02L standard.

The construction and use of infiltration galleries are permitted under 15A NCAC 02T .0700. The effectiveness of an infiltration system depends in large part on the type of soils, or classification of soils, receiving the wastewater. Annual hydraulic loading rates shall be based on in-situ measurement of saturated hydraulic conductivity in the most restrictive horizon for each soil mapping unit. United States Department of Agriculture (USDA) soil map of the Site indicates that over half of the native soil is Udorthents, loamy (USDA, 2019). The capacity of the most limiting layer of this soil type to transmit water is described as ranging from a very low to high (0.00 to 1.98 inches/hour) capacity.

Before extracted water could be recycled for infiltration gallery use, inorganic constituents, including boron, chloride, cobalt, manganese among others, would have to be treated. Treatment would have to be sufficient so wastewater recycled to the groundwater system would not result in constituent concentrations greater than 02L groundwater standards. Treatment of conservative and variably conservative constituents could result in complicated systems with significant operation and maintenance efforts. Therefore, the use of infiltration galleries to dispose of treated groundwater is not retained for further consideration.

Non Discharge Permit/Land Application

Land application of groundwater involves the distribution of extracted groundwater onto land to irrigate the vegetative cover and supplying the vegetative cover with nutrients beneficial for growth. The vegetative cover can include grasses, tree wells, wetland species, native species of trees and shrubs, and ornamental trees and shrubbery.

The primary focus of groundwater remediation efforts is to reduce boron concentrations beyond the anticipated compliance boundary to acceptable levels. Consequently, extracted groundwater would be expected to contain boron. Boron is essential for plant growth. More specifically, boron in soil must be continuously delivered to growing tissues through roots and vascular tissues to maintain cell wall biosynthesis and optimal plant development (Takano, 2006). Boron is also essential for plant nitrogen assimilation, for the development of root nodules in nitrogen-fixing plants, and for the formation of polysaccharide linkages in plant cell walls (Park, 2002). If extracted groundwater is land applied, boron would be made available for plant uptake.

Extracted groundwater could be used to irrigate more than 300 acres of planted vegetative cover following the implementation of source control measures. Land application of extracted groundwater would occur within the compliance boundary. A large scale irrigation system could be used to apply thousands of gallons of water onto the vegetative cover daily. Of the water applied, much of it would be lost to evaporation, particularly during sunny dry periods. Likewise, water taken up by vegetation would be lost by way of plant transpiration. All remaining water would either infiltrate into the soil or migrate downslope to wetland areas via surface water runoff.

Land application of extracted groundwater must comply with 15A NCAC 02T – *Waste Not Discharged To Surface Waters*. Duke Energy would submit an application for a non-discharge permit in accordance with 15A NCAC 02T .0105 - .0109. General permits can be effective for up to eight years. General permits issued pursuant to 15A NCAC 02T shall be considered individual permits for purposes of Compliance Boundaries established under 15A NCAC 02L .0107. Permitted facilities shall designate an Operator in Responsible Charge and a back-up operator as required by the Water Pollution Control System Operators Certification Commission.

Application of wastewater to the ground surface or surface irrigation of wastewater is governed by 15A NCAC 02L .0500 - *Wastewater Irrigation Systems*. Requirements under this subsection include:

- A soil scientist must prepare a soil report that evaluates receiving soil conditions and who makes recommendations for loading rates of liquids and wastewater constituents.
- A hydrogeologic report must be prepared by a licensed geologist, soil scientist, or professional engineer for industrial waste treatment systems with a design flow of over 25,000 gallons per day.
- The applicant must prepare a Residuals Management Plan.
- Each facility shall provide flow equalization with a capacity of 25 percent of the daily system design flow unless the facility uses lagoon treatment.
- Management areas shall be designed to maintain one-foot vertical separation between the seasonal high water table and the ground surface.
- Automatically activated irrigation systems shall be connected to a rain or moisture sensor to prevent irrigation during precipitation events or wet conditions that would cause runoff.

Setback requirements for irrigation sites (15A NCAC 02T .056) are summarized in **Table 6-11**.

The DWR might require monitoring and reporting to characterize the waste (extracted groundwater) and its effect upon surface water, ground water, or wetlands.

Land application of extracted groundwater could be used as a means to maintain the vegetative cover that would be established following implementation of source control measures. However, the designated area would have to be able to take continuous flow during both dry and wet seasons, which would not be practical. Additionally, unless the vegetation is harvested, boron uptake will be returned to the soil and aquifer upon death and decomposition of the plant matter. Therefore, land application is not retained as an alternative means for management of extracted wastewater.

Beneficial Reuse

Beneficial reuse of extracted groundwater involves the evaluation of existing Station water demand and the repurposing of extracted groundwater to satisfy a need for water. Beneficial reuse of extracted groundwater can do the following:

- Provide an alternative to groundwater treatment.
- Reduce reliance on sources of non-potable water required for plant operations.
- Reduce the need and capacity for wastewater treatment.

A NCDENR 2017 Annual Water Use Report for the Allen Steam Station indicated that water was withdrawn from the Catawba River every day in 2017. The average daily withdrawal in a given month ranged from 99.5 million gallons per day (MGD) to 624.8 MGD. The average daily discharge in a given month ranged from 99.4 to 624.3 MGD (NCDENR, 2018).

Beneficial Reuse: Fire Protection

A limited amount of extracted groundwater might be used to supplement or supply water stored for fire suppression within Station operations. However, the need for fire suppression water is limited, storage is problematic and would not justify the effort and expense to substitute extracted groundwater for fire suppression water obtained from the Catawba River (Lake Wylie).

Beneficial Reuse: Non-Contact Cooling Water

Extracted groundwater might be used to supplement or supply makeup water used for non-contact cooling within Station operations. The alkalinity of groundwater could pose potential scaling problems for some applications. However, certain groundwater constituents including the constituents that comprise alkalinity would be diluted by non-contact cooling water obtained from the Catawba River. Use of extracted groundwater for non-contact cooling water is not retained, but might be reconsidered in the future.

Beneficial Reuse: Dust Suppression and Truck Wash

A limited amount of extracted groundwater can possibly be used for dust suppression during implementation of source control measures. Similarly, extracted groundwater can possibly be used for washing the tires of haul trucks leaving the ash basins during implementation of source control measures. The use of extracted groundwater for dust suppression and truck washing would be confined within ash basin limit of ash management. However, the need for dust suppression and truck wash water is limited and would not justify the effort and expense to substitute extracted groundwater for dust suppression and truck wash water obtained from the Catawba River (Lake Wylie). Therefore, beneficial use of the water is not retained for further consideration.

6.4.6 Technology Evaluation Summary

A summary of the remedial technologies presented above and the rationale for either retaining or rejecting a specific technology is presented in **Table 6-12**.

In conclusion, remedial technologies retained for further consideration include, MNA, in-situ technology groundwater flushing, and vertical extraction wells. Groundwater treatment technologies retained include pH adjustment and precipitation. These technologies were retained to meet NPDES permit discharge limits which was the only technology retained for management of extracted groundwater. Phytoremediation was also retained for potential corrective action of seeps. No beneficial reuse technology is retained at this time.

6.5 Evaluation of Remedial Alternatives

(CAP Content Section 6.D)

Technologies evaluated and retained for consideration as discussed in **Section 6.4** were used to formulate the following three groundwater remedial alternatives to remediate groundwater affected by the ash basins or coal piles at Allen:

- Remedial Alternative 1: Groundwater remediation by MNA
- Remedial Alternative 2: Groundwater remediation by extraction
- Remedial Alternative 3: Groundwater extraction combined with targeted clean water infiltration/injection and treatment

These groundwater remedial alternatives are detailed in the following subsections. Information to address *CAP Content Section 6.D.a.iv* is provided in **Sections 6.6** and **6.7**.

6.5.1 Remedial Alternative 1 – Monitored Natural Attenuation

(CAP Content Section 6.D.a)

Alternative 1 is the use of MNA to address groundwater COI concentrations that are at or beyond the ash basin compliance boundary. Under this alternative and based on flow and transport model simulations, the boron and sulfate groundwater plumes would naturally attenuate to less than the 02L standard in approximately 320 years under the closure by excavation scenario and approximately 310 years under the closure-in-place scenario. A detailed comprehensive analysis of MNA is provided in **Appendix I**.

6.5.1.1 Problem Statement and Remediation Goals

(CAP Content Section 6.D.a.i)

A limited number of constituents in groundwater associated with the Allen ash basins and coal piles occur at or beyond the compliance boundary to the north, northeast, and east of the source areas at concentrations detected greater than applicable 02L standards, IMAC, or background values, whichever is greater. Remediation goals are to restore groundwater quality at or beyond the compliance boundary by returning COIs to acceptable concentrations (02L/IMAC or background, whichever is greater), or as closely thereto as is economically and technologically feasible consistent with 15A NCAC 02L. 0106(a). In the future, alternative standards may be proposed as allowed under 02L .0106(k). This approach is considered reasonable given the documented lack of human health or ecological risk at Allen *(CAP Content Section 6.D.a.i.2).*

The following groundwater COIs to be addressed by corrective action are identified (**Table 6-6**) and discussed in **Section 6.1.3**: boron, cobalt, iron, manganese, strontium, sulfate, and TDS *(CAP Content Section 6.D.a.i.1)*. These are the COIs that exhibit a discernable plume associated with the ash basins and/or coal piles.

More extensive discussion of the CSM can be found in **Section 5.0**, discussion of flow and transport modeling in **Appendix G**, and discussion of geochemical modeling in **Appendix H**.

6.5.1.2 Conceptual Model

(CAP Content Section 6.D.a.ii)

Based on the CSM (**Section 5.0**) and flow and transport modeling results (**Appendix G**), the groundwater COIs are hydraulically controlled within the topographic drainage basin downgradient of the source areas.

Source control is a primary component of MNA as a remedial strategy. Ash basin decanting commenced on June 6, 2019, and is scheduled to be completed by June 30, 2020. Decanting is a form of active source control by removing ponded water in the ash basin, which is considered a critical component of reducing constituent migration from the ash basins. As of December 1, 2019, 53,300,000 gallons of water has been decanted and the corresponding pond water elevation has decreased by 14.1 feet. After decanting and basin closure, the groundwater divides that control the migration of COI will become more pronounced and located farther from the basins. Decanting and basin closure will reduce the potentiometric head that contributes to the downward vertical gradient upstream of the ash basins dams. A lower downward gradient would reduce downward COI migration and enhance MNA effectiveness. As a result, constituent concentration reductions through natural attenuation processes are anticipated following decanting.

For the coal pile area, the conceptual site model would change following decommissioning of the Station. Infiltration of water through the coal piles into the subsurface is a source of groundwater COIs underlying the main and live coal piles. This source would be eliminated from the Site as part of decommissioning. MNA effectiveness would be enhanced following complete elimination of coal from the main and live coal piles.

The following three chemical natural attenuation mechanisms are an effective corrective action approach north, northeast and east of ash basins and coal pile area because they aid in stabilizing control of reactive and variable reactive COIs cobalt, iron, manganese, and strontium in groundwater by the following processes:

- **Sorption**: Chemical attachment of electrochemically charged ions to charged receptors in the subsurface media
- **Precipitation:** Removal of a COI from a dissolved state in groundwater by incorporation into the matrix of a solid such as a mineral or an amorphous mass
- **Ion Exchange**: Incorporation of an ion into the crystal structure of a matrix mineral or amorphous solid

The following five physical natural attenuation mechanisms are also an effective corrective action approach north, northeast, and east of the ash basins and coal pile area because they control the migration and distribution of all or some COIs, particularly boron, sulfate, and TDS, in groundwater by the following processes:

- **Dilution**: Reduce COI concentrations through mixing with unaffected groundwater
- **Dispersion**: Reduce COI concentrations through variability of the flow velocity and concentration gradients

- **Transfer to surface water**: Reduce COI concentrations through mixing and flushing with surface water to further reduce the potential for concentrations to be greater than 02B standards
- **Groundwater flow control within the stream valley system**: Control COI migration within hydraulic divide boundaries south, west and north of the ash basins and coal pile area
- **Phyto-attenuation:** Uptake of the COIs by plants or organisms

More information on one or more effective natural attenuation mechanism for reducing the concentration of the COI in groundwater can be found in **Appendix I,** Table ES-1.

Currently, COIs in groundwater do not pose an unacceptable risk to human health or the environment under conservative exposure scenarios and, if implemented alone, MNA would not pose an unacceptable risk to human health or the environment in the future. Source control and groundwater monitoring would verify protection of human health and the environment and to confirm model predictions. The applicable technologies that would support this alternative include groundwater monitoring wells within the former source area and near the former waste boundary, along downgradient flow transects, at a potential future point of compliance, in sentinel areas prior to receptors, and near the maximum predicted extent of migration. There are 234 monitoring wells installed associated with the ash basins and coal piles. A majority of the wells have dedicated sampling equipment and an approved interim monitoring plan is in place. A subset of these monitoring wells could be immediately used for monitoring the effectiveness of Alternative 1.

6.5.1.3 Predictive Modeling

(CAP Content Section 6.D.a.iii)

Predictive modeling has been conducted to estimate when boron and sulfate concentrations would be reduced to 02L standards using MNA alone (primarily relying on natural attenuation by dilution). The simulations indicate boron and sulfate concentrations would naturally attenuate to less than the 02L standard in approximately 310 to 320 years. The flow and transport modeling report that provides the predictions for boron and sulfate is presented in **Appendix G**. Similarly, a geochemical modeling report is presented in **Appendix H**. The geochemical modeling report describes the natural attenuation of the constituents that have multiple natural attenuation mechanisms, in addition to dilution.

6.5.2 Remedial Alternative 2 – Groundwater Extraction and Treatment

(CAP Content Section 6.D.a)

Alternative 2 consists of groundwater extraction and treatment as a remedial alternative for the areas north, northeast and east of the ash basins and coal piles at or beyond the compliance boundary. This alternative provides technology for groundwater capture (*i.e.* extraction) to address Site specific COIs. Under this alternative, compliance will be achieved in an excess of 500 years from system startup and operation.

6.5.2.1 Problem Statement and Remediation Goals

(CAP Content Section 6.D.a.i)

Constituents in groundwater associated with the Allen ash basins and coal piles occur at or beyond the compliance boundary to the north, northeast, and east of the source areas at concentrations detected greater than applicable 02L standards, IMAC, or background values, whichever is greater. Remediation goals are to restore groundwater quality at or beyond the compliance boundary by returning COIs to acceptable concentrations (02L/IMAC or background, whichever is greater), or as closely thereto as is economically and technologically feasible consistent with 15A NCAC 02L .0106(a). In the future, alternative standards may be proposed as allowed under 02L .0106(k). This approach is considered reasonable given the documented lack of human health or ecological risk at Allen *(CAP Content Section 6.D.a.i.2).*

The following groundwater COIs to be addressed by corrective action are identified (**Table 6-6**) and discussed in **Section 6.1.3**: boron, cobalt, iron, manganese, strontium, sulfate, and TDS *(CAP Content Section 6.D.a.i.1)*. These are the COIs that exhibit a discernable plume associated with the ash basins and/or coal piles.

The conceptual model and predictive modeling discussions summarize the foundations for development of the groundwater extraction and treatment alternative. More extensive discussion of the CSM can be found in **Section 5.0**, discussion of flow and transport modeling in **Appendix G**, and discussion of geochemical modeling in **Appendix H**.

6.5.2.2 Conceptual Model

(CAP Content Section 6.D.a.ii)

The applicable technologies that comprise Alternative 2 include:

- 87 extraction wells to the north, northeast and east of the ash basins and coal pile area
- Pumps, associated piping, and control systems
- Discharge piping and structure
- pH adjustment or other treatment systems

The flow and transport model predicts a total groundwater extraction flow rate of approximately 970 gpm. The number of extraction wells is estimated based on flow and transport modeling results.

The system design includes a large number of extraction wells to be completed into the shallow bedrock to allow full drawdown within the shallow and deep (transition zone) flow zones. Depths of extraction wells are dependent on the contacts between the shallow, deep and bedrock flow zones and fractures within the bedrock. As a result, extraction well depths range from approximately 65 feet bgs to 395 feet bgs in the design.

Based on the CSM (**Section 5.0**) and flow and transport modeling results (**Appendix G**), the groundwater COIs are hydraulically controlled within the topographic drainage basin downgradient of the source areas. The following groundwater COIs subject to corrective action are identified and discussed in **Section 6.1.3**.

The distribution of conservative COIs (boron, sulfate and TDS) represents the area of maximum COI distribution at or beyond the compliance boundary and is the focus of corrective action. Focusing remedial action selection on addressing the mobile COIs will also address the reactive COIs as they will follow the same flow path but with greater attenuation. With some exceptions, other COIs have generally not migrated horizontally or vertically in the shallow, deep, and bedrock flow zones appreciably from the source areas, and are not expected to do so due to constituent geochemical characteristics and Site geochemical and hydrogeologic conditions as detailed in **Appendix H**.

It is expected that extracted water would be treated and discharge through the existing NPDES Outfall 002 or the existing LRB through NPDES Outfall 006 based on currently available groundwater data and the current permit. If necessary, a treatment method other than pH control would be selected based on the quantity and quality of the extracted groundwater.

A preliminary summary of groundwater data and current discharge permit limits is presented in **Table 6-10**.

6.5.2.3 Predictive Modeling

(CAP Content Section 6.D.a.iii)

A groundwater extraction system would hydraulically control and remove COI mass at or beyond the compliance boundary. A groundwater extraction system would reduce the mass and concentrations of COIs in Site groundwater. The permeability of the formations might limit extraction flow rates. Simulated groundwater extraction flow rates per well are approximately 13 gpm for combined saprolite/deep wells and 4 gpm for bedrock wells.

The flow and transport model predicts the maximum extent of the COI plume at any point in time will be approximately 1,500 feet beyond the compliance boundary as indicated by sulfate downgradient from the RAB. For boron, the maximum extent of the simulated plume at any point in time will be approximately 300 feet beyond the compliance boundary. Simulations indicate that boron and sulfate concentrations in groundwater would meet the 02L standards at the compliance boundary in excess of 500 years after ash basin closure.

6.5.3 Remedial Alternative 3: Groundwater Extraction Combined with Targeted Clean Water Infiltration and Treatment

(CAP Content Section 6.D.a)

Alternative 3 consists of groundwater extraction combined with clean water infiltration (*i.e.* groundwater recharge) and treatment for the areas north, northeast, and east of the ash basins and coal pile area at or beyond the compliance boundary. This alternative provides technology for groundwater control and capture (*i.e.* infiltration and extraction) to address Site specific COIs. Under this alternative, compliance is achieved in approximately 10 years from system startup and operation.

6.5.3.1 Problem Statement and Remediation Goals

(CAP Content Section 6.D.a.i)

Constituents in groundwater associated with the Allen ash basins and coal pile area occur at or beyond the compliance boundary to the north, northeast and east of the source areas at concentrations detected greater than applicable 02L standards, IMAC, or background values, whichever is greater. Remediation goals are to restore groundwater quality at or beyond the compliance boundary by returning COIs to acceptable concentrations (02L/IMAC or background, whichever is greater), or as closely thereto as is economically and technologically feasible consistent with 15A NCAC 02L. 0106(a). In the future, alternative standards may be proposed as allowed under 02L .0106(k). This approach is considered reasonable given the documented lack of human health or ecological risk at Allen *(CAP Content Section 6.D.a.i.2).*

The following groundwater COIs to be addressed by corrective action are identified (**Table 6-6**) and discussed in **Section 6.1.3**: boron, cobalt, iron, manganese, strontium, sulfate, and TDS *(CAP Content Section 6.D.a.i.1)*. These are the COIs that exhibit a discernable plume associated with the ash basins and/or coal piles.

The conceptual model and predictive modeling discussions summarize the foundations for development of the groundwater extraction and treatment alternative. More extensive discussion of the CSM can be found in **Section 5.0**, discussion of flow and transport modeling in **Appendix G**, and discussion of geochemical modeling in **Appendix H**.

6.5.3.2 Conceptual Model

(CAP Content Section 6.D.a.ii)

The applicable technologies that comprise this alternative include:

- 87 extraction wells
- 76 vertical clean water infiltration wells or approximately 48 vertical clean water infiltration wells combined with approximately 22 horizontal clean water infiltration wells
- Pumps, associated piping, and control systems
- Infiltration and discharge piping and structure
- pH adjustment or other treatment systems, if necessary

The proposed designs and well locations are shown on **Figures 6-28a** and **6-28b**. Horizontal infiltration wells may be used in place of some vertical infiltration wells depending on access to the coal pile area and the power block area. Vertical wells would be preferred because vertical wells: are more adaptable for changing site conditions; have similar design components with the majority of the Site and other locations; cost less to install; have more predictable performance; and are easier to maintain. However, flow and transport model simulations indicate that the time to achieve 02L compliance boron and sulfate would be the same using either vertical or horizontal infiltration wells.

To achieve compliance with 02L, the flow and transport model predicts a total groundwater extraction flow rate of approximately 970 gpm and a infiltration flow rate of approximately 380 gpm if only vertical clean water infiltration wells are used or approximately 230 gpm (vertical wells) and 175 gpm (horizontal wells) if vertical and horizontal clean water infiltration wells are used.

The number of extraction and clean water infiltration wells is estimated based on flow and transport modeling results (**Appendix G**). **Table 6-13** summarizes the systems groundwater extraction well and clean water infiltration well information. Raw water used for infiltration would be obtained from the Catawba River using an intake currently used for Station operations. The plant water system would be accessed from the existing distribution system. Pressure for delivery of the water to infiltration wells would be obtained by connecting the infiltration system tank located on the Site.

The system design includes a large number of extraction wells to be completed into the shallow bedrock to allow full drawdown within the shallow and deep (transition zone) flow zones. Depths of extraction wells are dependent on the contacts between the shallow, deep and bedrock flow zones and fractures within the bedrock. As a result, extraction well depths range from approximately 65 feet bgs to 395 feet bgs in the design.

The system design also includes a large number of clean water infiltration wells to be completed into the shallow and deep (transition zone) flow zones. Depths of extraction wells are dependent on the contacts between the shallow, deep and bedrock flow zones. As a result, infiltration well depths range from approximately 75 feet bgs to 138 feet bgs in the design.

Horizontal wells, if used, would be installed at two depths at each location. One well would be installed in the shallow flow zone and another would be installed deeper within the transition zone. Installing horizontal wells at two different depths increases the surface area for flushing of constituents and, as indicated by modeling, also prevents downward migration of constituents that could result if only shallow horizontal wells are installed.

Based on the CSM (**Section 5.0**) and flow and transport modeling results (**Appendix G**), the groundwater COIs are hydraulically controlled within the topographic drainage basin downgradient of the ash basins and coal pile area. The following groundwater COIs subject to corrective action are identified and discussed in **Section 6.1.3**: boron, cobalt, iron, manganese, strontium, sulfate, and TDS. These are the COIs that exhibit a discernable plume associated with the ash basins and/or coal piles.

The distribution of conservation COIs (boron, sulfate and TDS) represents the area of maximum COI distribution at or beyond the compliance boundary and is the focus of corrective action. Because this alternative provides hydraulic control and capture of boron and sulfate, the most mobile COIs, it addresses all of the targeted COIs, because reactive and variably reactive COIs will follow the same flow path but with greater attenuation. With some exceptions, other COIs have generally not migrated horizontally or vertically in the shallow, deep, and bedrock flow zones appreciably from the source area, and are not expected to do so due to constituent geochemical characteristics and Site geochemical and hydrogeologic conditions.

It is expected that infiltrations water obtained from the Catawba River would be treated for pH and suspended solids using pH adjustment technology and flocculation technology. It is expected that extracted water would be treated and discharge through the existing NPDES Outfall 002 based on currently available groundwater data and the current permit. If necessary, a treatment method other than pH control would be selected based on the quantity and quality of extracted groundwater.

A preliminary summary of groundwater data and current discharge permit limits is presented in **Table 6-10**.

6.5.3.3 Predictive Modeling

(CAP Content Section 6.D.a.iii)

A clean water infiltration and extraction system would result in localized groundwater flow control and increase the rate of mass removal. While the permeability of the formations will limit flow, the additional volume of groundwater created by clean water infiltration will increase the effectiveness of the system, flushing the system with clean infiltration water and reducing COI concentrations. Simulated groundwater extraction flow rates per well are approximately 13 gpm for combined saprolite/deep wells and 4 gpm for bedrock wells. The flow and transport report (**Appendix G**) and geochemical modeling report (**Appendix H)** provide detailed predictions, descriptions, and explanations of the effects of clean water infiltration and extraction.

The flow and transport model predicts the maximum extent of the COI plume at any point in time will be approximately 1,500 feet beyond the compliance boundary as indicated by sulfate downgradient from the RAB. For boron, the maximum extent of the simulated plume at any point in time will be approximately 300 feet beyond the compliance. Simulations indicate that boron and sulfate concentrations in groundwater would meet 02L standards at the compliance boundary approximately 10 years after implementation of the remedial system.

6.6 Remedial Alternatives Screening Criteria

(CAP Content Section 6.D.a.iv)

This section provides supplemental information beyond the CAP content guidance to describe the screening criteria used to evaluate groundwater remediation alternatives at Allen. The screening criteria used to evaluate technologies and alternatives for groundwater corrective action are described below. These screening criteria are based on the criteria outlined in 15A NCAC 02L .0106(i) and 40 Code of Federal Register (CFR) 300.430. The source of the screening criteria descriptions is 40 CFR 300.430. These screening criteria will be used in evaluating the three remedial alternatives identified in **Section 6.5**.

- Protection of human health and the environment
- Compliance with applicable regulations
- Technical and logistical feasibility
- Time required to initiate and implement corrective action alternative

- Short-term effectiveness
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, and volume
- Time required to achieve remediation goals
- Community acceptance

Additional considerations for remedial alternative evaluations include:

- Adaptive site management and remediation considerations
- Sustainability

Protection of Human Health and the Environment

The Updated Human and Ecological Risk Assessments report (**Appendix E**) has determined that there are no imminent hazards to public health and safety or the environment associated with coal ash basin or coal ash constituents in Site soil and groundwater. The updated risk assessment indicates acceptable risk and no exposure to residential receptors at or near the ash basin (no completed exposure pathways). The assessment did not result in an increase of risks to ecological receptors (mallard duck, great blue heron, muskrat, river otter, kill deer bird) exposed to surface water and sediments associated with the ash basins or coal pile area. Regardless, potential corrective measures are being evaluated for regulatory compliance.

Technologies and remedial alternatives are evaluated to determine whether they can achieve regulatory compliance within a reasonable timeframe, without detriment to human health and the environment.

Compliance with Applicable Regulations

Technologies and alternatives are herein evaluated to assess compliance with applicable federal and state environmental laws and regulations. These include:

- CAMA (NC SB 729, Subpart 2)
- Groundwater Standards (NCAC, Title 15A, Subchapter 02L)
- Well construction and maintenance standards (NCAC Title 15A Subchapter 02C)
- NPDES (40 CFR Part 122)
- Sediment erosion and control (NCAC Title 15A Chapter 04)

Technical and Logistical Feasibility

The ease or difficulty of implementing technologies and alternatives are assessed by considering the following types of factors as appropriate:

- Technical feasibility, including technical difficulties and unknowns associated with the construction and operation of a technology, the reliability of the technology, ease of undertaking additional remedial actions, and the ability to monitor the effectiveness of the remedy
- Administrative feasibility, including activities needed to coordinate with agencies, and the ability and time required to obtain any necessary approvals and permits
- Availability of services and materials, including the availability of adequate off-Site treatment, storage capacity, and management capacity and services; as well as the availability of necessary equipment and specialists, and provisions to ensure any necessary additional resources

Time Required to Initiate and Implement Corrective Action Alternative

The time required to initiate and fully implement a groundwater remedial action takes into consideration the following activities, if applicable:

- Source control measures
- Bench-scale testing, if needed
- Treatability testing
- Pilot-testing
- Hydraulic conductivity testing
- Groundwater remedial alternative system design
- Permitting
- System Installation
- Startup

These activities might be requisite to finalize the system design, attain regulatory approval, or initiate construction. Therefore, these activities might dictate the time it takes to initiate and fully implement a remedial alternative.

Short-term Effectiveness

The short-term effects of alternatives are assessed considering the following:

- Short-term risks that might be posed to the community during implementation
- Potential impacts on workers during implementation and the effectiveness of mitigation
- Potential environmental effects during implementation and the effectiveness of mitigation
- Time until protection is achieved

Long-term Effectiveness and Permanence

Technologies and alternatives are assessed for long-term effectiveness in reducing COI concentrations and permanence in maintaining those reduced concentrations in groundwater, along with the degree of certainty that technologies will be successful. Factors considered, as appropriate, include the following:

- Magnitude of residual risk remaining from untreated material remaining at the conclusion of remedial activities. The characteristics of the residuals should be considered to the degree that they could affect long-term achievement of remediation goals, considering their volume, toxicity, and mobility. Since there is no current risk, the potential for a remedial technology to increase potential risk to a receptor is considered in the evaluation process.
- Adequacy and reliability of controls as a means of evaluating alternatives in addition to managing residual risk.

Reduction of Toxicity, Mobility, and Volume

The degree to which technologies employ recycling or treatment that reduces toxicity, mobility, or volume will be assessed, including how treatment is used to address the principal risks posed at the Site. Factors considered, as appropriate, include the following:

- The treatment or recycling processes the technologies employ and constituents that will be treated
- The mass of COIs that will be destroyed, treated, or recycled
- The degree of expected reduction in toxicity, mobility, or volume
- The degree to which the treatment is irreversible

- The type and quantity of residuals that will remain after treatment, considering the persistence, toxicity, and mobility of such substances and their constituents
- The degree to which treatment reduces the inherent hazards posed by risks at the Site

Predicted Time Required to Achieve Remediation Goals

This criterion includes the estimated time necessary to achieve remedial action objectives. This includes time required for permitting, pilot scale testing, design completion and approval, and implementation of approved remedies.

Cost

The costs of construction and long-term costs to operate and maintain the technologies and alternatives are considered. Costs that are grossly excessive compared to overall effectiveness may be considered as one of several factors used to eliminate alternatives. Alternatives that provide effectiveness and implementability similar to that of another alternative by employing a similar method of treatment or engineering control, but at greater cost, may be eliminated.

Community Acceptance

This assessment considers likely support, concerns, or opposition from community stakeholders about the alternatives. This assessment might not be fully informed until comments on the proposed plan are received. However, some general assumptions of how an alternative would be accepted by the community can be made.

Adaptive Site Management and Remediation Considerations

Remediation alternatives are evaluated to determine whether an adaptive site management process would address challenges associated with meeting remedial objectives. Adaptive site management is the process of iteratively reviewing site information, remedial system performance, and current data to determine whether adjustments or changes in the remediation system are appropriate. The adaptive site management approach may be adjusted over the site's life cycle as new site information and technologies become available. This approach is particularly useful at complex sites where remediation is difficult and may require a long time, or where NCDEQ approves alternate groundwater standards for COIs, such as 4,000 μg/L for boron, pursuant to its authority under 15A NCAC 02L .0106(k). Duke Energy might request alternate standards for ash basin- and coal pile-related constituents, including boron, as allowed under 15A NCAC 02L .0106(k). Alternate standards are appropriate at Allen given the lack of human health and ecological risks at the Site. Factors included in this evaluation include:

- Potential to hinder use of alternative or contingency technologies later
- Suitability to later modifications or synergistic with other technologies
- Information that could be gained from technology implementation to improve the Site Conceptual Model and better inform future remediation decision-making
- Ability to adjust and optimize the technology based on performance data
- Suitability for implementation in a sequential remedial action strategy
- Flexibility to implement optimization without significant system modifications

Sustainability

In accordance with sustainability corporate governance documents integral to Duke Energy and guidance provided by the USEPA, analysis of the sustainability of the remedial alternatives proposed in this CAP Update was identified as an important element to be completed as part of remedy selection process described herein.

Sustainable site remediation projects maximize the benefit of cleanup activities through reductions of the footprint of selected remedies, while preserving the effectiveness of the cleanup measures.

The USEPA, along with ASTM International, developed the Standard Guide to Greener Cleanups – ASTM E2893, which was utilized during the evaluation process as part of the remedial alternative selection effort. ASTM E2893 describes a process to evaluate and implement cleanup activities in order to reduce the footprint of remediation projects. Two primary approaches are described in the document: a qualitative Best Management Practices (BMP) process and quantitative evaluation. Quantitative evaluation was utilized for remedy selection in this CAP Update.

As stated in the ASTM standard, during the remedial selection process, "… the user considers how various remedial options may contribute to the environmental footprint. Conducting a quantitative evaluation at this phase of the remedial alternative selection process provides stakeholders with information to help identify environmental footprint reduction opportunities for all alternatives that are protective of human health and the environment, comply with applicable environmental regulations and guidance, and meet project objectives (ASTM, 2016)."

Each remedial alternative has been assessed using SiteWise™, a public domain tool for evaluating remediation projects based on the overall footprint. SiteWise™ estimates collateral impacts through several quantitative sustainability metrics. The output data from SiteWise™ that can be utilized for remedial alternative comparison includes greenhouse gases, energy usage, and criteria air pollutants (including sulfur oxides, oxides of nitrogen, and particulate matter), water use, and resource consumption. The assessment quantified impacts associated with activities expected to occur during the remedial alternative construction phase, system operations where applicable and long-term monitoring.

Two core elements of the USEPA's Greener Cleanup principles were not quantified through the use of the SiteWise™ tool, as part of the alternatives evaluation: water consumption and waste generation. The analysis tool is set up to quantify the footprint of municipal water use and the accompanying discharge of wastewater for treatment to a publicly owned treatment works (POTW). The remediation activities proposed in the CAP Update do not use municipal water or discharge to a POTW, thereby making that input inapplicable for the calculation. Due to the difficulty of estimating reliable quantities of waste generated during construction the input was considered too uncertain to use as a criteria. These two elements were set aside as less-relevant to remedy selection for the purposes of this CAP Update than the other quantifiable data points available. For the quantitative evaluation of alternatives discussed here, the primary assessments for consideration during sustainability screening are CO2, NOx, SOx, PM10 and energy usage.

Results of these sustainability evaluations are presented and discussed in the detailed analysis sections of the specific alternatives (**Section 6.7**).

6.7 Remedial Alternatives Criteria Evaluation

(CAP Content Section 6.D.a.iv)

Groundwater remediation Alternatives 1, 2 and 3 were formulated in **Section 6.5** using groundwater remediation technologies evaluated and retained for consideration in **Section 6.4**. The criterion for conducting detailed analysis of each groundwater remedial alternative are presented and explained here in **Section 6.7**. The groundwater remediation alternatives formulated in **Section 6.5** will undergo detailed comparative analysis in the following subsections. A summary of the remediation alternative detailed analysis is also included in **Appendix M**.

6.7.1 Remedial Alternative 1 – Monitored Natural Attenuation

Protection of Human Health and the Environment

(CAP Content Section 6.D.a.iv.1)

There is no measurable difference between evaluated Site risks and risks indicated by background concentrations; therefore, no material increases in risks to human health related to the source areas have been identified. The groundwater corrective action is being planned to address regulatory requirements. The risk assessment identified no current human health or ecological risk associated with groundwater downgradient of the source areas. Water supply wells are located upgradient and sidegradient of the source areas and an alternate water supply has been provided to those who selected this option. Surface water quality standards downgradient of the COI-affected plumes are also met.

Based on the absence of receptors, it is anticipated that MNA would continue to be protective of human health and the environment because modeling results indicate COI concentrations will diminish with time. Natural attenuation mechanisms will reduce COI concentrations, and model predictions indicate that no existing water supply wells would be impacted. After decanting and closure the hydraulic divide to the north, west, and south of the ash basins would be more pronounced and groundwater flow would continue toward the Catawba River.

Compliance with Applicable Regulations

(CAP Content Section 6.D.a.iv.2)

MNA would comply with applicable regulations assuming the conditions provided in 02L can be achieved. State and federal groundwater regulations allow for MNA as an acceptable remediation program if regulatory requirements are met. The following are the applicable 02L regulations:

> *(l) Any person required to implement an approved corrective action plan for a non-permitted site pursuant to this Rule may request that the Director approve such a plan based upon natural processes of degradation and attenuation of contaminants. A request submitted to the Director under this Paragraph shall include a description of site specific conditions, including written documentation of projected groundwater use in the contaminated area based on current state or local government planning efforts; the technical basis for the request; and any other information requested by the Director to thoroughly evaluate the request. In addition, the person making the request must demonstrate to the satisfaction of the Director: (1) that all sources of contamination and free product have been removed or controlled pursuant to Paragraph (f) of this Rule; (2) that the contaminant has the capacity to degrade or attenuate under the site-specific conditions; (3) that the time and direction of contaminant travel can be predicted with reasonable certainty; (4) that contaminant migration will not result in any violation of applicable groundwater standards at any existing or foreseeable receptor; (5) that contaminants have not and will not migrate*

> *onto adjacent properties, or that: (A) such properties are served by an existing public water supply system dependent on surface waters or hydraulically isolated groundwater, or (B) the owners of such properties have consented in writing to the request; (6) that, if the contaminant plume is expected to intercept surface waters, the groundwater discharge will not possess contaminant concentrations that would result in violations of standards for surface waters contained in 15A NCAC 2B .0200; (7) that the person making the request will put in place a groundwater monitoring program sufficient to track the degradation and attenuation of contaminants and contaminant by-products within and down gradient of the plume and to detect contaminants and contaminant by-products prior to their reaching any existing or foreseeable receptor at least one year's time of travel upgradient of the receptor and no greater than the distance the groundwater at the contaminated site is predicted to travel in five years; (8) that all necessary access agreements needed to monitor groundwater quality pursuant to Subparagraph (7) of this Paragraph have been or can be obtained; (9) that public notice of the request has been provided in accordance with Rule .0114(b) of this Section; and (10) that the proposed corrective action plan would be consistent with all other environmental laws.*

Appendix I includes a detailed evaluation of the applicability of Alternative 1: MNA as a remedial alternative for the Site.

Long-term Effectiveness and Permanence

(CAP Content Section 6.D.a.iv.3)

MNA would be an effective long-term technology, assuming source control and institutional controls (such as an RS designation) for the affected area. Natural attenuation mechanisms are understood and have been documented (**Appendix I**). Once equilibrium conditions of COI concentrations less than 02L standards are achieved, it is unlikely that the concentrations would increase.

Implementation of MNA will not result in increased residual risk as current conditions and predicted conditions do not indicate unacceptable risk to human health or environment. Additionally, Duke Energy connected 191 households to City of Belmont water supply, fitted 10 households with water treatment systems, and abandoned three public water supply wells that served 77 households. These water supply improvements were made within a 0.5-miles of the ash basin compliance boundary in accordance with General Statutes 130A-309.211(c1) of House Bill 630 (2015). Furthermore, Duke Energy voluntarily connected two businesses and 23 households to the City of Belmont water supply that were otherwise not eligible per G.S. Section 130A-309.211(c1).

Institutional controls (provided by the restricted designation) to limit access to groundwater may also be implemented.

The adequacy and reliability of this approach would be documented with the implementation and maintenance of an effectiveness monitoring program to identify variations from the expected conditions. If factors that are not known at this time were to affect the attenuation process in the future, alternative measures could be taken. Monitoring will be in place to evaluate progress and allow sufficient time to implement changes.

Reduction of Toxicity, Mobility, and Volume

(CAP Content Section 6.D.a.iv.4)

While the COIs are inorganic and cannot be destroyed, they exist in the aquifer as molecules that interact with the natural components of the matrices to prevent mobility and toxicity to receptors. MNA can reduce aqueous concentrations while increasing solid phase concentrations and can therefore, under certain geochemical conditions, reduce COI plume concentrations, volume, and mass. There are no treatment or recycling processes involved with MNA as well as no residuals.

Short-term Effectiveness

(CAP Content Section 6.D.a.iv.5)

The stability and limited areal extent of the COI plume, along with the lack of unacceptable current risk to human and ecological receptors indicates current conditions are protective. Therefore, the technology is effective in the short-term.

There are 234 monitoring wells installed associated with the ash basins and coal pile area. Although some within the immediate areas of the basins will have to be abandoned as part of closure, monitoring wells along the waste boundary and at select downgradient areas will remain to monitor natural attenuation in the short-term.

Technical and Logistical Feasibility

(CAP Content Section 6.D.a.iv.6)

A majority of the 234 monitoring wells have dedicated sampling equipment and an approved interim monitoring plan is in place. A subset of these monitoring wells could be immediately used for MNA purposes. Therefore, the technology could be implemented easily. Other than the abandonment of select wells within the ash basins from closure, no construction is required to implement this option. Implementation of an MNA program is a well-defined process, with established requirements for sampling, laboratory analysis, reporting, performance review, and communication of findings to stakeholders.

Time Required to Initiate and Implement Corrective Action Technologies and Alternatives

(CAP Content Section 6.D.a.iv.7)
The time required for implementation of an MNA program could be as immediate as approval of the approach since an extensive monitoring well network already exists. Procedures for collection, analysis, and communication of results are also established and currently in place.

6.7.2 Remedial Alternative 2 – Groundwater Extraction and Treatment

Protection of Human Health and the Environment

(CAP Content Section 6.D.a.iv.1)
There is no measurable difference between evaluated Site risks and risks indicated by background concentrations; therefore, no material increases in risks to human health related to the source areas have been identified. The groundwater corrective action is being planned to address regulatory requirements. The risk assessment identified no current human health or ecological risk associated with groundwater downgradient of the source areas. Water supply wells are located upgradient and side-gradient of the source areas and an alternate water supply has been provided to those who selected this option. Surface water quality standards downgradient of the COI-affected plumes are also met.

Based on the absence of receptors, it is anticipated that groundwater extraction would create conditions that continue to be protective of human health and the environment because the COI concentrations will diminish with time. By extracting COI mass within the existing COI plumes, which are not affecting receptors, active groundwater extraction would further protect human health and the environment. Therefore, water supply wells would remain unaffected by COIs related to the source areas.

Compliance with Applicable Regulations

(CAP Content Section 6.D.a.iv.2)
Groundwater extraction only and treatment would comply with applicable regulations. Those regulations would include: CAMA, groundwater standards, and extraction well installation and permitting**.** Discharge of extracted water would be in compliance with appropriate discharge requirements, such as pH or

other COI limitations in the NPDES permit and proper operation and maintenance of an effectiveness monitoring system.

Activities will also be in compliance with applicable regulations with proper operation and maintenance of an effectiveness monitoring system.

Long-Term Effectiveness and Permanence

(CAP Content Section 6.D.a.iv.3)

Groundwater extraction may contribute to effective and permanent achievement of groundwater standards. Although, as indicated by the modeling results for this alternative, extraction flow rates would be low after basin decanting and source control measures have been implemented. However, it still can provide a benefit through hydraulic capture and mass removal, which are significant factors in achieving remedial objectives. If factors that are not known at this time were to affect the remediation process in the future, alternative measures could be taken to modify the remedial approach.

Reduction of Toxicity, Mobility, and Volume

(CAP Content Section 6.D.a.iv.4)

Although the COIs are inorganic and cannot be destroyed, a groundwater extraction system would help reduce COI concentrations and, therefore, toxicity, mobility, and volume of COI-affected groundwater. Groundwater extraction would remove constituent mass from the area of regulatory concern. The extracted groundwater would be appropriately treated and discharged according to applicable regulatory requirements. It is anticipated that extracted groundwater would be discharged through the NPDES permitted Outfall 002. Analysis of predicted specific COI concentrations and mass in extracted groundwater during conceptual design of the remediation system may be completed to further assess compliance with discharge regulatory requirements. Treatment technologies for extracted groundwater would be further evaluated after NCDEQ approves the CAP Update and after pilot testing for the proposed extraction system is complete.

Short-term Effectiveness

(CAP Content Section 6.D.a.iv.5)

The stability and limited extent of the COI plume, along with the absence of completed exposure pathways, indicates there are no short-term effects on the environment, workers or the local community. While there are areas with COI concentrations greater than 02L concentrations, the areas are not presenting unacceptable short-term risks. Hydraulic capture of groundwater would occur as soon as the groundwater extraction system is placed into service.

Technical and Logistical Feasibility

(CAP Content Section 6.D.a.iv.6)

Installation of the proposed a groundwater extraction system would require significant efforts in planning, designing, and execution of site preparation. The extensive layout of groundwater remediation system wells, piping, and treatment system components, as well as site topography and other access constraints such as power block infrastructure pose significant challenges to constructability. However, with early awareness of the aforementioned complexities and effective communications between the design, implementation and project management teams, successful construction of the system would be anticipated. If necessary, vertical extraction wells could be installed in phases as access becomes available as the Station is decommissioned.

Time Required to Initiate and Implement Corrective Action Technologies and Alternatives

(CAP Content Section 6.D.a.iv.7)

Design and installation of the system could be completed in approximately two to three years after CAP approval.

Predicted Time Required to Meet Remediation Goals

(CAP Content Section 6.D.a.iv.8)

Time to achieve the remediation goal of reducing the concentration of boron beyond the compliance boundary to levels less than the 02L standard was estimated by predictive flow and transport modeling. Modeling results for this alternative, for both the east and northeast areas, predict that the extraction flow rate per well would be approximately 13 gpm for combined saprolite/deep wells and 4 gpm for bedrock wells. These simulated flow rates are reasonably similar to the flow rates of approximately 5 gpm obtained during dewatering for construction of the holding basin within the footprint of the coal pile. The simulated flow rates are greater than the observed flow rates because the simulated extraction wells extend deeper into zones with greater yield. The flow and transport simulations predict that boron concentrations in groundwater would meet the boron and sulfate 02L standards at the compliance boundary in excess of 500 years after system startup and operation. Thus, groundwater remediation under this alternative would be slow compared with that of Alternative 3.

Cost

(CAP Content Section 6.D.a.iv.9)
The estimated costs for this alternative have not been fully developed. However, due to the increase in materials and equipment required, the capital cost and annual cost would be more than Alternative 1 and less than Alternative 3. Because Alternative 3 requires the additional material and equipment for clean water infiltration, the capital and operating cost would be greater than Alternative 2. Despite this, the significantly longer lifetime of the Alternative 2 system operating indicates that the life cycle costs would likely be the largest of the three alternatives.

Community Acceptance

(CAP Content Section 6.D.a.iv.10)
It is expected that there will be positive and negative sentiment about implementation of a groundwater extraction only and treatment system. No landowner is anticipated to be affected. The affected property is owned by Duke Energy. It is anticipated that the extracted groundwater would be discharged through a NPDES permitted outfall that flows toward the Catawba River and that the discharge would be treated as necessary to meet all permit limits. An expanded groundwater extraction system which addresses potential COI plume expansion across the entire east and northeast perimeter of the ash basins and coal pile area might improve public perception. Until the final Site remedy is developed and comments are received and reviewed, assessment of community acceptance will not be fully known.

It is anticipated that groundwater extraction and treatment would generally receive more positive community acceptance than MNA under Alternative 1 since it involves more active measures to attempt physical extraction of COI mass from groundwater. This alternative would likely be perceived as more robust than MNA in addressing groundwater impacts even if modeling predicts essentially the same effects between MNA and groundwater extraction.

Adaptive Site Management and Remediation Considerations

Groundwater extraction using conventional well technology is an adaptable process. It can be easily modified to address changes to COI plume configuration or COI concentrations. Individual well pumping rates can be adjusted or eliminated or additional wells can be installed to address COI plume changes. Also, while it is not expected, treatment of the system discharge can be modified to address changes in COI concentrations or permit limits.

Sustainability

The footprint for Alternative 2 was quantified based on energy use and associated emissions, during the construction phase (e.g., material quantities and transportation), active remediation activities (e.g., groundwater pumping and treatment) and groundwater monitoring activities (e.g., transportation). The results of the footprint calculations for Alternative 2 are summarized in **Table 6-14**. A summary of sustainability calculations for Alternative 2 can be found in **Appendix L**.

The footprint of Alternative 2 is the most emission-intensive remedial alternative being considered. This alternative would use extensive materials for construction to install 87 extraction wells and energy during operations; therefore, generating a similar environmental footprint as Alternative 3. Opportunities for system optimization and energy savings could be pursued throughout the remediation timeframe, as conditions change and component technologies possibly evolve to lessen the environmental footprint. However, the significantly-longer operational window of Alternative 2, when compared to Alternative 3, would be the predominant factor contributing to an environmental footprint.

6.7.3 Remedial Alternative 3 – Groundwater Extraction Combined with Targeted Clean Water Infiltration and Treatment

Protection of Human Health and the Environment

(CAP Content Section 6.D.a.iv.1)

There is no measurable difference between evaluated Site risks and risks indicated by background concentrations; therefore, no material increases in risks to human health related to the source areas have been identified. The groundwater corrective action is being planned to address regulatory requirements. The risk assessment identified no current human health or ecological risk associated with groundwater downgradient of the source areas. Water supply wells are located upgradient and sidegradient of the source areas and an alternate water supply has been provided to those who selected this option. Surface water quality standards downgradient of the COI-affected plumes are also met.

Based on the absence of receptors, it is anticipated that groundwater extraction would create conditions that continue to be protective of human health and the environment because the COI concentrations will diminish with time.

By extracting COI mass within the existing COI plumes, which are not affecting receptors, active groundwater extraction would further protect human health and the environment. While the permeability of the formations will limit flow, the additional volume of infiltration water created will increase the effectiveness of the system in enhancing COI mass movement for extraction. Therefore, water supply wells would remain unaffected by COIs related to the source areas.

Compliance with Applicable Regulations

(CAP Content Section 6.D.a.iv.2)

Clean water infiltration, extraction and treatment would comply with applicable regulations. Those regulations would include: CAMA, groundwater standards, infiltration and extraction well installation and permitting. Discharge of extracted water would be in compliance with appropriate discharge requirements, such as pH or other COI limitations in the NPDES permit and proper operation and maintenance of an effectiveness monitoring system. If the water supply for clean water infiltration wells is from a surface water source, additional permitting may be required.

Activities will also be in compliance with applicable regulations with proper operation and maintenance of an effectiveness monitoring system.

Long-term Effectiveness and Permanence

(CAP Content Section 6.D.a.iv.3)

Clean water infiltration and extraction will contribute to effective and permanent achievement of groundwater standards by facilitating movement of impacted groundwater such that the COI plume is hydraulically controlled and COI mass is more effectively removed as predicted by modeling results.

The adequacy and reliability of this approach would be documented with the implementation of an effectiveness monitoring program that would identify variations from the expected outcome. If factors that are not known at this time were to affect the remediation process in the future, alternative measures could be taken to modify the remedial approach.

Reduction of Toxicity, Mobility, and Volume

(CAP Content Section 6.D.a.iv.4)

Although the COIs are inorganic and cannot be destroyed, a groundwater extraction combined with clean water infiltration would help reduce COI concentrations and, therefore, toxicity, mobility, and volume of COI-affected groundwater. Groundwater extraction combined with clean water infiltration would remove constituent mass from the area of regulatory concern. The extracted groundwater would be appropriately treated and discharged according to applicable regulatory requirements. It is anticipated that extracted groundwater would be discharged through the NPDES permitted Outfall 002. Analysis of predicted specific COI concentrations and mass in extracted groundwater during conceptual design of the remediation system may be completed to further assess compliance with discharge regulatory requirements. Treatment technologies for clean water infiltration and extracted groundwater will be evaluated after NCDEQ approves the CAP Update and after pilot testing for the proposed extraction system is complete.

Short-term Effectiveness

(CAP Content Section 6.D.a.iv.5)

The stability and limited extent of the COI plume, along with the absence of completed exposure pathways, indicates there are no short-term effects on the environment, workers or the local community. While there are areas with COI concentrations greater than 02L concentrations, the areas are not presenting unacceptable short-term risks. Hydraulic control and capture of groundwater would occur as soon as the groundwater extraction and clean water infiltration system is placed into service.

Technical and Logistical Feasibility

(CAP Content Section 6.D.a.iv.6)

Installation of the proposed clean water infiltration and extraction system would require significant efforts in planning, designing, and execution of site preparation. The extensive layout of groundwater remediation system wells, piping, and treatment system components, as well as site topography and other access constraints such as power block infrastructure access constraints pose significant challenges to constructability. However, with early awareness of the aforementioned complexities and effective communications between the design, implementation and project management teams, successful construction of the system would be anticipated.

Time Required to Initiate and Implement Corrective Action Technologies and Alternatives

(CAP Content Section 6.D.a.iv.7)

Design and installation of the system could be completed in approximately two to three years after CAP approval.

Time Required to Meet Remediation Goals

(CAP Content Section 6.D.a.iv.8)

Time to achieve the remediation goal of reducing the concentration of boron and sulfate beyond the compliance boundary to levels less than the 02L standards was estimated by predictive flow and transport modeling. Modeling results for this alternative, for both the east and northeast areas, predict that the extraction flow rate per well would be approximately 13 gpm for combined saprolite/deep wells and 4 gpm for bedrock wells. The model simulates infiltration rates of combined shallow and deep zone wells to be 5 gpm. These simulated flow rates are reasonably similar to the flow rates of approximately 5 gpm obtained during dewatering for construction of the holding basin within the footprint of the coal pile. The simulated flow rates are greater than the observed flow rates because the simulated extraction wells extend deeper into zones with greater yield. Due to increased flow rates and soil flushing from the infiltration wells, the flow and transport model predicts that boron and sulfate concentrations in groundwater would meet 02L standards at the compliance boundary approximately 10 years after system startup, a considerably shorter time frame than Alternatives 1 or 2.

Cost

(CAP Content Section 6.D.a.iv.9)

The increase in materials and equipment required, the capital cost and annual cost would be significantly more than Alternative 1. Relative to Alternative 2, additional material and equipment would be required for clean water infiltration, therefore the capital and also the operating cost would be greater than Alternative 2. Despite this, the significantly less lifetime of the Alternative 3 system operating indicates that the life cycle costs would be the least of the three alternatives.

Community Acceptance

(CAP Content Section 6.D.a.iv.10)

It is expected that there will be positive and negative sentiment about implementation of a clean water infiltration and extraction system. No landowner is anticipated to be affected. The affected property is owned by Duke Energy. It is anticipated that the extracted groundwater would be discharged through a NPDES permitted outfall that flows toward the Catawba River and that the discharge would be treated as necessary to meet all permit limits. An expanded groundwater extraction system which addresses potential COI plume expansion across the entire east and northeast perimeter of the ash basins and coal pile area may improve public perception. Until the final Site remedy is developed and comments are received and reviewed, assessment of community acceptance will not be fully known.

It is anticipated that groundwater extraction combined with clean water infiltration and treatment under would generally receive more positive community acceptance than MNA under Alternative 1 since it involves more active measures to attempt physical extraction of COI mass from groundwater and would likely be perceived as more robust than MNA.

Alternative 3 could receive more positive community acceptance than Alternative 2 because it involves additional measures to reduce COI concentrations and enhances extraction of COI mass from groundwater which would result in compliance with 02L sooner than Alternative 2.

Adaptive Site Management and Remediation Considerations

Clean water infiltration and extraction using conventional well technology is an adaptable process. It can be easily modified to address changes to COI plume configuration or COI concentrations. Individual well infiltration and pumping rates can be adjusted or eliminated or additional wells can be installed to address COI plume changes. Also, while it is not expected, treatment of the system discharge can be modified to address changes in COI concentrations or permit limits.

Sustainability

The footprint of Alternative 3 was quantified based on energy use and associated emissions, during the construction phase (e.g., material quantities and transportation), active remediation activities (e.g., groundwater pumping and treatment) and groundwater monitoring activities (e.g., transportation). The results of the footprint calculations for Alternative 3 are summarized in **Table 6-14**. A summary of sustainability calculations for Alternative 3 can be found in **Appendix L**.

The footprint of Alternative 3 is the second-most energy-intensive of the remedial alternatives being considered. Alternative 1 (MNA) requires significantly less materials and energy than Alternative 3 and is therefore characterized by a dramatically smaller footprint. Alternative 3 presents lower, but generally comparable, footprint metrics when measured against Alternative 2. Compared to Alternative 2, Alternative 3 utilizes the same number of extraction wells (87) and either 76 additional vertical clean-water infiltration wells or 48 vertical clean-water infiltration wells combined with 22 horizontal clean-water infiltration wells, generating a higher material-related footprint for the construction phase. However, the reduced timeframe of remediation system operation for Alternative 3 (estimated for this calculation as 8 years) when compared to Alternative 2 (estimated for this calculation as 500 years) produces air emissions approaching the levels of Alternative 2. Opportunities for system optimization and energy savings could be pursued throughout the remediation timeframe, as conditions change and component technologies possibly evolve.

6.8 Proposed Remedial Alternative Selected for Source Area

(CAP Content Section 6.E)

Based on the alternatives detailed analysis using criteria presented in **Section 6.7**, the favored remedy for groundwater remediation is **Alternative 3, Groundwater Extraction Combined with Targeted Clean Water Infiltration and Treatment**.

To comply with 15A NCAC 02L .0106(h), corrective action plans must contain the following items, which are included in the following subsection:

- A description of the proposed targeted corrective action and reasons for its selection.
- Specific plans, including engineering details where applicable, for restoring groundwater quality.
- A schedule for the implementation and operation of the proposed plan.
- A monitoring plan for evaluating the effectiveness of the proposed corrective action and the movement of the COI plume.

Each of these corrective action plan components are included in the following subsections.

6.8.1 Description of Proposed Remedial Alternative and Rationale for Selection

(CAP Content Section 6.E.a)

The selected remedy for groundwater remediation, Alternative 3, is intended to provide the remedial technology that has demonstrated to provide the most effective means for restoration of groundwater quality at or beyond the compliance boundary by returning COIs to acceptable concentrations (02L/IMAC or background, whichever is greater), or as closely thereto as is economically and technologically feasible, consistent with 15A NCAC 02L. 0106(a), and to address 15A NCAC 02L .0106(j) *(CAP Content Section 6.E.a.i).*

The groundwater remediation system includes 87 vertical extraction wells and either approximately 76 vertical clean water infiltration wells or approximately 48 vertical clean water infiltration combined with approximately 22 horizontal clean water infiltration wells.

The groundwater remediation system also includes all associated piping and controls, and, as necessary, treatment facilities for both clean water infiltration and extraction water. **Figure 6-28a** provides a conceptual layout of the proposed groundwater extraction combined with clean water infiltration remediation system showing vertical infiltration wells. **Figure 6-28b** provides a conceptual layout of the proposed groundwater extraction combined with clean water infiltration remediation system showing horizontal infiltration wells in place of some vertical infiltration wells. Model results predict the 02L standard of 700 μg/L for boron and 250 mg/L for sulfate will be achieved at the Allen ash basin compliance boundary approximately 10 years after system startup and operation (**Figures 6-28h** through **6-28k**).

All three groundwater remedial alternatives evaluated contribute to continued protection of human health and the environment, however, a the approach of groundwater extraction combined with clean water infiltration and treatment appears to be the most practical solution given the predicted time frames for 02L compliance. Rationale for selections follows, and is based off multiple lines of evidence, including empirical data collected at Allen, geochemical modeling, and groundwater flow and transport modeling.

Alternative 1 relies on natural attenuation processes and, while there is evidence to suggest that natural attenuation is occurring, one or more levels of the MNA tiered analysis did not meet evaluation criteria for selecting the groundwater remedial alternative, including:

- Predicted timeframe to achieve applicable criteria at the compliance boundary is approximately 460 years after basin closure by excavation and 270 years after basin closure by closure-in-place, which does not meet the criteria of achieving the standards at a timeframe similar to more active remedies.
- Currently boron and sulfate are greater than 02L standards in bedrock at or beyond the compliance boundary. Boron concentrations greater than the 02L standard are predicted based on the groundwater model to occur in bedrock in the future, at or beyond the compliance boundary east of ash

basins. Sulfate concentrations greater than the 02L standard are predicted to occur in bedrock in the future, at or beyond the compliance boundary north and east of the coal pile area.

More detail on the results from the MNA tiered analysis and why MNA alone is not an appropriate corrective action solution at this time can be found in **Appendix I**. MNA may be an appropriate polishing remedy in the future.

Alternative 2 and Alternative 3, remediation systems represent an adaptable approach. The system could be modified relatively easily if conditions change. The addition of wells or adjusting well pumping schemes can be readily accomplished. Although groundwater extraction from Alternative 2 and Alternative 3 involves a verified remedial technology for groundwater capture and provides a long-term and permanent approach, Alternative 3 is a more robust system.

The flow rate predicted for Alternative 2 is insufficient to restore ash basin-affected groundwater at or beyond the compliance boundary within a reasonable (*i.e.* approximately 30 years) timeframe, and therefore does not meet the Duke Energy's corrective action goals. The additional volume of groundwater created by recharge from clean water infiltration has the ability to increase the flushing capacity of the system with clean water and reducing COI concentrations, significantly increasing the effectiveness of the remediation system. Alternative 3, groundwater extraction and clean water infiltration, is projected to satisfy remedial action objectives in a shorter timeframe (approximately 10 years) relative to Alternative 2 (greater than 500 years). Alternative 3 includes clean water infiltration wells, with groundwater infiltration rates of approximately 5 gpm per well for vertical wells and 7 gpm per well for horizontal wells, for a total system infiltration rate ranging from approximately 335 to 345 gpm. The extraction rate per well for Alternative 3 is approximately 13 gpm for combined saprolite/deep wells and 4 gpm for bedrock wells, for a total system extraction rate of approximately 950 gpm. Comparatively, Alternative 2 relies on technology where extraction rates are limited to the groundwater formation's natural flow rates, without the additional volume of water from clean water infiltration wells to increase flushing capacity. The extraction rate per well for Alternative 2 is approximately 10 gpm for combined saprolite/deep wells and 5 gpm for bedrock wells, for a total system extraction rate of approximately 650 gpm. By supplementing the natural groundwater system with clean water infiltration, extraction rates increases and therefore, increase the effectiveness of the remediation system and reduce the timeframe to meet compliance by more than 250 years.

Additionally, Alternative 2 does not restore ash basin-affected groundwater at or beyond the compliance boundary by returning COI concentrations to the groundwater quality standards, or applicable background concentrations (whichever are greater), or as closely thereto as is economically and technologically feasible consistent with 15A NCAC 02L. 0106(a). An extraction only and treatment system would have to maintain operation for a longer period of time, relative to Alternative 3, which adds a substantial operation and maintenance (O&M) cost and lessens the economically feasibility.

Although Alternatives 2 and 3 generate a larger environmental footprint in the sustainability analysis than MNA, the footprint of a groundwater remediation system is still small in comparison to other elements of the ash basin closure process. During design phases of the groundwater remediation project, opportunities for energy efficiency and reduction of the project environmental footprint can be evaluated. Potential duplication of intensive construction efforts should be considered.

Relative to Alternative 2, Alternative 3 would accelerate removal of COI mass from the groundwater system, reducing the groundwater plume footprint to within the compliance boundary, and achieve compliance within a shorter timeframe as is economically and technologically feasible. Therefore, Alternative 3 is the favored remedial alternative for implementation at Allen. The long-term effectiveness would be documented through an effectiveness monitoring program detailed in **Section 6.8.5**.

Seep Corrective Action

As stated in the SOC, ash basin decanting is expected to substantially reduce or eliminate the seeps. Groundwater corrective action discussed in this CAP Update and ash basin closure would also reduce or eliminate the seeps. After completion of decanting, remaining seeps (constructed and non-constructed), if not dispositioned in accordance with the SOC, would be characterized for determination of disposition. After seep characterization, an amendment to the CAP and/or Closure Plan, may be required to address remaining seeps. Duke Energy is prepared to address those seeps through corrective action sufficient to protect public health, natural resources, and the environment. Seeps that have the potential to not be fully dispositioned post-decanting are listed on **Table 6-8** and discussed in terms of with corrective action strategies, sequentially below. In summary, decanting, ash basin closure, and groundwater extraction are the anticipated corrective action strategies to address each of the seeps and no additional corrective action is planned at this time.

Non constructed seep S-02, located southeast of the AAB, is covered by the SOC. As of November 2019, decanting has substantially reduced flow at this location such that overland flow infiltrates prior to reaching the Catawba River (Lake Wylie). The last reported flow at this location was during SOC-related sampling during August 2019. During that time flow was minimal (approximately 0.07 cubic feet per second). No flow or standing water was observed during inspections in October and November 2019. This indicates that decanting has been an effective corrective measure and that it may be appropriate for S-02 to be dispositioned. Duke Energy will continue to monitor S-02 and if flow resumes unexpectedly sometime in the future, additional corrective measures, such as phytoremediation technology, would be considered.

The NPDES Permit includes constructed seep S-3 (identified as Toe Drain Outfall 103) and constructed seep S-4 (identified as Toe Drain Outfall 104), which are east of the AAB. As permitted outfalls, corrective action is not necessary for these former seeps. However, in the future, additional corrective action to manage potential flow from these seeps may be considered proactively. As of November 2019, flow has been reduced, but not yet ceased, in response to decanting from the AAB. Continued decanting and basin closure may cause these outfalls to cease flowing and therefore be dispositioned, but retained as permitted outfalls. Groundwater extraction in the vicinity of these outfalls, planned as part of this CAP Update may also cause flow to cease. If flow continues, additional corrective action could include construction of a sump along the flow path of the seeps to capture flow that could be managed with extracted groundwater. In the interim, Duke Energy will to continue to monitor the outfalls in accordance with the NPDES permit.

Non-constructed seeps S-5, S-6, and S-7 emerge intermittently below the ordinary high water mark. Flow, if present, is often concealed beneath the Lake Wylie water surface. Flow was observed as recently as November 2019 from S-5 and S-6, but was concealed, if present, at S-7. Source control measures (i.e. decanting and ash basin closure) are anticipated to reduce potential for flow to continue. Corrective action planned as part of this CAP Update includes installation of extraction wells in the vicinity of these seeps. Groundwater modeling indicates extraction wells would reduce or eliminate these seeps. Duke

Energy plans to continue to monitor these seeps and if continued decanting, source control, and groundwater corrective action measures are not effective in ceasing flow, then additional corrective measures would be considered, such as capturing flow for management with extracted groundwater or phytoremediation technologies.

The NPDES Permit also includes constructed seep S-8 (identified as Toe Drain Outfall 108) and constructed seep S-8B (identified as Toe Drain Outfall 108B), which are east of the AAB. As permitted outfalls, corrective action is not necessary for these former seeps. Pre-decanting, flow in these outfalls was minimal at less than 0.001 cubic feet per second with the last reported flow observed during SOC-related sampling during February 2019. No flow or standing water was observed during inspections in October and November 2019. This indicates that decanting has been an effective corrective measure and that it would be appropriate for the seeps S-8 and S-8B to be dispositioned, but maintained as NPDES outfalls. Additionally, basin closure and groundwater extraction wells planned as part of this CAP Update may also reduce the potential for flow to resume at these outfalls. Duke Energy will continue to monitor these locations in accordance with the NPDES Permit and if flow resumes unexpectedly sometime in the future, additional corrective measures would be considered.

Flow at seep S-10, located north of primary pond 1 of the AAB, is currently captured within a French drain system and managed for treatment within the lined retention basin. Decanting has reduced flow and flow is anticipated to be further reduced or ceased as decanting continues. S-10 is encompassed within the area included to be a part of ash basin closure. Basin closure would eliminate the seep. Duke Energy plans to continue to monitor S-10 in accordance with the SOC. If flow increases substantially and unexpectedly in the future prior to implementation of additional closure activities, additional corrective measures would be considered.

Final corrective action plans for constructed and non-constructed seeps that are not dispositioned post-decanting will be proposed in an amendment to this CAP Update and submitted based on the schedule outlined in the SOC.

6.8.2 Design Details

(CAP Content Section 6.E.b)

Design of the proposed clean water infiltration and extraction system would require a pilot test (i.e., installation of a portion of the system) to facilitate refinement of the final system design. A pilot test work plan will be prepared to facilitate implementation of the system. As part of this process, the groundwater flow and transport model will likely be refined to determine the final number and locations of system wells. As the pilot testing and design process evolves, refinements to the systems and timeframe, including a potential reduction in the time needed to achieve compliance may occur compared to the model predictions presented in this CAP.

The intent of the design would be to maximize pore volume exchange (*i.e.* groundwater flushing) and establish groundwater flow control and capture in areas downgradient of the ash basins and coal pile area. Basic installation components of the recommended alternative include:

- 87 extraction wells and appurtenances
- 76 clean water vertical infiltration wells and appurtenances or 48 clean water vertical infiltration wells combined with 22 clean water horizontal infiltration wells and appurtenances
- Well vault and wellhead piping, fittings, and instrumentation
- A system to control water level within each groundwater extraction well
- Groundwater extraction system discharge piping
- Groundwater physical chemical treatment
- Clean water infiltration pre-treatment system
- Clean infiltration water distribution system
- Electric power supply
- Groundwater remediation telemetry system

Conceptual process flow diagrams for infiltration, extraction, and treatment systems are provided on **Figures 6-29** through **6-31.** The detailed design elements presented below may be adjusted based on a final technical review.

6.8.2.1 Process Flow Diagrams for All Major Components of Proposed Remedy

(CAP Content Section 6.E.b.i)

Conceptual process flow diagrams for extraction and treatment systems are provided on **Figures 6-29** through **6-31**.

Below is a 10-step process for remedy design considerations and implementation of major components, including design assumptions, calculations, and specifications where applicable at the conceptual design stage.

Site Preparation (Step 1 – Create Access)

Installation of the proposed clean water infiltration and extraction system would require significant efforts in planning, designing, and execution of site preparation. The extensive layout of groundwater remediation system wells, piping, and treatment system components, as well as site topography and access constraints pose significant challenges to constructability. Furthermore, installation of groundwater extraction wells between the coal pile areas and the Catawba River would be challenging due to the presence of buried utilities and above ground infrastructure (e.g., railroad tracks) the area. However, with early awareness of the aforementioned complexities and effective communications between the design, implementation and project management teams, successful construction of the system would be anticipated.

Safe access roads for mobile construction equipment (e.g., drill rigs), as well as long-term operation and maintenance needs, will likely require extensive clearing, grubbing, grading, and access improvement.

A certain level of flexibility regarding well placement is expected to be required due to site conditions encountered during construction. Prior to construction and following the pump tests, an assessment of the precise locations of wells would be made in collaboration with the modeler. If the model predictions are not affected, relocation from the predetermined location due to terrain or other site-specific constraints would expedite construction.

Land disturbance will require E&SC to be implemented and likely reviewed and approved by a regulatory agency. Adaptable E&SC should be planned to limit project delays by avoiding formal modifications of plans.

Decommissioning would include removal of the coal pile. It is anticipated that the coal piles will remain in place until the Station is retired, currently planned for 2024 for Units 1, 2, and 3 and 2028 for Units 4 and 5. Removal of the coal piles would allow access for installation of vertical wells within the footprint of the coal piles. However, horizontal wells could be installed within the footprint of the main coal pile prior to decommissioning.

Pilot Tests (Step 2 – To Finalize Design)

A pilot test would involve installation of a portion of the planned system to evaluate how the system performs and to make initial progress towards remediation at the same time. The results of the pilot test would be used to refine and scale up the final design thereby maximizing the likelihood of successful operation in the field. Clean water infiltration tests would be conducted to determine the infiltration rates of clean water infiltration wells screened within or across saprolite, transition zone, and bedrock flow zones.

Extraction pilot test wells will be screened within or across a flow zone similar to model simulations to the extent feasible.

Pilot test results will be used to:

- Determine site-specific well yields for each flow zone
- Validate predictive flow and transport modeling
- Refine predictive flow and transport modeling, as needed
- Confirm groundwater extraction well capture zones in the saprolite and transition zone flow zones beyond available data
- If warranted, make adjustments to the groundwater extraction system design
- If warranted, make design adjustments to conveyance for infiltration water
- If warranted, make design adjustments to the groundwater treatment system

Clean water infiltration test wells will be screened within or across flow zones, similar to model simulations to the extent feasible. Groundwater infiltration test results will be used to:

- Determine site-specific well infiltration rates
- Validate predictive flow and transport modeling
- Verify predictive flow and transport modeling

- If warranted, make adjustments to the clean water infiltration system design
- If warranted, make design adjustments to conveyances for infiltration groundwater
- If warranted, make design adjustments to the clean water infiltration treatment system

The extraction and clean water infiltration wells used for testing would be included in the final groundwater remediation system design.

Clean Water Infiltration and Extraction Well Design (Step 3 – Install Wells)

(CAP Content Section 6.E.b.i)

The preliminary design for the groundwater remediation system includes installation of approximately 87 extraction wells and either approximately 76 vertical clean water infiltration wells or approximately 48 vertical clean water infiltration wells combined with approximately 22 horizontal clean water infiltration wells and (**Figures 6-28a** and **6-28b**). The clean water infiltration and extraction wells would be installed to the north, northeast and east of the ash basins and coal pile area. The locations are based on predicted COI plume configuration, with the intent of capturing groundwater to create groundwater flow control, COI mass removal, and reduced migration of potentially mobile COIs. The predicted effects of the wells are defined in detail in flow and transport modeling results (**Appendix G**).

Extraction wells would be completed in the shallow, deep and bedrock flow zones to depths ranging from approximately 65 feet bgs to 365 feet bgs. Vertical clean water infiltration wells would be completed in the shallow and deep zones to depths ranging from 75 to 138 feet bgs. Horizontal wells, if included, would be completed in the shallow zone at an approximate depth of 20 feet bgs and within or near the deep zone at an approximate depth of 80 feet bgs. Groundwater infiltration and extraction wells would be installed by a North Carolina licensed well driller in accordance with NCAC 15A, Subchapter 2C – Well Construction Standards, Rule 108 Standards of Construction: Wells Other Than Water Supply (15A NCAC 02C .0108). Modeled clean water infiltration well details are provided on **Table 6-15**. Modeled extraction well details are provided on **Table 6-16**.

The clean water infiltration and extraction wells might be drilled using hollow stem auger, air percussion/hammer, sonic methods, or a combination thereof. The drilling method would depend on Site conditions and well type (e.g., vertical or horizontal). All materials and installations would be in accordance with 15A NCAC 02C. Completed wells would be 6 inches in diameter to facilitate the installation of pumps and instrumentation (e.g., level control) in groundwater extraction wells. For vertical wells, the top of the sand pack would extend to approximately 2 feet above the top of well screens overlain by a bentonite well seal at least 2 feet thick installed on top of the sand pack and a neat cement grout with 5 percent bentonite would be placed on top of the bentonite well seal and would fill the remaining well annulus to within 3 feet of the ground surface. Typical well construction schematics for infiltration and extraction wells are included as **Figures 6-28c** through **6-28f**.

If horizontal wells are used for infiltration, the wells would be installed by certified North Carolina well driller as double- or single-ended horizontal infiltration wells in the footprint of the coal pile as shown conceptually on **Figures 6-28d** and **6-28e**. A typical horizontal environmental well is installed at an angle approximately minus 12 degrees from horizontal (Ellington-DTD, 2004). The equipment would be set up at a distance such that the boring at an angle that is predetermined and would reach the point of beginning of the screen at the target depth of the screen. A directional pilot bore smaller than the diameter of the well would be installed using a navigational system, such as a wireline navigation system. Drilling fluid would be used for cutting the borehole and stabilizing the borehole wall until the well materials are installed. Surface seals would be installed in the annulus at both ends, and the well will be developed. One end of the well would be capped with a water-tight seal. The well head will be completed in a manner similar to the vertical injection wells. (Ellington-DTD, 2019).

Well Head Configuration (Step 4 – Construct Well Heads)

(CAP Content Section 6.E.b.i)

The proposed extraction and clean water infiltration well vaults would be precast concrete with aluminum access doors that include a drainage channel. The concrete enclosures would be finished below grade and the piping and fittings in the enclosures would be Type 304 stainless steel to reduce risk of damage during O&M. Due to the location of plant infrastructure and utilities, any of the extraction wells and some of the infiltration wells will be located in internal plant roads. Plant personnel have indicated that the vehicular traffic on these roads are passenger cars and light trucks travelling at speeds of 30 miles per hour or less. Well heads that cannot be protected by bollards must have enclosures meeting the appropriate H20 loading.

Any above ground piping would be insulated and heat traced. The piping would transition from the Type 304 stainless steel to high density polyethylene (HDPE) at a flange near the opening where the HDPE pipe leaves the enclosure. The buried sections of pipe would be fusion-welded HDPE (**Figure 6-25g**).

The enclosures would have a 2-inch drain with a compression cap for controlled release of rainwater or condensate. A water level sensor would be mounted on the wall of the enclosure approximately 6-inches above the floor. Should water accumulate to that level, the extraction pump or infiltration water would be stopped and an alarm would be sent to the operator, who could ascertain the cause of the high water level.

Clean Water Infiltration Wells (Step 4A)

(CAP Content Section 6.E.b.i)

An HDPE distribution header would convey clean water from the infiltration water treatment system to each clean water infiltration well (**Figure 6-28c**). A seal at the top of the well through which the clean water infiltration pipe and wiring would enter the well, would be designed to be leak free.

The hydraulic head at each clean water infiltration well would be controlled by a pressure control valve. Ten-feet of water (4.34 pounds per square in gauge) is the infiltration pressure used in the predictive groundwater flow and transport model, but the pressure could be increased or decreased to achieve performance objectives. Operation of the clean water infiltration wells would comply with 15A NCAC 02C.0225. Infiltration pressures and rates would be determined based on the hydraulic conductivity of the strata receiving the clean water.

The amount of water flowing into the clean water infiltration well would be measured by a flow rate and flow totalizing meter. At startup, a ball valve at the top of the well would be opened to allow water to displace the air in the well and system piping. Also, pressure transducers installed at the top of each clean water infiltration well would monitor well head pressures (**Figure 6-28c**).

Other appurtenances in the piping system would include a pressure gauge, ball valves to isolate piping for maintenance, and a solenoid valve that would close to stop the flow of infiltration water in the event high water level in the vault.

Operational parameters, such as infiltration flow rate, totalized infiltration flow, and well head pressure, as well as critical malfunctions such as accumulation of water in the well vault would be transmitted to the groundwater remediation system owner via telemetry system.

Extraction Wells (Step 4B)

(CAP Content Section 6.E.b.i)
A pump would be installed in each groundwater extraction well. If the water level in the well is above the top water level switch, the pump would run to pump the water to lower water level switch, which would cause the pump shut off. The flow of extracted groundwater from the submersible pump would be measured using a flow rate and flow totalizer meter before being conveyed to groundwater discharge piping for treatment and management (**Figure 6-30**). Other appurtenances in the piping system would include:

- a check valve to prevent back flow into the well,
- a sampling port, a pressure gauge to indicate the pressure generated by the pump,
- ball valves to isolate piping for maintenance,
- and a flow control valve such as a stainless steel globe or gate valve (**Figure 6-30**)

Operational parameters, such as flow and water level, and critical malfunctions, such as accumulation of water in the well vault, would be transmitted via telemetry system to inform the system operator of the status in the well and enclosure.

Clean Water Infiltration Water Treatment (Step 5 – Build Infiltration Treatment)

(CAP Content Section 6.E.b.i)

Water used for clean water infiltration will be obtained from the Catawba River. Water supplied to the clean water infiltration wells is non-potable water that is suitable for infiltration as part of the remediation process and not for consumption.

The existing raw water intake would be used. The intake is located along the west bank of the Catawba River on the east side of Duke Energy property near the power block. Raw water would travel through the existing plant distribution system to an infiltration water treatment plant. The treatment system would condition the water prior to storage and distribution to the clean water infiltration wells.

The Catawba River is a dynamic source of water and would provide water of varying quality. Treatment would address suspended particulates and total dissolved solids (TDS) and biological growth (*e.g.*, algae and bacteria) that would be present in raw river water. The 02L standard for TDS is 500 mg/L.

A modular flocculation, settling, and filtration treatment process may be used to reduce TDS to concentrations less than 500 mg/L and to disinfect the river water. A polymer and a disinfectant (*e.g.*, sodium hypochlorite) would be added to raw river water in a rapid mix tank. The polymer would flocculate with TDS and the disinfectant would kill waterborne bacteria and algae. Treated water and flocculant would flow from the rapid mix tank to a modular sedimentation tank where the flocculant and particulates would settle. Sedimentation tank effluent would undergo filtration to remove suspended flocculant and particulates. The filtered water would be pumped to a holding tank where clean infiltration water would be stored prior to distribution to the clean water infiltration wells. Water leaving the holding tank might undergo dechlorination (*e.g.*, sulfur dioxide or sodium metabisulfite) as it enters the clean water infiltration water distribution system (**Figure 6-31**).

Parallel treatment processes would facilitate infiltration system operation and maintenance and should achieve optimal runtime and performance. Individual system components (e.g., vertical turbine pumps, equalization tanks, modular treatment system or transfer pumps) could be operated singularly or in parallel and achieve 100 percent groundwater infiltration capacity. Liquid waste materials generated as a result of maintenance (e.g., filter backwash or wash water) would be directed to the plant drain system for treatment and management. The equalization tanks, treatment system, transfer pumps, and holding tank would be housed in an enclosed structure to prevent exposure to prevailing weather conditions.

Groundwater Extraction Water Treatment (Step 6 – Address Groundwater Treatment)

(CAP Content Section 6.E.b.i)

Extracted groundwater would be treated by a proposed groundwater treatment plant or the LRB located at the Site. The proposed groundwater treatment process is expected to consist of pH adjustment. The pH adjustment system would consist of chemical addition for the purpose of changing the pH to meet permit limits established at NPDES Outfall 002. It should be considered the existing pH adjustment system, provided by Evoqua used to dewater the AAB, or the LRB could assist or eliminate the need for the proposed groundwater treatment plant. If so, a modified treatment method could be selected based on the quantity and quality of the extracted groundwater.

Clean Water Infiltration Well Distribution System (Step 7 – Conceptual Clean Water Infiltration System Considerations)

The purpose of the clean water infiltration distribution system is to convey water from the Catawba River to the infiltration water treatment system and to convey water from the infiltration water treatment system to the clean water infiltration wells. The distribution lines would be constructed with blowoffs so that the system may be flushed to remove buildup on piping walls.

An existing water intake would convey water through the existing fire suppression system to the clean infiltration water treatment plant for treatment and storage. A storage tank would be elevated above the injection wells to create positive hydraulic head via gravity to maintain positive pressures at the clean water infiltration wells. Clean infiltration water would be conveyed from the storage tank through a pipe system to the clean water infiltration wells. Pressure regulating valves would be installed at each clean water infiltration well to control groundwater infiltration rate.

Based upon predictive groundwater flow and transport modeling, the infiltration flow rate per well would be approximately 5 gpm for combined saprolite/deep wells.

Groundwater Extraction Well Discharge Piping (Step 8 – Conceptual Extraction System Considerations)

The proposed groundwater extraction system would consist of 87 groundwater extraction wells (**Figures 6-28a** and **6-28b**). Based upon predictive groundwater flow and transport modeling, extraction flow rate per well would be approximately 13 gpm for combined saprolite/deep wells and 4 gpm for bedrock wells. These simulated flow rates are reasonably similar to the flow rates of approximately 5 gpm obtained during dewatering for construction of the holding basin within the footprint of the coal pile. The simulated flow rates are greater than the observed flow rates because the simulated extraction wells extend deeper into zones with greater yield. In total, the estimated volume of extracted groundwater is approximately 955 to 972 gpm. At that rate, the maximum daily volume would be approximately 1.3 MGD.

Each of the groundwater extraction wells would discharge into one of a series of below or above ground pump stations. The pump stations would operate off of internal level controls and have redundancy built in them for operation and maintenance. Extracted groundwater would be pumped to the proposed groundwater treatment plant for treatment and discharge.

6.8.2.2 Engineering Designs with Assumptions, Calculations, and Specifications

(CAP Content Section 6.E.b.ii)

Pipelines (Step 9 – Pipeline Specifics)

(CAP Content Section 6.E.b.ii)

High density polyethylene (HDPE) piping will be used for water conveyance in all areas where buried piping will be installed. Polyvinyl Chloride (PVC) and/or Ductile Iron Pipe (DIP) may be used for gravity sewer and where unusual circumstances occur. Water conveyance will include:

- Groundwater pumped from extraction wells and conveyed to the physical-chemical wastewater treatment system
- Surface water pumped from the Catawba River and conveyed to the clean water infiltration water treatment system
- Infiltration water treatment system effluent to clean water infiltration wells

HDPE piping will conform to standard HDPE pipe specifications such as the following:

- ASTM F714, "Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter,"
- ASTM D3035,"Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter."
- ANSI/AWWA C906, "Polyethylene (PE) Pressure Pipe and Fittings, 4" to 63", for Water Distribution and Transmission."
- Cell Classification PE445574C per ASTM D3350
- Plastics Pipe Institute (PPI) TR-4 Listing as PE4710 / PE3408
- Hydrostatic Design Basis 1,600 psi @ 73°F (23°C) and 1,000 psi @ 140°F (60°C) per ASTM D2837

Fittings will be molded from HDPE compound having cell classification equal to or exceeding the compound used in the pipe manufacture to ensure compatibility of polyethylene resins. Substitution may be allowed for approved material with use of flanged joint sections.

Heat fusion welding of the piping and fittings would be in accordance with Duke Procedure Number: CCP-ENGSTD-NA-QA-004, “Quality Assurance and Quality Control of HDPE Pipe Butt Fusion Joints Revision 3,” July 8, 2019. Only qualified operators trained in Duke Energy’s HDPE fusion standards would be allowed to perform fusion welding.

Flanged connections would be in accordance with Duke Procedure Number: CCP-ENGSTD-NA-QA-005, “Requirements for Installation of Polyethylene Flanged Joints Revision Number 0,” August 5, 2019.

The locations of the HDPE piping systems for extraction and infiltration water are generally in low traffic areas. The HDPE piping will be typically installed below grade in 3-foot deep excavated trenches constructed with compacted granular bedding material. The trenches will be backfilled with a minimum of 2-feet of excavated native soil and compacted. Pipe in areas with regular traffic of more than two axles will be installed in trenches designed to comply with AWWA M-55, "PE Pipe – Design and Installation" or an approved alternative design.

The design flow rate is approximately 350 gpm for the clean water infiltration system and 950 gpm for the groundwater extraction system. Infiltration water distribution lines would connect to each clean water infiltration well. Likewise, each groundwater extraction well will be connected the groundwater extraction system to convey extracted groundwater to the groundwater extraction treatment plant. Preliminary calculations pertaining to the piping design (e.g., pipe sizing, pressures, flow, friction losses, etc.) are provided in **Appendix N**.

Localized collection tanks and pumps or pump stations might be integrated into the piping system to allow for independent operation of various segments of the system.

Hydrostatic leak testing in accordance with the most current edition of *Handbook of Polyethylene Pipe*, or an approved alternate method, will be performed and passed prior to the piping being placed into operation.

Pipe Network Calculations (Step 10 – Pipeline Headloss Calculations)

(CAP Content Section 6.E.b.ii)

The extraction and clean water infiltration networks for the proposed alternative were designed using Pipe Flow® Expert. Pipe Flow® Expert is a software used to determine volumetric flow rates, pressure in pipes, friction losses, pump head, and other information. The calculated outputs and graphically represented conceptual network layouts are found in **Appendix N**.

The extraction network consists of approximately 87 extraction wells with lines for conveyance and branching pipes providing connections to the wells. The network operates via gravity and pump flow, collecting the majority of the flow from the extraction wells and conveying under pressure from a common collection point to the groundwater extraction treatment system. The network was evaluated by generating a model with well elevations and depths, pipe lengths, etc. Once these values were incorporated, the calculations were performed using the model to determine the nature of flow in the network and to ensure that the desired movement in the pipe system was occurring. After the flow through the system was verified, pipe diameters and required pump head outputs were calculated. The calculation outputs took into account the interacting flows in the system, pipe cleanouts for periodic jetting, and frictional losses from fittings and pipes to provide evidence of the efficacy of the proposed pipe network layout design.

The infiltration network consists of either approximately 76 vertical clean water infiltration wells or approximately 48 vertical clean water infiltration wells combined with approximately 22 horizontal clean water infiltration wells. Clean water infiltration wells flow via gravity from an elevated infiltration tank. The infiltration network was evaluated similarly to the extraction network; however, due to the operation under gravity flow from an elevated tank, the network was designed to be operated without conveyance or infiltration pumps. Accordingly, the calculations performed using the model were to determine the pipe diameters and the required elevation of the infiltration water tank.

Telemetry System Design

The groundwater remediation system would be managed using telemetry system that would enable remote monitoring and operational capabilities. The telemetry system would be designed to meet the system owner O&M requirements.

Electrical Design

It is unlikely that existing electrical capacity in the vicinity of the proposed groundwater remediation system would be sufficient to provide electrical power to pumps, the clean water infiltration water treatment system, and other power requirements. Additional electrical capacity is anticipated to meet groundwater remediation system power requirements.

System Operation and Maintenance Issues

The effectiveness of the system will be dependent on maintaining adequate infiltration and extraction flow rates through the wells, and stable water levels, for an extended period of time. This will necessitate effective operation and maintenance of the wells. As described in this section and in the Contingency Plan (**Section 6.8.8**), each well will be equipped with a control and monitoring system and monitored continuously by the control system, and an alert sent if the water level falls outside the prescribed range. Adjustments to pumping operations can be made if the root cause of the alert is determined to be system performance.

Another factor in maintaining the effectiveness of the wells will be monitoring and maintaining the well screens to prevent a loss of efficiency due to mineral and/or biological fouling. If well performance monitoring indicates a decrease in flow rate, the well will be inspected for fouling and the screens will be cleaned as appropriate. Additionally, cleanouts will be installed on pipes to facilitate periodic maintenance, preventing mineral scaling or biological fouling on the conveyance pipe network.

In addition to well performance monitoring and maintenance, other system elements, such as pumps controls, will receive routine maintenance in accordance with the manufacturer's recommendations.

6.8.2.3 Permits for Remedy and Schedule

(CAP Content Section 6.E.b.iii)

The design documents would provide the necessary plans and specifications for procurement and construction purposes. This would include Site layout drawings, plans and profiles, well enclosure details, trench and discharge piping outlet details, well construction schematics, piping and instrumentation diagrams/drawings and complete equipment, materials and construction specifications.

Permit applications that may be needed for the proposed remedy include:

- Erosion and Sediment Control permit
- In Situ Groundwater Remediation Injection Well permit
- NPDES Storm Water permit
- Water Withdrawal and Transfer registration
- Wetlands permit

The schedule for obtaining permits is based off the project implementation schedule as discussed in **Section 6.8.6** and presented on **Figure 6-32**.

6.8.2.4 Schedule and Cost of Implementation

(CAP Content Section 6.E.b.iv)

An implementation schedule for the proposed corrective action is provided in **Figure 6-32**. The exact timeline of the schedule milestones is dependent on various factors, including NCDEQ review and approval, permitting, weather, and field conditions.

Duke Energy will provide construction reports monthly from the beginning of construction until construction is complete and Duke Energy assumes full responsibility for operation of the groundwater remediation system.

Reporting will include:

- Health and Safety/Man Hours
- Tasks completed the prior month
- Problems affecting schedule (*e.g.,* inclement weather)
- Measures taken to achieve construction milestones (*e.g.*, increase number of drilling crews)
- Contingency actions employed, if any
- Tasks to be completed by next reporting period
- Provide updated schedule/Gantt chart

Duke Energy progress reports would be submitted to NCDEQ monthly.

The cost estimate for Alternative 3 is based on capital costs for design and implementation, and the operations, maintenance (O&M) and monitoring costs, including well redevelopment and replacement on an annual basis.

The design costs include work plans, design documents and reports necessary for implementation of the alternative. Implementation costs include procurement and construction.

O&M costs are based on annual routine labor, materials and equipment to effectively conduct monitoring, routine annual and 5-year reporting, and routine and non-routine maintenance costs.

A detailed cost estimate for this Alternative is provided in **Appendix K**.

6.8.2.5 Measure to Ensure Health and Safety

(CAP Content Section 6.E.b.v)

There is no measurable difference between evaluated Site risks and risks indicated by background concentrations; therefore, no material increases in risks to human health related to the source areas have been identified. The groundwater corrective action is being planned to address regulatory requirements. The risk assessment identified no current human health or ecological risk associated with groundwater downgradient of the source areas. Water supply wells are located upgradient and/or sidegradient of the source areas and eligible households have been offered an alternate water supply. Surface water quality standards downgradient of the COI-affected plume are also met. Based on the absence of receptors, it is anticipated that groundwater extraction would create conditions that continue to be protective of human health and the environment because the COI concentrations will diminish with time.

6.8.2.6 Description of all Other Activities and Notifications being conducted to Ensure Compliance with 02L, CAMA, and Other Relevant Laws and Regulations

(CAP Content Section 6.E.b.vi)

This CAP Update is for the ash basins and the additional source area hydrologically connected to the ash basins, the coal piles, as identified in NCDEQs April 5, 2019 letter (**Appendix A**). The CAP Update addresses the requirements of G.S. Section 130A-309.211(b), complies with NCAC 15A Subchapter 02L. 0106 corrective action requirements, and follows the CAP guidance provided by NCDEQ in a letter to Duke Energy.

6.8.3 Requirements For 02L .0106(l) – MNA

(CAP Content Section 6.E.c)

The requirements for implementing corrective action by MNA, under 02L .0106(l), are provided in **Section 6.7.1** and **Appendix I**. MNA is not applicable at this time for Allen as described in **Section 6.8.1**.

6.8.4 Requirements For 02L .0106(k) – Alternate Standards

(CAP Content Section 6.E.d)

Regulation 02L .0106(k), states that a request may be made for approval of a corrective action plan that uses standards other than the 02L groundwater quality standards. Duke Energy may request alternate standards for ash basin-related constituents, including boron, as allowed under 15A NCAC 02L .0106(k).

Alternate standards are appropriate at Allen given the lack of human health and ecological risks at the Site. G.S. Section 130A, Article 9, Part 8 allows risk-based remediation as a clean-up option where the use of remedial actions and land use controls can manage properties safely for intended use. Risk-based corrective action is where constituent concentrations are remediated to an alternative standard based on the actual posed risks rather than applicable background-levels or regulatory standards. The requirements for implementing corrective action by remediating to alternate standards, under 02L .0106(k), are as follows:

- Sources are removed or controlled;
- Time and direction of contaminant travel can be predicted with reasonable certainty;
- COIs have and will not migrate onto adjacent properties unless specific conditions are met (i.e., alternative water sources, written property owner approval, etc.);
- Standards specified in Rule .0202 of this Subchapter will be met at a location no closer than one year time of travel upgradient of an existing or foreseeable receptor, based on travel time and the natural attenuation capacity of subsurface materials or on a physical barrier to groundwater migration that exists or will be installed by the person making the request;
- If contaminant plume is expected to intercept surface waters, the groundwater discharge will not possess contaminant concentrations that would result in violations of standards for surface waters contained in 15A NCAC 02B .0200;
- Public notice of the request has been provided in accordance with Rule .0114(b) of this Section; and
- Proposed corrective action plan would be consistent with all other environmental laws

The alternative groundwater clean-up values may be used to aid in risk management decisions at Allen.

6.8.5 Sampling and Reporting

(CAP Content Section 6.E.e)

An effectiveness monitoring plan (EMP) has been developed as part of this CAP consistent with 02L. 0106(h)(4). The EMP is designed to monitor groundwater conditions at Allen and document progress towards the remedial objectives over time. This plan is designed to be adaptive over the project life cycle and can be modified as the groundwater remediation system design is prepared, completed, or evaluated for termination.

Duke Energy implemented an IMP after the plan was that was submitted to NCDEQ on October 23, 2018 and subsequent additional modifications were agreed upon between Duke Energy and NCDEQ. The IMP includes the locations of groundwater wells sampled quarterly and semiannually.

The EMP is required by G.S. Section 130A-309.211(b)(1)(e). The IMP will be replaced by the EMP upon NCDEQ approval of the CAP Update. Either submittal of the EMP, or the pilot test work plan and permit applications (as applicable), will fulfill G.S. Section 130A-309.209(b)(3).

The EMP, presented in **Appendix O**, is designed to be adaptable and target key areas where changes to groundwater conditions are most likely to occur due to corrective action and ash basin closure activities. The EMP will be used to evaluate progress towards remediation. EMP key areas for monitoring are based on the following considerations:

- Include background locations
- Include designated flow paths
- Within areas of observed or anticipated changing Site conditions, and/or have increasing constituent concentration trends
- Will effectively monitor COI plume stability and model simulation verification
- The EMP will be used to evaluate progress towards remediation

EMP elements including well systems, locations, frequency, parameters, schedule and reporting evaluation are summarized below and outlined on **Table 6-17.** Effectiveness monitoring well locations are illustrated on **Figure 6-33**. The EMP will be implemented 30 days after CAP approval, and will continue until there is a total of three years of data confirming COIs are below applicable standards at or beyond the compliance boundary, at which time a request for completion of active remediation will be filed with NCDEQ. If applicable standards are not met, the EMP will continue and transition to post-closure monitoring, if necessary.

After ash basin closure and following ash basin closure certification, a post-closure groundwater monitoring plan (PCMP) will be implemented at the Site for a minimum of 30 years in accordance with G.S. Section 130A-309.214(a)(4)k.2. If groundwater monitoring results are below applicable standards at the compliance boundary for three years, Duke Energy may request completion of corrective action in accordance with G.S. Section 130A-309.214(a)(3)b. If groundwater monitoring results are above applicable standards, the PCMP will continue. An EMP work flow and optimization process is outlined on a flow chart on **Figure 6-34**.

Optimization of the plan to help determine the remedy's performance, appropriate number of sample locations, sampling frequency, and laboratory analytes, and statistical analysis to evaluate the plume stability conditions would be conducted during EMP review periods. The optimization process would be conducted using software designed to improve long-term groundwater monitoring programs such as Monitoring and Remediation Optimization System (MAROS).

6.8.5.1 Progress Reports and Schedule

(CAP Content Section 6.E.e.i)

After groundwater remediation implementation, evaluation of Site conditions, groundwater transport rates, and plume stability would be based on quantitative rationale using statistical, mathematical, modeling, or empirical evidence. Existing data from historical monitoring and pilot testing would be used to provide baseline information prior to groundwater remediation implementation. Schedule and reporting of system quantitative evaluations, review and optimization would include:

- **Annual Reporting Evaluation:** The EMP will be evaluated annually for optimization and adaption for effective long-term observations, using a data-need rationale for each location. The annual evaluation would include a comparison of observed concentrations compared to model predictions and an evaluation of statistical concentration trends, such as the Mann-Kendall test.

  Results of the evaluation would be reported in annual monitoring reports and are proposed to be submitted to NCDEQ annually. The reports would include the following:

  - Laboratory reports on electronic media,

- Tables summarizing the past year's monitoring events,
- Historical data tables,
- Figures showing the historical data versus time for the designated monitoring locations and parameters,
- Figures showing sample locations,
- Statistical analysis (Mann-Kendall test) of data to determine if trends are present, if performed,
- Identification of exceedances of comparative values,
- Groundwater elevation contour maps in plan view and isoconcentration contour maps in plan view for one or more of the prior year's sampling events (as mutually agreed upon by Duke Energy and NCDEQ),
- Any notable observations related to water level fluctuations or constituent concentration trends attributable to extraction system performance or water table drawdown, and
- Recommendations regarding modifications to the Plan

- **5-Year Review:** Similar to annual evaluation and reporting, the EMP would be re-evaluated and modified as part of each 5-year review period as adaptive or, if necessary, additional corrective actions are implemented or water quality observations warrant adjustments of the plan. The annual evaluation would include elements of the annual evaluation, plus updated background analysis, confirmation of risk assessment, evaluation of statistical concentration trends, analytical result comparison and model verification. If needed, flow and transport models could be updated as part of the 5-year review process to refine future predictions and the associated routine data needed to confirm the predictions.

Optimization of the monitoring network could be evaluated if the remedy is determined to be effective or when conditions re-stabilize after the implementation of closure or, if necessary, additional corrective action implementation. Optimization of the monitoring network could include a lesser monitoring frequency and/or parameter list. Flow and transport model predictions indicate very slow changes in conservative (boron) concentrations will occur over time. Geochemical model predictions indicate very little or much slower changes in the remaining COI distributions will occur. Therefore, a monitoring frequency consistent with these predictions would be proposed following confirmation of the models through site data.

If necessary, modifications to the corrective action approach would be proposed to achieve compliance within the target timeframe.

A flow diagram for effectiveness monitoring plan work and optimization is depicted on **Figure 6-34**.

6.8.5.2 Sampling and Reporting Plan During Active Remediation

(CAP Content Section 6.E.e.ii)

Groundwater Monitoring Network

EMP monitoring will provide a comprehensive monitoring strategy that (1) monitors the performance and effectiveness of the selected remedial alternative, (2) can provide adequate areal (horizontal) and vertical coverage to monitor plume status at or beyond the compliance boundary and with regard to potential receptors, and (3) confirm flow and transport and geochemical model predictions. This monitoring would be implemented north and northwest of the ash basin (**Figure 6-33**). EMP groundwater well monitoring network objectives are outlined below:

- Compliance with 02L
- Measure and track the effectiveness of the proposed clean water infiltration and extraction system
- Monitor plume status at or beyond the compliance boundary (horizontally and vertically)
- Verify predictive model simulations
- Verify no unacceptable impact to downgradient receptors
- Verify attainment of remedy objectives through validated model simulations
- Identify new potential releases of constituents into groundwater from changing site conditions
- Monitor approved background locations

The EMP would include 66 groundwater monitoring wells (**Table 6-17**). Several of the existing monitoring wells at the site might be abandoned from ash basin closure and related construction activities. In the event that closure activities extend to the proposed EMP well locations, the layout of wells would be modified, if necessary.

Groundwater Monitoring Flow Paths - Trend Analysis

The monitoring network will provide adequate horizontal and vertical coverage in the area of groundwater remediation to monitor:

- Changes in groundwater quality as Site conditions change (*e.g.*, groundwater remediation effects, ash basin closure commences),
- Transport rates, and
- Plume stability

Horizontal and vertical coverage would be provided by using groundwater monitoring wells located downgradient of the source areas within the corrective action area. To monitor performance, groundwater monitoring wells are located within the area of corrective action at specific intervals or as close as possible from the source area to a receptor as illustrated in **Figure 6-33.**

Multi parameters sondes would be installed in wells along the primary flow paths in the active remedy area (**Figure 6-33**). Wells that are, but are not shown as installed along primary flow paths in **Figure 6-33** include AB-10S/D/BR/BRL and GWA-5S/D/BRA/BRL. **Table 6-17** provides a detailed list of monitoring wells to be included in the EMP, along with wells proposed to have multi parameter sondes installed. Daily monitoring of changes in groundwater quality on a real-time basis using multi-parameter sondes and telemetry technology would allow continuous monitoring and evaluation of geochemical conditions. Geochemical conditions, monitored using pH and Eh, would be compared to geochemical modeling results to evaluate changes that could potentially affect the mobility (K_d) of reactive and variably-reactive COIs. Water levels would also be monitored by the multi-parameter sondes to verify simulated changes to groundwater flow from groundwater remediation, and during and after ash basin closure. Having groundwater quality and water level data readily available will increase the response time to implement contingencies if field parameters significantly deviate from predicted responses. Contingency plans are included in **Section 6.8.8**.

Plume stability evaluation would be based primarily on results of trend analyses. Trend analyses might be conducted using Mann-Kendall trend test. The Mann-Kendall trend test is a non-parametric test that calculates trends based on ranked data and has the flexibility to accommodate any data distribution and is insensitive to outliers and non-detects. The test is best used when large variations in the magnitude of concentrations may be present and may otherwise influence a time-series trend analysis.

Trend analysis would be conducted using data from EMP geochemically non-reactive, conservative constituents (**Table 6-17**). These constituents include boron, chloride, and TDS, and best depict the areal extent of the plume and plume stability and physical attenuation, either from active remedy or natural dilution and dispersion.

Trend analysis of designated groundwater monitoring flow path wells (**Figure 6-33**) would be part of the decision metrics for determining termination of the active remedy.

Sampling Frequency

Multiple years of quarterly and semiannual monitoring data are available for use in trend analysis and to establish a baseline to evaluate corrective action performance. The monitoring plan sampling frequency is based on semi-annual sampling events to be consistent with other groundwater monitoring performed at the Site.

Semi-annual monitoring following implementation of corrective action is recommended for the 66 monitoring wells to be included in the EMP. Over four years of quarterly monitoring data are available for existing wells, which will be used to supplement trend analysis and to establish a baseline to evaluate corrective action performance.

Newly installed wells to be added to the EMP would be monitored by quarterly sampling events. Quarterly sampling would target locations of proposed newly installed wells with fewer than four quarters of data. Quarterly monitoring of parameters outlined on **Table 6-17** is proposed for newly installed wells.

Quantitative evaluations would also determine additional data needs (i.e., increased sampling frequency) for refining statistical and empirical model development. Additional monitoring described in the contingency plan would be implemented if significant geochemical condition changes are identified that could result in mobilization of reactive or variably-reactive COIs.

Sampling and Analysis Protocols

EMP sampling and analysis protocol will be similar to the existing IMP with some adjustment for anticipated changing site conditions. Detailed protocols are presented in **Appendix O**. Samples would be analyzed by a North Carolina certified laboratory for the parameters listed in **Table 6-17** as summarized below. Laboratory detection limits for each constituent are targeted to be at or less than applicable regulatory values (i.e., 02L or IMAC).

- **Groundwater Quality Parameters:** Based on the constituent management approach, 7 constituents warrant corrective action at the Site, and are included as groundwater quality parameters to be monitored as part of the EMP. These constituents are as follows:
    - Boron
    - Cobalt
    - Iron
    - Manganese
    - Strontium
    - Sulfate
    - Total Dissolved Solids

  Geochemically conservative, non-reactive constituents boron, sulfate, and TDS best depict the areal extent of the groundwater plume. Analyses of these constituents will be used to monitor plume stability and physical attenuation from groundwater flushing and extraction, by comparing monitoring results with flow and transport model simulations.

  Changing geochemical conditions that could cause sorption or precipitation/co-precipitation mechanisms that might affect mobility of non-conservative and variable constituents would be evaluated using multi parameter sonde data.

- **Groundwater Field Parameters:** The following six field parameters will be monitored to confirm that monitoring well conditions have stabilized prior to sample collection and to evaluate data quality: water level, pH, specific conductance, temperature, dissolved oxygen, and oxidation reduction potential. For remedy performance monitoring, these parameters will be measured daily by a multi-parameter sondes installed in each flow path monitoring well and used to evaluate geochemical conditions from remedy effectiveness.

  Major cations and anions would be analyzed to evaluate monitoring data quality (electrochemical charge balance). These include alkalinity, bicarbonate alkalinity, aluminum, calcium, iron, magnesium, manganese, nitrate + nitrite, potassium and sodium. Total organic carbon (TOC), ferrous iron, and sulfate analyses are also proposed as monitoring parameters. TOC is recommended to help determine if an organic compound is contributing to TDS, and ferrous iron and sulfate to monitor potential dissolution of iron oxides and sulfide precipitates as an indicator of changing conditions related to corrective action. These parameters are indicated on **Table 6-17** as water quality parameters.

6.8.6 Sampling and Reporting Plan After Termination of Active Remediation

(CAP Content Section 6.E.e.iii)

Termination of the proposed remedial alternative will be consistent with and implemented in accordance with NCDEQ Subchapter 02L .0106(m). A flow chart of the decision metrics, request, and review timeline for termination is outlined on **Figure 6-35** *(CAP Content Section 6.E.e.iii.1)*. This process will provide stakeholders an opportunity to evaluate terminating the system, as appropriate, in the vicinity of the well or wells where groundwater restoration completion is being evaluated.

Trend analysis described in **Section 6.8.5** would be part of the decision metrics for determining termination of the active remedy *(CAP Content Section 6.E.e.iii.1.A and B).* Groundwater remediation effectiveness monitoring will transition to the attainment monitoring phase when NCDEQ determines that the remediation monitoring phase is complete at a particular well or area.

6.8.7 Proposed Interim Activities Prior to Implementation

(CAP Content Section 6.E.f)

In accordance with requirements of G.S. Section 130A-309.211(b)(3), implementation of the proposed corrective action will begin within 30 days of NCDEQ approval of the CAP Update.

Prior to pilot testing, the clean infiltration water will be sampled for geochemical and physical parameters for baseline conditions to evaluate the potential for biofouling and plugging of the clean water infiltration well screens. During pilot testing, extracted groundwater will be collected and analyzed for geochemical parameters consistent with the NPDES permit**.**

Additional interim activities to be conducted prior to implementation of the corrective action remedy include:

- Implementation of the EMP within 30 days of CAP approval
- Submittal of permit and registration applications to NCDEQ, as applicable

6.8.8 Contingency Plan

(CAP Content Section 6.E.g)

The purpose of the Contingency Plan is to monitor changes in conditions and operations to effectively reach the remedial action objectives. The contingency plan addresses operations, groundwater conditions and performance.

The Contingency Plan would be defined in greater detail as design elements of the system are finalized. A groundwater monitoring program to measure and track the effectiveness of the proposed comprehensive clean water infiltration and extraction system is described in **Section 6.8.2**. This plan is designed to be adaptive and can be modified as the groundwater remediation system design is prepared, completed, or evaluated for termination.

6.8.8.1 Description of Contingency Plan

(CAP Content Section 6.E.g.i)

The contingency plan addresses the following areas:

- Operations (including infiltration and extraction wells, pumping, piping, electrical, and controls)
- Groundwater quality
- Groundwater levels

- Groundwater treatment
- Comparison to predicted concentrations and water levels

A health and safety plan and an operations manual will be prepared. The health and safety plan will deal with management of spills and other unplanned releases and the operation manual will address operational training including backup personnel, emergency response training, and reporting to appropriate authorities.

6.8.8.2 Decision Metrics for Contingency Plan Areas

(CAP Content Section 6.E.g.ii)

This section outlines decision metrics and possible contingency actions in support of a resilient groundwater corrective action strategy.

Operations

A computer control telemetry system would be installed with the system to provide timely information to the Site Operator regarding key operational features, particularly infiltration and extraction well water levels and flow rates. The control system will be tied into a remote monitoring station to alert key personnel as to the nature and urgency of the issue. The system would be programmed with expected values for measured parameters. Alerts would be sent when actual values are outside the programmed range. Based on the alerts, the functional problem would be evaluated and repairs or replacement of faulty equipment will be completed. The expected duration of operations will exceed the life expectancy of most of the mechanical equipment that will comprise the system so ongoing replacement of equipment will be part of the operations and maintenance program.

Several aspects of the monitoring system would be used to optimize system operations, including:

- Maintaining target flow rates and water levels for each well is important to minimize the potential for loss of clean water infiltration water and extracted groundwater flow control. Each well would be monitored continuously by the control system, with all data being recorded, and an alert sent if the flow rate or water level is outside the prescribed range. In addition to automated systems, each element of the system will be physically inspected and maintained as part of a routine operations and maintenance program.

- Leak detection systems could detect possible leaks related to pumping, piping and/or wells, and the respective element of the system could be shut down and a message will be immediately sent to the operator and to backup personnel. The potential leak will be inspected and repaired prior to restarting the system element.
- Continuous monitoring of key parameters would help maintain proper operation of the system, if pH adjustment or other water treatment technology is employed. Variances between prescribed ranges will alert the operator and other key personnel and may result in automatic system shut down.
- Routine documented inspections of key components of the system would be done by the operator to track system status and system performance.
- System maintenance schedules would be established to track system performance. System elements will be maintained in accordance with manufacturer's recommendations, which will be contained in a system Operation and Maintenance (O&M) Manual. Corrective measures, performed by appropriately skilled personnel, will be taken if mechanical issues are identified during routine maintenance monitoring.

Groundwater Quality

The EMP includes a primary network of wells that will provide focused monitoring in critical areas following corrective action implementation.

After each sampling event, data will be entered into a comprehensive data base system. Trend analyses will be conducted, spatially and temporally, to evaluate COI plume changes. If groundwater quality field parameters or constituent concentrations significantly deviate from predicted responses, a focused investigation will be conducted to determine if the variation is due to system performance or other factors. Based on this analysis, possible responses could include adding or abandoning infiltration or extraction wells, or changing flow rates or target water levels.

To assess the effectiveness of changes, or to determine if the unexpected data trends are temporary, increased monitoring frequency or additional monitoring locations may be conducted.

If subsequent results continue to show non-conformance, a more comprehensive assessment and corrective action plan for the specific non-conformance may be completed and implemented.

Groundwater Levels

Water levels in selected EMP monitoring wells will be monitored using downhole instrumentation until Site conditions have stabilized. Water level data will be evaluated as part of the ongoing monitoring. Technical evaluations will include spatial and temporal trend analyses, drawdown calculations, and flow and transport model refinement to reflect current conditions, as needed. If results conclude that water levels are not similar to predicted patterns a focused investigation will be conducted that could include adjusting system pumping rates, refining the flow and transport model for infiltration and extraction rates, adding monitoring wells to the EMP monitoring network for greater resolution, installation of monitoring wells in key areas, and/or other activities.

If subsequent results from ongoing investigation continue to show non-conformance, a corrective action response with suggested approaches to determine possible reasons for the non-conformance would be implemented until resolution is achieved.

Groundwater Treatment

If extracted groundwater treatment is required prior to discharge through a permitted outfall, evaluation of that system will be part of the routine monitoring program.

If a treatment system is not meeting performance standards or if trends suggest performance is not optimal, an analysis of the trends and an assessment of the system will be completed and corrective measures implemented. Changes could be the result of changing influent characteristics.

Comparison to Predicted Concentrations and Water Levels

Many aspects of the proposed remediation approach are based on modeling and predicted groundwater conditions. As remedial efforts begin, hydraulic conditions change, and additional groundwater data are collected, the models will be updated. However, as conditions change, especially at the beginning of the process there maybe deviations from existing data trends and model predictions. The models will be updated to reflect changing conditions, as necessary, and changes in predicted results will be analyzed to determine if the remedial approach needs to be modified to effectively address the changes.

Given that groundwater infiltration is an element of the system, there is a potential that soil might become saturated near the ground surface, with the potential to create surface discharges. If this occurs, reducing infiltration rates by adjusting water-level controllers at wells near the area or increasing the extraction system would be used to control surficial saturation.

6.9 Summary and Conclusions

This CAP Update meets the corrective action requirements under G.S. and Subchapter 02L.0106 and to addresses Subchapter 02L.0106(j). This CAP Update proposes a remedy for COIs in groundwater associated with the Allen coal ash basins and coal piles that are beyond the Site's compliance boundary to the north, northeast, and east of these source areas. This CAP Update provides:

- A groundwater remediation approach that can be implemented under either closure scenario (closure-in-place or closure-by-excavation).
- A screening process of multiple potential groundwater corrective action alternatives that would address areas requiring corrective action.
- A selection and description of the favored corrective action groundwater remedy: **Alternative 3, Groundwater Extraction Combined with Clean Water Infiltration and Treatment**.
- Specific plans, including engineering design details, for restoring groundwater quality.
- A schedule for the implementation and operation of the corrective action strategy.
- A monitoring plan for evaluating the performance and effectiveness of corrective action groundwater remedy, and its effect on the restoration of groundwater quality.
- Planned activities prior to full-scale implementation including pilot testing in selected areas and water treatment testing. Pilot test work plan(s) will be submitted to NCDEQ within 30 days of CAP approval to fulfill G.S. Section 130A-309.211(b)(3).

7.0 PROFESSIONAL CERTIFICATIONS

(CAP Content Section 7)

Certification for the Submittal of a Corrective Action Plan

Responsible Party and/or Permittee: Duke Energy Carolinas, LLC

Contact Person: Paul Draovitch

Address: 526 South Church Street

City: Charlotte **State:** NC **Zip Code:** 28202

Site Name: Allen Steam Station

Address: 253 Plant Allen Road

City: Belmont **State:** NC **Zip Code:** 28012

Groundwater Incident Number: Not Assigned

We, Christopher Suttell **Professional Geologist** and James Clemmer, a **Professional Engineer** for SynTerra Corporation (firm or company of employment) do hereby certify that the information indicated herein is as part of the required Corrective Action Plan (CAP) and that to the best of our knowledge of the data, assessments, conclusions, recommendations and other associated materials are correct, complete and accurate.

Sworn to and subscribed before me this 27 day of December 2019

DARNELL B. DELLINGER
Notary Public, State of South Carolina
My Commission Expires 12/22/2025

NORTH CAROLINA LICENSED GEOLOGIST SEAL 2426 CHRISTOPHER J. SUTTELL

Christopher J. Suttell, NC LG 2426
Project Manager

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 18675 JAMES E. CLEMMER

12-23-2019

James E. Clemmer, NC PE 18675
Project Engineer

8.0 REFERENCES

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TABLES

(CAP Content Section 9)

Table ES-1

Summary of Allen Assessment Documentation

Included in Executive Summary text

Table ES-2

Summary of Allen Assessment Activities

Included in Executive Summary text

Table ES-3

Components of Source control, active remediation, and monitoring

Included in Executive Summary text

TABLE 1-1
SUMMARY OF ONSITE INCIDENTS
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELMONT, NC

Station Name	Station Location	DEQ Section	Incident Number	Occurrence Date	Status	Closure Date	Release Type	Latitude	Longitude	Proximity to Ash Basins (ft)	Notes
Allen	Belmont	UST	11186	3/24/1993	Open	NA	Petroleum	35.190243	-81.008476	1,522	NA
Allen	Belmont	UST	16184	11/24/1997	Open	NA	Petroleum	35.188744	-81.007921	1,242	NA
Allen	Belmont	UST	40625	2/22/2016	Open	NA	Petroleum	35.188794	-81.007403	1,250	NA
Allen	Belmont	UST	40581	2/29/2016	Open	NA	Petroleum	35.187947	-81.007367	912	NA
Allen	Belmont	UST	18137	11/24/1997	Open	NA	Petroleum	35.188745	-81.00792	1,230	NA
Allen	Belmont	IHSB	NONCD0002824	5/5/2006	Open	NA	PCE	35.18819	-81.01127	450	Former APS #88058 (Per DENR letter 10/17/2008) AOC3A PCE in soil at depth of 16-18ft at conc. 0.032 mg/kg > UST Section Soil-to-GW MSCC of 0.0074 mg/kg; GW conc. <MDL

Prepared By: LWD Checked By: EMY

Notes:
Onsite incident records provided by Duke Energy
DEQ - Department of Environmental Quality
ft - feet
UST - Underground Storage Tank
NA - Not Available
IHSB - Inactive Hazardous Sites Branch
PCE - tetrachloroethene
DENR - Department of Environment and Natural Resources
mg/kg - milligrams per kilogram
GW - groundwater
MSCC - Maximum Soil Contaminant Concentration
MDL - Method Detection Limit

TABLE 3-1
SUMMARY OF ONSITE FACILITIES
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELMONT, NC

Facility Name	Evaluated as Source Area in CAP Update	CSA Schedule	Operational Status	Source Material	Area or Capacity	Rationale for Evaluation
Retired Ash Basin/Inactive Ash Basin	Yes	NA	Inactive	Coal Ash/NPDES Permitted waste streams	132 acres	CAMA regulated unit
Active Ash Basin	Yes	NA	Inactive	Coal Ash/NPDES Permitted waste streams	169 acres	CAMA regulated unit
Coal Pile	Yes	NA	Operational	Coal	18.5 acres	Adjacent to and hydrologically connected to the ash basins
Gypsum Pad	No	Mar-20	Operational	Gypsum	3.5 acres	Not hydrologically connected to the ash basins

Prepared by: LWD Checked by: CJS

Notes:

CSA Schedule – applicable only for units identified in the letter "Final Comprehensive Site Assessment and Corrective Action Plans Approvals for Duke Energy Coal Ash Facilities (April 5, 2019)"

NA – Not Applicable

CAP – Corrective Action Plan

CAMA – North Carolina Coal Ash Management Act

NPDES – National Pollution Discharge Elimination System

TABLE 4-1
BACKGROUND SOIL SAMPLE SUMMARY
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELMONT, NC

Soil Boring	**Depth Range (feet bgs)**	**Number of Sampled Intervals**
BG-1D	(1-50)	4
BG-2D	(1-20)	3
BG-3D	(1-20)	3
GWA-8D	(38.5-50)	2
GWA-14D	(10-12)	1
BGSB-BG-1	(4-25)	3
BGSB-BG-2	(4-25)	3
BGSB-BG-3	(4-35)	3
BGSB-GW-8	(4-25)	3
BGSB-GWA-23	(4-22)	3
BGSB-GWA-26	(4-25)	3

Prepared by: LWD Checked by: CJS

TABLE 4-2
BACKGROUND VALUES FOR SOIL
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELMONT, NC

Constituent	Reporting Unit	PSRG Protection of Groundwater	2018 Background Threshold Value[1]	2019 Updated Background Threshold Value[2]	Piedmont Background Threshold Value Range[3]
pH*	S.U.	NE	4.4 - 6.2	4.3 - 6.6	2.3 - 9.8
Aluminum	mg/kg	110,000	44,683	42,879	25,978 - 81,619
Antimony	mg/kg	0.9	0.61	0.61	0.177 - 0.9
Arsenic	mg/kg	5.8	2.4	2.4	1.2 - 43.13
Barium	mg/kg	580	384	229	122.2 - 1,063
Beryllium	mg/kg	63	1.3	1.8	1.2 - 4.52
Boron	mg/kg	45	6.8	23	14.4 - 56.3
Cadmium	mg/kg	3	0.038	1	0.03 - 1
Calcium	mg/kg	NE	630	1,260	410 - 8,769
Chloride	mg/kg	NE	14	423	12 - 423
Chromium	mg/kg	3.8	57	49	20 - 440
Cobalt	mg/kg	0.9	29	68	27 - 81.68
Copper	mg/kg	700	71	81	17.4 - 216
Iron	mg/kg	150	61,162	60,916	24,500 - 85,345
Lead	mg/kg	270	13.5	19.8	7.5 - 95.23
Magnesium	mg/kg	NE	10,584	17,097	760 - 51,829
Manganese	mg/kg	65	1,222	1,927	370 - 3,388
Mercury	mg/kg	1	0.1	0.1	0.04 - 0.113
Molybdenum	mg/kg	7.1	5.4	5.4	1.83 - 12
Nickel	mg/kg	130	9.9	53.5	9.2 - 237
Nitrate (as N)	mg/kg	NE	0.3	0.28	0.25 - 31.2
Nitrate	mg/kg	NE	---	43.7	40.3 - 48.8
Potassium	mg/kg	NE	10,698	18,117	427 - 35,600
Selenium	mg/kg	2.1	0.81	2.30	1.58 - 6.857
Sodium	mg/kg	NE	600	730	338 - 1,500
Strontium	mg/kg	1,500	31	28.73	7.1 - 200
Sulfate	mg/kg	1,438^	14	437	12 - 437
Thallium	mg/kg	0.28	0.48	0.48	0.166 - 2.132
Total Organic Carbon	mg/kg	NE	---	3,470	742 - 4,960
Vanadium	mg/kg	350	132	132	42 - 230.9
Zinc	mg/kg	1,200	72.3	80.8	60.5 - 325.5

Prepared by: LWD Checked by: EMY

Notes:

2018 background threshold values were approved by North Carolina Department of Environmental Quality (NCDEQ) on May 14, 2018.

^ - PSRG Protection of Groundwater value was calculated using the equation shown in **Section 6**

* - Upper and lower threshold values calculated for parameter

[1] - Background threshold values were calculated using data from background unsaturated soil samples collected February 2015 to May 2015.

[2] - Updated background threshold values were calculated using data from background unsaturated soil samples collected February 2015 to August 2017. The background threshold value updates retained extreme outlier concentrations in background unsaturated soil datasets (SynTerra, 2019).

[3] - Piedmont background threshold value ranges include the Duke Energy calculated 2017[4] and 2019[5] background threshold values from 10 Duke Energy facilities located in the Piedmont physiographic region (Allen Steam Station[5], Belews Creek Steam Station[5], Buck Steam Station[4], Cape Fear Steam Electric Plant[4], Cliffside Steam Station[5], Dan River Steam Station[4], Marshall Steam Station[5], Mayo Steam Electric Plant[5], Riverbend Steam Station[4], and Roxboro Steam Electric Plant[5]).

--- - 2018 background threshold value was not calculated for constituent.

mg/kg - milligrams per kilogram

NE - not established

S.U. - standard unit

PSRG - preliminary soil remediation goals

TABLE 4-3
BACKGROUND VALUES FOR GROUNDWATER
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELMONT, NC

Constituent	Reporting Unit	15A NCAC 02L Standard	2018 Background Threshold Values[1]			2019 Updated Background Threshold Values[2]			Piedmont Background Threshold Value Range[3]
			Shallow Flow Zone	Deep Flow Zone	Bedrock Flow Zone	Shallow Flow Zone	Deep Flow Zone	Bedrock Flow Zone	
pH	S.U.	6.5 - 8.5	4.4 - 7.4	6.2 - 7.5	7.2 - 8.4	4.5 - 7.8	6.1 - 8.5	6.6 - 9.0	3.6 - 9
Alkalinity	mg-$CaCO_3$/L	NE	105	77	116	105	134	138	19 - 379
Aluminum	µg/L	NE	534	304	301	1,238	540	736	100 - 1,238
Antimony	µg/L	1*	1	1	1	1	1	3	0.5 - 2.9
Arsenic	µg/L	10	1	1	2	1	1	2	0.2 - 6.35
Barium	µg/L	700	105	132	21	87	103	25	10.52 - 840
Beryllium	µg/L	4*	0	0	0	0.1	1	0.1	0.0625 - 1
Bicarbonate	mg-$CaCO_3$/L	NE	105	77	116	106	125	136	19 - 388
Boron	µg/L	700	50	50	50	50	50	50	50 - 176.8
Cadmium	µg/L	2	1	1	0	0.08	1	0.08	0.08 - 1
Calcium	mg/L	NE	20	17	25	21	31	28	4 - 111
Carbonate	mg-$CaCO_3$/L	NE	5	5	5	5	5	5	5 - 10
Chloride	mg/L	250	5	5	5	11	5	9	3.34 - 250
Chromium	µg/L	10	7	7	6	9	16	10	1 - 26
Chromium (VI)	µg/L	NE	2	1	0	2	2	0.8	0.03 - 12
Cobalt	µg/L	1*	2	1	0	6	0.8	0.3	0.088 - 88.85
Copper	µg/L	1,000	3	3	2	3	2	2	0.5 - 17.15
Fluoride	mg/L	2	---	---	---	0.1	0.1	0.1	0.1 - 1.8
Iron	µg/L	300	884	356	284	1,422	665	1,242	56.3 - 37,500
Lead	µg/L	15	0	0	0	1	0.2	0.1	0 - 2
Lithium	µg/L	NE	---	---	---	3	25	26	2 - 95.39
Magnesium	mg/L	NE	6	5	8	6	7	8	1 - 45
Manganese	µg/L	50	225	26	278	608	256	360	7 - 9,170
Mercury	µg/L	1	0	0	0	0.2	0.2	0.1	0.05 - 0.5
Methane	µg/L	NE	12	10	90	15	125	10	1 - 2,505
Molybdenum	µg/L	NE	1	2	9	7	26	11	0.5 - 26.2
Nickel	µg/L	100	6	5	3	9	10	7	0.87 - 48
Nitrate + Nitrite	mg-N/L	NE	1	1	2	3	3	3	0.02 - 6.3
Potassium	mg/L	NE	6	5	8	5	10	19	1.609 - 18.8
Selenium	µg/L	20	1	1	1	0.5	0.8	0.5	0.5 - 2.4
Sodium	mg/L	NE	21	12	12	21	24	15	6 - 190
Strontium	µg/L	NE	298	232	154	300	240	181	27 - 2,120
Sulfate	mg/L	250	2	5	3	5	15	7	1.2 - 510
Sulfide	mg/L	NE	0	0	0	0.1	0.1	0.1	0.1 - 2
TDS	mg/L	500	163	158	165	154	173	221	50 - 1,200
Thallium	µg/L	0.2*	0	0	0	0.1	0.1	0.1	0.1 - 0.2
TOC	mg/L	NE	1	1	6	12	11	2	1 - 12.3
Total Radium	pCi/L	5^	1	1	1	2	2	1	0.494 - 35
Total Uranium	µg/mL	0.03^	0	0	0	0.0005	0.0005	0.0009	0.0002 - 0.864
Vanadium	µg/L	0.3*	6	12	16	4	16	13	0.33 - 25.8
Zinc	µg/L	1,000	45	10	15	45	15	13	5 - 140

Prepared by: LWD Checked by: JYT

Notes:

2018 background threshold values (BTVs) approved by North Carolina Department of Environmental Quality (NCDEQ) on May 14, 2018.

Background threshold values have been rounded to similar levels of precision as 15A North Carolina Administrative Code (NCAC) 02L Standard or Interim Maximum Allowable Concentration (IMAC).

[1] - BTVs were calculated using data from background groundwater samples collected June 2015 to September 2017.

[2] - Updated BTVs were calculated using data from background groundwater samples collected March 2011 to December 2018.

[3] - Piedmont background threshold value ranges include the Duke Energy calculated 2017[4] and 2019[5] background threshold values from 10 Duke Energy facilities located in the Piedmont physiographic region (Allen Steam Station[5], Belews Creek Steam Station[5], Buck Steam Station[4], Cape Fear Steam Electric Plant[4], Cliffside Steam Station[5], Dan River Steam Station[4], Marshall Steam Station[5], Mayo Steam Electric Plant[5], Riverbend Steam Station[4], and Roxboro Steam Electric Plant[5]).

--- - 2018 BTV was not calculated for constituent.

* - IMAC of the 15A NCAC 02L Standard, Appendix 1, April 1, 2013.

^ - Federal Maximum Contaminant Level (MCL)

µg/L - micrograms per liter

µg/mL - micrograms per milliliter

mg/L - milligrams per liter

mg-$CaCO_3$/L - milligrams calcium carbonate per liter

mg-N/L - milligrams nitrogen per liter

NE - not established

pCi/L - picocuries per liter

S.U. - standard units

TDS - total dissolved solids

TOC - total organic carbon

TABLE 4-4
BACKGROUND DATASET RANGES FOR SURFACE WATER
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELMONT, NC

Constituent	Reporting Unit	Comparison Criteria	Background Range
Constituents with 15A NCAC 02B (Class B, Water Supply: WS-V)[1] Standards			
pH	S.U.	6.0-9.0	6.3 - 7.6
Dissolved Oxygen	mg/L	≥ 4	4.1 - 9
Temperature	deg C	≤ 32	11 - 29
Turbidity	NTU	≤ 25	5.4 - 29.4
Arsenic	µg/L	10	0.33 - <1
Arsenic (Dissolved)	µg/L	acute: 340, chronic: 150	0.3 - <1
Barium	µg/L	1000	11.1 - 18.6
Beryllium (Dissolved)	µg/L	acute: 65, chronic: 6.5	<0.1
Cadmium (Dissolved)[2]	µg/L	acute: 0.82, chronic: 0.15	<0.08 - <0.1
Chloride	mg/L	230	3.6 - 7.1
Chromium (III) (Dissolved)[2, 3]	µg/L	acute: 180, chronic: 24	NA
Chromium (VI) (Dissolved)	µg/L	acute: 16, chronic: 11	NA
Copper (Dissolved)[2]	µg/L	acute: 3.6, chronic: 2.7	0.9 - 3.5
Fluoride	mg/L	1.8	<0.1
Lead (Dissolved)[2]	µg/L	acute: 14, chronic: 0.54	0.033 J - <0.2
Mercury	µg/L	chronic: 0.012	0.000452 j,B - 0.00201
Nickel	µg/L	25	0.13 j - 1
Nickel (Dissolved)[2]	µg/L	acute:140, chronic: 16	0.2 j - <1
Nitrate + Nitrite	mg-N/L	10	0.12 - 0.38
Selenium	µg/L	chronic: 5	<0.5 - <1
Silver (Dissolved)[2]	µg/L	acute: 0.3, chronic: 0.06	<0.5
Sulfate	mg/L	250	2.8 - 4.5
Thallium	µg/L	2	0.015 j - <0.2
Total Dissolved Solids	mg/L	500	29 - 150
Total Hardness	mg/L	100	13.7 - 16.6
Zinc (Dissolved)[2]	µg/L	acute: 36, chronic: 36	<5 - <10
Constituents with USEPA National Recommended Water Quality Criteria			
Alkalinity	mg/L	chronic: 20	12.7 - 17.6
Aluminum	µg/L	acute: 620, chronic: 300	65.8 j - 510
Antimony	µg/L	5.6	0.15 j - 0.53
Iron	µg/L	1000	82.3 - 846
Manganese	µg/L	50	22.5 - 78.4
Constituents without 02B or USEPA Criteria			
Bicarbonate	mg-$CaCO_3$/L	NE	12.7 - 17.6
Boron	µg/L	NE	30.8 j - 60.5
Cadmium	µg/L	NE	<0.08 - <0.1
Calcium	mg/L	NE	2.82 - 4.95
Carbonate Alkalinity	mg-$CaCO_3$/L	NE	<5
Chromium	µg/L	NE	0.17 j - 1.7
Chromium (VI)	µg/L	NE	<0.025 - 0.069
Cobalt	µg/L	NE	0.073 j - 0.28
Copper	µg/L	NE	1.2 - 4.8
Lead	µg/L	NE	0.094 j - 0.48 j
Lithium	µg/L	NE	0.13 - 0.36
Magnesium	mg/L	NE	1.53 - 2.14
Methane	µg/L	NE	14.4 - 49.5

TABLE 4-4
BACKGROUND DATASET RANGES FOR SURFACE WATER
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELMONT, NC

Constituent	Reporting Unit	Comparison Criteria	Background Range
Constituents without 02B or USEPA Criteria (Continued)			
Molybdenum	µg/L	NE	0.17 j - 0.44 j
Potassium	mg/L	NE	<5
Sodium	mg/L	NE	3.49 j - 5.38
Strontium	µg/L	NE	26.1 - 35.9
Sulfide	mg/L	NE	<0.1
Total Organic Carbon	mg/L	NE	1.4 - 2.2
Total Radium	pCi/L	NE	NA
Total Uranium	µg/mL	NE	0.000035 j - 0
Vanadium	µg/L	NE	0.71 - 1.7
Zinc	µg/L	NE	2.7 j - 35.6

Prepared by: LWD Checked by: CJS

Notes:

Background locations were approved by North Carolina Department of Environmental Quality (NCDEQ).

All samples are subject to Class C water quality standards.

[1] 15A NCAC 02B .0101 Class B (Recreation)- Freshwaters protected for primary recreation which includes swimming on a frequent or organized basis and all Class C uses.

[2] Standard value dependent on hardness. Calculated hardness dependent metal standards represent most conservative value. Standards are calculated using 25 mg/L hardness, regardless if actual instream hardness values are greater than 25 mg/L.

[3] Chromium speciation is not performed for trivalent chromium (Cr(III)). Trivalent values are derived by subtracting hexavalent chromium values from dissolved chromium values. Where a dissolved chromium value is less than the detection limit ("<"), it is considered a whole number for purposes of deriving a trivalent chromium value.

Acute - "Compliance with acute instream metals standards shall only be evaluated using an average of two or more samples collected with one hour." Reference 15A NCAC 02B .0211

Chronic - "Compliance with chronic instream metals standards shall only be evaluated using averages of a minimum of four samples taken on consecutive days, or as a 96-hour average" Reference 15A NCAC 02B .0211.

mg/L - milligrams per liter

µg/L - micrograms per liter

µg/mL - micrograms per milliliter

mg-$CaCO_3$/L - milligrams calcium carbonate per liter

mg-N/L - milligram nitrogen per liter

NA - not available

NE - not established

pCi/L - picocuries per liter

S.U. - standard unit

TABLE 4-5
BACKGROUND DATASET RANGES FOR SEDIMENT
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELMONT, NC

Constituent	Reporting Unit	Background Range
pH*	S.U.	6.4 - 7.5
Aluminum	mg/kg	3,200 - 28,000
Antimony	mg/kg	<0.57 - <0.63
Arsenic	mg/kg	0.39 j - 2
Barium	mg/kg	25 - 95
Beryllium	mg/kg	0.096j - 0.25
Boron	mg/kg	<3 - <8.6
Cadmium	mg/kg	0.04 j - <0.16
Calcium	mg/kg	310 j - 1,600
Chloride	mg/kg	3.1 j - <13
Chromium	mg/kg	5.5 - 25
Chromium (III)	mg/kg	NA
Cobalt	mg/kg	1.6 - 16
Copper	mg/kg	2.7 - 20
Iron	mg/kg	3,700 - 44,000
Lead	mg/kg	1.5 - 9.4
Magnesium	mg/kg	370 - 2,300
Manganese	mg/kg	130 - 310
Mercury	mg/kg	<0.095 - <0.1
Molybdenum	mg/kg	<2.3 - <2.5
Nickel	mg/kg	1.7 j - 15
Nitrate (as N)	mg/kg	<0.26 - <0.27
Nitrate	mg/kg	NA
Potassium	mg/kg	400 - 1,400
Selenium	mg/kg	1.3 j - <1.6
Silver	mg/kg	<0.57 - <0.63
Sodium	mg/kg	<290 - <320
Strontium	mg/kg	4.4 - 8.4
Sulfate	mg/kg	<13 - <14
Sulfide	mg/kg	<32 - <34.8
Thallium	mg/kg	0.051 j - 0.2
Total Organic Carbon	mg/kg	400 j,H - 11,700 H
Vanadium	mg/kg	8 - 100
Zinc	mg/kg	11 - 36

Prepared by: LWD Checked by: CJS

Notes:

Background locations were approved by North Carolina Department of Environmental Quality (NCDEQ).

* - Upper and lower threshold values calculated for parameter
mg/kg - milligrams per kilogram
NE - not established
S.U. - standard unit
PSRG - Preliminary Soil Remediation Goals

TABLE 5-1a
MARCH 2019 WATER LEVEL MEASUREMENTS AND ELEVATIONS
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELMONT, NC

Well ID	Top of Casing Elevation (ft. NAVD 88)	Top of Screen Elevation (ft. NAVD 88)	Bottom of Screen Elevation (ft. NAVD 88)	March 2019 Measured Water Level[1] (ft. BTOC)	March 2019 Water Elevation (ft. NAVD 88)	Monitoring Flow Zone
AB-01R	675.86	622.57	602.57	53.20	622.66	Shallow
AB-02	638.74	631.70	616.70	10.62	628.12	Shallow
AB-02D	638.33	570.20	565.20	12.28	626.05	Deep
AB-04BR	648.50	565.59	560.59	3.30	645.25	Bedrock
AB-04D	649.17	601.98	596.98	3.38	645.79	Deep
AB-04S	650.42	635.52	620.52	5.12	645.34	Shallow
AB-05	677.02	647.10	632.10	38.18	638.84	Shallow
AB-06A	579.30	546.08	543.08	6.43	572.87	Shallow
AB-06R	579.90	541.00	538.00	5.93	573.97	Shallow
AB-09D	582.73	464.80	459.80	12.30	570.43	Deep
AB-09S	582.72	575.02	560.02	10.96	571.76	Shallow
AB-10BR	576.71	423.93	413.93	7.15	569.56	Bedrock
AB-10BRL	576.10	365.68	355.68	5.49	570.61	Bedrock
AB-10D	574.97	514.91	509.91	6.70	568.27	Deep
AB-10S	575.05	569.61	554.61	6.72	568.33	Shallow
AB-11D	618.07	600.39	595.39	4.94	613.13	Deep
AB-12D	651.73	558.71	553.71	6.71	645.04	Deep
AB-12S	651.67	641.64	626.64	8.50	643.19	Shallow
AB-13D	648.54	578.89	573.89	4.05	644.49	Deep
AB-13S	648.72	639.98	624.98	3.58	645.14	Shallow
AB-14BR	642.20	548.90	543.90	10.38	631.82	Bedrock
AB-14D	641.80	620.06	610.06	11.56	630.24	Deep
AB-20D	649.30	521.57	516.57	9.33	639.94	Deep
AB-20S	649.42	641.74	626.74	10.77	638.65	Ash Pore Water
AB-21BR	647.68	481.66	476.66	10.33	637.35	Bedrock
AB-21BRL	647.59	421.40	416.40	10.27	637.32	Bedrock
AB-21D	647.57	501.70	496.70	10.17	637.40	Deep
AB-21S	647.41	638.82	623.82	10.40	637.01	Ash Pore Water
AB-21SL	647.36	609.78	599.78	10.20	637.16	Ash Pore Water
AB-21SS	647.06	565.92	555.92	10.26	634.80	Shallow
AB-22BR	645.03	442.00	437.00	44.89	600.14	Bedrock
AB-22BRL	645.09	402.32	397.32	40.25	604.84	Bedrock
AB-22D	644.81	485.11	480.11	44.92	599.89	Deep
AB-22S	644.89	560.16	545.16	49.64	595.25	Shallow
AB-23BRU	646.47	525.40	520.40	67.07	579.40	Deep
AB-23S	646.61	618.38	603.38	8.19	638.42	Ash Pore Water
AB-24BR	648.32	492.10	487.10	11.9	636.42	Bedrock
AB-24D	647.86	535.05	530.05	11.52	636.34	Deep
AB-24S	647.86	639.89	624.89	9.89	637.97	Ash Pore Water
AB-24SL	647.92	619.52	609.52	10.42	637.50	Ash Pore Water
AB-25BR	647.11	504.39	499.39	10.94	636.17	Bedrock
AB-25BRU	646.76	536.41	531.41	10.65	636.11	Deep
AB-25S	647.22	639.46	624.46	8.54	638.68	Ash Pore Water
AB-25SL	646.97	614.45	599.45	10.50	636.47	Ash Pore Water
AB-25SS	646.83	574.08	564.08	10.44	636.39	Shallow

TABLE 5-1a
MARCH 2019 WATER LEVEL MEASUREMENTS AND ELEVATIONS
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELMONT, NC

Well ID	Top of Casing Elevation (ft. NAVD 88)	Top of Screen Elevation (ft. NAVD 88)	Bottom of Screen Elevation (ft. NAVD 88)	March 2019 Measured Water Level[1] (ft. BTOC)	March 2019 Water Elevation (ft. NAVD 88)	Monitoring Flow Zone
AB-26D	643.42	452.05	447.05	58.23	585.19	Deep
AB-26S	643.32	558.50	548.50	59.61	583.71	Shallow
AB-27BR	643.11	460.50	455.50	22.59	620.52	Bedrock
AB-27D	643.24	533.04	528.04	24.40	618.84	Deep
AB-27S	643.25	635.53	620.53	4.79	638.46	Ash Pore Water
AB-28D	644.17	486.32	481.32	14.15	630.02	Deep
AB-28S	644.19	639.35	624.35	4.95	639.24	Ash Pore Water
AB-29D	620.46	508.09	503.09	5.91	614.55	Deep
AB-29S	620.46	615.60	600.60	7.17	613.29	Ash Pore Water
AB-29SL	620.45	584.59	574.59	7.11	613.34	Ash Pore Water
AB-29SS	620.33	543.60	533.60	7.51	612.82	Shallow
AB-30D	621.38	483.53	478.53	30.30	591.08	Deep
AB-30S	621.21	616.46	601.46	33.40	587.81	Ash Pore Water
AB-31D	627.25	496.43	491.43	46.85	580.40	Deep
AB-31S	627.20	569.40	554.40	48.11	579.09	Shallow
AB-32D	624.40	504.63	499.63	45.05	579.35	Deep
AB-32S	624.34	569.70	554.70	44.20	580.14	Shallow
AB-33D	627.39	508.27	503.27	33.65	593.74	Deep
AB-33S	627.00	603.96	588.96	24.49	602.51	Ash Pore Water
AB-33SS	626.42	578.83	568.83	23.96	602.46	Shallow
AB-34D	632.93	195.17	490.17	18.70	614.23	Deep
AB-34S	632.88	613.16	598.16	17.36	615.52	Ash Pore Water
AB-35BR	664.54	479.73	474.73	40.42	624.12	Bedrock
AB-35D	664.55	545.65	540.65	40.60	623.95	Deep
AB-35PWS	663.47	572.69	562.69	40.35	623.12	Deep
AB-35S	664.47	626.62	611.62	42.17	622.30	Ash Pore Water
AB-36D	626.68	531.02	526.02	3.38	623.30	Deep
AB-36S	627.18	619.09	609.09	1.01	626.17	Shallow
AB-37D	628.09	564.89	559.89	0.50	627.59	Deep
AB-37S	628.01	621.88	606.88	3.50	624.51	Ash Pore Water
AB-38BR	634.13	529.90	524.90	3.1	631.03	Bedrock
AB-38D	634.41	563.62	558.62	3.45	630.96	Deep
AB-38S	634.64	621.67	606.67	3.32	631.32	Ash Pore Water
AB-38SS	634.57	604.72	594.72	3.22	631.35	Shallow
AB-39D	637.46	551.48	546.48	14.22	623.24	Deep
AB-39S	637.47	604.42	589.42	15.81	621.66	Ash Pore Water
BG-01BR	694.01	522.25	512.25	54.77	639.24	Bedrock
BG-01DA	693.93	559.63	554.63	55.07	638.86	Deep
BG-01S	695.13	640.63	625.63	58.10	637.03	Shallow
BG-02BRA2	644.03	510.25	500.25	54.73	589.30	Bedrock
BG-02D	644.22	534.33	529.33	55.20	589.02	Deep
BG-02S	644.31	588.41	573.41	53.16	591.15	Shallow
BG-03D	674.44	578.99	573.99	65.00	609.44	Deep
BG-03S	675.18	602.50	587.50	65.73	609.45	Shallow
BG-04BR	662.08	499.01	494.01	87.69	574.39	Bedrock

TABLE 5-1a
MARCH 2019 WATER LEVEL MEASUREMENTS AND ELEVATIONS
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELMONT, NC

Well ID	Top of Casing Elevation (ft. NAVD 88)	Top of Screen Elevation (ft. NAVD 88)	Bottom of Screen Elevation (ft. NAVD 88)	March 2019 Measured Water Level[1] (ft. BTOC)	March 2019 Water Elevation (ft. NAVD 88)	Monitoring Flow Zone
BG-04D	661.62	552.83	547.83	86.99	574.63	Deep
BG-04S	662.19	580.89	565.89	85.00	577.19	Shallow
CCR-11DA	580.85	492.26	487.26	7.85	573.00	Deep
CCR-11S	580.34	569.56	554.56	6.41	573.93	Shallow
CCR-14D	592.39	467.68	462.68	19.65	572.74	Deep
CCR-14S	592.42	579.23	564.23	13.93	578.49	Shallow
CCR-16BR	585.79	504.97	493.97	10.32	574.51	Bedrock
CCR-16D	584.83	514.14	509.14	11.36	573.33	Bedrock
CCR-16S	584.69	570.95	555.95	12.04	572.65	Shallow
CCR-17D	593.47	500.10	495.10	6.92	586.55	Bedrock
CCR-17S	592.95	576.89	561.89	15.05	577.90	Shallow
CCR-18D	585.13	397.00	392.00	10.37	574.76	Deep
CCR-18S	584.64	572.43	557.43	12.59	572.05	Shallow
CCR-1DA	652.59	571.64	566.64	22.62	629.97	Deep
CCR-1S	652.23	634.25	619.25	22.39	629.84	Shallow
CCR-20D[2]	607.43	426.44	421.44	0.00	607.43	Deep
CCR-20S	606.41	594.67	579.67	1.53	604.88	Shallow
CCR-21D	650.67	501.45	496.45	19.93	630.74	Deep
CCR-21S	651.05	629.70	614.70	20.55	630.50	Shallow
CCR-22DA	653.04	487.13	482.13	20.93	632.11	Deep
CCR-22S	653.22	629.77	614.77	18.79	634.43	Shallow
CCR-23D	647.36	528.25	523.25	13.08	634.28	Deep
CCR-23S	647.26	626.22	611.22	13.99	633.27	Shallow
CCR-26BR	589.79	510.41	500.41	14.80	574.99	Bedrock
CCR-26D	589.95	531.74	521.74	15.21	574.74	Deep
CCR-26S	589.96	564.18	554.18	15.68	574.28	Shallow
CCR-2D	643.94	518.23	513.23	22.10	621.84	Deep
CCR-2S	643.60	627.37	612.37	19.15	624.45	Shallow
CCR-3DA	643.60	525.68	520.68	47.06	596.54	Deep
CCR-3S	642.78	616.03	601.03	27.88	614.90	Shallow
CCR-4DA	627.83	492.54	487.54	35.08	598.01	Deep
CCR-4SA	629.20	602.04	587.04	27.63	607.16	Shallow
CCR-5D	617.73	493.24	488.24	24.93	596.52	Deep
CCR-5S	618.16	602.45	587.45	22.87	599.47	Shallow
CCR-6D	608.43	479.30	474.30	21.00	589.96	Deep
CCR-6S	608.73	598.48	583.48	17.27	596.05	Shallow
CCR-7D	597.65	464.71	459.71	11.97	590.92	Deep
CCR-7S	597.95	588.43	573.43	12.83	590.69	Shallow
CCR-8D	590.93	465.10	460.10	8.33	587.75	Deep
CCR-8S	590.93	580.96	565.96	8.00	588.66	Shallow
CCR-9D	584.03	489.28	484.28	2.71	581.32	Deep
CCR-9S	583.81	576.43	561.43	4.03	579.78	Shallow
CCR-BG-1DA	661.17	535.79	530.79	30.67	628.87	Deep
CCR-BG-1S	660.37	617.39	602.39	28.50	627.50	Shallow
CP-1D	591.50	509.85	499.85	7.75	583.75	Deep

TABLE 5-1a
MARCH 2019 WATER LEVEL MEASUREMENTS AND ELEVATIONS
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELMONT, NC

Well ID	Top of Casing Elevation (ft. NAVD 88)	Top of Screen Elevation (ft. NAVD 88)	Bottom of Screen Elevation (ft. NAVD 88)	March 2019 Measured Water Level[1] (ft. BTOC)	March 2019 Water Elevation (ft. NAVD 88)	Monitoring Flow Zone
CP-1S	591.15	561.72	551.72	5.42	585.73	Shallow
CP-2D	589.06	532.36	522.36	11.99	577.07	Deep
CP-2S	589.17	559.72	549.72	13.02	576.15	Shallow
CP-3D	576.47	495.45	485.45	7.81	568.66	Deep
CP-3S	576.56	550.80	540.80	7.95	568.61	Shallow
CP-4D	576.37	513.49	503.49	7.10	569.27	Deep
CP-4S	576.29	553.37	543.37	8.07	568.22	Shallow
CP-5D	580.89	531.38	521.38	9.63	571.26	Deep
CP-5S	580.79	561.14	551.14	7.88	572.91	Shallow
CP-6BR	583.18	351.53	340.53	12.38	571.15	Bedrock
CP-6D	582.69	509.26	499.26	10.74	571.95	Deep
CP-6S	582.85	563.21	553.21	10.05	572.80	Shallow
GWA-01BR	629.37	509.72	504.72	9.62	619.75	Bedrock
GWA-01D	629.38	548.53	543.53	9.58	619.80	Deep
GWA-01S	629.27	621.53	606.53	8.85	620.42	Shallow
GWA-02D	579.66	459.27	454.27	1.44	578.22	Deep
GWA-02S	579.36	566.45	551.45	13.29	566.07	Shallow
GWA-03BRA	583.81	408.65	398.65	8.66	575.15	Bedrock
GWA-03BRL[2]	580.61	119.17	109.17	0	580.61	Bedrock
GWA-03D	580.30	438.47	433.47	5.13	575.17	Deep
GWA-03S	583.59	570.59	555.59	9.85	573.74	Shallow
GWA-04BR	580.02	432.53	427.53	7.24	572.78	Bedrock
GWA-04BRL	580.32	372.46	362.46	7.12	573.20	Bedrock
GWA-04D	580.30	485.45	480.45	7.68	572.62	Deep
GWA-04S	580.32	573.54	558.54	7.09	573.23	Shallow
GWA-05BRA	581.18	442.78	437.78	8.23	572.95	Bedrock
GWA-05BRL	581.16	246.46	236.46	7.65	573.51	Bedrock
GWA-05D	581.02	470.17	465.17	8.04	572.98	Bedrock
GWA-05S	580.93	569.30	554.30	7.49	573.44	Shallow
GWA-06BRA	629.48	444.48	439.48	37.67	591.81	Bedrock
GWA-06BRL	630.61	338.05	328.05	38.52	592.09	Bedrock
GWA-06DA	630.16	508.49	503.49	38.35	591.81	Deep
GWA-06S	628.35	603.04	588.04	30.08	598.27	Shallow
GWA-07D	594.27	459.69	454.69	13.37	580.90	Deep
GWA-07S	595.05	577.40	562.40	8.17	586.88	Shallow
GWA-08D	676.66	554.08	549.08	65.67	610.99	Deep
GWA-08S[3]	676.88	630.43	615.43	BP	BP	Shallow
GWA-09BR	648.04	501.25	496.25	6.35	641.69	Bedrock
GWA-09D	647.74	536.39	531.39	5.96	641.69	Deep
GWA-09S	647.57	638.63	623.63	6.71	640.85	Shallow
GWA-14DA	654.05	550.09	545.09	18.95	635.10	Deep
GWA-14S	653.57	634.80	619.80	18.45	635.12	Shallow
GWA-15D	633.27	548.99	543.99	3.88	629.39	Deep
GWA-15S	632.71	616.05	601.05	2.92	629.79	Shallow
GWA-16D	656.06	554.57	544.57	51.33	604.73	Deep

TABLE 5-1a
MARCH 2019 WATER LEVEL MEASUREMENTS AND ELEVATIONS
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELMONT, NC

Well ID	Top of Casing Elevation (ft. NAVD 88)	Top of Screen Elevation (ft. NAVD 88)	Bottom of Screen Elevation (ft. NAVD 88)	March 2019 Measured Water Level[1] (ft. BTOC)	March 2019 Water Elevation (ft. NAVD 88)	Monitoring Flow Zone
GWA-16S	656.59	608.37	593.37	52.37	604.22	Shallow
GWA-17D	681.72	564.34	554.34	65.27	616.45	Deep
GWA-17S	681.89	610.18	595.18	64.62	617.27	Shallow
GWA-18D	651.14	561.60	556.60	21.67	629.47	Deep
GWA-18S	651.04	593.38	578.38	21.55	629.49	Shallow
GWA-19D	669.95	545.02	540.02	41.18	628.77	Deep
GWA-19S	669.85	627.98	612.98	38.94	630.91	Shallow
GWA-21BR	671.74	470.07	465.07	29.73	642.01	Bedrock
GWA-21DA	670.02	491.07	486.07	27.71	642.31	Deep
GWA-21S	671.24	644.92	629.92	22.04	649.20	Shallow
GWA-22D	665.29	485.29	480.29	27.15	638.14	Deep
GWA-22S	665.14	640.27	625.27	24.84	640.30	Shallow
GWA-23D	669.26	589.38	584.38	25.08	644.18	Deep
GWA-23S	670.09	647.04	632.04	25.92	644.17	Shallow
GWA-24BR	675.45	514.96	510.06	36.03	639.42	Bedrock
GWA-24D	675.59	552.53	547.53	35.46	640.02	Deep
GWA-24SA	675.74	642.80	627.80	35.10	640.93	Shallow
GWA-26D	683.12	568.27	553.27	45.04	638.08	Deep
GWA-26S	683.10	637.66	612.66	45.06	638.04	Shallow

Prepared by: LWD Checked by: JYT

Notes:

[1] - Manual water levels collected on March 13, 2019

[2] - Artesian conditions present

[3] - GWA-08S pump intake is approximately 77 feet below top of casing

ft. BTOC - feet below top of casing

ft. NAVD 88 - feet North American Vertical Datum of 1988

BP - field measurement recorded as water level below pump intake

- water level identified as anomolous likely due to field transcription error

TABLE 5-1b
OCTOBER 2019 WATER LEVEL MEASUREMENTS AND ELEVATIONS
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELMONT, NC

Well ID	Top of Well Casing (ft. NAVD 88)	Top of Screen Elevation (ft. NAVD 88)	Bottom of Screen Elevation (ft. NAVD 88)	October 2019 Measured Water Level[1] (ft. BTOC)	October 2019 Water Elevation (ft. NAVD 88)	Monitoring Zone
AB-33D	627.39	508.27	503.27	34.58	592.81	Deep
AB-33S	627.00	603.96	588.96	26.59	600.41	Ash Pore Water
AB-33SS	626.42	578.83	568.83	27.53	598.89	Shallow
AB-34D	632.93	195.17	490.17	22.25	610.68	Deep
AB-34S	632.88	613.16	598.16	19.40	613.48	Ash Pore Water
AB-39D	637.46	551.48	546.48	18.15	619.31	Deep
AB-39S	637.47	604.42	589.42	18.45	619.02	Ash Pore Water
AB-40D	635.04	521.36	511.36	35.00	600.04	Deep
AB-40SS	635.04	591.73	581.73	32.71	602.33	Shallow
AB-41D	634.55	500.98	490.98	29.59	604.96	Deep
AB-41SS	634.49	567.71	557.71	28.22	606.27	Shallow
AB-42AP	634.10	601.12	591.12	26.85	607.25	Ash Pore Water
AB-42D	634.12	518.04	508.04	30.28	603.84	Deep
AB-42SS	634.00	557.58	547.58	29.02	604.98	Shallow
AB-43AP	632.98	599.58	589.58	26.51	606.47	Ash Pore Water
AB-43D	632.98	544.38	534.38	25.30	607.68	Deep
AB-43SS	633.02	565.74	555.74	25.19	607.83	Shallow
AB-44AP	633.78	616.06	606.06	DRY	DRY	Ash Pore Water
AB-44D	633.86	504.44	494.44	27.98	605.88	Deep
AB-44SS	633.75	576.84	566.84	28.01	605.74	Shallow
CCR-03DA	643.60	525.68	520.68	DRY	DRY	Deep
CCR-03S	642.78	616.03	601.03	29.39	613.39	Shallow
CCR-04DA	627.83	492.54	487.54	36.40	591.43	Deep
CCR-04SA	629.20	602.04	587.04	28.74	600.46	Shallow
CCR-05D	617.73	493.24	488.24	21.02	596.71	Deep
CCR-05S	618.16	602.45	587.45	19.15	599.01	Shallow
CCR-06D	608.43	479.30	474.30	19.27	589.16	Deep
CCR-06S	608.73	598.48	583.48	BP	BP	Shallow
CCR-07D	597.65	464.71	459.71	8.88	588.77	Deep
CCR-07S	597.95	588.43	573.43	9.85	588.10	Shallow
CCR-08D	590.93	465.10	460.10	7.10	583.83	Deep
CCR-08S	590.93	580.96	565.96	5.90	585.03	Shallow
CCR-09D	584.03	489.28	484.28	5.78	578.25	Deep
CCR-09S	583.81	576.43	561.43	6.35	577.46	Shallow
CCR-26BR	589.79	510.41	500.41	18.04	571.75	Bedrock
CCR-26D	589.95	531.74	521.74	18.38	571.57	Deep
CCR-26S	589.96	564.18	554.18	18.58	571.38	Shallow
CP-01D	591.50	509.85	499.85	12.31	579.19	Deep
CP-01S	591.15	561.72	551.72	9.80	581.35	Shallow
CP-02D	589.06	532.36	522.36	13.55	575.51	Deep
CP-02S	589.17	559.72	549.72	14.32	574.85	Shallow
CP-03D	576.47	495.45	485.45	10.54	565.93	Deep
CP-03S	576.56	550.80	540.80	10.60	565.96	Shallow
CP-04D	576.37	513.49	503.49	9.91	566.46	Deep
CP-04S	576.29	553.37	543.37	10.93	565.36	Shallow
CP-05D	580.89	531.38	521.38	12.37	568.52	Deep

TABLE 5-1b
OCTOBER 2019 WATER LEVEL MEASUREMENTS AND ELEVATIONS
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELMONT, NC

Well ID	Top of Well Casing (ft. NAVD 88)	Top of Screen Elevation (ft. NAVD 88)	Bottom of Screen Elevation (ft. NAVD 88)	October 2019 Measured Water Level[1] (ft. BTOC)	October 2019 Water Elevation (ft. NAVD 88)	Monitoring Zone
CP-05S	580.79	561.14	551.14	12.75	568.04	Shallow
CP-06D	582.69	509.26	499.26	13.37	569.32	Deep
CP-06S	582.85	563.21	553.21	14.41	568.44	Shallow
CP-06BR	583.18	351.53	340.53	15.25	567.93	Bedrock
GWA-06BRA	629.48	444.48	439.48	39.85	589.63	Bedrock
GWA-06BRL	630.61	338.05	328.05	29.84	600.77	Bedrock
GWA-06DA	630.16	508.49	503.49	40.38	589.78	Deep
GWA-06S	628.35	603.04	588.04	31.34	597.01	Shallow
GWA-07D	594.27	459.69	454.69	16.88	577.39	Deep
GWA-07S	595.05	577.40	562.40	11.80	583.25	Shallow
GWA-27D	628.22	475.67	465.67	42.24	585.98	Deep
GWA-27S	628.39	576.14	566.14	36.17	592.22	Shallow
GWA-28BR	588.62	458.31	448.31	14.28	574.34	Bedrock
GWA-28D	588.72	547.25	537.25	14.31	574.41	Deep
GWA-28S	589.17	570.03	560.03	14.42	574.75	Shallow
GWA-29BR	579.09	482.08	472.08	13.72	565.37	Bedrock
GWA-29D	579.04	518.24	508.24	13.72	565.32	Deep
GWA-29S	579.26	548.09	538.09	13.59	565.67	Shallow
GWA-30D	596.34	540.15	530.15	10.88	585.46	Deep
GWA-30S	596.14	573.57	563.57	8.96	587.18	Shallow

Prepared by: LWD Checked by: MAF

Notes:

[1] - Manual water levels collected on October 24, 2019

[2] - CCR-06S pump intake is approximately 20 feet below top of casing

ft. BTOC - feet below top of casing

ft. NAVD 88 - feet North American Vertical Datum of 1988

BP - field measurement recorded as water level below pump intake

TABLE 5-2
GROUNDWATER BALANCE SUMMARY
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELMONT, NC

Modeling Scenario	**Pre-Decanting**		**Post-Decanting**		**Closure-in-Place**		**Closure-by-Excavation**	
Water Balance Components	Flow in (gpm)	Flow out (gpm)	Flow in (gpm)	Flow out (gpm)	Flow in (gpm)	Flow out (gpm)	Flow in (gpm)	Flow out (gpm)
Direct recharge to the active ash basin	40	0	71	0	4	0	25	0
Direct recharge to the retired ash basin	41	0	41	0	6	0	41	0
Direct recharge to the watershed outside of the ash basins	57	0	60	0	82	0	106	0
Ash basin ponds	428	155	0	0	0	20	0	129
Flow to drainages inside of the ash basins	0	39	0	14	0	0	0	0
Flow to drainages outside of the ash basins	0	27	0	15	0	0	0	6
Wells and septic return outside of the ash basins	12	12	12	13	15	15	17	18
Flow toward southeast of AAB	0	17	0	5	0	0	0	0
Flow towards drainage canal north of the RAB	0	5	0	3	0	0	0	0
Flow towards the coal pile	0	25	0	19	1	10	5	4
Flow through and under the dam	0	293	0	110	0	56	0	29

Prepared by: JFE Checked by: LWD

Notes:
Flow in refers to recharge to the groundwater system
Flow out refers to discharge from the groundwater system
gpm - gallons per minute

TABLE 5-3
SURFACE WATER CLASSIFICATIONS
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELMONT, NC

Adjacent Surface Water Body	Surface Water Classification (15A NCAC 02B .0300)
Catawba River (Lake Wylie)	Class B, WS-V
South Fork Catawba River	Class B, WS-V

Prepared by: LWD Checked by: CJS

Notes:

1. Class B waters are protected for primary recreation which includes swimming on a frequent or organized basis and all Class C uses.
2. Class WS-V waters are generally upstream of Class WS-IV waters or waters currently or formerly used by industry for water supply. These waters are also protected for Class C uses.

NCAC – North Carolina Administrative Code
WS – Water Supply

TABLE 6-1
BORON CONCENTRATIONS IN GROUNDWATER
BELOW SOURCE AREA
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELMONT, NC

Well Beneath Ash (Flow Zone)	Number of Sample Events	Time Period of Record	Boron Concentration Range in Groundwater (µg/L)	Boron Concentration Range in Overlying Pore Water (µg/L)
AB-20D (deep)	14	06/2015 – 08/2018	28.3 j – <50	1810 – 6800 (approximately 10 feet of saturated ash)
AB-21SS (shallow)	1	09/2018	<50[1]	3280 M1 – 8930 (approximately 40 feet of saturated ash)
AB-21D (deep)	14	06/2015 - 08/2018	29 j - <50	
AB-21BR (bedrock)	13	06/2015 - 02/2018	26.5 j - <50	
AB-21BRL (bedrock)	8	12/2016 - 08/2018	26.4 j - <50	
AB-23BRU (deep)	12	07/2015 – 08/2018	29.1 j – 74.5	377 – 561 (approximately 15 feet of saturated ash)
AB-24D (deep)	14	06/2015 – 08/2018	<50[1]	190 – 658 (approximately 25 feet of saturated ash)
AB-24BR (bedrock)	8	12/2016 - 08/2018	<50[1]	
AB-25SS (shallow)	1	09/2018	1180	234 B - 2800 (approximately 40 feet of saturated ash)
AB-25BRU (deep)	14	06/2015 - 08/2018	25.9 j - <50	
AB-25BR (bedrock)	13	06/2015 - 08/2018	25.4 j - 54.6	
AB-27D (deep)	12	06/2015 – 08/2018	253 j+ – 1500	418 – 560 (less than 5 feet of saturated ash)
AB-27BR (bedrock)	8	12/2016 - 08/2018	88.2 - 164	

TABLE 6-1
BORON CONCENTRATIONS IN GROUNDWATER
BELOW SOURCE AREA
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELMONT, NC

Well Beneath Ash (Flow Zone)	Number of Sample Events	Time Period of Record	Boron Concentration Range in Groundwater (µg/L)	Boron Concentration Range in Overlying Pore Water (µg/L)
AB-28D (deep)	11	06/2015 – 08/2018	37 j – 82.2	729 – 1150 (less than 5 feet of saturated ash)
AB-29SS (shallow)	1	09/2018	604	356 – 2310 (approximately 40 feet of saturated ash)
AB-29D (deep)	14	06/2015 - 08/2018	210 – 423	
AB-30D (deep)	12	06/2015 – 08/2018	<50[1]	809 – 996 (approximately 10 feet of saturated ash)
AB-33SS (shallow)	1	09/2018	1820	580 – 908 (less than 5 feet of saturated ash)
AB-33D (deep)	14	06/2015 - 08/2018	150 - 190	
AB-34D (deep)	12	07/2015 – 08/2018	<50[1]	91 – 341 (approximately 5 feet of saturated ash)
AB-35PWS (shallow)	1	09/2018	<50[1]	823 – 1110 (approximately 15 feet of saturated ash)
AB-35D (deep)	14	06/2015 - 08/2018	26.1 j - <50	
AB-35BR (bedrock)	14	06/2015 - 08/2018	32.5 j - <50	
AB-37D (deep)	13	07/2015 – 08/2018	<50[1]	<50 (less than 5 feet of saturated ash)

TABLE 6-1
BORON CONCENTRATIONS IN GROUNDWATER BELOW SOURCE AREA
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELMONT, NC

Well Beneath Ash (Flow Zone)	Number of Sample Events	Time Period of Record	Boron Concentration Range in Groundwater (µg/L)	Boron Concentration Range in Overlying Pore Water (µg/L)
AB-38SS (shallow)	1	09/2018	<50[1]	68.6 – 179 (less than 5 feet of saturated ash)
AB-38D (deep)	14	07/2015 - 08/2018	<50[1]	
AB-38BR (bedrock)	8	12/2016 - 08/2018	<50[1]	
AB-39D (deep)	15	06/2015 – 08/2018	76.2 - 93.9	96.3 – 149 (approximately 25 feet of saturated ash)

Prepared by: LWD Checked by: CJS

Notes:
µg/L – micrograms per liter
< – Concentration not detected at or above the adjusted reporting limit.
[1] – Concentrations have not been detected at or above the reporting limit across all sampling events.
j – Estimated concentration above the adjusted method detection limit and below the adjusted reporting limit.
j+ - Estimated concentration, biased high.
B – Target analyte detected in method blank at or above the reporting limit. Target analyte concentration in sample is less than 10 times the concentration in the method blank. Analyte concentration in sample could be due to blank contamination.
M1 - Matrix spike recovery was high: the associated Laboratory Control Spike (LCS) was acceptable.

TABLE 6-2
SOIL PSRG POG STANDARD EQUATION PARAMETERS AND VALUES
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELMONT, NC

$C_{soil} = C_{gw} [K_d + (\theta_w + \theta_a H')/P_b]df$			
Inorganic Parameters	**Parameter Definition**	**Default Values**	**Units**
C_{soil}	Calculated source concentrations for soil	NA	mg/kg
C_{gw}	Applicable groundwater target concentration: 15A NCAC 02L Standard	15A NCAC 02L Standard	mg/L
df	Dilution factor[1]	20	unitless
K_d	Soil -water partition coefficient for inorganics (range)	Constituent Specific[4]	L/kg
θ_w	Water-filled soil porosity - vadose soils[2]	0.3	L_{water}/L_{soil}
θ_a	Air filled soil porosity - vadose soils[3]	0.13	L_{air}/L_{soil}
P_b	Dry bulk density[2]	1.6	kg/L
H'	Henry's law constant-dimensionless where: H' = Henry's law constant (atm - m3/mole) x conversion factor of 41	Constituent Specific[3,5]	unitless

Prepared by: LWD Checked by: PWA

Notes:

[1] - Default value from Soil Screening Guidance: Technical Background Document (USEPA, 1996)

[2] - Site specific value (Murdoch *et al.*, 2019). Effective porosity represents unconsolidated material.

[3] - DEQ default value appropriate for North Carolina

[4] - Constituent Specific- Soil water partition coefficients (K_d) were obtained from the Groundwater Quality Signatures for Assessing Potential Impacts from Coal Combustion Product Leachate (EPRI, 2012). Sulfate K_d ranges from 0.1 to 2.1, based on sands/sediments and a pH range of 4.6 to 7.2

[5] – a value of 0 is used for sulfate

NA - Not applicable

NCAC – North Carolina Administrative Code

mg/kg – milligrams per kilogram

mg/L – milligrams per liter

L/kg – liters per kilogram

L_{water}/L_{soil} – volume of water filled spaces per volume of soil

L_{air}/L_{soil} – volume of air filled spaces per volume of soil

kg/L – kilogram per liter

TABLE 6-3
SUMMARY OF UNSATURATED SOIL ANALYTICAL RESULTS
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELMONT, NC

Analytical Parameter		Antimony	Arsenic	Beryllium	Boron	Cadmium	Chromium	Cobalt	Iron	Manganese	Molybdenum	Nickel	Selenium	Strontium	Sulfate	Thallium	Vanadium
Reporting Units		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
PSRG Protection of Groundwater		**0.9**	**5.8**	**63**	**45**	**3**	3.8*	0.9	150	65	**7.1**	**130**	2.1	**1500**	**1438^**	0.28	**350**
2018 Background Threshold Values[1]		0.61	2.391	1.31	6.8	0.038	**56.9**	29.2	**61162**	1222	5.4	9.87	0.812	31	14	**0.482**	132
2019 Background Threshold Values[2]		0.61	2.358	1.77	23.1	1	48.8	**67.7**	60916	**1927**	5.4	53.5	**2.3**	28.73	437	0.482	131.9
Sample ID	**Sample Collection Date**	**Analytical Results**															
Background																	
BG-01D (1-2)	04/27/2015	<6.3	<6.3	<0.32	<15.8	<0.76	15.2	13.3	35100	340	<3.2	2.2	<6.3	3.3	<305	<6.3	78.1
BG-01D (19-20.5)	04/28/2015	<6.2	<6.2	0.36	<15.5	<0.74	14.7	14.5	27600	436	<3.1	1.8	<6.2	<3.1	<304	<6.2	68.1
BG-01D (45-50)	05/01/2015	<7.6	<7.6	0.91	23.4 j+	<0.92	6.2	18.7	33600	1060	<3.8	5.3	<7.6	10.1	<363	<7.6	79.3
BG-01D (56-57)	04/30/2015	<7.2	<7.2	1.6	**48.2 j-**	<0.86	5.6 j-	28.7 j-	51900 j-	805 j+	<3.6	12	**4.3 j+**	27.4	<363	<7.2	116 j+
BG-02D (1-2.5)	05/14/2015	<8.7	<8.7	0.38 j	<21.8	<1	6.7	5.6 j	51300	627	<4.4	<2.2	<6.5	3.9 j	<423	<8.7	81.6
BG-02D (18-20)	05/14/2015	<7	<7	0.95	<17.6	<0.84	2.7	19.4	32400	1340	<3.5	<1.8	<5.3	16.7	<336	<7	77.5
BG-02D (48.5-50)	05/14/2015	<6.4	<6.4	0.34	<16.1	<0.77	<1.6	10	16300	426	<3.2	<1.6	<4.8	21.3	<304	<6.4	36.8
BG-02D (8.5-10)	05/14/2015	<6.4	<6.4	0.35	<16.1	<0.77	3.1	9.7	23100	587	<3.2	1.4 j	<4.8	5.5	<315	<6.4	49
BG-02S (48.5-50)	05/19/2015	<6.1	<6.1	0.36	<15.1	<0.73	1.9	6.6	18200	574	<3	1.7	<4.5	21.3	<294	<6.1	32.3
BG-03D (1-2.5)	02/23/2015	<1.4	<3.4	0.85	<17.2	0.11 j	30.9	19.8	24900	712	<3.4	53.5	2.3 j	12	<345	<1.4	48.5
BG-03D (13.5-15)	02/23/2015	<1.2	<3	<0.36	<3	0.35	1.7	28.5	13600	962	<0.6	2.1	<3	1.5	<311	<1.2	40.9
BG-03D (18.5-20)	02/23/2015	<1.2	<1.2	0.071 j	<3	<0.14	7.6	3.9	6400	172	0.69	0.78	<1.2	1.3	<291	<1.2	15.3
BG-03D (62-64)	03/02/2015	<3	<3	0.26 j	13.4	<0.36	1	8.8	17800	524	<0.6	1.8	<3	15.5	<295	<3	45.9
BGSB-BG-01 (14-15)	08/30/2017	<0.57	1 B	0.97	<2.5	0.064	3.4	43	20000	740	<2	3.7	0.34 j	1.4	<12	0.43	73
BGSB-BG-01 (24-25)	08/30/2017	<0.59	0.94 B	1.8	<6.8	0.038	17	53	58000	1700	<5.4	22	0.49 j	1.5 j	<14	0.31	130
BGSB-BG-01 (4-5)	08/30/2017	<0.53	1.9 B	0.61	<2.8	<0.027	8.7	1.9	41000	170	<2.2	4.4	0.59 j	1 j	<12	0.14	91
BGSB-BG-02 (14-15)	08/30/2017	0.25 j	0.7 B	0.55	<2.9	<0.026	2.8	13	20000	620	<2.3	2.7	<1.4	9	<12 M	0.27	57
BGSB-BG-02 (24-25)	08/30/2017	<0.56	0.78 B	1.1	<2.8	0.02 j	2.6	12	18000	570	<2.3	2.7	<1.5	14	<12	0.29	72
BGSB-BG-02 (4-5)	08/30/2017	0.12 j,M	1.5 B,M	0.91 M	<3.2 M	<0.031	6.9	8.8	40000 M	400	<2.5 M	5.9	0.5 j	6.2	<13 M	0.26	93 M
BGSB-BG-03 (24-25)	08/31/2017	<0.55	0.9 B	0.81	<2.8	<0.028	2.3	17	17000	400	<2.2	2.6	0.34 j	2.9	<12	0.3	66
BGSB-BG-03 (34-35)	08/31/2017	<0.56	0.96 B	0.9	<5.6	0.036	2.3	11	18000	820	<4.5	1.9 j	0.3 j	17	<11	0.21	67
BGSB-BG-03 (4-5)	08/31/2017	<0.61	1.7 B	1.9	<17	0.045	**71**	59	52000	1200	<14	67	0.6 j	6.2 j	<14	0.33	88
BGSB-GW-08 (14-15)	08/31/2017	<0.61	1.3 B	0.99	<3	<0.031	22	3.4	41000	150	<2.4	7.8 j	0.45 j	26	<13	0.056 j	110
BGSB-GW-08 (24-25)	08/31/2017	<0.53	0.85 B	1.1	<6	<0.027	12	8.9	32000	470	<4.8	8.3	0.47 j	28	<13	0.094 j	84
BGSB-GW-08 (4-5)	08/31/2017	0.16 j	1.6 B	1.1	<2.9	<0.03	28	3.8	48000	170	<2.3	7.1	0.83 j	5.3	32	0.097 j	100
BGSB-GWA-23 (14-15)	08/30/2017	<0.67	1.1 B	0.9	<2.7	<0.033	1.3	28	13000	410	<2.2	4.3	<1.7	0.67 j	<14	0.19	54
BGSB-GWA-23 (21-22)	08/30/2017	<0.6	0.82 B	0.85	<6.1	<0.03	2.5	12	18000	590	<4.9	2.5 j	0.35 j	0.99 j	<13	0.28	53
BGSB-GWA-23 (4-5)	08/30/2017	<0.54	1.9 B	0.54	<2.7	<0.027	7.1	1.9	26000	110	<2.2	3.5	0.5 j	0.81 j	<13	0.14	77
BGSB-GWA-26 (14-15)	08/30/2017	<0.56	0.87 B	0.74	<3	<0.028	2.8	14	20000	560	<2.4	2.5	<1.5	6.7	<13	0.34	66
BGSB-GWA-26 (24-25)	08/30/2017	0.25 j	0.73 B	0.73	<2.8	0.03	3.7	20	18000	680	<2.2	2.5	<1.4	4.1	<12	0.3	61
BGSB-GWA-26 (4-5)	08/30/2017	<0.6	1.6 B	0.7	<2.8	<0.03	6.6	4.5	32000	230	<2.2	3.9 j	0.51 j	6.2	<14	0.21	85
GWA-08D (38.5-40)	02/18/2015	<1.5	<3.7	1.3	41.3	<0.18	47.3	32.6	44300 j+	1190	<0.75	20.8	<3.7	<7.5	<372	<1.5	90
GWA-08D (48.5-50)	02/18/2015	<1.5	<3.6	1.5	42.5	<0.18	48.8	39.8	43000 j+	1280	<7.3	50.6	<3.6	<7.3	<375	<1.5	89.9
GWA-14D (0-2)	06/09/2015	<7.2	<7.2	<0.36	<18	<0.86	18.6	<7.2	40400	186	<3.6	4	<7.2	5.1	<355	<7.2	101
GWA-14D (10-12)	06/09/2015	<9.2	<9.2	<0.46	<23.1	<1.1	4.9	5.7 j	34700	501	<4.6	5.1	<9.2	<4.6	<437	<9.2	89.8
GWA-14D (18-20)	06/09/2015	<7.1	<7.1	0.39	<17.8	<0.85	7.6	20.7	30400	454	<3.6	5	<7.1	<3.6	<358	<7.1	85.5
Beyond Ash Basin Waste Boundary																	
AB-09 (0.5-1)	04/11/2019	<0.61	1.3	1.5	<9.2	<0.16	19	17	42000	680	<2.4	16	0.63 j	22	64	0.34	87
AB-09 (2-3)	04/11/2019	<0.58	1.4	0.91	<2.9	<0.15	22	6.5	25000	190	<2.3	11	0.58 j	5.2	120	0.2	56
AB-10 (0.5-1)	04/11/2019	<0.63	1.8	0.74	<9.4	0.058 j	28	6	42000	380	<2.5	14	0.6 j	8.7	<13	0.26	100
AB-10 (2-3)	04/11/2019	<0.65	2.6	0.87	<13	<0.17	53	5	59000	95	<2.6	21	<1.7	8.3	29	0.26	130

TABLE 6-3
SUMMARY OF UNSATURATED SOIL ANALYTICAL RESULTS
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELMONT, NC

	Analytical Parameter	Antimony	Arsenic	Beryllium	Boron	Cadmium	Chromium	Cobalt	Iron	Manganese	Molybdenum	Nickel	Selenium	Strontium	Sulfate	Thallium	Vanadium
	Reporting Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
	PSRG Protection of Groundwater	**0.9**	**5.8**	**63**	**45**	**3**	3.8*	0.9	150	65	**7.1**	**130**	2.1	**1500**	**1438^**	0.28	**350**
	2018 Background Threshold Values[1]	0.61	2.391	1.31	6.8	0.038	**56.9**	29.2	**61162**	1222	5.4	9.87	0.812	31	14	**0.482**	132
	2019 Background Threshold Values[2]	0.61	2.358	1.77	23.1	1	48.8	**67.7**	60916	**1927**	5.4	53.5	**2.3**	28.73	437	0.482	131.9
Sample ID	Sample Collection Date	Analytical Results															
Beyond Ash Basin Waste Boundary (Continued)																	
AB-11 (0.5-1)	04/11/2019	<0.58	0.72	0.56	<8.7	<0.15	32	12	34000	550	<2.3	10	0.65 j	5.5	25	0.15	84
AB-11 (2-3)	04/11/2019	<0.54	0.81	0.56	<8.1	<0.14	27	9.2	29000	250	<2.2	11	<1.4	6	20	0.19	71
CCR-23 (0.5-1)	04/11/2019	<0.61	0.9	0.75	<9.1	<0.16	12	4.4	49000	220	<2.4	7.4	0.81 j	9.4	56	0.15 j	110
CCR-23 (2-3)	04/11/2019	<0.6	1.3	0.73	<9	<0.16	18	5.5	41000	270	<2.4	11	0.71 j	8.5	13 M	0.2	92
CCR-26 (0.5-1)	04/11/2019	<0.55	2.9	0.52	<11	<0.14	31	4.7	45000	140	<2.2	7.4	0.93 j	4.6	93	0.23	110
CCR-26 (2-3)	04/11/2019	<0.62	1.5	0.42	<9.3	<0.16	9.9	3.6	45000	170	<2.5	4.1	0.79 j	1.8	130	0.088 j	110
CP-01SB (2-3)	11/16/2018	<0.55	1.4	0.33	<8.2	<0.14	11	4.5	49000	190	<2.2	7.4	0.58 j	2.4	<14	0.2	120
CP-02SB (2-3)	11/13/2018	<0.64	**21**	0.24	<16	<0.17	29	17	**100000**	290	<2.6	27	1 j	23	410	0.31	220
CP-02SB (5-6)	11/13/2018	<0.56	5.4	0.25	<8.4	0.1 j	**58**	25	42000	**5400**	<2.3	19	1.3 j	6.9	210 M	**0.59**	92
CP-02SB (8-9)	11/13/2018	<0.65	1.9	0.41	<9.8	<0.17	38	16	**62000**	420	<2.6	19	0.89 j	2.9	470 M	0.16 j	170
CP-03SB (2-3)	11/17/2018	<0.54	1.8	0.19	<5.4	<0.14	16	12	41000	420	<2.1	14	<1.4	9.4	410	0.27	110
CP-03SB (5-6)	11/17/2018	<0.65	<3.3	0.45	<6.5	<0.17	18	36	58000	1100	<2.6	18	<8.5	2.6	1000	0.23	130
CP-04SB (4-5)	11/30/2018	<0.61	**29**	0.73	<6.1	0.053 j	19	11	45000	460	<2.4	12	0.9 j	15	1300	**0.57**	84
GWA-01 (0.5-1)	04/11/2019	<0.6	1.3	0.73	<8.9	<0.16	19	9	41000	630	<2.4	12	<1.6	6.4	49	0.22	88
GWA-01 (2-3)	04/11/2019	<0.61	2.7	0.86	<9.2	<0.16	26	15	42000	1900	<2.4	21	<1.6	5.1	76	0.42	93
GWA-02 (0.5-1)	04/11/2019	<0.58	1.2	0.73	1.8 j	0.06 j	25	9.4	26000	1300	<2.3	12	1.3 j	9.4	<12	0.31	61
GWA-02 (1-2)	04/11/2019	<0.58	0.98	0.73	1.7 j	0.044 j	25	9.8	25000	1300	<2.3	12	1.4 j	11	16	0.29	58
GWA-03 (0.5-1)	04/11/2019	<0.59	0.73	0.64	<8.8	<0.15	19	6	46000	310	<2.4	10	0.65 j	5.7	120	0.14 j	96
GWA-03 (2-3)	04/11/2019	<0.72	1.9	0.5	<11	<0.19	16	1.7	47000	170	<2.9	8.8	<1.9	1.8	48	0.12 j	89
GWA-03BR (8.5-10)	04/11/2015	<7.3	<7.3	0.27 j	<18.3	<0.88	5.7	12.7	23700	309	<3.7	2.1	<7.3	10.5	<360	<7.3	64.2
GWA-05 (0.5-1)	04/11/2019	<0.56	2.4	0.84	<8.3	0.064 j	14	11	33000	450	<2.2	12	0.68 j	14	37	0.3	75
GWA-05 (2-3)	04/11/2019	<0.58	1.1	0.78	<8.6	0.04 j	22	8.9	35000	390	<2.3	11	0.85 j	6.7	47	0.23	84
GWA-05D (2-4)	05/14/2015	<6.2	<6.2	0.75	<15.5	<0.74	9.5	16.2	24200	578	<3.1	6.2	**2.5 j**	7	489	<6.2	70.8
GWA-06D (28.5-30)	03/03/2015	<3.4	2.1 j	0.41	15.7	<0.4	2.3	21.7	18600	1350	<0.67	6.3	1.8 j	7.9	745	<3.4	56.4
GWA-07 (0.5-1)	04/11/2019	<0.57	1.9	0.62	<8.6	<0.15	21	9.7	34000	720	<2.3	13	0.91 j	16	21	0.2	66
GWA-07 (2-3)	04/11/2019	<0.63 M	3.7 M	0.85	<8.9	0.12 j	34	7.6 M	42000 M	400 M	<2.4	18	1.2 j	15	26	0.25	80
GWA-09S (4-6)	05/11/2015	<7.2	<7.2	0.53	<18.1	<0.87	2.6	12.7	25600	652	<3.6	2.1	<7.2	17	<363	<7.2	63.3
GWA-15D (1.9-2)	06/08/2015	<7.2	<7.2	<0.36	<18	<0.86	10.1	3.8 j	22400	302	<3.6	3.6	<7.2	6.2	<374	<7.2	57.4
GWA-27SB (10-11)	10/08/2019	<0.78	1.3	0.57	<3.9	<0.2	6.7	6.7	32000	210	<3.1	5.6	1.4 j	3.7	15 j	0.25	60
GWA-27SB (14-15)	10/08/2019	<0.74	1.8	1.7	<11	<0.19	**60**	16	**98000**	210	<3	16	**3.8 j**	0.75 j	<15 M	0.083 j	210
GWA-27SB (19-20)	10/08/2019	<0.75	2.9	1.7	<11	<0.19	**62**	48	**87000**	1200	<3	27	**5.1 j**	1 j	200	0.14 j	200
GWA-28SB (11-12)	10/15/2019	<0.7	1.3	0.87	<7	<0.18	13	26	38000	800	<2.8	9.9	**3.3 j**	10	260	0.19	100
GWA-28SB (14-15)	10/15/2019	<0.66	1.1	0.81	<3.3	<0.17	4.2	23	27000	690	<2.7	5.9	**3.2 j**	22	160	0.18	68

TABLE 6-3
SUMMARY OF UNSATURATED SOIL ANALYTICAL RESULTS
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELMONT, NC

	Analytical Parameter	Antimony	Arsenic	Beryllium	Boron	Cadmium	Chromium	Cobalt	Iron	Manganese	Molybdenum	Nickel	Selenium	Strontium	Sulfate	Thallium	Vanadium
	Reporting Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
	PSRG Protection of Groundwater	**0.9**	**5.8**	**63**	**45**	**3**	3.8*	0.9	150	65	**7.1**	**130**	2.1	**1500**	**1438^**	0.28	**350**
	2018 Background Threshold Values[1]	0.61	2.391	1.31	6.8	0.038	**56.9**	29.2	**61162**	1222	5.4	9.87	0.812	31	14	**0.482**	132
	2019 Background Threshold Values[2]	0.61	2.358	1.77	23.1	1	48.8	**67.7**	60916	**1927**	5.4	53.5	**2.3**	28.73	437	0.482	131.9
Sample ID	**Sample Collection Date**	**Analytical Results**															
GWA-29SB (10-11)	09/13/2019	<0.61	2.9	0.51	<5.2	0.16	17	12	41000	560	<2.1	11	2	16	270	0.2 B	58
GWA-30SB (2-3)	08/26/2019	<0.64	1.1	1.2	2.8 j	<0.17	3.2	11	36000	410	<2.3	12	**4.9**	26	700	0.4 B	120
GWA-30SB (5-6)	08/27/2019	<0.65	1.4	1.3	3.3 j	<0.17	4.2	13	31000	550	<2.7	12	**3.4**	34	610	0.41 B	110
Within Ash Basin Waste Boundary																	
AB-22D (13-14.5)	06/15/2015	<8.1	<8.1	<0.4	<20.2	<0.97	6.6	6.4 j	29700	332	<4	3.5	<8.1	2.7 j	<405	<8.1	85.1
AB-26D (13.5-15)	06/16/2015	<6.4	<6.4	<0.32	<16	<0.77	15.9	14.9	33800	800	<3.2	4.8	<6.4	2 j	<320	<6.4	76.5
AB-26D (33.5-35)	06/16/2015	<6.2	<6.2	0.35	<15.5	<0.74	7.4 j	14.2	28100	890 j	<3.1	5.1	<6.2	2.4 j	<322	<6.2	69.8
AB-31D (13.5-15)	04/20/2015	<5.9	<5.9	0.26 j	37	<0.71	12.7	8.7	47600	350 j+	<3	2.6	<5.9	3.5	170 j	<5.9	67.8
AB-31D (33.5-35)	04/20/2015	<6.6	<6.6	0.44	13.7 j	<0.79	13	14.6	15400	297 j+	<3.3	4.9	<6.6	3.1 j	<337	<6.6	42.5
AB-32S (13.5-15)	05/05/2015	<6.4	3.4 j+	0.96	23.7 j+	<0.76	17.2	56.8	34300	952	<3.2	6	<6.4	5.6	<301	<6.4	80.7
AB-32S (33.5-35)	05/05/2015	<6.1	<30.7	0.66	20 j+	<0.74	14.5	**82.3**	26800	822	<3.1	10.4	<6.1	4.2	<297	<6.1	77.8
AB-34D (14-14)	02/10/2015	<3.5	**39.8**	1.7	18.5	<0.41	14.9	5.8	5090	58.1	0.6 j	10.4	**3.7**	101	193 j	<3.5	39.9
SB-01 (3-5)	02/12/2015	<1.4	**44.5**	1.6	10.1	0.27	11.8	5.2	4320 j+	41.2 j+	1.1	9.8	2	176	<357	<1.4	40.2
SB-02 (18.5-20)	02/11/2015	<3.5	<7	0.61	40.7	<0.84	3.8	30.1	39800	1640	<7	3.2 j	<7	1.2	<345	<3.5	87.3
SB-04 (25-26.5)	02/10/2015	<3.7	<3.7	0.47	**45.7**	<0.44	31.1	7.9	46600	476	<7.4	4.6	<3.7	0.6 j	<367	<3.7	70

Prepared by: JHG Checked by: LWD / EMY

Notes:

1 - Background threshold values were calculated using data from background unsaturated soil samples collected February 2015 to May 2015.

2 - Background threshold values were calculated using data from background unsaturated soil samples collected February 2015 to August 2017.

- bold highlighted concentration indicates value is greater than applicable regulatory standard (PSRG POG).

- bold highlighted concentration indicates value is greater than greatest background threshold value where there is no regulatory standard, or background threshold values are greater than regulatory standard.

- highlighted concentration indicates value is either within range of background threshold values for constituents where there is no regulatory standard/background threshold values are greater than regulatory standard, or within range of background threshold value and the regulatory standard.

PSRG - Preliminary Soil Remediation Goals for the Protection of Groundwater (POG); NCDEQ Inactive Hazardous Sites Branch (IHSB) Preliminary Soil Remediation Goals table (February 2018)

* - North Carolina PSRG POG is for hexavalent chromium, soil analytical is for total chromium.

< - Concentration not detected at or above the adjusted reporting limit.

^ - PSRG Protection of Groundwater value was calculated using the equation shown in Section 6.1.2

mg/kg - milligrams per kilogram

B - Target analyte detected in method blank at or above the reporting limit. Target analyte concentration in sample is less than 10X the concentration in the method blank. Analyte concentration in sample could be due to blank contamination.

j - Estimated concentration above the adjusted method detection limit and below the adjusted reporting limit.

j- Estimated concentration, biased low.

j+ - Estimated concentration, biased high.

M - Matrix spike / matrix spike dup failure.

TABLE 6-4
SOURCE AREA INTERIM ACTIONS
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELMONT, NC

Interim Actions	Remedy
Active Ash Basin Decanting	Active source remediation by removing ponded water in the active ash basin. Decanting will lower the hydraulic head within the coal ash basin and reduce hydraulic gradients, generally reducing groundwater seepage velocities and COI transport potential. Decanting will return the groundwater flow system to its approximate condition, prior to construction of the active ash basin, with the re-establishment of natural groundwater flow.
Source Area Stabilization	Retired ash basin dam (GASTO-016) modifications including spillway repair, installation of new principal spillway, vegetation/tree removal, and slope repair were completed. Active ash basin dam (GASTO-061) modifications including spillway repair, installation of new principal spillway, and slope repair were completed.
Lined Holding Basin Construction	Control and management of storm water runoff from the coal pile area was improved by construction of a lined holding basin between the main and live coal piles. Improved handling of the storm water in this area impedes migration of COIs potentially derived from contact with the coal stored in this area.

Prepared by: LWD Checked by: CJS

Notes:
COI – Constituent of Interest

TABLE 6-5
MEANS OF GROUNDWATER COIs - JANUARY 2018 TO JUNE 2019 AND OCTOBER 2019
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
DUKE ENERGY, CAROLINAS, LLC, BELMONT, NC

Analytical Parameters		Antimony	Arsenic	Beryllium	Boron	Cadmium	Chromium (VI)	Chromium	Cobalt	Iron	Lithium	Manganese	Molybdenum	Nickel	Selenium	Strontium	Sulfate	Thallium	Total Dissolved Solids	Vanadium
Reporting Units		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	µg/L	mg/L	µg/L
15A NCAC 02L Standard		**1***	**10**	**4***	**700**	**2**	**NE**	**10**	**1***	300	NE	50	NE	**100**	**20**	NE	**250**	**0.2***	**500**	0.3*
2018 Background Threshold Values (Shallow Flow Zone)[1]		0.76	0.59	0.12	50	1	2.2	6.8	1.5	884	NE	225	0.844	5.8	0.5	298	1.5	0.1	163	**5.7**
2019 Background Threshold Values (Shallow Flow Zone)[2]		1	0.71	0.13	50	0.08	**2.3**	9.1	**5.7**	**1,422**	**3**	**608**	**6.7**	8.9	0.5	**300**	5.4	0.1	154	3.9
2019 Background Dataset Range (Shallow Flow Zone)[2]		0.084 j - <1	0.048 j - 2.3	0.01 j,S1 - 0.22	4.4 j - <50	0.028 j - <0.08	0.013 j - 3.2	0.11 j - 37.6	0.038 j - 19.2	29 j - 2940	0.16 j - 3.6	2.8 j - 1620	0.09 j - 10.7	0.14 j - 26.2	0.32 j - <0.5	2.6 j - 309	<0.1 - 10.7	0.017 j - <0.2	15 - <250	0.088 j - 7.5
2018 Background Threshold Values (Deep Flow Zone)[1]		1	1	0.03	50	1	1.3	6.8	1	356	NE	26.2	1.8	5	0.62	232	5.4	0.1	158	11.5
2019 Background Threshold Values (Deep Flow Zone)[2]		0.69	1.1	1	50	1	**1.5**	**16.1**	0.82	**665**	**25.3**	**256**	**26.2**	10.3	0.75	**240**	14.5	0.1	173	**16.1**
2019 Background Dataset Range (Deep Flow Zone)[2]		0.096 j - 0.85	0.048 j - 1.4	0.01 j - <1	5.8 - 50.3	0.035 j - <1	0.015 j - 1.8	0.23 j,B,S1 - 93.2	0.019 j - 4.6	27.5 j,B - 823	0.89 - 44.9	2.7 j - 900	0.21 j - 30.2	0.16 j - 52.6	0.34 j - 1.2	31 - 251	0.5 j - 22	0.016 j - <0.1	43 - 280	1.2 - 17.9
2018 Background Threshold Values (Bedrock Flow Zone)[1]		0.5	1.6	0.1	50	0.08	0.23	5.6	0.3	284	NE	278	8.9	3.4	0.5	154	2.9	0.1	165	**15.9**
2019 Background Threshold Values (Bedrock Flow Zone)[2]		**2.6**	1.6	0.1	50	0.08	**0.77**	**10.2**	0.35	**1,242**	**26.3**	**360**	**11**	6.9	0.5	**181**	7.3	0.1	221	12.5
2019 Background Dataset Range (Bedrock Flow Zone)[2]		0.27 j - 3.9	0.24 - 1.6	0.01 j - <0.1	35.6 j - <50	<0.08	<0.025 - 0.66	0.33 j - 8.9	0.021 j - 0.31	40.7 j - 715	0.9 j - 26.3	2.8 j - 278	1.7 - 10.5	0.22 j - 5.8	0.17 j - <0.5	97.7 - 223	1.8 - 33.3	0.02 j - <0.1	104 - 222	7.5 - 15.9
Sample ID	**Flow Zone**	**Means Results**																		
Background Locations[4]																				
AB-12D	Deep	< 0.5	0.1	< 0.1	< 50	< 0.08	0.51	0.59	< 0.1	86	< 2.5	< 5	0.24	< 0.5	0.61	181	3.9	< 0.1	103	3.7
AB-12S	Shallow	< 0.5	< 0.1	0.06	< 50	< 0.08	0.15	0.43	0.6	265	< 2.5	49	< 0.5	< 0.5	< 0.5	< 5	< 1	< 0.1	45	0.6
BG-01BR	Bedrock	0.62	1	< 0.1	37	< 0.08	0.38	1	0.1	106	< 2.5	19	8.2	0.71	< 0.5	164	5.8	< 0.1	163	8.1
BG-01DA	Deep	< 0.5	0.23	< 0.1	< 50	< 0.08	0.28	1.7	0.1	68	1.3	4	1.3	1.3	< 0.5	114	2.3	< 0.1	108	9.7
BG-01S	Shallow	< 0.5	0.19	< 0.1	< 50	< 0.08	0.33	2.3	0.1	334	< 2.5	11	< 0.5	2.3	< 0.5	30	< 1	< 0.1	36	0.84
BG-02BRA-2	Bedrock	2.1	1.3	< 0.1	< 50	< 0.08	0.99	1.5	0.1	71	37.4	5	7.9	0.88	< 0.5	218	19.8	< 0.1	187	10.8
BG-02D	Deep	< 0.5	0.22	< 0.1	< 50	< 0.08	0.98	1.3	0.1	144	10.5	7	0.92	0.55	< 0.5	180	1.1	< 0.1	116	8.4
BG-02S	Shallow	< 0.5	0.18	< 0.1	< 50	< 0.08	1.8	2.0	0.1	199	0.55	11	< 0.5	0.56	< 0.5	184	< 1	< 0.1	137	2.1
BG-03D	Deep	< 0.5	0.13	< 0.1	< 50	< 0.08	0.45	0.73	< 0.1	< 50	2.9	< 5	0.32	< 0.5	< 0.5	209	< 1	< 0.1	114	6.5
BG-03S	Shallow	< 0.5	0.16	< 0.1	< 50	< 0.08	1.3	1.7	0.1	323	2.8	17	0.22	0.86	< 0.5	263	< 1	< 0.1	135	3.3
BG-04BR	Bedrock	< 0.5	0.28	< 0.1	< 50	< 0.08	0.23	1.5	0.1	207	1.5	11	1.9	0.87	< 0.5	99	2.2	< 0.1	125	9.1
BG-04D	Deep	< 0.5	0.25	< 0.1	< 50	< 0.08	0.72	1.1	0.2	310	5	92	2.1	0.61	< 0.5	199	1.5	< 0.1	150	7
BG-04S	Shallow	< 0.5	0.23	< 0.1	< 50	< 0.08	0.16	1.8	0.2	249	< 2.5	34	0.32	4.6	< 0.5	289	< 1	< 0.1	141	2.4
CCR-BG-01DA	Deep	0.46	0.27	< 0.1	6	< 0.08	-	0.58	0.2	-	14.3	-	6.5	-	< 0.5	-	< 1	< 0.1	114	-
CCR-BG-01S	Shallow	< 0.5	< 0.1	< 0.1	6	< 0.08	-	1.4	1.4	-	0.75	-	< 0.5	-	< 0.5	-	1.2	< 0.1	29	-
GWA-16D	Deep	< 0.5	0.21	< 0.1	< 50	< 0.08	0.56	1.6	0.1	165	1.6	9	0.44	0.84	< 0.5	119	1	< 0.1	72	7.9
GWA-16S	Shallow	< 0.5	0.21	< 0.1	< 50	< 0.08	0.48	1.3	0.2	228	2.4	49	3.7	2.2	< 0.5	191	0.7	< 0.1	101	1.1
GWA-19D	Deep	0.33	0.3	< 0.1	< 50	< 0.08	0.57	0.62	< 0.1	55	39.7	< 5	1.4	< 0.5	< 0.5	191	4.2	< 0.1	153	10.5
GWA-19S	Shallow	< 0.5	0.29	< 0.1	< 50	< 0.08	0.79	1.4	0.2	250	< 2.5	17	0.24	1.2	< 0.5	123	< 1	< 0.1	47	0.97
GWA-21BR	Bedrock	1.3	0.85	< 0.1	< 50	< 0.08	0.1	1.3	0.3	657	16.0	149	5.8	0.78	< 0.5	164	2.8	< 0.1	176	12.3
GWA-21DA	Deep	< 0.5	0.15	< 0.1	< 50	< 0.08	1.1	1.6	0.1	187	1.8	6	0.8	0.56	< 0.5	112	1.4	< 0.1	134	15.9
GWA-21S	Shallow	< 0.5	< 0.1	0.17	< 50	< 0.08	0.4	0.63	1.1	97	< 2.5	78	< 0.5	1.1	< 0.5	24	< 1	< 0.1	31	0.18
GWA-23D	Deep	< 0.5	0.36	< 0.1	< 50	< 0.08	0.1	< 0.5	4	63	1.5	814	7.5	< 0.5	< 0.5	84	2.2	< 0.1	134	3.9
GWA-23S	Shallow	< 0.5	< 0.1	< 0.1	< 50	< 0.08	0.25	2.3	0.6	95	< 2.5	23	< 0.5	2.5	< 0.5	5	0.9	< 0.1	26	< 0.3
GWA-26D	Deep	0.4	0.67	< 0.1	< 50	< 0.08	0.042	0.68	0.2	185	< 2.5	230	15.1	0.82	< 0.5	95	11.2	< 0.1	121	1.8
GWA-26S	Shallow	< 0.5	0.22	< 0.1	< 50	< 0.08	1.1	2	0.1	165	< 2.5	14	0.55	< 0.5	< 0.5	69	0.7	< 0.1	70	2.3
At or Within the Waste Boundary Locations																				
AB-20D	Deep	< 0.5	0.69	< 0.1	< 50	< 0.08	1	1.1	< 0.1	54	< 2.5	< 5	3.3	< 0.5	< 0.5	130	8	< 0.1	130	10.5
AB-20S	Ash Pore Water	1.2	18	< 0.1	1,836	0.085	0.17	0.99	0.29	475	161	33.8	10.1	23.4	115	1,734	134	0.26	476	6.8
AB-21BR	Bedrock	-	-	-	< 50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AB-21BRL	Bedrock	< 0.5	2	0.11	< 50	< 0.08	0.044	< 0.5	0.1	< 50	7.4	55	9.5	< 0.5	< 0.5	94	11.3	< 0.1	144	2.7
AB-21D	Deep	-	-	-	< 50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AB-21S	Ash Pore Water	0.32	827	< 0.1	3,800	0.11	< 0.025	0.54	1	9,464	215	1,166	358	1.8	0.91	3,708	78.9	< 0.1	544	6.1
AB-21SL	Ash Pore Water	3.5	494	0.053	7,746	0.28	< 0.025	< 0.5	0.54	508	282	133	2,962	3	< 0.5	1,898	131	< 0.1	405	11.5
AB-21SS	Shallow	0.67	0.56	< 0.1	78	< 0.08	0.051	< 0.5	0.6	172	< 2.5	114	1.2	1.1	< 0.5	99	1.3	< 0.1	95	3.3
AB-22BR	Bedrock	< 0.5	0.27	< 0.1	**1,834**	< 0.08	0.065	1.5	0.3	441	18.0	99	2.1	3.8	< 0.5	**284**	26.3	< 0.1	365	1.3
AB-22BRL	Bedrock	< 0.5	0.27	< 0.1	**1,948**	< 0.08	0.043	1.7	0.2	114	2.8	9	1.5	2.8	< 0.5	**349**	42.7	< 0.1	259	4.3
AB-22D	Deep	< 0.5	0.11	< 0.1	**2,010**	< 0.08	0.061	1.5	0.4	445	2.3	166	0.83	3.9	< 0.5	**441**	37.9	< 0.1	490	5.3
AB-22S	Shallow	< 0.5	0.13	< 0.1	< 50	< 0.08	0.029	0.53	**31.7**	**1,675**	< 2.5	**1,146**	< 0.5	2.7	< 0.5	62	2.1	0.063	54	0.23
AB-23BRU	Deep	-	-	-	58	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AB-23S	Ash Pore Water	0.95	1193	< 0.1	427	< 0.08	< 0.025	< 0.5	0.039	74.5	224	25.7	51.4	< 0.5	< 0.5	670	17.9	< 0.1	112	16.4
AB-24BR	Bedrock	< 0.5	0.33	< 0.1	< 50	< 0.08	0.042	< 0.5	0.1	88	1.5	85	2.1	2.1	< 0.5	103	3.6	< 0.1	97	11.4
AB-24D	Deep	-	-	-	< 50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AB-24S	Ash Pore Water	0.94	135	< 0.1	773	< 0.08	0.029	0.41	1.9	3480	56.7	951	35.7	4.2	0.68	1,922	80	0.056	360	9.5
AB-24SL	Ash Pore Water	0.47	691	< 0.1	631	< 0.08	0.03	< 0.5	< 0.1	95.3	128	37.2	57	0.56	0.51	709	18.3	< 0.1	127	2.5
AB-25BR	Bedrock	-	-	-	< 50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AB-25BRU	Deep	-	-	-	< 50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AB-25S	Ash Pore Water	6.5	206	< 0.1	1,234	< 0.08	0.033	< 0.5	2	479.4	147	188	139	2.8	0.54	1364	47.9	0.14	220	28
AB-25SL	Ash Pore Water	0.7	886	< 0.1	1,065	< 0.08	0.037	< 0.5	< 0.1	72.7	144	30.4	113	1.2	< 0.5	1,274	35.3	< 0.1	183	8.6
AB-25SS	Shallow	0.15	0.37	< 0.1	**1,213**	< 0.08	0.028	0.82	1	107	1.1	314	5.0	3.1	< 0.5	237	27.2	< 0.1	152	1.2
AB-26D	Deep	< 0.5	0.24	< 0.1	325	< 0.08	0.33	2.2	0.3	337	9.1	100	1.3	1.9	< 0.5	225	39.8	< 0.1	183	6.2
AB-26S	Shallow	< 0.5	0.11	< 0.1	**1,046**	< 0.08	0.15	3.5	1.2	743	1.2	240	< 0.5	4.4	< 0.5	208	65.8	< 0.1	158	0.93
AB-27BR	Bedrock	< 0.5	0.44	< 0.1	142	< 0.08	0.039	0.35	0.2	79	6.1	192	1.8	0.72	< 0.5	166	19.9	< 0.1	203	0.72
AB-27D	Deep	< 0.5	2.5	< 0.1	**985**	< 0.08	0.061	1	0.8	**791**	1.3	161	2.8	1.1	1.4	**361**	74.4	< 0.1	205	3.9
AB-27S	Ash Pore Water	< 0.5	198	< 0.1	436	< 0.08	< 0.025	< 0.5	4.3	17,775	25	3,718	2	0.43	< 0.5	1,132	16.9	< 0.1	306	0.39
AB-28D	Deep	< 0.5	0.42	< 0.1	81	< 0.08	0.44	0.61	< 0.1	< 50	**52.8**	< 5	0.73	0.71	< 0.5	**254**	18.1	< 0.1	182	9.6
AB-28S	Ash Pore Water	0.48	13.2	< 0.1	1,047	< 0.08	< 0.025	0.79	8.8	8610	8.5	2,695	10.8	3.3	1.6	2,263	194	0.36	537	< 0.3
AB-29D	Deep	< 0.5	0.32	< 0.1	380	< 0.08	0.47	0.62	0.4	< 50	1.9	7	0.3	3.2	< 0.5	**243**	49.2	< 0.1	178	6.9
AB-29S	Ash Pore Water	0.53	447	< 0.1	780	< 0.08	< 0.025	< 0.5	2.5	2,564	49.7	2,007	9.8	1.6	< 0.5	1,191	60.1	< 0.1	236	6.9
AB-29SL	Ash Pore Water	5.2	69.9	< 0.1	2,088	< 0.08	0.036	< 0.5	< 0.1	57.3	56.5	315	22.9	< 0.5	8.4	1,073	141	< 0.1	290	59.2
AB-29SS	Shallow	< 0.5	0.13	< 0.1	569	< 0.08	1.4	1.8	0.2	135	< 2.5	94	0.16	0.73	< 0.5	**323**	94	< 0.1	230	4.9
AB-30D	Deep	< 0.5	0.15	< 0.1	< 50	< 0.08	0.35	0.45	0.1	< 50	1.8	3	0.16	< 0.5	< 0.5	186	26.4	< 0.1	152	11.9
AB-30S	Ash Pore Water	0.38	297	< 0.1	549	< 0.08	0.075	< 0.5	2.1	4,312	30.8	1070	6.2	1.3	0.86	1,248	132	0.082	349	6.5
AB-31D	Deep	-	-	-	412	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AB-31S	Shallow	< 0.5	0.079	< 0.1	**1,995**	0.095	0.21	1.5	0.1	447	0.6	36	< 0.5	0.86	< 0.5	**301**	122	< 0.1	228	1.1
AB-32D	Deep	< 0.5	0.19	< 0.1	663	< 0.08	0.039	1.2	0.3	254	3.2	18	0.56	0.94	< 0.5	211	30.5	< 0.1	162	7.6
AB-32S	Shallow	< 0.5	0.64	< 0.1	< 50	< 0.08	0.038	0.8	**17.1**	**39,240**	< 0.5	**6,014**	< 0.5	1.4	< 0.5	43	2	< 0.1	73	0.31
AB-33D	Deep	**1.1**	0.24	< 0.1	190	< 0.08	0.06	1.8	0.1	68	**79.2**	47	0.93	1.2	< 0.5	**426**	7.9	< 0.1	175	3.2
AB-33S	Ash Pore Water	< 0.5	0.24	0.16	835	0.15	0.034	1.2	21.6	8,703	3.6	5,146	6	4.1	0.97	2,162	240	0.11	580	< 0.3
AB-33SS	Shallow	< 0.5	0.37	< 0.1	**1,958**	< 0.08	< 0.025	< 0.5	3.2	814	< 2.5	**717**	< 0.5	1	< 0.5	30	115	< 0.1	216	0.43
AB-34D	Deep	< 0.5	0.14	< 0.1	< 50	< 0.08	0.44	1.7	0.2	260	< 2.5	6	0.6	2	< 0.5	128	1.3	< 0.1	98	11.5
AB-34S	Ash Pore Water	< 0.5	0.45	< 0.1	311	< 0.08	< 0.025	< 0.5	1.9	135,667	1.5	7,918	< 0.5	0.51	< 0.5	1,567	201	< 0.1	485	< 0.3
AB-35BR	Bedrock	0.37	0.41	< 0.1	< 50	< 0.08	**0.92**	2.4	0.2	94	1.8	9	2.4	0.82	< 0.5	129	2.8	< 0.1	107	7.5
AB-35D	Deep	0.42	0.95	< 0.1	< 50	< 0.08	-	3.1	< 0.1	< 50	17.3	< 5	1.8	< 0.5	< 0.5	193	3.5	< 0.1	-	14.8
AB-35PWS	Shallow	< 0.5	0.38	< 0.1	< 50	< 0.08	0.71	2.4	0.6	292	**7.8**	101	0.79	1.4	< 0.5	144	4.3	< 0.1	105	**8.7**
AB-35S	Ash Pore Water	< 0.5	94.8	< 0.1	1008	< 0.08	< 0.025	2	0.27	37580	183.4	6302	14.9	2.1	< 0.5	1,906	130	< 0.1	558	0.81
AB-36D	Deep	< 0.5	0.41	< 0.1	< 50	< 0.08	0.15	< 0.5	< 0.1	133	1.4	5	1	1.1	< 0.5	119	3.8	< 0.1	95	8
AB-36S	Ash Pore Water	< 0.5	82.4	< 0.1	175	< 0.08	< 0.025	< 0.5	1.7	13754	41.8	1127	2	2.9	< 0.5	1,165	3.2	< 0.1	195	1.1

TABLE 6-5
MEANS OF GROUNDWATER COIs - JANUARY 2018 TO JUNE 2019 AND OCTOBER 2019
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
DUKE ENERGY, CAROLINAS, LLC, BELMONT, NC

	Analytical Parameters	Antimony	Arsenic	Beryllium	Boron	Cadmium	Chromium (VI)	Chromium	Cobalt	Iron	Lithium	Manganese	Molybdenum	Nickel	Selenium	Strontium	Sulfate	Thallium	Total Dissolved Solids	Vanadium
	Reporting Units	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	µg/L	mg/L	µg/L
	15A NCAC 02L Standard	**1***	**10**	**4***	**700**	**2**	**NE**	**10**	**1***	300	NE	50	NE	**100**	**20**	NE	**250**	**0.2***	**500**	0.3*
	2018 Background Threshold Values (Shallow Flow Zone)[1]	0.76	0.59	0.12	50	1	2.2	6.8	1.5	884	NE	225	0.844	5.8	0.5	298	1.5	0.1	163	**5.7**
	2019 Background Threshold Values (Shallow Flow Zone)[2]	1	0.71	0.13	50	0.08	**2.3**	9.1	**5.7**	**1,422**	**3**	**608**	**6.7**	8.9	0.5	**300**	5.4	0.1	154	3.9
	2019 Background Dataset Range (Shallow Flow Zone)[2]	0.084 j - <1	0.048 j - 2.3	0.01 j,S1 - 0.22	4.4 j - <50	0.028 j - <0.08	0.013 j - 3.2	0.11 j - 37.6	0.038 j - 19.2	29 j - 2940	0.16 j - 3.6	2.8 j - 1620	0.09 j - 10.7	0.14 j - 26.2	0.32 j - <0.5	2.6 j - 309	<0.1 - 10.7	0.017 j - <0.2	15 - <250	0.088 j - 7.5
	2018 Background Threshold Values (Deep Flow Zone)[1]	1	1	0.03	50	1	1.3	6.8	1	356	NE	26.2	1.8	5	0.62	232	5.4	0.1	158	11.5
	2019 Background Threshold Values (Deep Flow Zone)[2]	0.69	1.1	1	50	1	**1.5**	**16.1**	0.82	**665**	**25.3**	**256**	**26.2**	10.3	0.75	**240**	14.5	0.1	173	**16.1**
	2019 Background Dataset Range (Deep Flow Zone)[2]	0.096 j - 0.85	0.048 j - 1.4	0.01 j - <1	5.8 - 50.3	0.035 j - <1	0.015 j - 1.8	0.23 j,B,S1 - 93.2	0.019 j - 4.6	27.5 j,B - 823	0.89 - 44.9	2.7 j - 900	0.21 j - 30.2	0.16 j - 52.6	0.34 j - 1.2	31 - 251	0.5 j - 22	0.016 j - <0.1	43 - 280	1.2 - 17.9
	2018 Background Threshold Values (Bedrock Flow Zone)[1]	0.5	1.6	0.1	50	0.08	0.23	5.6	0.3	284	NE	278	8.9	3.4	0.5	154	2.9	0.1	165	**15.9**
	2019 Background Threshold Values (Bedrock Flow Zone)[2]	**2.6**	1.6	0.1	50	0.08	**0.77**	**10.2**	0.35	**1,242**	**26.3**	**360**	**11**	6.9	0.5	**181**	7.3	0.1	221	12.5
	2019 Background Dataset Range (Bedrock Flow Zone)[2]	0.27 j - 3.9	0.24 - 1.6	0.01 j - <0.1	35.6 j - <50	<0.08	<0.025 - 0.66	0.33 j - 8.9	0.021 j - 0.31	40.7 j - 715	0.9 j - 26.3	2.8 j - 278	1.7 - 10.5	0.22 j - 5.8	0.17 j - <0.5	97.7 - 223	1.8 - 33.3	0.02 j - <0.1	104 - 222	7.5 - 15.9
Sample ID	**Flow Zone**	**Means Results**																		
At or Within the Waste Boundary Locations (Continued)																				
AB-37D	Deep	< 0.5	0.27	< 0.1	< 50	< 0.08	0.16	< 0.5	< 0.1	82	1.2	< 5	1.6	< 0.5	< 0.5	146	2.6	< 0.1	130	9.3
AB-37S	Ash Pore Water	< 0.5	0.19	< 0.1	< 50	< 0.08	0.3	0.59	< 0.1	139	< 2.5	12.5	0.11	0.56	< 0.5	143	2.0	< 0.1	112	7.5
AB-38BR	Bedrock	< 0.5	0.24	< 0.1	< 50	< 0.08	0.035	0.33	0.3	< 50	2.1	74	1.9	2	< 0.5	**395**	15.2	< 0.1	191	5.7
AB-38D	Deep	< 0.5	0.20	< 0.1	< 50	< 0.08	0.099	< 0.5	0.6	159	14.8	50	0.45	2.7	< 0.5	**397**	16.6	< 0.1	199	4.8
AB-38S	Ash Pore Water	< 0.5	213	< 0.1	118	< 0.08	< 0.025	0.59	1.3	33980	6.3	1552	1.7	0.65	< 0.5	786	5.6	0.1	164	0.44
AB-38SS	Shallow	< 0.5	0.17	< 0.1	< 50	< 0.08	< 0.025	0.87	3.5	356	< 2.5	167	< 0.5	4.1	< 0.5	109	2.9	< 0.1	120	1
AB-39D	Deep	< 0.5	0.18	< 0.1	90	< 0.08	0.06	< 0.5	0.1	58	3.7	26	0.19	1.3	4.7	**438**	33.1	< 0.1	221	2.6
AB-39S	Ash Pore Water	< 0.5	1.8	< 0.1	119	< 0.08	< 0.025	< 0.5	1.9	59440	0.6	5488	0.25	< 0.5	< 0.5	274	3.4	< 0.1	230	0.65
AB-40D	Deep	<1	<1	<1	142	<1	<0.025	8	**2.7**	**734**	4.195 j	**701**	2	7.86	<1	**375**	63	<0.2	254	2.88
AB-40SS	Shallow	<1	0.421 j	1.11	**1,160**	<1	0.062 P4,M1,R1,R0	2.82	**50.4**	**41,200**	**33**	**7,400**	0.203 j	41.3	<1	**3,240**	**590**	**0.614**	**942**	0.564
AB-41D	Deep	<1	0.471 j	<1	90	<1	<0.025	5.99	0.9 j	473	3.736 j	**412**	1.69	3.89	<1	**547**	160	<0.2	211	2.94
AB-41SS	Shallow	<1	**27.5**	**29**	144	**2.36**	<0.025 P4,R0	0.684 j	**5050**	393	**8**	**393,000**	1.21	**467**	12.3	**1,230**	**2,200**	0.085 j	**3,640**	1
AB-42AP	Ash Pore Water	4.9	206	<1	2,270	<1	0.1	0.553 j	1.56	38,900	288	3,750	28.8	2.07	0.845 j	4,110	430	0.231	951	1.69
AB-42D	Deep	<1	0.487 j	<1	<50	<1	0.026	1.41	0.4 j	321	<5	71	4.2	1.06	<1	99	4.7	<0.2	117	5.36
AB-42SS	Shallow	<1	<1	<1	<50	<1	0.2	0.832 j	3.3	278	<5	451	0.702 j	4.26	<1	139	1.3	<0.2	122	2.84
AB-43AP	Ash Pore Water	1.13	1,220	<1	1,880	<1	<0.025	1.5	1.4	17,800	162	2310.0	82.8	1.49	<1	3,170	160	0.187 j	554	12
AB-43D	Deep	<1	<1	<1	<50	<1	1.1	2.58	0.7 j	167	<5	65	0.881 j	1.26	<1	222	2.1 S1	<0.2	144	6.95
AB-43SS	Shallow	<1	2.1	<1	<50	<1	0.26	8.98	3.3	485	**9**	**1,360**	2.84	9.27	<1	**420**	24	<0.2	208	2.85
AB-44D	Deep	<1	<1	<1	38 j	<1	0.88	2.26	0.4 j	479	2.384 j	191	1.25	0.828 j	<1	219	34	<0.2	153	5.67
AB-44SS	Shallow	<1	<1	<1	**1,190**	<1	<0.025	0.37 j	**12.9**	306	2.026 j	**4,800**	0.272 j	6.86	<1	**410**	**370**	<0.2	**577**	0.764
CCR-01DA	Deep	< 0.5	0.19	< 0.1	6	< 0.08	-	0.6125	0.8	-	1.8	-	1.2	-	< 0.5	-	1	< 0.1	125	-
CCR-01S	Shallow	0.19	< 0.1	0.062	13	< 0.08	-	1.1	5	-	1	-	0.2	-	< 0.5	-	2.8	< 0.1	30	-
CCR-02D	Deep	< 0.5	0.29	< 0.1	72	< 0.08	-	< 0.5	0.5	-	**46.8**	-	1.0	-	< 0.5	-	13.5	< 0.1	293	-
CCR-02S	Shallow	0.66	0.13	0.049	4	< 0.08	-	3.5	0.8	-	1.5	-	0.7	-	< 0.5	-	0.7	< 0.1	31	-
CCR-03DA	Deep	0.27	0.85	< 0.1	12	< 0.08	-	1.1	0.2	-	21.6	-	6.1	-	< 0.5	-	10.4	< 0.1	250	-
CCR-03S	Shallow	< 0.5	0.32	0.13	463	0.27	-	2.4	**46.4**	-	1.5	-	< 0.5	-	0.92	-	112	0.11	231	-
CCR-04DA	Deep	< 0.5	1.1	< 0.1	40	< 0.08	-	0.71	0.3	-	24.7	-	0.56	-	< 0.5	-	170	< 0.1	431	-
CCR-04SA	Shallow	< 0.5	**77.6**	**21.9**	296	**4.7**	-	1.8	**2,100**	-	**44.2**	-	< 0.5	-	**45.5**	-	**1,310**	**0.80**	**1,913**	-
CCR-05D	Deep	< 0.5	0.27	< 0.1	38	< 0.08	-	< 0.5	0.2	-	1.8	-	0.9	-	< 0.5	-	42	< 0.1	193	-
CCR-05S	Shallow	< 0.5	4.7	**7.8**	638	**6.7**	-	0.56	**633**	-	**180.5**	-	< 0.5	-	8.5	-	**796**	**2.2**	**1,275**	-
CCR-06D	Deep	< 0.5	0.13	< 0.1	25	< 0.08	-	< 0.5	0.1	-	2.9	-	0.86	-	< 0.5	-	6.6	< 0.1	125	-
CCR-06S	Shallow	< 0.5	5.4	1.6	620	< 0.08	-	1.2	**38.2**	-	**22.7**	-	< 0.5	-	4.1	-	**2,738**	**3.6**	**4,060**	-
CCR-07D	Deep	< 0.5	0.12	< 0.1	**733**	< 0.08	-	1.1	0.3	-	1.3	-	0.54	-	< 0.5	-	92.1	< 0.1	223	-
CCR-07S	Shallow	< 0.5	0.3	0.13	**1,805**	0.087	-	0.91	**6.2**	-	1.7	-	< 0.5	-	< 0.5	-	241	< 0.1	455	-
CCR-08D	Deep	< 0.5	0.14	< 0.1	**1,355**	< 0.08	-	0.55	0.2	-	4.2	-	0.22	-	< 0.5	-	95.8	< 0.1	219	-
CCR-08S	Shallow	< 0.5	0.49	0.1	**1,595**	0.12	-	0.51	**46.4**	-	0.7	-	< 0.5	-	0.79	-	**253**	0.12	419	-
CCR-09D	Deep	< 0.5	< 0.1	< 0.1	**1,863**	< 0.08	-	< 0.5	0.2	-	2.1	-	2.5	-	< 0.5	-	134	< 0.1	264	-
CCR-09S	Shallow	< 0.5	0.2	< 0.1	**1,355**	< 0.08	-	< 0.5	**19.3**	-	< 2.5	-	< 0.5	-	< 0.5	-	191	0.12	321	-
CCR-11DA	Deep	< 0.5	< 0.1	< 0.1	**1,390**	< 0.08	-	0.68	0.1	-	1.2	-	0.76	-	0.36	-	81.4	< 0.1	182	-
CCR-11S	Shallow	< 0.5	0.086	< 0.1	178	< 0.08	-	1.2	0.1	-	1	-	**10.9**	-	1.8	-	83.8	< 0.1	278	-
CCR-14D	Deep	< 0.5	0.27	< 0.1	576	< 0.08	-	2	0.4	-	1.7	-	1.8	-	< 0.5	-	43.2	< 0.1	178	-
CCR-14S	Shallow	< 0.5	0.079	< 0.1	680	< 0.08	-	< 0.5	**9.1**	-	1	-	< 0.5	-	0.55	-	34.7	< 0.1	109	-
CCR-16BR	Bedrock	< 0.5	0.12	< 0.1	479	< 0.08	0.28	0.57	< 0.1	88	< 2.5	< 5	0.32	1.4	< 0.5	**264**	37.6	< 0.1	164	8.1
CCR-16D	Bedrock	< 0.5	0.35	< 0.1	604	< 0.08	-	< 0.5	0.1	-	**36.7**	-	0.78	-	< 0.5	-	38.8	< 0.1	184	-
CCR-16S	Shallow	< 0.5	0.27	0.058	**1,720**	0.080	-	0.68	2	-	0.9	-	< 0.5	-	< 0.5	-	125	0.077	286	-
CCR-17D	Bedrock	< 0.5	0.24	< 0.1	**1,520**	< 0.08	-	< 0.5	0.1	-	1.6	-	0.43	-	< 0.5	-	47.8	< 0.1	302	-
CCR-17S	Shallow	< 0.5	0.083	< 0.1	**1,398**	< 0.08	-	1.7	0.8	-	0.5	-	< 0.5	-	< 0.5	-	43.8	0.13	202	-
CCR-18D	Deep	< 0.5	0.16	< 0.1	286	< 0.08	-	< 0.5	0.2	-	1.3	-	0.73	-	< 0.5	-	47.3	< 0.1	258	-
CCR-18S	Shallow	< 0.5	0.26	0.61	24	< 0.08	-	1.6	**24**	-	1.9	-	< 0.5	-	0.6	-	69.8	< 0.1	129	-
CCR-20D	Deep	< 0.5	0.11	< 0.1	508	< 0.08	-	0.56	0.5	-	0.9	-	0.42	-	0.68	-	44	< 0.1	261	-
CCR-20S	Shallow	< 0.5	0.11	0.46	185	< 0.08	-	2	**12.1**	-	2.9	-	< 0.5	-	0.49	-	15	< 0.1	122	-
CCR-21D	Deep	< 0.5	0.1	< 0.1	401	< 0.08	-	< 0.5	0.1	-	9.5	-	0.58	-	< 0.5	-	44.5	< 0.1	308	-
CCR-21S	Shallow	< 0.5	0.11	2	**1,618**	0.73	-	0.67	**48.6**	-	**7.6**	-	< 0.5	-	0.29	-	22.9	**0.21**	179	-
CCR-22DA	Deep	**1.5**	0.46	< 0.1	17	< 0.08	-	3	0.1	-	11.7	-	9.3	-	< 0.5	-	27.9	< 0.1	188	-
CCR-22S	Shallow	< 0.5	< 0.1	0.24	4	< 0.08	-	0.91	4.6	-	2.8	-	< 0.5	-	< 0.5	-	3.3	0.063	74	-
CCR-23D	Deep	< 0.5	0.12	< 0.1	5	< 0.08	-	0.67	0.6	-	1.3	-	0.89	-	< 0.5	-	2.3	< 0.1	136	-
CCR-23S	Shallow	< 0.5	< 0.1	0.062	3	< 0.08	-	< 0.5	0.8	-	0.5	-	< 0.5	-	< 0.5	-	< 1	< 0.1	61	-
GWA-06BRA	Bedrock	0.91	0.2	< 0.1	< 50	< 0.08	0.056	3	**3.7**	253	16.9	220	1.4	3	< 0.5	**714**	130	< 0.1	378	6.7
GWA-06BRL	Bedrock	0.15	4.2	< 0.1	75	< 0.08	0.034	1.1	0.4	401	4	67	**17.3**	1.4	< 0.5	**376**	71.8	< 0.1	264	0.74
GWA-06DA	Deep	0.66	0.84	< 0.1	29	< 0.08	0.026	2.3	0.5	**936**	12.9	**761**	0.9	2.3	< 0.5	**998**	**341**	< 0.1	**870**	0.95
GWA-06S	Shallow	< 0.5	**121**	**35.1**	281	**6.9**	**5.1**	8.6	**3,072**	**2,720**	**36.4**	**131,200**	< 0.5	**660**	**84.1**	**1,436**	**1,380**	**0.61**	**2,225**	0.73
GWA-27D	Deep	<1	<1	<1	29 j	<1	<0.025	2.33	**2.1**	**942**	<5	**351**	3.34	3.9	0.344 j	**1,040**	**260**	<0.2	**530**	3.2
GWA-27S	Shallow	<1	<1	0.384 j	143	1.34	0.3 P4,RO	4.09	**785**	217	1.982 j	**45,200**	0.155 j	**151**	<1	**304**	**270**	<0.2	478	0.307
GWA-30D	Deep	<1	<1	<1	207	<1	0.038	0.388 j	**4.94**	652	4.823 j	**1,300**	0.434 j	10.6	<1	**1,690**	**640**	<0.2	289	1.26
GWA-30S	Shallow	<1	0.438 j	<1	361	0.909 j	<0.025 P4,RO	0.704 j	**67.2**	67	<5	**23,700**	0.091 j	24.6	<1	221	**980**	<0.2	254	1.16
At or Beyond the Compliance Boundary Locations - Upgradient of the Ash Basin																				
AB-04BR	Bedrock	< 0.5	0.21	< 0.1	< 50	0.14	**1.5**	1.5	**1.2**	< 50	4	213	2.3	1.5	< 0.5	**266**	4.8	< 0.1	217	3.4
AB-04D	Deep	< 0.5	0.075	< 0.1	< 50	< 0.08	**5.4**	6.3	0.1	103	< 2.5	7	< 0.5	2.7	< 0.5	184	1.9	< 0.1	103	4.5
AB-04S	Shallow	< 0.5	0.14	< 0.1	< 50	< 0.08	0.1	< 0.5	0.2	622	0.51	38	< 0.5	0.59	< 0.5	51	9.4	< 0.1	93	1.1
AB-13D	Deep	< 0.5	0.13	< 0.1	< 50	< 0.08	0.86	1.3	0.1	129	< 2.5	8	0.72	0.81	< 0.5	190	< 1	< 0.1	122	5.9
AB-13S	Shallow	< 0.5	< 0.1	< 0.1	< 50	< 0.08	0.45	0.81	0.8	57	< 2.5	66	< 0.5	2.7	< 0.5	67	1.6	< 0.1	85	0.76
AB-14BR	Bedrock	< 0.5	1.1	< 0.1	< 50	< 0.08	0.17	< 0.5	< 0.1	< 50	1.7	< 5	7.7	< 0.5	< 0.5	149	5	< 0.1	134	15.3
AB-14D	Deep	< 0.5	< 0.1	0.12	158	< 0.08	**2.7**	2.7	0.9	125	< 2.5	12	< 0.5	5.7	< 0.5	66	27.5	< 0.1	110	0.65
GWA-09BR	Bedrock	0.8	0.44	< 0.1	< 50	0.096	0.22	0.51	0.1	79	4.5	19	8.1	0.61	< 0.5	117	11.5	< 0.1	131	9.8
GWA-09D	Deep	< 0.5	0.2	< 0.1	< 50	< 0.08	0.62	1.0	0.1	164	< 2.5	9	0.89	0.48	< 0.5	112	2.3	< 0.1	97	5.9
GWA-09S	Shallow	< 0.5	0.21	0.11	< 50	< 0.08	0.041	0.61	**7.1**	156	< 2.5	324	< 0.5	2.9	< 0.5	78	16.3	< 0.1	104	0.42
GWA-14DA	Deep	**1.4**	0.73	< 0.1	< 50	< 0.08	0.997	1.2	0.1	< 50	**25.3**	< 5	4.2	0.43	< 0.5	206	5.2	< 0.1	135	13.2
GWA-14S	Shallow	< 0.5	0.1	0.14	< 50	0.12	0.21	0.51	3.1	91	< 2.5	23	< 0.5	1.6	< 0.5	4	< 1	< 0.1	47	< 0.3

TABLE 6-5
MEANS OF GROUNDWATER COIs - JANUARY 2018 TO JUNE 2019 AND OCTOBER 2019
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
DUKE ENERGY, CAROLINAS, LLC, BELMONT, NC

Analytical Parameters		Antimony	Arsenic	Beryllium	Boron	Cadmium	Chromium (VI)	Chromium	Cobalt	Iron	Lithium	Manganese	Molybdenum	Nickel	Selenium	Strontium	Sulfate	Thallium	Total Dissolved Solids	Vanadium
Reporting Units		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	µg/L	mg/L	µg/L
15A NCAC 02L Standard		**1***	**10**	**4***	**700**	**2**	**NE**	**10**	**1***	300	NE	50	NE	**100**	**20**	NE	**250**	**0.2***	**500**	0.3*
2018 Background Threshold Values (Shallow Flow Zone)[1]		0.76	0.59	0.12	50	1	2.2	6.8	1.5	884	NE	225	0.844	5.8	0.5	298	1.5	0.1	163	**5.7**
2019 Background Threshold Values (Shallow Flow Zone)[2]		1	0.71	0.13	50	0.08	**2.3**	9.1	**5.7**	**1,422**	**3**	**608**	**6.7**	8.9	0.5	**300**	5.4	0.1	154	3.9
2019 Background Dataset Range (Shallow Flow Zone)[2]		0.084 j - <1	0.048 j - 2.3	0.01 j,S1 - 0.22	4.4 j - <50	0.028 j - <0.08	0.013 j - 3.2	0.11 j - 37.6	0.038 j - 19.2	29 j - 2940	0.16 j - 3.6	2.8 j - 1620	0.09 j - 10.7	0.14 j - 26.2	0.32 j - <0.5	2.6 j - 309	<0.1 - 10.7	0.017 j - <0.2	15 - <250	0.088 j - 7.5
2018 Background Threshold Values (Deep Flow Zone)[1]		1	1	0.03	50	1	1.3	6.8	1	356	NE	26.2	1.8	5	0.62	232	5.4	0.1	158	11.5
2019 Background Threshold Values (Deep Flow Zone)[2]		0.69	1.1	1	50	1	**1.5**	**16.1**	0.82	**665**	**25.3**	**256**	**26.2**	10.3	0.75	**240**	14.5	0.1	173	**16.1**
2019 Background Dataset Range (Deep Flow Zone)[2]		0.096 j - 0.85	0.048 j - 1.4	0.01 j - <1	5.8 - 50.3	0.035 j - <1	0.015 j - 1.8	0.23 j,B,S1 - 93.2	0.019 j - 4.6	27.5 j,B - 823	0.89 - 44.9	2.7 j - 900	0.21 j - 30.2	0.16 j - 52.6	0.34 j - 1.2	31 - 251	0.5 j - 22	0.016 j - <0.1	43 - 280	1.2 - 17.9
2018 Background Threshold Values (Bedrock Flow Zone)[1]		0.5	1.6	0.1	50	0.08	0.23	5.6	0.3	284	NE	278	8.9	3.4	0.5	154	2.9	0.1	165	**15.9**
2019 Background Threshold Values (Bedrock Flow Zone)[2]		**2.6**	1.6	0.1	50	0.08	**0.77**	**10.2**	0.35	**1,242**	**26.3**	**360**	**11**	6.9	0.5	**181**	7.3	0.1	221	12.5
2019 Background Dataset Range (Bedrock Flow Zone)[2]		0.27 j - 3.9	0.24 - 1.6	0.01 j - <0.1	35.6 j - <50	<0.08	<0.025 - 0.66	0.33 j - 8.9	0.021 j - 0.31	40.7 j - 715	0.9 j - 26.3	2.8 j - 278	1.7 - 10.5	0.22 j - 5.8	0.17 j - <0.5	97.7 - 223	1.8 - 33.3	0.02 j - <0.1	104 - 222	7.5 - 15.9
Sample ID	**Flow Zone**	**Means Results**																		
At or Beyond the Compliance Boundary Locations - Upgradient of the Ash Basin (Continued)																				
GWA-15D	Deep	< 0.5	0.15	< 0.1	< 50	0.12	1	1.4	< 0.1	< 50	2.0	4	0.13	0.91	< 0.5	**246**	3.5	< 0.1	155	5.0
GWA-15S	Shallow	< 0.5	0.14	< 0.1	71	< 0.08	0.99	1.2	0.1	229	< 2.5	25	< 0.5	2.4	< 0.5	169	11.1	< 0.1	107	4.4
GWA-22D	Deep	0.17	0.17	< 0.1	< 50	< 0.08	0.79	2.7	0.3	317	1.7	18	0.49	3.7	< 0.5	**291**	1.2	< 0.1	186	12
GWA-22S	Shallow	< 0.5	0.086	0.1	< 50	0.13	0.1	0.56	**15.1**	246	< 2.5	521	< 0.5	2.1	< 0.5	6	1.4	< 0.1	< 25	0.25
GWA-24BR	Bedrock	< 0.5	0.65	< 0.1	< 50	< 0.08	0.17	0.85	0.3	700	4.5	32	3.4	1.1	< 0.5	110	10.1	< 0.1	131	9.5
GWA-24D	Deep	< 0.5	0.23	< 0.1	< 50	< 0.08	1.2	1.3	0.1	244	< 2.5	7.2	0.31	0.4	< 0.5	92	2.8	< 0.1	112	11.1
GWA-24SA	Shallow	< 0.5	< 0.1	< 0.1	< 50	< 0.08	0.25	1.7	0.4	198	< 2.5	66	< 0.5	3.6	< 0.5	10	< 1	< 0.1	38	0.41
At or Beyond the Compliance Boundary Locations - Downgradient of the Ash Basin																				
AB-06A	Shallow	< 0.5	0.13	< 0.1	< 50	< 0.08	**9.9**	**10.5**	0.1	52	0.54	12	< 0.5	1.1	0.42	227	30.4	< 0.1	135	3.7
AB-06R	Shallow	< 0.5	0.15	< 0.1	< 50	< 0.08	**6.7**	7.2	0.1	100	< 2.5	38	< 0.5	1.8	0.35	212	29.7	< 0.1	131	3.4
AB-09D	Deep	< 0.5	0.087	< 0.1	551	< 0.08	0.3	< 0.5	< 0.1	76	< 2.5	11	0.18	< 0.5	1.7	**330**	49.1	< 0.1	197	6.5
AB-09S	Shallow	< 0.5	0.11	< 0.1	**722**	< 0.08	< 0.025	< 0.5	**8.6**	**8,062**	< 0.5	**10,050**	< 0.5	0.89	< 0.5	147	33.9	< 0.1	131	< 0.3
AB-10BR	Bedrock	< 0.5	0.19	< 0.1	554	< 0.08	0.065	1.6	0.3	504	< 2.5	35	0.8	1.9	< 0.5	**527**	46.8	< 0.1	271	7.8
AB-10BRL	Bedrock	< 0.5	8.3	< 0.1	420	< 0.08	0.047	0.94	0.1	333	3.9	70	8.9	1.3	< 0.5	**565**	165	< 0.1	**551**	0.47
AB-10D	Deep	< 0.5	0.083	< 0.1	< 50	< 0.08	**2.8**	2.8	0.1	57	< 2.5	< 5	< 0.5	0.58	< 0.5	209	28.3	< 0.1	147	4.6
AB-10S	Shallow	< 0.5	< 0.1	< 0.1	< 50	< 0.08	0.037	< 0.5	1.9	96	< 0.5	**772**	< 0.5	0.88	< 0.5	220	19.4	< 0.1	124	0.54
AB-11D	Deep	< 0.5	< 0.1	< 0.1	< 50	< 0.08	**3.2**	3.4	< 0.1	87	< 0.5	< 5	< 0.5	< 0.5	< 0.5	123	< 1	< 0.1	98	1.8
CCR-26BR	Bedrock	< 0.5	0.22	< 0.1	< 50	< 0.08	**1.9**	1.8	0.1	62	3.8	6	0.61	0.79	1.2	**629**	149	< 0.1	377	4.1
CCR-26D	Deep	< 0.5	0.13	< 0.1	< 50	< 0.08	**2**	2.1	< 0.1	176	2.1	19	0.28	0.71	0.66	**320**	56.4	< 0.1	197	4.3
CCR-26S	Shallow	< 0.5	1.9	< 0.1	< 50	< 0.08	< 0.025	0.62	**11.2**	**45,575**	< 2.5	**1,100**	0.17	1.1	< 0.5	98	2.2	< 0.1	80	0.29
CP-01D	Deep	**1.4**	0.18	< 0.1	76	< 0.08	0.14	3.6	**2.4**	< 50	4.6	**30,133**	< 0.5	1.8	0.91	**1,510**	**657**	< 0.1	**1,074**	1.1
CP-01S	Shallow	< 0.5	0.48	< 0.1	< 50	< 0.08	< 0.025	0.7	**51.4**	**32,733**	< 2.5	**5,133**	0.16	0.63	< 0.5	**341**	**342**	0.18	**563**	< 0.3
CP-02D	Deep	< 0.5	0.28	< 0.1	24	0.080	< 0.025	0.73	**2.2**	75	3.6	**1,673**	0.4	34.7	< 0.5	**3,697**	**2,152**	< 0.1	**3,318**	2.9
CP-02S	Shallow	< 0.5	0.79	< 0.1	< 50	0.10	< 0.025	0.9	**10.4**	**3,243**	< 2.5	**2,960**	0.36	13.7	< 0.5	**3,100**	**1,746**	< 0.1	**2,656**	0.37
CP-03D	Deep	< 0.5	0.55	< 0.1	< 50	< 0.08	< 0.025	0.52	**8**	**3,190**	3.8	**3,223**	1.5	2.8	< 0.5	**1,330**	**540**	< 0.1	**929**	0.42
CP-03S	Shallow	0.28	0.97	0.24	< 50	0.35	< 0.025	1.1	**49.4**	1,061	**4.8**	**3,090**	< 0.5	5.1	2.3	**901**	**928**	0.076	**1,434**	0.39
CP-04D	Deep	< 0.5	0.26	< 0.1	478	< 0.08	< 0.025	< 0.5	0.3	431	4.7	**418**	0.51	1.9	< 0.5	**584**	24	< 0.1	291	3.9
CP-04S	Shallow	< 0.5	0.11	< 0.1	32	< 0.08	< 0.025	< 0.5	**18.8**	**5,970**	< 2.5	**3,400**	< 0.5	0.34	< 0.5	109	65.2	0.12	133	< 0.3
CP-05D	Deep	< 0.5	0.18	< 0.1	**709**	< 0.08	0.036	< 0.5	**1.4**	474	4.8	**459**	0.59	1.6	< 0.5	**868**	**253**	< 0.1	491	1.1
CP-05S	Shallow	< 0.5	0.19	< 0.1	< 50	< 0.08	< 0.025	0.86	**36.1**	**4,544**	< 2.5	**5,523**	< 0.5	1.8	< 0.5	45.6	18.9	0.11	138	0.34
CP-06BR	Bedrock	0.18	4.7	< 0.1	47	< 0.08	0.042	< 0.5	< 0.1	< 50	4.8	14	6.6	0.4	< 0.5	**194**	50	< 0.1	267	0.30
CP-06D	Deep	< 0.5	0.24	< 0.1	**1,488**	< 0.08	0.041	1.4	**1**	562	2.7	**280**	1.3	0.5	< 0.5	**456**	122	< 0.1	266	0.78
CP-06S	Shallow	< 0.5	0.29	< 0.1	**1,354**	< 0.08	0.029	< 0.5	**12.9**	**4,517**	2.5	**2,790**	< 0.5	0.42	< 0.5	**341**	185	< 0.1	323	< 0.3
GWA-01BR	Bedrock	< 0.5	0.84	< 0.1	< 50	< 0.08	0.086	0.55	0.2	< 50	10.8	33	1.7	< 0.5	< 0.5	**244**	15	< 0.1	175	6.3
GWA-01D	Deep	< 0.5	0.19	< 0.1	52	< 0.08	**6.5**	6.6	< 0.1	70	6.1	7	0.26	0.64	< 0.5	**288**	11.6	< 0.1	177	5.9
GWA-01S	Shallow	< 0.5	< 0.1	0.12	< 50	< 0.08	0.83	2.9	3.4	86	< 2.5	13	< 0.5	1.7	< 0.5	11	< 1	0.043	75	< 0.3
GWA-02D	Deep	< 0.5	0.14	< 0.1	< 50	< 0.08	**2.6**	2.8	< 0.1	126	3.4	5	0.19	< 0.5	< 0.5	132	1.6	< 0.1	106	4.3
GWA-02S	Shallow	< 0.5	< 0.1	0.092	< 50	< 0.08	0.058	< 0.5	**6.8**	85	< 2.5	150	< 0.5	0.96	< 0.5	29	< 1	< 0.1	40	< 0.3
GWA-03BRA	Bedrock	1.4	1.9	< 0.1	85	< 0.08	0.037	1.1	0.1	< 50	**41.5**	< 5	2.4	1.6	< 0.5	111	17.8	< 0.1	149	0.66
GWA-03BRL	Bedrock	< 0.5	1.4	< 0.1	< 50	< 0.08	0.036	< 0.5	< 0.1	< 50	< 2.5	5	3.1	< 0.5	0.55	129	6.1	< 0.1	128	5.2
GWA-03D	Deep	< 0.5	0.3	< 0.1	117	< 0.08	0.31	0.86	0.3	133	6.2	13	1	0.46	< 0.5	133	10.9	< 0.1	129	8.4
GWA-03S	Shallow	< 0.5	0.13	< 0.1	338	< 0.08	< 0.025	0.84	**11.5**	**7,092**	0.66	**2,130**	< 0.5	0.76	< 0.5	96	41.4	< 0.1	129	< 0.3
GWA-04BR	Bedrock	0.54	0.33	< 0.1	380	< 0.08	0.038	< 0.5	< 0.1	62	2.2	53	2.8	< 0.5	0.52	130	41.4	< 0.1	179	1.2
GWA-04BRL	Bedrock	0.12	3.4	< 0.1	206	< 0.08	0.14	3.2	0.1	128	15.6	38	**26.5**	2.4	0.92	**375**	**261**	< 0.1	**1,146**	4.8
GWA-04D	Deep	< 0.5	0.092	< 0.1	679	< 0.08	0.03	< 0.5	< 0.1	70	< 2.5	14	0.36	< 0.5	1.3	**243**	68.3	< 0.1	170	4.5
GWA-04S	Shallow	< 0.5	0.13	< 0.1	**2,027**	< 0.08	0.029	0.67	4.3	505	0.51	533	< 0.5	0.54	< 0.5	**372**	147	0.062	272	< 0.3
GWA-05BRA	Bedrock	< 0.5	0.88	< 0.1	**736**	< 0.08	0.038	0.62	0.1	134	2	87	3.1	0.92	< 0.5	**220**	56.7	< 0.1	195	0.75
GWA-05BRL	Bedrock	0.29	5.4	< 0.1	43	< 0.08	0.036	< 0.5	0.1	111	1.3	24	8.5	1.5	< 0.5	**202**	55.4	< 0.1	208	1.2
GWA-05D	Bedrock	< 0.5	0.31	< 0.1	656	< 0.08	0.095	0.58	0.3	242	6.4	147	0.75	0.69	< 0.5	**225**	37.6	< 0.1	171	4.7
GWA-05S	Shallow	< 0.5	0.26	< 0.1	< 50	0.3	0.052	0.58	**21.3**	1,250	< 2.5	**5,804**	< 0.5	3.2	0.51	44	16	0.12	116	0.43
GWA-07D	Deep	< 0.5	0.11	< 0.1	< 50	< 0.08	**6.6**	6.6	< 0.1	88	1.2	5	0.14	0.64	2.8	**582**	112	< 0.1	304	4.3
GWA-07S	Shallow	< 0.5	1.6	1.0	< 50	0.24	**6.5**	6.6	**65.5**	148	**4.3**	334	< 0.5	9.7	3.7	18	101	0.11	170	< 0.3
GWA-28BR	Bedrock	<1	0.551 j	<1	21 j	<1	<0.025 M1	<1	<1	53	2.979 j	89	5.13	<1	<1	**853**	**480**	<0.2	**794**	3.06
GWA-28D	Deep	<1	<1	<1	<50	<1	<0.025	2.16	**10.1**	**734**	6	**3,270**	2.2	2.56	0.528 j	**1,980**	**880**	<0.2	**1,480**	1.2
GWA-28S	Shallow	<1	<1	0.63 j	<50	<1	<0.025	0.496 j	**22.4**	386	<5	**4,800**	0.092 j	2.46	0.436 j	120	**1,100**	0.126 j	**1,520**	0.954
GWA-29BR	Bedrock	<1	0.454 j	<1	<50	<1	<0.025	0.75 j	**1.9**	1000	2.916 j	**449**	3.26	2.11	<1	**2,840**	**1,100**	<0.2	**1,870**	2.39
GWA-29D	Deep	<1	<1	<1	<50	<1	<0.025	0.541 j	**4.1**	367	<5	**610**	1.97	16.9	0.423 j	**2,090**	**680**	<0.2	**1,170**	2.05
GWA-29S	Shallow	<1	0.338 j	<1	<50	<1	<0.025	<1	**9.1**	400	<5	**2,210**	0.293 j	3.74	<1	**504**	190	<0.2	384	0.417
At or Beyond the Compliance Boundary Locations - Sidegradient of the Ash Basin																				
AB-01R	Shallow	< 0.5	0.1	< 0.1	< 50	< 0.08	**3.8**	4.3	0.1	97	0.97	7	0.15	1.4	0.9	**363**	114	< 0.1	258	2.2
AB-02	Shallow	< 0.5	< 0.1	0.1	< 50	< 0.08	0.31	0.43	0.8	96	0.71	34	< 0.5	1.2	< 0.5	4	1.1	< 0.1	30	< 0.3
AB-02D	Deep	< 0.5	0.1	< 0.1	< 50	< 0.08	**2.5**	2.5	< 0.1	73	0.59	< 5	< 0.5	0.89	< 0.5	87	< 1	< 0.1	69	4.3
AB-05	Shallow	< 0.5	< 0.1	< 0.1	< 50	< 0.08	1.4	4.6	0.1	512	0.6	15	< 0.5	2.9	< 0.5	17	1	< 0.1	29	1.1
GWA-08D	Deep	< 0.5	0.1	< 0.1	< 50	< 0.08	0.60	1.2	0.2	177	1.5	6	0.49	1.3	< 0.5	**268**	1.1	< 0.1	128	7
GWA-08S	Shallow	< 0.5	< 0.1	< 0.1	< 50	< 0.08	**5.2**	8	0.3	450	< 2.5	19	0.66	13.1	< 0.5	**463**	1.6	< 0.1	203	0.83

TABLE 6-5
MEANS OF GROUNDWATER COIs - JANUARY 2018 TO JUNE 2019 AND OCTOBER 2019
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
DUKE ENERGY, CAROLINAS, LLC, BELMONT, NC

Analytical Parameters		Antimony	Arsenic	Beryllium	Boron	Cadmium	Chromium (VI)	Chromium	Cobalt	Iron	Lithium	Manganese	Molybdenum	Nickel	Selenium	Strontium	Sulfate	Thallium	Total Dissolved Solids	Vanadium
Reporting Units		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	µg/L	mg/L	µg/L
15A NCAC 02L Standard		**1***	**10**	**4***	**700**	**2**	**NE**	**10**	**1***	300	NE	50	NE	**100**	**20**	NE	**250**	**0.2***	**500**	0.3*
2018 Background Threshold Values (Shallow Flow Zone)[1]		0.76	0.59	0.12	50	1	2.2	6.8	1.5	884	NE	225	0.844	5.8	0.5	298	1.5	0.1	163	**5.7**
2019 Background Threshold Values (Shallow Flow Zone)[2]		1	0.71	0.13	50	0.08	**2.3**	9.1	**5.7**	**1,422**	**3**	**608**	**6.7**	8.9	0.5	**300**	5.4	0.1	154	3.9
2019 Background Dataset Range (Shallow Flow Zone)[2]		0.084 j - <1	0.048 j - 2.3	0.01 j,S1 - 0.22	4.4 j - <50	0.028 j - <0.08	0.013 j - 3.2	0.11 j - 37.6	0.038 j - 19.2	29 j - 2940	0.16 j - 3.6	2.8 j - 1620	0.09 j - 10.7	0.14 j - 26.2	0.32 j - <0.5	2.6 j - 309	<0.1 - 10.7	0.017 j - <0.2	15 - <250	0.088 j - 7.5
2018 Background Threshold Values (Deep Flow Zone)[1]		1	1	0.03	50	1	1.3	6.8	1	356	NE	26.2	1.8	5	0.62	232	5.4	0.1	158	11.5
2019 Background Threshold Values (Deep Flow Zone)[2]		0.69	1.1	1	50	1	**1.5**	**16.1**	0.82	**665**	**25.3**	**256**	**26.2**	10.3	0.75	**240**	14.5	0.1	173	**16.1**
2019 Background Dataset Range (Deep Flow Zone)[2]		0.096 j - 0.85	0.048 j - 1.4	0.01 j - <1	5.8 - 50.3	0.035 j - <1	0.015 j - 1.8	0.23 j,B,S1 - 93.2	0.019 j - 4.6	27.5 j,B - 823	0.89 - 44.9	2.7 j - 900	0.21 j - 30.2	0.16 j - 52.6	0.34 j - 1.2	31 - 251	0.5 j - 22	0.016 j - <0.1	43 - 280	1.2 - 17.9
2018 Background Threshold Values (Bedrock Flow Zone)[1]		0.5	1.6	0.1	50	0.08	0.23	5.6	0.3	284	NE	278	8.9	3.4	0.5	154	2.9	0.1	165	**15.9**
2019 Background Threshold Values (Bedrock Flow Zone)[2]		**2.6**	1.6	0.1	50	0.08	**0.77**	**10.2**	0.35	**1,242**	**26.3**	**360**	**11**	6.9	0.5	**181**	7.3	0.1	221	12.5
2019 Background Dataset Range (Bedrock Flow Zone)[2]		0.27 j - 3.9	0.24 - 1.6	0.01 j - <0.1	35.6 j - <50	<0.08	<0.025 - 0.66	0.33 j - 8.9	0.021 j - 0.31	40.7 j - 715	0.9 j - 26.3	2.8 j - 278	1.7 - 10.5	0.22 j - 5.8	0.17 j - <0.5	97.7 - 223	1.8 - 33.3	0.02 j - <0.1	104 - 222	7.5 - 15.9
Sample ID	**Flow Zone**	**Means Results**																		
At or Beyond the Compliance Boundary Locations - Sidegradient of the Ash Basin (Continued)																				
GWA-17D	Deep	< 0.5	0.2	< 0.1	< 50	< 0.08	0.31	1.6	**1.1**	459	2	102	0.82	1.1	< 0.5	**256**	3.3	< 0.1	122	5.2
GWA-17S	Shallow	< 0.5	0.2	< 0.1	< 50	< 0.08	**6.3**	6.4	0.1	148	0.69	10	0.35	1.7	< 0.5	131	4.7	< 0.1	79	2
GWA-18D	Deep	< 0.5	0.4	< 0.1	< 50	< 0.08	0.88	1.4	0.1	67	4.0	9	0.64	1.1	< 0.5	166	2.6	< 0.1	113	8
GWA-18S	Shallow	< 0.5	0.5	< 0.1	< 50	< 0.08	0.95	1.4	0.1	763	0.34	77	0.35	2	< 0.5	188	< 1	< 0.1	105	4.9

Prepared by: LWD Checked by: JYT / DAA
Revised by: EMY / LWD

Notes:

[1] - Background threshold values were calculated using data from background groundwater samples collected June 2015 to September 2017.

[2] - Background threshold values and background dataset ranges were calculated using data from background groundwater samples collected March 2011 to December 2018.

Statistical mean calculated from data ranging from January 2018 to June 2019. Ash pore water results are not compared to groundwater standards or criteria.

For wells with datasets containing fewer than four valid results, the most recent valid sample data was used.

Means were calculated for wells with four or more valid sample results. Sample results were excluded from calculations:

1) if turbidity >10 NTU (for COIs other than boron)
2) for unusable data (R0 qualified)
3) if a result was non-detect at a reporting limit (RL) greater than the normal laboratory RL

Bold text - greatest comparative value

- bold highlighted concentration indicates value is greater than the 15A NCAC 02L .0202 Standard or the IMAC. (Effective date for 15A NCAC 02L .0202 Standard and IMAC is April 1, 2013)

- bold highlighted concentration indicates value is greater than greatest background threshold value where there is no regulatory standard, or background threshold values are greater than regulatory standard

- highlighted concentration indicates value is either within range of background threshold values for constituents where there is no regulatory standard/background threshold values are greater than regulatory standard, or within range of background threshold value and the regulatory standard

* - Interim Maximum Allowable Concentrations (IMACs) of the 15A NCAC 02L Standard, Appendix 1, April 1, 2013.

< - concentration not detected at or above the adjusted reporting limit.

\- - no available data to conduct mean analysis

NE - not established

mg/L - milligrams per liter

µg/L - micrograms per liter

TABLE 6-6
COI MANAGEMENT MATRIX
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELMONT, NC

Constituents of Interest (2018 CSA Update)	Reporting Unit	02L or IMAC Criterion	Groundwater Zone Statistically Derived Background Value[1,2] Flow Zone	2018	2019	Allen Steam Station Flow Zone Background Dataset Range	Allen Steam Station Background Dataset Range (All Flow Zones)	Piedmont Background Value Range (All Flow Zones)	Maximum Mean Concentration Near or Beyond Compliance Boundary	Groundwater Exceedance Ratio[3]	Number of Wells Greater Than Comparative Criteria Near or Beyond Compliance Boundary	Groundwater Monitoring Wells With COI Concentration Greater Than Comparative Criteria	Present in Ash Pore Water Above Comparative Criteria (mean of ash pore water from January 2018 to June 2019)	Exceeds Flow Zone Background Dataset Range	Exceeds Site-Specific Background Range	Exceeds Piedmont Province Background Range	Downgradient of Source Area at Concentrations Greater than Criteria	Geochemical Mobility[4]	Rationale for Selection of COIs for Corrective Action Evaluation (constituents where no means are greater than comparative criteria in all flow zones and/or multiple lines of evidence support that constituent occurrences are not related to the source areas, no corrective action is warranted)
Constituent Standards and Values - 02L Criterion													**Lines of Evidence (LOE) - 02L Criterion**						**Rationale - 02L Criterion**
Arsenic	µg/L	10	Shallow	1	1	0.048 j - 2.3	0.048 j - 2.3	0.1 - 6.35	1.92	0.19	0	-	Y	0	0	0	N	Variable	No means exceed comparative criteria
			Transition Zone	1	1	0.048 j - 1.4			0.30	0.03	0	-		0	0	0	N		No means exceed comparative criteria
			Bedrock	2	2	0.24 - 1.6			8.30	0.83	0	-		0	0	0	N		No means exceed comparative criteria
Boron	µg/L	700	Shallow	50	50	4.4 j - <50	4.4 j - 50.3	49.09 - 176.8	2027	2.90	5	AB-09S, CCR-16S, CCR-17S, CP-06S, GWA-04S	Y	5	5	5	Y	Conservative	Exceedances depict a plume-like distribution likely related to the ash basins
			Transition Zone	50	50	5.8 - 50.3			1488	2.13	3	CCR-11DA, CP-05D, CP-06D		3	3	3	Y		Exceedances depict a plume-like distribution likely related to the ash basins
			Bedrock	50	50	35.6 j - <50			1520	2.17	2	CCR-17D, GWA-05BRA		2	2	2	Y		Exceedances depict a plume-like distribution likely related to the ash basins
Cadmium	µg/L	2	Shallow	1	0.08	0.028 j - <0.08	0.028 j - <1	0.08 - 1	0.35	0.17	0	-	N	0	0	0	N	Non-Conservative	No means exceed comparative criteria
			Transition Zone	1	1	0.035 j - <1			0.08	0.04	0	-		0	0	0	N		No means exceed comparative criteria
			Bedrock	0.08	0.08	<0.08			< 0.08	NA	0	-		0	0	0	N		No means exceed comparative criteria
Chromium (Total)	µg/L	10	Shallow	6.79	9.07	0.11 j - 37.6	0.11 j - 93.2	1 - 26	11	1.05	1	AB-06A	N	0	0	0	N	Non-Conservative	No means exceed comparative criteria
			Transition Zone	6.80	16.10	0.23 j,B,S1 - 93.2			7	0.41	0	-		0	0	0	N		No means exceed comparative criteria
			Bedrock	5.60	10.19	0.33 j - 8.9			3	0.31	0	-		0	0	0	N		No means exceed comparative criteria
Iron	µg/L	300	Shallow	884	1,422	29 j - 2940	27.5 j,B - 2940	56.3 - 37500	45575	32.05	8	AB-09S, CCR-26S, CP-01S, CP-02S, CP-04S, CP-05S, CP-06S, GWA-03S	Y	8	8	1	Y	Variable	Exceedances depict a plume-like distribution likely related to the coal pile area (except anamolous AB-09S and CCR-26S)
			Transition Zone	356	665	27.5 j,B - 823			3190	4.80	2	CP-03D, GWA-28D		1	1	0	Y		Exceedance falls within the plume-like distribution likely related to the coal pile area
			Bedrock	284	1,242	40.7 j - 715			504	0.41	0	-		0	0	0	N		No means exceed Site specific background maximum
Manganese	µg/L	50	Shallow	225	608	2.8 j - 1620	2.7 j - 1620	7 - 9170	10050	16.53	13	AB-09S, AB-10S, CCR-26S, CP-01S, CP-02S, CP-03S, CP-04S, CP-05S, CP-06S, GWA-03S, GWA-05S, GWA-28S, GWA-29S	Y	11	11	1	Y	Variable	Exceedances depict a plume-like distribution likely related to the source areas
			Transition Zone	26	256	2.7 j - 900			30133	117.71	8	CP-01D, CP-02D, CP-03D, CP-04D, CP-05D, CP-06D, GWA-28D, GWA-29D		4	4	1	Y		Exceedances depict a plume-like distribution likely related to the coal pile area
			Bedrock	278	360	2.8 j - 278			449	1.25	1	GWA-29BR		1	0	0	Y		No means exceed Site specific background maximum
Nickel	µg/L	100	Shallow	6	9	0.14 j - 26.2	0.14 j - 52.6	1.98 - 20	13.7	0.14	0	-	N	0	0	0	N	Variable	No means exceed comparative criteria
			Transition Zone	5	10	0.16 j - 52.6			34.7	0.35	0	-		0	0	0	N		No means exceed comparative criteria
			Bedrock	3	7	0.22 j - 5.8			2.4	0.02	0	-		0	0	0	N		No means exceed comparative criteria
Selenium	µg/L	20	Shallow	0.5	0.50	0.32 j - <0.5	0.17 j - 1.2	0.5 - 2	4	0.19	0	-	N	0	0	0	N	Variable	No means exceed comparative criteria
			Transition Zone	0.62	0.75	0.34 j - 1.2			3	0.14	0	-		0	0	0	N		No means exceed comparative criteria
			Bedrock	0.5	0.50	0.17 j - <0.5			1	0.06	0	-		0	0	0	N		No means exceed comparative criteria
Sulfate	mg/L	250	Shallow	2	5	<0.1 - 10.7	<0.1 - 33.3	1.2 - 510	1746	6.98	4	CP-01S, CP-02S, CP-03S, GWA-28S	N	4	4	3	Y	Conservative	Exceedances depict a plume-like distribution likely related to the coal pile area
			Transition Zone	5	15	0.5 j - 22			880	3.52	6	CP-01D, CP-02D, CP-03D, CP-05D, GWA-28D, GWA-29D		6	6	5	Y		Exceedances depict a plume-like distribution likely related to the coal pile area
			Bedrock	3	7	1.8 - 33.3			1100	4.40	3	GWA-04BRL, GWA-28BR, GWA-29BR		3	3	1	Y		Exceedances depict a plume-like distribution likely related to the coal pile area. Anamolous exceedances at locations in deep bedrock.
Total Dissolved Solids	mg/L	500	Shallow	163	154	15 - <250	15 - 280	50 - 1200	2656	5.31	4	CP-01S, CP-02S, CP-03S, GWA-28S	Y	4	4	3	Y	Conservative	Exceedances depict a plume-like distribution likely related to the coal pile area
			Transition Zone	158	173	43 - 280			3318	6.64	5	CP-01D, CP-02D, CP-03D, GWA-28D, GWA-29D		5	5	2	Y		Exceedances depict a plume-like distribution likely related to the coal pile area
			Bedrock	165	221	104 - 222			1870	3.74	4	AB-10BRL, GWA-04BRL, GWA-28BR, GWA-29BR		4	4	1	Y		Exceedances depict a plume-like distribution likely related to the coal pile area. Anamolous exceedances at locations in deep bedrock.
Constituent Standards and Values - IMAC Criterion													**Lines of Evidence (LOE) - IMAC Criterion**						**Rationale - IMAC Criterion**
Antimony	µg/L	1	Shallow	0.76	1.00	0.084 j - <1	0.084 j - 3.9	0.5 - 4.247	0	0.28	0	-	Y	0	0	0	N	Conservative	No means exceed comparative criteria
			Transition Zone	0.50	0.69	0.096 j - 0.85			1	1.38	1	CP-01D		1	0	0	Y		No means exceed Site specific background maximum
			Bedrock	0.50	2.60	0.27 j - 3.9			1	0.54	0	-		0	0	0	N		No means exceed comparative criteria
Beryllium	µg/L	4	Shallow	0.124	0.130	0.01 j,S1 - 0.22	0.01 j - <1	0.053 - 1	1	0.26	0	-	N	0	0	0	N	Non-Conservative	No means exceed comparative criteria
			Transition Zone	0.029	1.000	0.01 j - <1			< 0.1	NA	0	-		0	0	0	N		No means exceed comparative criteria
			Bedrock	0.100	0.100	0.01 j - <0.1			< 0.1	NA	0	-		0	0	0	N		No means exceed comparative criteria
Cobalt	µg/L	1	Shallow	1.520	5.700	0.038 j - 19.2	0.019 j - 19.2	0.2 - 88.85	51	9.02	16	AB-09S, CCR-14S, CCR-18S, CCR-26S, CP-01S, CP-02S, CP-03S, CP-04S, CP-05S, CP-06S, GWA-02S, GWA-03, GWA-05S, GWA-07S, GWA-28S, GWA-29S	Y	7	7	0	Y	Variable	Exceedances generally depict a plume-like distribution likely related to the coal pile area
			Transition Zone	0.502	0.822	0.019 j - 4.6			10	10.10	7	CP-01D, CP-02D, CP-03D, CP-05D, CP-06D, GWA-28D, GWA-29D		2	0	0	Y		No means exceed Site specific background maximum
			Bedrock	0.300	0.348	0.021 j - 0.31			2	1.90	1	GWA-29BR		1	0	0	Y		No means exceed Site specific background maximum
Thallium	µg/L	0.2	Shallow	0.1	0.1	0.017 j - <0.2	0.016 j - <0.1	0.1 - 0.2	0.2	0.88	0	-	Y	0	0	0	N	Variable	No means exceed comparative criteria
			Transition Zone	0.1	0.1	0.016 j - <0.1			< 0.1	NA	0	-		0	0	0	N		No means exceed comparative criteria
			Bedrock	0.1	0.1	0.02 j - <0.1			< 0.1	NA	0	-		0	0	0	N		No means exceed comparative criteria
Vanadium	µg/L	0.3	Shallow	6	4	0.088 j - 7.5	0.088 j - 17.9	0.38 - 26	3.7	0.65	0	-	Y	0	0	0	N	Non-Conservative	No means exceed comparative criteria
			Transition Zone	12	16	1.2 - 17.9			8.4	0.52	0	-		0	0	0	N		No means exceed comparative criteria
			Bedrock	16	13	7.5 - 15.9			8.1	0.51	0	-		0	0	0	N		No means exceed comparative criteria
Constituent Standards and Values - Background Criterion													**Lines of Evidence (LOE) - Background Criterion**						**Rationale - Background Criterion**
Chromium (Hexavalent)	µg/L	NE	Shallow	2	2	0.013 j - 3.2	0.013 j - 3.2	0.03 - 12	9.9	4.21	5	AB-01R, AB-06A, AB-06R, GWA-07S, GWA-08S	N	5	5	0	Y	Variable	Not in ash pore water, AB-01R, GWA-07S, GWA-08S outside conservative plume, majority of AB-06A/R values for CrVI > Cr (Total) --- unreliable
			Transition Zone	1	2	0.015 j - 1.8			6.6	4.40	7	AB-02D, AB-10D, AB-11D, CCR-26D, GWA-01D, GWA-02D, GWA-07D		7	2	0	Y		Not in ash pore water, GWA-1D and GWA-7D outside boron plume, GWA-1D anamolous
			Bedrock	0	0.8	<0.025 - 0.66			1.9	2.42	1	CCR-26BR		1	0	0	Y		No means exceed Site specific background maximum
Molybdenum	µg/L	NE	Shallow	1	7	0.09 j - 10.7	0.09 j - 30.2	0.5 - 26	11	1.62	1	CCR-11S	Y	1	0	0	Y	Variable	No means exceed Site specific background maximum
			Transition Zone	2	26	0.21 j - 30.2			2	0.07	0	-		0	0	0	N		No means exceed comparative criteria
			Bedrock	9	11	1.7 - 10.5			27	2.41	1	GWA-04BRL		1	0	0	Y		No means exceed Site specific background maximum
Strontium	µg/L	NE	Shallow	298	300	2.6 j - 309	2.6 j - 309	27 - 2272	3100	10.33	8	AB-01R, CP-01S, CP-02S, CP-03S, CP-06S, GWA-04S, GWA-08S, GWA-29S	Y	8	8	1	Y	Non-Conservative	Exceedances generally depict a plume-like distribution likely related to the coal pile area, with sporadic exceedances upgradient, sidegradient, and downgradient of the retired ash basin
			Transition Zone	232	240	31 - 251			3697	15.40	14	AB-09D, CCR-26D, CP-01D, CP-02D, CP-03D, CP-04D, CP-05D, CP-06D, GWA-01D, GWA-04D, GWA-07D, GWA-08D, GWA-28D, GWA-29D		13	11	1	Y		Exceedances generally depict a plume-like distribution likely related to the coal pile area, with sporadic exceedances downgradient of the active ash basin/retired ash basin and sidegradient of the retired ash basin
			Bedrock	154	181	97.7 - 223			2840	15.69	12	AB-10BR, AB-10BRL, CCR-16BR, CCR-26BR, CP-06BR, GWA-01BR, GWA-04BRL, GWA-05BRA, GWA-05BRL, GWA-05D, GWA-28BR, GWA-29BR		9	6	1	Y		Exceedances are sporadic throughout the Site, downgradient of the active ash basin, retired ash basin, and sidegradient of the retired ash basin

Created by: LWD Checked by: CJS

Notes:
- Reference Criterion
- Evidence supports inclusion
- Evidence supports exclusion

[1] - Background values were calculated using data from background groundwater samples collected June 2015 to September 2017.
[2] - Updated background values were calculated using data from background groundwater samples collected March 2011 to December 2018.
[3] - The exceedance ratio is the calculated COI mean concentration divided by criterion concentration.
[4] - Assignment of conservative, non-conservative, or variable behavior is based on geochemical modeling results.
> - greater than
< - less than
APW - ash pore water
COI - constituent of interest
CSA - Comprehensive Site Assessment
IMAC - interim maximum allowable concentration
µg/L - micrograms per liter
mg/L - milligrams per liter
NA - Not Applicable
NE - Not Established
Y - Yes
N - No

TABLE 6-7
SUMMARY TREND ANALYSIS RESULTS FOR
MONITORING WELLS
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELMONT, NC

Wells Within the Waste Boundary

Well ID	Boron	Sulfate	Total Dissolved Solids
Ash Pore Water Wells			
AB-20S	D	D	D
AB-21S	S	D	NT
AB-21SL	I	S	S
AB-22S	ND	D	NT
AB-23S	D	I	I
AB-24S	I	I	I
AB-24SL	S	S	S
AB-25S	D	D	D
AB-25SL	D	D	D
AB-26S	S	S	S
AB-27S	S	NT	I
AB-28S	S	S	S
AB-29S	S	D	D
AB-29SL	S	D	D
AB-30S	NT	NT	I
AB-31S	S	S	I
AB-32S	ND	S	S
AB-33S	I	D	D
AB-34S	I	NT	I
AB-35S	I	D	D
AB-36S	NT	D	S
AB-37S	ND	D	S
AB-38S	S	NT	I
AB-39S	S	I	S
Shallow Flow Zone			
AB-21SS	ND	D	D
AB-25SS	S	I	I
AB-29SS	S	S	S
AB-33SS	S	S	S
AB-35PWS	NE	NE	NE
AB-38SS	ND	NT	S

Wells Within the Waste Boundary

Well ID	Boron	Sulfate	Total Dissolved Solids
Deep Flow Zone			
AB-20D	ND	D	NT
AB-21D	ND	NE	NE
AB-22D	I	S	I
AB-23BRU	S	NE	NE
AB-24D	ND	NE	NE
AB-25BRU	S	NE	NE
AB-26D	I	I	S
AB-27D	NT	S	D
AB-28D	I	D	S
AB-29D	I	I	S
AB-30D	ND	I	I
AB-31D	S	NE	NE
AB-32D	S	I	I
AB-33D	S	NT	S
AB-34D	ND	D	NT
AB-35D	ND	NE	NE
AB-36D	ND	D	S
AB-37D	ND	D	S
AB-38D	ND	NT	S
AB-39D	I	I	S
Bedrock Flow Zone			
AB-21BR	ND	NE	NE
AB-21BRL	S	NT	S
AB-22BR	S	S	NT
AB-22BRL	S	S	S
AB-24BR	ND	NT	S
AB-25BR	ND	NE	NE
AB-27BR	S	NT	I
AB-35BR	ND	D	D
AB-38BR	ND	S	S

Wells Between Waste Boundary and Compliance Boundary

Well ID	Boron	Sulfate	Total Dissolved Solids
Shallow Flow Zone			
CCR-01S	NE	NE	NE
CCR-02S	ND	D	S
CCR-03S	S	D	S
CCR-04SA	NT	S	S
CCR-05S	S	I	I
CCR-06S	S	I	I
CCR-07S	S	I	I
CCR-08S	S	I	I
CCR-09S	S	I	I
CCR-20S	I	I	I
CCR-21S	D	I	D
CCR-22S	ND	D	I
CCR-23S	ND	D	NT
GWA-06S	ND	D	D
GWA-18S	ND	D	S
Deep Flow Zone			
CCR-01DA	ND	S	S
CCR-02D	D	S	D
CCR-03DA	ND	S	S
CCR-04DA	S	S	S
CCR-05D	S	S	S
CCR-06D	D	NT	S
CCR-07D	I	I	S
CCR-08D	S	I	I
CCR-09D	D	S	S
CCR-20D	I	I	S
CCR-21D	I	S	S
CCR-22DA	S	NT	S
CCR-23D	ND	S	S
GWA-06DA	D	I	I
GWA-18D	ND	NT	S
Bedrock Flow Zone			
GWA-06BRA	ND	S	S
GWA-06BRL	NE	NE	NE

Wells Near or Beyond Compliance Boundary

Well ID	Boron	Sulfate	Total Dissolved Solids
Shallow Flow Zone			
AB-01R	ND	I	I
AB-02	ND	NT	ND
AB-06A	ND	I	I
AB-06R	ND	I	I
AB-09S	S	S	S
AB-10S	ND	I	I
CCR-11S	NT	D	S
CCR-14S	D	D	D
CCR-16S	I	I	S
CCR-17S	I	I	S
CCR-18S	D	S	D
CCR-26S	ND	NT	S
CP-01S	ND	S	D
CP-02S	ND	S	S
CP-03S	ND	S	D
CP-04S	NE	NE	NE
CP-05S	NE	NE	NE
CP-06S	S	S	S
GWA-01S	ND	ND	I
GWA-02S	ND	D	NT
GWA-03S	S	D	NT
GWA-04S	S	S	I
GWA-05S	ND	NT	NT
GWA-07S	ND	S	S
GWA-08S	ND	NT	D
Deep Flow Zone			
AB-02D	ND	D	NT
AB-09D	D	I	S
AB-10D	ND	I	I
AB-11D	ND	S	S
CCR-11DA	S	S	S
CCR-14D	S	S	S
CCR-18D	I	D	S
CCR-26D	ND	S	S

Wells Near or Beyond Compliance Boundary

Well ID	Boron	Sulfate	Total Dissolved Solids
Deep Flow Zone			
CP-01D	S	S	S
CP-02D	I	S	S
CP-03D	ND	S	D
CP-04D	NE	NE	NE
CP-05D	NE	NE	NE
CP-06D	S	S	S
GWA-01D	I	S	I
GWA-02D	ND	D	S
GWA-03D	S	S	S
GWA-04D	S	I	S
GWA-07D	ND	I	I
GWA-08D	ND	S	S
Bedrock Wells			
AB-10BR	NE	NE	NE
AB-10BRL	NE	NE	NE
CCR-16BR	S	D	S
CCR-16D	S	I	I
CCR-17D	S	I	I
CCR-26BR	ND	S	S
CP-06BR	NT	NE	NE
GWA-01BR	ND	S	I
GWA-03BRA	D	S	S
GWA-03BRL	NE	NE	NE
GWA-04BR	S	S	S
GWA-04BRL	NE	NE	NE
GWA-05BRA	D	S	I
GWA-05BRL	NE	NE	NE
GWA-05D	S	I	S

Mann-Kendall trend analysis and results prepared by Arcadis U.S. Inc.

Notes:

1. Summary of results and trends are presented for samples collected from 2004 - 2019.
2. Trend results are presented when at least four samples were available and frequency of detection was >50%. Statistically significant trends are reported at the 95% confidence level.
3. Variability Index (VI) is calculated as the (maximum - minimum) / median concentration and is calculated using detected concentrations only. Values less than 1 indicate low variability in the dataset.

ND	= Greater than 50 percent of constituent concentrations were non-detect
D	= Statistically significant, decreasing concentration trend
S	= Stable. No significant trend and variability is low (VI ≤ 1)
NT	= No significant trend and variability is high (VI > 1)
I	= Statistically significant, increasing concentration trend.
NE	= Insufficient number of samples to evaluate trend (n < 4)

TABLE 6-8
SEEP CORRECTIVE ACTION STRATEGY
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELMONT, NC

Seep ID	Regulatory Program	General Location	Approximate Average Present Flow (cfs)	Anticipated Seep Corrective Action Strategy
S-2	SOC	Southeast of the AAB	No flow	No additional corrective action, other than decanting, is anticipated because decanting has been an effective corrective measure to reduce flow such that overland flow infiltrates prior to reaching the Catawba River (Lake Wylie). Basin closure and groundwater corrective action measures in the vicinity of S-2 would reduce the potential for flow to resume.
S-3 Toe Drain Outfall 103	NPDES	East of AAB	0.01	No corrective action is necessary because S-03 is a permitted NPDES outfall (Toe Drain Outfall 103). Decanting has been effective in reducing flow. Further decanting, basin closure, and groundwater extraction may cause flow to cease. If not, Duke may proactively impart corrective action measures such as capturing flow for management with extracted groundwater.
S-4 Toe Drain Outfall 104	NPDES	East of AAB	0.01	No corrective action is necessary because S-04 is a permitted NPDES outfall (Toe Drain Outfall 104). Decanting has been effective in reducing flow. Further decanting, basin closure, and groundwater extraction may cause flow to cease. If not, Duke may proactively impart corrective action measures such as capturing flow for management with extracted groundwater.
S-5	SOC	East of AAB	Insufficient for monitoring	Source control measures (i.e. decanting and ash basin closure) and groundwater corrective action measures (extraction wells) are anticipated to reduce potential for flow to continue. However, corrective action may not be necessary at this time because flow emerges below the ordinary high water mark. Duke Energy plans to continue to monitor this seep and if continued decanting is not effective in ceasing flow, then additional corrective measures would be considered, such as capturing flow for management with extracted groundwater
S-6	SOC	East of AAB	Insufficient for monitoring	Source control measures (i.e. decanting and ash basin closure) and groundwater corrective action measures (extraction wells) are anticipated to reduce potential for flow to continue. However, corrective action may not be necessary at this time because flow emerges below the ordinary high water mark. Duke Energy plans to continue to monitor this seep and if continued decanting is not effective in ceasing flow, then additional corrective measures would be considered, such as capturing flow for management with extracted groundwater
S-7	SOC	East of AAB	Insufficient for monitoring	Source control measures (i.e. decanting and ash basin closure) and groundwater corrective action measures (extraction wells) are anticipated to reduce potential for flow to continue. However, corrective action may not be necessary at this time because flow emerges below the ordinary high water mark. Duke Energy plans to continue to monitor this seep and if continued decanting is not effective in ceasing flow, then additional corrective measures would be considered, such as capturing flow for management with extracted groundwater
S-8 Toe Drain Outfall 108	NPDES	East of AAB	No flow	No corrective action is necessary because S-8 is a permitted NPDES outfall. No additional corrective action, other than decanting, is anticipated because decanting has been an effective corrective measure in ceasing flow. Further decanting, basin closure, and groundwater extraction would reduce the potential for flow to resume.
S-8B Toe Drain Outfall 108B	NPDES	East of AAB	No flow	No corrective action is necessary because S-8B is a permitted NPDES outfall. No additional corrective action, other than decanting, is anticipated because decanting has been an effective corrective measure in ceasing flow. Further decanting, basin closure, and groundwater extraction would reduce the potential for flow to resume.
S-10	SOC	North of Primary Pond 1 of the AAB	Insufficient for monitoring	No additional corrective action, other than source control, is anticipated because decanting has reduced flow and ash basin closure would eliminate the seep.

Prepared by: CJS Checked by: LWD

Notes:
cfs- cubic feet per second
NPDES – National Pollution Discharge Elimination System
SOC – Special Order by Consent
AAB - Active Ash Basin

TABLE 6-9
WATER SUPPLY WELL ANALYTICAL RESULTS SUMMARY
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELMONT, NC

Analytical Parameter		Antimony	Arsenic	Beryllium	Boron	Cadmium	Chromium (VI)	Chromium	Cobalt	Iron	Lithium	Manganese	Molybdenum	Nickel	Selenium	Strontium	Sulfate	Thallium	Total Dissolved	Vanadium	Impacted by Coal Ash?	Comments
Reporting Units		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	µg/L	mg/L	µg/L		
15A NCAC 02L Standard		1*	**10**	**4***	**700**	**2**	**NE**	10	**1***	300	NE	50	NE	**100**	**20**	NE	**250**	**0.2***	**500**	0.3*		
Background Threshold Values (Bedrock Unit)[1]		0.5	1.6	0.1	50	0.08	0.23	5.6	0.3	284	NE	278	8.9	3.4	0.5	154	2.9	0.1	165	**15.9**		
Background Threshold Values (Bedrock Unit)[2]		**2.6**	1.6	0.1	50	0.08	**0.765**	**10.19**	0.3	**1,242**	**26.3**	**360**	**11**	6.944	0.5	**181**	7.3	0.1	221	12.5		
Background Data Set Range (Bedrock Unit)[2]		0.27 j - 3.9	0.24 - 1.6	0.01 j - <0.1	35.6 j - <50	<0.08	<0.025 - 0.66	0.33 j - 8.9	0.021 j - 0.31	40.7 j - 715	0.9 j - 26.3	2.8 j - 278	1.7 - 10.5	0.22 j - 5.8	0.17 j - <0.5	97.7 - 223	1.8 - 33.3	0.02 j - <0.1	104 - 222	7.5 - 15.9		
Sample ID	Sample Collection Date	Analytical Results																				
AL1	02/10/2015	<1	<5	<1	<100	<0.1	<10	<1	<1	65	NA	<5	<5	<5	<5	130	<1	<0.1	98	5	No	All COIs are below comparative criteria
AL1	08/03/2015	<0.5	<0.5	<0.2	<5	<0.08	0.17	<0.5	<0.5	<50	NA	1.1	0.63	<0.5	<0.5	124	<2	<0.1	100	6.3		
AL100	03/17/2015	<3	<10	<1	<100	<1	<20	<10	<5	19.7	NA	1.54	<10	<10	<10	162	<10	<1	134	10	No	All COIs are below comparative criteria
AL100	05/12/2015	<0.5	<0.5	<0.2	<5	<0.08	0.56	0.71	<0.5	<50	NA	<0.5	0.89	<0.5	<0.5	161	2.8	<0.1	150	12.8		
AL-1000	01/01/2016	<0.5	0.53	<0.1	<25	<0.08	0.2	<0.5	<0.1	<50	NA	1.3	0.91	<0.5	0.53	**331**	4.4	<0.1	184	7.3	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, separated by a hydrologic divide.
AL-1001	01/01/2016	<0.5	0.78	<0.1	<25	<0.08	0.042	<0.5	<0.1	<50	NA	2.7	2.5	<0.5	<0.5	**296**	60.4	<0.1	200	0.78	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, separated by a hydrologic divide. GWA-9S/D/BR, located between the source areas and AL-1001, do not exceed background for strontium.
AL-1002	01/01/2016	<0.5	1.2	<0.1	<25	<0.08	<0.03	<0.5	<0.1	<50	NA	2.7	3.2	<0.5	<0.5	177	4.3	<0.1	103	2.4	No	All COIs are below comparative criteria
AL-1003	01/01/2016	<0.5	1.1	<0.1	<25	<0.08	0.052	<0.5	<0.1	<50	NA	<0.5	4.1	<0.5	<0.5	151	5.9	<0.1	133	2.2	No	All COIs are below comparative criteria
AL-1004	01/01/2016	<0.5	1.5	<0.1	<25	<0.08	0.1	<0.5	<0.1	<50	NA	0.54	1.8	<0.5	2	**235**	4.9	<0.1	183	5.6	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, separated by a hydrologic divide. GWA-9S/D/BR, located between the source areas and AL-1001, do not exceed background for strontium.
AL-1005	01/01/2016	<0.5	<0.1	<0.1	<25	<0.08	**1.6**	1.6	<0.1	<50	NA	0.85	<0.5	<0.5	<0.5	80.9	<2	<0.1	65	4.3	No	Northwest and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, separated by a hydrologic divide.
AL-1006	01/01/2016	<0.5	0.99	<0.1	<25	<0.08	0.2	<0.5	<0.1	<50	NA	<0.5	1.8	<0.5	0.96	121	3.7	<0.1	118	15	No	All COIs are below comparative criteria
AL-1007	01/01/2016	<0.5	<0.1	<0.1	<25	<0.08	**3**	3.1	<0.1	112	NA	2.6	<0.5	<0.5	<0.5	**280**	3	<0.1	127	3.9	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, along a hydrologic divide.
AL-1008	01/01/2016	<0.5	<0.1	<0.1	<25	<0.08	**1.8**	2.2	<0.1	<50	NA	1.3	<0.5	<0.5	<0.5	168	2.2	<0.1	108	6.7	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, separated by a hydrologic divide.
AL-1009	01/01/2016	<0.5	0.12	<0.1	<25	<0.08	**0.82**	1.4	<0.1	<50	NA	0.91	<0.5	<0.5	<0.5	**202**	<2	<0.1	139	5.4	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, separated by a hydrologic divide.
AL101	05/22/2015	<0.5	<0.5	<0.2	<5	<0.08	0.61	2.9	<0.5	<50	NA	6.9	<0.5	1.6	<0.5	72.5	<0.002	<0.1	40	4	No	All COIs are below comparative criteria
AL-1010	01/01/2016	<0.5	0.12	<0.1	<25	<0.08	**5.9**	5.8	<0.1	<50	NA	1.1	<0.5	<0.5	<0.5	145	<2	<0.1	106	5.5	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, separated by a hydrologic divide.
AL-1011	01/01/2016	<0.5	0.12	<0.1	<25	<0.08	**2.8**	2.7	<0.1	<50	NA	2	<0.5	<0.5	<0.5	146	<2	<0.1	93	5.9	No	South and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, separated by a hydrologic divide.
AL-1012	01/01/2016	<0.5	1.1	<0.1	<25	<0.08	0.047	0.92	<0.1	<50	NA	2.5	3	0.83	<0.5	**249**	10.3	<0.1	98	0.6	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, separated by a hydrologic divide.
AL-1013	01/01/2016	<0.5	3.1	<0.1	<25	<0.08	0.09	<0.5	<0.1	<50	NA	<0.5	2.8	<0.5	<0.5	**277**	6.2	<0.1	137	4.2	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, separated by a hydrologic divide.
AL-1014	01/01/2016	<0.5	0.1	<0.1	<25	<0.08	0.31	0.6	<0.1	<50	NA	<0.5	<0.5	<0.5	<0.5	**210**	2.1	<0.1	128	6.7	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, separated by a hydrologic divide. GWA-9S/D/BR, located between the source areas and AL-1014, do not exceed background for strontium.
AL-1015	01/01/2016	<0.5	1.1	<0.1	<25	<0.08	<0.03	<0.5	<0.1	<50	NA	8.4	3.9	<0.5	<0.5	162	10.5	<0.1	130	<0.3	No	All COIs are below comparative criteria
AL-1016	01/01/2016	<0.5	0.16	<0.1	<25	<0.08	**2**	2.2	<0.1	<50	NA	<0.5	<0.5	<0.5	<0.5	**184**	2.3	<0.1	146	10.4	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, separated by a hydrologic divide.
AL-1017	01/01/2016	<0.5	0.82	<0.1	<25	<0.08	0.058	5.6	0.1	968	NA	14	4	1.2	<0.5	**256**	6.4	<0.1	116	3.5	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, separated by a hydrologic divide.
AL-1018	01/01/2016	<0.5	<0.1	<0.1	<25	0.1	<0.15	0.55	<0.1	**3870**	NA	16.2	<0.5	<0.5	<0.5	**206**	3.4	<0.1	150	6	No	Invalid dataset; pH or turbidity issues
AL102	04/29/2015	<0.5	<0.5	<0.2	9.5	<0.08	**1.4**	2.6	<0.5	<50	NA	<0.5	<0.5	0.79	<0.5	116	<2	<0.1	109	9	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, along a hydrologic divide.
AL-1020	01/01/2016	<0.5	0.17	<0.1	<25	<0.08	0.15	0.58	<0.1	405	NA	5.2	<0.5	<0.5	<0.5	**228**	<2	<0.1	145	5.9	No	South and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, separated by a hydrologic divide.
AL-1021	01/01/2016	<0.5	0.12	<0.1	<25	<0.08	0.58	0.81	<0.1	<50	NA	<0.5	<0.5	<0.5	<0.5	**204**	<2	<0.1	111	3.6	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, separated by a hydrologic divide.
AL-1022	01/01/2016	<0.5	1.4	<0.1	<25	<0.08	0.067	<0.5	<0.1	<50	NA	<0.5	2	<0.5	<0.5	96.7	6.4	<0.1	112	**16.3**	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, separated by a hydrologic divide.
AL-1023	01/01/2016	<0.5	<0.1	<0.1	<25	<0.08	0.71	0.99	<0.1	<50	NA	1.6	<0.5	<0.5	<0.5	134	<2	<0.1	92	4.5	No	All COIs are below comparative criteria
AL-1024	01/01/2016	<0.5	1.8	<0.1	<25	<0.08	0.23	0.75	<0.1	69.8	NA	3	2.9	<0.5	0.77	**297**	4.9	<0.1	145	14.8	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, separated by a hydrologic divide.
AL-1025	01/01/2016	<0.5	0.24	<0.1	<25	<0.08	**2.2**	3.7	<0.1	<50	NA	0.57	0.82	<0.5	<0.5	139	1.2	<0.1	110	10.3	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, separated by a hydrologic divide.
AL-1026	01/01/2016	<0.5	0.67	<0.1	<25	<0.08	0.45	0.83	<0.1	119	NA	3	1.4	<0.5	0.56	122	3	<0.1	83	11	No	All COIs are below comparative criteria
AL-1027	01/01/2016	<0.5	0.16	<0.1	<25	<0.08	0.11	<0.5	<0.1	<50	NA	<0.5	0.78	<0.5	<0.5	136	4.5	<0.1	123	11.9	No	All COIs are below comparative criteria
AL103	02/25/2015	0.078	<1	<1	<500	0.22	<10	7.2	0.74	**2700**	NA	3.6	0.7	3.6	<1	110	<1	<1	120	9.1	No	Invalid dataset; pH or turbidity issues
AL11	03/17/2015	<3	<10	<1	<100	<1	<20	2.28	<5	<50	NA	<10	<10	<10	<10	135	<10	<1	104	4.35	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, along a hydrologic divide.
AL11	05/08/2015	<0.5	<0.5	<0.2	<5	<0.08	**1.6**	2.6	<0.5	<50	NA	<0.5	<0.5	0.64	<0.5	153	2.2	<0.1	118	5.2		
AL110	05/18/2015	<0.5	<0.5	<0.2	<5	<0.08	**1.7**	2.1	<0.5	<50	NA	<0.5	1	<0.5	<0.5	110	2	<0.1	110	11.3	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles.
AL111	02/19/2015	0.1	<1	<1	43	0.067	<10	0.8	0.068	<50	NA	2	<2	0.7	<1	110	0.6	0.063	140	9.5	No	South and sidegradient of the Site. Chromium (VI) is not a COI associated with the Allen source areas.
AL111	07/30/2015	<0.5	<0.5	<0.2	<5	<0.08	**1.1**	1.3	<0.5	<50	NA	1.2	<0.5	0.56	<0.5	120	2.8	<0.1	109	10.4		
AL112	04/28/2015	<0.5	1.2	<0.2	9.2	<0.08	0.05	<0.5	<0.5	<50	NA	0.65	2.9	<0.5	0.71	**187**	6.5	<0.1	144	4	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, separated by a hydrologic divide.
AL113	04/28/2015	<0.5	<0.5	<0.2	<5	<0.08	**2**	2.8	<0.5	<50	NA	0.66	0.64	<0.5	<0.5	169	2.2	<0.1	108	11.4	No	West and upgradient of the ash basins. Chromium (VI) is not a COI associated with the Allen source areas.
AL114	04/28/2015	<0.5	<0.5	<0.2	<5	<0.08	**2.2**	2.7	<0.5	<50	NA	0.97	0.64	<0.5	<0.5	162	2.3	<0.1	128	10.5	No	West and upgradient of the ash basins. Chromium (VI) is not a COI associated with the Allen source areas.
AL115	04/28/2015	<0.5	0.82	<0.2	38.8	<0.08	0.16	0.63	<0.5	238	NA	23.9	2.7	0.89	<0.5	**3400**	**373**	<0.1	**675**	5.3	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, separated by a hydrologic divide.
AL117	03/23/2015	0.089	<1	<1	120	<1	<10	1.4	0.11	200	NA	3.5	1.1	1.6	1	**440**	34	<1	270	5.1	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, separated by a hydrologic divide.
AL117	07/31/2015	<0.5	<0.5	<0.2	42	<0.08	0.15	0.95	<0.5	118	NA	2.6	0.68	1.2	1.8	**463**	38.3	<0.1	254	5.4		
AL118	02/10/2015	<1	<5	<1	<100	<0.1	<10	2	<1	<50	NA	<5	<5	<5	<5	**230**	1.09	<0.1	106	6	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, along a hydrologic divide.
AL118	08/03/2015	<0.5	<0.5	<0.2	<5	<0.08	**2.3**	2.8	<0.5	<50	NA	<0.5	<0.5	1.1	<0.5	**183**	<2	<0.1	107	10.6		
AL119	04/27/2015	<0.5	1.2	<0.2	7.4	<0.08	0.056	1.3	<0.5	144	NA	6.6	3.4	0.81	<0.5	129	5.6	<0.1	114	3.1	No	All COIs are below comparative criteria
AL12	04/27/2015	<0.5	<0.5	<0.2	<5	<0.08	**1.5**	1.7	<0.5	<50	NA	0.8	<0.5	<0.5	<0.5	**286**	4.5	<0.1	146	2.4	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, along a hydrologic divide.
AL120	04/29/2015	<0.5	1.1	<0.2	15.8	<0.08	<0.03	<0.5	<0.5	<50	NA	8.9	3.6	<0.5	<0.5	162	11.2	<0.1	128	<1	No	All COIs are below comparative criteria
AL121	05/19/2015	<0.5	<0.5	<0.2	<5	<0.08	**1.7**	2	<0.5	<50	NA	1	<0.5	<0.5	<0.5	67.1	<2	<0.1	73	13.1	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, separated by a hydrologic divide.
AL122	05/19/2015	<0.5	<0.5	<0.2	<5	<0.08	0.25	1.6	0.66	**4300**	NA	23.1	<0.5	2.7	<0.5	**285**	<2	<0.1	129	8.4	No	Invalid dataset; pH or turbidity issues
AL122	08/14/2015	<0.5	<0.5	<0.2	<5	<0.08	0.21	1.1	0.56	**2100**	NA	17.3	<0.5	2	<0.5	**248**	<2	<0.1	117	6.3		
AL123	05/15/2015	<0.5	<0.5	<0.2	<5	<0.08	**2**	2.2	<0.5	<50	NA	0.74	<0.5	1.1	<0.5	173	<2	<0.1	160	7.6	No	All COIs are below comparative criteria
AL124	05/21/2015	<0.5	<0.5	<0.2	<5	<0.08	**1**	1.1	<0.5	<50	NA	<0.5	0.56	<0.5	<0.5	**198**	2.6	<0.1	133	9.3	No	South and sidegradient of the Site. Chromium (VI) is not a COI associated with the Allen source areas. Strontium value is less than the bedrock flow zone background range.
AL125	05/18/2015	<0.5	3.6	<0.2	5.6	<0.08	<0.03	<0.5	<0.5	<50	NA	6.7	7	<0.5	<0.5	111	6.9	<0.1	97	<1	No	All COIs are below comparative criteria
AL126	05/28/2015	<0.5	<0.5	<0.2	<5	<0.08	**4.2**	4.4	<0.5	<50	NA	<0.5	<0.5	<0.5	<0.5	118	2.1	<0.1	103	12	No	South and sidegradient of the Site. Chromium (VI) is not a COI associated with the Allen source areas.
AL127	05/19/2015	<0.5	<0.5	<0.2	<5	<0.08	**4.4**	5	<0.5	<50	NA	<0.5	<0.5	<0.5	<0.5	130	<2	<0.1	109	10.6	No	South and sidegradient of the Site. Chromium (VI) is not a COI associated with the Allen source areas.
AL129	05/20/2015	<0.5	<0.5	<0.2	<5	<0.08	0.41	0.63	<0.5	<50	NA	0.87	<0.5	<0.5	<0.5	**225**	2.8	<0.1	182	6.8	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, separated by a hydrologic divide.

TABLE 6-9
WATER SUPPLY WELL ANALYTICAL RESULTS SUMMARY
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELMONT, NC

	Analytical Parameter	Antimony	Arsenic	Beryllium	Boron	Cadmium	Chromium (VI)	Chromium	Cobalt	Iron	Lithium	Manganese	Molybdenum	Nickel	Selenium	Strontium	Sulfate	Thallium	Total Dissolved Solids	Vanadium	Impacted by Coal Ash?	Comments
	Reporting Units	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	µg/L	mg/L	µg/L		
	15A NCAC 02L Standard	1*	10	4*	700	2	NE	10	1*	300	NE	50	NE	100	20	NE	250	0.2*	500	0.3*		
	Background Threshold Values (Bedrock Unit)[1]	0.5	1.6	0.1	50	0.08	0.23	5.6	0.3	284	NE	278	8.9	3.4	0.5	154	2.9	0.1	165	15.9		
	Background Threshold Values (Bedrock Unit)[2]	2.6	1.6	0.1	50	0.08	0.765	10.19	0.3	1,242	26.3	360	11	6.944	0.5	181	7.3	0.1	221	12.5		
	Background Data Set Range (Bedrock Unit)[2]	0.27 j - 3.9	0.24 - 1.6	0.01 j - <0.1	35.6 j - <50	<0.08	<0.025 - 0.66	0.33 j - 8.9	0.021 j - 0.31	40.7 j - 715	0.9 j - 26.3	2.8 j - 278	1.7 - 10.5	0.22 j - 5.8	0.17 j - <0.5	97.7 - 223	1.8 - 33.3	0.02 j - <0.1	104 - 222	7.5 - 15.9		
Sample ID	Sample Collection Date	Analytical Results																				
AL130	05/21/2015	<0.5	<0.5	<0.2	<5	<0.08	2.4	2.4	<0.5	<50	NA	1.1	<0.5	<0.5	<0.5	106	<2	<0.1	110	7.9	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, separated by a hydrologic divide.
AL131	05/28/2015	<0.5	<0.5	<0.2	<5	<0.08	0.78	1.1	<0.5	<50	NA	<0.5	<0.5	<0.5	<0.5	59.5	<2	<0.1	75	7.9	No	North and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, separated by a hydrologic divide.
AL132	07/30/2015	<0.5	<0.5	<0.2	<5	<0.08	0.93	0.98	<0.5	<50	NA	<0.5	<0.5	<0.5	<0.5	234	2.1	<0.1	133	7.8	No	South and sidegradient of the Site. Chromium (VI) is not a COI associated with the Allen source areas. Strontium value is slightly greater than the bedrock flow zone background range, but is less than the shallow and deep flow zone background range.
AL133	05/28/2015	<0.5	<0.5	<0.2	<5	<0.08	0.72	0.95	<0.5	273	NA	5.2	<0.5	<0.5	<0.5	89.9	<2	<0.1	99	7.4	No	All COIs are below comparative criteria
AL135	08/27/2015	<0.5	<0.5	<0.2	<5	<0.08	2.1	2.4	<0.5	88.6	NA	3	<0.5	<0.5	<0.5	180	2.1	<0.1	107	7	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, separated by a hydrologic divide.
AL136	05/18/2015	<0.5	<0.5	<0.2	<5	<0.08	2.8	3.3	<0.5	52.8	NA	0.82	<0.5	0.57	<0.5	378	2.1	<0.1	233	4.5	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, along a hydrologic divide.
AL137	07/28/2015	<0.5	<0.5	<0.2	<5	<0.08	0.33	<0.5	<0.5	<50	NA	<0.5	<0.5	<0.5	<0.5	155	4.6	<0.1	101	6.5	No	All COIs are below comparative criteria
AL138	08/05/2015	<0.5	<0.5	<0.2	<5	<0.08	1.2	1.4	<0.5	<50	NA	<0.5	<0.5	<0.5	<0.5	215	<2	<0.1	160	6.4	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, separated by a hydrologic divide.
AL139	07/28/2015	<0.5	<0.5	<0.2	<5	<0.08	0.64	0.81	<0.5	<50	NA	4.1	<0.5	<0.5	<0.5	81.4	2.7	<0.1	81	5.4	No	All COIs are below comparative criteria
AL14	02/10/2015	<1	<5	<1	<100	<0.1	5	4	<1	<50	NA	<5	<5	<5	<5	360	6.92	<0.1	214	2	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, along a hydrologic divide.
AL140	07/28/2015	<0.5	<0.5	<0.2	<5	<0.08	2.4	2.5	<0.5	58.4	NA	2	<0.5	<0.5	<0.5	189	2.8	<0.1	151	4.7	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, along a hydrologic divide.
AL141	07/28/2015	<0.5	<0.5	<0.2	<5	0.092	4.4	3.9	<0.5	<50	NA	1.8	<0.5	0.58	<0.5	104	<2	<0.1	98	12.8	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, along a hydrologic divide.
AL142	08/27/2015	<0.5	<0.5	<0.2	<5	<0.08	0.079	0.89	<0.5	958	NA	21.3	<0.5	0.71	<0.5	125	<2	<0.1	105	4.9	No	All COIs are below comparative criteria
AL15	03/02/2015	<3	<10	<1	<100	<1	<20	<10	<5	14.5	NA	<10	<10	<10	<10	222	<10	<1	138	3.68	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, along a hydrologic divide.
AL15	05/19/2015	<0.5	<0.5	<0.2	10.9	<0.08	1.8	2	<0.5	<50	NA	1.8	<0.5	<0.5	<0.5	227	4.6	<0.1	156	4.8		
AL16	02/10/2015	<1	<5	<1	<100	<0.1	<10	2	<1	510	NA	9	<5	<5	<5	150	<1	<0.1	96	3	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, along a hydrologic divide.
AL16	07/29/2015	<0.5	<0.5	<0.2	<5	<0.08	1.8	1.7	<0.5	<50	NA	0.87	<0.5	<0.5	<0.5	128	<2	<0.1	116	4.2		
AL17	02/16/2015	<3	<10	<1	<100	<1	<20	<10	<5	57.7	NA	1.37	<10	<10	<10	160	<10	<1	106	5.58	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles.
AL17	05/11/2015	<0.5	<0.5	<0.2	<5	<0.08	1.1	1.4	<0.5	59.3	NA	1.7	<0.5	<0.5	<0.5	168	2.1	<0.1	130	7.8		
AL19	03/02/2015	<3	<10	<1	<100	<1	<20	<10	<5	19.4	NA	<10	<10	<10	<10	228	<10	<1	155	3.84	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles.
AL19	05/12/2015	<0.5	<0.5	<0.2	<5	<0.08	2.6	2.7	<0.5	<50	NA	1.1	<0.5	<0.5	<0.5	233	<2	<0.1	157	4.5		
AL2	04/29/2015	<0.5	0.64	<0.2	6.6	<0.08	1	1.5	<0.5	<50	NA	0.92	1.2	<0.5	0.66	142	3	<0.1	114	9.9	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, separated by a hydrologic divide.
AL20	02/16/2015	<3	<10	<1	<100	<1	<20	<10	<5	<50	NA	<10	<10	<10	<10	165	<10	<1	84	10.3	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles.
AL20	05/19/2015	<0.5	<0.5	<0.2	<5	<0.08	1.4	1.6	<0.5	<50	NA	<0.5	<0.5	<0.5	<0.5	160	2.1	<0.1	134	12		
AL-2000-RAW	10/18/2017	<0.5	0.17	<0.1	49	<0.08	0.029	2.3	<0.1	<50	NA	<0.5	2.2	<0.5	0.79	2.4	105	<0.1	263	<0.3	No	All COIs are below comparative criteria
AL-2001-RAW	10/17/2017	<0.5	0.46	<0.1	<25	0.13	0.2	0.98	<0.1	<50	NA	0.65	1	<0.5	<0.5	207	1.5	<0.1	137	6.4	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, separated by a hydrologic divide.
AL-2001-RAW	12/04/2017	<0.5	0.74	<0.1	<5	<0.08	0.2	<0.5	<0.1	<50	NA	0.93	1.3	<0.5	<0.5	225	2.6	<0.1	141	6		
AL-2003-RAW	10/17/2017	<0.5	0.1	<0.1	<25	0.11	1.6	1.7	<0.1	<50	NA	0.54	<0.5	<0.5	<0.5	262	1.6	<0.1	90	9.7	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles.
AL-2003-RAW	12/19/2017	<0.5	<0.1	<0.1	<5	<0.08	1.5	1.7	<0.1	<50	NA	<0.5	<0.5	<0.5	<0.5	257	1.8	<0.1	161	9.4		
AL-2005-RAW	11/02/2017	<0.5	1.3	0.25	<25	<0.08	1.3	1.7	<0.1	<50	NA	1.6	4.2	<0.5	0.68	114	3.2	<0.1	102	3.5	No	South and sidegradient of the Site. Chromium (VI) is not a COI associated with the Allen source areas.
AL-2007-RAW	11/02/2017	<0.5	0.22	<0.1	<25	0.19	6.8	6.9	<0.1	<50	NA	<0.5	<0.5	<0.5	<0.5	74.9	<1	<0.1	91	7.9	No	South and sidegradient of the Site. Chromium (VI) is not a COI associated with the Allen source areas.
AL-2008-RAW	11/02/2017	<0.5	0.25	0.14	<25	<0.08	1.7	2.1	<0.1	<50	NA	<0.5	<0.5	<0.5	<0.5	120	<1	<0.1	109	11	No	South and sidegradient of the Site. Chromium (VI) is not a COI associated with the Allen source areas.
AL-2010-RAW	10/18/2017	<0.5	0.11	<0.1	<25	<0.08	1.1	2.5	<0.1	<50	NA	<0.5	<0.5	1.2	<0.5	173	1.1	<0.1	121	11.9	No	South and sidegradient of the Site. Chromium (VI) is not a COI associated with the Allen source areas.
AL-2012-RAW	10/17/2017	<0.5	0.16	<0.1	<25	<0.08	1.7	2.5	<0.1	131	NA	5.8	0.52	0.76	<0.5	87.8	<1	<0.1	135	9.5	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, separated by a hydrologic divide.
AL-2012-RAW	12/19/2017	<0.5	0.18	<0.1	<5	<0.08	1.8	2.1	<0.1	<50	NA	2.4	0.53	<0.5	<0.5	89.3	<1	<0.1	91	9.1		
AL-2013-RAW	10/18/2017	<0.5	0.15	<0.1	<25	<0.08	0.59	0.76	<0.1	<50	NA	1.1	<0.5	<0.5	<0.5	150	1.5	<0.1	109	10.5	No	All COIs are below comparative criteria
AL-2013-RAW	12/20/2017	<0.5	0.14	<0.1	<5	<0.08	0.66	0.84	<0.1	<50	NA	<0.5	<0.5	<0.5	<0.5	144	1.9	<0.1	112	10.4		
AL21	02/16/2015	<3	<10	<1	<100	<1	<20	<10	<5	<50	NA	<10	<10	<10	<10	152	<10	<1	84	11.7	No	All COIs are below comparative criteria
AL21	05/12/2015	<0.5	<0.5	<0.2	<5	<0.08	0.74	0.92	<0.5	<50	NA	<0.5	<0.5	<0.5	<0.5	158	2.2	<0.1	119	12.6		
AL22	05/21/2015	<0.5	<0.5	<0.2	<5	<0.08	0.39	0.58	<0.5	<50	NA	<0.5	2.2	<0.5	<0.5	109	3.2	<0.1	133	8.9	No	All COIs are below comparative criteria
AL23	02/03/2015	<1	<1	<0.4	<25	<0.1	<20	<5	0.79	310	NA	1.4	0.57	1.5	<1	100	0.64	<0.5	57	13	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles.
AL23	05/14/2015	<0.5	<0.5	<0.2	<5	<0.08	1.1	1.5	<0.5	<50	NA	1.1	0.54	0.51	<0.5	110	2.2	<0.1	94	13.4		
AL24	02/11/2015	<1	<5	<1	<100	<0.1	<10	<1	<1	<50	NA	<5	2	<5	<5	82	1.86	<0.1	99	12	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles.
AL24	08/03/2015	<0.5	<0.5	<0.2	<5	<0.08	0.77	0.89	<0.5	<50	NA	<0.5	2.5	<0.5	<0.5	80.7	3.8	<0.1	107	12.5		
AL25	02/25/2015	0.081	<1	<1	<500	<1	<10	1.4	<1	<50	NA	0.63	0.14	0.24	<1	230	<1	<1	140	4.3	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles.
AL25	07/30/2015	<0.5	<0.5	<0.2	<5	<0.08	2.3	2.7	<0.5	<50	NA	<0.5	<0.5	0.53	<0.5	240	<2	<0.1	143	5.3		
AL26	02/16/2015	<3	<10	<1	<100	<1	<20	<10	<5	15.6	NA	<10	<10	<10	<10	178	<10	<1	102	6.08	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles.
AL26	05/13/2015	<0.5	<0.5	<0.2	<5	<0.08	0.55	0.79	<0.5	<50	NA	0.68	<0.5	<0.5	<0.5	187	2.5	<0.1	147	7.6		
AL27	02/11/2015	<1	<5	<1	<100	<0.1	<10	2	<1	<50	NA	<5	<5	<5	<5	230	<1	<0.1	144	4	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles.
AL27	08/17/2015	<0.5	<0.5	<0.2	<5	<0.08	1.8	2	<0.5	<50	NA	1.2	<0.5	0.53	<0.5	221	<2	<0.1	166	4.2		
AL28	02/18/2015	<0.4	0.18	<0.11	<20	<0.06	2.05	2.05	<0.03	<25	NA	<0.84	0.95	0.2	<0.16	75	<5	<0.06	152	13	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles.
AL29	02/25/2015	0.072	<1	<1	<500	<1	<10	2.3	<1	<50	NA	0.64	0.32	0.55	<1	72	<1	<1	92	8.3	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles.
AL29	07/29/2015	<0.5	<0.5	<0.2	<5	<0.08	2.2	2.1	<0.5	<50	NA	0.65	<0.5	<0.5	<0.5	86.4	<2	<0.1	100	6.8		
AL3	03/04/2015	0.2	<1	<1	49	<1	<10	1.1	0.099	100	NA	5.2	0.36	0.33	<1	74	0.15	<1	70	6.8	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, separated by a hydrologic divide.
AL3	07/29/2015	<0.5	<0.5	<0.2	7.1	<0.08	1.9	1.9	<0.5	<50	NA	0.54	<0.5	<0.5	<0.5	80.2	<2	<0.1	83	7.7		
AL30	02/16/2015	<3	<10	<1	<100	<1	<20	2.41	<5	<50	NA	<10	<10	<10	<10	210	<10	<1	113	5.07	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles.
AL30	05/15/2015	<0.5	<0.5	<0.2	<5	<0.08	3.5	3.6	<0.5	<50	NA	<0.5	<0.5	<0.5	<0.5	220	<2	<0.1	122	5.8		
AL31	04/09/2015	1.16	<0.08	<0.11	43	<0.06	<5	2.47	<0.02	92.8	NA	2.59	<0.11	0.5	0.22	89	<5	<0.06	88.6	22.6	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles.
AL31	08/13/2015	<0.5	<0.5	<0.2	<5	<0.08	1.7	2	<0.5	<50	NA	1.1	<0.5	<0.5	<0.5	90	<2	<0.1	70	2.9		
AL32	07/29/2015	<0.5	<0.5	<0.2	<5	<0.08	2.7	2.4	<0.5	<50	NA	1.1	<0.5	<0.5	<0.5	157	<2	<0.1	100	2.7	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles.
AL33	02/16/2015	<3	<10	<1	<100	<1	<20	<10	<5	<50	NA	<10	<10	<10	<10	119	<10	<1	52	5.38	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles.
AL33	05/15/2015	<0.5	<0.5	<0.2	<5	<0.08	4.1	4.2	<0.5	<50	NA	<0.5	<0.5	0.53	<0.5	127	<2	<0.1	116	6.4	No	
AL34	02/16/2015	<3	<10	<1	<100	<1	<20	<10	<5	<50	NA	<10	<10	<10	<10	139	<10	<1	82	8.43	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles.
AL34	05/14/2015	<0.5	<0.5	<0.2	<5	<0.08	2.3	2.6	<0.5	<50	NA	<0.5	<0.5	<0.5	<0.5	146	2.2	<0.1	108	10.1		
AL39 WELL A	02/17/2015	<0.5	<0.08	<0.11	<20	<0.06	<1.5	2.18	<0.03	<15	NA	<0.84	3.67	0.46	<0.16	134	5	<0.06	112	3.54	No	West and upgradient of the Site. Chromium (VI) is not a COI associated with the Allen source areas.
AL39 WELL A	07/30/2015	<0.5	<0.5	<0.2	<5	<0.08	0.78	0.84	<0.5	<50	NA	<0.5	<0.5	<0.5	<0.5	103	<2	<0.1	77	2.9		
AL39 WELL B	02/17/2015	<0.4	0.92	<0.11	<20	<0.06	<1.5	1.08	<0.04	<15	NA	<0.43	0.16	0.26	1.81	115	<5	<0.06	212	13.1	No	All COIs are below comparative criteria
AL39 WELL B	07/30/2015	<0.5	0.86	<0.2	<5	<0.08	0.18	0.85	<0.5	271	NA	8.9	3.7	<0.5	1.6	124	6.5	<0.1	139	12.7		
AL40	02/17/2015	0.42	<0.08	<0.11	<20	<0.06	<1.5	0.6	<0.03	15.3	NA	1.36	0.34	0.19	<0.16	71	<5	<0.06	87	3.15	No	All COIs are below comparative criteria
AL40	08/03/2015	<0.5	<0.5	<0.2	<5	<0.08	0.19	1.1	<0.5	<50	NA	1.3	<0.5	<0.5	<0.5	68.5	<2	<0.1	64	3.4		
AL41	05/21/2015	<0.5	<0.5	<0.2	<5	<0.08	0.12	<0.5	<0.5	<50	NA	<0.5	0.69	<0.5	<0.5	47.2	<2	<0.1	49	3.5	No	All COIs are below comparative criteria
AL42	02/03/2015	0.14	<1	0.04	<25	<0.1	<20	<5	0.085	200	NA	0.58	0.21	0.66	<1	80	0.34	<0.5	56	2.9	No	All COIs are below comparative criteria
AL42	05/15/2015	<0.5	<0.5	<0.2	<5	<0.08	0.72	0.89	<0.5	<50	NA	<0.5	<0.5	<0.5	<0.5	80.3	<2	<0.1	62	3.6		
AL44	04/24/2015	<0.5	<0.5	<0.2	26.9	<0.08	0.17	<0.5	1.4	<50	NA	9.2	<0.5	1.1	<0.5	31.8	<2	<0.1	63	<1	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, along a hydrologic divide.
AL45	02/03/2015	0.31	<1	0.064	<25	<0.1	<20	0.74	0.089	1400	NA	4.1	0.39	0.77	<1	80	<1	<0.5	61	8.2	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, along a hydrologic divide.
AL45	05/15/2015	<0.5	<0.5	<0.2	<5	<0.08	0.69	0.89	<0.5	<50	NA	0.6	<0.5	<0.5	<0.5	77	<2	<0.1	74	5.3		
AL47	02/11/2015	<1	<5	<1	<100	<0.1	<10	2	<1	<50	NA	<5	<5	<5	<5	240	1.02	<0.1	167	4	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, along a hydrologic divide.
AL47	10/22/2015	<0.5	<0.5	<0.2	<5	<0.08	2.2	2.6	<0.5	70.9	NA	2.6	<0.5	<0.5	<0.5	276	<2	<0.1	229	3.6		
AL48	02/20/2015	0.064	0.5	<1	68	0.063	<10	7.5	<1	4000	NA	4.7	0.14	<2	<1	160	1.8	0.08	100	16	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, along a hydrologic divide.
AL48	08/17/2015	<0.5	<0.5	<0.2	<5	<0.08	3.8	4.4	<0.5	<50	NA	2.5	<0.5	<0.5	<0.5	158	4	<0.1	109	6.1		

TABLE 6-9
WATER SUPPLY WELL ANALYTICAL RESULTS SUMMARY
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELMONT, NC

Analytical Parameter		Antimony	Arsenic	Beryllium	Boron	Cadmium	Chromium (VI)	Chromium	Cobalt	Iron	Lithium	Manganese	Molybdenum	Nickel	Selenium	Strontium	Sulfate	Thallium	Total Dissolved	Vanadium	Impacted by Coal Ash?	Comments
Reporting Units		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	µg/L	mg/L	µg/L		
15A NCAC 02L Standard		1*	10	4*	700	2	NE	10	1*	300	NE	50	NE	100	20	NE	250	0.2*	500	0.3*		
Background Threshold Values (Bedrock Unit)[1]		0.5	1.6	0.1	50	0.08	0.23	5.6	0.3	284	NE	278	8.9	3.4	0.5	154	2.9	0.1	165	15.9		
Background Threshold Values (Bedrock Unit)[2]		2.6	1.6	0.1	50	0.08	0.765	10.19	0.3	1,242	26.3	360	11	6.944	0.5	181	7.3	0.1	221	12.5		
Background Data Set Range (Bedrock Unit)[2]		0.27 j - 3.9	0.24 - 1.6	0.01 j - <0.1	35.6 j - <50	<0.08	<0.025 - 0.66	0.33 j - 8.9	0.021 j - 0.31	40.7 j - 715	0.9 j - 26.3	2.8 j - 278	1.7 - 10.5	0.22 j - 5.8	0.17 j - <0.5	97.7 - 223	1.8 - 33.3	0.02 j - <0.1	104 - 222	7.5 - 15.9		
Sample ID	Sample Collection Date	Analytical Results																				
AL49	04/23/2015	<0.5	<0.5	<0.2	<5	<0.08	0.9	1.2	<0.5	<50	NA	0.91	<0.5	<0.5	<0.5	141	2.6	<0.1	117	12.6	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, along a hydrologic divide.
AL5	02/10/2015	<1	<5	<1	<100	<0.1	4	3	<1	75	NA	<5	2	<5	<5	110	1.11	<0.1	88	14	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, along a hydrologic divide.
AL50 WELL A	04/29/2015	<0.5	1.5	<0.2	7	<0.08	0.21	<0.5	<0.5	<50	NA	<0.5	4.3	<0.5	0.66	91.4	5.9	<0.1	125	5.5	No	All COIs are below comparative criteria
AL50 WELL B	04/29/2015	<0.5	<0.5	<0.2	5.8	<0.08	0.24	<0.5	<0.5	<50	NA	<0.5	<0.5	<0.5	<0.5	62.9	<2	<0.1	78	6.7	No	All COIs are below comparative criteria
AL50 WELL C	04/29/2015	<0.5	<0.5	<0.2	102	<0.08	1.1	1.8	<0.5	<50	NA	<0.5	<0.5	1	<0.5	133	4.9	<0.1	96	3.7	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, along a hydrologic divide.
AL50 WELL C	06/11/2015	<0.5	<0.5	<0.2	18.6	<0.08	<0.03	<0.5	<0.5	<50	NA	<0.5	<0.5	<0.5	<0.5	<0.5	NA	<0.1	NA	<1		
AL51	02/03/2015	<1	<1	<0.4	<25	<0.1	<20	<5	0.21	1200	NA	0.88	<10	2.1	0.31	300	<1	<0.5	160	2	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, along a hydrologic divide.
AL51	05/14/2015	<0.5	<0.5	<0.2	<5	<0.08	0.43	0.76	<0.5	<50	NA	0.58	<0.5	<0.5	<0.5	346	2	<0.1	178	2.4		
AL52	02/20/2015	0.053	<1	<1	62	<1	<10	0.35	<1	<50	NA	0.76	<2	0.46	<1	240	<1	<1	130	3.2	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, along a hydrologic divide.
AL52	07/29/2015	<0.5	<0.5	<0.2	<5	<0.08	0.12	0.71	<0.5	<50	NA	0.73	<0.5	<0.5	<0.5	232	<2	<0.1	158	3.4		
AL53	02/17/2015	<0.4	0.12	<0.11	<20	<0.06	2.9	4.06	<0.03	<15	NA	<0.84	<0.11	0.58	<0.16	142	<5	<0.06	75	4.3	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, along a hydrologic divide.
AL54	02/03/2015	<1	<1	<0.4	<25	<0.1	<20	1.5	0.24	580	NA	3.9	<10	2.2	<1	240	2.8	<0.5	130	3	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, along a hydrologic divide.
AL54	05/15/2015	<0.5	<0.5	<0.2	<5	<0.08	2.9	3.2	<0.5	<50	NA	1.3	<0.5	<0.5	<0.5	251	3.8	<0.1	145	4.4		
AL55	02/03/2015	0.25	0.44	<0.4	<25	<0.1	8.4	0.65	0.21	330	NA	1.4	0.27	1.2	<1	140	1	<0.5	97	6.8	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, along a hydrologic divide.
AL55	10/22/2015	<0.5	<0.5	<0.2	<5	<0.08	1.5	2	<0.5	<50	NA	<0.5	<0.5	<0.5	<0.5	131	2.5	<0.1	125	7.5		
AL56	02/25/2015	0.12	<1	<1	66	<1	<10	4.5	0.26	920	NA	9.9	0.24	1.7	<1	230	<1	0.057	140	7.6	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, along a hydrologic divide.
AL56	08/13/2015	<0.5	<0.5	<0.2	<5	<0.08	<0.03	2	2.1	7160	NA	361	0.51	2.8	<0.5	182	2.6	<0.1	133	3.5		
AL57	07/28/2015	<0.5	<0.5	<0.2	<5	<0.08	1	1.2	<0.5	<50	NA	1.3	<0.5	<0.5	<0.5	205	<2	<0.1	123	8.3	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, along a hydrologic divide.
AL58	02/03/2015	0.1	0.59	<0.4	<25	<0.1	<20	<5	0.22	690	NA	3.2	0.49	2	<1	200	2.8	<0.5	120	10	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, along a hydrologic divide.
AL58	05/15/2015	<0.5	0.82	<0.2	6.6	<0.08	0.24	0.63	<0.5	<50	NA	4.4	<0.5	<0.5	<0.5	203	4.3	<0.1	137	12.2		
AL59	04/23/2015	<0.5	<0.5	<0.2	<5	<0.08	2.3	2.5	<0.5	<50	NA	0.78	<0.5	<0.5	<0.5	167	<2	0.24	107	19.1	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles.
AL59	06/03/2015	<0.5	<0.5	<0.2	<5	<0.08	2.4	3	<0.5	<50	NA	1.9	<0.5	<0.5	<0.5	183	<2	<0.1	99	17.1		
AL6	02/16/2015	<3	<10	<1	<100	<1	<20	<10	<5	<50	NA	<10	<10	<10	<10	90.2	<10	<1	81	4.49	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, along a hydrologic divide.
AL6	05/13/2015	<0.5	<0.5	<0.2	<5	<0.08	3.2	3.5	<0.5	60.8	NA	<0.5	<0.5	<0.5	<0.5	94	2.1	<0.1	86	6.4		
AL60	04/27/2015	<0.5	<0.5	<0.2	<5	<0.08	5.3	5.8	<0.5	56.9	NA	8.6	<0.5	0.96	<0.5	317	<2	<0.1	197	9	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles.
AL61	07/28/2015	<0.5	<0.5	<0.2	<5	<0.08	4.6	4.8	<0.5	<50	NA	0.57	<0.5	<0.5	<0.5	208	3.3	<0.1	148	13.6	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles.
AL62	02/17/2015	<0.4	0.12	<0.11	<20	<0.06	2.26	2.84	<0.03	<15	NA	<0.84	0.45	0.42	<0.16	205	<5	<0.06	108	11.2	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles.
AL63	02/17/2015	<0.5	<0.08	<0.11	<20	<0.06	1.94	3.31	0.05	435	NA	2.74	0.27	0.81	0.25	274	6	<0.06	204	7.02	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles.
AL64	04/23/2015	<0.5	<0.5	<0.2	<5	<0.08	4.3	4.4	<0.5	<50	NA	1.6	<0.5	2.6	<0.5	424	<2	<0.1	233	2.8	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles.
AL65	04/24/2015	<0.5	<0.5	<0.2	<5	<0.08	0.25	<0.5	<0.5	<50	NA	<0.5	1.1	<0.5	0.52	180	3.2	<0.1	165	6	No	All COIs are below comparative criteria
AL66	04/24/2015	<0.5	<0.5	<0.2	<5	<0.08	0.38	0.5	<0.5	<50	NA	3.9	<0.5	1.2	<0.5	306	<2	<0.1	160	5.3	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles.
AL67	02/25/2015	0.12	0.31	<1	47	<1	<10	0.72	<1	47	NA	2.1	1	0.72	<1	150	0.59	<1	150	12	No	All COIs are below comparative criteria
AL67	07/29/2015	<0.5	<0.5	<0.2	5.3	<0.08	0.62	0.89	<0.5	<50	NA	0.66	1.2	<0.5	<0.5	132	3.3	<0.1	159	13.3		
AL68	08/03/2015	<0.5	<0.5	<0.2	<5	<0.08	1.8	2.8	<0.5	85.9	NA	2.8	0.63	<0.5	<0.5	182	2.7	<0.1	160	15.4	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles.
AL69	04/27/2015	<0.5	<0.5	<0.2	<5	<0.08	1.2	1.8	<0.5	75.8	NA	1.9	<0.5	<0.5	<0.5	219	<2	<0.1	141	8.4	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles.
AL7	05/19/2015	<0.5	<0.5	<0.2	<5	<0.08	0.97	1.2	<0.5	<50	NA	<0.5	<0.5	<0.5	<0.5	180	<2	<0.1	119	10.9	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles.
AL70	03/17/2015	<3	<10	<1	<100	<1	<20	1.8	<5	33.4	NA	<10	<10	<10	<10	240	<10	<1	158	8.09	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles.
AL70	05/15/2015	<0.5	<0.5	<0.2	<5	<0.08	1.6	1.8	<0.5	<50	NA	<0.5	<0.5	0.57	<0.5	265	2.7	<0.1	162	9.4		
AL71	05/22/2015	<0.5	<0.5	<0.2	<5	<0.08	1	1.5	<0.5	<50	NA	<0.5	<0.5	<0.5	<0.5	256	<2	<0.1	149	9.2	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles.
AL72	05/22/2015	<0.5	<0.5	<0.2	<5	<0.08	1.1	2.5	<0.5	<50	NA	7.7	<0.5	<0.5	<0.5	265	<2	<0.1	132	5.1	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles.
AL73	02/17/2015	<0.4	0.12	<0.11	<20	<0.06	<5	3.11	<0.03	55	NA	<0.84	<0.12	0.75	<0.16	188	<5	<0.06	61	9.6	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, along a hydrologic divide.
AL73	07/29/2015	<0.5	<0.5	<0.2	<5	<0.08	2.4	2.2	<0.5	<50	NA	0.72	<0.5	0.66	<0.5	181	<2	<0.1	133	9.3		
AL74	05/08/2015	<0.5	<0.5	<0.2	<5	<0.08	2	2.1	<0.5	<50	NA	2.2	<0.5	<0.5	<0.5	293	<2	<0.1	168	5.8	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, along a hydrologic divide.
AL75	02/25/2015	0.095	<1	<1	<500	<1	<10	1.2	<1	<50	NA	1	0.17	0.26	<1	86	<1	<1	110	14	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, along a hydrologic divide.
AL75	08/14/2015	<0.5	<0.5	<0.2	<5	<0.08	1.7	2.1	<0.5	<50	NA	1	<0.5	<0.5	<0.5	82	<2	<0.1	99	13.8		
AL76	02/17/2015	<0.4	0.13	<0.11	<20	<0.06	2.62	2.62	<0.03	<25	NA	1.5	<0.12	0.45	<0.16	109	<5	<0.06	87	8.34	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, along a hydrologic divide.
AL77	04/24/2015	<0.5	<0.5	<0.2	<5	<0.08	0.7	1	<0.5	<50	NA	0.54	<0.5	<0.5	<0.5	238	2.5	<0.1	157	8.6	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, along a hydrologic divide.
AL78	04/24/2015	<0.5	<0.5	<0.2	<5	<0.08	0.1	<0.5	<0.5	<50	NA	1	<0.5	<0.5	<0.5	86.1	<2	<0.1	70	2.1	No	All COIs are below comparative criteria
AL79	05/18/2015	<0.5	<0.5	<0.2	<5	<0.08	0.33	0.6	<0.5	54.9	NA	0.71	<0.5	<0.5	<0.5	157	2.1	<0.1	104	4.4	No	All COIs are below comparative criteria
AL8	03/23/2015	0.08	<1	<1	97	<1	<10	3	<1	<50	NA	<5	0.4	0.55	<1	240	<1	<1	130	8.1	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, along a hydrologic divide.
AL8	07/29/2015	<0.5	<0.5	<0.2	<5	<0.08	3.5	3.1	<0.5	<50	NA	25.9	<0.5	0.7	<0.5	237	<2	<0.1	132	8.5		
AL81	07/28/2015	<0.5	<0.5	<0.2	<5	<0.08	0.78	0.73	<0.5	<50	NA	6.5	<0.5	0.95	<0.5	228	<2	<0.1	137	2.2	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, along a hydrologic divide.
AL82	04/27/2015	<0.5	<0.5	<0.2	<5	<0.08	0.81	1.4	<0.5	<50	NA	1.7	<0.5	0.71	<0.5	392	2.1	<0.1	223	4.7	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, along a hydrologic divide.
AL83	05/21/2015	<0.5	<0.5	<0.2	<5	<0.08	3.5	3.5	<0.5	<50	NA	1.5	<0.5	1.3	<0.5	289	3.9	<0.1	228	9	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, along a hydrologic divide.
AL84	04/27/2015	<0.5	<0.5	<0.2	<5	<0.08	0.59	0.55	<0.5	59.8	NA	15.7	<0.5	<0.5	<0.5	185	<2	<0.1	134	8.2	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, along a hydrologic divide.
AL85	04/24/2015	<0.5	<0.5	<0.2	<5	<0.08	2.5	2.6	<0.5	<50	NA	<0.5	<0.5	<0.5	<0.5	69.2	<2	<0.1	67	9.6	No	South and sidegradient of the Site. Chromium (VI) is not a COI associated with the Allen source areas.
AL88	10/27/2015	<0.5	<0.5	<0.2	<5	<0.08	0.82	1.4	<0.5	136	NA	34.6	<0.5	0.62	<0.5	83.2	<2	<0.1	63	<1	No	South and sidegradient of the Site. Chromium (VI) is not a COI associated with the Allen source areas.
AL89	02/25/2015	0.14	0.31	<1	67	<1	<10	2.9	<1	<50	NA	0.72	0.39	0.44	<1	120	<1	0.1	140	11	No	South and sidegradient of the Site. Chromium (VI) is not a COI associated with the Allen source areas.
AL89	07/30/2015	<0.5	<0.5	<0.2	<5	<0.08	4	4	<0.5	<50	NA	<0.5	<0.5	<0.5	<0.5	113	<2	<0.1	75	12		
AL9	02/10/2015	<1	<5	<1	<100	<0.1	5	6	<1	<50	NA	<5	<5	<5	<5	300	1.22	<0.1	165	7	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, along a hydrologic divide.
AL90	02/11/2015	<1	<5	<1	<100	<0.1	<10	3	<1	2100	NA	6	<5	<5	<5	160	<1	<0.1	96	10	No	South and sidegradient of the Site. Chromium (VI) is not a COI associated with the Allen source areas.
AL90	07/30/2015	<0.5	<0.5	<0.2	<5	<0.08	1.9	2.4	<0.5	283	NA	8.4	<0.5	0.72	<0.5	142	<2	<0.1	101	5.5		
AL91	04/27/2015	<0.5	<0.5	<0.2	<5	<0.08	1.5	2.1	<0.5	67.6	NA	0.5	<0.5	<0.5	<0.5	127	2	<0.1	98	12.2	No	South and sidegradient of the Site. Chromium (VI) is not a COI associated with the Allen source areas.
AL92	02/12/2015	<1	<5	<1	<100	<0.1	<10	<1	<1	<50	NA	<5	<5	<5	<5	110	<1	<0.1	65	5	No	All COIs are below comparative criteria
AL92	08/03/2015	<0.5	<0.5	<0.2	<5	<0.08	0.46	1.2	<0.5	<50	NA	0.5	<0.5	<0.5	<0.5	125	<2	<0.1	90	5.1		
AL93	02/20/2015	0.064	<1	<1	90	<1	<10	1.3	0.099	94	NA	7.7	0.77	0.68	<1	82	<1	<1	80	9.6	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, separated by a hydrologic divide.
AL93	08/17/2015	<0.5	<0.5	<0.2	<5	<0.08	1.5	2.4	<0.5	52.3	NA	5.2	0.61	<0.5	<0.5	81.8	<2	<0.1	98	9.7		
AL94	02/17/2015	<0.4	2.39	<0.11	<20	<0.06	<5	1.3	<0.03	16.3	NA	<0.84	4.84	0.56	2.49	142	5	<0.06	156	26.5	No	West and upgradient of the Site. Not within the direction of groundwater flow from the ash basins or coal piles. Outside of the Site drainage system, separated by a hydrologic divide.
AL94	08/27/2015	<0.5	2.4	<0.2	5.5	<0.08	0.18	<0.5	<0.5	<50	NA	<0.5	5.1	<0.5	1.7	131	5.4	<0.1	124	24.9		
AL95	05/08/2015	<0.5	<0.5	<0.2	7.4	<0.08	1.3	1.8	<0.5	1980	NA	39.7	<0.5	0.71	<0.5	186	<2	<0.1	107	2.5	No	Invalid dataset; pH or turbidity issues
AL96	02/19/2015	<0.4	0.16	<0.11	<20	<0.06	<5	0.82	<0.03	<25	NA	<0.84	<0.11	0.18	<0.16	141	<5	<0.06	91	6.8	No	All COIs are below comparative criteria
AL96	08/14/2015	<0.5	<0.5	<0.2	<5	<0.08	0.43	0.75	<0.5	<50	NA	<0.5	<0.5	<0.5	<0.5	123	<2	<0.1	90	5.9		

TABLE 6-9
WATER SUPPLY WELL ANALYTICAL RESULTS SUMMARY
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELMONT, NC

Analytical Parameter		Antimony	Arsenic	Beryllium	Boron	Cadmium	Chromium (VI)	Chromium	Cobalt	Iron	Lithium	Manganese	Molybdenum	Nickel	Selenium	Strontium	Sulfate	Thallium	Total Dissolved	Vanadium	Impacted by Coal Ash?	Comments
Reporting Units		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	µg/L	mg/L	µg/L		
15A NCAC 02L Standard		1*	**10**	**4***	**700**	**2**	**NE**	10	**1***	300	NE	50	NE	**100**	**20**	NE	**250**	**0.2***	**500**	0.3*		
Background Threshold Values (Bedrock Unit)[1]		0.5	1.6	0.1	50	0.08	0.23	5.6	0.3	284	NE	278	8.9	3.4	0.5	154	2.9	0.1	165	**15.9**		
Background Threshold Values (Bedrock Unit)[2]		**2.6**	1.6	0.1	50	0.08	**0.765**	**10.19**	0.3	**1,242**	**26.3**	**360**	**11**	6.944	0.5	**181**	7.3	0.1	221	12.5		
Background Data Set Range (Bedrock Unit)[2]		0.27 j - 3.9	0.24 - 1.6	0.01 j - <0.1	35.6 j - <50	<0.08	<0.025 - 0.66	0.33 j - 8.9	0.021 j - 0.31	40.7 j - 715	0.9 j - 26.3	2.8 j - 278	1.7 - 10.5	0.22 j - 5.8	0.17 j - <0.5	97.7 - 223	1.8 - 33.3	0.02 j - <0.1	104 - 222	7.5 - 15.9		
Sample ID	**Sample Collection Date**	**Analytical Results**																				
AL97	02/11/2015	<1	<5	<1	<100	<0.1	<10	<1	<1	<50	NA	6	4	<5	<5	130	6.93	<0.1	111	0.28	No	All COIs are below comparative criteria
AL97	08/03/2015	<0.5	1.4	<0.2	8	<0.08	<0.03	<0.5	<0.5	<50	NA	5.3	4.7	<0.5	<0.5	112	7	<0.1	102	<1		
AL98	02/17/2015	<0.4	1.84	<0.11	<20	<0.06	<5	0.82	<0.03	<25	NA	6.43	3.95	0.6	<0.16	34	14	<0.06	173	0.25	No	All COIs are below comparative criteria
AL99	02/12/2015	<1	<5	<1	<100	<0.1	<10	<1	<1	<50	NA	<5	<5	<5	<5	140	1.18	<0.1	73	6	No	South and sidegradient of the Site. Chromium (VI) is not a COI associated with the Allen source areas.
AL99	07/30/2015	<0.5	<0.5	<0.2	<5	<0.08	**0.78**	0.91	<0.5	<50	NA	<0.5	<0.5	<0.5	<0.5	121	<2	<0.1	105	7.1		

Prepared by: LWD Checked by: JYT

Notes:

[1] - Background threshold values were calculated using data from background groundwater samples collected June 2015 to September 2017.

[2] - Background threshold values were calculated using data from background groundwater samples collected March 2011 to December 2018.

Bold text - greatest comparative value

- bold highlighted concentration indicates value is greater than the 15A NCAC 02L .0202 Standard or the IMAC. (Effective date for 15A NCAC 02L .0202 Standard and IMAC is April 1, 2013)
- bold highlighted concentration indicates value is greater than greatest background threshold value where there is no regulatory standard, or background threshold values are greater than regulatory standard
- highlighted concentration indicates value is either within range of background threshold values for constituents where there is no regulatory standard/background threshold values are greater than regulatory standard, or within range of background threshold value and the regulatory standard
- highlighted concentration indicates turbidity value is out of range [>10 Nephelometric Turbidity Units (NTUs)] or pH value was not measured. Results are deemed invalid.

* - Interim Maximum Allowable Concentrations (IMACs) of the 15A NCAC 02L Standard, Appendix 1, April 1, 2013.
< - concentration not detected at or above the adjusted reporting limit.
NE - not established
NA - not available
mg/L - milligrams per liter
µg/L - micrograms per liter

TABLE 6-10
NPDES PERMIT LIMITS AND ANTICIPATED GROUNDWATER REMEDIATION PARAMETER LEVELS
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELMONT, NC

Outfall 002 Effluent Limitations and Monitoring Requirements			Geomean Concentrations by Flow Zone [1]		
Parameter	**Monthly Average**	**Daily Maximum**	**Shallow**	**Deep**	**Bedrock**
Flow (MGD)	NS	NS/1.00[2]	NA	NA	NA
TSS	30.0 mg/L	50.0 mg/L	4.6 mg/L	4.0 mg/L	3.5 mg/L
Oil & Grease	15.0 mg/L	20.0 mg/L	NA	NA	NA
5-day BOD	30.0 mg/L	45.0 mg/L	NA	NA	NA
Fecal Coliform	200/100 mL	400/100 mL	NA	NA	NA
Total Silver	3.74 µg/L	15.13 µg/L	0.4 µg/L	NA	0.3 µg/L
Total Iron[3]	1.0 mg/L	1.0 mg/L	0.87 mg/L	0.19 mg/L	0.103 mg/L
Total Copper[3]	1.0 mg/L	1.0 mg/L	0.001 mg/L	0.001 mg/L	0.001 mg/L
Chronic Toxicity	Note[4]		NA	NA	NA
pH	Between 6.0 and 9.0 S.U.		5.5 S.U. (+1.7/-1.9)	7.2 S.U. (+4.2/-1.7)	8.3 S.U. (+2.2/-1.9)

Prepared by: VTV Checked by: LWD

Notes:

[1] – Downgradient groundwater monitoring wells; 2018 and Q1 2019 data
[2]– 1 MGD limit applies only when dewatering
[3] – Limits apply only when chemical metal cleaning wastewaters are being discharged.
[4] – Whole effluent toxicity shall be monitored by chronic toxicity (Ceriodaphnia) Pass/Fail at 23.6%
MGD – million gallons per day
NS – not specified
TSS – total suspended solids
BOD – biological oxygen demand
S.U. – standard units
NA – not analyzed

TABLE 6-11
FEATURE IRRIGATION SYSTEM SETBACK
CORRRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELMONT, NC

Feature	Irrigation System Setback (feet)	
	Spray	Drip
Private residence	400	100
Place of assembly owned by permittee	200	15
Surface waters	100	100
Property line	150	50

Prepared by: VTV Checked by: LWD

TABLE 6-12
REMEDIAL TECHNOLOGY SCREENING SUMMARY
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELMONT, NC

Summary of Remedial Technology Screening	**Retain Technology for Further Consideration**	
Technology	**Yes/No**	**Rationale**
Monitored Natural Attenuation (MNA)	Yes	COIs pose no unacceptable risk to human health or the environment under conservative exposure scenarios and could be implemented in conjunction with source control measures.
In-Situ Technologies		
Low Permeability Barriers (LPB)	No	Feasible, but technically challenging and costly.
Groundwater Flushing	Yes	Possible application to enhance capture of mobile COIs (*e.g.*, boron).
Encapsulation	No	The area, depth and heterogeneity of geological conditions requiring groundwater remediation are greater in size and complexity for uniform implementation of this technology.
Permeable Reactive Barrier (PRB)	No	The area, depth, and heterogeneity of geological conditions requiring groundwater remediation are too large for feasible trenching. Injection of reagents through boreholes is possible; however, technology is not well established for boron.
Groundwater Extraction Technologies		
Vertical Extraction Wells	Yes	Applicable for groundwater extraction of mobile COIs.
Horizontal or Angular Extraction Wells	No	While potentially effective, vertical extraction wells are deemed more cost effective.
Extraction Trenches	No	Saprolite is too thick for trenching to be effective.
Hydraulic Fracturing	No	Not warranted based upon the limited extent of COIs in bedrock.
Phytoremediation	No	Limited effectiveness as an extraction technology due to extraction rates and not feasible to reach to targeted depths (greater than 100 feet in some areas).
Groundwater Treatment Technologies		
pH Adjustment	Yes	Retained for remedial alternatives that include clean water infiltration or extraction.
Precipitation	Yes	Retained for remedial alternatives that include clean water infiltration or groundwater extraction.

TABLE 6-12
REMEDIAL TECHNOLOGY SCREENING SUMMARY
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELMONT, NC

Summary of Remedial Technology Screening	Retain Technology for Further Consideration	
Technology	**Yes/No**	**Rationale**
Ion Exchange	No	No feasible or economical method to dispose of the regeneration effluent and groundwater influent streams might have geochemical characteristics that interfere with other treatment technology.
Membrane Filtration	No	Pretreatment and a high volume of reject effluent that requires additional treatment prior to disposal make this technology costly and high maintenance. Other treatment options to remove soluble metals from extracted groundwater are better suited for the Site.
Phytoremediation	Yes	Could potentially serve as a means of groundwater treatment in specific areas where ash removal has occurred and for treatment of seeps.
Management of Extracted Groundwater		
NPDES Permitted Discharge	Yes	Discharge to Outfall 002 or Outfall 006
Publicly Owned Treatment Works (POTW)	No	Would use much of available capacity and POTW might not accept large volume of groundwater.
Non-Discharge Permit	---	---
• Infiltration Gallery	No	Treatment prior to application could result in a complicated system with significant operation and maintenance efforts.
• Land Application	No	Treatment prior to application could result in a complicated system with significant operation and maintenance efforts.
Beneficial Reuse	---	---
• Fire Protection	No	Not feasible to store extracted groundwater for fire protection.
• Non-Contact Cooling Water	No	Potential application and could be reconsidered in the future, but not recommended at this time.
• Dust Suppression and Truck Wash	No	The need for dust suppression and truck wash water is limited and would not justify the effort and expense to substitute extracted groundwater for dust suppression and truck wash water.

Prepared by: LWD Checked by: CJS

TABLE 6-13
ALTERNATIVE 3 GROUNDWATER EXTRACTION AND CLEAN WATER INFILTRATION WELL SUMMARY
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELMONT, NC

<table>
<tr><th colspan="6">Groundwater Extraction Well System</th></tr>
<tr><th colspan="3">Horizontal and Vertical Wells</th><th colspan="3">Vertical Wells Only</th></tr>
<tr><th colspan="3">Extraction Well System</th><th colspan="3">Extraction Well System</th></tr>
<tr><th>Number of Wells</th><th>Flow Zone</th><th>Total Depth (ft bgs)</th><th>Number of Wells</th><th>Flow Zone</th><th>Total Depth (ft bgs)</th></tr>
<tr><td>14</td><td>Shallow/Deep</td><td>60-89</td><td>14</td><td>Shallow/Deep</td><td>60-89</td></tr>
<tr><td>36</td><td>Shallow/Deep</td><td>90-119</td><td>36</td><td>Shallow/Deep</td><td>90-119</td></tr>
<tr><td>19</td><td>Shallow/Deep</td><td>120-149</td><td>19</td><td>Shallow/Deep</td><td>120-149</td></tr>
<tr><td>18</td><td>Bedrock</td><td>190-400</td><td>18</td><td>Bedrock</td><td>190-400</td></tr>
<tr><td colspan="3">Total Well Count: 87</td><td colspan="3">Total Well Count: 87</td></tr>
<tr><td colspan="3">System flow and operation assumptions:
Flow rate: Approximately 13 gpm per shallow/deep flow zone well and 4 gpm per bedrock well. Total system extraction flow rate of approximately 970 gpm. The groundwater extraction rate is based on predictive flow and transport modeling, which assumes a 50 percent well efficiency.
Extraction wells operate to maintain water level near bottom of the well.</td><td colspan="3">System flow and operation assumptions:
Flow rate: Approximately 13 gpm per shallow/deep flow zone well and 4 gpm per bedrock well. Total system extraction flow rate of approximately 970 gpm. The groundwater extraction rate is based on predictive flow and transport modeling, which assumes a 50 percent well efficiency.
Extraction wells operate to maintain water level near bottom of the well.</td></tr>
<tr><th colspan="3">Clean Water Infiltration Well System</th><th colspan="3">Clean Water Infiltration Well System</th></tr>
<tr><th colspan="3">Vertical Wells</th><th colspan="3">Vertical Wells</th></tr>
<tr><th>Number of Wells</th><th>Flow Zone</th><th>Total Depth (ft bgs)</th><th>Number of Wells</th><th>Flow Zone</th><th>Total Depth (ft bgs)</th></tr>
<tr><td>11</td><td>Shallow/Deep</td><td>60-89</td><td>36</td><td>Shallow/Deep</td><td>60-89</td></tr>
<tr><td>32</td><td>Shallow/Deep</td><td>90-119</td><td>35</td><td>Shallow/Deep</td><td>90-119</td></tr>
<tr><td>5</td><td>Shallow/Deep</td><td>120-149</td><td>5</td><td>Shallow/Deep</td><td>120-149</td></tr>
<tr><td colspan="3">Total Well Count: 48</td><td colspan="3">Total Well Count: 76</td></tr>
<tr><td colspan="3">System flow and operation assumptions:
Flow rate: 5 gpm per well. Total system infiltration flow rate of approximately 230 gpm. The groundwater infiltration rate is based on predictive flow and transport modeling, which assumes a 25 percent well efficiency.
Clean water infiltration wells are assumed to operate with pressure head set to 4.3 to 6.5 psi.</td><td colspan="3">System flow and operation assumptions:
Flow rate: 5 gpm per well. Total system infiltration flow rate of approximately 380 gpm. The groundwater infiltration rate is based on predictive flow and transport modeling, which assumes a 25 percent well efficiency.
Clean water infiltration wells are assumed to operate with pressure head set to 4.3 to 6.5 psi.</td></tr>
<tr><th colspan="3">Horizontal Well</th><th colspan="3">Horizontal Well</th></tr>
<tr><th>Number of Wells</th><th>Flow Zone</th><th>Total Depth (ft bgs)</th><td colspan="3" rowspan="4">Not Applicable</td></tr>
<tr><td>11 (258-470 feet long)</td><td>Shallow</td><td>20</td></tr>
<tr><td>11 (255-470 feet long)</td><td>Shallow</td><td>80</td></tr>
<tr><td colspan="3">System flow and operation assumptions:
Flow rate: Total infiltration flow rate of approximately 175 gpm. The groundwater infiltration rate is based on predictive flow and transport modeling, which assumes a 25 percent well efficiency.
Clean water infiltration wells operate with pressure head set to 4.3 to 6.5 psi.</td></tr>
</table>

Prepared by: LWD Checked by: JFE

Notes:
ft bgs – feet below ground surface
gpm – gallons per minute
psi - pounds per square inch

TABLE 6-14
ENVIRONMENTAL SUSTAINABILITY COMPARISONS FOR REMEDIATION ALTERNATIVES
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELMONT NC

Remedial Alternative		Remedial Alternative 1 – Groundwater Remediation by MNA	Remedial Alternative 2 – Groundwater Remediation by Extraction		Remedial Alternative 3 – Groundwater Remediation by Clean Water Infiltration and Extraction	
Emissions	**Units**		**Horizontal and Vertical Wells**	**Vertical Wells Only**	**Horizontal and Vertical Wells**	**Vertical Wells Only**
CO_2 Emissions	metric ton	4.57E+00	4.86E+05	4.78E+05	2.62E+04	2.96E+04
Onsite NO_x emissions	metric ton	0.00E+00	9.06E+01	9.06E+01	1.14E+02	1.45E+02
Onsite SO_x Emissions	metric ton	0.00E+00	9.26E+00	9.26E+00	1.16E+01	1.48E+01
Onsite PM_{10} Emissions	metric ton	0.00E+00	8.16E+00	8.16E+00	1.03E+01	1.31E+01
Total NO_x emissions	metric ton	1.69E-03	1.83E+03	1.80E+03	1.66E+02	1.97E+02
Total SO_x Emissions	metric ton	5.96E-05	1.63E+03	1.60E+03	5.37E+01	5.46E+01
Total PM_{10} Emissions	metric ton	3.43E-04	1.94E+02	1.90E+02	2.34E+01	3.10E+01
Total Energy Used	MMBTU	5.75E+01	8.72E+06	8.65E+06	7.30E+06	7.34E+06
Total Emissions	**metric ton**	**4.58E+00**	**4.90E+05**	**4.81E+05**	**2.66E+04**	**3.00E+04**

Notes:

Prepared by: GTC Checked by: CBC

Revised by: LWD

CO_2 - Airborne emissions of carbon dioxide

MMBTU - Million British Thermal Units

NO_X - Airborne emissions of nitrogen oxides (combination of nitrogen monoxide and nitrogen dioxide)

SO_X - Airborne emissions of sulfur oxides (combination of sulfur monoxide, sulfur dioxide, sulfur trioxide, and others)

PM_{10} - Airborne emissions of particulate matter that is 10 micrometers or less in diameter

TABLE 6-15
MODELED CLEAN WATER INFILTRATION WELL DETAILS
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELMONT, NC

Horizontal and Vertical Wells								Vertical Wells Only							
Well ID	**Easting (NAD 88)**	**Northing (NAD 88)**	**Approximate Ground Surface Elevation (feet)**	**Pressure at Well Head (ft of Head Above Ground Surface)**	**Well Depth (ft BGS)**	**Targeted Flow Zones**	**Total Simulated Flow (gpm)**	**Well ID**	**Easting (NAD 88)**	**Northing (NAD 88)**	**Approximate Ground Surface Elevation (feet)**	**Pressure at Well Head (ft of Head Above Ground Surface)**	**Well Depth (ft BGS)**	**Targeted Flow Zones**	**Total Simulated Flow (gpm)**
Vertical Injection Wells								**Vertical Injection Wells**							
IW-01	1398745.70	529382.00	635	4.3	131	Saprolite and Transition Zone	8.9	IW-01	1398745.70	529382.00	635	4.3	131	Saprolite and Transition Zone	5
IW-02	1398864.10	529456.50	616	4.3	133	Saprolite and Transition Zone	9	IW-02	1398864.10	529456.50	616	4.3	133	Saprolite and Transition Zone	5
IW-03	1399030.30	529464.10	597	4.3	138	Saprolite and Transition Zone	5	IW-03	1399030.30	529464.10	597	4.3	138	Saprolite and Transition Zone	5
IW-04	1399588.00	530230.00	588	4.3	104	Saprolite and Transition Zone	4	IW-04	1399588.00	530230.00	588	4.3	104	Saprolite and Transition Zone	5
IW-05	1399517.30	530222.40	588	4.3	102	Saprolite and Transition Zone	3	IW-05	1399517.30	530222.40	588	4.3	102	Saprolite and Transition Zone	5
IW-06	1399439.00	530124.90	588	4.3	103	Saprolite and Transition Zone	3	IW-06	1399439.00	530124.90	588	4.3	103	Saprolite and Transition Zone	5
IW-07	1399160.20	529937.80	588	4.3	94	Saprolite and Transition Zone	4	IW-07	1399160.20	529937.80	588	4.3	94	Saprolite and Transition Zone	5
IW-08	1399238.50	529956.90	588	4.3	99	Saprolite and Transition Zone	3	IW-08	1399238.50	529956.90	588	4.3	99	Saprolite and Transition Zone	5
IW-09	1399364.50	529998.90	588	4.3	104	Saprolite and Transition Zone	3	IW-09	1399364.50	529998.90	588	4.3	104	Saprolite and Transition Zone	5
IW-10	1399444.70	530037.10	588	4.3	107	Saprolite and Transition Zone	3	IW-10	1399444.70	530037.10	588	4.3	107	Saprolite and Transition Zone	5
IW-11	1399555.50	530035.20	588	4.3	109	Saprolite and Transition Zone	3	IW-11	1399555.50	530035.20	588	4.3	109	Saprolite and Transition Zone	5
IW-12	1399631.90	530037.10	588	4.3	111	Saprolite and Transition Zone	3	IW-12	1399631.90	530037.10	588	4.3	111	Saprolite and Transition Zone	5
IW-13	1399120.10	529769.70	588	4.3	99	Saprolite and Transition Zone	4	IW-13	1399120.10	529769.70	588	4.3	99	Saprolite and Transition Zone	5
IW-14	1399280.50	529857.60	588	4.3	98	Saprolite and Transition Zone	3	IW-14	1399280.50	529857.60	588	4.3	98	Saprolite and Transition Zone	5
IW-15	1399482.90	529939.70	588	4.3	107	Saprolite and Transition Zone	3	IW-15	1399482.90	529939.70	588	4.3	107	Saprolite and Transition Zone	5
IW-16	1399660.60	529956.90	588	4.3	112	Saprolite and Transition Zone	3	IW-16	1399660.60	529956.90	588	4.3	112	Saprolite and Transition Zone	5
IW-17	1399118.10	529609.30	587	4.3	118	Saprolite and Transition Zone	4	IW-17	1399118.10	529609.30	587	4.3	118	Saprolite and Transition Zone	5
IW-18	1399244.20	529697.10	588	4.3	100	Saprolite and Transition Zone	4	IW-18	1399244.20	529697.10	588	4.3	100	Saprolite and Transition Zone	5
IW-19	1399364.50	529764.00	588	4.3	90	Saprolite and Transition Zone	3	IW-19	1399364.50	529764.00	588	4.3	90	Saprolite and Transition Zone	5
IW-20	1399555.50	529771.60	588	4.3	85	Saprolite and Transition Zone	3	IW-20	1399555.50	529771.60	588	4.3	85	Saprolite and Transition Zone	5
IW-21	1399630.00	529849.90	588	4.3	101	Saprolite and Transition Zone	3	IW-21	1399630.00	529849.90	588	4.3	101	Saprolite and Transition Zone	5
IW-22	1399706.40	529851.80	588	4.3	105	Saprolite and Transition Zone	3	IW-22	1399706.40	529851.80	588	4.3	105	Saprolite and Transition Zone	5
IW-23	1399782.80	529846.10	588	4.3	108	Saprolite and Transition Zone	3	IW-23	1399782.80	529846.10	588	4.3	108	Saprolite and Transition Zone	5
IW-24	1399116.20	529382.00	598	4.3	129	Saprolite and Transition Zone	6	IW-24	1399116.20	529382.00	598	4.3	129	Saprolite and Transition Zone	5
IW-25	1399118.10	529452.70	593	4.3	129	Saprolite and Transition Zone	5	IW-25	1399118.10	529452.70	593	4.3	129	Saprolite and Transition Zone	5
IW-26	1399360.70	529615.00	589	4.3	88	Saprolite and Transition Zone	5	IW-26	1399360.70	529615.00	589	4.3	88	Saprolite and Transition Zone	5
IW-27	1399740.80	529773.50	588	4.3	96	Saprolite and Transition Zone	4	IW-27	1399740.80	529773.50	588	4.3	96	Saprolite and Transition Zone	5
IW-28	1399817.20	529765.90	588	4.3	99	Saprolite and Transition Zone	4	IW-28	1399817.20	529765.90	588	4.3	99	Saprolite and Transition Zone	5
IW-29	1399819.10	529693.30	588	4.3	90	Saprolite and Transition Zone	5	IW-29	1399819.10	529693.30	588	4.3	90	Saprolite and Transition Zone	5
IW-30	1399931.80	529678.00	588	4.3	94	Saprolite and Transition Zone	4	IW-30	1399931.80	529678.00	588	4.3	94	Saprolite and Transition Zone	5
IW-31	1399973.80	529773.50	588	4.3	106	Saprolite and Transition Zone	4	IW-31	1399973.80	529773.50	588	4.3	106	Saprolite and Transition Zone	5
IW-32	1400012.00	529943.50	588	4.3	119	Saprolite and Transition Zone	6	IW-32	1400012.00	529943.50	588	4.3	119	Saprolite and Transition Zone	5
IW-33	1400099.80	529773.50	588	4.3	110	Saprolite and Transition Zone	5	IW-33	1400099.80	529773.50	588	4.3	110	Saprolite and Transition Zone	5
IW-34	1400052.10	529687.60	588	4.3	99	Saprolite and Transition Zone	4	IW-34	1400052.10	529687.60	588	4.3	99	Saprolite and Transition Zone	5
IW-35	1400145.70	529679.90	588	4.3	103	Saprolite and Transition Zone	4	IW-35	1400145.70	529679.90	588	4.3	103	Saprolite and Transition Zone	5
IW-36	1399324.40	529366.70	593	4.3	96	Saprolite and Transition Zone	7	IW-36	1399324.40	529366.70	593	4.3	96	Saprolite and Transition Zone	5
IW-37	1399439.00	529435.50	590	4.3	86	Saprolite and Transition Zone	7	IW-37	1399439.00	529435.50	590	4.3	86	Saprolite and Transition Zone	5
IW-38	1399486.80	529387.70	590	4.3	82	Saprolite and Transition Zone	7	IW-38	1399486.80	529387.70	590	4.3	82	Saprolite and Transition Zone	5
IW-39	1399555.50	529443.10	589	4.3	78	Saprolite and Transition Zone	6	IW-39	1399555.50	529443.10	589	4.3	78	Saprolite and Transition Zone	5
IW-40	1399593.70	529469.90	589	4.3	77	Saprolite and Transition Zone	6	IW-40	1399593.70	529469.90	589	4.3	77	Saprolite and Transition Zone	5
IW-41	1399740.80	529517.60	588	4.3	77	Saprolite and Transition Zone	6	IW-41	1399740.80	529517.60	588	4.3	77	Saprolite and Transition Zone	5
IW-42	1399855.40	529552.00	588	4.3	77	Saprolite and Transition Zone	6	IW-42	1399855.40	529552.00	588	4.3	77	Saprolite and Transition Zone	5
IW-43	1399970.00	529597.80	588	4.3	86	Saprolite and Transition Zone	5	IW-43	1399970.00	529597.80	588	4.3	86	Saprolite and Transition Zone	5
IW-44	1400097.90	529622.60	588	4.3	91	Saprolite and Transition Zone	4	IW-44	1400097.90	529622.60	588	4.3	91	Saprolite and Transition Zone	5
IW-45	1400189.60	529601.60	588	4.3	94	Saprolite and Transition Zone	4	IW-45	1400189.60	529601.60	588	4.3	94	Saprolite and Transition Zone	5

TABLE 6-15
MODELED CLEAN WATER INFILTRATION WELL DETAILS
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELMONT, NC

Horizontal and Vertical Wells								Vertical Wells Only							
Well ID	Easting (NAD 88)	Northing (NAD 88)	Approximate Ground Surface Elevation (feet)	Pressure at Well Head (ft of Head Above Ground Surface)	Well Depth (ft BGS)	Targeted Flow Zones	Total Simulated Flow (gpm)	Well ID	Easting (NAD 88)	Northing (NAD 88)	Approximate Ground Surface Elevation (feet)	Pressure at Well Head (ft of Head Above Ground Surface)	Well Depth (ft BGS)	Targeted Flow Zones	Total Simulated Flow (gpm)
IW-46	1400287.00	529609.30	588	4.3	101	Saprolite and Transition Zone	5	IW-46	1400287.00	529609.30	588	4.3	101	Saprolite and Transition Zone	5
IW-47	1400097.90	529536.70	588	4.3	79	Saprolite and Transition Zone	4	IW-47	1400097.90	529536.70	588	4.3	79	Saprolite and Transition Zone	5
IW-48	1400399.70	529372.40	585	4.3	75	Saprolite and Transition Zone	5.5	IW-48	1399446.70	529179.50	599	4.3	93	Saprolite and Transition Zone	5
Horizontal Injection Wells								IW-49	1399561.20	529229.20	596	4.3	87	Saprolite and Transition Zone	5
HZ-1	NA	NA	NA	4.3	20	Saprolite	6.9	IW-50	1399668.20	529246.40	595	4.3	84	Saprolite and Transition Zone	5
HZ-2	NA	NA	NA	4.3	20	Saprolite	8	IW-51	1399779.00	529305.60	592	4.3	79	Saprolite and Transition Zone	5
HZ-3	NA	NA	NA	4.3	20	Saprolite	6	IW-52	1399891.70	529322.80	590	4.3	77	Saprolite and Transition Zone	5
HZ-4	NA	NA	NA	4.3	20	Saprolite	7	IW-53	1399970.00	529378.20	589	4.3	74	Saprolite and Transition Zone	5
HZ-5	NA	NA	NA	4.3	20	Saprolite	6	IW-54	1400094.10	529393.50	588	4.3	72	Saprolite and Transition Zone	5
HZ-6	NA	NA	NA	4.3	20	Saprolite	6	IW-55	1400191.50	529458.40	588	4.3	77	Saprolite and Transition Zone	5
HZ-7	NA	NA	NA	4.3	20	Saprolite	7	IW-56	1400292.70	529456.50	587	4.3	80	Saprolite and Transition Zone	5
HZ-8	NA	NA	NA	4.3	20	Saprolite	7	IW-57	1399630.00	529103.20	597	4.3	91	Saprolite and Transition Zone	5
HZ-9	NA	NA	NA	4.3	20	Saprolite	6	IW-58	1399700.70	529179.50	594	4.3	85	Saprolite and Transition Zone	5
HZ-10	NA	NA	NA	4.3	20	Saprolite	7	IW-59	1399817.20	529173.80	592	4.3	81	Saprolite and Transition Zone	5
HZ-11	NA	NA	NA	4.3	20	Saprolite	8	IW-60	1399887.80	529244.50	591	4.3	79	Saprolite and Transition Zone	5
HZ-12	NA	NA	NA	4.3	80	Saprolite	8	IW-61	1399929.90	529168.10	590	4.3	81	Saprolite and Transition Zone	5
HZ-13	NA	NA	NA	4.3	80	Saprolite	9	IW-62	1400008.20	529244.50	589	4.3	79	Saprolite and Transition Zone	5
HZ-14	NA	NA	NA	4.3	80	Saprolite	7	IW-63	1400050.20	529313.20	588	4.3	75	Saprolite and Transition Zone	5
HZ-15	NA	NA	NA	4.3	80	Saprolite	8	IW-64	1400145.70	529242.60	588	4.3	77	Saprolite and Transition Zone	5
HZ-16	NA	NA	NA	4.3	80	Saprolite	7	IW-65	1400187.70	529313.20	587	4.3	73	Saprolite and Transition Zone	5
HZ-17	NA	NA	NA	4.3	80	Saprolite	6	IW-66	1400283.20	529378.20	587	4.3	72	Saprolite and Transition Zone	5
HZ-18	NA	NA	NA	4.3	80	Saprolite	7	IW-67	1400399.70	529372.40	585	4.3	75	Saprolite and Transition Zone	5
HZ-19	NA	NA	NA	4.3	80	Saprolite	7	IW-68	1399714.00	529047.80	593	4.3	90	Saprolite and Transition Zone	5
HZ-20	NA	NA	NA	4.3	80	Saprolite	7	IW-69	1399815.30	529049.70	592	4.3	88	Saprolite and Transition Zone	5
HZ-21	NA	NA	NA	4.3	80	Saprolite	8	IW-70	1399929.90	529043.90	590	4.3	89	Saprolite and Transition Zone	5
HZ-22	NA	NA	NA	4.3	80	Saprolite	9.2	IW-71	1400055.90	529055.40	589	4.3	86	Saprolite and Transition Zone	5

Prepared by: JFE Checked by: LWD

Notes:
All depths are approximated and may change depending on site conditions.
Flowrates are approximate and may change depending on site conditions.
DTW - depth to water
ft - feet
ft BGS - feet below ground surface
gpm - gallons per minute
NA - Not applicable

TABLE 6-16
MODELED GROUNDWATER EXTRACTION WELL
DETAILS CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELMONT, NC

Horizontal and Vertical Wells							
Well ID	**Easting (NAD 88)**	**Northing (NAD 88)**	**Approximate Ground Surface Elevation (feet)**	**Operational Water Elevation Maintained In Well (feet)**	**Well Depth (ft BGS)**	**Targeted Flow Zones**	**Total Simulated Flow (gpm)**
Vertical Extraction Wells							
EX-1	1400563.10	529767.50	572	464	118	Saprolite and Transition Zone	13
EX-2	1400681.00	529601.80	572	464	118	Saprolite and Transition Zone	13
EX-3	1400690.73	529449.88	574	466	118	Saprolite and Transition Zone	13
EX-4	1400682.89	529309.70	574	477	107	Saprolite and Transition Zone	13
EX-5	1400623.09	529177.36	578	511	77	Saprolite and Transition Zone	13
EX-6	1400614.10	528977.10	583	496	97	Saprolite and Transition Zone	13
EX-7	1400617.90	528812.90	583	487	106	Saprolite and Transition Zone	13
EX-8	1400616.60	528657.50	583	490	103	Saprolite and Transition Zone	13
EX-9	1399970.40	529472.80	588	515	83	Saprolite and Transition Zone	13
EX-10	1399854.40	529437.00	588	515	83	Saprolite and Transition Zone	13
EX-11	1399739.30	529392.60	590	513	87	Saprolite and Transition Zone	13
EX-12	1399633.70	529360.60	590	512	88	Saprolite and Transition Zone	13
EX-13	1399522.40	529321.90	592	509	93	Saprolite and Transition Zone	13
EX-14	1399402.60	529296.40	594	504	100	Saprolite and Transition Zone	13
EX-15	1399238.98	529228.85	607	492	125	Saprolite and Transition Zone	13
EX-16	1399324.92	529164.85	611	502	119	Saprolite and Transition Zone	13
EX-17	1399447.42	529040.52	601	507	104	Saprolite and Transition Zone	13
EX-18	1399558.96	528925.33	599	505	104	Saprolite and Transition Zone	13
EX-19	1399633.92	528808.31	598	497	111	Saprolite and Transition Zone	13
EX-20	1399708.89	528705.91	595	490	115	Saprolite and Transition Zone	13
EX-21	1399739.97	528607.18	599	487	122	Saprolite and Transition Zone	13
EX-22	1399930.90	528607.60	596	480	126	Saprolite and Transition Zone	13
EX-23	1400053.50	528599.90	595	477	128	Saprolite and Transition Zone	13
EX-24	1400145.50	528599.20	593	476	127	Saprolite and Transition Zone	13
EX-25	1400240.40	528602.80	590	475	125	Saprolite and Transition Zone	13
EX-26	1400340.40	528602.80	589	477	122	Saprolite and Transition Zone	13
EX-27	1400446.90	528602.80	588	478	120	Saprolite and Transition Zone	13
EX-28	1400624.20	528462.00	583	478	115	Saprolite and Transition Zone	13
EX-29	1400621.50	528250.40	584	481	113	Saprolite and Transition Zone	13
EX-30	1400627.00	528077.20	584	481	113	Saprolite and Transition Zone	13
EX-31	1400627.00	527898.50	582	479	113	Saprolite and Transition Zone	13
EX-32	1400624.20	527766.50	583	483	110	Saprolite and Transition Zone	13
EX-33	1400624.13	527621.81	582	490	102	Saprolite and Transition Zone	13
EX-34	1400618.50	527501.30	581	488	103	Saprolite and Transition Zone	13
EX-35	1400621.17	527425.57	581	485	106	Saprolite and Transition Zone	13
EX-36	1400627.00	527191.90	581	474	117	Saprolite and Transition Zone	13
EX-37	1400566.50	527007.70	582	477	115	Saprolite and Transition Zone	13
EX-38	1400508.70	526826.30	585	482	113	Saprolite and Transition Zone	13
EX-39	1400500.50	526683.30	583	481	112	Saprolite and Transition Zone	13
EX-40	1400508.70	526471.70	583	472	121	Saprolite and Transition Zone	13
EX-41	1400505.30	526299.00	581	456	135	Saprolite and Transition Zone	13
EX-42	1400507.30	526103.90	578	449	139	Saprolite and Transition Zone	13
EX-43	1400507.30	525897.00	575	481	104	Saprolite and Transition Zone	13
EX-44	1400454.10	525739.30	588	508	90	Saprolite and Transition Zone	13
EX-45	1400454.10	525552.00	589	526	73	Saprolite and Transition Zone	13
EX-46	1400508.60	525466.20	580	523	67	Saprolite and Transition Zone	13
EX-47	1400508.60	525340.40	588	521	77	Saprolite and Transition Zone	13
EX-48	1400560.10	525300.40	579	515	74	Saprolite and Transition Zone	13
EX-49	1400508.60	525203.90	593	514	89	Saprolite and Transition Zone	13
EX-50	1400567.20	525217.20	588	511	87	Saprolite and Transition Zone	13
EX-51	1400619.10	525168.90	577	501	86	Saprolite and Transition Zone	13
EX-52	1400514.00	525075.50	586	499	97	Saprolite and Transition Zone	13
EX-53	1400627.00	525080.00	583	492	101	Saprolite and Transition Zone	13
EX-54	1400631.20	524996.70	577	481	106	Saprolite and Transition Zone	13

Vertical Wells Only							
Well ID	**Easting (NAD 88)**	**Northing (NAD 88)**	**Approximate Ground Surface Elevation (feet)**	**Operational Water Elevation Maintained In Well (feet)**	**Well Depth (ft BGS)**	**Targeted Flow Zones**	**Total Simulated Flow (gpm)**
Vertical Extraction Wells							
EX-1	1400563.10	529767.50	572	464	118	Saprolite and Transition Zone	13
EX-2	1400681.00	529601.80	572	464	118	Saprolite and Transition Zone	13
EX-3	1400690.73	529449.88	574	466	118	Saprolite and Transition Zone	13
EX-4	1400682.89	529309.70	574	477	107	Saprolite and Transition Zone	13
EX-5	1400623.09	529177.36	578	511	77	Saprolite and Transition Zone	13
EX-6	1400614.10	528977.10	583	496	97	Saprolite and Transition Zone	13
EX-7	1400617.90	528812.90	583	487	106	Saprolite and Transition Zone	13
EX-8	1400616.60	528657.50	583	490	103	Saprolite and Transition Zone	13
EX-9	1399970.40	529472.80	588	515	83	Saprolite and Transition Zone	13
EX-10	1399854.40	529437.00	588	515	83	Saprolite and Transition Zone	13
EX-11	1399739.30	529392.60	590	513	87	Saprolite and Transition Zone	13
EX-12	1399633.70	529360.60	590	512	88	Saprolite and Transition Zone	13
EX-13	1399522.40	529321.90	592	509	93	Saprolite and Transition Zone	13
EX-14	1399402.60	529296.40	594	504	100	Saprolite and Transition Zone	13
EX-15	1399238.98	529228.85	607	492	125	Saprolite and Transition Zone	13
EX-16	1399324.92	529164.85	611	502	119	Saprolite and Transition Zone	13
EX-17	1399447.42	529040.52	601	507	104	Saprolite and Transition Zone	13
EX-18	1399558.96	528925.33	599	505	104	Saprolite and Transition Zone	13
EX-19	1399633.92	528808.31	598	497	111	Saprolite and Transition Zone	13
EX-20	1399708.89	528705.91	595	490	115	Saprolite and Transition Zone	13
EX-21	1399739.97	528607.18	599	487	122	Saprolite and Transition Zone	13
EX-22	1399930.90	528607.60	596	480	126	Saprolite and Transition Zone	13
EX-23	1400053.50	528599.90	595	477	128	Saprolite and Transition Zone	13
EX-24	1400145.50	528599.20	593	476	127	Saprolite and Transition Zone	13
EX-25	1400240.40	528602.80	590	475	125	Saprolite and Transition Zone	13
EX-26	1400340.40	528602.80	589	477	122	Saprolite and Transition Zone	13
EX-27	1400446.90	528602.80	588	478	120	Saprolite and Transition Zone	13
EX-28	1400624.20	528462.00	583	478	115	Saprolite and Transition Zone	13
EX-29	1400621.50	528250.40	584	481	113	Saprolite and Transition Zone	13
EX-30	1400627.00	528077.20	584	481	113	Saprolite and Transition Zone	13
EX-31	1400627.00	527898.50	582	479	113	Saprolite and Transition Zone	13
EX-32	1400624.20	527766.50	583	483	110	Saprolite and Transition Zone	13
EX-33	1400624.13	527621.81	582	490	102	Saprolite and Transition Zone	13
EX-34	1400618.50	527501.30	581	488	103	Saprolite and Transition Zone	13
EX-35	1400621.17	527425.57	581	485	106	Saprolite and Transition Zone	13
EX-36	1400627.00	527191.90	581	474	117	Saprolite and Transition Zone	13
EX-37	1400566.50	527007.70	582	477	115	Saprolite and Transition Zone	13
EX-38	1400508.70	526826.30	585	482	113	Saprolite and Transition Zone	13
EX-39	1400500.50	526683.30	583	481	112	Saprolite and Transition Zone	13
EX-40	1400508.70	526471.70	583	472	121	Saprolite and Transition Zone	13
EX-41	1400505.30	526299.00	581	456	135	Saprolite and Transition Zone	13
EX-42	1400507.30	526103.90	578	449	139	Saprolite and Transition Zone	13
EX-43	1400507.30	525897.00	575	481	104	Saprolite and Transition Zone	13
EX-44	1400454.10	525739.30	588	508	90	Saprolite and Transition Zone	13
EX-45	1400454.10	525552.00	589	526	73	Saprolite and Transition Zone	13
EX-46	1400508.60	525466.20	580	523	67	Saprolite and Transition Zone	13
EX-47	1400508.60	525340.40	588	521	77	Saprolite and Transition Zone	13
EX-48	1400560.10	525300.40	579	515	74	Saprolite and Transition Zone	13
EX-49	1400508.60	525203.90	593	514	89	Saprolite and Transition Zone	13
EX-50	1400567.20	525217.20	588	511	87	Saprolite and Transition Zone	13
EX-51	1400619.10	525168.90	577	501	86	Saprolite and Transition Zone	13
EX-52	1400514.00	525075.50	586	499	97	Saprolite and Transition Zone	13
EX-53	1400627.00	525080.00	583	492	101	Saprolite and Transition Zone	13
EX-54	1400631.20	524996.70	577	481	106	Saprolite and Transition Zone	13

TABLE 6-16
MODELED GROUNDWATER EXTRACTION WELL
DETAILS CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELMONT, NC

Horizontal and Vertical Wells

Well ID	Easting (NAD 88)	Northing (NAD 88)	Approximate Ground Surface Elevation (feet)	Operational Water Elevation Maintained In Well (feet)	Well Depth (ft BGS)	Targeted Flow Zones	Total Simulated Flow (gpm)
Vertical Extraction Wells							
EX-55	1400548.80	524947.00	575	481	104	Saprolite and Transition Zone	13
EX-56	1400554.10	524810.50	575	458	127	Saprolite and Transition Zone	13
EX-57	1400508.60	524679.40	575	437	148	Saprolite and Transition Zone	13
EX-58	1400508.60	525466.20	580	255	335	Bedrock	4
EX-59	1400508.60	525340.40	588	255	343	Bedrock	4
EX-60	1400560.10	525300.40	579	395	194	Bedrock	4
EX-61	1400508.60	525203.90	593	255	348	Bedrock	4
EX-62	1400567.20	525217.20	588	390	208	Bedrock	4
EX-63	1400619.10	525168.90	577	380	207	Bedrock	4
EX-64	1400514.00	525075.50	586	240	356	Bedrock	4
EX-65	1400627.00	525080.00	583	370	223	Bedrock	4
EX-66	1400631.20	524996.70	577	360	227	Bedrock	4
EX-67	1400548.80	524947.00	575	220	365	Bedrock	4
EX-68	1400554.10	524810.50	575	205	380	Bedrock	4
EX-69	1400508.60	524679.40	575	190	395	Bedrock	4
EX-70	1399285.30	529454.70	592	487	115	Saprolite and Transition Zone	13
EX-71	1399408.30	529497.80	590	502	98	Saprolite and Transition Zone	13
EX-72	1399520.00	529533.40	590	512	88	Saprolite and Transition Zone	13
EX-73	1399630.40	529559.20	588	512	86	Saprolite and Transition Zone	13
EX-74	1399779.90	529609.40	588	506	92	Saprolite and Transition Zone	13
EX-75	1399893.23	529640.77	588	501	97	Saprolite and Transition Zone	13
EX-76	1400337.60	529856.70	583	466	127	Saprolite and Transition Zone	13
EX-77	1400238.40	529947.50	586	466	130	Saprolite and Transition Zone	13
EX-78	1400191.90	530032.00	586	467	129	Saprolite and Transition Zone	13
EX-79	1400145.40	530120.70	587	468	129	Saprolite and Transition Zone	13
EX-80	1400101.10	530217.90	587	469	128	Saprolite and Transition Zone	13
EX-81	1400054.60	530332.00	588	471	127	Saprolite and Transition Zone	13
EX-82	1399739.30	529392.60	594	380	224	Bedrock	4
EX-83	1399633.70	529360.60	592	387	215	Bedrock	4
EX-84	1399522.40	529321.90	590	390	210	Bedrock	4
EX-85	1399402.60	529296.40	590	392	208	Bedrock	4
EX-86	1399854.80	529435.40	588	393	205	Bedrock	4
EX-87	1399969.80	529473.30	588	396	202	Bedrock	4

Vertical Wells Only

Well ID	Easting (NAD 88)	Northing (NAD 88)	Approximate Ground Surface Elevation (feet)	Operational Water Elevation Maintained In Well (feet)	Well Depth (ft BGS)	Targeted Flow Zones	Total Simulated Flow (gpm)
Vertical Extraction Wells							
EX-55	1400548.80	524947.00	575	481	104	Saprolite and Transition Zone	13
EX-56	1400554.10	524810.50	575	458	127	Saprolite and Transition Zone	13
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EX-59	1400508.60	525340.40	588	255	343	Bedrock	4
EX-60	1400560.10	525300.40	579	395	194	Bedrock	4
EX-61	1400508.60	525203.90	593	255	348	Bedrock	4
EX-62	1400567.20	525217.20	588	390	208	Bedrock	4
EX-63	1400619.10	525168.90	577	380	207	Bedrock	4
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EX-65	1400627.00	525080.00	583	370	223	Bedrock	4
EX-66	1400631.20	524996.70	577	360	227	Bedrock	4
EX-67	1400548.80	524947.00	575	220	365	Bedrock	4
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EX-69	1400508.60	524679.40	575	190	395	Bedrock	4
EX-70	1399285.30	529454.70	592	487	115	Saprolite and Transition Zone	13
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EX-72	1399520.00	529533.40	590	512	88	Saprolite and Transition Zone	13
EX-73	1399630.40	529559.20	588	512	86	Saprolite and Transition Zone	13
EX-74	1399779.90	529609.40	588	506	92	Saprolite and Transition Zone	13
EX-75	1399893.23	529640.77	588	501	97	Saprolite and Transition Zone	13
EX-76	1400337.60	529856.70	583	466	127	Saprolite and Transition Zone	13
EX-77	1400238.40	529947.50	586	466	130	Saprolite and Transition Zone	13
EX-78	1400191.90	530032.00	586	467	129	Saprolite and Transition Zone	13
EX-79	1400145.40	530120.70	587	468	129	Saprolite and Transition Zone	13
EX-80	1400101.10	530217.90	587	469	128	Saprolite and Transition Zone	13
EX-81	1400054.60	530332.00	588	471	127	Saprolite and Transition Zone	13
EX-82	1399739.30	529392.60	594	380	224	Bedrock	4
EX-83	1399633.70	529360.60	592	387	215	Bedrock	4
EX-84	1399522.40	529321.90	590	390	210	Bedrock	4
EX-85	1399402.60	529296.40	590	392	208	Bedrock	4
EX-86	1399854.80	529435.40	588	393	205	Bedrock	4
EX-87	1399969.80	529473.30	588	396	202	Bedrock	4

Prepared by: JFE Checked by: LWD

Notes:
All depths are approximated and may change depending on site conditions.
Flowrates are approximate and may change depending on site conditions.
DTW - depth to water
ft - feet
ft BGS - feet below ground surface
gpm - gallons per minute
NA - Not applicable

TABLE 6-17
EFFECTIVENESS MONITORING PLAN ELEMENTS
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELMONT, NC

Effectiveness Monitoring Plan (EMP) **Implemented 30 days after CAP Approval**	**Post-Closure Monitoring Plan (PCMP)** **Implemented after completion of ash basin closure activities**

Groundwater Monitoring Network

EMP Groundwater Well Monitoring Network
(background, downgradient of source areas)

AB-9S	CCR-26BR	GWA-5D
AB-9D	CCR-BG-1S[1]	GWA-5BRA
AB-10S	CCR-BG-1DA[1]	GWA-5BRL
AB-10D	CP-1S	GWA-6S
AB-10BR	CP-1D	GWA-6DA
AB-10BRL	CP-2S	GWA-6BRA
BG-1S[1]	CP-2D	GWA-6BRL
BG-1DA[1]	CP-3S	GWA-7S
BG-1BR[1]	CP-3D	GWA-7D
CCR-3S	CP-4S	GWA-21S[1]
CCR-3DA	CP-4D	GWA-21DA[1]
CCR-16S	CP-5S	GWA-21BR[1]
CCR-16D	CP-5D	GWA-27S
CCR-16BR	CP-6S	GWA-27D
CCR-18S	CP-6D	GWA-28S
CCR-18D	CP-6BR	GWA-28D
CCR-20S	EX-81[5]	GWA-28BR
CCR-20D	GWA-3S	GWA-29S
CCR-21S	GWA-3D	GWA-29D
CCR-21D	GWA-3BRA	GWA-29BR
CCR-26S	GWA-3BRL	GWA-30S
CCR-26D	GWA-5S	GWA-30D

PCMP Groundwater Well Monitoring Network
(background, downgradient of source areas)

A PCMP will be implemented at the Site in accordance with G.S. 130A-309.214(a)(4)k.2 after completion of ash basin closure activities.

Sampling Parameters and Frequency

EMP Groundwater Quality[3, 4]
(Semi-Annual Sampling Frequency)

Alkalinity	*Ferrous Iron*	*Sodium*
Aluminum	*Iron*	Strontium
Bicarbonate Alkalinity	*Magnesium*	*Sulfate*[2]
Boron[2]	*Manganese*	Total Dissolved Solids[2]
Calcium	*Nitrate + Nitrite*	*Total Organic Carbon*
Cobalt	*Potassium*	

PCMP Groundwater Quality
(Sampling frequency to be determined)

Parameters and sampling frequency to be included in the PCMP in accordance with G.S. 130A-309.214(a)(4)k.2 when submitted.

CMP and PCMP Groundwater Field Parameters

Water Level	Specific Conductivity	Temperature
pH	Oxidation Reduction Potential	Dissolved Oxygen

Review and Reporting

EMP Review

Annual Effectiveness Monitoring Evaluation and Reporting
1) Summary of annual groundwater monitoring results
2) Evaluate statistical concentration trends
2) Comparison of observed concentrations to model predictions
3) Evaluation of compliance with applicable Standards
4) Evaluation of system performance and effectiveness
4) Recommend plan adjustments, if applicable, to optimize the remedial action

5-Year Performance Review Reporting
1) Update background analysis
2) Confirm Risk Assessment assumptions remain valid
3) Re-evaluate effectiveness of technology
4) Verify modeling results, update model if needed
5) Modify corrective action approach, as needed, to achieve compliance goal established

PCMP Review

Annual Evaluation and Reporting:
1) Summary of annual groundwater monitoring results
2) Evaluate statistical concentration trends
2) Comparison of observed concentrations to model predictions
3) Evaluation 02L compliance
4) Recommend plan adjustments, if applicable

At a frequency no greater than 5 years:
1) Update background analysis
2) Confirm Risk Assessment assumptions remain valid
3) Verify model results, update if needed

Monitoring Program Duration

EMP Duration

30 days after CAP approval, the EMP will be implemented at the Site and will continue until there is a total of three years of data confirming COIs are below applicable Standards at or beyond the compliance boundary, at which time a request for completion of active remediation will be filed with NCDEQ.

If applicable standards are not met, the EMP will continue and transition to post-closure monitoring if necessary.

PCMP Duration

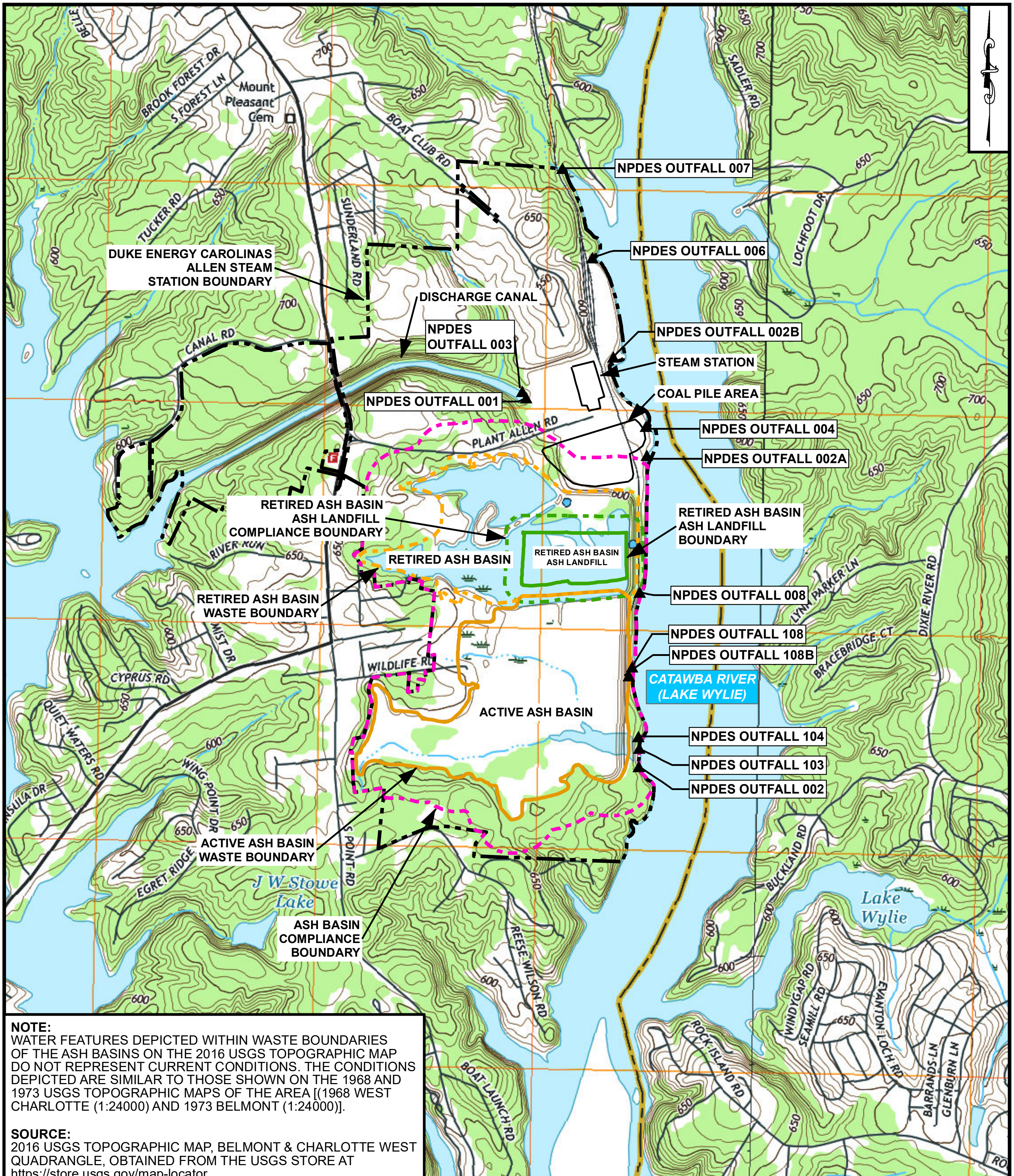
After ash basin closure and following ash basin closure certification, a PCMP will be implemented at the Site for a minimum of 30 years in accordance with G. S. 130A-309.214(4)(k)(2).

Early termination:
If groundwater monitoring results are below applicable Standards at the compliance boundary for three years, Duke Energy will request completion of corrective action in accordance with G.S. 130A-309.214(a)(3)b. If groundwater monitoring results are above applicable Standards, the PCMP will continue.

[1] Approved background groundwater monitoring location
[2] Geochemically non-reactive constituent (i.e., conservative corrective action COI) that best depicts the areal extent of the plume; monitors plume stability and physical attenuation
[3] The number of monitoring wells and parameters may be adjusted based on additional data and the effects of corrective action.
[4] Groundwater standards may be modified over time in accordance with 02L .0106(k)
[5] Proposed extraction well to be installed as part of the remedial alternative
Italicized parameters - parameters for general water quality to evaluate monitoring data quality
Wells indicated in red will have geochemical sondes placed to monitor geochemical conditions

FIGURES

(CAP Content Section 10)



NOTE:
WATER FEATURES DEPICTED WITHIN WASTE BOUNDARIES OF THE ASH BASINS ON THE 2016 USGS TOPOGRAPHIC MAP DO NOT REPRESENT CURRENT CONDITIONS. THE CONDITIONS DEPICTED ARE SIMILAR TO THOSE SHOWN ON THE 1968 AND 1973 USGS TOPOGRAPHIC MAPS OF THE AREA [(1968 WEST CHARLOTTE (1:24000) AND 1973 BELMONT (1:24000)].

SOURCE:
2016 USGS TOPOGRAPHIC MAP, BELMONT & CHARLOTTE WEST QUADRANGLE, OBTAINED FROM THE USGS STORE AT https://store.usgs.gov/map-locator.

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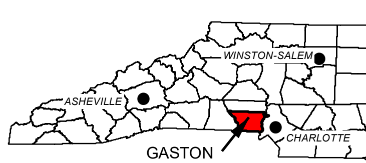

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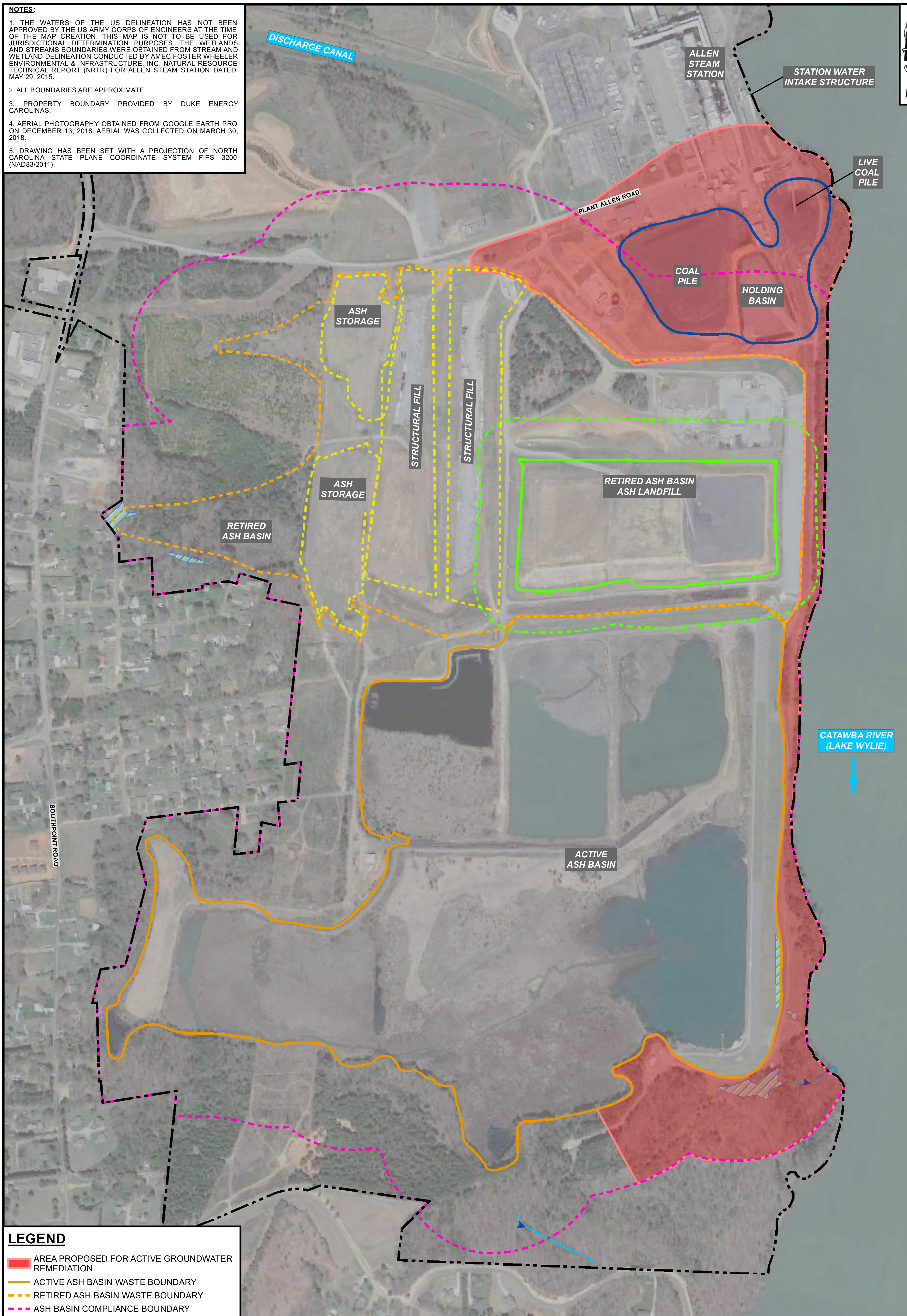
FIGURE ES-1
USGS LOCATION MAP
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA

DRAWN BY: B. YOUNG DATE: 05/02/2019
REVISED BY: C. WYATT DATE: 12/08/2019
CHECKED BY: L. DRAGO DATE: 12/08/2019
APPROVED BY: L. DRAGO DATE: 12/08/2019
PROJECT MANAGER: C. SUTTELL

GRAPHIC SCALE
1,000 0 1,000 2,000
(IN FEET)



NOTES:

1. THE WATERS OF THE US DELINEATION HAS NOT BEEN APPROVED BY THE US ARMY CORPS OF ENGINEERS AT THE TIME OF THE MAP CREATION. THIS MAP IS NOT TO BE USED FOR JURISDICTIONAL DETERMINATION PURPOSES. THE WETLANDS AND STREAMS BOUNDARIES WERE OBTAINED FROM STREAM AND WETLAND DELINEATION CONDUCTED BY AMEC FOSTER WHEELER ENVIRONMENTAL & INFRASTRUCTURE, INC. NATURAL RESOURCE TECHNICAL REPORT (NRTR) FOR ALLEN STEAM STATION DATED MAY 29, 2015.

2. ALL BOUNDARIES ARE APPROXIMATE.

3. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.

4. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON DECEMBER 13, 2018. AERIAL WAS COLLECTED ON MARCH 30, 2018.

5. DRAWING HAS BEEN SET WITH A PROJECTION OF NORTH CAROLINA STATE PLANE COORDINATE SYSTEM FIPS 3200 (NAD83/2011).

LEGEND

- AREA PROPOSED FOR ACTIVE GROUNDWATER REMEDIATION
- ACTIVE ASH BASIN WASTE BOUNDARY
- RETIRED ASH BASIN WASTE BOUNDARY
- ASH BASIN COMPLIANCE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL WASTE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL COMPLIANCE BOUNDARY
- DORS FILLS BOUNDARIES
- SITE FEATURE
- DUKE ENERGY CAROLINAS PROPERTY LINE
- STREAM (AMEC NRTR 2015)
- WETLAND (AMEC NRTR 2015)

DUKE ENERGY. CAROLINAS

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GRAPHIC SCALE
250 0 250 500
(IN FEET)

DRAWN BY: K. KING DATE: 06/19/2019
REVISED BY: J. KIRTZ DATE: 12/19/2019
APPROVED BY: L. DRAGO DATE: 12/19/2019
CHECKED BY: L. DRAGO DATE: 12/19/2019
PROGRAM MANAGER: C. SUTTELL

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FIGURE ES-2
AREA PROPOSED FOR CORRECTIVE ACTION
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA

Figure ES-3a

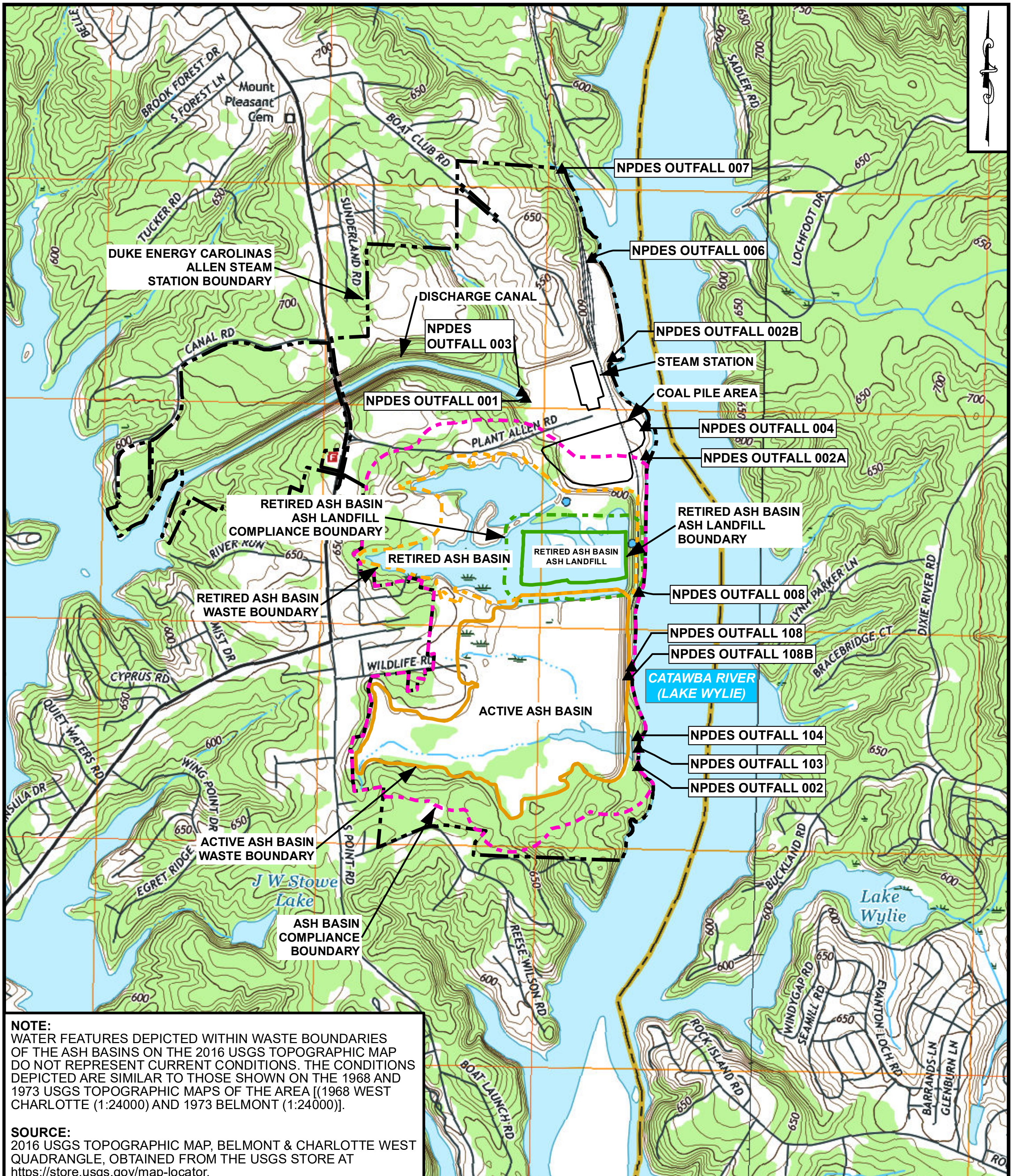
Proposed Corrective Action Approach Well System Layout (Vertical Wells Only)

Provided in separate electronic figure file as a large sheet size

ES-3b

Proposed Corrective Action Approach Well System Layout (Vertical and Horizontal Wells)

Provided in separate electronic figure file as a large sheet size



NOTE:
WATER FEATURES DEPICTED WITHIN WASTE BOUNDARIES OF THE ASH BASINS ON THE 2016 USGS TOPOGRAPHIC MAP DO NOT REPRESENT CURRENT CONDITIONS. THE CONDITIONS DEPICTED ARE SIMILAR TO THOSE SHOWN ON THE 1968 AND 1973 USGS TOPOGRAPHIC MAPS OF THE AREA [(1968 WEST CHARLOTTE (1:24000) AND 1973 BELMONT (1:24000)].

SOURCE:
2016 USGS TOPOGRAPHIC MAP, BELMONT & CHARLOTTE WEST QUADRANGLE, OBTAINED FROM THE USGS STORE AT https://store.usgs.gov/map-locator.

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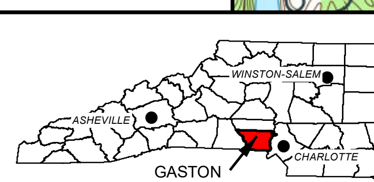

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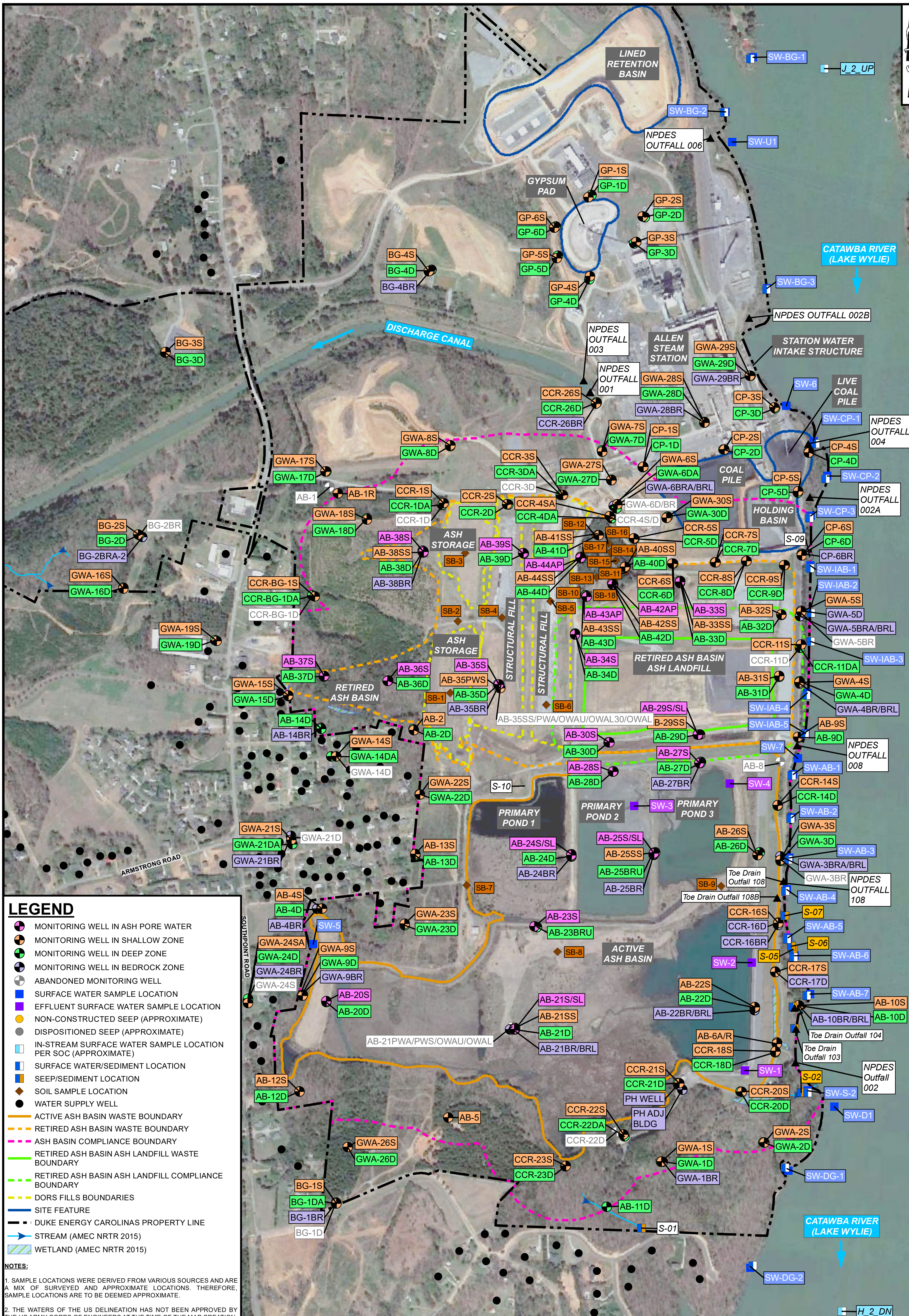
FIGURE 1-1
USGS LOCATION MAP
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA

DRAWN BY: B. YOUNG	DATE: 05/02/2019
REVISED BY: C. WYATT	DATE: 12/08/2019
CHECKED BY: L. DRAGO	DATE: 12/08/2019
APPROVED BY: L. DRAGO	DATE: 12/08/2019
PROJECT MANAGER: C. SUTTELL	

GRAPHIC SCALE
1,000 0 1,000 2,000
(IN FEET)



LEGEND

- MONITORING WELL IN ASH PORE WATER
- MONITORING WELL IN SHALLOW ZONE
- MONITORING WELL IN DEEP ZONE
- MONITORING WELL IN BEDROCK ZONE
- ABANDONED MONITORING WELL
- SURFACE WATER SAMPLE LOCATION
- EFFLUENT SURFACE WATER SAMPLE LOCATION
- NON-CONSTRUCTED SEEP (APPROXIMATE)
- DISPOSITIONED SEEP (APPROXIMATE)
- IN-STREAM SURFACE WATER SAMPLE LOCATION PER SOC (APPROXIMATE)
- SURFACE WATER/SEDIMENT LOCATION
- SEEP/SEDIMENT LOCATION
- SOIL SAMPLE LOCATION
- WATER SUPPLY WELL
- ACTIVE ASH BASIN WASTE BOUNDARY
- RETIRED ASH BASIN WASTE BOUNDARY
- ASH BASIN COMPLIANCE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL WASTE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL COMPLIANCE BOUNDARY
- DORS FILLS BOUNDARIES
- SITE FEATURE
- DUKE ENERGY CAROLINAS PROPERTY LINE
- STREAM (AMEC NRTR 2015)
- WETLAND (AMEC NRTR 2015)

NOTES:

1. SAMPLE LOCATIONS WERE DERIVED FROM VARIOUS SOURCES AND ARE A MIX OF SURVEYED AND APPROXIMATE LOCATIONS. THEREFORE, SAMPLE LOCATIONS ARE TO BE DEEMED APPROXIMATE.

2. THE WATERS OF THE US DELINEATION HAS NOT BEEN APPROVED BY THE US ARMY CORPS OF ENGINEERS AT THE TIME OF THE MAP CREATION. THIS MAP IS NOT TO BE USED FOR JURISDICTIONAL DETERMINATION PURPOSES. THE WETLANDS AND STREAMS BOUNDARIES WERE OBTAINED FROM STREAM AND WETLAND DELINEATION CONDUCTED BY AMEC FOSTER WHEELER ENVIRONMENTAL & INFRASTRUCTURE, INC. NATURAL RESOURCE TECHNICAL REPORT (NRTR) FOR ALLEN STEAM STATION DATED MAY 29, 2015.

3. ALL BOUNDARIES ARE APPROXIMATE.

4. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.

5. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON DECEMBER 13, 2018. AERIAL WAS COLLECTED ON MARCH 30, 2018.

6. DRAWING HAS BEEN SET WITH A PROJECTION OF NORTH CAROLINA STATE PLANE COORDINATE SYSTEM FIPS 3200 (NAD83).

DUKE ENERGY. CAROLINAS

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375 0 375 750

GRAPHIC SCALE IN FEET

DRAWN BY: K. KING DATE: 05/07/2019
REVISED BY: C. WYATT DATE: 12/08/2019
APPROVED BY: L. DRAGO DATE: 12/08/2019
CHECKED BY: L. DRAGO DATE: 12/08/2019
PROGRAM MANAGER: C. SUTTELL

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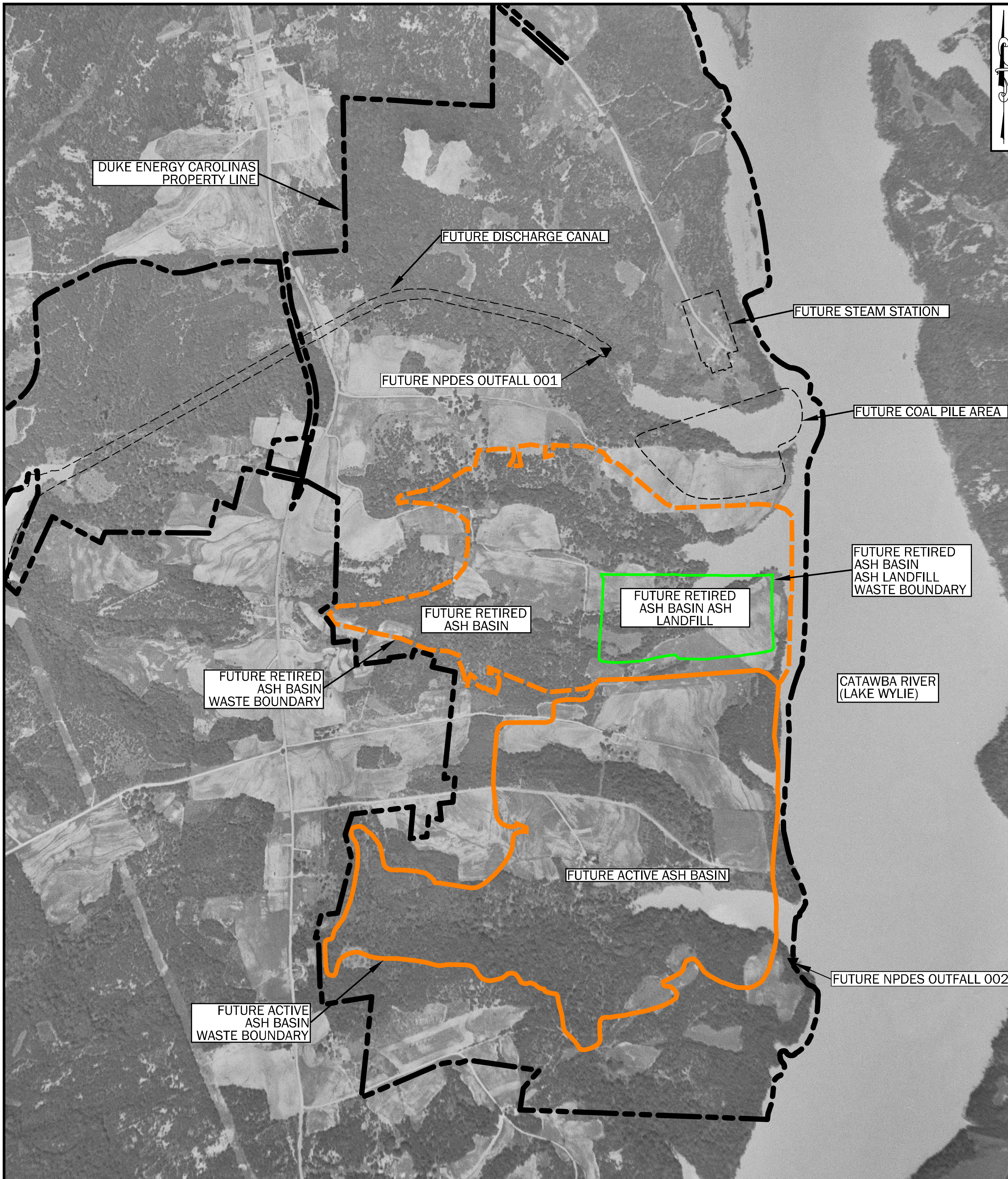
FIGURE 1-2
SITE LAYOUT MAP
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA



SOURCE:
MAY 15, 1948 AERIAL PHOTOGRAPH OBTAINED FROM THE USGS EARTH EXPLORER WEB SITE AT
http://earthexplorer.usgs.gov/

DUKE ENERGY CAROLINAS

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GRAPHIC SCALE
600 0 600 1200
IN FEET

DRAWN BY: A. FEIGL DATE: 01/28/2019
REVISED BY: C. NEWELL DATE: 12/10/2019
CHECKED BY: L. DRAGO DATE: 12/10/2019
APPROVED BY: L. DRAGO DATE: 12/10/2019
PROJECT MANAGER: C. SUTTELL

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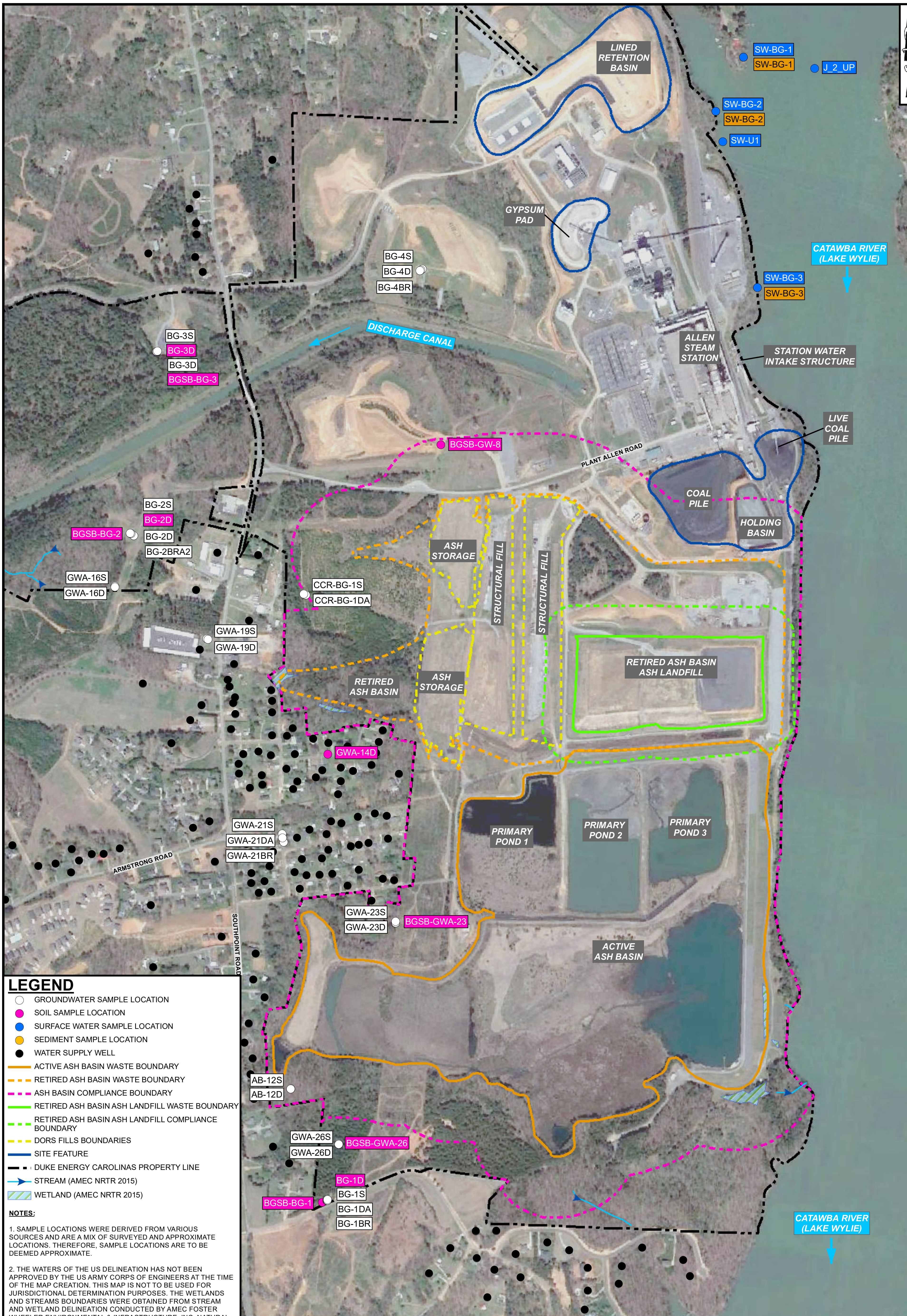
FIGURE 1-3
1948 AERIAL PHOTOGRAPH
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA



LEGEND

- GROUNDWATER SAMPLE LOCATION
- SOIL SAMPLE LOCATION
- SURFACE WATER SAMPLE LOCATION
- SEDIMENT SAMPLE LOCATION
- WATER SUPPLY WELL
- ACTIVE ASH BASIN WASTE BOUNDARY
- RETIRED ASH BASIN WASTE BOUNDARY
- ASH BASIN COMPLIANCE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL WASTE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL COMPLIANCE BOUNDARY
- DORS FILLS BOUNDARIES
- SITE FEATURE
- DUKE ENERGY CAROLINAS PROPERTY LINE
- STREAM (AMEC NRTR 2015)
- WETLAND (AMEC NRTR 2015)

NOTES:

1. SAMPLE LOCATIONS WERE DERIVED FROM VARIOUS SOURCES AND ARE A MIX OF SURVEYED AND APPROXIMATE LOCATIONS. THEREFORE, SAMPLE LOCATIONS ARE TO BE DEEMED APPROXIMATE.

2. THE WATERS OF THE US DELINEATION HAS NOT BEEN APPROVED BY THE US ARMY CORPS OF ENGINEERS AT THE TIME OF THE MAP CREATION. THIS MAP IS NOT TO BE USED FOR JURISDICTIONAL DETERMINATION PURPOSES. THE WETLANDS AND STREAMS BOUNDARIES WERE OBTAINED FROM STREAM AND WETLAND DELINEATION CONDUCTED BY AMEC FOSTER WHEELER ENVIRONMENTAL & INFRASTRUCTURE, INC. NATURAL RESOURCE TECHNICAL REPORT (NRTR) FOR ALLEN STEAM STATION DATED MAY 29, 2015.

3. ALL BOUNDARIES ARE APPROXIMATE.

4. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.

5. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON DECEMBER 13, 2018. AERIAL WAS COLLECTED ON MARCH 30, 2018.

6. DRAWING HAS BEEN SET WITH A PROJECTION OF NORTH CAROLINA STATE PLANE COORDINATE SYSTEM FIPS 3200

DUKE ENERGY CAROLINAS

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DRAWN BY: K. KING	DATE: 05/03/2019
REVISED BY: C. WYATT	DATE: 12/08/2019
CHECKED BY: L. DRAGO	DATE: 12/08/2019
APPROVED BY: L. DRAGO	DATE: 12/08/2019
PROGRAM MANAGER: C. SUTTELL	

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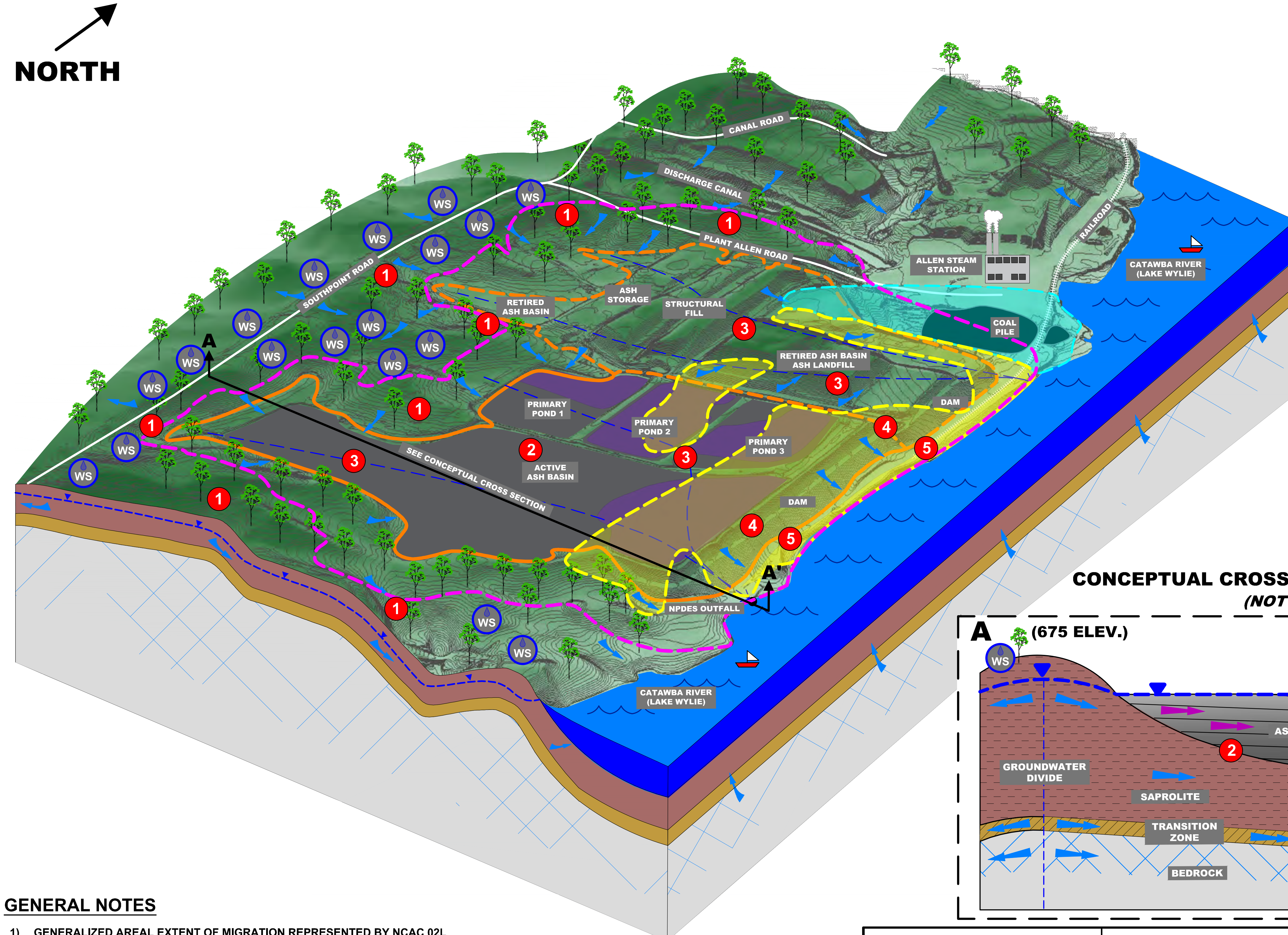
FIGURE 4-1
BACKGROUND SAMPLE LOCATION MAP
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA



SITE FEATURES KEY

1 GROUNDWATER FLOWS FROM RIDGES WEST, NORTHWEST, AND SOUTH OF THE ASH BASINS THAT COINCIDE WITH GROUNDWATER DIVIDES WHICH PROVIDE HYDRAULIC CONTROL OF CONSTITUENT MIGRATION WITHIN FORMER STREAM VALLEYS AND AWAY FROM POTENTIAL RECEPTORS AND WATER SUPPLY WELLS

2 LIMITED COI MIGRATION THROUGH SAPROLITE, TRANSITION ZONE, AND INTERCONNECTED BEDROCK FRACTURES. BEDROCK FRACTURE OCCURRENCE DIMINISHES WITH DEPTH

3 FORMER STREAM CHANNELS IN ASH BASINS

4 PONDED WATER IN THE ASH BASINS CAUSES LIMITED AREA OF DOWNWARD VERTICAL MIGRATION OF CONSTITUENTS NEAR THE DAM DUE TO ELEVATED HYDRAULIC HEAD

5 UPWARD VERTICAL GRADIENTS IN GROUNDWATER IMMEDIATELY DOWNGRADIENT OF THE ASH BASIN DAMS LIMIT DEEP VERTICAL MIGRATION OF CONSTITUENTS

AREA OF BORON CONCENTRATION IN GROUNDWATER GREATER THAN CRITERIA (SEE GENERAL NOTE 1)

AREA OF SULFATE CONCENTRATION IN GROUNDWATER GREATER THAN CRITERIA (SEE GENERAL NOTE 2)

GENERALIZED GROUNDWATER FLOW DIRECTION

GENERALIZED ASH PORE WATER FLOW DIRECTION

APPROXIMATE FORMER STREAM WITH FLOW DIRECTION

ACTIVE ASH BASIN WASTE BOUNDARY

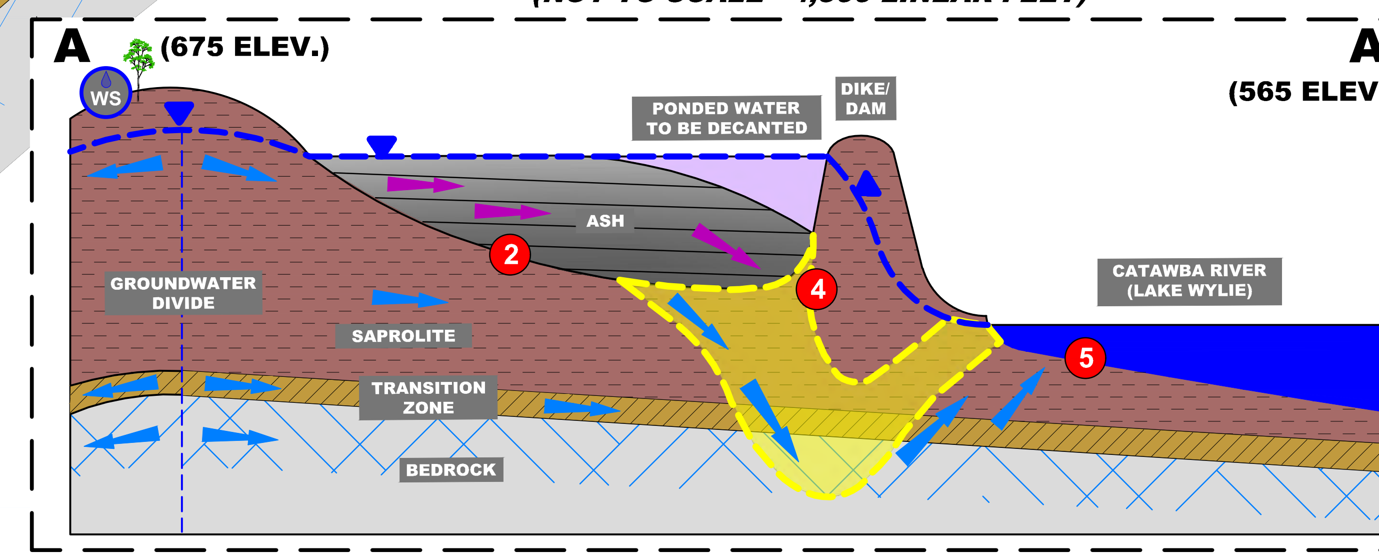
RETIRED ASH BASIN WASTE BOUNDARY

ASH BASIN COMPLIANCE BOUNDARY

WS GENERAL AREA OF WATER SUPPLY WELL USERS (SEE GENERAL NOTE 3)

CONCEPTUAL CROSS-SECTION OF PRE-DECANTING CONDITIONS

(NOT TO SCALE - 4,500 LINEAR FEET)



GENERAL NOTES

1) GENERALIZED AREAL EXTENT OF MIGRATION REPRESENTED BY NCAC 02L EXCEEDANCES OF BORON IN MULTIPLE FLOW ZONES.

2) GENERALIZED AREAL EXTENT OF MIGRATION REPRESENTED BY NCAC 02L EXCEEDANCES OF SULFATE IN MULTIPLE FLOW ZONES.

3) PERMANENT WATER SUPPLY HAS BEEN IMPLEMENTED PROVIDING 191 SURROUNDING WELL USERS WITH WATER TREATMENT SYSTEMS, THIS WORK WAS COMPLETED IN ACCORDANCE WITH HB630 AND SUBSEQUENTLY APPROVED BY NCDEQ ON OCTOBER 11, 2018.

4) ALL BOUNDARIES ARE APPROXIMATE.

DUKE ENERGY CAROLINAS

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VISUAL AID ONLY - DEPICTION NOT TO SCALE

DRAWN BY: A. FEIGL	DATE: 7/23/2019
REVISED BY: C. NEWELL	DATE: 12/9/2019
CHECKED BY: L. DRAGO	DATE: 12/9/2019
APPROVED BY: C. SUTTELL	DATE: 12/9/2019
PROJECT MANAGER: C. SUTTELL	

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FIGURE 5-1
CONCEPTUAL SITE MODEL - PRE-DECANTING CONDITIONS
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA

Figure 5-2

LeGrand Slope Aquifer System

Included in Section 5 text

Figure 5-3

Generalized Profile of Ash Basin Pre-decanting Flow Conditions in the Piedmont

Included in Section 5 text

Figure 5-4a

Water Level Map – Shallow Flow Zone – March 13, 2019

Provided in separate electronic figure file as a large sheet size

Figure 5-4b

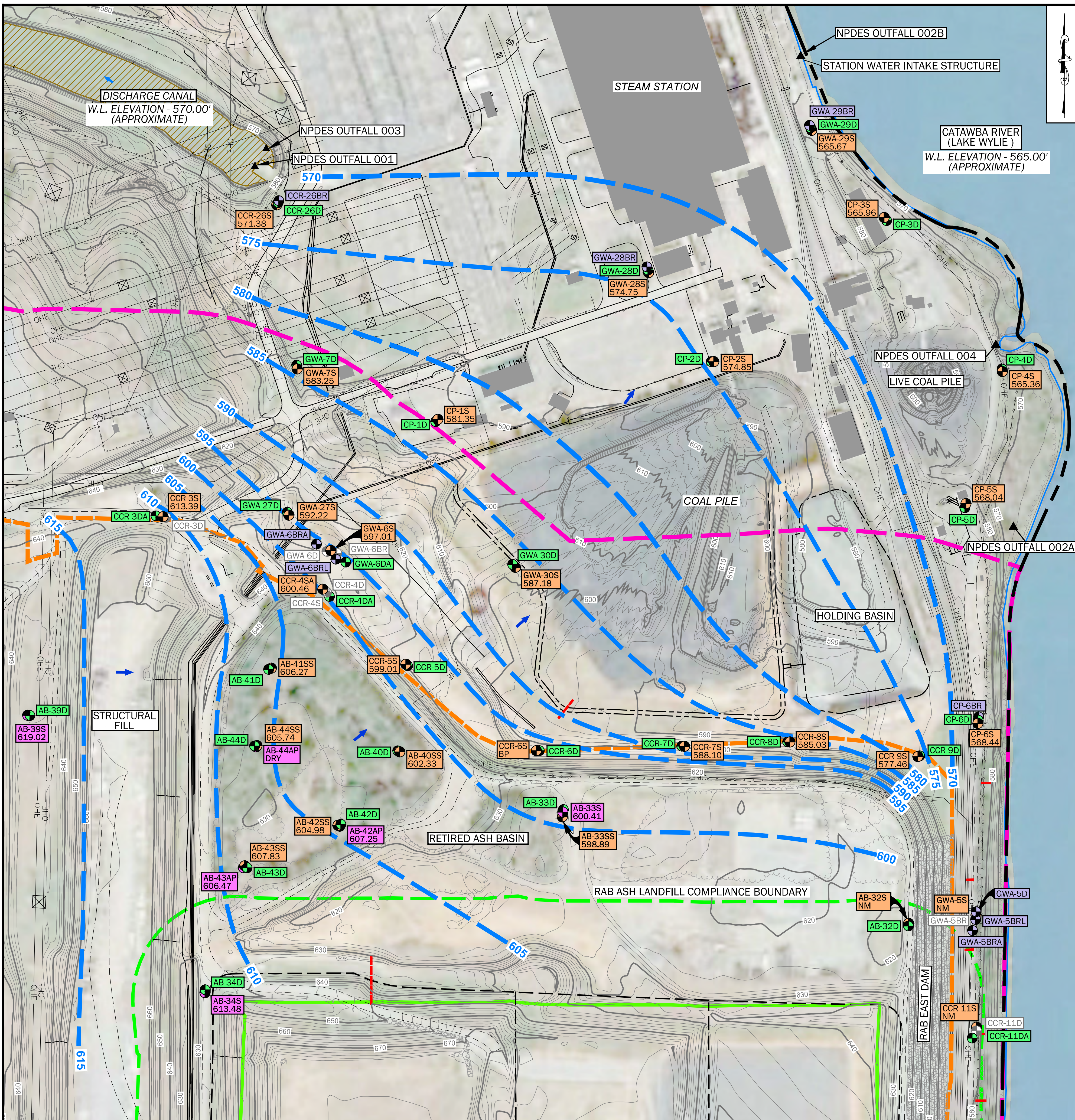
Water Level Map – Deep Flow Zone – March 13, 2019

Provided in separate electronic figure file as a large sheet size

Figure 5-4c

Water Level Map – Bedrock Flow Zone – March 13, 2019

Provided in separate electronic figure file as a large sheet size



LEGEND

Symbol	Description
630 (blue dashed line)	INFERRED WATER LEVEL IN SHALLOW ZONE *(NAVD 88, FEET)*
GWA-30S 587.18	WELL ID IN SHALLOW ZONE WATER LEVEL IN SHALLOW ZONE *(NAVD 88, FEET)*
AB-39S 619.02	WELL IN ASH PORE WATER WATER LEVEL IN ASH PORE WATER *(NAVD 88, FEET)*
GWA-9D	WELL IN DEEP ZONE
GWA-9BR	WELL IN BEDROCK ZONE
GWA-5BR	WELL ABANDONED
●	WATER SUPPLY WELL
▲ NPDES OUTFALL 002	NPDES OUTFALL (APPROXIMATE)
NM	NOT MEASURED
BP	WATER LEVEL BELOW PUMP
DRY	NO GROUNDWATER PRESENT AT THE TIME OF MEASUREMENT
	DUKE ENERGY CAROLINAS PROPERTY LINE
	ASH BASIN COMPLIANCE BOUNDARY
	RETIRED ASH BASIN WASTE BOUNDARY
	RETIRED ASH BASIN ASH LANDFILL WASTE BOUNDARY
	RETIRED ASH BASIN ASH LANDFILL COMPLIANCE BOUNDARY
	WETLAND BY AMEC FOSTER WHEELER
	STREAM (AERIAL PHOTOGRAPH & TOPOGRAPHIC MAP BASED)
	FLOW DIRECTION
	STREAM BY AMEC FOSTER WHEELER
	NPDES REGULATED WATER FEATURE
	RIP RAP
630	TOPOGRAPHIC CONTOUR (10' INTERVAL)
	TOPOGRAPHIC CONTOUR (2' INTERVAL)
	PIPING OBTAINED FROM DUKE ENERGY, STANTEC, AND SYNTERRA AOW INSPECTION.
	GROUNDWATER FLOW DIRECTION

NOTES:

1. WATER LEVELS COLLECTED OCTOBER 24, 2019.
2. NOT ALL UTILITIES ARE IDENTIFIED ON THIS DRAWING. THE UTILITIES SHOWN ON THIS DRAWING ARE VISUAL AIDS TO LOCATE THE STREAMS AND WETLANDS IN THE FIELD. THE HORIZONTAL LOCATION AND VERTICAL LOCATION HAVE NOT BEEN FIELD LOCATED ON ANY UTILITIES AND THE SHOWN LOCATIONS ARE APPROXIMATE.
3. THE TOPOGRAPHY IS BASED ON LIDAR BARE EARTH DATA OBTAINED FROM THE FRIS\NORTH CAROLINA FLOOD RISK INFORMATION SYSTEM AT http://fris.nc.gov/fris/Download.aspx?FIPS=031&ST=NC&user=General%20Public AND A DRAWING TITLED AERIAL TOPOGRAPHIC SURVEY-ALLEN STEAM STATION BY WSP, JOB NUMBER 157002.00 AND DRAWING FILE NAME APRIL 2014_ALLEN_FINAL_10-30-15.DWG
4. RETIRED ASH BASIN (RAB) LANDFILL WASTE BOUNDARY BASED LINER LIMITS IN THE S&ME DRAWINGS FOR THE RETIRED ASH BASIN (RAB) LANDFILL PHASE I, PROJECT NUMBER 7235-14-011, DATED 06-16-2015.
5. THE WATERS OF THE US DELINEATION HAS NOT BEEN APPROVED BY THE US ARMY CORPS OF ENGINEERS AT THE TIME OF THE MAP CREATION. THIS MAP IS A PRELIMINARY JURISDICTIONAL DETERMINATION ONLY. THE PRELIMINARY WETLANDS AND STREAMS BOUNDARIES WERE OBTAINED FROM AMEC FOSTER WHEELER ENVIRONMENTAL & INFRASTRUCTURE, INC. *NATURAL RESOURCE TECHNICAL REPORT (NRTR)* FOR ALLEN STEAM STATION DATED MAY 29, 2015.
6. DISPLAYED WATER SUPPLY WELL LOCATIONS REFLECT INFORMATION AVAILABLE UP TO DECEMBER 2017.
7. MARCH 03, 2018 AERIAL PHOTOGRAPH WAS OBTAINED FROM GOOGLE EARTH AT https://www.google.com/maps/.
9. ALL BOUNDARIES ARE APPROXIMATE.

DUKE ENERGY
CAROLINAS

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GRAPHIC SCALE
250 0 125 250 500
(IN FEET)

DRAWN BY: J. CHASTAIN	DATE: 2/21/2018
REVISED BY: C. NEWELL	DATE: 12/12/2019
CHECKED BY: L. DRAGO	DATE: 12/12/2019
APPROVED BY: C. SUTTELL	DATE: 12/12/2019
PROJECT MANAGER: C. SUTTELL	

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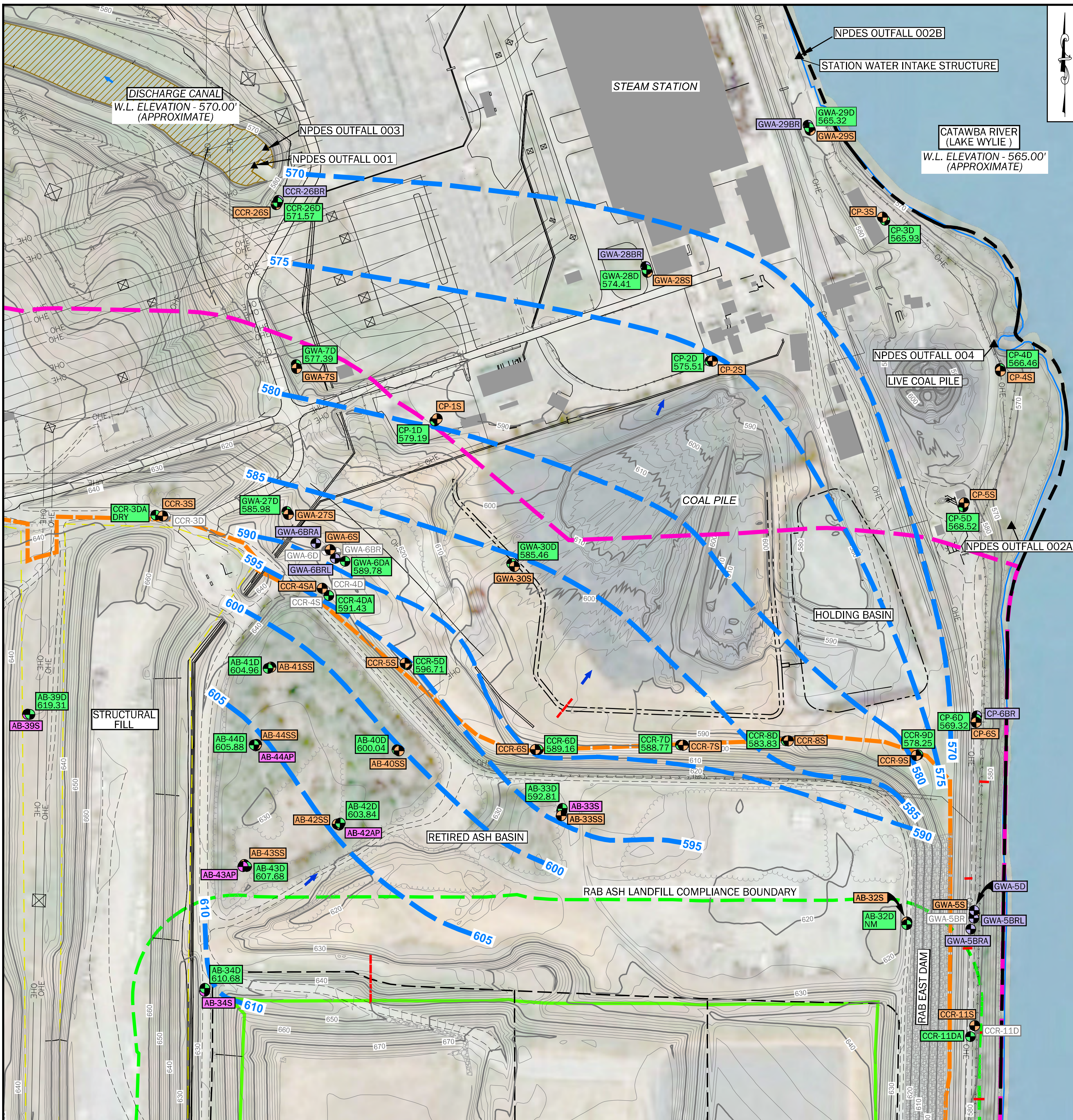
FIGURE 5-4d
WATER LEVEL MAP
SHALLOW FLOW ZONE
(OCTOBER 2019)
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA



LEGEND

- INFERRED WATER LEVEL IN DEEP ZONE *(NAVD 88, FEET)* (630)
- GWA-29D 565.32 — WELL ID IN DEEP ZONE; WATER LEVEL IN DEEP ZONE *(NAVD 88, FEET)*
- AB-20S — WELL IN ASH PORE WATER
- GWA-26S — WELL IN SHALLOW ZONE
- GWA-9BR — WELL IN BEDROCK ZONE
- GWA-5BR — WELL ABANDONED
- WATER SUPPLY WELL
- NPDES OUTFALL 002 — NPDES OUTFALL (APPROXIMATE)
- NM — NOT MEASURED
- BP — WATER LEVEL BELOW PUMP
- DRY — NO GROUNDWATER PRESENT AT THE TIME OF MEASUREMENT
- DUKE ENERGY CAROLINAS PROPERTY LINE
- ASH BASIN COMPLIANCE BOUNDARY
- RETIRED ASH BASIN WASTE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL WASTE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL COMPLIANCE BOUNDARY
- WETLAND BY AMEC FOSTER WHEELER
- STREAM (AERIAL PHOTOGRAPH & TOPOGRAPHIC MAP BASED)
- FLOW DIRECTION
- STREAM BY AMEC FOSTER WHEELER
- NPDES REGULATED WATER FEATURE
- RIP RAP
- TOPOGRAPHIC CONTOUR (10' INTERVAL) (630)
- TOPOGRAPHIC CONTOUR (2' INTERVAL)
- PIPING OBTAINED FROM DUKE ENERGY, STANTEC, AND SYNTERRA AOW INSPECTION.
- GROUNDWATER FLOW DIRECTION

NOTES:

1. WATER LEVELS COLLECTED OCTOBER 24, 2019.
2. NOT ALL UTILITIES ARE IDENTIFIED ON THIS DRAWING. THE UTILITIES SHOWN ON THIS DRAWING ARE VISUAL AIDS TO LOCATE THE STREAMS AND WETLANDS IN THE FIELD. THE HORIZONTAL LOCATION AND VERTICAL LOCATION HAVE NOT BEEN FIELD LOCATED ON ANY UTILITIES AND THE SHOWN LOCATIONS ARE APPROXIMATE.
3. THE TOPOGRAPHY IS BASED ON LIDAR BARE EARTH DATA OBTAINED FROM THE FRIS\NORTH CAROLINA FLOOD RISK INFORMATION SYSTEM AT http://fris.nc.gov/fris/Download.aspx?FIPS=031&ST=NC&user=General%20Public AND A DRAWING TITLED AERIAL TOPOGRAPHIC SURVEY-ALLEN STEAM STATION BY WSP, JOB NUMBER 157002.00 AND DRAWING FILE NAME APRIL 2014_ALLEN_FINAL_10-30-15.DWG
4. RETIRED ASH BASIN (RAB) LANDFILL WASTE BOUNDARY BASED LINER LIMITS IN THE S&ME DRAWINGS FOR THE RETIRED ASH BASIN (RAB) LANDFILL PHASE I, PROJECT NUMBER 7235-14-011, DATED 06-16-2015.
5. THE WATERS OF THE US DELINEATION HAS NOT BEEN APPROVED BY THE US ARMY CORPS OF ENGINEERS AT THE TIME OF THE MAP CREATION. THIS MAP IS A PRELIMINARY JURISDICTIONAL DETERMINATION ONLY. THE PRELIMINARY WETLANDS AND STREAMS BOUNDARIES WERE OBTAINED FROM AMEC FOSTER WHEELER ENVIRONMENTAL & INFRASTRUCTURE, INC. *NATURAL RESOURCE TECHNICAL REPORT (NRTR)* FOR ALLEN STEAM STATION DATED MAY 29, 2015.
6. DISPLAYED WATER SUPPLY WELL LOCATIONS REFLECT INFORMATION AVAILABLE UP TO DECEMBER 2017.
7. MARCH 03, 2018 AERIAL PHOTOGRAPH WAS OBTAINED FROM GOOGLE EARTH AT https://www.google.com/maps/.
9. ALL BOUNDARIES ARE APPROXIMATE.

DUKE ENERGY CAROLINAS

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GRAPHIC SCALE
250 0 125 250 500
(IN FEET)

DRAWN BY: J. CHASTAIN	DATE: 2/21/2018
REVISED BY: C. NEWELL	DATE: 12/12/2019
CHECKED BY: L. DRAGO	DATE: 12/12/2019
APPROVED BY: C. SUTTELL	DATE: 12/12/2019
PROJECT MANAGER: C. SUTTELL	

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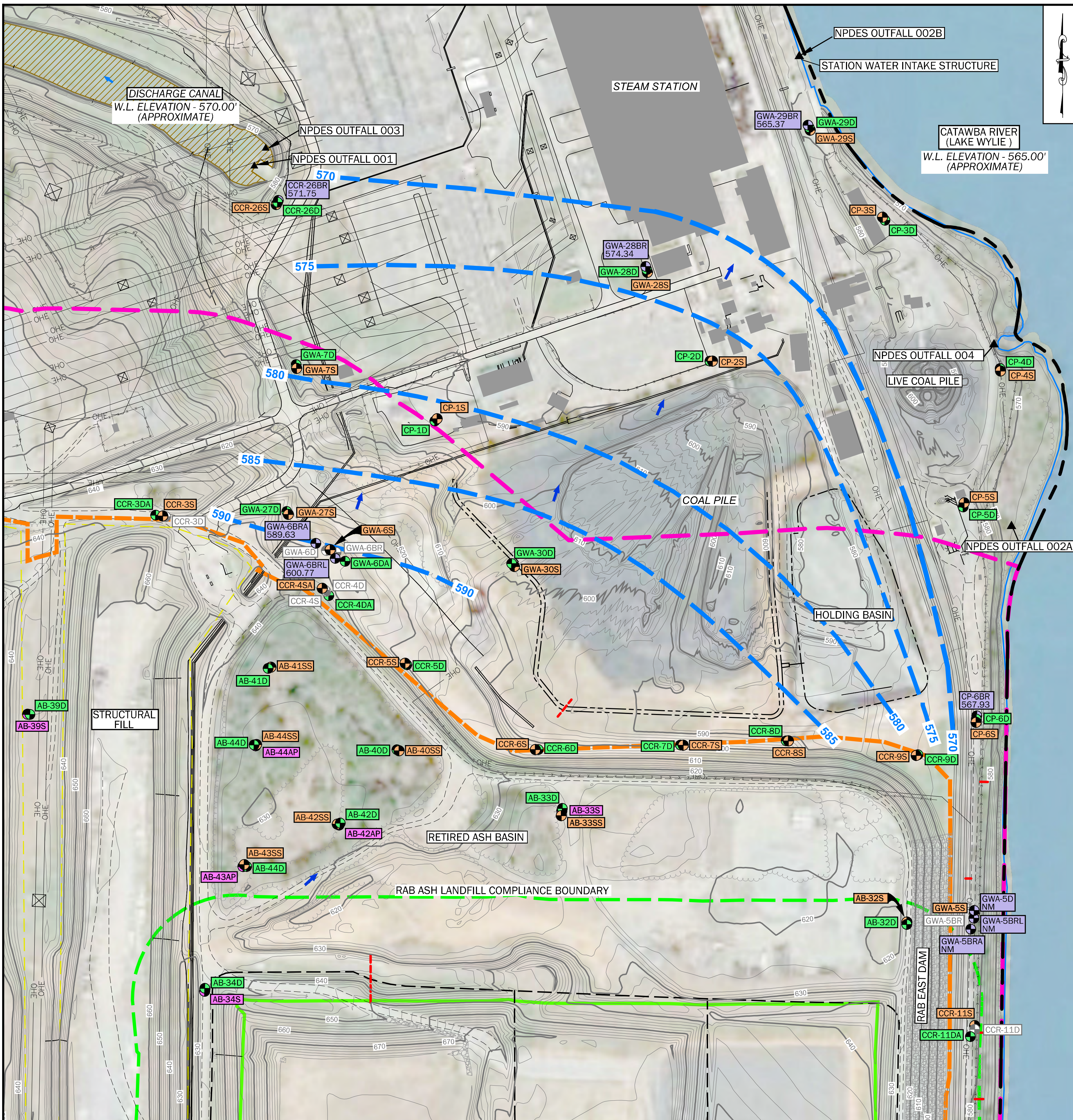
FIGURE 5-4e
WATER LEVEL MAP
DEEP FLOW ZONE
(OCTOBER 2019)
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA



LEGEND

630	INFERRED WATER LEVEL IN BEDROCK ZONE *(NAVD 88, FEET)*
GWA-9BR 638.19	WELL ID IN BEDROCK ZONE WATER LEVEL IN BEDROCK ZONE *(NAVD 88, FEET)*
AB-20S	WELL IN ASH PORE WATER
GWA-26S	WELL IN SHALLOW ZONE
GWA-9D	WELL IN DEEP ZONE
GWA-5BR	WELL ABANDONED
	WATER SUPPLY WELL
NPDES OUTFALL 002	NPDES OUTFALL (APPROXIMATE)
NM	NOT MEASURED
	DUKE ENERGY CAROLINAS PROPERTY LINE
	ASH BASIN COMPLIANCE BOUNDARY
	RETIRED ASH BASIN WASTE BOUNDARY
	RETIRED ASH BASIN ASH LANDFILL WASTE BOUNDARY
	RETIRED ASH BASIN ASH LANDFILL COMPLIANCE BOUNDARY
	WETLAND BY AMEC FOSTER WHEELER
	STREAM (AERIAL PHOTOGRAPH & TOPOGRAPHIC MAP BASED)
	FLOW DIRECTION
	STREAM BY AMEC FOSTER WHEELER
	NPDES REGULATED WATER FEATURE
	RIP RAP
630	TOPOGRAPHIC CONTOUR (10' INTERVAL)
	TOPOGRAPHIC CONTOUR (2' INTERVAL)
	PIPING OBTAINED FROM DUKE ENERGY, STANTEC, AND SYNTERRA AOW INSPECTION.
	GROUNDWATER FLOW DIRECTION

NOTES:

1. WATER LEVELS COLLECTED OCTOBER 24, 2019.
2. NOT ALL UTILITIES ARE IDENTIFIED ON THIS DRAWING. THE UTILITIES SHOWN ON THIS DRAWING ARE VISUAL AIDS TO LOCATE THE STREAMS AND WETLANDS IN THE FIELD. THE HORIZONTAL LOCATION AND VERTICAL LOCATION HAVE NOT BEEN FIELD LOCATED ON ANY UTILITIES AND THE SHOWN LOCATIONS ARE APPROXIMATE.
3. THE TOPOGRAPHY IS BASED ON LIDAR BARE EARTH DATA OBTAINED FROM THE FRIS\NORTH CAROLINA FLOOD RISK INFORMATION SYSTEM AT http://fris.nc.gov/fris/Download.aspx?FIPS=031&ST=NC&user=General%20Public AND A DRAWING TITLED AERIAL TOPOGRAPHIC SURVEY-ALLEN STEAM STATION BY WSP, JOB NUMBER 157002.00 AND DRAWING FILE NAME APRIL 2014_ALLEN_FINAL_10-30-15.DWG
4. RETIRED ASH BASIN (RAB) LANDFILL WASTE BOUNDARY BASED LINER LIMITS IN THE S&ME DRAWINGS FOR THE RETIRED ASH BASIN (RAB) LANDFILL PHASE I, PROJECT NUMBER 7235-14-011, DATED 06-16-2015.
5. THE WATERS OF THE US DELINEATION HAS NOT BEEN APPROVED BY THE US ARMY CORPS OF ENGINEERS AT THE TIME OF THE MAP CREATION. THIS MAP IS A PRELIMINARY JURISDICTIONAL DETERMINATION ONLY. THE PRELIMINARY WETLANDS AND STREAMS BOUNDARIES WERE OBTAINED FROM AMEC FOSTER WHEELER ENVIRONMENTAL & INFRASTRUCTURE, INC. *NATURAL RESOURCE TECHNICAL REPORT (NRTR)* FOR ALLEN STEAM STATION DATED MAY 29, 2015.
6. DISPLAYED WATER SUPPLY WELL LOCATIONS REFLECT INFORMATION AVAILABLE UP TO DECEMBER 2017.
7. MARCH 03, 2018 AERIAL PHOTOGRAPH WAS OBTAINED FROM GOGGLE EARTH AT https://www.goggle.com/maps/.
9. ALL BOUNDARIES ARE APPROXIMATE.

DUKE ENERGY CAROLINAS

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GRAPHIC SCALE

250 0 125 250 500

(IN FEET)

DRAWN BY: J. CHASTAIN	DATE: 2/21/2018
REVISED BY: C. NEWELL	DATE: 12/12/2019
CHECKED BY: L. DRAGO	DATE: 12/12/2019
APPROVED BY: C. SUTTELL	DATE: 12/12/2019
PROJECT MANAGER: C. SUTTELL	

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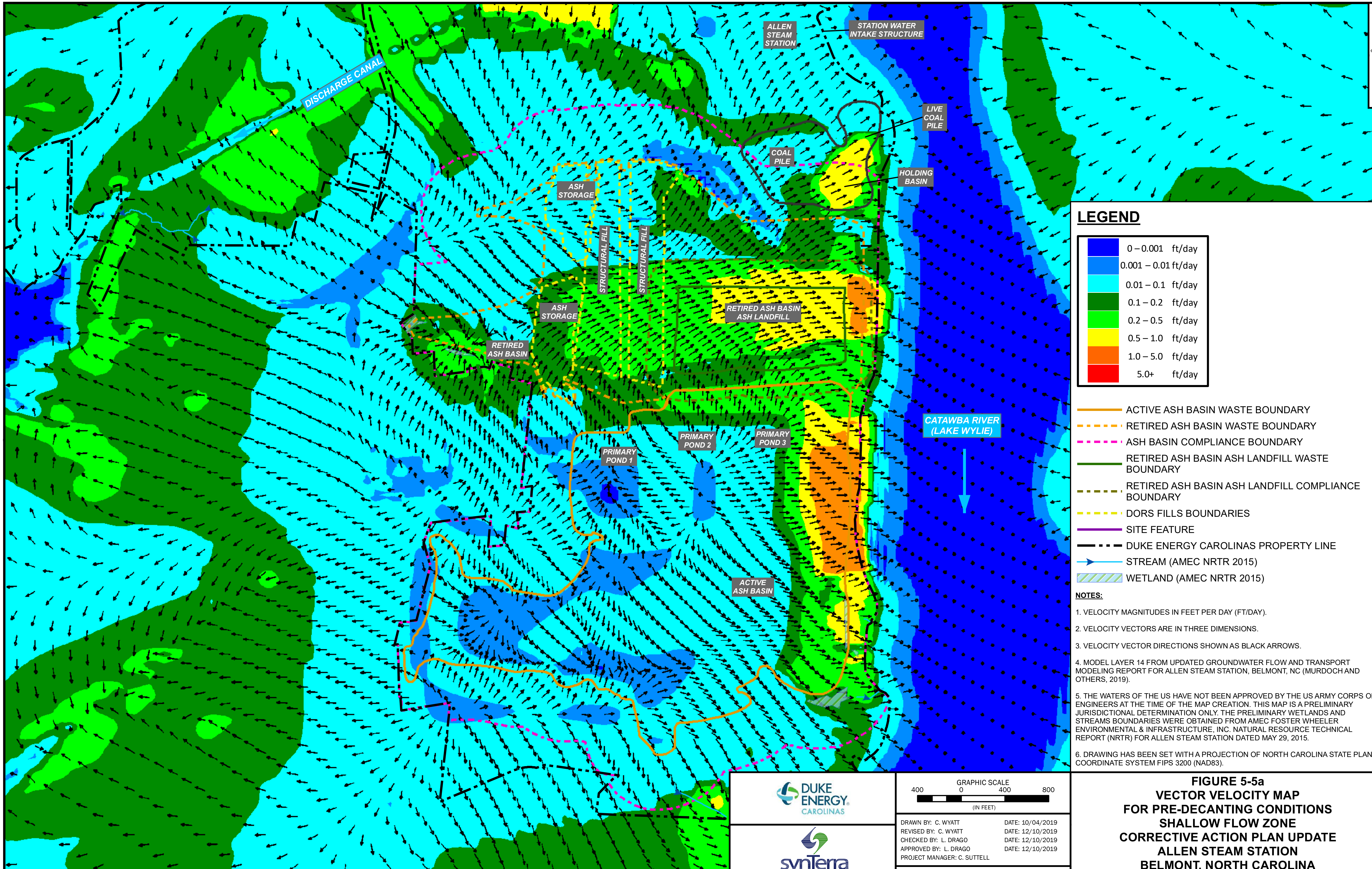
FIGURE 5-4f
WATER LEVEL MAP
BEDROCK FLOW ZONE
(OCTOBER 2019)
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA



LEGEND

0 – 0.001	ft/day
0.001 – 0.01	ft/day
0.01 – 0.1	ft/day
0.1 – 0.2	ft/day
0.2 – 0.5	ft/day
0.5 – 1.0	ft/day
1.0 – 5.0	ft/day
5.0+	ft/day

- ACTIVE ASH BASIN WASTE BOUNDARY
- RETIRED ASH BASIN WASTE BOUNDARY
- ASH BASIN COMPLIANCE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL WASTE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL COMPLIANCE BOUNDARY
- DORS FILLS BOUNDARIES
- SITE FEATURE
- DUKE ENERGY CAROLINAS PROPERTY LINE
- STREAM (AMEC NRTR 2015)
- WETLAND (AMEC NRTR 2015)

NOTES:

1. VELOCITY MAGNITUDES IN FEET PER DAY (FT/DAY).
2. VELOCITY VECTORS ARE IN THREE DIMENSIONS.
3. VELOCITY VECTOR DIRECTIONS SHOWN AS BLACK ARROWS.
4. MODEL LAYER 14 FROM UPDATED GROUNDWATER FLOW AND TRANSPORT MODELING REPORT FOR ALLEN STEAM STATION, BELMONT, NC (MURDOCH AND OTHERS, 2019).
5. THE WATERS OF THE US HAVE NOT BEEN APPROVED BY THE US ARMY CORPS OF ENGINEERS AT THE TIME OF THE MAP CREATION. THIS MAP IS A PRELIMINARY JURISDICTIONAL DETERMINATION ONLY. THE PRELIMINARY WETLANDS AND STREAMS BOUNDARIES WERE OBTAINED FROM AMEC FOSTER WHEELER ENVIRONMENTAL & INFRASTRUCTURE, INC. NATURAL RESOURCE TECHNICAL REPORT (NRTR) FOR ALLEN STEAM STATION DATED MAY 29, 2015.
6. DRAWING HAS BEEN SET WITH A PROJECTION OF NORTH CAROLINA STATE PLANE COORDINATE SYSTEM FIPS 3200 (NAD83).

DUKE ENERGY CAROLINAS

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GRAPHIC SCALE
400 0 400 800
(IN FEET)

DRAWN BY: C. WYATT DATE: 10/04/2019
REVISED BY: C. WYATT DATE: 12/10/2019
CHECKED BY: L. DRAGO DATE: 12/10/2019
APPROVED BY: L. DRAGO DATE: 12/10/2019
PROJECT MANAGER: C. SUTTELL

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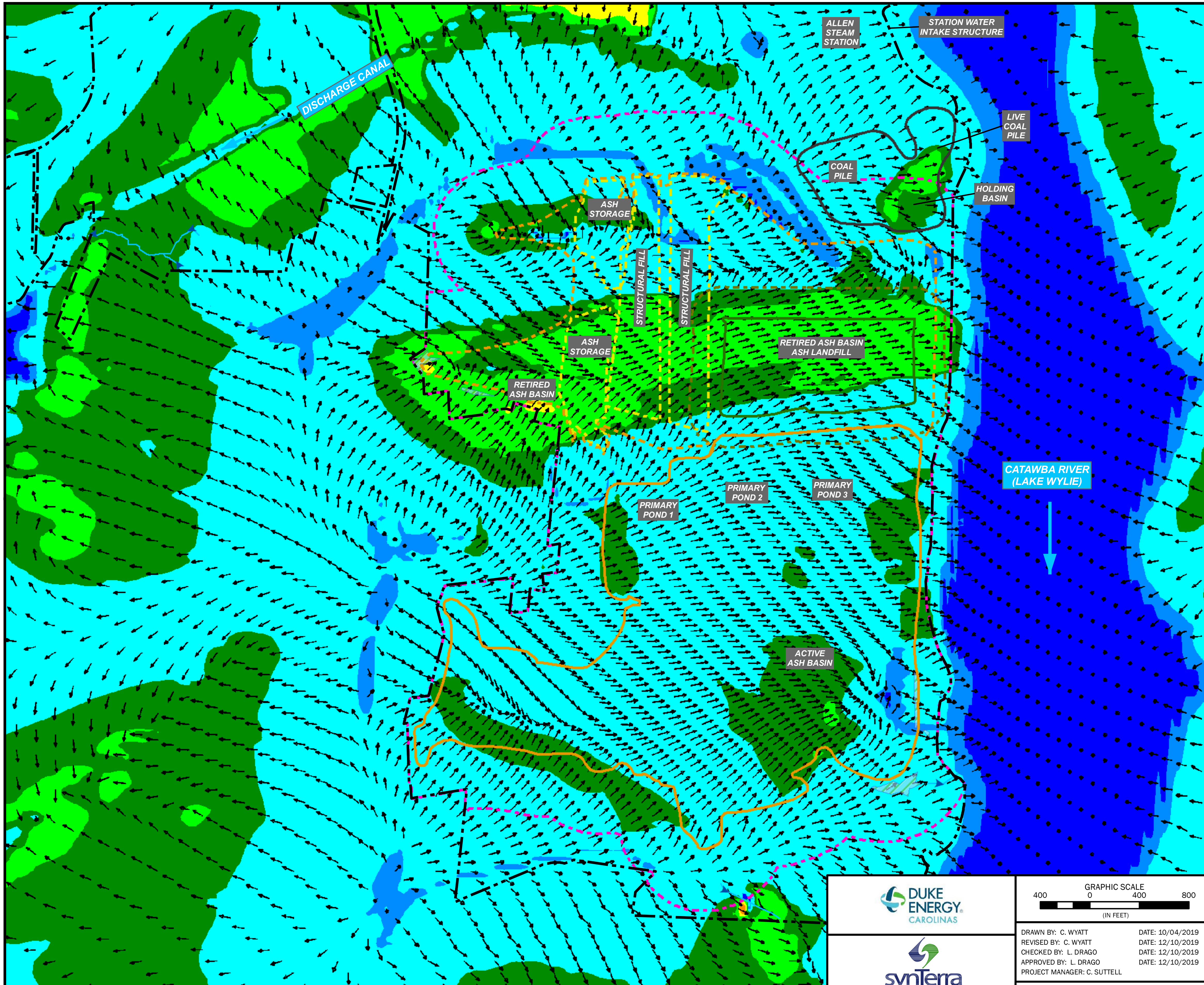
FIGURE 5-5a
VECTOR VELOCITY MAP
FOR PRE-DECANTING CONDITIONS
SHALLOW FLOW ZONE
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA



LEGEND

0 – 0.001	ft/day
0.001 – 0.01	ft/day
0.01 – 0.1	ft/day
0.1 – 0.2	ft/day
0.2 – 0.5	ft/day
0.5 – 1.0	ft/day
1.0 – 5.0	ft/day
5.0+	ft/day

ACTIVE ASH BASIN WASTE BOUNDARY

RETIRED ASH BASIN WASTE BOUNDARY

ASH BASIN COMPLIANCE BOUNDARY

RETIRED ASH BASIN ASH LANDFILL WASTE BOUNDARY

RETIRED ASH BASIN ASH LANDFILL COMPLIANCE BOUNDARY

DORS FILLS BOUNDARIES

SITE FEATURE

DUKE ENERGY CAROLINAS PROPERTY LINE

STREAM (AMEC NRTR 2015)

WETLAND (AMEC NRTR 2015)

NOTES:

1. VELOCITY MAGNITUDES IN FEET PER DAY (FT/DAY).

2. VELOCITY VECTORS ARE IN THREE DIMENSIONS.

3. VELOCITY VECTOR DIRECTIONS SHOWN AS BLACK ARROWS.

4. MODEL LAYER 14 FROM UPDATED GROUNDWATER FLOW AND TRANSPORT MODELING REPORT FOR ALLEN STEAM STATION, BELMONT, NC (MURDOCH AND OTHERS, 2019).

5. THE WATERS OF THE US HAVE NOT BEEN APPROVED BY THE US ARMY CORPS OF ENGINEERS AT THE TIME OF THE MAP CREATION. THIS MAP IS A PRELIMINARY JURISDICTIONAL DETERMINATION ONLY. THE PRELIMINARY WETLANDS AND STREAMS BOUNDARIES WERE OBTAINED FROM AMEC FOSTER WHEELER ENVIRONMENTAL & INFRASTRUCTURE, INC. NATURAL RESOURCE TECHNICAL REPORT (NRTR) FOR ALLEN STEAM STATION DATED MAY 29, 2015.

6. DRAWING HAS BEEN SET WITH A PROJECTION OF NORTH CAROLINA STATE PLANE COORDINATE SYSTEM FIPS 3200 (NAD83).

DUKE ENERGY CAROLINAS

synTerra

GRAPHIC SCALE

400 0 400 800

(IN FEET)

DRAWN BY: C. WYATT	DATE: 10/04/2019
REVISED BY: C. WYATT	DATE: 12/10/2019
CHECKED BY: L. DRAGO	DATE: 12/10/2019
APPROVED BY: L. DRAGO	DATE: 12/10/2019
PROJECT MANAGER: C. SUTTELL	

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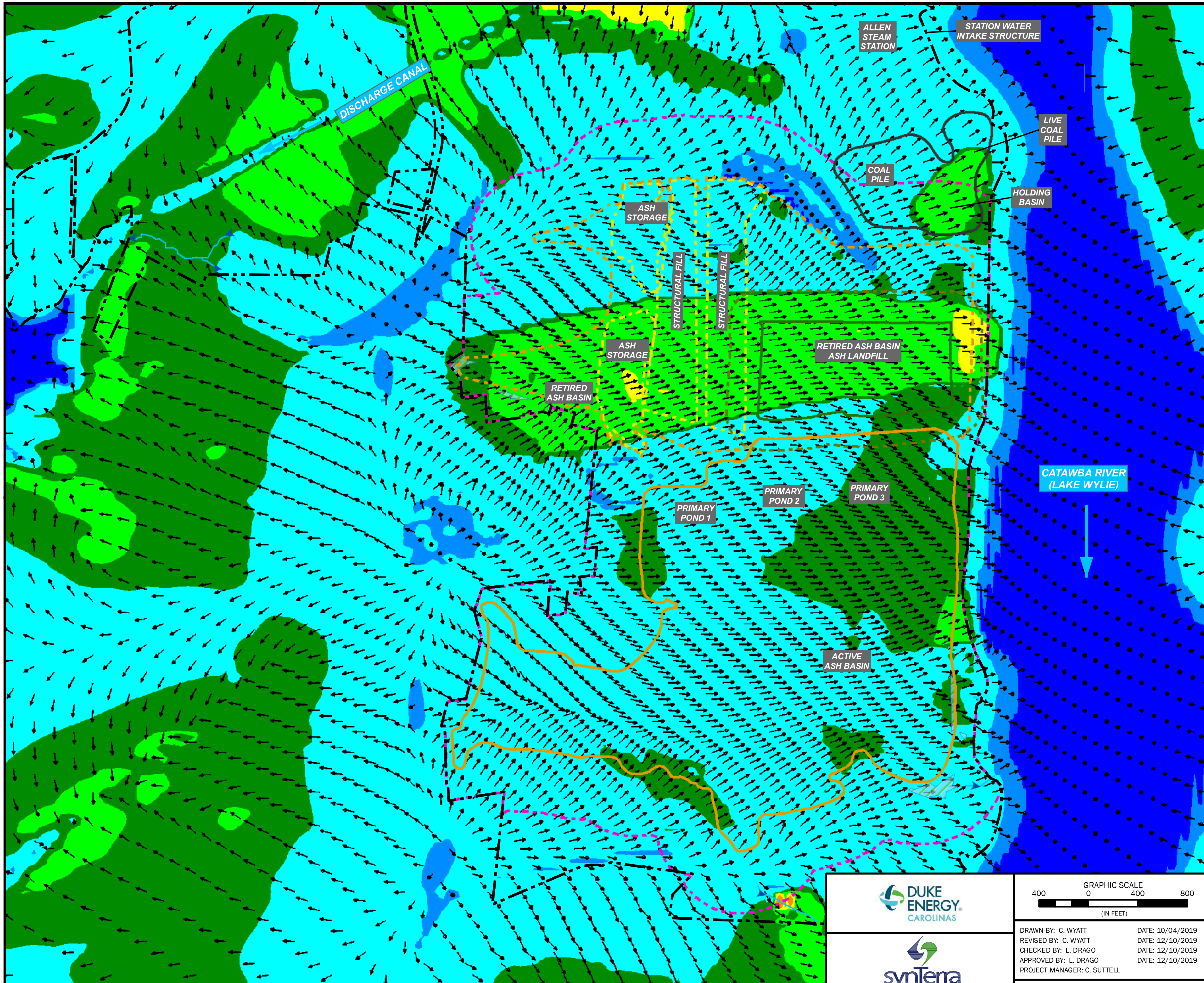
FIGURE 5-5b
VECTOR VELOCITY MAP FOR CLOSURE-BY-EXCAVATION CONDITIONS SHALLOW FLOW ZONE CORRECTIVE ACTION PLAN UPDATE ALLEN STEAM STATION BELMONT, NORTH CAROLINA



NOTES:

1. VELOCITY MAGNITUDES IN FEET PER DAY (FT/DAY).

2. VELOCITY VECTORS ARE IN THREE DIMENSIONS.

3. VELOCITY VECTOR DIRECTIONS SHOWN AS BLACK ARROWS.

4. MODEL LAYER 14 FROM UPDATED GROUNDWATER FLOW AND TRANSPORT MODELING REPORT FOR ALLEN STEAM STATION, BELMONT, NC (MURDOCH AND OTHERS, 2019).

5. THE WATERS OF THE US HAVE NOT BEEN APPROVED BY THE US ARMY CORPS OF ENGINEERS AT THE TIME OF THE MAP CREATION. THIS MAP IS A PRELIMINARY JURISDICTIONAL DETERMINATION ONLY. THE PRELIMINARY WETLANDS AND STREAMS BOUNDARIES WERE OBTAINED FROM AMEC FOSTER WHEELER ENVIRONMENTAL & INFRASTRUCTURE, INC. NATURAL RESOURCE TECHNICAL REPORT (NRTR) FOR ALLEN STEAM STATION DATED MAY 29, 2015.

6. DRAWING HAS BEEN SET WITH A PROJECTION OF NORTH CAROLINA STATE PLANE COORDINATE SYSTEM FIPS 3200 (NAD83).

DUKE ENERGY CAROLINAS

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DRAWN BY: C. WYATT — DATE: 10/04/2019
REVISED BY: C. WYATT — DATE: 12/10/2019
CHECKED BY: L. DRAGO — DATE: 12/10/2019
APPROVED BY: L. DRAGO — DATE: 12/10/2019
PROJECT MANAGER: C. SUTTELL

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FIGURE 5-5c
VECTOR VELOCITY MAP FOR CLOSURE-IN-PLACE CONDITIONS SHALLOW FLOW ZONE
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA

NOTES:

1. THE CATAWBA RIVER (LAKE WYLIE) IS A RECEIVING WATERBODY (CLASS B, WS-V) COVERED BY SOC NO. S17-009.

2. GROUNDWATER TO SURFACE WATER (02L-02B) SAMPLES WERE COLLECTED TO ASSESS WHETHER GROUNDWATER MIGRATION IS CAUSING CONSTITUENT CONCENTRATIONS IN THE CATAWBA RIVER (LAKE WYLIE) TO BE GREATER THAN THE APPLICABLE 02B STANDARDS. 02L-02B SAMPLING WAS CONDUCTED FROM AUGUST 20 – AUGUST 23, 2018 FOLLOWING DIVISION APPROVED PROTOCOLS. IN THE FIVE DAYS PRIOR TO SAMPLING, A TOTAL OF 0.76 INCHES OF RAINFALL WAS OBSERVED AT ALLEN STEAM STATION. DURING THE FOUR DAY SAMPLING EVENT, A TOTAL OF 0.05 INCHES OF RAINFALL WAS OBSERVED AT ALLEN STEAM STATION.

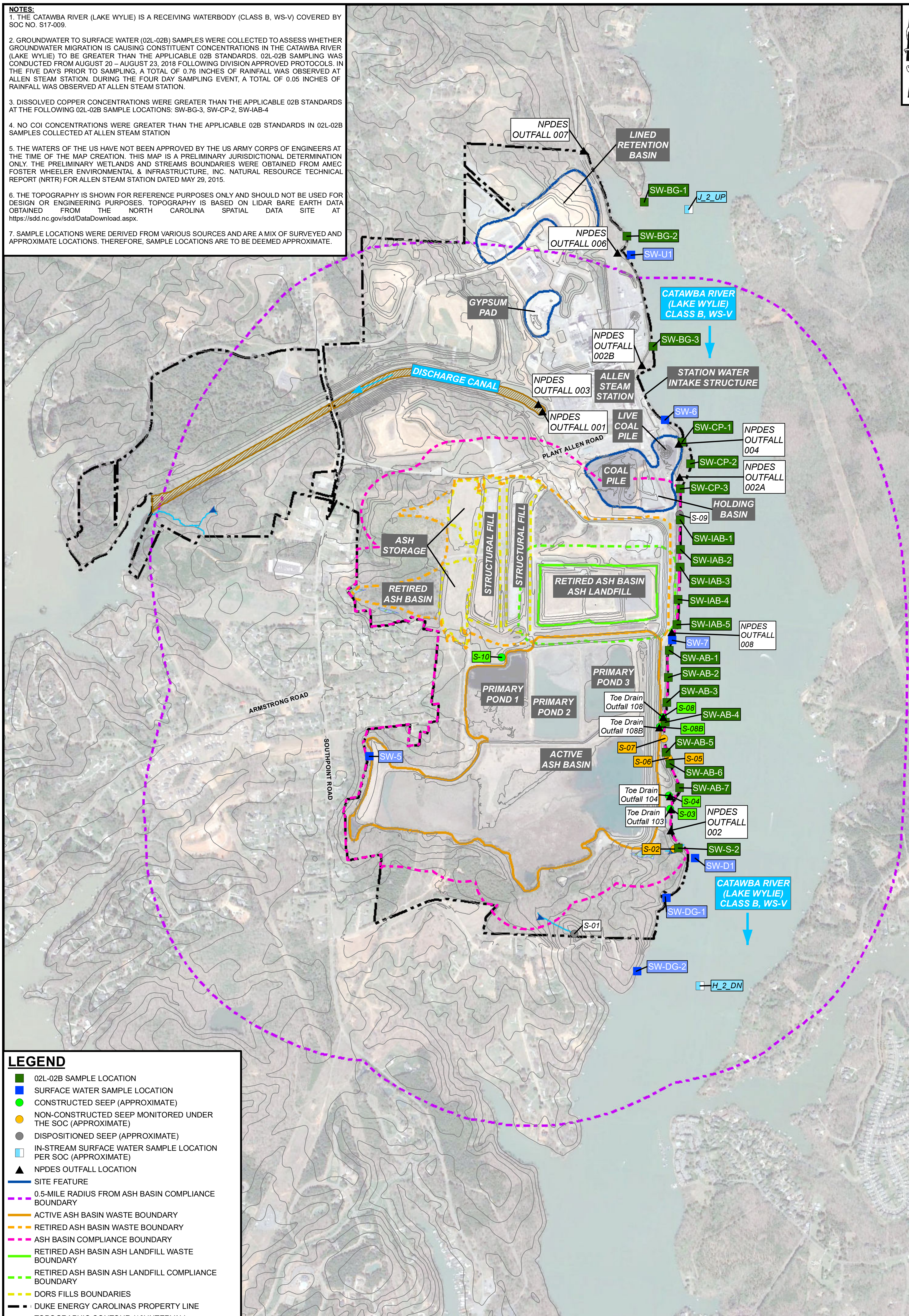
3. DISSOLVED COPPER CONCENTRATIONS WERE GREATER THAN THE APPLICABLE 02B STANDARDS AT THE FOLLOWING 02L-02B SAMPLE LOCATIONS: SW-BG-3, SW-CP-2, SW-IAB-4

4. NO COI CONCENTRATIONS WERE GREATER THAN THE APPLICABLE 02B STANDARDS IN 02L-02B SAMPLES COLLECTED AT ALLEN STEAM STATION

5. THE WATERS OF THE US HAVE NOT BEEN APPROVED BY THE US ARMY CORPS OF ENGINEERS AT THE TIME OF THE MAP CREATION. THIS MAP IS A PRELIMINARY JURISDICTIONAL DETERMINATION ONLY. THE PRELIMINARY WETLANDS AND STREAMS BOUNDARIES WERE OBTAINED FROM AMEC FOSTER WHEELER ENVIRONMENTAL & INFRASTRUCTURE, INC. NATURAL RESOURCE TECHNICAL REPORT (NRTR) FOR ALLEN STEAM STATION DATED MAY 29, 2015.

6. THE TOPOGRAPHY IS SHOWN FOR REFERENCE PURPOSES ONLY AND SHOULD NOT BE USED FOR DESIGN OR ENGINEERING PURPOSES. TOPOGRAPHY IS BASED ON LIDAR BARE EARTH DATA OBTAINED FROM THE NORTH CAROLINA SPATIAL DATA SITE AT https://sdd.nc.gov/sdd/DataDownload.aspx.

7. SAMPLE LOCATIONS WERE DERIVED FROM VARIOUS SOURCES AND ARE A MIX OF SURVEYED AND APPROXIMATE LOCATIONS. THEREFORE, SAMPLE LOCATIONS ARE TO BE DEEMED APPROXIMATE.



LEGEND

- 02L-02B SAMPLE LOCATION
- SURFACE WATER SAMPLE LOCATION
- CONSTRUCTED SEEP (APPROXIMATE)
- NON-CONSTRUCTED SEEP MONITORED UNDER THE SOC (APPROXIMATE)
- DISPOSITIONED SEEP (APPROXIMATE)
- IN-STREAM SURFACE WATER SAMPLE LOCATION PER SOC (APPROXIMATE)
- NPDES OUTFALL LOCATION
- SITE FEATURE
- 0.5-MILE RADIUS FROM ASH BASIN COMPLIANCE BOUNDARY
- ACTIVE ASH BASIN WASTE BOUNDARY
- RETIRED ASH BASIN WASTE BOUNDARY
- ASH BASIN COMPLIANCE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL WASTE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL COMPLIANCE BOUNDARY
- DORS FILLS BOUNDARIES
- DUKE ENERGY CAROLINAS PROPERTY LINE
- TOPOGRAPHIC CONTOUR (10' INTERVAL)
- STREAM (AMEC NRTR 2015)
- WETLAND (AMEC NRTR 2015)
- NPDES REGULATED WATER FEATURE

NOTES:

8. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.

9. ALL BOUNDARIES ARE APPROXIMATE.

10. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON DECEMBER 13, 2018. AERIAL WAS COLLECTED ON MARCH 30, 2018.

11. DRAWING HAS BEEN SET WITH A PROJECTION OF NORTH CAROLINA STATE PLANE COORDINATE SYSTEM FIPS 3200 (NAD83).

DUKE ENERGY CAROLINAS

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600 0 600 1,200

GRAPHIC SCALE IN FEET

DRAWN BY: K. KING	DATE: 05/03/2019
REVISED BY: C. WYATT	DATE: 12/06/2019
CHECKED BY: L. DRAGO	DATE: 12/06/2019
APPROVED BY: L. DRAGO	DATE: 12/06/2019
PROGRAM MANAGER: C. SUTTELL	

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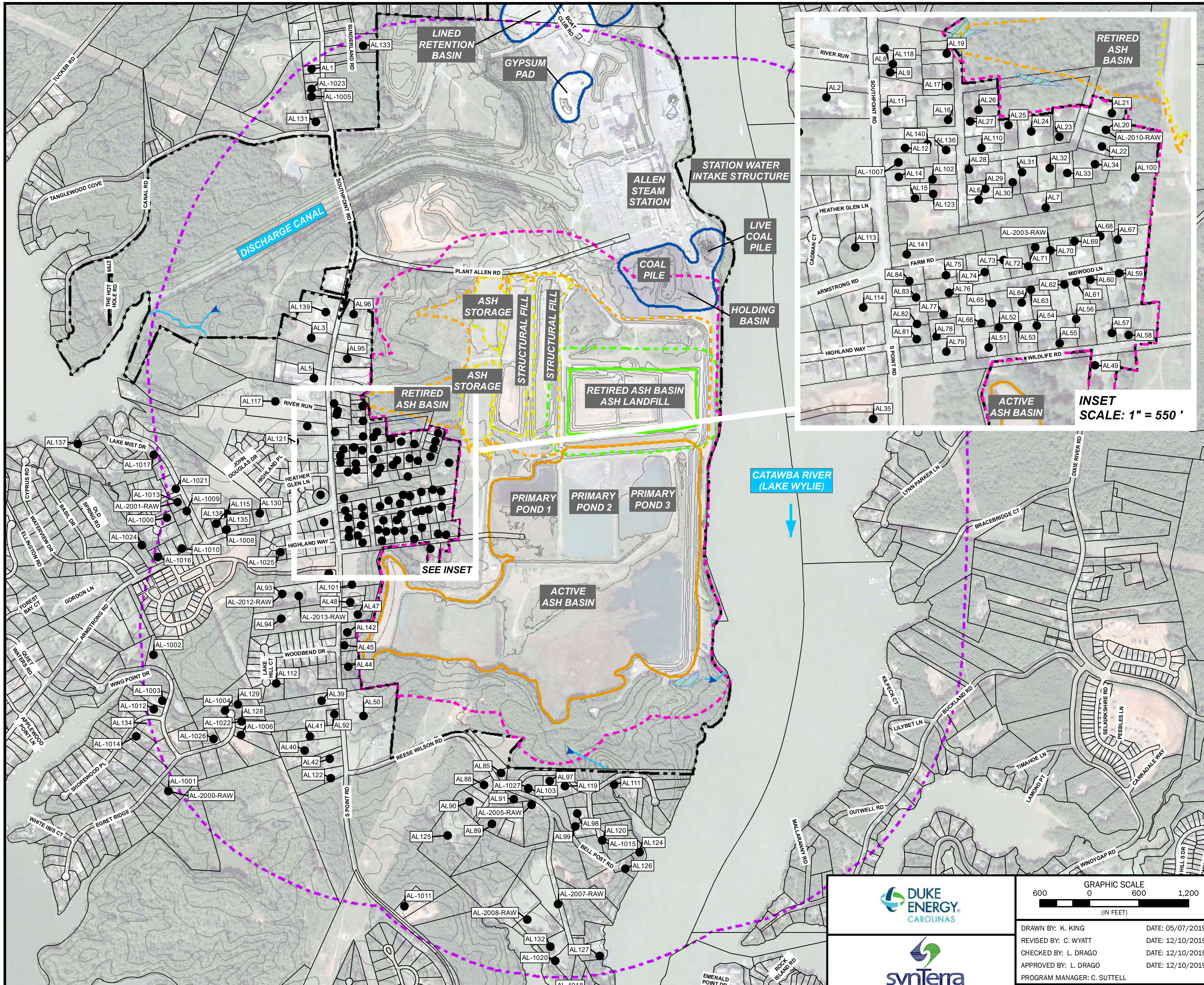
FIGURE 5-6
MAP OF SURFACE WATERS
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA



LEGEND

- WATER SUPPLY WELL
- 0.5- MILE RADIUS OF ASH BASIN COMPLIANCE BOUNDARY
- ACTIVE ASH BASIN WASTE BOUNDARY
- RETIRED ASH BASIN WASTE BOUNDARY
- ACTIVE ASH BASIN COMPLIANCE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL WASTE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL COMPLIANCE BOUNDARY
- DORS FILLS BOUNDARIES
- SITE FEATURE
- DUKE ENERGY CAROLINAS PROPERTY LINE
- TOPOGRAPHIC CONTOUR (10' INTERVAL)
- STREAM (AMEC NRTR 2015)
- WETLAND (AMEC NRTR 2015)

NOTES:

1. INFORMATION PROVIDED IN *ALLEN STEAM STATION 1. HB 630 PROVISION OF PERMANENT WATER SUPPLY COMPLETION DOCUMENTATION*, DUKE ENERGY, AUGUST 1, 2018 **(APPENDIX D)**.

2. WATER SUPPLY WELL ANALYTICAL RESULTS ARE LOCATED IN TABLE 1, **APPENDIX C**.

3. NON-DUKE PARCEL BOUNDARIES PROVIDED BY NC ONEMAP, DATED 2018. http://data.nconemap.gove/downloads/vector/parcels

4. THE WATERS OF THE US DELINEATION HAS NOT BEEN APPROVED BY THE US ARMY CORPS OF ENGINEERS AT THE TIME OF THE MAP CREATION. THIS MAP IS NOT TO BE USED FOR JURISDICTIONAL DETERMINATION PURPOSES. THE WETLANDS AND STREAMS BOUNDARIES WERE OBTAINED FROM STREAM AND WETLAND DELINEATION CONDUCTED BY AMEC FOSTER WHEELER ENVIRONMENTAL & INFRASTRUCTURE, INC. NATURAL RESOURCE TECHNICAL REPORT (NRTR) FOR ALLEN STEAM STATION DATED MAY 29, 2015.

5. THE TOPOGRAPHY IS SHOWN FOR REFERENCE PURPOSES ONLY AND SHOULD NOT BE USED FOR DESIGN OR ENGINEERING PURPOSES. TOPOGRAPHY IS BASED ON LIDAR BARE EARTH DATA OBTAINED FROM THE NORTH CAROLINA SPATIAL DATA SITE AT https://sdd.nc.gov/sdd/DataDownload.aspx.

6. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.

7. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON OCTOBER 11, 2017. AERIAL WAS COLLECTED ON OCTOBER 8, 2016.

8. DRAWING HAS BEEN SET WITH A PROJECTION OF NORTH CAROLINA STATE PLANE COORDINATE SYSTEM FIPS 3200 (NAD83/2011).

DUKE ENERGY CAROLINAS

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GRAPHIC SCALE
600 0 600 1,200
(IN FEET)

DRAWN BY: K. KING	DATE: 05/07/2019
REVISED BY: C. WYATT	DATE: 12/10/2019
CHECKED BY: L. DRAGO	DATE: 12/10/2019
APPROVED BY: L. DRAGO	DATE: 12/10/2019
PROGRAM MANAGER: C. SUTTELL	

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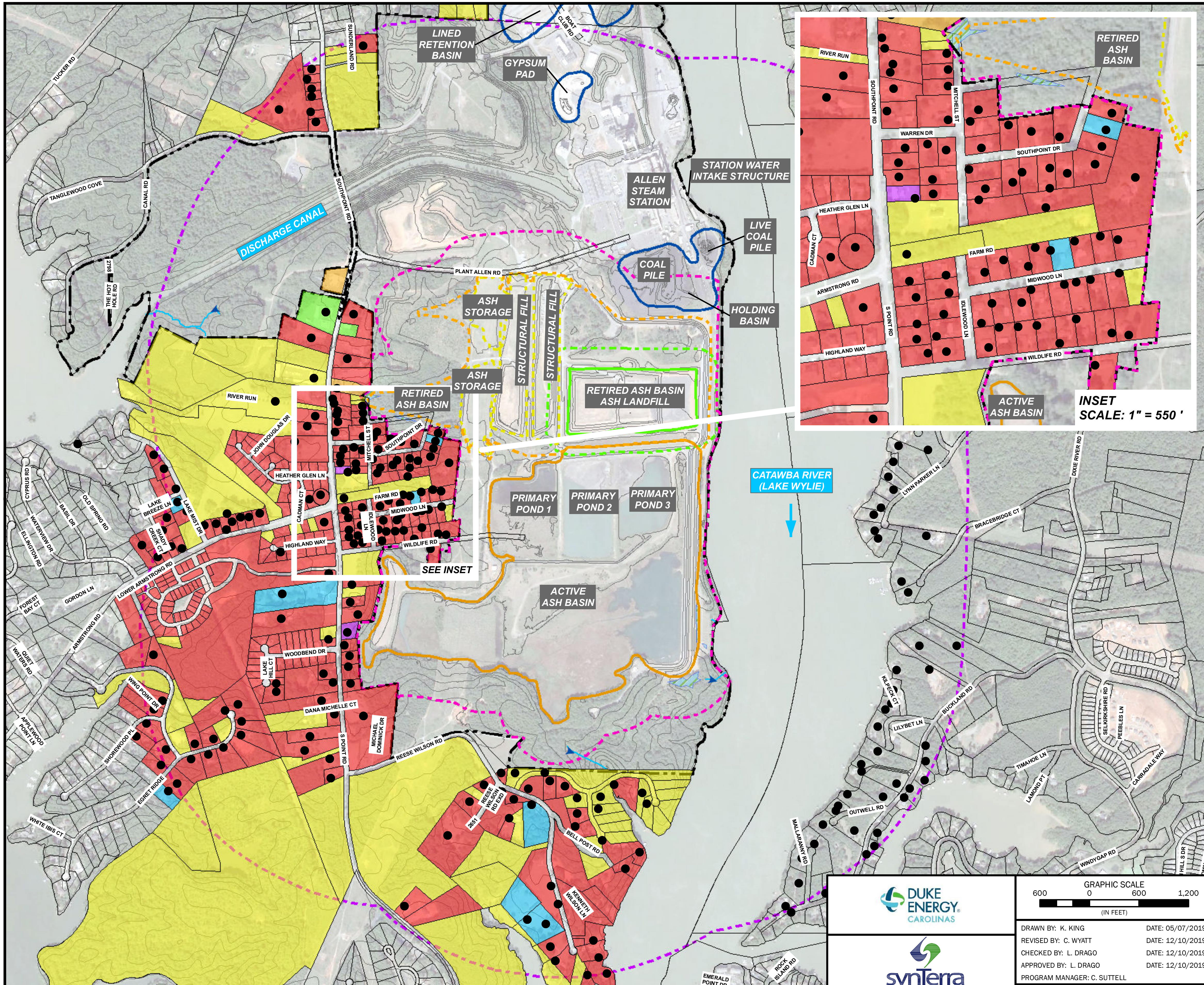
FIGURE 5-7a
WATER SUPPLY WELL SAMPLE LOCATIONS
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA



LEGEND

- PUBLIC WATER SUPPLY
- WATER TREATMENT SYSTEM
- OPT OUT OR NON-RESPONSIVE
- LOCATIONS DEEMED NOT ELIGIBLE PER HOUSE BILL 630 (BUSINESS/CHURCH/SCHOOL)
- LOCATIONS DEEMED NOT ELIGIBLE PER HOUSE BILL 630 (BUSINESS/CHURCH/SCHOOL) BUT VOLUNTARILY SUPPLIED PERMANENT WATER SOLUTION
- VACANT PARCEL
- WATER SUPPLY WELL
- 0.5- MILE RADIUS OF ASH BASIN COMPLIANCE BOUNDARY
- ACTIVE ASH BASIN WASTE BOUNDARY
- RETIRED ASH BASIN WASTE BOUNDARY
- ACTIVE ASH BASIN COMPLIANCE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL WASTE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL COMPLIANCE BOUNDARY
- DORS FILLS BOUNDARIES
- SITE FEATURE
- DUKE ENERGY CAROLINAS PROPERTY LINE
- TOPOGRAPHIC CONTOUR (10' INTERVAL)
- STREAM (AMEC NRTR 2015)
- WETLAND (AMEC NRTR 2015)

NOTES:

1. INFORMATION PROVIDED IN *ALLEN STEAM STATION HB 630 PROVISION OF PERMANENT WATER SUPPLY COMPLETION DOCUMENTATION*, DUKE ENERGY, AUGUST 1, 2018 **(APPENDIX D)**.

2. WATER SUPPLY WELL ANALYTICAL RESULTS ARE LOCATED IN TABLE 1, **APPENDIX C**.

3. NON-DUKE PARCEL BOUNDARIES PROVIDED BY NC ONEMAP, DATED 2018. http://data.nconemap.gove/downloads/vector/parcels

4. THE WATERS OF THE US DELINEATION HAS NOT BEEN APPROVED BY THE US ARMY CORPS OF ENGINEERS AT THE TIME OF THE MAP CREATION. THIS MAP IS NOT TO BE USED FOR JURISDICTIONAL DETERMINATION PURPOSES. THE WETLANDS AND STREAMS BOUNDARIES WERE OBTAINED FROM STREAM AND WETLAND DELINEATION CONDUCTED BY AMEC FOSTER WHEELER ENVIRONMENTAL & INFRASTRUCTURE, INC. NATURAL RESOURCE TECHNICAL REPORT (NRTR) FOR ALLEN STEAM STATION DATED MAY 29, 2015.

5. THE TOPOGRAPHY IS SHOWN FOR REFERENCE PURPOSES ONLY AND SHOULD NOT BE USED FOR DESIGN OR ENGINEERING PURPOSES. TOPOGRAPHY IS BASED ON LIDAR BARE EARTH DATA OBTAINED FROM THE NORTH CAROLINA SPATIAL DATA SITE AT https://sdd.nc.gov/sdd/DataDownload.aspx.

6. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.

7. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON OCTOBER 11, 2017. AERIAL WAS COLLECTED ON OCTOBER 8, 2016.

8. DRAWING HAS BEEN SET WITH A PROJECTION OF NORTH CAROLINA STATE PLANE COORDINATE SYSTEM FIPS 3200 (NAD83/2011).

GRAPHIC SCALE
600 0 600 1,200
(IN FEET)

DRAWN BY: K. KING	DATE: 05/07/2019
REVISED BY: C. WYATT	DATE: 12/10/2019
CHECKED BY: L. DRAGO	DATE: 12/10/2019
APPROVED BY: L. DRAGO	DATE: 12/10/2019
PROGRAM MANAGER: C. SUTTELL	

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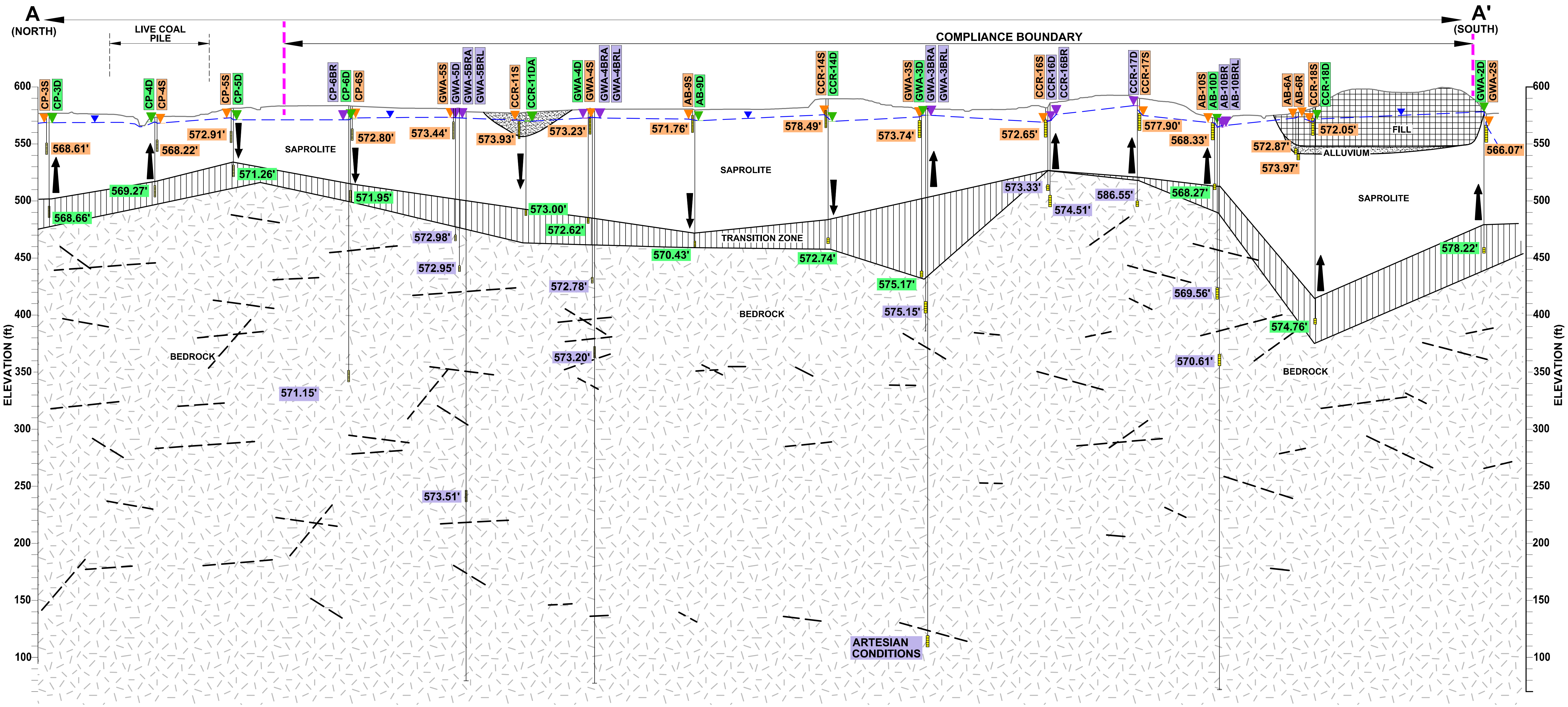
FIGURE 5-7b
HB 630 PROVISION OF PERMANENT WATER SUPPLY COMPLETION MAP
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA

Figure 6-1

Fly Ash and Bottom Ash Interbedded Depiction

Included in Section 6 text



NOTE:
CROSS SECTION A-A' IS LINEAR IN NATURE AND ALL LOCATIONS NOT ALONG THE CROSS SECTION ARE PROJECTED ONTO THE CROSS SECTION.

CROSS SECTION LOCATION

LEGEND

GWA-22S	WELL IN FILL/ALLUVIUM/SAPROLITE
GWA-22D	WELL IN TRANSITION ZONE
GWA-21BR	WELL IN BEDROCK
AB-35S	WELL IN ASH PORE WATER
CCR-11D	ABANDONED WELL/ GEOTECHNICAL BORING
	GENERALIZED WATER TABLE
	ALLUVIUM
	FILL
	SAPROLITE
	TRANSITION ZONE
	BEDROCK
	PREDOMINANT BEDROCK FRACTURE ORIENTATION
	GENERALIZED VERTICAL HYDRAULIC GRADIENT
	SHALLOW ZONE FLOW LAYER GROUNDWATER WELL WATER LEVEL ELEVATION
	DEEP ZONE FLOW LAYER GROUNDWATER WELL WATER LEVEL ELEVATION
	BEDROCK FLOW LAYER GROUNDWATER WELL WATER LEVEL ELEVATION
	WELL SCREEN
568.66'	WATER LEVEL ELEVATION (NAVD 88) (LABEL COLORING BY FLOW ZONE)
	COMPLIANCE BOUNDARY

NOTES

1. DEPTH TO WATER GAUGED IN MONITORING WELLS ON MARCH 13, 2019, REFERENCED TO NORTH AMERICAN VERTICAL DATUM (NAVD) OF 1988.
2. GROUNDWATER FLOW IS APPROXIMATELY WEST TO EAST, PERPENDICULAR TO THE CROSS SECTION.
3. FRACTURES DEPICTED ON THIS CROSS SECTION REPRESENTS THE GENERALIZED FRACTURE ORIENTATIONS BASED ON TELEVIEWER LOGGING AT SITE SPECIFIC BOREHOLES. AS CONCEPTUALLY ILLUSTRATED HERE, TELEVIEWER LOGGING RESULTS DID NOT INDICATE ANY DISTINCT, CONSISTENT FRACTURE SETS, BUT A WIDE VARIETY OF FRACTURE ORIENTATIONS AT THE SITE. THE ACTUAL NUMBER OF FRACTURES IS FAR TOO NUMEROUS TO ILLUSTRATE AT THIS SCALE. IN ADDITION, THE DEPTH AND LENGTH OF FRACTURES VERSUS DEPTH ARE CONCEPTUAL ONLY.
4. ALL BOUNDARIES ARE APPROXIMATE.
5. CROSS SECTION REPRESENTATIVE OF PRE-DECANTING CONDITIONS.

DUKE ENERGY CAROLINAS

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GRAPHIC SCALE
0 112 225 450

HORIZONTAL SCALE: 1" = 450'
VERTICAL SCALE: 1" = 90'
5X VERTICAL EXAGGERATION

DRAWN BY: C. NEWELL	DATE: 9/13/2019
REVISED BY: C. NEWELL	DATE: 12/5/2019
CHECKED BY: L. DRAGO	DATE: 12/5/2019
APPROVED BY: C. SUTTELL	DATE: 12/5/2019
PROJECT MANAGER: C. SUTTELL	
LAYOUT: FIG_6-2	

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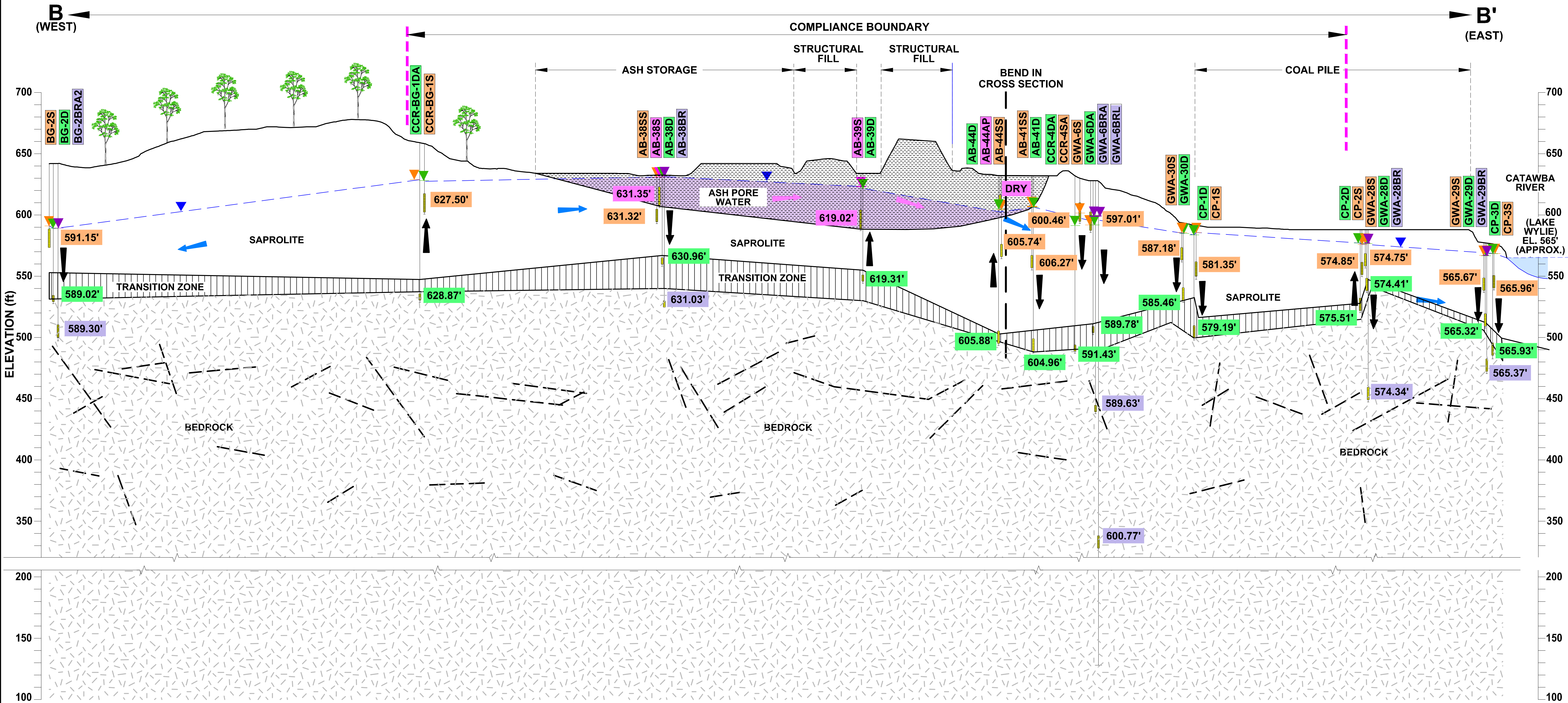
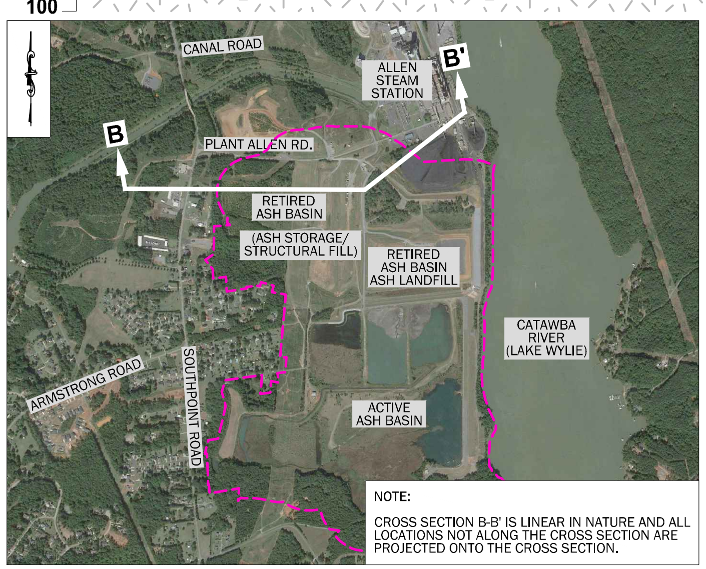
FIGURE 6-2
GENERAL CROSS SECTION A-A'
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA





NOTE:
CROSS SECTION B-B' IS LINEAR IN NATURE AND ALL LOCATIONS NOT ALONG THE CROSS SECTION ARE PROJECTED ONTO THE CROSS SECTION.

CROSS SECTION LOCATION

LEGEND

- GWA-22S — WELL IN FILL/ALLUVIUM/SAPROLITE
- GWA-22D — WELL IN TRANSITION ZONE
- GWA-21BR — WELL IN BEDROCK
- AB-35S — WELL IN ASH PORE WATER
- GENERALIZED WATER TABLE
- GENERALIZED GROUNDWATER FLOW DIRECTION
- GENERALIZED ASH PORE WATER FLOW DIRECTION
- GENERALIZED VERTICAL HYDRAULIC GRADIENT
- ASH
- ASH PORE WATER
- SAPROLITE
- TRANSITION ZONE
- BEDROCK
- SURFACE WATER
- PREDOMINANT BEDROCK FRACTURE ORIENTATION
- ASH PORE WATER FLOWLAYER WATER LEVEL ELEVATION
- SHALLOW ZONE FLOW LAYER GROUNDWATER WELL WATER LEVEL ELEVATION
- DEEP ZONE FLOW LAYER GROUNDWATER WELL WATER LEVEL ELEVATION
- BEDROCK FLOW LAYER GROUNDWATER WELL WATER LEVEL ELEVATION
- 589.02' — WATER LEVEL ELEVATION (NAVD 88) (LABEL COLORING BY FLOW ZONE)
- WELL SCREEN
- BREAKLINE
- COMPLIANCE BOUNDARY

NOTES

1. DEPTH TO WATER GAUGED IN MONITORING WELLS ON MARCH 13, 2019, AND OCTOBER 24, 2019 (AB-41SS, AB-41D, AB-44AP, AB-44SS, AB-44D, GWA-28S, GWA-28D, GWA-28BR, GWA-29S, GWA-29D, GWA-29BR, GWA-30S, GWA-30D) REFERENCED TO NORTH AMERICAN VERTICAL DATUM (NAVD) OF 1988.
2. FRACTURES DEPICTED ON THIS CROSS SECTION REPRESENTS THE GENERALIZED FRACTURE ORIENTATIONS BASED ON TELEVIEWER LOGGING AT SITE SPECIFIC BOREHOLES. AS CONCEPTUALLY ILLUSTRATED HERE, TELEVIEWER LOGGING RESULTS DID NOT INDICATE ANY DISTINCT, CONSISTENT FRACTURE SETS, BUT A WIDE VARIETY OF FRACTURE ORIENTATIONS AT THE SITE. THE ACTUAL NUMBER OF FRACTURES IS FAR TOO NUMEROUS TO ILLUSTRATE AT THIS SCALE. IN ADDITION, THE DEPTH AND LENGTH OF FRACTURES VERSUS DEPTH ARE CONCEPTUAL ONLY.
3. ALL BOUNDARIES ARE APPROXIMATE.
4. CROSS SECTION REPRESENTATIVE OF PRE-DECANTING CONDITIONS.

DUKE ENERGY CAROLINAS

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GRAPHIC SCALE
0 100 200 400'

HORIZONTAL SCALE: 1" = 400'
VERTICAL SCALE: 1" = 80'
5X VERTICAL EXAGGERATION

DRAWN BY: J. CHASTAIN	DATE: 7/26/2019
REVISED BY: D. KREFSKI	DATE: 12/6/2019
CHECKED BY: L. DRAGO	DATE: 12/6/2019
APPROVED BY: C. SUTTELL	DATE: 12/6/2019
PROJECT MANAGER: C. SUTTELL	
LAYOUT: XSECTB-B(6-3)	

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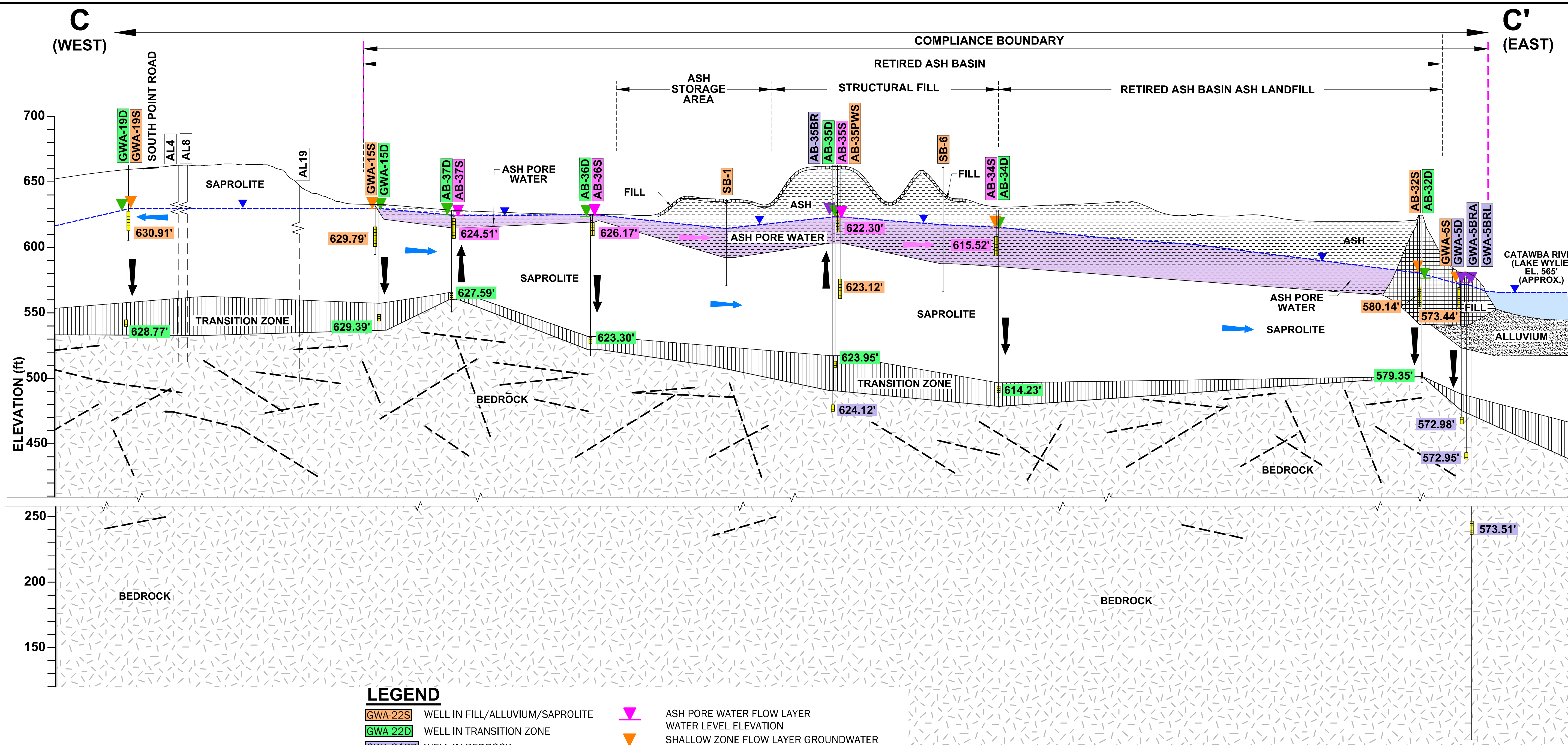
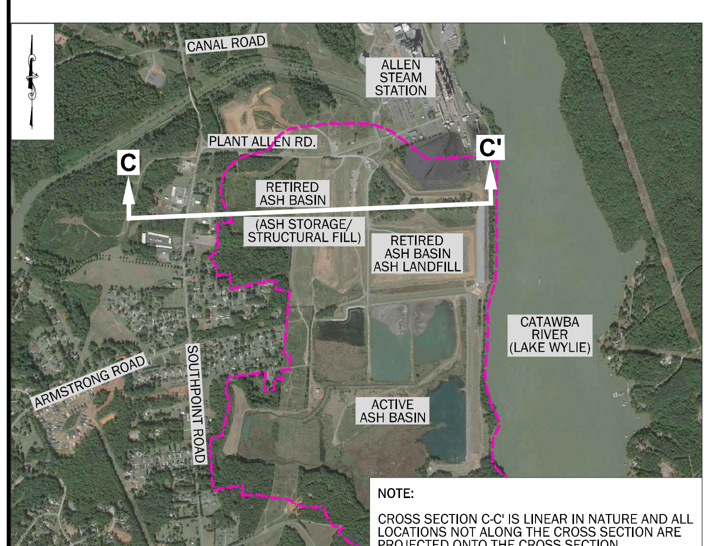
FIGURE 6-3
GENERAL CROSS SECTION B-B'
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA



LEGEND

- GWA-22S — WELL IN FILL/ALLUVIUM/SAPROLITE
- GWA-22D — WELL IN TRANSITION ZONE
- GWA-21BR — WELL IN BEDROCK
- AB-35S — WELL IN ASH PORE WATER
- GWA-5BR — ABANDONED WELL/ GEOTECHNICAL BORING
- AL34 — WATER SUPPLY WELL - (DEPTH UNKNOWN)
- GENERALIZED WATER TABLE
- GENERALIZED GROUNDWATER FLOW DIRECTION
- GENERALIZED ASH PORE WATER FLOW DIRECTION
- GENERALIZED VERTICAL HYDRAULIC GRADIENT
- ASH
- ASH PORE WATER
- ALLUVIUM
- FILL
- SAPROLITE
- TRANSITION ZONE
- BEDROCK
- SURFACE WATER
- PREDOMINANT BEDROCK FRACTURE ORIENTATION
- ASH PORE WATER FLOW LAYER WATER LEVEL ELEVATION
- SHALLOW ZONE FLOW LAYER GROUNDWATER WELL WATER LEVEL ELEVATION
- DEEP ZONE FLOW LAYER GROUNDWATER WELL WATER LEVEL ELEVATION
- BEDROCK FLOW LAYER GROUNDWATER WELL WATER LEVEL ELEVATION
- 140 — WATER LEVEL ELEVATION (NAVD 88) (LABEL COLORING BY FLOW ZONE)
- WELL SCREEN
- BREAKLINE
- COMPLIANCE BOUNDARY



CROSS SECTION LOCATION

NOTES

1. DEPTH TO WATER GAUGED IN MONITORING WELLS ON MARCH 13, 2019, REFERENCED TO NORTH AMERICAN VERTICAL DATUM (NAVD) OF 1988.
2. FRACTURES DEPICTED ON THIS CROSS SECTION REPRESENTS THE GENERALIZED FRACTURE ORIENTATIONS BASED ON TELEVIEWER LOGGING AT SITE SPECIFIC BOREHOLES. AS CONCEPTUALLY ILLUSTRATED HERE, TELEVIEWER LOGGING RESULTS DID NOT INDICATE ANY DISTINCT, CONSISTENT FRACTURE SETS, BUT A WIDE VARIETY OF FRACTURE ORIENTATIONS AT THE SITE. THE ACTUAL NUMBER OF FRACTURES IS FAR TOO NUMEROUS TO ILLUSTRATE AT THIS SCALE. IN ADDITION, THE DEPTH AND LENGTH OF FRACTURES VERSUS DEPTH ARE CONCEPTUAL ONLY.
3. ALL BOUNDARIES ARE APPROXIMATE.
4. CROSS SECTION REPRESENTATIVE OF PRE-DECANTING CONDITIONS.

DUKE ENERGY CAROLINAS

synTerra

GRAPHIC SCALE
0 100 200 400

HORIZONTAL SCALE: 1" = 400'
VERTICAL SCALE: 1" = 80'
5X VERTICAL EXAGGERATION

DRAWN BY: J. CHASTAIN	DATE: 7/26/2019
REVISED BY: D. KREFSKI	DATE: 12/8/2019
CHECKED BY: L.DRAGO	DATE: 12/8/2019
APPROVED BY: C. SUTTELL	DATE: 12/8/2019
PROJECT MANAGER: C. SUTTELL	
LAYOUT: XSECTCC(6-4)	

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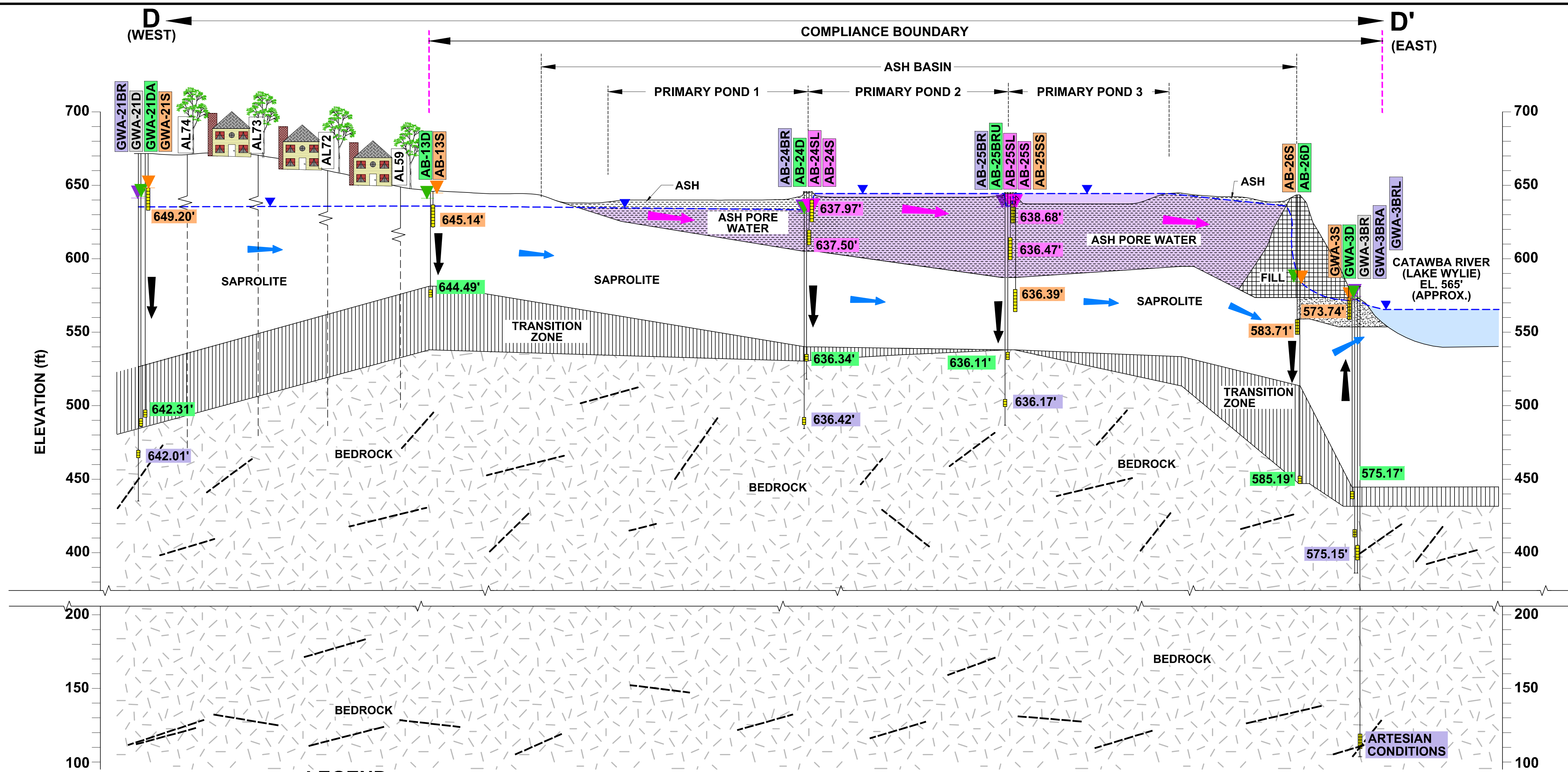
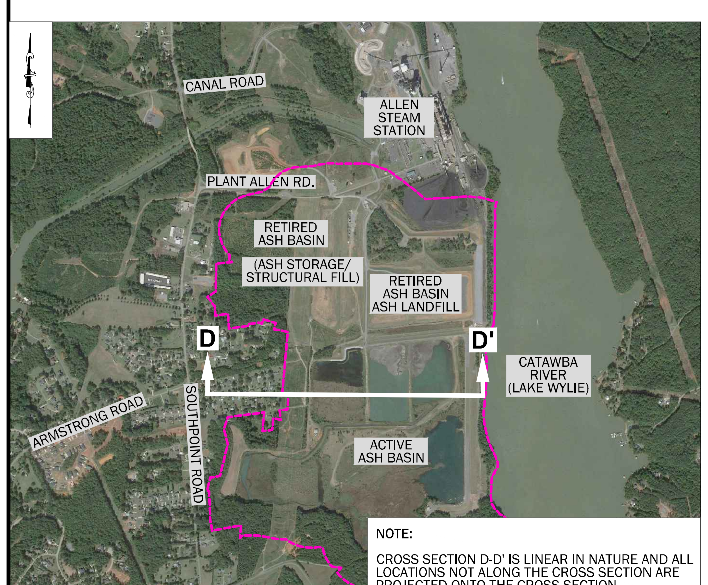
FIGURE 6-4
GENERAL CROSS SECTION C-C'
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA



LEGEND

GWA-22S	WELL IN FILL/ALLUVIUM/SAPROLITE
GWA-22D	WELL IN TRANSITION ZONE
GWA-21BR	WELL IN BEDROCK
AB-35S	WELL IN ASH PORE WATER
GWA-5BR	ABANDONED WELL/ GEOTECHNICAL BORING
AL34	WATER SUPPLY WELL - (DEPTH UNKNOWN)
	GENERALIZED WATER TABLE
	GENERALIZED GROUNDWATER FLOW DIRECTION
	GENERALIZED ASH PORE WATER FLOW DIRECTION
	GENERALIZED VERTICAL HYDRAULIC GRADIENT
	ASH
	ASH PORE WATER
	ALLUVIUM
	FILL
	SAPROLITE
	TRANSITION ZONE
	BEDROCK
	SURFACE WATER
	PREDOMINANT BEDROCK FRACTURE ORIENTATION
	ASH PORE WATER FLOW LAYER WATER LEVEL ELEVATION
	SHALLOW ZONE FLOW LAYER GROUNDWATER WELL WATER LEVEL ELEVATION
	DEEP ZONE FLOW LAYER GROUNDWATER WELL WATER LEVEL ELEVATION
	BEDROCK FLOW LAYER GROUNDWATER WELL WATER LEVEL ELEVATION
649.20'	WATER LEVEL ELEVATION (NAVD 88) (LABEL COLORING BY FLOW ZONE)
	WELL SCREEN
	BREAKLINE
	COMPLIANCE BOUNDARY



NOTE:

CROSS SECTION D-D' IS LINEAR IN NATURE AND ALL LOCATIONS NOT ALONG THE CROSS SECTION ARE PROJECTED ONTO THE CROSS SECTION.

CROSS SECTION LOCATION

NOTES

1. DEPTH TO WATER GAUGED IN MONITORING WELLS ON MARCH 13, 2019, REFERENCED TO NORTH AMERICAN VERTICAL DATUM (NAVD) OF 1988.
2. FRACTURES DEPICTED ON THIS CROSS SECTION REPRESENTS THE GENERALIZED FRACTURE ORIENTATIONS BASED ON TELEVIEWER LOGGING AT SITE SPECIFIC BOREHOLES. AS CONCEPTUALLY ILLUSTRATED HERE, TELEVIEWER LOGGING RESULTS DID NOT INDICATE ANY DISTINCT, CONSISTENT FRACTURE SETS, BUT A WIDE VARIETY OF FRACTURE ORIENTATIONS AT THE SITE. THE ACTUAL NUMBER OF FRACTURES IS FAR TOO NUMEROUS TO ILLUSTRATE AT THIS SCALE. IN ADDITION, THE DEPTH AND LENGTH OF FRACTURES VERSUS DEPTH ARE CONCEPTUAL ONLY.
3. ALL BOUNDARIES ARE APPROXIMATE.
4. CROSS SECTION REPRESENTATIVE OF PRE-DECANTING CONDITIONS.

DUKE ENERGY CAROLINAS

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GRAPHIC SCALE
0 100 200 400

HORIZONTAL SCALE: 1" = 400'
VERTICAL SCALE: 1" = 80'
5X VERTICAL EXAGGERATION

DRAWN BY: J. CHASTAIN DATE: 7/26/2019
REVISED BY: D. KREFSKI DATE: 12/8/2019
CHECKED BY: L.DRAGO DATE: 12/8/2019
APPROVED BY: C. SUTTELL DATE: 12/8/2019
PROJECT MANAGER: C. SUTTELL
LAYOUT: XSECTDD (6-5)

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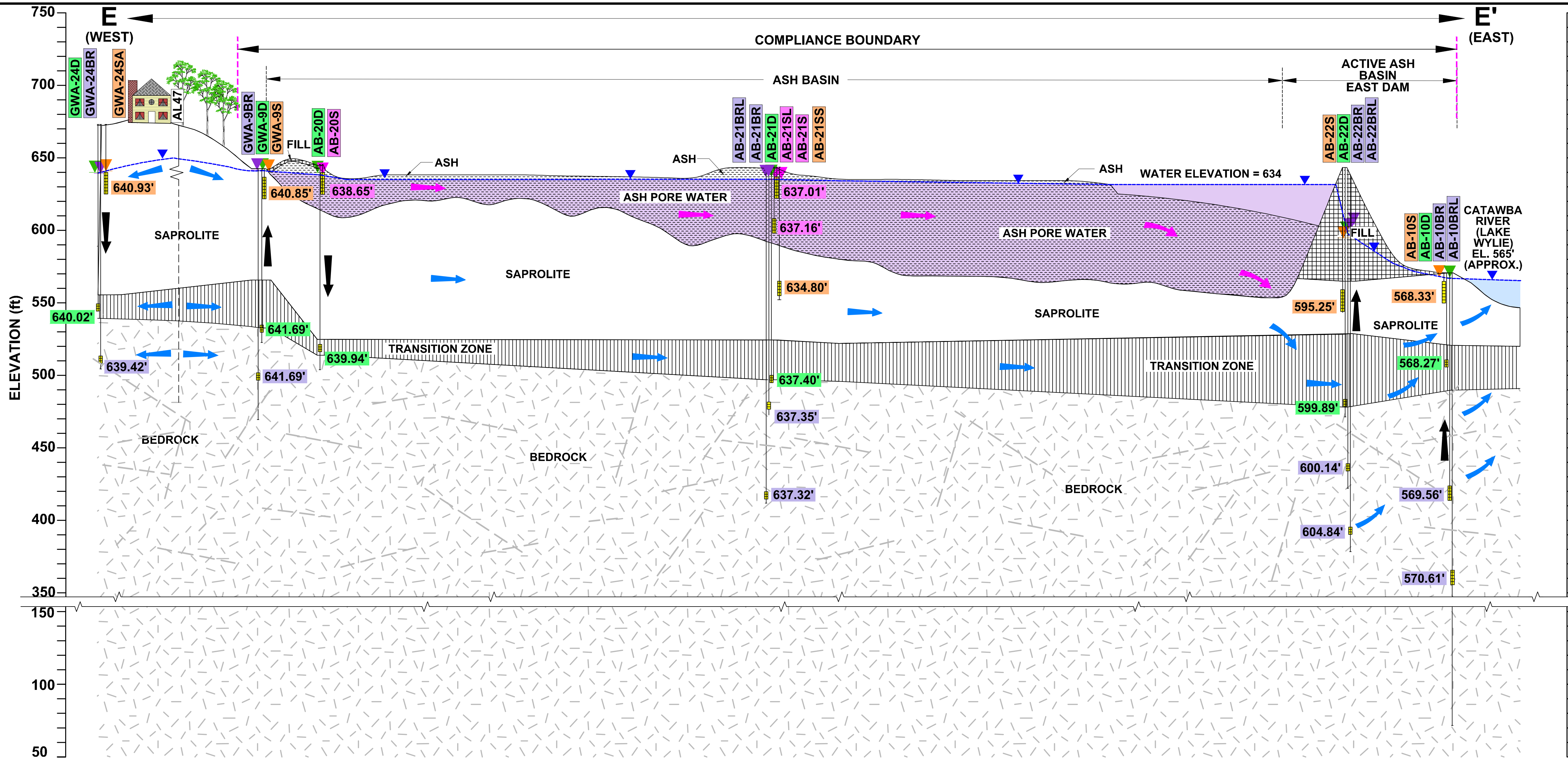
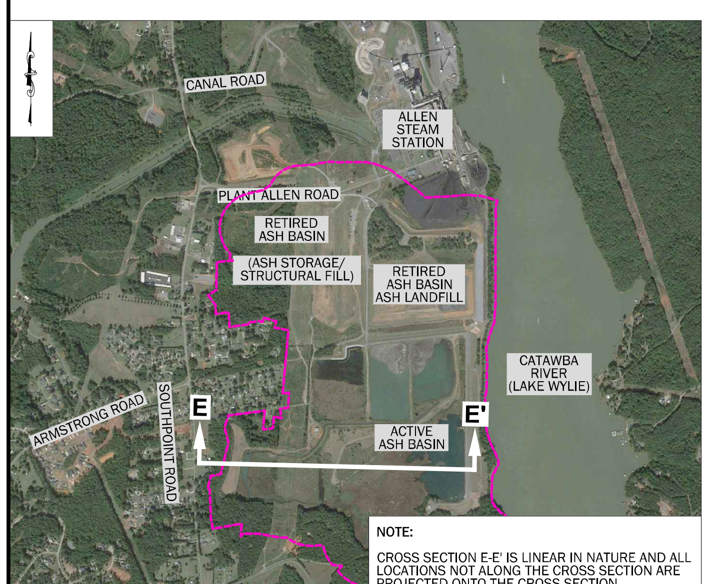
FIGURE 6-5
GENERAL CROSS SECTION D-D'
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA



LEGEND

GWA-22S	WELL IN FILL/ALLUVIUM/SAPROLITE
GWA-22D	WELL IN TRANSITION ZONE
GWA-21BR	WELL IN BEDROCK
AB-35S	WELL IN ASH PORE WATER
GWA-5BR	ABANDONED WELL/ GEOTECHNICAL BORING
AL34	WATER SUPPLY WELL - (DEPTH UNKNOWN)
	GENERALIZED WATER TABLE
	GENERALIZED GROUNDWATER FLOW DIRECTION
	GENERALIZED ASH PORE WATER FLOW DIRECTION
	GENERALIZED VERTICAL HYDRAULIC GRADIENT
	ASH
	ASH PORE WATER
	ALLUVIUM
	FILL
	SAPROLITE
	TRANSITION ZONE
	BEDROCK
	SURFACE WATER
	PREDOMINANT BEDROCK FRACTURE ORIENTATION
	ASH PORE WATER FLOW LAYER WATER LEVEL ELEVATION
	SHALLOW ZONE FLOW LAYER GROUNDWATER WELL WATER LEVEL ELEVATION
	DEEP ZONE FLOW LAYER GROUNDWATER WELL WATER LEVEL ELEVATION
	BEDROCK FLOW LAYER GROUNDWATER WELL WATER LEVEL ELEVATION
649.20'	WATER LEVEL ELEVATION (NAVD 88) (LABEL COLORING BY FLOW ZONE)
	WELL SCREEN
	BREAKLINE
	COMPLIANCE BOUNDARY



CROSS SECTION LOCATION

NOTES

1. DEPTH TO WATER GAUGED IN MONITORING WELLS ON MARCH 13, 2019, REFERENCED TO NORTH AMERICAN VERTICAL DATUM (NAVD) OF 1988.
2. FRACTURES DEPICTED ON THIS CROSS SECTION REPRESENTS THE GENERALIZED FRACTURE ORIENTATIONS BASED ON TELEVIEWER LOGGING AT SITE SPECIFIC BOREHOLES. AS CONCEPTUALLY ILLUSTRATED HERE, TELEVIEWER LOGGING RESULTS DID NOT INDICATE ANY DISTINCT, CONSISTENT FRACTURE SETS, BUT A WIDE VARIETY OF FRACTURE ORIENTATIONS AT THE SITE. THE ACTUAL NUMBER OF FRACTURES IS FAR TOO NUMEROUS TO ILLUSTRATE AT THIS SCALE. IN ADDITION, THE DEPTH AND LENGTH OF FRACTURES VERSUS DEPTH ARE CONCEPTUAL ONLY.
3. ALL BOUNDARIES ARE APPROXIMATE.
4. CROSS SECTION REPRESENTATIVE OF PRE-DECANTING CONDITIONS.

DUKE ENERGY CAROLINAS

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GRAPHIC SCALE
0 100 200 400

HORIZONTAL SCALE: 1" = 400'
VERTICAL SCALE: 1" = 80'
5X VERTICAL EXAGGERATION

DRAWN BY: J. CHASTAIN	DATE: 7/26/2019
REVISED BY: D. KREFSKI	DATE: 12/8/2019
CHECKED BY: L.DRAGO	DATE: 12/8/2019
APPROVED BY: C. SUTTELL	DATE: 12/8/2019
PROJECT MANAGER: C. SUTTELL	
LAYOUT: XSECTEE 6-6	

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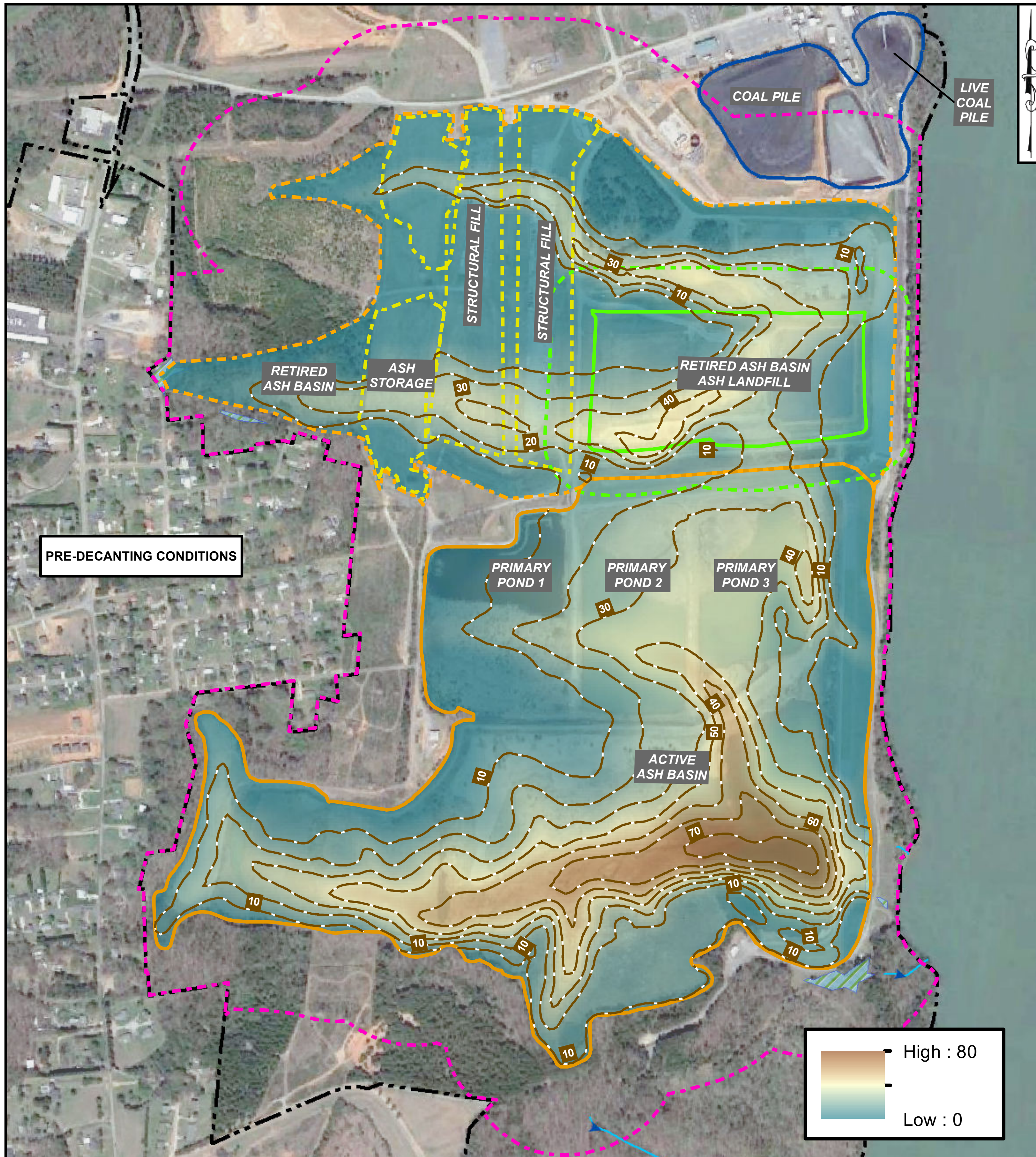
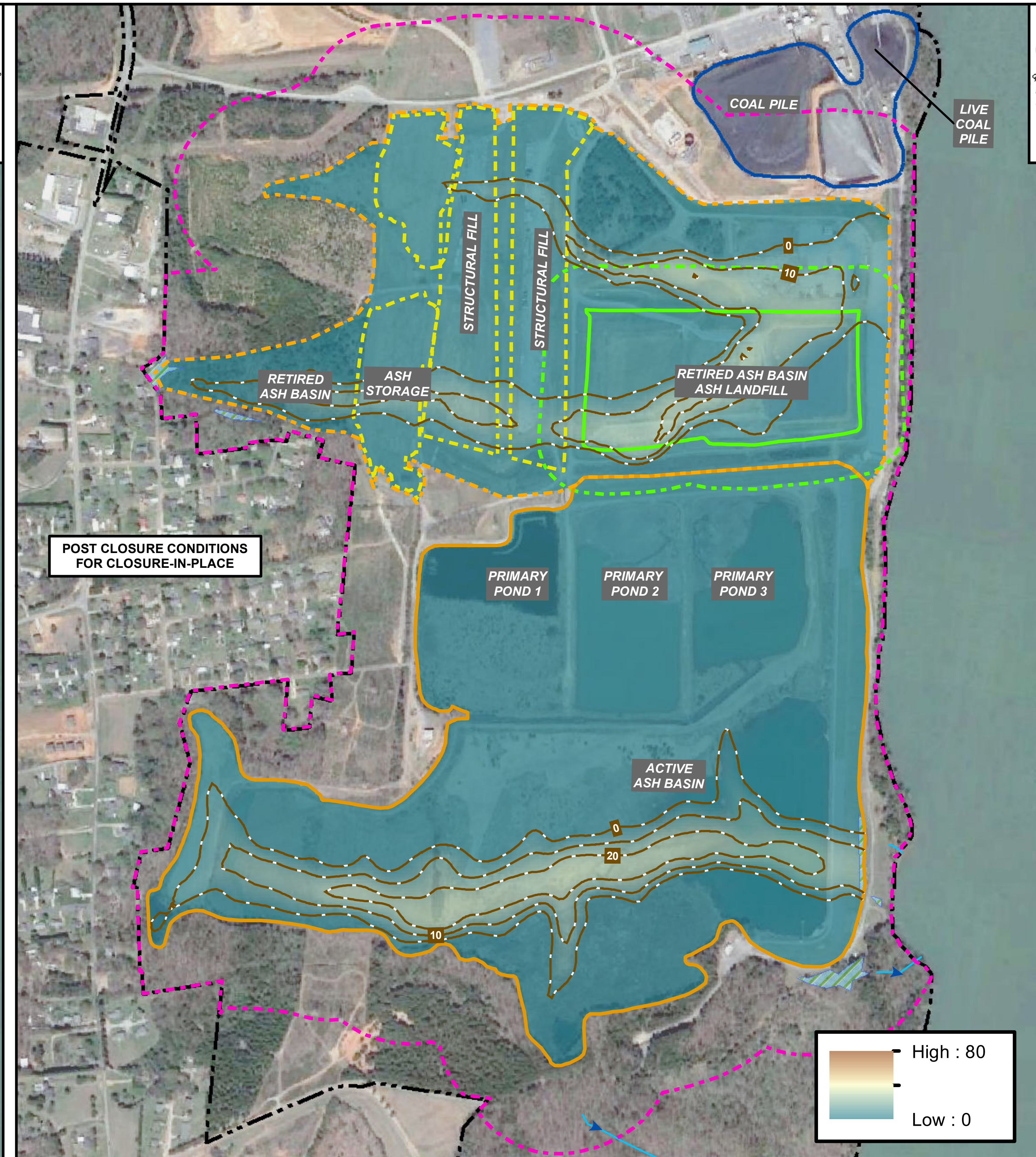
FIGURE 6-6
GENERAL CROSS SECTION E-E'
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA





LEGEND

- APPROXIMATE SATURATED ASH THICKNESS ISOPACH (FEET)
- ACTIVE ASH BASIN WASTE BOUNDARY
- RETIRED ASH BASIN WASTE BOUNDARY
- ASH BASIN COMPLIANCE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL WASTE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL COMPLIANCE BOUNDARY
- DORS FILLS BOUNDARIES
- SITE FEATURE
- DUKE ENERGY CAROLINAS PROPERTY LINE

NOTES:

1. ASH THICKNESS ISOPACH SURFACES FROM UPDATED GROUNDWATER FLOW AND TRANSPORT MODELING REPORT FOR ALLEN STEAM STATION BELMONT, NC (MURDOCH AND OTHERS, 2019)

2. THE SATURATED ASH THICKNESS IS CALCULATED USING THE APPROXIMATED BOTTOM OF ASH FROM THE F&T MODEL SIMULATION AND SIMULATED PRE-DECANTED HYDRAULIC HEADS. THE HYDRAULIC HEAD IN THE SIMULATION IS ABOVE THE TOP OF ASH IN AREAS WHERE ASH PONDED WATER OCCURS, AND IN THESE AREAS THE SATURATED ASH THICKNESS IS OVERESTIMATED.

3. THE WATERS OF THE US HAVE NOT BEEN APPROVED BY THE US ARMY CORPS OF ENGINEERS AT THE TIME OF THE MAP CREATION. THIS MAP IS A PRELIMINARY JURISDICTIONAL DETERMINATION ONLY. THE PRELIMINARY WETLANDS AND STREAMS BOUNDARIES WERE OBTAINED FROM AMEC FOSTER WHEELER ENVIRONMENTAL & INFRASTRUCTURE, INC. NATURAL RESOURCE TECHNICAL REPORT (NRTR) FOR ALLEN STEAM STATION DATED MAY 29, 2015.

4. ALL BOUNDARIES ARE APPROXIMATE.

5. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.

6. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON DECEMBER 13, 2018. AERIAL WAS COLLECTED ON MARCH 30, 2018.

7. DRAWING HAS BEEN SET WITH A PROJECTION OF NORTH CAROLINA STATE PLANE COORDINATE SYSTEM FIPS 3200 (NAD83).

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GRAPHIC SCALE

375 0 375 750

(IN FEET)

DRAWN BY: C. WYATT	DATE: 10/10/2019
REVISED BY: C. WYATT	DATE: 12/08/2019
CHECKED BY: L. DRAGO	DATE: 12/08/2019
APPROVED BY: L. DRAGO	DATE: 12/08/2019
PROJECT MANAGER: C. SUTTELL	

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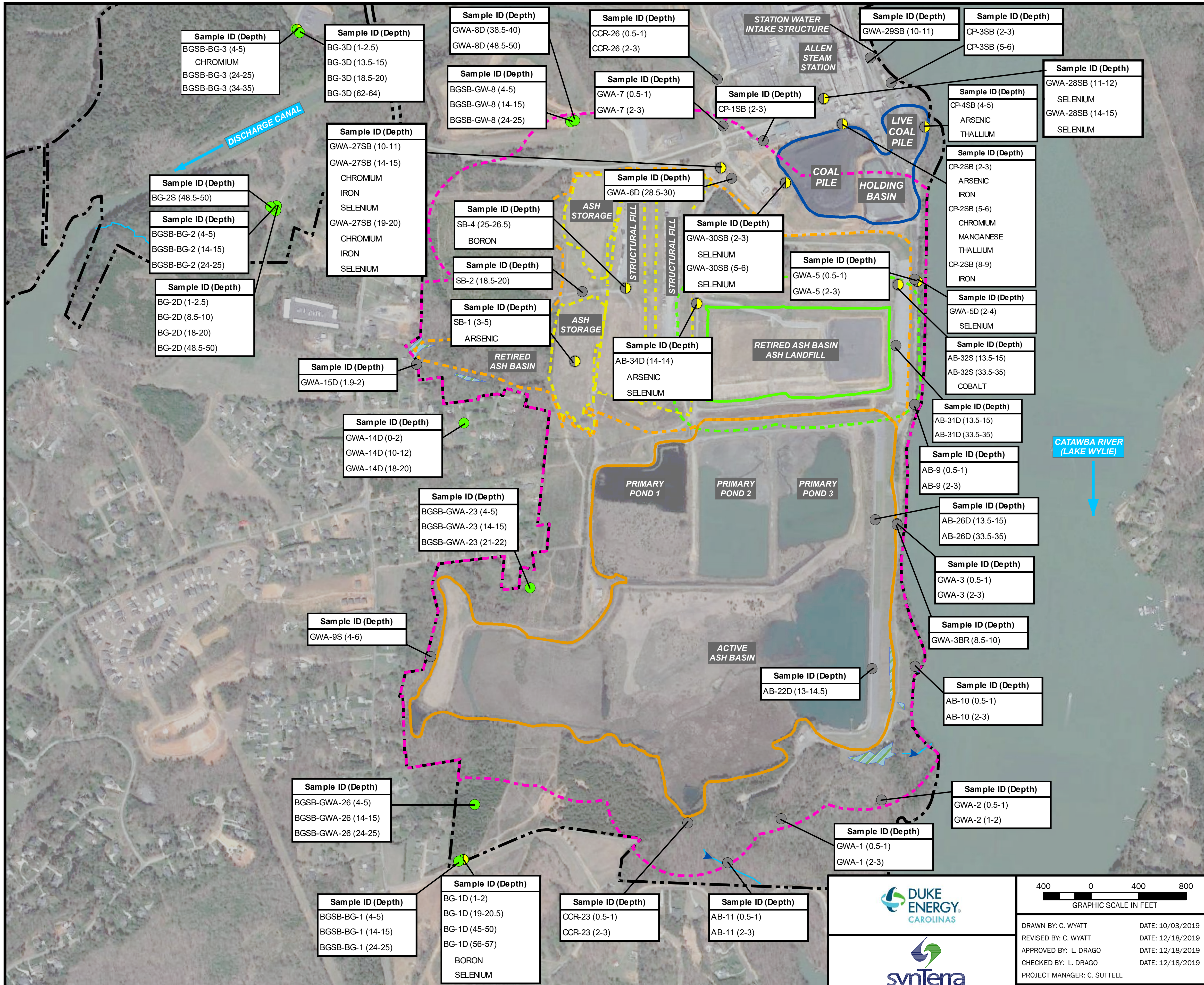
FIGURE 6-7
SATURATED ASH THICKNESS MAP FOR PRE-DECANTING AND POST-CLOSURE CONDITIONS
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA



LEGEND

- BACKGROUND LOCATION WITH NO EXCEEDANCES
- LOCATION WITH NO EXCEEDANCES
- BACKGROUND LOCATION WITH ONE OR MORE EXCEEDANCES
- LOCATION WITH ONE OR MORE EXCEEDANCES
- SITE FEATURE
- ACTIVE ASH BASIN WASTE BOUNDARY
- RETIRED ASH BASIN WASTE BOUNDARY
- ASH BASIN COMPLIANCE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL WASTE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL COMPLIANCE BOUNDARY
- DORS FILLS BOUNDARIES
- DUKE ENERGY CAROLINAS PROPERTY LINE
- STREAM (AMEC NRTR 2015)
- WETLAND (AMEC NRTR 2015)

NOTES:

1. DISCRETE SOIL SAMPLES EXCEED COMPARATIVE CRITERIA FOR CONSTITUENTS LISTED UNDER THE SAMPLE ID. REFER TO **TABLE 6-3** FOR A SUMMARY OF UNSATURATED SOIL ANALYTICAL RESULTS.

2. SAMPLE DEPTH IS FEET BELOW GROUND SURFACE.

3. THE WATERS OF THE US DELINEATION HAS NOT BEEN APPROVED BY THE US ARMY CORPS OF ENGINEERS AT THE TIME OF THE MAP CREATION. THIS MAP IS NOT TO BE USED FOR JURISDICTIONAL DETERMINATION PURPOSES. THE WETLANDS AND STREAMS BOUNDARIES WERE OBTAINED FROM STREAM AND WETLAND DELINEATION CONDUCTED BY AMEC FOSTER WHEELER ENVIRONMENTAL & INFRASTRUCTURE, INC. NATURAL RESOURCE TECHNICAL REPORT (NRTR) FOR ALLEN STEAM STATION DATED MAY 29, 2015.

4. ALL BOUNDARIES ARE APPROXIMATE.

5. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.

6. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON OCTOBER 11, 2017. AERIAL WAS COLLECTED ON OCTOBER 8, 2016.

7. DRAWING HAS BEEN SET WITH A PROJECTION OF NORTH CAROLINA STATE PLANE COORDINATE SYSTEM FIPS 3200 (NAD83).

DUKE ENERGY CAROLINAS

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DRAWN BY: C. WYATT	DATE: 10/03/2019
REVISED BY: C. WYATT	DATE: 12/18/2019
APPROVED BY: L. DRAGO	DATE: 12/18/2019
CHECKED BY: L. DRAGO	DATE: 12/18/2019
PROJECT MANAGER: C. SUTTELL	

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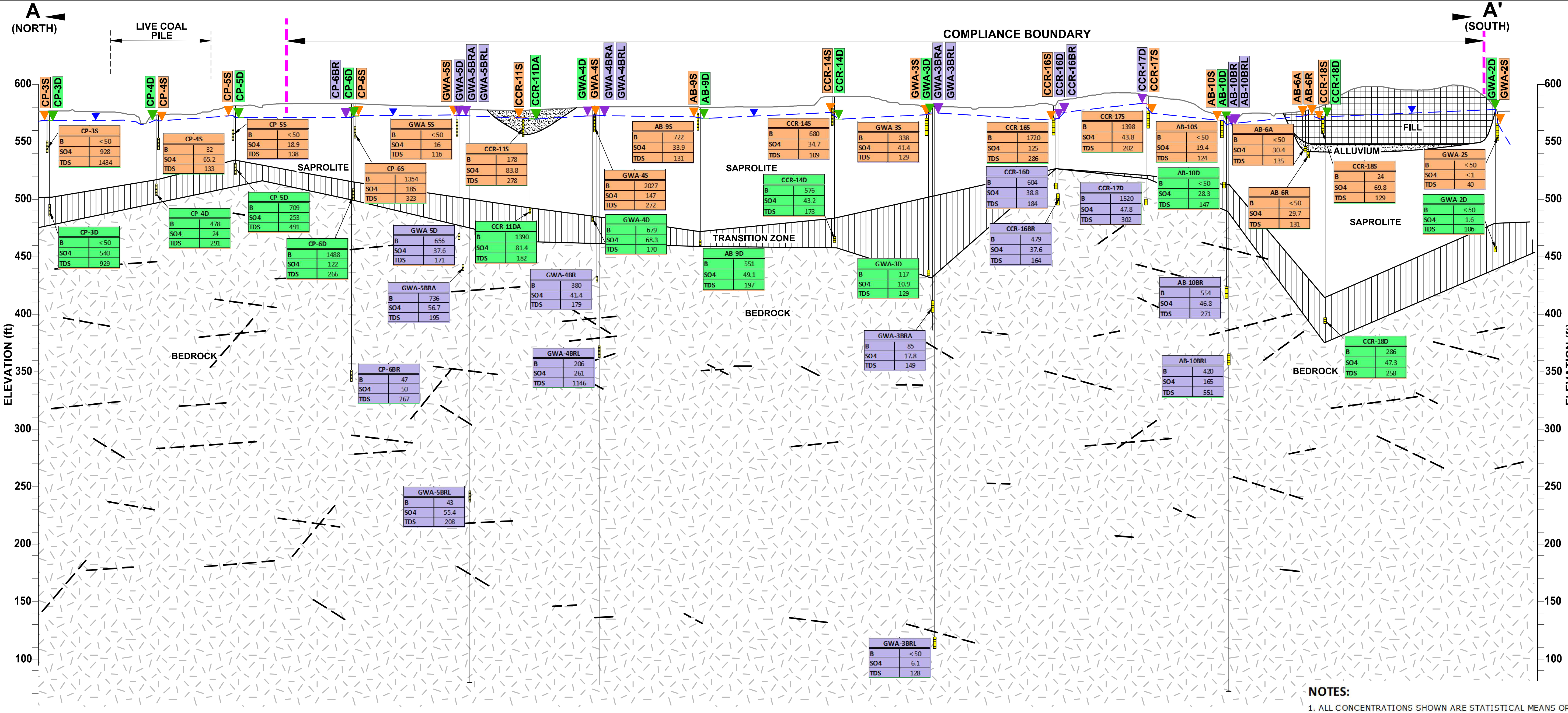
FIGURE 6-8
UNSATURATED SOIL SAMPLE LOCATIONS AND EXCEEDANCES
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA



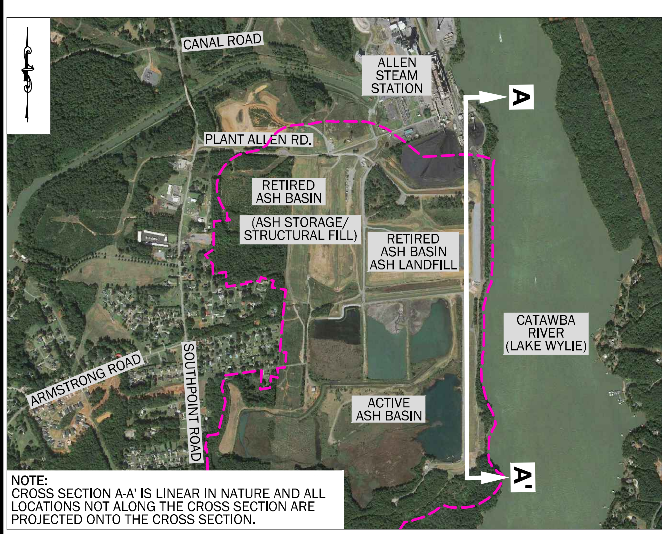
NOTES:

1. ALL CONCENTRATIONS SHOWN ARE STATISTICAL MEANS OR GEOMEANS CALCULATED BASED ON CENTRAL TENDENCY OF DATASET USING DATA RANGING FROM JANUARY 2018 TO JUNE 2019.
2. BORON (B) CONCENTRATIONS ARE IN MICROGRAMS PER LITER (µg/L)
3. SULFATE (SO4) AND TOTAL DISSOLVED SOLIDS (TDS) CONCENTRATIONS ARE IN MILLIGRAMS PER LITER (mg/L)

- NO DATA AVAILABLE

ANALYTICAL PARAMETER	B	SO4	TDS
REPORTING UNITS	µg/L	mg/L	mg/L
15A NCAC 02L STANDARD	700	250	500
BACKGROUND THRESHOLD VALUE (SHALLOW FLOW	50	5.4	154
BACKGROUND THRESHOLD VALUE (DEEP FLOW ZONE)[1]	50	14.5	173
BACKGROUND THRESHOLD VALUE (BEDROCK FLOW	50	7.3	221

[1] - BACKGROUND THRESHOLD VALUES WERE CALCULATED USING DATA FROM BACKGROUND GROUNDWATER SAMPLES COLLECTED MARCH 2011 TO DECEMBER 2018 AS SUBMITTED IN JUNE 2019.



CROSS SECTION LOCATION

LEGEND

- GWA-22S WELL IN FILL/ALLUVIUM/SAPROLITE
- GWA-22D WELL IN TRANSITION ZONE
- GWA-21BR WELL IN BEDROCK
- AB-35S WELL IN ASH PORE WATER
- CCR-11D ABANDONED WELL/ GEOTECHNICAL BORING
- GENERALIZED WATER TABLE
- ALLUVIUM
- FILL
- SAPROLITE
- TRANSITION ZONE
- BEDROCK
- PREDOMINANT BEDROCK FRACTURE ORIENTATION
- SHALLOW ZONE FLOW LAYER GROUNDWATER WELL WATER LEVEL ELEVATION
- DEEP ZONE FLOW LAYER GROUNDWATER WELL WATER LEVEL ELEVATION
- BEDROCK FLOW LAYER GROUNDWATER WELL WATER LEVEL ELEVATION
- WELL SCREEN
- CP-3D (B <50, SO4 540, TDS 929): MEAN BORON (B) CONCENTRATION (µg/L) MEAN SULFATE (SO4) CONCENTRATION (mg/L) MEAN TOTAL DISSOLVED SOLIDS (TDS) CONCENTRATION (mg/L)
- COMPLIANCE BOUNDARY

NOTES

1. DEPTH TO WATER GAUGED IN MONITORING WELLS ON MARCH 13, 2019, REFERENCED TO NORTH AMERICAN VERTICAL DATUM (NAVD) OF 1988.
2. GROUNDWATER FLOW IS APPROXIMATELY WEST TO EAST, PERPENDICULAR TO THE CROSS SECTION.
3. FRACTURES DEPICTED ON THIS CROSS SECTION REPRESENTS THE GENERALIZED FRACTURE ORIENTATIONS BASED ON TELEVIEWER LOGGING AT SITE SPECIFIC BOREHOLES. AS CONCEPTUALLY ILLUSTRATED HERE, TELEVIEWER LOGGING RESULTS DID NOT INDICATE ANY DISTINCT, CONSISTENT FRACTURE SETS, BUT A WIDE VARIETY OF FRACTURE ORIENTATIONS AT THE SITE. THE ACTUAL NUMBER OF FRACTURES IS FAR TOO NUMEROUS TO ILLUSTRATE AT THIS SCALE. IN ADDITION, THE DEPTH AND LENGTH OF FRACTURES VERSUS DEPTH ARE CONCEPTUAL ONLY.
4. ALL BOUNDARIES ARE APPROXIMATE.
5. CROSS SECTION REPRESENTATIVE OF PRE-DECANTING CONDITIONS.

DUKE ENERGY CAROLINAS

synTerra

GRAPHIC SCALE
0 112 225 450
HORIZONTAL SCALE: 1" = 450'
VERTICAL SCALE: 1" = 90'
5X VERTICAL EXAGGERATION

DRAWN BY: C. NEWELL	DATE: 9/13/2019
REVISED BY: D. KREFSKI	DATE: 12/5/2019
CHECKED BY: L. DRAGO	DATE: 12/5/2019
APPROVED BY: C. SUTTELL	DATE: 12/5/2019
PROJECT MANAGER: C. SUTTELL	
LAYOUT: XSECT_AA (6-9A)	

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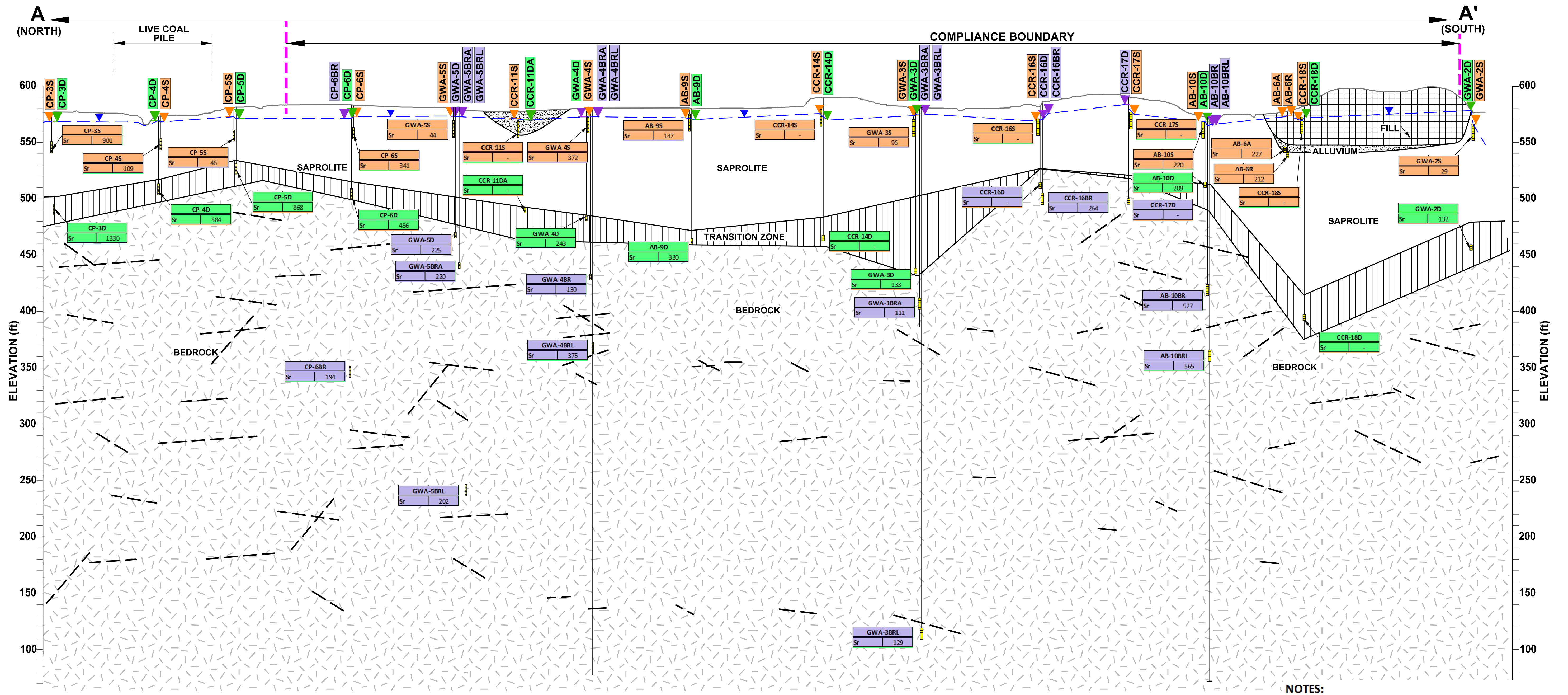
FIGURE 6-9a
GENERAL CROSS SECTION A-A' CONSERVATIVE GROUP MEAN OF BORON, SULFATE AND TOTAL DISSOLVED SOLIDS (TDS) CORRECTIVE ACTION PLAN UPDATE ALLEN STEAM STATION BELMONT, NORTH CAROLINA



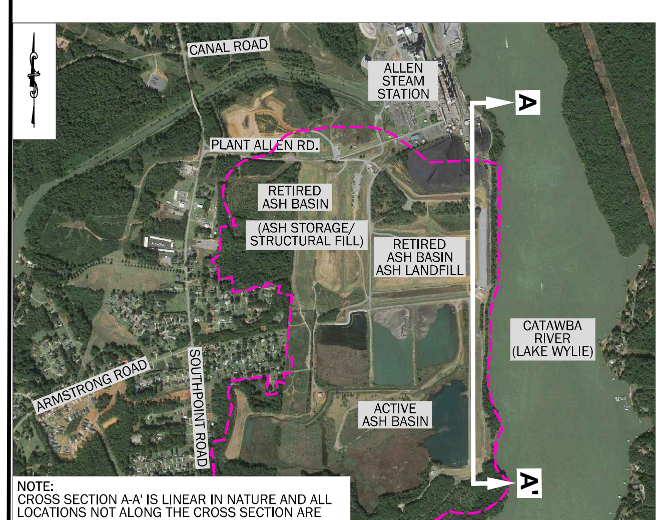
NOTES:

1. ALL CONCENTRATIONS SHOWN ARE STATISTICAL MEANS OR GEOMEANS CALCULATED BASED ON CENTRAL TENDENCY OF DATASET USING DATA RANGING FROM JANUARY 2018 TO JUNE 2019.
2. STRONTIUM (Sr) CONCENTRATIONS ARE IN MICROGRAMS PER LITER (µg/L)

- NO DATA AVAILABLE

ANALYTICAL PARAMETER	Sr
REPORTING UNITS	µg/L
15A NCAC 02L STANDARD	NE
BACKGROUND THRESHOLD VALUE (SHALLOW FLOW ZONE)[1]	300
BACKGROUND THRESHOLD VALUE (DEEP FLOW ZONE)[1]	240
BACKGROUND THRESHOLD VALUE (BEDROCK FLOW	181

[1] - BACKGROUND THRESHOLD VALUES WERE CALCULATED USING DATA FROM BACKGROUND GROUNDWATER SAMPLES COLLECTED MARCH 2011 TO DECEMBER 2018 AS SUBMITTED IN JUNE 2019.



NOTE:
CROSS SECTION A-A' IS LINEAR IN NATURE AND ALL LOCATIONS NOT ALONG THE CROSS SECTION ARE PROJECTED ONTO THE CROSS SECTION.

CROSS SECTION LOCATION

LEGEND

- GWA-22S — WELL IN FILL/ALLUVIUM/SAPROLITE
- GWA-22D — WELL IN TRANSITION ZONE
- GWA-21BR — WELL IN BEDROCK
- AB-35S — WELL IN ASH PORE WATER
- CCR-11D — ABANDONED WELL/ GEOTECHNICAL BORING
- GENERALIZED WATER TABLE
- ALLUVIUM
- FILL
- SAPROLITE
- TRANSITION ZONE
- BEDROCK
- PREDOMINANT BEDROCK FRACTURE ORIENTATION
- SHALLOW ZONE FLOW LAYER GROUNDWATER WELL WATER LEVEL ELEVATION
- DEEP ZONE FLOW LAYER GROUNDWATER WELL WATER LEVEL ELEVATION
- BEDROCK FLOW LAYER GROUNDWATER WELL WATER LEVEL ELEVATION
- WELL SCREEN
- CP-3S Sr 901 — MEAN STRONTIUM CONCENTRATION (µg/L)
- COMPLIANCE BOUNDARY

NOTES

1. DEPTH TO WATER GAUGED IN MONITORING WELLS ON MARCH 13, 2019, REFERENCED TO NORTH AMERICAN VERTICAL DATUM (NAVD) OF 1988.
2. GROUNDWATER FLOW IS APPROXIMATELY WEST TO EAST, PERPENDICULAR TO THE CROSS SECTION.
3. FRACTURES DEPICTED ON THIS CROSS SECTION REPRESENTS THE GENERALIZED FRACTURE ORIENTATIONS BASED ON TELEVIEWER LOGGING AT SITE SPECIFIC BOREHOLES. AS CONCEPTUALLY ILLUSTRATED HERE, TELEVIEWER LOGGING RESULTS DID NOT INDICATE ANY DISTINCT, CONSISTENT FRACTURE SETS, BUT A WIDE VARIETY OF FRACTURE ORIENTATIONS AT THE SITE. THE ACTUAL NUMBER OF FRACTURES IS FAR TOO NUMEROUS TO ILLUSTRATE AT THIS SCALE. IN ADDITION, THE DEPTH AND LENGTH OF FRACTURES VERSUS DEPTH ARE CONCEPTUAL ONLY.
4. ALL BOUNDARIES ARE APPROXIMATE.
5. CROSS SECTION REPRESENTATIVE OF PRE-DECANTING CONDITIONS.

DUKE ENERGY CAROLINAS

synTerra

GRAPHIC SCALE
0 112 225 450
HORIZONTAL SCALE: 1" = 450'
VERTICAL SCALE: 1" = 90'
5X VERTICAL EXAGGERATION

DRAWN BY: C. NEWELL DATE: 9/13/2019
REVISED BY: D. KREFSKI DATE: 12/5/2019
CHECKED BY: L. DRAGO DATE: 12/5/2019
APPROVED BY: C. SUTTELL DATE: 12/5/2019
PROJECT MANAGER: C. SUTTELL
LAYOUT: XSECT_AA (6-9B)

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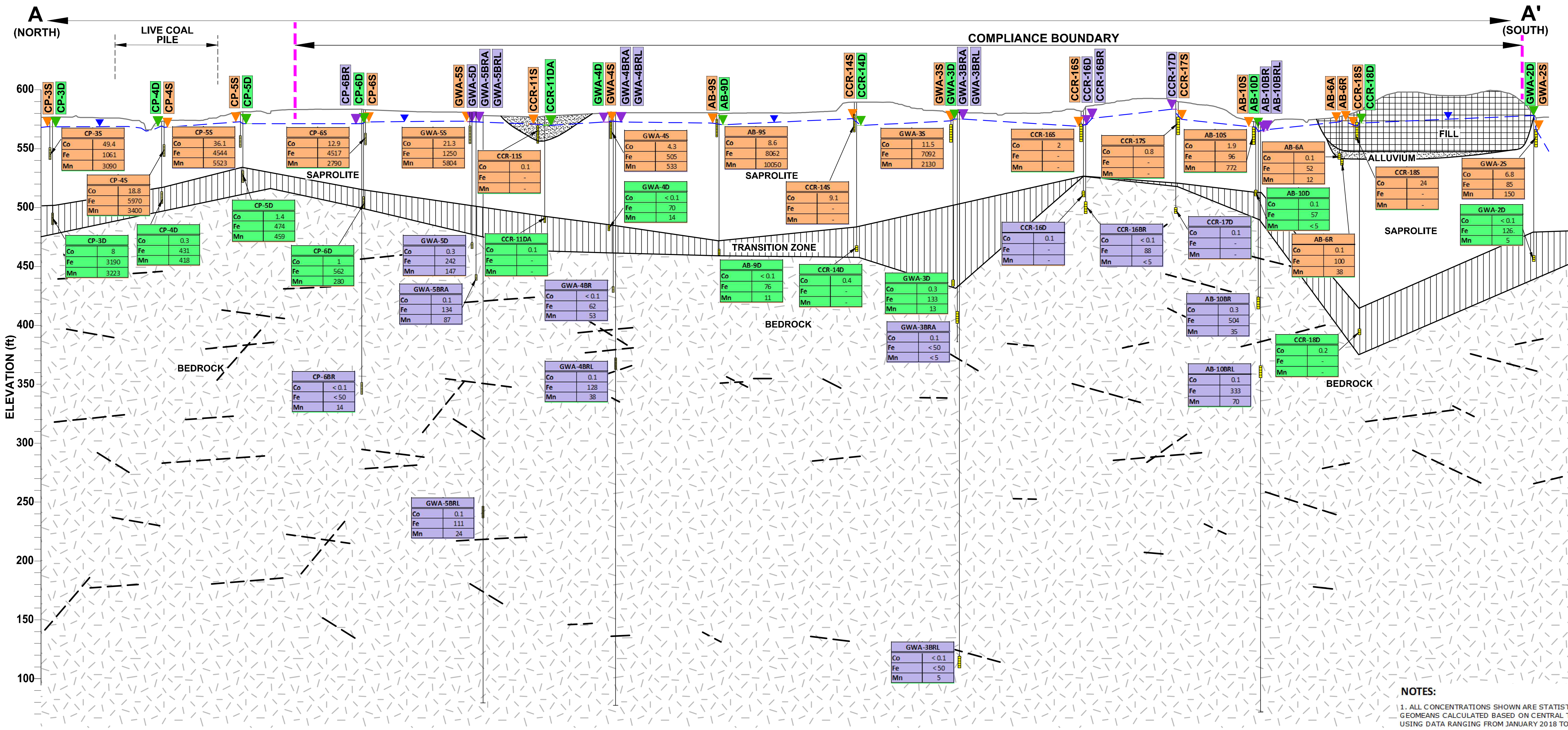
FIGURE 6-9b
GENERAL CROSS SECTION A-A'
NON-CONSERVATIVE GROUP
MEAN OF STRONTIUM
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA



NOTES:

1. ALL CONCENTRATIONS SHOWN ARE STATISTICAL MEANS OR GEOMEANS CALCULATED BASED ON CENTRAL TENDENCY OF DATASET USING DATA RANGING FROM JANUARY 2018 TO JUNE 2019.

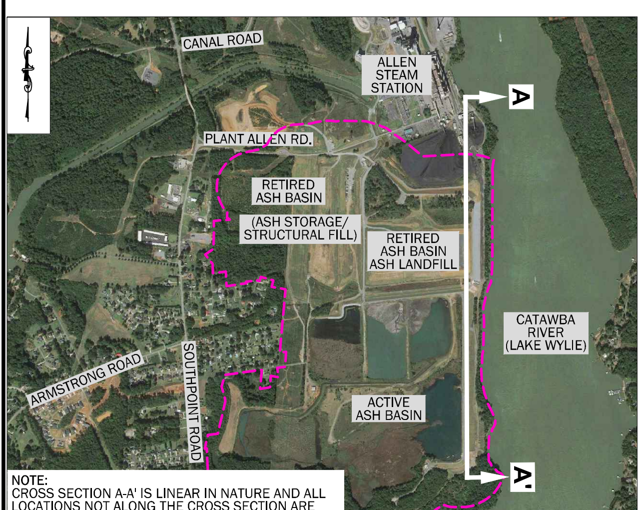
2. COBALT (Co), IRON (Fe), AND MANGANESE (Mn) CONCENTRATIONS ARE IN MICROGRAMS PER LITER (µg/L)

- NO DATA AVAILABLE

ANALYTICAL PARAMETER	Co	Fe	Mn
REPORTING UNITS	µg/L	µg/L	µg/L
15A NCAC 02L STANDARD	1*	300	50
BACKGROUND THRESHOLD VALUE (SHALLOW FLOW ZONE)[1]	5.7	1,422	608
BACKGROUND THRESHOLD VALUE (DEEP FLOW ZONE)[1]	0.82	665	256
BACKGROUND THRESHOLD VALUE (BEDROCK FLOW ZONE)[1]	0.35	1,242	360

* - INTERIM MAXIMUM ALLOWABLE CONCENTRATIONS (IMACs) OF THE 15A NCAC 02L STANDARD APPENDIX 1, APRIL 1, 2013.

[1] - BACKGROUND THRESHOLD VALUES WERE CALCULATED USING DATA FROM BACKGROUND GROUNDWATER SAMPLES COLLECTED MARCH 2011 TO DECEMBER 2018 AS SUBMITTED IN JUNE 2019.



NOTE:
CROSS SECTION A-A' IS LINEAR IN NATURE AND ALL LOCATIONS NOT ALONG THE CROSS SECTION ARE PROJECTED ONTO THE CROSS SECTION.

CROSS SECTION LOCATION

LEGEND

- GWA-22S — WELL IN FILL/ALLUVIUM/SAPROLITE
- GWA-22D — WELL IN TRANSITION ZONE
- GWA-21BR — WELL IN BEDROCK
- AB-35S — WELL IN ASH PORE WATER
- CCR-11D — ABANDONED WELL/ GEOTECHNICAL BORING
- GENERALIZED WATER TABLE
- ALLUVIUM
- FILL
- SAPROLITE
- TRANSITION ZONE
- BEDROCK
- PREDOMINANT BEDROCK FRACTURE ORIENTATION
- SHALLOW ZONE FLOW LAYER GROUNDWATER WELL WATER LEVEL ELEVATION
- DEEP ZONE FLOW LAYER GROUNDWATER WELL WATER LEVEL ELEVATION
- BEDROCK FLOW LAYER GROUNDWATER WELL WATER LEVEL ELEVATION
- WELL SCREEN
- CP-6BR: Co < 0.1, Fe < 50, Mn 14 — MEAN COBALT (Co) CONCENTRATION (µg/L) MEAN IRON (Fe) CONCENTRATION (µg/L) MEAN MANGANESE CONCENTRATION (µg/L)
- COMPLIANCE BOUNDARY

NOTES

1. DEPTH TO WATER GAUGED IN MONITORING WELLS ON MARCH 13, 2019, REFERENCED TO NORTH AMERICAN VERTICAL DATUM (NAVD) OF 1988.
2. GROUNDWATER FLOW IS APPROXIMATELY WEST TO EAST, PERPENDICULAR TO THE CROSS SECTION.
3. FRACTURES DEPICTED ON THIS CROSS SECTION REPRESENTS THE GENERALIZED FRACTURE ORIENTATIONS BASED ON TELEVIEWER LOGGING AT SITE SPECIFIC BOREHOLES. AS CONCEPTUALLY ILLUSTRATED HERE, TELEVIEWER LOGGING RESULTS DID NOT INDICATE ANY DISTINCT, CONSISTENT FRACTURE SETS, BUT A WIDE VARIETY OF FRACTURE ORIENTATIONS AT THE SITE. THE ACTUAL NUMBER OF FRACTURES IS FAR TOO NUMEROUS TO ILLUSTRATE AT THIS SCALE. IN ADDITION, THE DEPTH AND LENGTH OF FRACTURES VERSUS DEPTH ARE CONCEPTUAL ONLY.
4. ALL BOUNDARIES ARE APPROXIMATE.
5. CROSS SECTION REPRESENTATIVE OF PRE-DECANTING CONDITIONS.

DUKE ENERGY CAROLINAS

synTerra

GRAPHIC SCALE
0 112 225 450

HORIZONTAL SCALE: 1" = 450'
VERTICAL SCALE: 1" = 90'
5X VERTICAL EXAGGERATION

DRAWN BY: C. NEWELL	DATE: 9/13/2019
REVISED BY: D. KREFSKI	DATE: 12/5/2019
CHECKED BY: L. DRAGO	DATE: 12/5/2019
APPROVED BY: C. SUTTELL	DATE: 12/5/2019
PROJECT MANAGER: C. SUTTELL	
LAYOUT: XSECT_AA (6-9C)	

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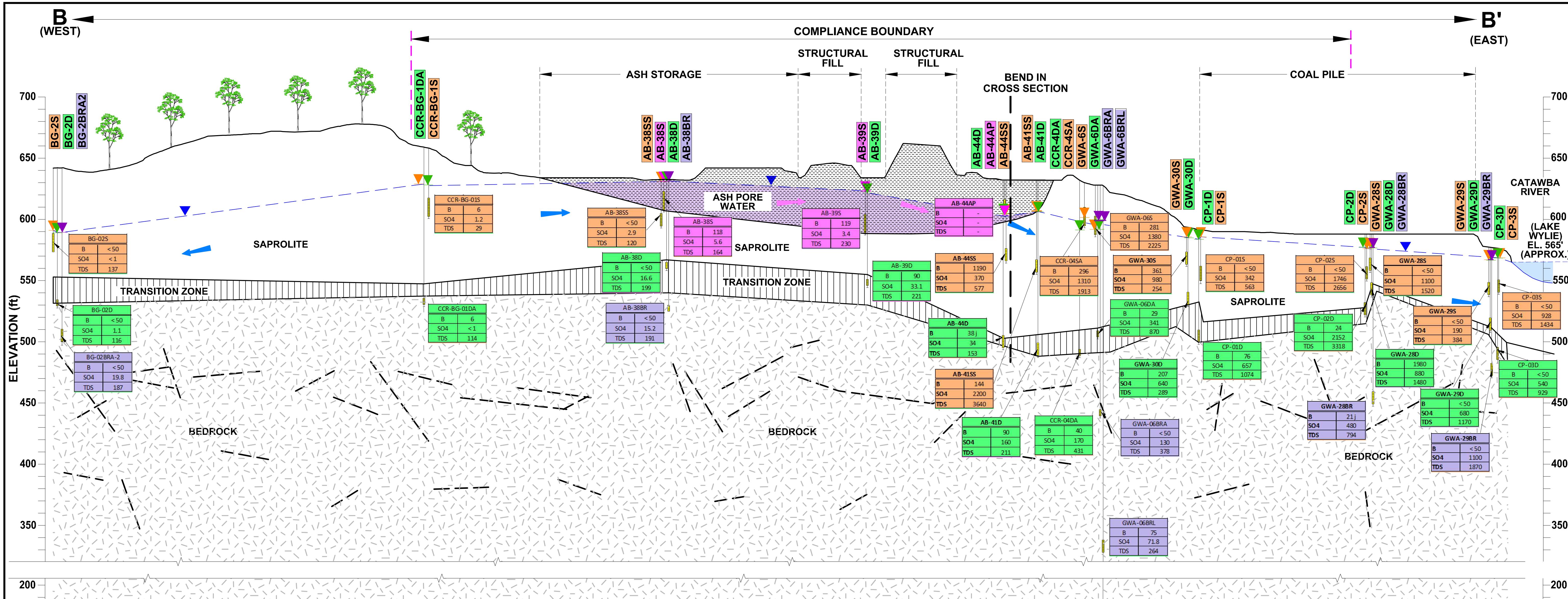
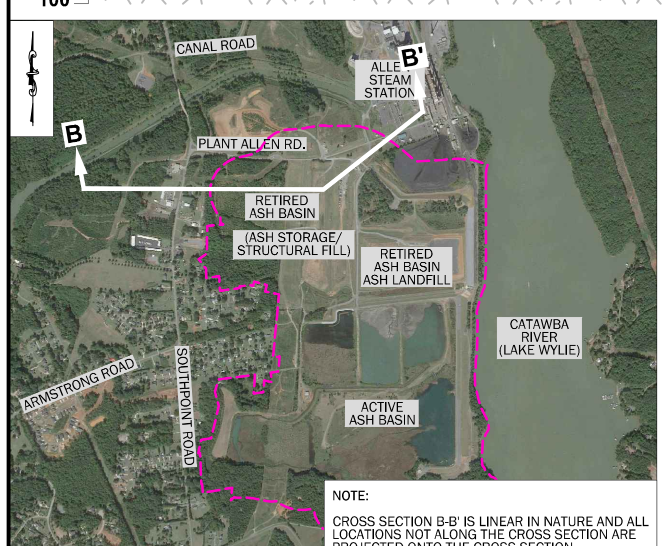
FIGURE 6-9c
GENERAL CROSS SECTION A-A'
VARIABLE GROUP
MEAN OF COBALT, IRON AND MANGANESE
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA





CROSS SECTION LOCATION

LEGEND

- GWA-22S — WELL IN FILL/ALLUVIUM/SAPROLITE
- GWA-22D — WELL IN TRANSITION ZONE
- GWA-21BR — WELL IN BEDROCK
- AB-35S — WELL IN ASH PORE WATER
- GENERALIZED WATER TABLE
- GENERALIZED GROUNDWATER FLOW DIRECTION
- GENERALIZED ASH PORE WATER FLOW DIRECTION
- ASH
- ASH PORE WATER
- SAPROLITE
- TRANSITION ZONE
- BEDROCK
- SURFACE WATER
- PREDOMINANT BEDROCK FRACTURE ORIENTATION
- ASH PORE WATER FLOW LAYER WATER LEVEL ELEVATION
- SHALLOW ZONE FLOW LAYER GROUNDWATER WELL WATER LEVEL ELEVATION
- DEEP ZONE FLOW LAYER GROUNDWATER WELL WATER LEVEL ELEVATION
- BEDROCK FLOW LAYER GROUNDWATER WELL WATER LEVEL ELEVATION
- BG-02D (B <50, SO4 1.1, TDS 116) — MEAN BORON (B) CONCENTRATION (µg/L) MEAN SULFATE (SO4) CONCENTRATION (mg/L) MEAN TOTAL DISSOLVED SOLIDS (TDS) CONCENTRATION (mg/L)
- WELL SCREEN
- BREAKLINE
- COMPLIANCE BOUNDARY

NOTES

1. DEPTH TO WATER GAUGED IN MONITORING WELLS ON MARCH 13, 2019, AND OCTOBER 24, 2019 (AB-41SS, AB-41D, AB-44AP, AB-44SS, AB-44D, GWA-28S, GWA-28D, GWA-28BR, GWA-29S, GWA-29D, GWA-29BR, GWA-30S, GWA-30D) REFERENCED TO NORTH AMERICAN VERTICAL DATUM (NAVD) OF 1988.
2. FRACTURES DEPICTED ON THIS CROSS SECTION REPRESENTS THE GENERALIZED FRACTURE ORIENTATIONS BASED ON TELEVIEWER LOGGING AT SITE SPECIFIC BOREHOLES. AS CONCEPTUALLY ILLUSTRATED HERE, TELEVIEWER LOGGING RESULTS DID NOT INDICATE ANY DISTINCT, CONSISTENT FRACTURE SETS, BUT A WIDE VARIETY OF FRACTURE ORIENTATIONS AT THE SITE. THE ACTUAL NUMBER OF FRACTURES IS FAR TOO NUMEROUS TO ILLUSTRATE AT THIS SCALE. IN ADDITION, THE DEPTH AND LENGTH OF FRACTURES VERSUS DEPTH ARE CONCEPTUAL ONLY.
3. ALL BOUNDARIES ARE APPROXIMATE.
4. CROSS SECTION REPRESENTATIVE OF PRE-DECANTING CONDITIONS.

NOTES:

1. ALL CONCENTRATIONS SHOWN ARE STATISTICAL MEANS OR GEOMEANS CALCULATED BASED ON CENTRAL TENDENCY OF DATASET USING DATA RANGING FROM JANUARY 2018 TO JUNE 2019.
2. BORON (B) CONCENTRATIONS ARE IN MICROGRAMS PER LITER (µg/L)
3. SULFATE (SO4) AND TOTAL DISSOLVED SOLIDS (TDS) CONCENTRATIONS ARE IN MILLIGRAMS PER LITER (mg/L)
4. MOST RECENT SAMPLE USED FOR AB-41SS/D, AB-44AP/SS/D, GWA-28S/D/BR, GWA-29S/D/BR, AND GWA-30S/D.

\- NO DATA AVAILABLE

ANALYTICAL PARAMETER	B	SO4	TDS
REPORTING UNITS	µg/L	mg/L	mg/L
15A NCAC 02L STANDARD	700	250	500
BACKGROUND THRESHOLD VALUE (SHALLOW FLOW	50	5.4	154
BACKGROUND THRESHOLD VALUE (DEEP FLOW ZONE)[1]	50	14.5	173
BACKGROUND THRESHOLD VALUE (BEDROCK FLOW	50	7.3	221

[1] - BACKGROUND THRESHOLD VALUES WERE CALCULATED USING DATA FROM BACKGROUND GROUNDWATER SAMPLES COLLECTED MARCH 2011 TO DECEMBER 2018 AS SUBMITTED IN JUNE 2019.

DUKE ENERGY CAROLINAS

synTerra

GRAPHIC SCALE
0 100 200 400'
HORIZONTAL SCALE: 1" = 400'
VERTICAL SCALE: 1" = 80'
5X VERTICAL EXAGGERATION

DRAWN BY: J. CHASTAIN	DATE: 7/26/2019
REVISED BY: D. KREFSKI	DATE: 12/6/2019
CHECKED BY: L. DRAGO	DATE: 12/6/2019
APPROVED BY: C. SUTTELL	DATE: 12/6/2019
PROJECT MANAGER: C. SUTTELL	
LAYOUT: XSECT6-10A	

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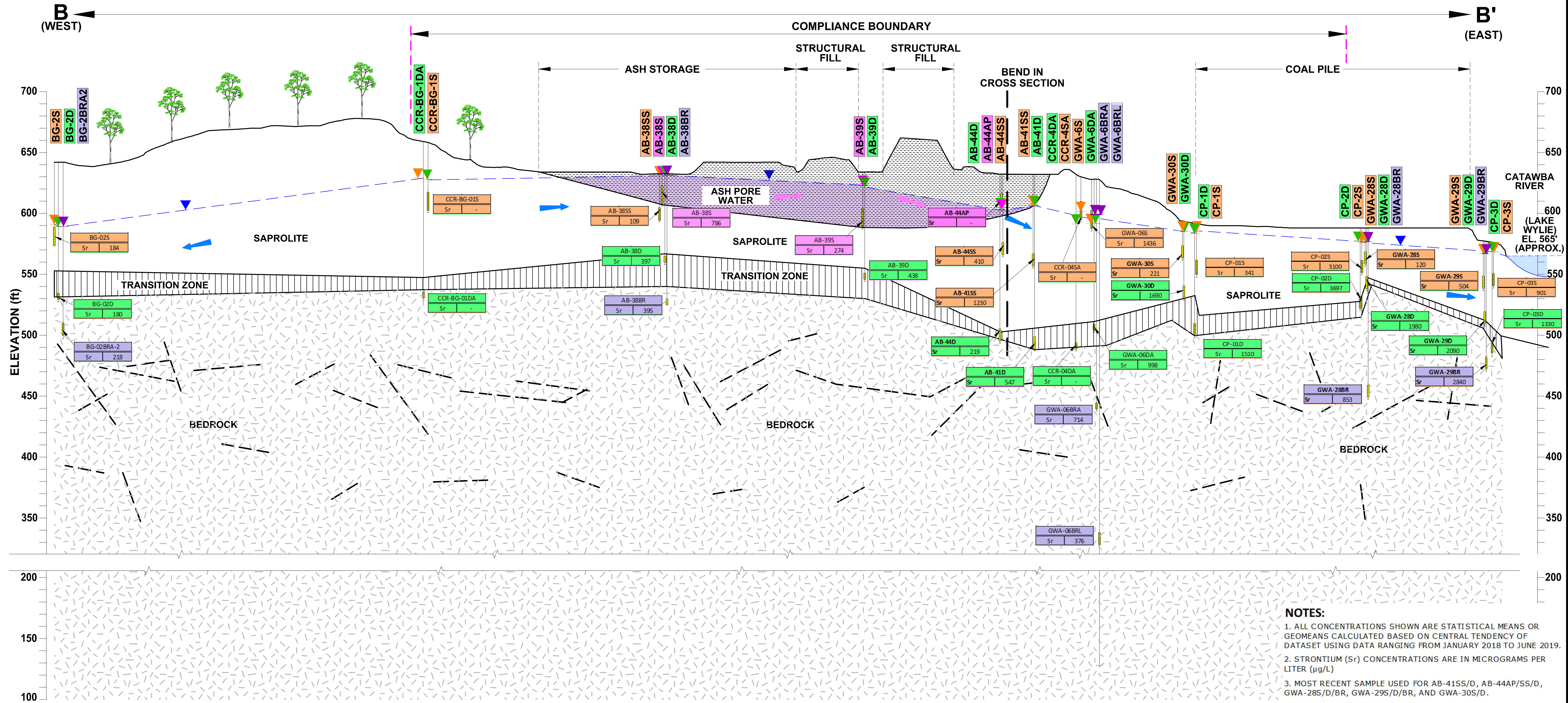
FIGURE 6-10a
GENERAL CROSS SECTION B-B'
CONSERVATIVE GROUP
MEAN OF BORON, SULFATE AND TOTAL DISSOLVED SOLIDS (TDS)
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA



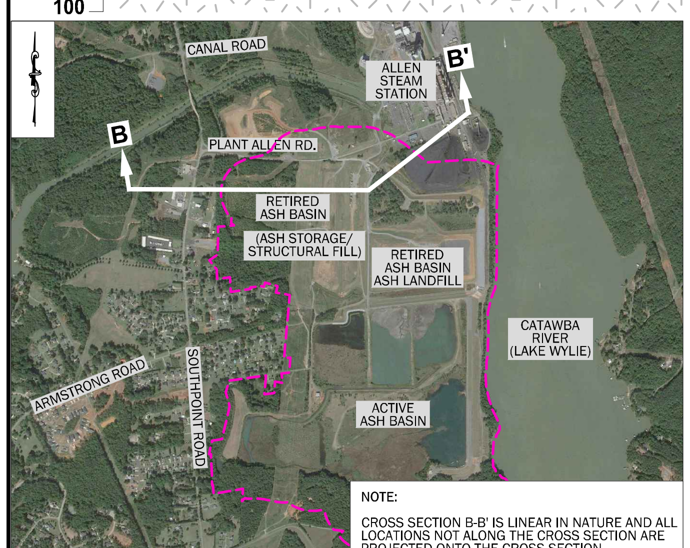
NOTES:

1. ALL CONCENTRATIONS SHOWN ARE STATISTICAL MEANS OR GEOMEANS CALCULATED BASED ON CENTRAL TENDENCY OF DATASET USING DATA RANGING FROM JANUARY 2018 TO JUNE 2019.
2. STRONTIUM (Sr) CONCENTRATIONS ARE IN MICROGRAMS PER LITER (µg/L)
3. MOST RECENT SAMPLE USED FOR AB-41SS/D, AB-44AP/SS/D, GWA-28S/D/BR, GWA-29S/D/BR, AND GWA-30S/D.

- NO DATA AVAILABLE

ANALYTICAL PARAMETER	Sr
REPORTING UNITS	µg/L
15A NCAC 02L STANDARD	NE
BACKGROUND THRESHOLD VALUE (SHALLOW FLOW ZONE)[1]	300
BACKGROUND THRESHOLD VALUE (DEEP FLOW ZONE)[1]	240
BACKGROUND THRESHOLD VALUE (BEDROCK FLOW	181

[1] - BACKGROUND THRESHOLD VALUES WERE CALCULATED USING DATA FROM BACKGROUND GROUNDWATER SAMPLES COLLECTED MARCH 2011 TO DECEMBER 2018 AS SUBMITTED IN JUNE 2019.



CROSS SECTION LOCATION

LEGEND

- GWA-22S — WELL IN FILL/ALLUVIUM/SAPROLITE
- GWA-22D — WELL IN TRANSITION ZONE
- GWA-21BR — WELL IN BEDROCK
- AB-35S — WELL IN ASH PORE WATER
- GENERALIZED WATER TABLE
- GENERALIZED GROUNDWATER FLOW DIRECTION
- GENERALIZED ASH PORE WATER FLOW DIRECTION
- ASH
- ASH PORE WATER
- SAPROLITE
- TRANSITION ZONE
- BEDROCK
- SURFACE WATER
- PREDOMINANT BEDROCK FRACTURE ORIENTATION
- ASH PORE LAYER WATER LEVEL ELEVATION
- SHALLOW ZONE FLOW LAYER GROUNDWATER WELL WATER LEVEL ELEVATION
- DEEP ZONE FLOW LAYER GROUNDWATER WELL WATER LEVEL ELEVATION
- BEDROCK FLOW LAYER GROUNDWATER WELL WATER LEVEL ELEVATION
- BG-02S Sr 184 — MEAN STRONTIUM CONCENTRATION (µg/L)
- WELL SCREEN
- BREAKLINE
- COMPLIANCE BOUNDARY

NOTES

1. DEPTH TO WATER GAUGED IN MONITORING WELLS ON MARCH 13, 2019, AND OCTOBER 24, 2019 (AB-41SS, AB-41D, AB-44AP, AB-44SS, AB-44D, GWA-28S, GWA-28D, GWA-28BR, GWA-29S, GWA-29D, GWA-29BR, GWA-30S, GWA-30D) REFERENCED TO NORTH AMERICAN VERTICAL DATUM (NAVD) OF 1988.
2. FRACTURES DEPICTED ON THIS CROSS SECTION REPRESENTS THE GENERALIZED FRACTURE ORIENTATIONS BASED ON TELEVIEWER LOGGING AT SITE SPECIFIC BOREHOLES. AS CONCEPTUALLY ILLUSTRATED HERE, TELEVIEWER LOGGING RESULTS DID NOT INDICATE ANY DISTINCT, CONSISTENT FRACTURE SETS, BUT A WIDE VARIETY OF FRACTURE ORIENTATIONS AT THE SITE. THE ACTUAL NUMBER OF FRACTURES IS FAR TOO NUMEROUS TO ILLUSTRATE AT THIS SCALE. IN ADDITION, THE DEPTH AND LENGTH OF FRACTURES VERSUS DEPTH ARE CONCEPTUAL ONLY.
3. ALL BOUNDARIES ARE APPROXIMATE.
4. CROSS SECTION REPRESENTATIVE OF PRE-DECANTING CONDITIONS.

DUKE ENERGY CAROLINAS

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GRAPHIC SCALE
0 100 200 400'

HORIZONTAL SCALE: 1" = 400'
VERTICAL SCALE: 1" = 80'
5X VERTICAL EXAGGERATION

DRAWN BY: J. CHASTAIN DATE: 7/26/2019
REVISED BY: D. KREFSKI DATE: 12/7/2019
CHECKED BY: L. DRAGO DATE: 12/7/2019
APPROVED BY: C. SUTTELL DATE: 12/7/2019
PROJECT MANAGER: C. SUTTELL
LAYOUT: XSECT6-10B

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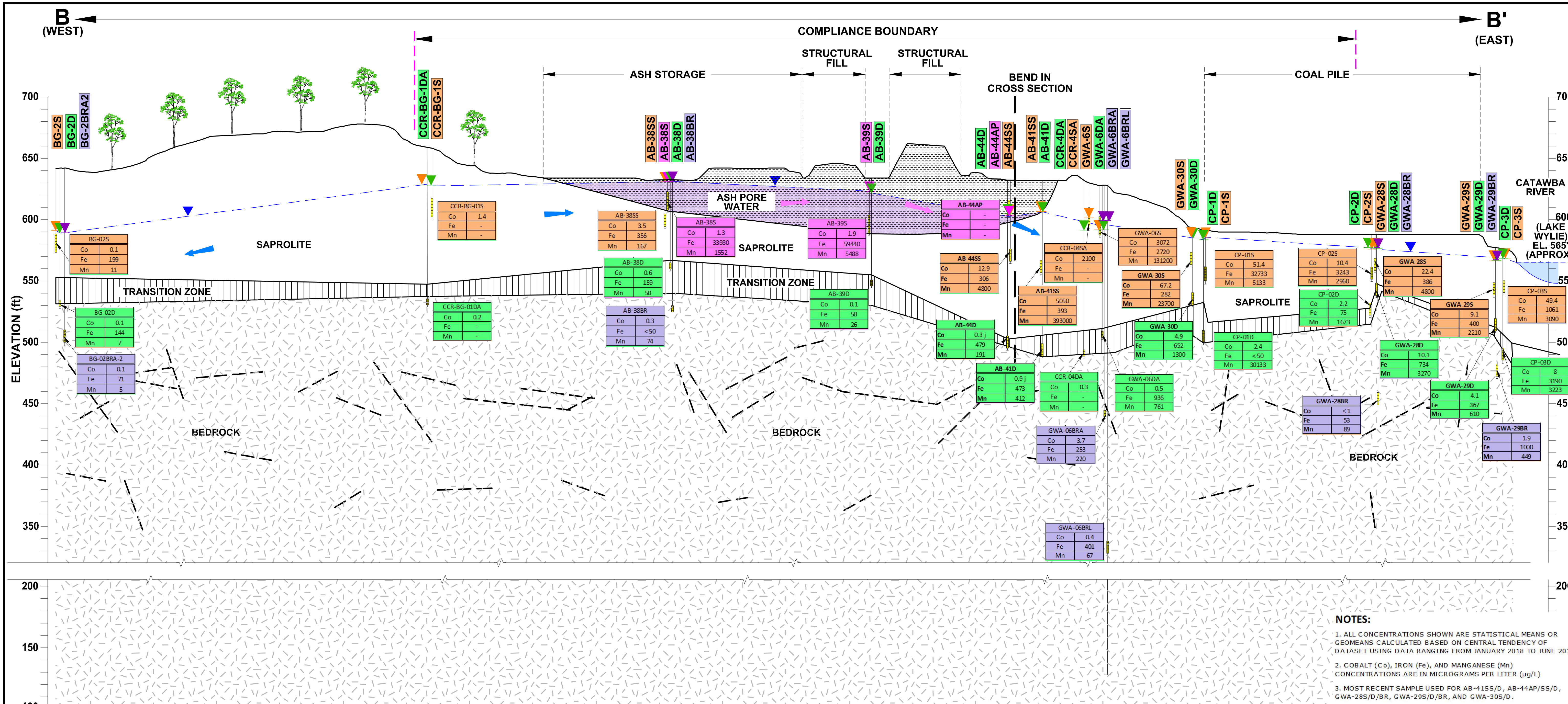
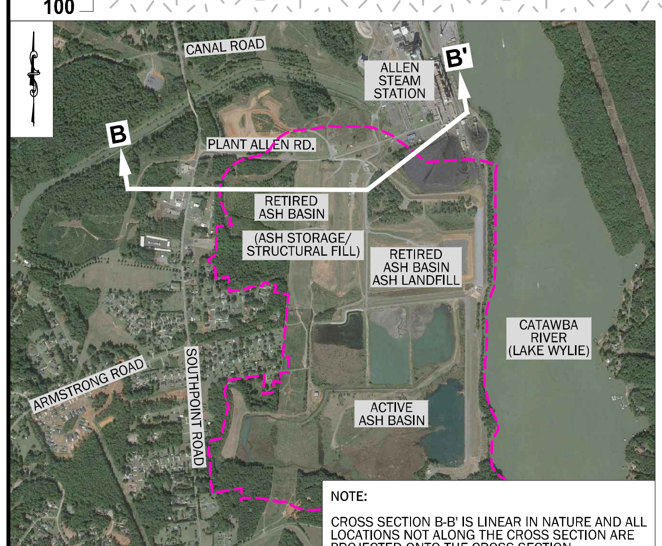
FIGURE 6-10b
GENERAL CROSS SECTION B-B'
NON-CONSERVATIVE GROUP
MEAN OF STRONTIUM
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA





NOTE:

CROSS SECTION B-B' IS LINEAR IN NATURE AND ALL LOCATIONS NOT ALONG THE CROSS SECTION ARE PROJECTED ONTO THE CROSS SECTION.

CROSS SECTION LOCATION

LEGEND

- GWA-22S WELL IN FILL/ALLUVIUM/SAPROLITE
- GWA-22D WELL IN TRANSITION ZONE
- GWA-21BR WELL IN BEDROCK
- AB-35S WELL IN ASH PORE WATER
- GENERALIZED WATER TABLE
- GENERALIZED GROUNDWATER FLOW DIRECTION
- GENERALIZED ASH PORE WATER FLOW DIRECTION
- ASH
- ASH PORE WATER
- SAPROLITE
- TRANSITION ZONE
- BEDROCK
- SURFACE WATER
- PREDOMINANT BEDROCK FRACTURE ORIENTATION
- ASH PORE WATER FLOW LAYER WATER LEVEL ELEVATION
- SHALLOW ZONE FLOW LAYER GROUNDWATER WELL WATER LEVEL ELEVATION
- DEEP ZONE FLOW LAYER GROUNDWATER WELL WATER LEVEL ELEVATION
- BEDROCK FLOW LAYER GROUNDWATER WELL WATER LEVEL ELEVATION
- GWA-06BRL / Co 0.4 / Fe 401 / Mn 67: MEAN COBALT (Co) CONCENTRATION (µg/L) MEAN IRON (Fe) CONCENTRATION (µg/L) MEAN MANGANESE CONCENTRATION (µg/L)
- WELL SCREEN
- BREAKLINE
- COMPLIANCE BOUNDARY

NOTES

1. DEPTH TO WATER GAUGED IN MONITORING WELLS ON MARCH 13, 2019, AND OCTOBER 24, 2019 (AB-41SS, AB-41D, AB-44AP, AB-44SS, AB-44D, GWA-28S, GWA-28D, GWA-28BR, GWA-29S, GWA-29D, GWA-29BR, GWA-30S, GWA-30D) REFERENCED TO NORTH AMERICAN VERTICAL DATUM (NAVD) OF 1988.
2. FRACTURES DEPICTED ON THIS CROSS SECTION REPRESENTS THE GENERALIZED FRACTURE ORIENTATIONS BASED ON TELEVIEWER LOGGING AT SITE SPECIFIC BOREHOLES. AS CONCEPTUALLY ILLUSTRATED HERE, TELEVIEWER LOGGING RESULTS DID NOT INDICATE ANY DISTINCT, CONSISTENT FRACTURE SETS, BUT A WIDE VARIETY OF FRACTURE ORIENTATIONS AT THE SITE. THE ACTUAL NUMBER OF FRACTURES IS FAR TOO NUMEROUS TO ILLUSTRATE AT THIS SCALE. IN ADDITION, THE DEPTH AND LENGTH OF FRACTURES VERSUS DEPTH ARE CONCEPTUAL ONLY.
3. ALL BOUNDARIES ARE APPROXIMATE.
4. CROSS SECTION REPRESENTATIVE OF PRE-DECANTING CONDITIONS.

NOTES:

1. ALL CONCENTRATIONS SHOWN ARE STATISTICAL MEANS OR GEOMEANS CALCULATED BASED ON CENTRAL TENDENCY OF DATASET USING DATA RANGING FROM JANUARY 2018 TO JUNE 2019.

2. COBALT (Co), IRON (Fe), AND MANGANESE (Mn) CONCENTRATIONS ARE IN MICROGRAMS PER LITER (µg/L)

3. MOST RECENT SAMPLE USED FOR AB-41SS/D, AB-44AP/SS/D, GWA-28S/D/BR, GWA-29S/D/BR, AND GWA-30S/D.

- NO DATA AVAILABLE

ANALYTICAL PARAMETER	Co	Fe	Mn
REPORTING UNITS	µg/L	µg/L	µg/L
15A NCAC 02L STANDARD	1*	300	50
BACKGROUND THRESHOLD VALUE (SHALLOW FLOW ZONE)[1]	5.7	1,422	608
BACKGROUND THRESHOLD VALUE (DEEP FLOW ZONE)[1]	0.82	665	256
BACKGROUND THRESHOLD VALUE (BEDROCK FLOW ZONE)[1]	0.35	1,242	360

* - INTERIM MAXIMUM ALLOWABLE CONCENTRATIONS (IMACs) OF THE 15A NCAC 02L STANDARD APPENDIX 1, APRIL 1, 2013.

[1] - BACKGROUND THRESHOLD VALUES WERE CALCULATED USING DATA FROM BACKGROUND GROUNDWATER SAMPLES COLLECTED MARCH 2011 TO DECEMBER 2018 AS SUBMITTED IN JUNE 2019.

DUKE ENERGY CAROLINAS

synTerra

GRAPHIC SCALE
0 100 200 400'
HORIZONTAL SCALE: 1" = 400'
VERTICAL SCALE: 1" = 80'
5X VERTICAL EXAGGERATION

DRAWN BY: J. CHASTAIN DATE: 7/26/2019
REVISED BY: D. KREFSKI DATE: 12/7/2019
CHECKED BY: L. DRAGO DATE: 12/7/2019
APPROVED BY: C. SUTTELL DATE: 12/7/2019
PROJECT MANAGER: C. SUTTELL
LAYOUT: XSECT6-10C

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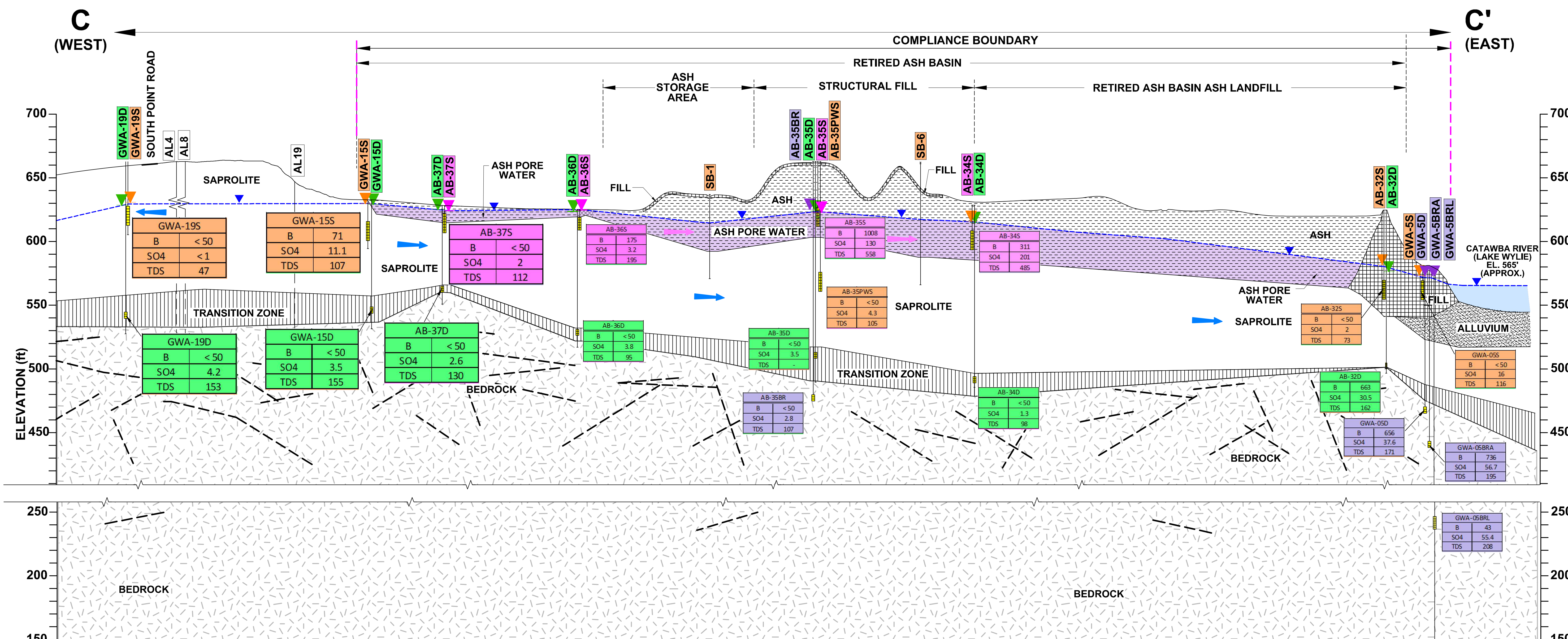
FIGURE 6-10c
GENERAL CROSS SECTION B-B'
VARIABLE GROUP
MEANS OF COBALT, IRON AND MANGANESE
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA



NOTES:

1. ALL CONCENTRATIONS SHOWN ARE STATISTICAL MEANS OR GEOMEANS CALCULATED BASED ON CENTRAL TENDENCY OF DATASET USING DATA RANGING FROM JANUARY 2018 TO JUNE 2019.

2. BORON (B) CONCENTRATIONS ARE IN MICROGRAMS PER LITER (µg/L)

3. SULFATE (SO4) AND TOTAL DISSOLVED SOLIDS (TDS) CONCENTRATIONS ARE IN MILLIGRAMS PER LITER (mg/L)

- NO DATA AVAILABLE

ANALYTICAL PARAMETER	B	SO4	TDS
REPORTING UNITS	µg/L	mg/L	mg/L
15A NCAC 02L STANDARD	700	250	500
BACKGROUND THRESHOLD VALUE (SHALLOW FLOW	50	5.4	154
BACKGROUND THRESHOLD VALUE (DEEP FLOW ZONE)[1]	50	14.5	173
BACKGROUND THRESHOLD VALUE (BEDROCK FLOW	50	7.3	221

[1] - BACKGROUND THRESHOLD VALUES WERE CALCULATED USING DATA FROM BACKGROUND GROUNDWATER SAMPLES COLLECTED MARCH 2011 TO DECEMBER 2018 AS SUBMITTED IN JUNE 2019.

NOTES

1. DEPTH TO WATER GAUGED IN MONITORING WELLS ON MARCH 13, 2019, REFERENCED TO NORTH AMERICAN VERTICAL DATUM (NAVD) OF 1988.
2. FRACTURES DEPICTED ON THIS CROSS SECTION REPRESENTS THE GENERALIZED FRACTURE ORIENTATIONS BASED ON TELEVIEWER LOGGING AT SITE SPECIFIC BOREHOLES. AS CONCEPTUALLY ILLUSTRATED HERE, TELEVIEWER LOGGING RESULTS DID NOT INDICATE ANY DISTINCT, CONSISTENT FRACTURE SETS, BUT A WIDE VARIETY OF FRACTURE ORIENTATIONS AT THE SITE. THE ACTUAL NUMBER OF FRACTURES IS FAR TOO NUMEROUS TO ILLUSTRATE AT THIS SCALE. IN ADDITION, THE DEPTH AND LENGTH OF FRACTURES VERSUS DEPTH ARE CONCEPTUAL ONLY.
3. ALL BOUNDARIES ARE APPROXIMATE.
4. CROSS SECTION REPRESENTATIVE OF PRE-DECANTING CONDITIONS.

LEGEND

- GWA-22S WELL IN FILL/ALLUVIUM/SAPROLITE
- GWA-22D WELL IN TRANSITION ZONE
- GWA-21BR WELL IN BEDROCK
- AB-35S WELL IN ASH PORE WATER
- GWA-5BR ABANDONED WELL/ GEOTECHNICAL BORING
- AL34 WATER SUPPLY WELL - (DEPTH UNKNOWN)
- GENERALIZED WATER TABLE
- GENERALIZED GROUNDWATER FLOW DIRECTION
- GENERALIZED ASH PORE WATER FLOW DIRECTION
- ASH
- ASH PORE WATER
- ALLUVIUM
- FILL
- SAPROLITE
- TRANSITION ZONE
- BEDROCK
- SURFACE WATER
- PREDOMINANT BEDROCK FRACTURE ORIENTATION
- ASH PORE WATER FLOW LAYER WATER LEVEL ELEVATION
- SHALLOW ZONE FLOW LAYER GROUNDWATER WELL WATER LEVEL ELEVATION
- DEEP ZONE FLOW LAYER GROUNDWATER WELL WATER LEVEL ELEVATION
- BEDROCK FLOW LAYER GROUNDWATER WELL WATER LEVEL ELEVATION
- AB-35D (B < 50; SO4 3.5; TDS -) MEAN BORON (B) CONCENTRATION (µg/L) MEAN SULFATE (SO4) CONCENTRATION (mg/L) MEAN TOTAL DISSOLVED SOLIDS (TDS) CONCENTRATION (mg/L)
- WELL SCREEN
- BREAKLINE
- COMPLIANCE BOUNDARY

NOTE:
CROSS SECTION C-C' IS LINEAR IN NATURE AND ALL LOCATIONS NOT ALONG THE CROSS SECTION ARE PROJECTED ONTO THE CROSS SECTION.

CROSS SECTION LOCATION

DUKE ENERGY CAROLINAS

synTerra

GRAPHIC SCALE
0 100 200 400
HORIZONTAL SCALE: 1" = 400'
VERTICAL SCALE: 1" = 80'
5X VERTICAL EXAGGERATION

DRAWN BY: J. CHASTAIN DATE: 7/26/2019
REVISED BY: D. KREFSKI DATE: 12/8/2019
CHECKED BY: L.DRAGO DATE: 12/8/2019
APPROVED BY: C. SUTTELL DATE: 12/8/2019
PROJECT MANAGER: C. SUTTELL
LAYOUT: XSECT (6-11A)

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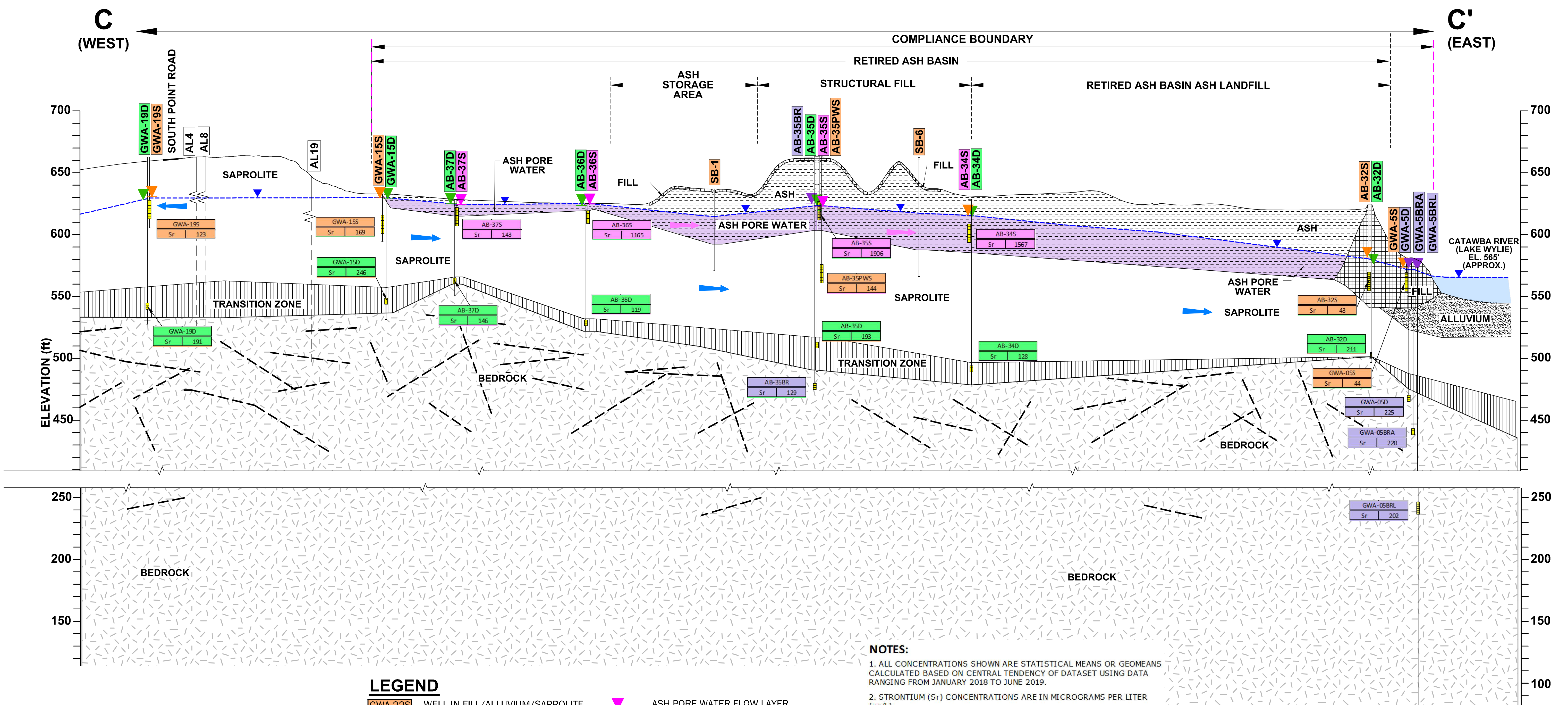
FIGURE 6-11a
GENERAL CROSS SECTION C-C' CONSERVATIVE GROUP MEAN OF BORON, SULFATE AND TOTAL DISSOLVED SOLIDS (TDS) CORRECTIVE ACTION PLAN UPDATE ALLEN STEAM STATION BELMONT, NORTH CAROLINA



NOTES:

1. ALL CONCENTRATIONS SHOWN ARE STATISTICAL MEANS OR GEOMEANS CALCULATED BASED ON CENTRAL TENDENCY OF DATASET USING DATA RANGING FROM JANUARY 2018 TO JUNE 2019.

2. STRONTIUM (Sr) CONCENTRATIONS ARE IN MICROGRAMS PER LITER (µg/L)

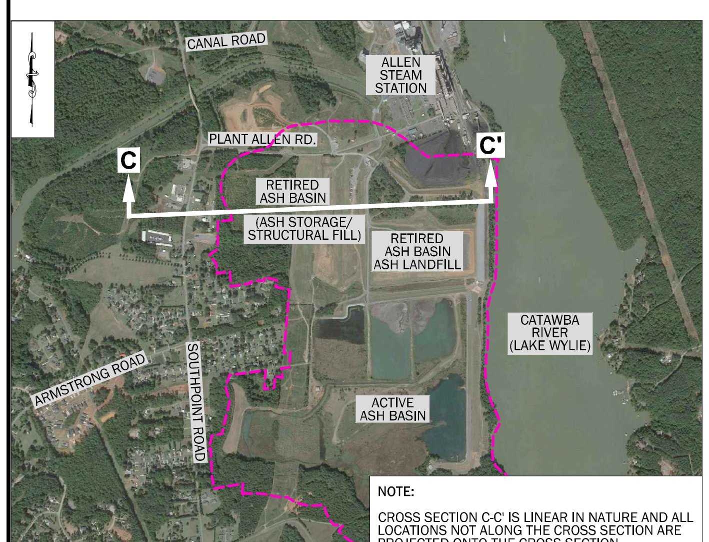
- NO DATA AVAILABLE

ANALYTICAL PARAMETER	Sr
REPORTING UNITS	µg/L
15A NCAC 02L STANDARD	NE
BACKGROUND THRESHOLD VALUE (SHALLOW FLOW ZONE)[1]	300
BACKGROUND THRESHOLD VALUE (DEEP FLOW ZONE)[1]	240
BACKGROUND THRESHOLD VALUE (BEDROCK FLOW	181

[1] - BACKGROUND THRESHOLD VALUES WERE CALCULATED USING DATA FROM BACKGROUND GROUNDWATER SAMPLES COLLECTED MARCH 2011 TO DECEMBER 2018 AS SUBMITTED IN JUNE 2019.

LEGEND

- GWA-22S WELL IN FILL/ALLUVIUM/SAPROLITE
- GWA-22D WELL IN TRANSITION ZONE
- GWA-21BR WELL IN BEDROCK
- AB-35S WELL IN ASH PORE WATER
- GWA-5BR ABANDONED WELL/ GEOTECHNICAL BORING
- AL34 WATER SUPPLY WELL - (DEPTH UNKNOWN)
- GENERALIZED WATER TABLE
- GENERALIZED GROUNDWATER FLOW DIRECTION
- GENERALIZED ASH PORE WATER FLOW DIRECTION
- ASH
- ASH PORE WATER
- ALLUVIUM
- FILL
- SAPROLITE
- TRANSITION ZONE
- BEDROCK
- SURFACE WATER
- PREDOMINANT BEDROCK FRACTURE ORIENTATION
- ASH PORE WATER FLOW LAYER WATER LEVEL ELEVATION
- SHALLOW ZONE FLOW LAYER GROUNDWATER WELL WATER LEVEL ELEVATION
- DEEP ZONE FLOW LAYER GROUNDWATER WELL WATER LEVEL ELEVATION
- BEDROCK FLOW LAYER GROUNDWATER WELL WATER LEVEL ELEVATION
- GWA-16S Sr 191 MEAN STRONTIUM CONCENTRATION (µg/L)
- WELL SCREEN
- BREAKLINE
- COMPLIANCE BOUNDARY



CROSS SECTION LOCATION

NOTES

1. DEPTH TO WATER GAUGED IN MONITORING WELLS ON MARCH 13, 2019, REFERENCED TO NORTH AMERICAN VERTICAL DATUM (NAVD) OF 1988.
2. FRACTURES DEPICTED ON THIS CROSS SECTION REPRESENTS THE GENERALIZED FRACTURE ORIENTATIONS BASED ON TELEVIEWER LOGGING AT SITE SPECIFIC BOREHOLES. AS CONCEPTUALLY ILLUSTRATED HERE, TELEVIEWER LOGGING RESULTS DID NOT INDICATE ANY DISTINCT, CONSISTENT FRACTURE SETS, BUT A WIDE VARIETY OF FRACTURE ORIENTATIONS AT THE SITE. THE ACTUAL NUMBER OF FRACTURES IS FAR TOO NUMEROUS TO ILLUSTRATE AT THIS SCALE. IN ADDITION, THE DEPTH AND LENGTH OF FRACTURES VERSUS DEPTH ARE CONCEPTUAL ONLY.
3. ALL BOUNDARIES ARE APPROXIMATE.
4. CROSS SECTION REPRESENTATIVE OF PRE-DECANTING CONDITIONS.

DUKE ENERGY CAROLINAS

synTerra

GRAPHIC SCALE
0 100 200 400
HORIZONTAL SCALE: 1" = 400'
VERTICAL SCALE: 1" = 80'
5X VERTICAL EXAGGERATION

DRAWN BY: J. CHASTAIN	DATE: 7/26/2019
REVISED BY: D. KREFSKI	DATE: 12/8/2019
CHECKED BY: L.DRAGO	DATE: 12/8/2019
APPROVED BY: C. SUTTELL	DATE: 12/8/2019
PROJECT MANAGER: C. SUTTELL	
LAYOUT: XSECT (6-11B)	

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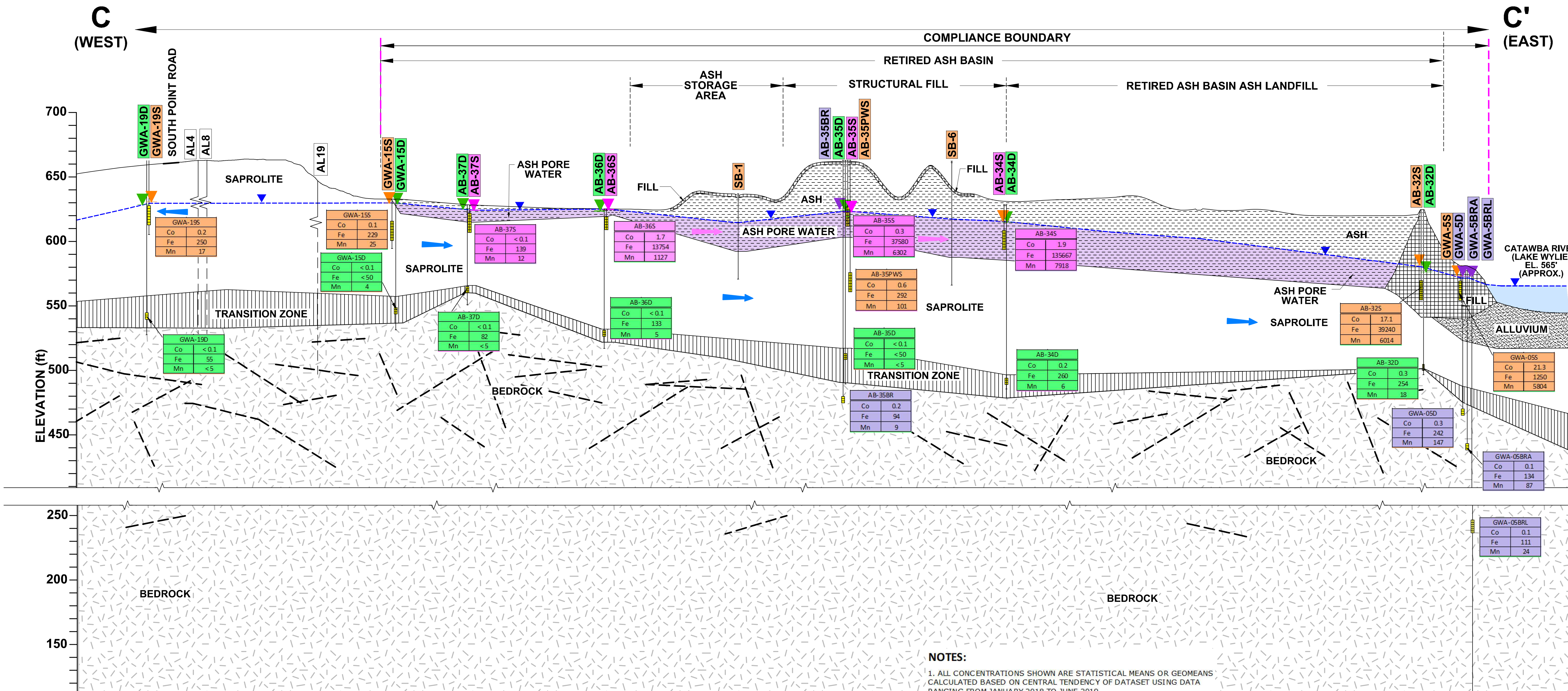
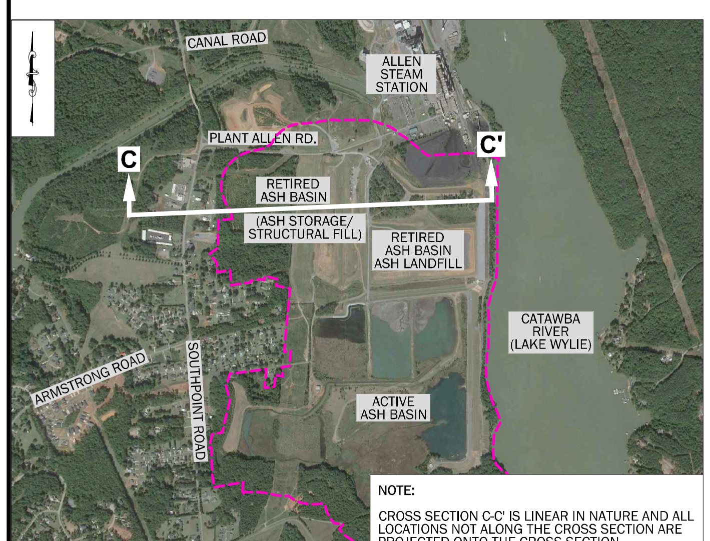
FIGURE 6-11b
GENERAL CROSS SECTION C-C'
NON-CONSERVATIVE GROUP
MEAN OF STRONTIUM
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA



LEGEND

- GWA-22S — WELL IN FILL/ALLUVIUM/SAPROLITE
- GWA-22D — WELL IN TRANSITION ZONE
- GWA-21BR — WELL IN BEDROCK
- AB-35S — WELL IN ASH PORE WATER
- GWA-5BR — ABANDONED WELL/ GEOTECHNICAL BORING
- AL34 — WATER SUPPLY WELL - (DEPTH UNKNOWN)
- GENERALIZED WATER TABLE
- GENERALIZED GROUNDWATER FLOW DIRECTION
- GENERALIZED ASH PORE WATER FLOW DIRECTION
- ASH
- ASH PORE WATER
- ALLUVIUM
- FILL
- SAPROLITE
- TRANSITION ZONE
- BEDROCK
- SURFACE WATER
- PREDOMINANT BEDROCK FRACTURE ORIENTATION
- ASH PORE WATER FLOW LAYER WATER LEVEL ELEVATION
- SHALLOW ZONE FLOW LAYER GROUNDWATER WELL WATER LEVEL ELEVATION
- DEEP ZONE FLOW LAYER GROUNDWATER WELL WATER LEVEL ELEVATION
- BEDROCK FLOW LAYER GROUNDWATER WELL WATER LEVEL ELEVATION
- AB-35BR (Co 0.16, Fe 94.3, Mn 9.1) — MEAN COBALT (Co) CONCENTRATION (µg/L) MEAN IRON (Fe) CONCENTRATION (µg/L) MEAN MANGANESE CONCENTRATION (µg/L)
- WELL SCREEN
- BREAKLINE
- COMPLIANCE BOUNDARY



NOTE:

CROSS SECTION C-C' IS LINEAR IN NATURE AND ALL LOCATIONS NOT ALONG THE CROSS SECTION ARE PROJECTED ONTO THE CROSS SECTION.

CROSS SECTION LOCATION

NOTES:

1. ALL CONCENTRATIONS SHOWN ARE STATISTICAL MEANS OR GEOMEANS CALCULATED BASED ON CENTRAL TENDENCY OF DATASET USING DATA RANGING FROM JANUARY 2018 TO JUNE 2019.

2. COBALT (Co), IRON (Fe), AND MANGANESE (Mn) CONCENTRATIONS ARE IN MICROGRAMS PER LITER (µg/L)

- NO DATA AVAILABLE

ANALYTICAL PARAMETER	Co	Fe	Mn
REPORTING UNITS	µg/L	µg/L	µg/L
15A NCAC 02L STANDARD	1*	300	50
BACKGROUND THRESHOLD VALUE (SHALLOW FLOW ZONE)[1]	5.7	1,422	608
BACKGROUND THRESHOLD VALUE (DEEP FLOW ZONE)[1]	0.82	665	256
BACKGROUND THRESHOLD VALUE (BEDROCK FLOW ZONE)[1]	0.35	1,242	360

* - INTERIM MAXIMUM ALLOWABLE CONCENTRATIONS (IMACs) OF THE 15A NCAC 02L STANDARD APPENDIX 1, APRIL 1, 2013.

[1] - BACKGROUND THRESHOLD VALUES WERE CALCULATED USING DATA FROM BACKGROUND GROUNDWATER SAMPLES COLLECTED MARCH 2011 TO DECEMBER 2018 AS SUBMITTED IN JUNE 2019.

NOTES

1. DEPTH TO WATER GAUGED IN MONITORING WELLS ON MARCH 13, 2019, REFERENCED TO NORTH AMERICAN VERTICAL DATUM (NAVD) OF 1988.
2. FRACTURES DEPICTED ON THIS CROSS SECTION REPRESENTS THE GENERALIZED FRACTURE ORIENTATIONS BASED ON TELEVIEWER LOGGING AT SITE SPECIFIC BOREHOLES. AS CONCEPTUALLY ILLUSTRATED HERE, TELEVIEWER LOGGING RESULTS DID NOT INDICATE ANY DISTINCT, CONSISTENT FRACTURE SETS, BUT A WIDE VARIETY OF FRACTURE ORIENTATIONS AT THE SITE. THE ACTUAL NUMBER OF FRACTURES IS FAR TOO NUMEROUS TO ILLUSTRATE AT THIS SCALE. IN ADDITION, THE DEPTH AND LENGTH OF FRACTURES VERSUS DEPTH ARE CONCEPTUAL ONLY.
3. ALL BOUNDARIES ARE APPROXIMATE.
4. CROSS SECTION REPRESENTATIVE OF PRE-DECANTING CONDITIONS.

DUKE ENERGY CAROLINAS

synTerra

GRAPHIC SCALE
0 100 200 400
HORIZONTAL SCALE: 1" = 400'
VERTICAL SCALE: 1" = 80'
5X VERTICAL EXAGGERATION

DRAWN BY: J. CHASTAIN DATE: 7/26/2019
REVISED BY: D. KREFSKI DATE: 12/8/2019
CHECKED BY: L.DRAGO DATE: 12/8/2019
APPROVED BY: C. SUTTELL DATE: 12/8/2019
PROJECT MANAGER: C. SUTTELL
LAYOUT: XSECT (6-11C)

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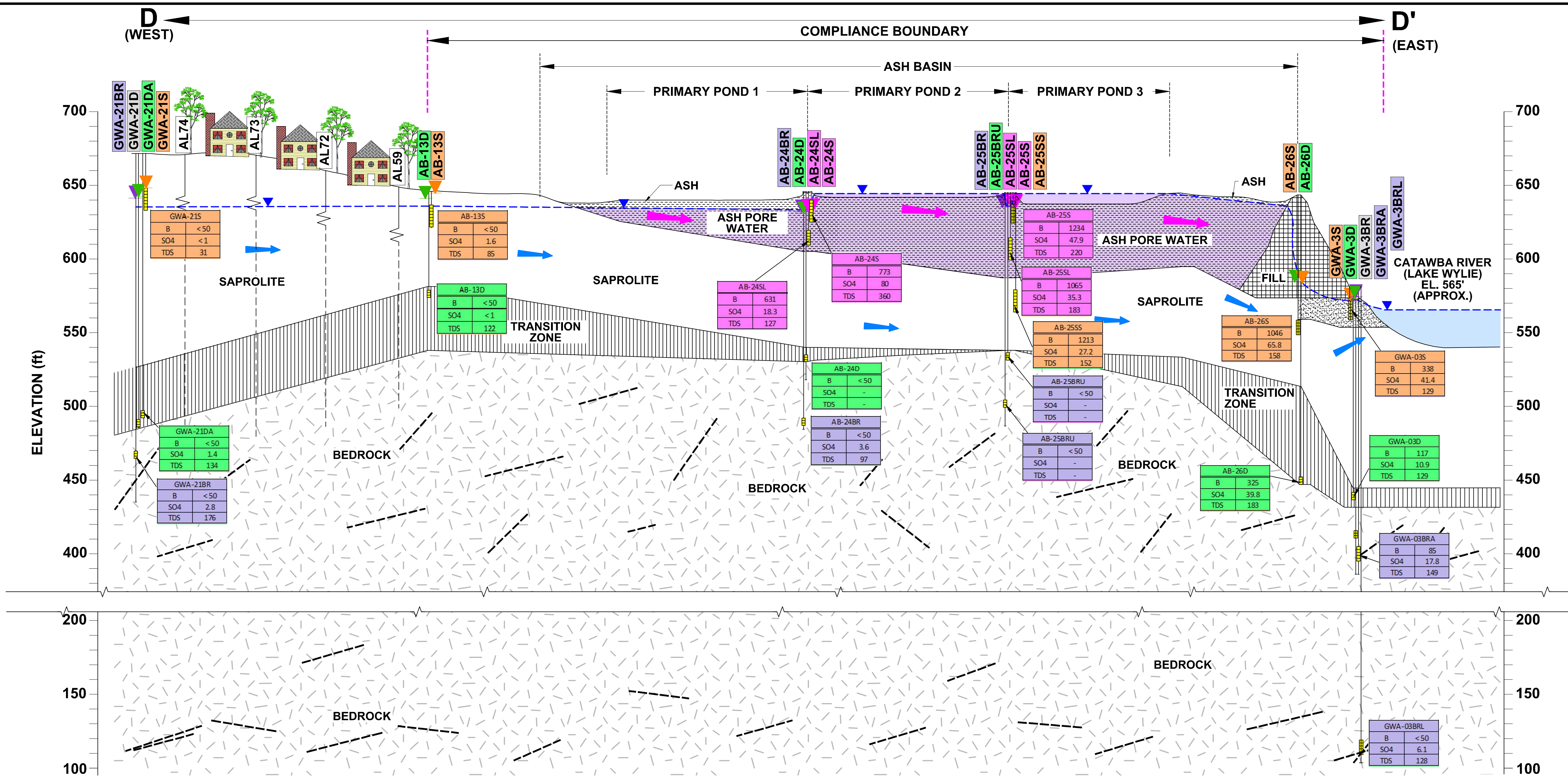
FIGURE 6-11c
GENERAL CROSS SECTION C-C'
VARIABLE GROUP
MEAN OF COBALT, IRON AND MANGANESE
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA



LEGEND

- GWA-22S — WELL IN FILL/ALLUVIUM/SAPROLITE
- GWA-22D — WELL IN TRANSITION ZONE
- GWA-21BR — WELL IN BEDROCK
- AB-35S — WELL IN ASH PORE WATER
- GWA-5BR — ABANDONED WELL/ GEOTECHNICAL BORING
- AL34 — WATER SUPPLY WELL - (DEPTH UNKNOWN)
- GENERALIZED WATER TABLE
- GENERALIZED GROUNDWATER FLOW DIRECTION
- GENERALIZED ASH PORE WATER FLOW DIRECTION
- ASH
- ASH PORE WATER
- ALLUVIUM
- FILL
- SAPROLITE
- TRANSITION ZONE
- BEDROCK
- SURFACE WATER
- PREDOMINANT BEDROCK FRACTURE ORIENTATION
- ASH PORE WATER FLOW LAYER WATER LEVEL ELEVATION
- SHALLOW ZONE FLOW LAYER GROUNDWATER WELL WATER LEVEL ELEVATION
- DEEP ZONE FLOW LAYER GROUNDWATER WELL WATER LEVEL ELEVATION
- BEDROCK FLOW LAYER GROUNDWATER WELL WATER LEVEL ELEVATION
- GWA-21DA B <50 SO4 1 TDS 134 — MEAN BORON (B) CONCENTRATION (µg/L) MEAN SULFATE (SO4) CONCENTRATION (mg/L) MEAN TOTAL DISSOLVED SOLIDS (TDS) CONCENTRATION (mg/L)
- WELL SCREEN
- BREAKLINE
- COMPLIANCE BOUNDARY

NOTES

1. DEPTH TO WATER GAUGED IN MONITORING WELLS ON MARCH 13, 2019, REFERENCED TO NORTH AMERICAN VERTICAL DATUM (NAVD) OF 1988.
2. FRACTURES DEPICTED ON THIS CROSS SECTION REPRESENTS THE GENERALIZED FRACTURE ORIENTATIONS BASED ON TELEVIEWER LOGGING AT SITE SPECIFIC BOREHOLES. AS CONCEPTUALLY ILLUSTRATED HERE, TELEVIEWER LOGGING RESULTS DID NOT INDICATE ANY DISTINCT, CONSISTENT FRACTURE SETS, BUT A WIDE VARIETY OF FRACTURE ORIENTATIONS AT THE SITE. THE ACTUAL NUMBER OF FRACTURES IS FAR TOO NUMEROUS TO ILLUSTRATE AT THIS SCALE. IN ADDITION, THE DEPTH AND LENGTH OF FRACTURES VERSUS DEPTH ARE CONCEPTUAL ONLY.
3. ALL BOUNDARIES ARE APPROXIMATE.
4. CROSS SECTION REPRESENTATIVE OF PRE-DECANTING CONDITIONS.

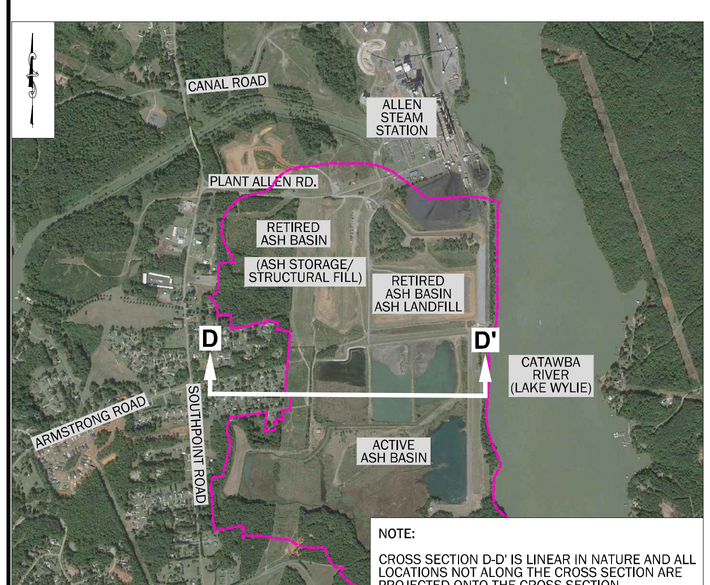
NOTES:

1. ALL CONCENTRATIONS SHOWN ARE STATISTICAL MEANS OR GEOMEANS CALCULATED BASED ON CENTRAL TENDENCY OF DATASET USING DATA RANGING FROM JANUARY 2018 TO JUNE 2019.
2. BORON (B) CONCENTRATIONS ARE IN MICROGRAMS PER LITER (µg/L)
3. SULFATE (SO4) AND TOTAL DISSOLVED SOLIDS (TDS) CONCENTRATIONS ARE IN MILLIGRAMS PER LITER (mg/L)

- NO DATA AVAILABLE

ANALYTICAL PARAMETER	B	SO4	TDS
REPORTING UNITS	µg/L	mg/L	mg/L
15A NCAC 02L STANDARD	700	250	500
BACKGROUND THRESHOLD VALUE (SHALLOW FLOW	50	5.4	154
BACKGROUND THRESHOLD VALUE (DEEP FLOW ZONE)[1]	50	14.5	173
BACKGROUND THRESHOLD VALUE (BEDROCK FLOW	50	7.3	221

[1] - BACKGROUND THRESHOLD VALUES WERE CALCULATED USING DATA FROM BACKGROUND GROUNDWATER SAMPLES COLLECTED MARCH 2011 TO DECEMBER 2018 AS SUBMITTED IN JUNE 2019.



CROSS SECTION LOCATION

DUKE ENERGY CAROLINAS

synTerra

GRAPHIC SCALE
0 100 200 400
HORIZONTAL SCALE: 1" = 400'
VERTICAL SCALE: 1" = 80'
5X VERTICAL EXAGGERATION

DRAWN BY: J. CHASTAIN	DATE: 7/26/2019
REVISED BY: D. KREFSKI	DATE: 12/8/2019
CHECKED BY: L.DRAGO	DATE: 12/8/2019
APPROVED BY: C. SUTTELL	DATE: 12/8/2019
PROJECT MANAGER: C. SUTTELL	
LAYOUT: XSECT_DD (6-12A)	

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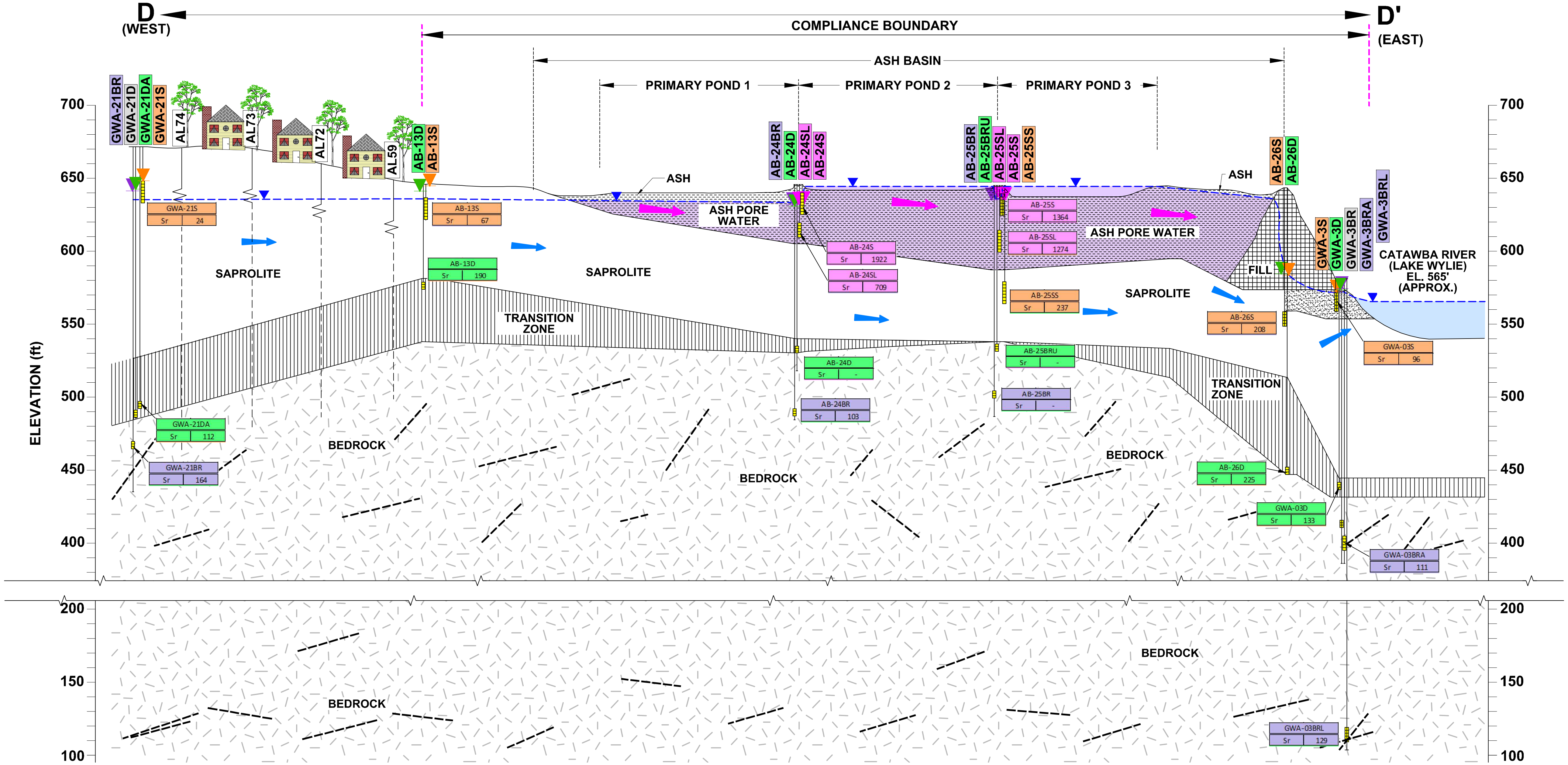
FIGURE 6-12a
GENERAL CROSS SECTION D-D'
CONSERVATIVE GROUP
MEAN OF BORON, SULFATE AND TOTAL DISSOLVED SOLIDS (TDS)
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA



LEGEND

GWA-22S WELL IN FILL/ALLUVIUM/SAPROLITE
GWA-22D WELL IN TRANSITION ZONE
GWA-21BR WELL IN BEDROCK
AB-35S WELL IN ASH PORE WATER
GWA-5BR ABANDONED WELL/ GEOTECHNICAL BORING
AL34 WATER SUPPLY WELL - (DEPTH UNKNOWN)
GENERALIZED WATER TABLE
GENERALIZED GROUNDWATER FLOW DIRECTION
GENERALIZED ASH PORE WATER FLOW DIRECTION
ASH
ASH PORE WATER
ALLUVIUM
FILL
SAPROLITE
TRANSITION ZONE
BEDROCK
SURFACE WATER
PREDOMINANT BEDROCK FRACTURE ORIENTATION
ASH PORE WATER FLOW LAYER WATER LEVEL ELEVATION
SHALLOW ZONE FLOW LAYER GROUNDWATER WELL WATER LEVEL ELEVATION
DEEP ZONE FLOW LAYER GROUNDWATER WELL WATER LEVEL ELEVATION
BEDROCK FLOW LAYER GROUNDWATER WELL WATER LEVEL ELEVATION
AB-13S Sr 67.4 MEANS STRONTIUM CONCENTRATION (mg/L)
WELL SCREEN
BREAKLINE
COMPLIANCE BOUNDARY

NOTES

1. DEPTH TO WATER GAUGED IN MONITORING WELLS ON MARCH 13, 2019, REFERENCED TO NORTH AMERICAN VERTICAL DATUM (NAVD) OF 1988.
2. FRACTURES DEPICTED ON THIS CROSS SECTION REPRESENTS THE GENERALIZED FRACTURE ORIENTATIONS BASED ON TELEVIEWER LOGGING AT SITE SPECIFIC BOREHOLES. AS CONCEPTUALLY ILLUSTRATED HERE, TELEVIEWER LOGGING RESULTS DID NOT INDICATE ANY DISTINCT, CONSISTENT FRACTURE SETS, BUT A WIDE VARIETY OF FRACTURE ORIENTATIONS AT THE SITE. THE ACTUAL NUMBER OF FRACTURES IS FAR TOO NUMEROUS TO ILLUSTRATE AT THIS SCALE. IN ADDITION, THE DEPTH AND LENGTH OF FRACTURES VERSUS DEPTH ARE CONCEPTUAL ONLY.
3. ALL BOUNDARIES ARE APPROXIMATE.
4. CROSS SECTION REPRESENTATIVE OF PRE-DECANTING CONDITIONS.

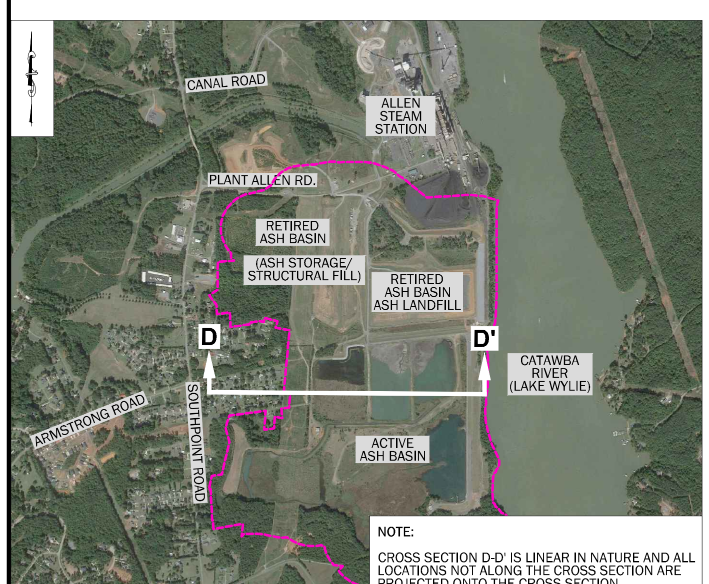
NOTES:

1. ALL CONCENTRATIONS SHOWN ARE STATISTICAL MEANS OR GEOMEANS CALCULATED BASED ON CENTRAL TENDENCY OF DATASET USING DATA RANGING FROM JANUARY 2018 TO JUNE 2019.
2. STRONTIUM (Sr) CONCENTRATIONS ARE IN MICROGRAMS PER LITER (µg/L)

- NO DATA AVAILABLE

ANALYTICAL PARAMETER	Sr
REPORTING UNITS	µg/L
15A NCAC 02L STANDARD	NE
BACKGROUND THRESHOLD VALUE (SHALLOW FLOW ZONE)[1]	300
BACKGROUND THRESHOLD VALUE (DEEP FLOW ZONE)[1]	240
BACKGROUND THRESHOLD VALUE (BEDROCK FLOW	181

[1] - BACKGROUND THRESHOLD VALUES WERE CALCULATED USING DATA FROM BACKGROUND GROUNDWATER SAMPLES COLLECTED MARCH 2011 TO DECEMBER 2018 AS SUBMITTED IN JUNE 2019.



NOTE:
CROSS SECTION D-D' IS LINEAR IN NATURE AND ALL LOCATIONS NOT ALONG THE CROSS SECTION ARE PROJECTED ONTO THE CROSS SECTION.

CROSS SECTION LOCATION

DUKE ENERGY CAROLINAS

synTerra

GRAPHIC SCALE
0 100 200 400
HORIZONTAL SCALE: 1" = 400'
VERTICAL SCALE: 1" = 80'
5X VERTICAL EXAGGERATION

DRAWN BY: J. CHASTAIN DATE: 7/26/2019
REVISED BY: D. KREFSKI DATE: 12/8/2019
CHECKED BY: L.DRAGO DATE: 12/8/2019
APPROVED BY: C. SUTTELL DATE: 12/8/2019
PROJECT MANAGER: C. SUTTELL
LAYOUT: XSECT_DD (6-12B)

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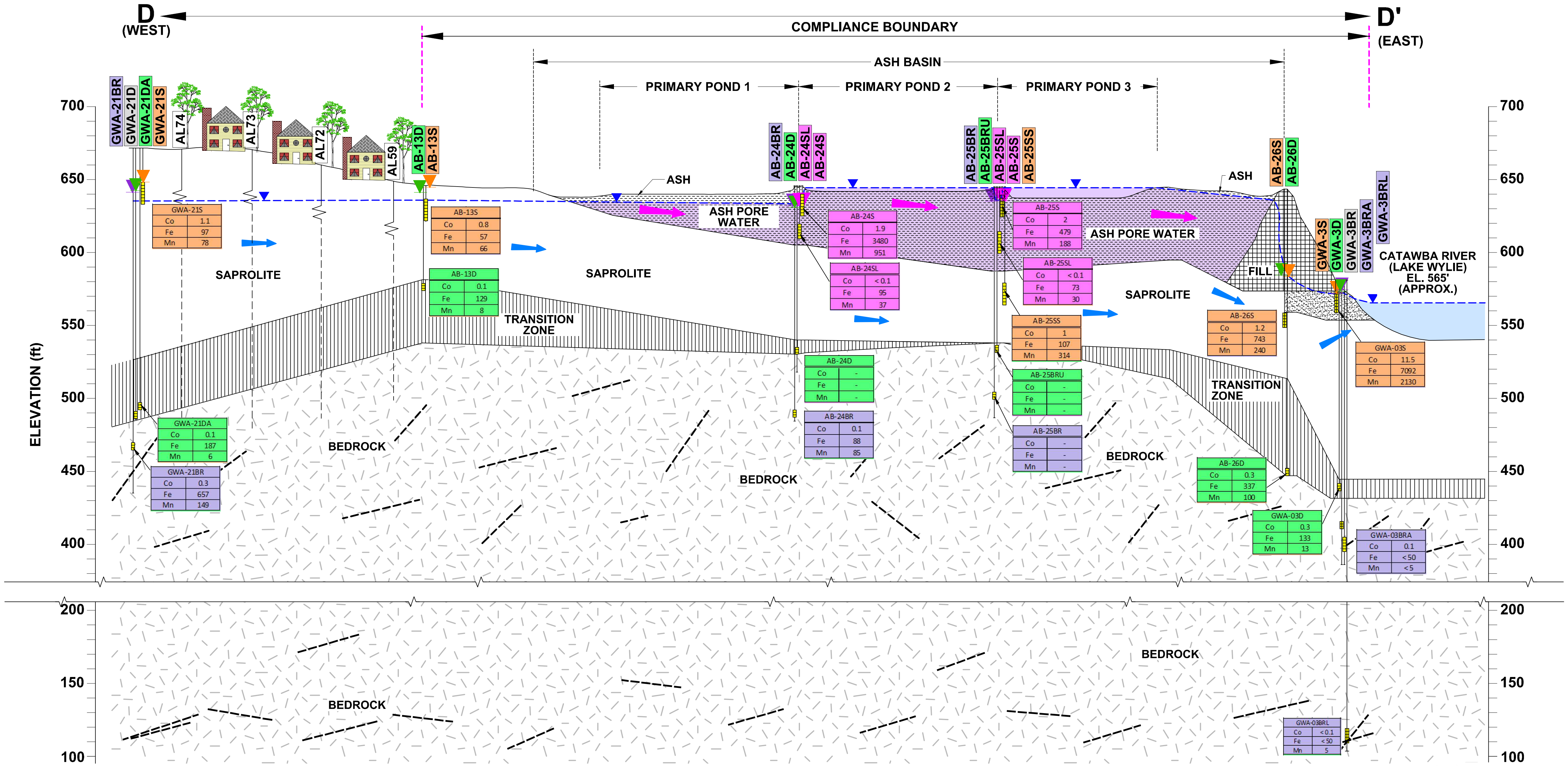
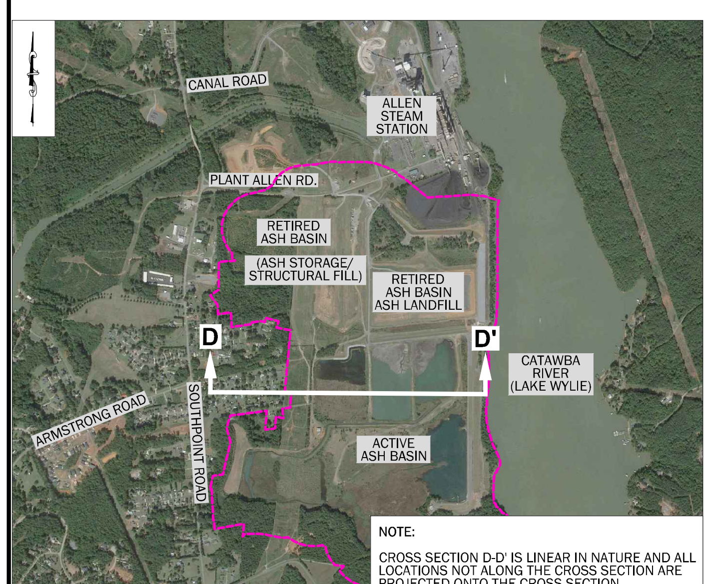
FIGURE 6-12b
GENERAL CROSS SECTION D-D'
NON-CONSERVATIVE GROUP
MEAN OF STRONTIUM
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA





CROSS SECTION LOCATION

LEGEND

- GWA-22S WELL IN FILL/ALLUVIUM/SAPROLITE
- GWA-22D WELL IN TRANSITION ZONE
- GWA-21BR WELL IN BEDROCK
- AB-35S WELL IN ASH PORE WATER
- GWA-5BR ABANDONED WELL/ GEOTECHNICAL BORING
- AL34 WATER SUPPLY WELL - (DEPTH UNKNOWN)
- GENERALIZED WATER TABLE
- GENERALIZED GROUNDWATER FLOW DIRECTION
- GENERALIZED ASH PORE WATER FLOW DIRECTION
- ASH
- ASH PORE WATER
- ALLUVIUM
- FILL
- SAPROLITE
- TRANSITION ZONE
- BEDROCK
- SURFACE WATER
- PREDOMINANT BEDROCK FRACTURE ORIENTATION
- ASH PORE WATER FLOW LAYER WATER LEVEL ELEVATION
- SHALLOW ZONE FLOW LAYER GROUNDWATER WELL WATER LEVEL ELEVATION
- DEEP ZONE FLOW LAYER GROUNDWATER WELL WATER LEVEL ELEVATION
- BEDROCK FLOW LAYER GROUNDWATER WELL WATER LEVEL ELEVATION
- MEAN BORON (B) CONCENTRATION (µg/L) MEAN SULFATE (SO4) CONCENTRATION (mg/L) MEAN TOTAL DISSOLVED SOLIDS (TDS) CONCENTRATION (mg/L)

GWA-21DA	
B	<50
SO4	1
TDS	134

- WELL SCREEN
- BREAKLINE
- COMPLIANCE BOUNDARY

NOTES

1. DEPTH TO WATER GAUGED IN MONITORING WELLS ON MARCH 13, 2019, REFERENCED TO NORTH AMERICAN VERTICAL DATUM (NAVD) OF 1988.
2. FRACTURES DEPICTED ON THIS CROSS SECTION REPRESENTS THE GENERALIZED FRACTURE ORIENTATIONS BASED ON TELEVIEWER LOGGING AT SITE SPECIFIC BOREHOLES. AS CONCEPTUALLY ILLUSTRATED HERE, TELEVIEWER LOGGING RESULTS DID NOT INDICATE ANY DISTINCT, CONSISTENT FRACTURE SETS, BUT A WIDE VARIETY OF FRACTURE ORIENTATIONS AT THE SITE. THE ACTUAL NUMBER OF FRACTURES IS FAR TOO NUMEROUS TO ILLUSTRATE AT THIS SCALE. IN ADDITION, THE DEPTH AND LENGTH OF FRACTURES VERSUS DEPTH ARE CONCEPTUAL ONLY.
3. ALL BOUNDARIES ARE APPROXIMATE.
4. CROSS SECTION REPRESENTATIVE OF PRE-DECANTING CONDITIONS.

NOTES:

1. ALL CONCENTRATIONS SHOWN ARE STATISTICAL MEANS OR GEOMEANS CALCULATED BASED ON CENTRAL TENDENCY OF DATASET USING DATA RANGING FROM JANUARY 2018 TO JUNE 2019.
2. COBALT (Co), IRON (Fe), AND MANGANESE (Mn) CONCENTRATIONS ARE IN MICROGRAMS PER LITER (µg/L)

- NO DATA AVAILABLE

ANALYTICAL PARAMETER	Co	Fe	Mn
REPORTING UNITS	µg/L	µg/L	µg/L
15A NCAC 02L STANDARD	1*	300	50
BACKGROUND THRESHOLD VALUE (SHALLOW FLOW ZONE)[1]	5.7	1,422	608
BACKGROUND THRESHOLD VALUE (DEEP FLOW ZONE)[1]	0.82	665	256
BACKGROUND THRESHOLD VALUE (BEDROCK FLOW ZONE)[1]	0.35	1,242	360

* - INTERIM MAXIMUM ALLOWABLE CONCENTRATIONS (IMACs) OF THE 15A NCAC 02L STANDARD APPENDIX 1, APRIL 1, 2013.

[1] - BACKGROUND THRESHOLD VALUES WERE CALCULATED USING DATA FROM BACKGROUND GROUNDWATER SAMPLES COLLECTED MARCH 2011 TO DECEMBER 2018 AS SUBMITTED IN JUNE 2019.

DUKE ENERGY CAROLINAS

synTerra

GRAPHIC SCALE
0 100 200 400

HORIZONTAL SCALE: 1" = 400'
VERTICAL SCALE: 1" = 80'
5X VERTICAL EXAGGERATION

DRAWN BY: J. CHASTAIN	DATE: 7/26/2019
REVISED BY: D. KREFSKI	DATE: 12/8/2019
CHECKED BY: L.DRAGO	DATE: 12/8/2019
APPROVED BY: C. SUTTELL	DATE: 12/8/2019
PROJECT MANAGER: C. SUTTELL	
LAYOUT: XSECT_DD (6-12C)	

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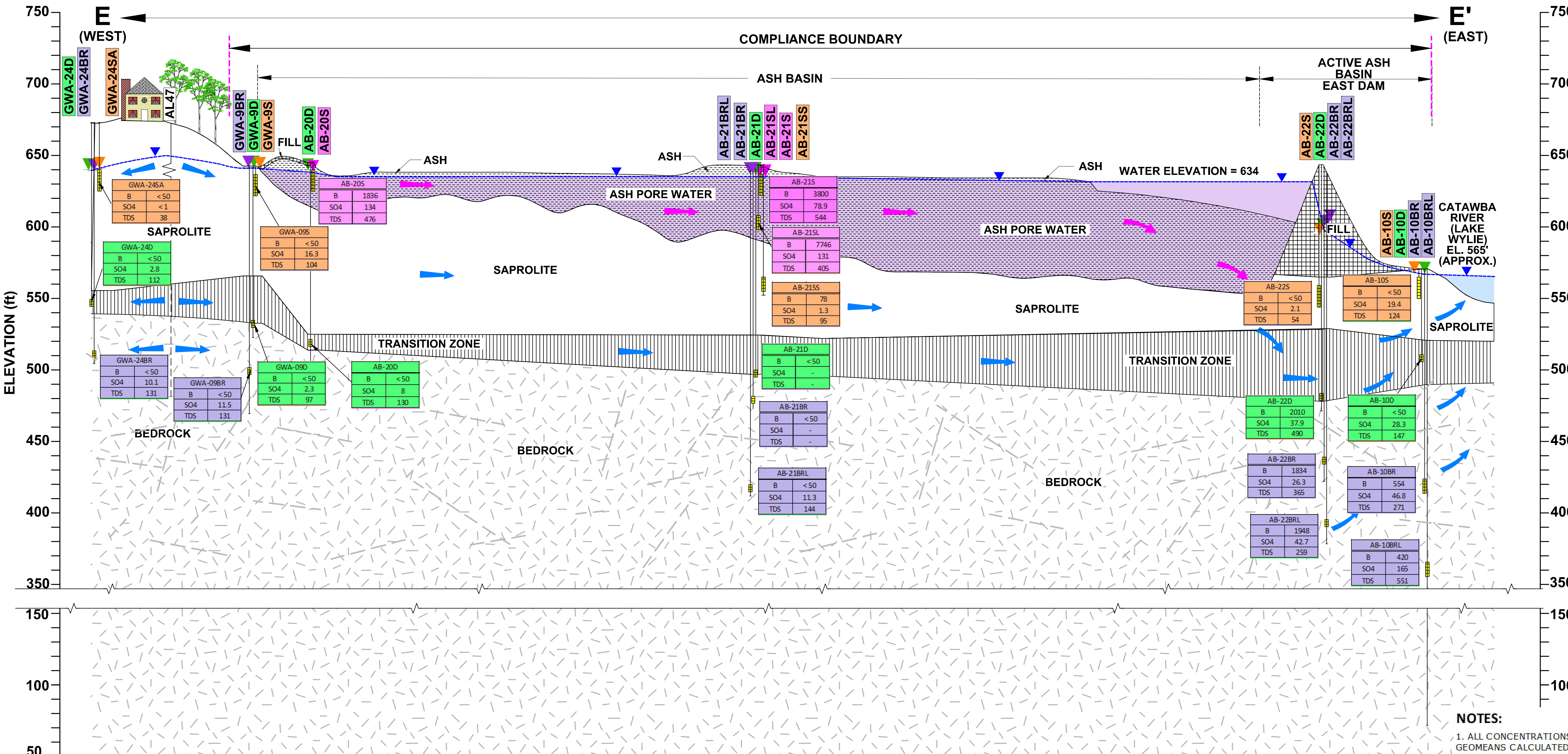
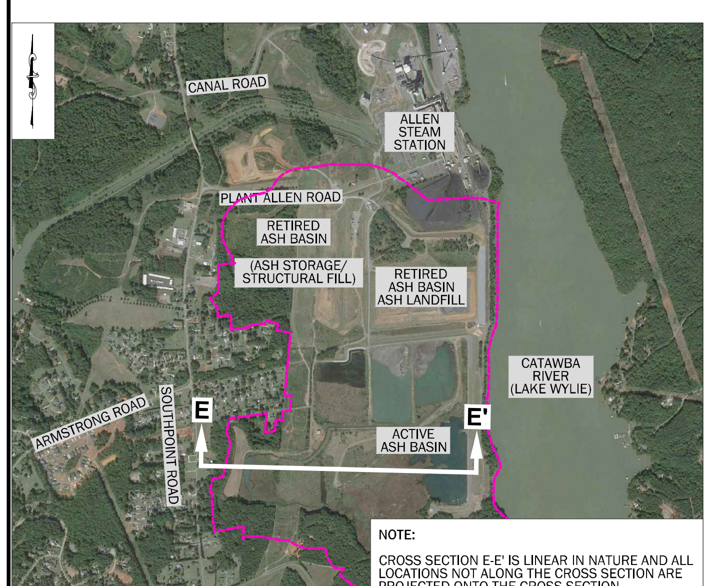
FIGURE 6-12c
GENERAL CROSS SECTION D-D'
VARIABLE GROUP
MEAN OF COBALT, IRON AND MANGANESE
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA





NOTE:
CROSS SECTION E-E' IS LINEAR IN NATURE AND ALL LOCATIONS NOT ALONG THE CROSS SECTION ARE PROJECTED ONTO THE CROSS SECTION.

CROSS SECTION LOCATION

LEGEND

- GWA-22S — WELL IN FILL/ALLUVIUM/SAPROLITE
- GWA-22D — WELL IN TRANSITION ZONE
- GWA-21BR — WELL IN BEDROCK
- AB-35S — WELL IN ASH PORE WATER
- GWA-5BR — ABANDONED WELL/ GEOTECHNICAL BORING
- AL34 — WATER SUPPLY WELL - (DEPTH UNKNOWN)
- GENERALIZED WATER TABLE
- GENERALIZED GROUNDWATER FLOW DIRECTION
- GENERALIZED ASH PORE WATER FLOW DIRECTION
- ASH
- ASH PORE WATER
- ALLUVIUM
- FILL
- SAPROLITE
- TRANSITION ZONE
- BEDROCK
- SURFACE WATER
- PREDOMINANT BEDROCK FRACTURE ORIENTATION
- ASH PORE WATER FLOW LAYER WATER LEVEL ELEVATION
- SHALLOW ZONE FLOW LAYER GROUNDWATER WELL WATER LEVEL ELEVATION
- DEEP ZONE FLOW LAYER GROUNDWATER WELL WATER LEVEL ELEVATION
- BEDROCK FLOW LAYER GROUNDWATER WELL WATER LEVEL ELEVATION
- AB-22D B 2010 SO4 37.9 TDS 490 — MEAN BORON (B) CONCENTRATION (µg/L) MEAN SULFATE (SO4) CONCENTRATION (mg/L) MEAN TOTAL DISSOLVED SOLIDS (TDS) CONCENTRATION (mg/L)
- WELL SCREEN
- BREAKLINE
- COMPLIANCE BOUNDARY

NOTES

1. DEPTH TO WATER GAUGED IN MONITORING WELLS ON MARCH 13, 2019, REFERENCED TO NORTH AMERICAN VERTICAL DATUM (NAVD) OF 1988.
2. FRACTURES DEPICTED ON THIS CROSS SECTION REPRESENTS THE GENERALIZED FRACTURE ORIENTATIONS BASED ON TELEVIEWER LOGGING AT SITE SPECIFIC BOREHOLES. AS CONCEPTUALLY ILLUSTRATED HERE, TELEVIEWER LOGGING RESULTS DID NOT INDICATE ANY DISTINCT, CONSISTENT FRACTURE SETS, BUT A WIDE VARIETY OF FRACTURE ORIENTATIONS AT THE SITE. THE ACTUAL NUMBER OF FRACTURES IS FAR TOO NUMEROUS TO ILLUSTRATE AT THIS SCALE. IN ADDITION, THE DEPTH AND LENGTH OF FRACTURES VERSUS DEPTH ARE CONCEPTUAL ONLY.
3. ALL BOUNDARIES ARE APPROXIMATE.
4. CROSS SECTION REPRESENTATIVE OF PRE-DECANTING CONDITIONS.

NOTES:

1. ALL CONCENTRATIONS SHOWN ARE STATISTICAL MEANS OR GEOMEANS CALCULATED BASED ON CENTRAL TENDENCY OF DATASET USING DATA RANGING FROM JANUARY 2018 TO JUNE 2019.

2. BORON (B) CONCENTRATIONS ARE IN MICROGRAMS PER LITER (µg/L)

3. SULFATE (SO4) AND TOTAL DISSOLVED SOLIDS (TDS) CONCENTRATIONS ARE IN MILLIGRAMS PER LITER (mg/L)

- NO DATA AVAILABLE

ANALYTICAL PARAMETER	B	SO4	TDS
REPORTING UNITS	µg/L	mg/L	mg/L
15A NCAC 02L STANDARD	700	250	500
BACKGROUND THRESHOLD VALUE (SHALLOW FLOW	50	5.4	154
BACKGROUND THRESHOLD VALUE (DEEP FLOW ZONE)[1]	50	14.5	173
BACKGROUND THRESHOLD VALUE (BEDROCK FLOW	50	7.3	221

[1] - BACKGROUND THRESHOLD VALUES WERE CALCULATED USING DATA FROM BACKGROUND GROUNDWATER SAMPLES COLLECTED MARCH 2011 TO DECEMBER 2018 AS SUBMITTED IN JUNE 2019.

DUKE ENERGY CAROLINAS

synTerra

GRAPHIC SCALE
0 100 200 400
HORIZONTAL SCALE: 1" = 400'
VERTICAL SCALE: 1" = 80'
5X VERTICAL EXAGGERATION

DRAWN BY: J. CHASTAIN DATE: 7/26/2019
REVISED BY: D. KREFSKI DATE: 12/9/2019
CHECKED BY: L.DRAGO DATE: 12/9/2019
APPROVED BY: C. SUTTELL DATE: 12/9/2019
PROJECT MANAGER: C. SUTTELL
LAYOUT: XSECTEE (6-13A)

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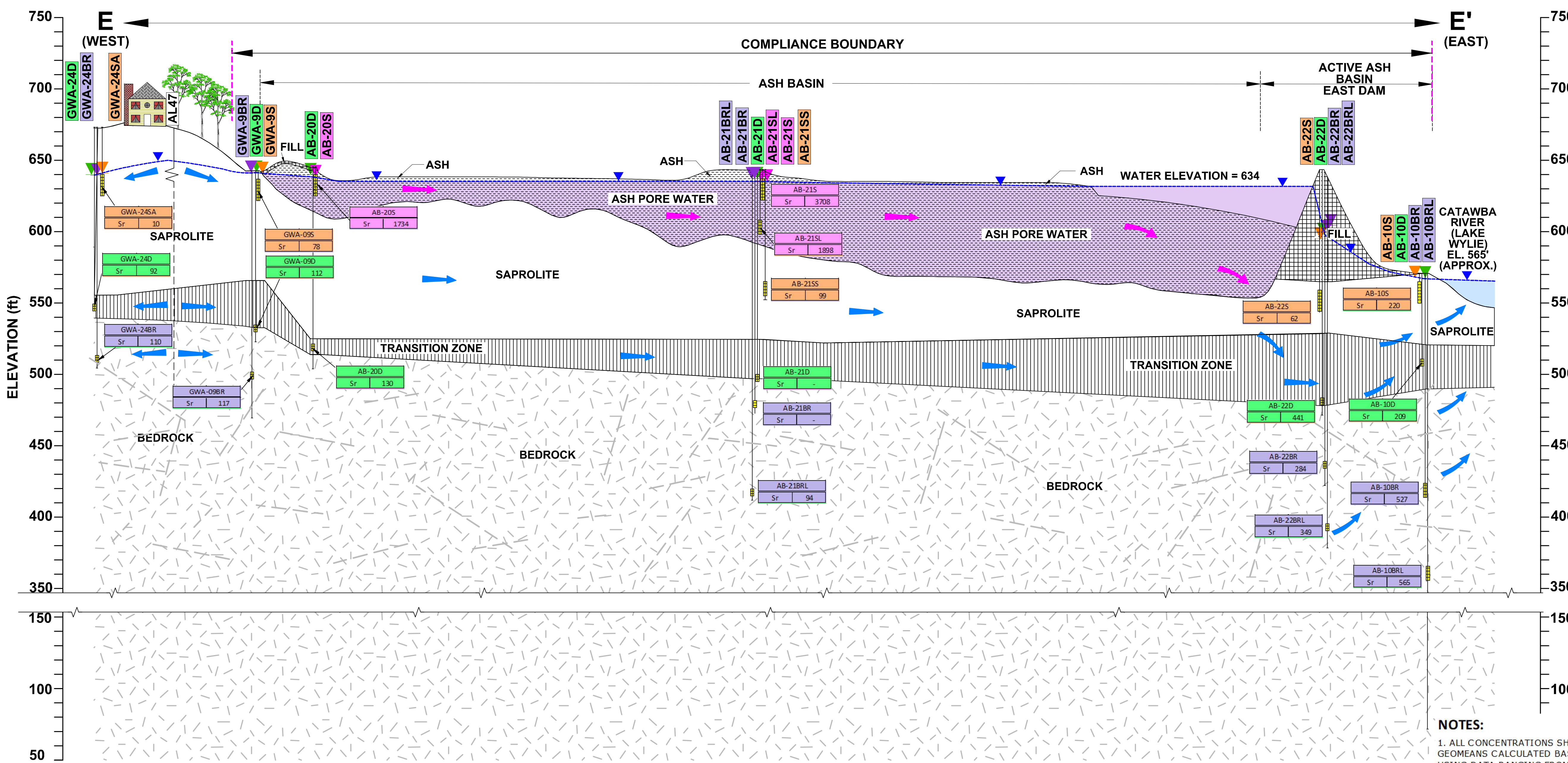
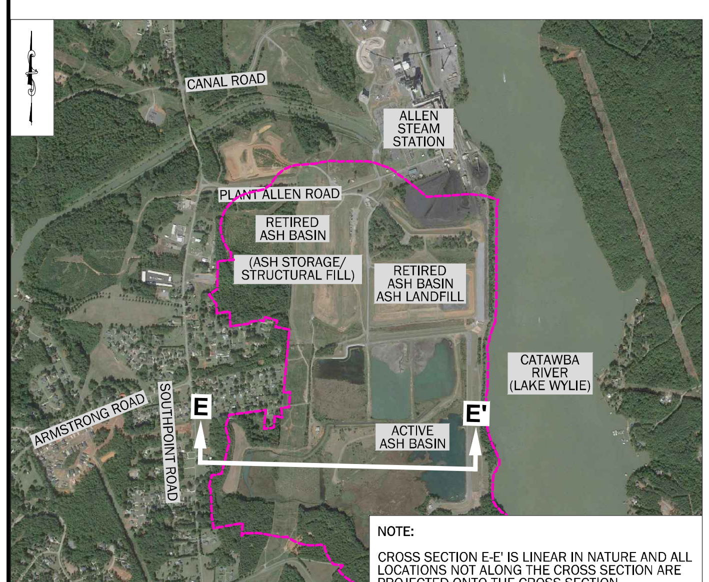
FIGURE 6-13a
GENERAL CROSS SECTION E-E' CONSERVATIVE GROUP MEAN OF BORON, SULFATE AND TOTAL DISSOLVED SOLIDS (TDS) CORRECTIVE ACTION PLAN UPDATE ALLEN STEAM STATION BELMONT, NORTH CAROLINA





CROSS SECTION LOCATION

LEGEND

- GWA-22S — WELL IN FILL/ALLUVIUM/SAPROLITE
- GWA-22D — WELL IN TRANSITION ZONE
- GWA-21BR — WELL IN BEDROCK
- AB-35S — WELL IN ASH PORE WATER
- GWA-5BR — ABANDONED WELL/ GEOTECHNICAL BORING
- AL34 — WATER SUPPLY WELL - (DEPTH UNKNOWN)
- GENERALIZED WATER TABLE
- GENERALIZED GROUNDWATER FLOW DIRECTION
- GENERALIZED ASH PORE WATER FLOW DIRECTION
- ASH
- ASH PORE WATER
- ALLUVIUM
- FILL
- SAPROLITE
- TRANSITION ZONE
- BEDROCK
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- PREDOMINANT BEDROCK FRACTURE ORIENTATION
- ASH PORE WATER FLOW LAYER WATER LEVEL ELEVATION
- SHALLOW ZONE FLOW LAYER GROUNDWATER WELL WATER LEVEL ELEVATION
- DEEP ZONE FLOW LAYER GROUNDWATER WELL WATER LEVEL ELEVATION
- BEDROCK FLOW LAYER GROUNDWATER WELL WATER LEVEL ELEVATION
- AB-21SS Sr 99.1 — MEAN STRONTIUM CONCENTRATION (µg/L)
- WELL SCREEN
- BREAKLINE
- COMPLIANCE BOUNDARY

NOTES

1. DEPTH TO WATER GAUGED IN MONITORING WELLS ON MARCH 13, 2019, REFERENCED TO NORTH AMERICAN VERTICAL DATUM (NAVD) OF 1988.
2. FRACTURES DEPICTED ON THIS CROSS SECTION REPRESENTS THE GENERALIZED FRACTURE ORIENTATIONS BASED ON TELEVIEWER LOGGING AT SITE SPECIFIC BOREHOLES. AS CONCEPTUALLY ILLUSTRATED HERE, TELEVIEWER LOGGING RESULTS DID NOT INDICATE ANY DISTINCT, CONSISTENT FRACTURE SETS, BUT A WIDE VARIETY OF FRACTURE ORIENTATIONS AT THE SITE. THE ACTUAL NUMBER OF FRACTURES IS FAR TOO NUMEROUS TO ILLUSTRATE AT THIS SCALE. IN ADDITION, THE DEPTH AND LENGTH OF FRACTURES VERSUS DEPTH ARE CONCEPTUAL ONLY.
3. ALL BOUNDARIES ARE APPROXIMATE.
4. CROSS SECTION REPRESENTATIVE OF PRE-DECANTING CONDITIONS.

NOTES:

1. ALL CONCENTRATIONS SHOWN ARE STATISTICAL MEANS OR GEOMEANS CALCULATED BASED ON CENTRAL TENDENCY OF DATASET USING DATA RANGING FROM JANUARY 2018 TO JUNE 2019.
2. STRONTIUM (Sr) CONCENTRATIONS ARE IN MICROGRAMS PER LITER (µg/L)

- NO DATA AVAILABLE

ANALYTICAL PARAMETER	Sr
REPORTING UNITS	µg/L
15A NCAC 02L STANDARD	NE
BACKGROUND THRESHOLD VALUE (SHALLOW FLOW ZONE)[1]	300
BACKGROUND THRESHOLD VALUE (DEEP FLOW ZONE)[1]	240
BACKGROUND THRESHOLD VALUE (BEDROCK FLOW	181

[1] - BACKGROUND THRESHOLD VALUES WERE CALCULATED USING DATA FROM BACKGROUND GROUNDWATER SAMPLES COLLECTED MARCH 2011 TO DECEMBER 2018 AS SUBMITTED IN JUNE 2019.

DUKE ENERGY CAROLINAS

synTerra

GRAPHIC SCALE
0 100 200 400
HORIZONTAL SCALE: 1" = 400'
VERTICAL SCALE: 1" = 80'
5X VERTICAL EXAGGERATION

DRAWN BY: J. CHASTAIN DATE: 7/26/2019
REVISED BY: D. KREFSKI DATE: 12/9/2019
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APPROVED BY: C. SUTTELL DATE: 12/9/2019
PROJECT MANAGER: C. SUTTELL
LAYOUT: XSECTEE (6-13B)

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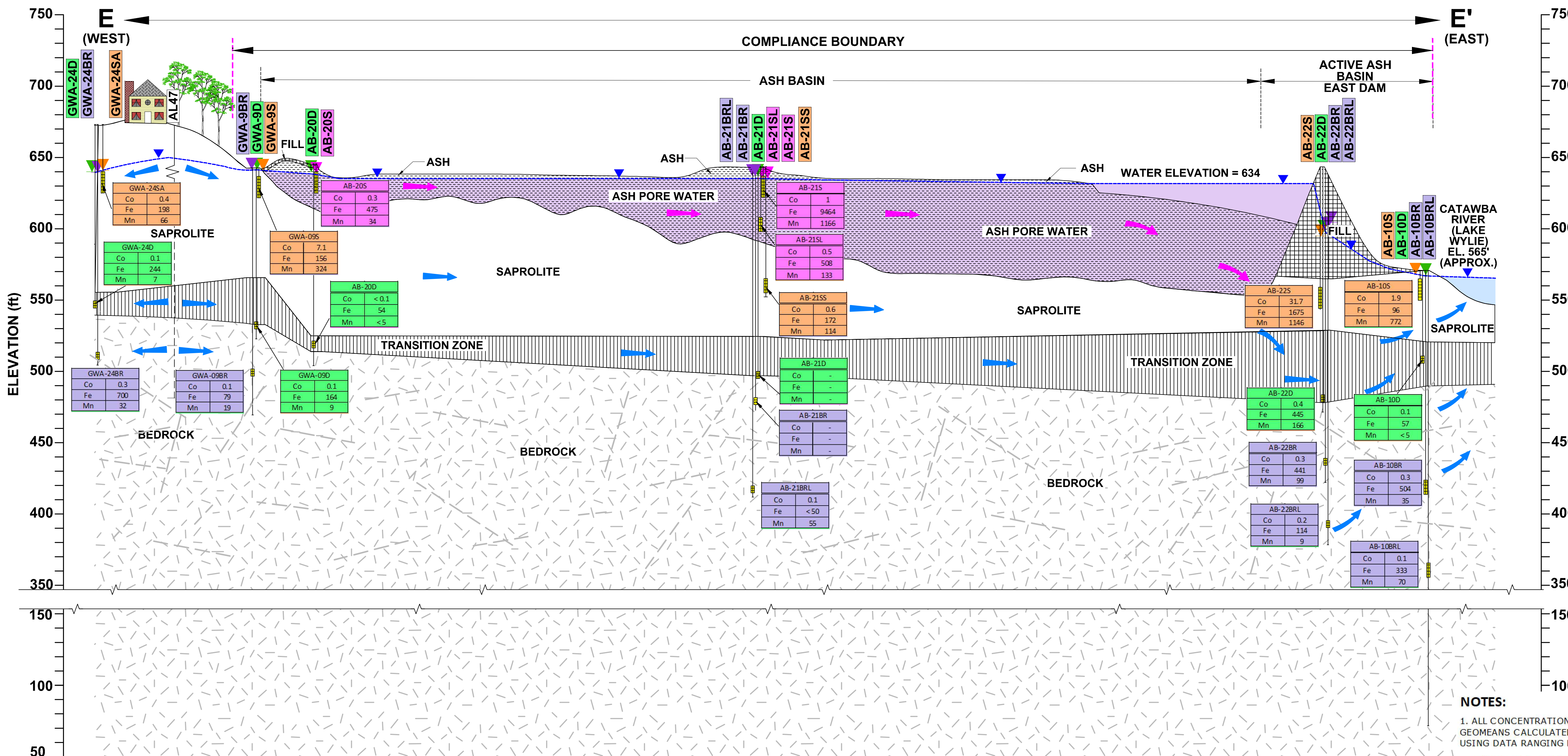
FIGURE 6-13b
GENERAL CROSS SECTION E-E'
NON-CONSERVATIVE GROUP
MEAN OF STRONTIUM
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA



NOTES:

1. ALL CONCENTRATIONS SHOWN ARE STATISTICAL MEANS OR GEOMEANS CALCULATED BASED ON CENTRAL TENDENCY OF DATASET USING DATA RANGING FROM JANUARY 2018 TO JUNE 2019.

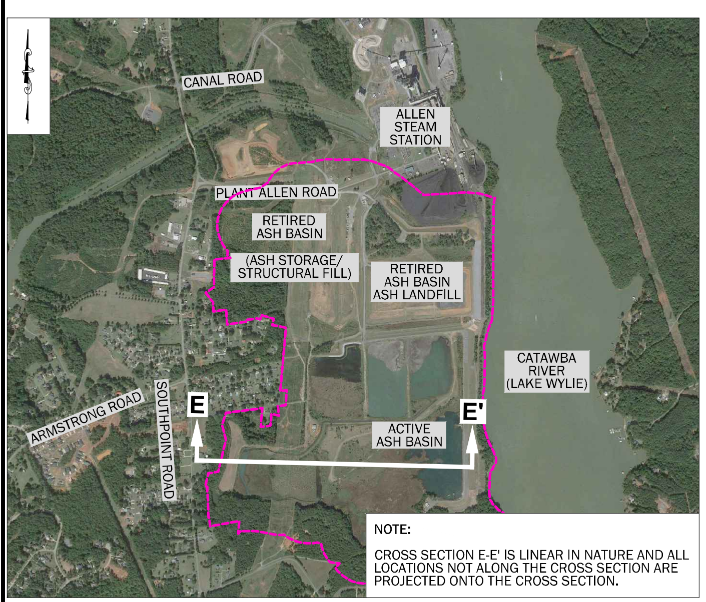
2. COBALT (Co), IRON (Fe), AND MANGANESE (Mn) CONCENTRATIONS ARE IN MICROGRAMS PER LITER (μg/L)

- NO DATA AVAILABLE

ANALYTICAL PARAMETER	Co	Fe	Mn
REPORTING UNITS	μg/L	μg/L	μg/L
15A NCAC 02L STANDARD	1*	300	50
BACKGROUND THRESHOLD VALUE (SHALLOW FLOW ZONE)[1]	5.7	1,422	608
BACKGROUND THRESHOLD VALUE (DEEP FLOW ZONE)[1]	0.82	665	256
BACKGROUND THRESHOLD VALUE (BEDROCK FLOW ZONE)[1]	0.35	1,242	360

* - INTERIM MAXIMUM ALLOWABLE CONCENTRATIONS (IMACs) OF THE 15A NCAC 02L STANDARD APPENDIX 1, APRIL 1, 2013.

[1] - BACKGROUND THRESHOLD VALUES WERE CALCULATED USING DATA FROM BACKGROUND GROUNDWATER SAMPLES COLLECTED MARCH 2011 TO DECEMBER 2018 AS SUBMITTED IN JUNE 2019.



CROSS SECTION LOCATION

LEGEND

- GWA-22S WELL IN FILL/ALLUVIUM/SAPROLITE
- GWA-22D WELL IN TRANSITION ZONE
- GWA-21BR WELL IN BEDROCK
- AB-35S WELL IN ASH PORE WATER
- GWA-5BR ABANDONED WELL/ GEOTECHNICAL BORING
- AL34 WATER SUPPLY WELL - (DEPTH UNKNOWN)
- GENERALIZED WATER TABLE
- GENERALIZED GROUNDWATER FLOW DIRECTION
- GENERALIZED ASH PORE WATER FLOW DIRECTION
- ASH
- ASH PORE WATER
- ALLUVIUM
- FILL
- SAPROLITE
- TRANSITION ZONE
- BEDROCK
- SURFACE WATER
- PREDOMINANT BEDROCK FRACTURE ORIENTATION
- ASH PORE WATER FLOW LAYER WATER LEVEL ELEVATION
- SHALLOW ZONE FLOW LAYER GROUNDWATER WELL WATER LEVEL ELEVATION
- DEEP ZONE FLOW LAYER GROUNDWATER WELL WATER LEVEL ELEVATION
- BEDROCK FLOW LAYER GROUNDWATER WELL WATER LEVEL ELEVATION
- AB-10BRL Co 0.13 Fe 333 Mn 70.1 — MEAN COBALT (Co) CONCENTRATION (μg/L) MEAN IRON (Fe) CONCENTRATION (μg/L) MEAN MANGANESE CONCENTRATION (μg/L)
- WELL SCREEN
- BREAKLINE
- COMPLIANCE BOUNDARY

NOTES

1. DEPTH TO WATER GAUGED IN MONITORING WELLS ON MARCH 13, 2019, REFERENCED TO NORTH AMERICAN VERTICAL DATUM (NAVD) OF 1988.
2. FRACTURES DEPICTED ON THIS CROSS SECTION REPRESENTS THE GENERALIZED FRACTURE ORIENTATIONS BASED ON TELEVIEWER LOGGING AT SITE SPECIFIC BOREHOLES. AS CONCEPTUALLY ILLUSTRATED HERE, TELEVIEWER LOGGING RESULTS DID NOT INDICATE ANY DISTINCT, CONSISTENT FRACTURE SETS, BUT A WIDE VARIETY OF FRACTURE ORIENTATIONS AT THE SITE. THE ACTUAL NUMBER OF FRACTURES IS FAR TOO NUMEROUS TO ILLUSTRATE AT THIS SCALE. IN ADDITION, THE DEPTH AND LENGTH OF FRACTURES VERSUS DEPTH ARE CONCEPTUAL ONLY.
3. ALL BOUNDARIES ARE APPROXIMATE.
4. CROSS SECTION REPRESENTATIVE OF PRE-DECANTING CONDITIONS.

DUKE ENERGY CAROLINAS

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GRAPHIC SCALE
0 100 200 400
HORIZONTAL SCALE: 1" = 400'
VERTICAL SCALE: 1" = 80'
5X VERTICAL EXAGGERATION

DRAWN BY: J. CHASTAIN DATE: 7/26/2019
REVISED BY: D. KREFSKI DATE: 12/9/2019
CHECKED BY: L.DRAGO DATE: 12/9/2019
APPROVED BY: C. SUTTELL DATE: 12/9/2019
PROJECT MANAGER: C. SUTTELL
LAYOUT: XSECTEE (6-13C)

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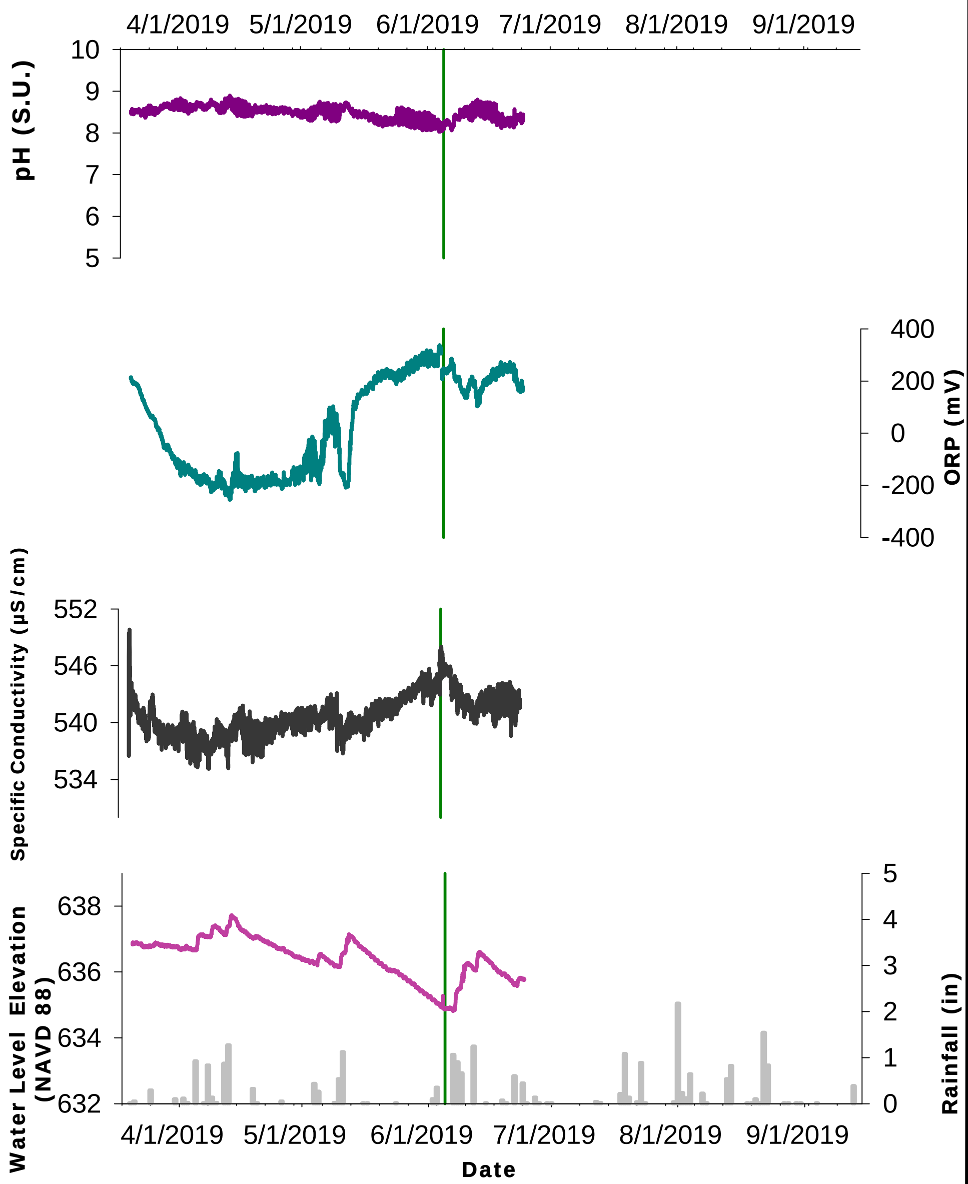
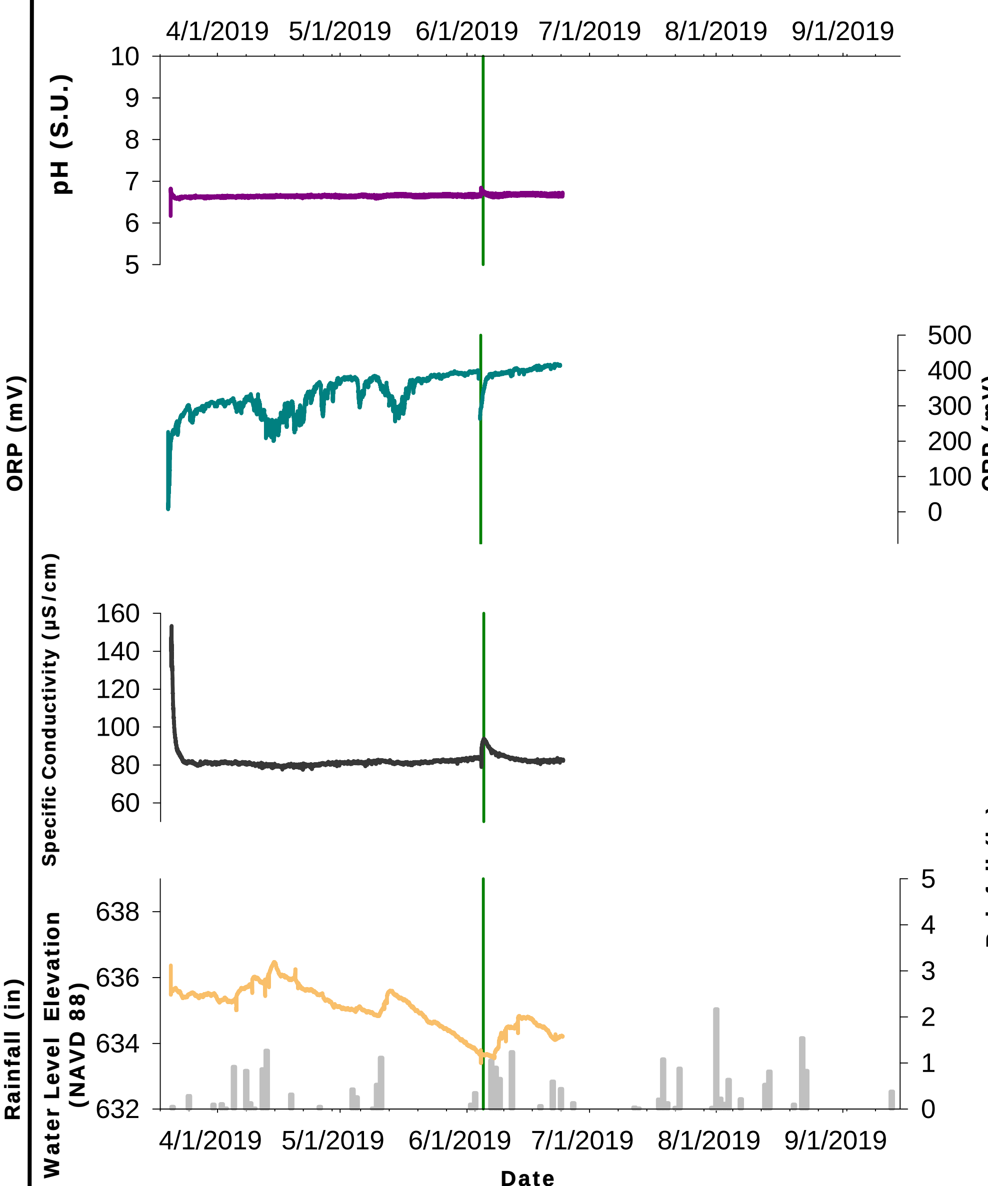
FIGURE 6-13c
GENERAL CROSS SECTION E-E'
VARIABLE GROUP
MEAN OF COBALT, IRON AND MANGANESE
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA

AB-21SL



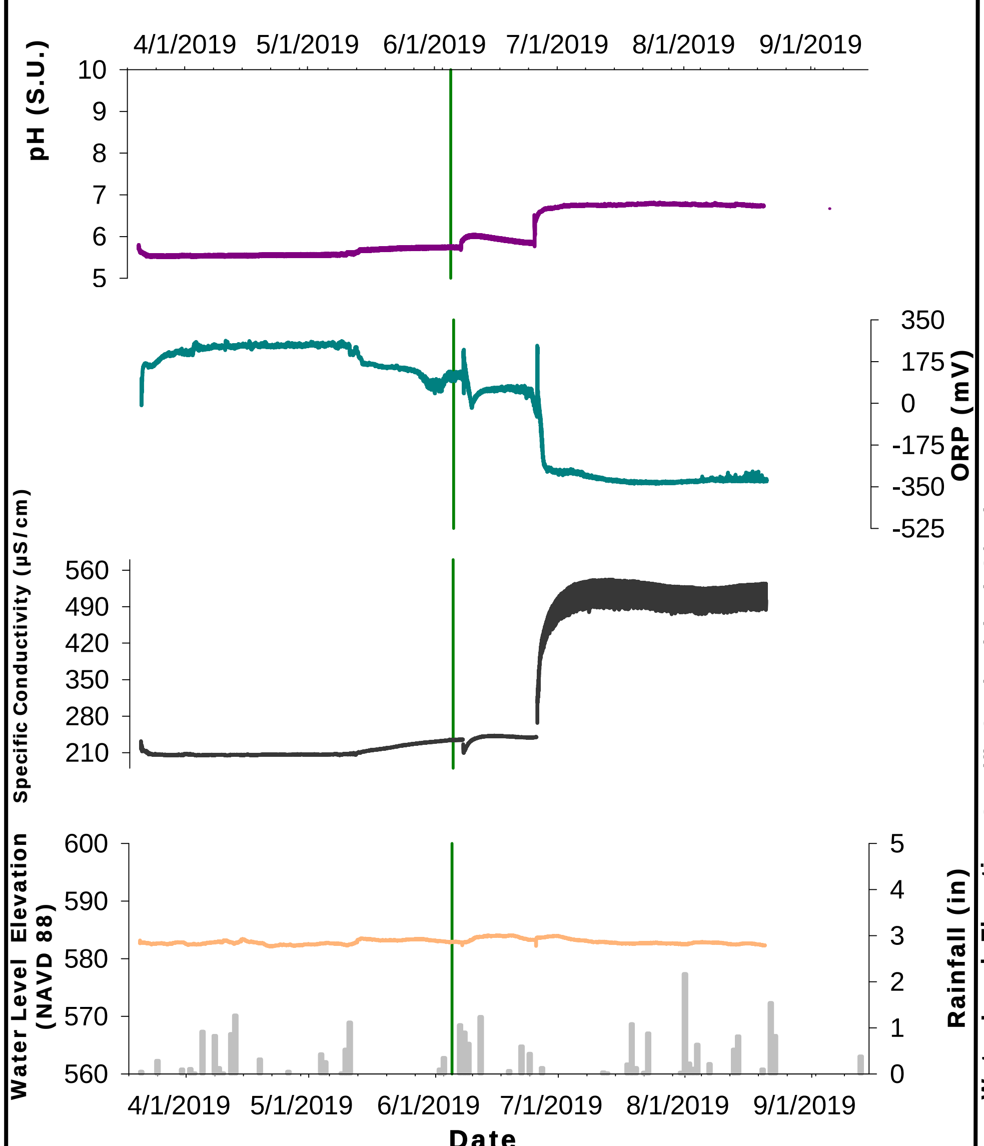
AB-21SL: Ash pore water well located in the southern portion of the Active Ash Basin. See **Figure 6-16** for monitoring location.

AB-21SS



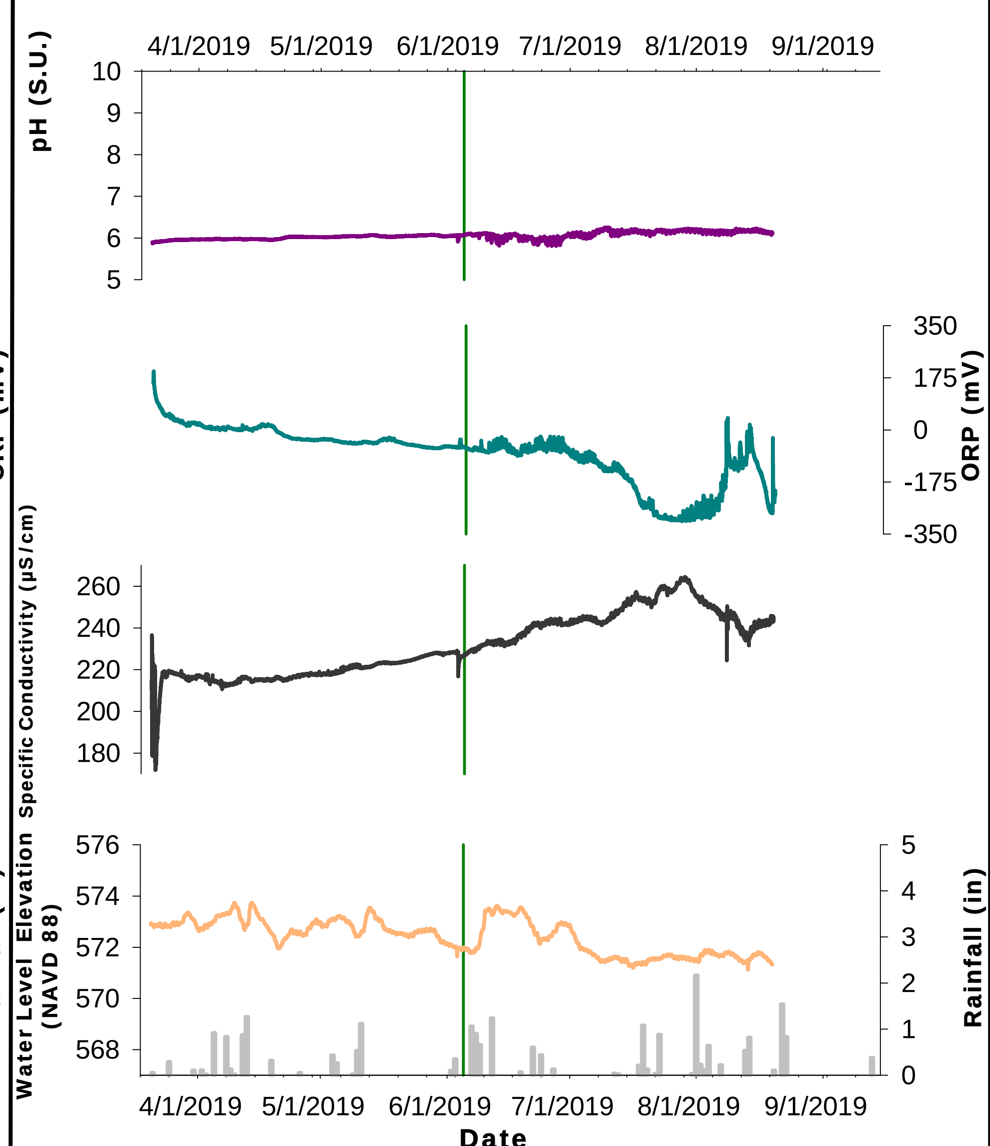
AB-21SS: Shallow flow zone well located in the southern portion of the Active Ash Basin. See **Figure 6-16** for monitoring location.

AB-26S



AB-26S: Shallow flow zone monitoring well located within the dam of the Active Ash Basin. See **Figure 6-16** for monitoring location.

GWA-3S



GWA-3S: Shallow flow zone well located downgradient of the Active Ash Basin. See **Figure 6-16** monitoring location.

LEGEND

- pH (S.U.)
- Oxidation Reduction Potential (ORP) (mV)
- Specific Conductivity (µS/cm)
- Decanting Start Date (06/05/2019)
- Daily Total Rainfall (inches)

Notes:
NAVD 88 – North American Vertical Datum
in – inches
µS/cm – micro Siemens per centimeter
mV – millivolts
S.U. – standard unit

DUKE ENERGY CAROLINAS

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DATE: 10/31/2019
DRAWN BY: D. AVARD
REVISED BY:
CHECKED BY: L. DRAGO
APPROVED BY: L. DRAGO
PROJECT MANAGER: C. SUTTELL

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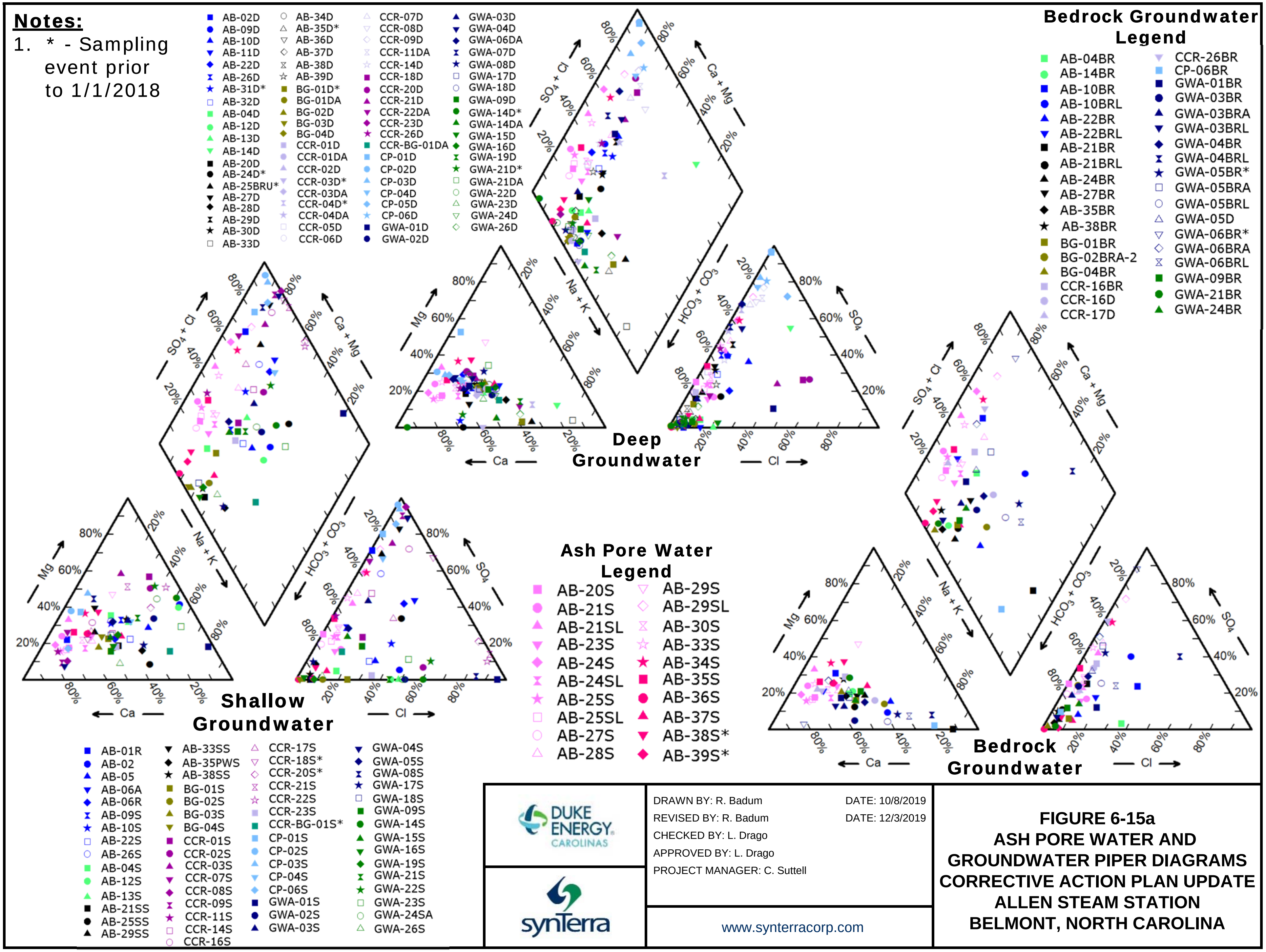
FIGURE 6-14
GEOCHEMICAL WATER QUALITY PLOTS
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NC



DUKE ENERGY
CAROLINAS

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DRAWN BY: R. Badum DATE: 10/8/2019
REVISED BY: R. Badum DATE: 12/3/2019
CHECKED BY: L. Drago
APPROVED BY: L. Drago
PROJECT MANAGER: C. Suttell

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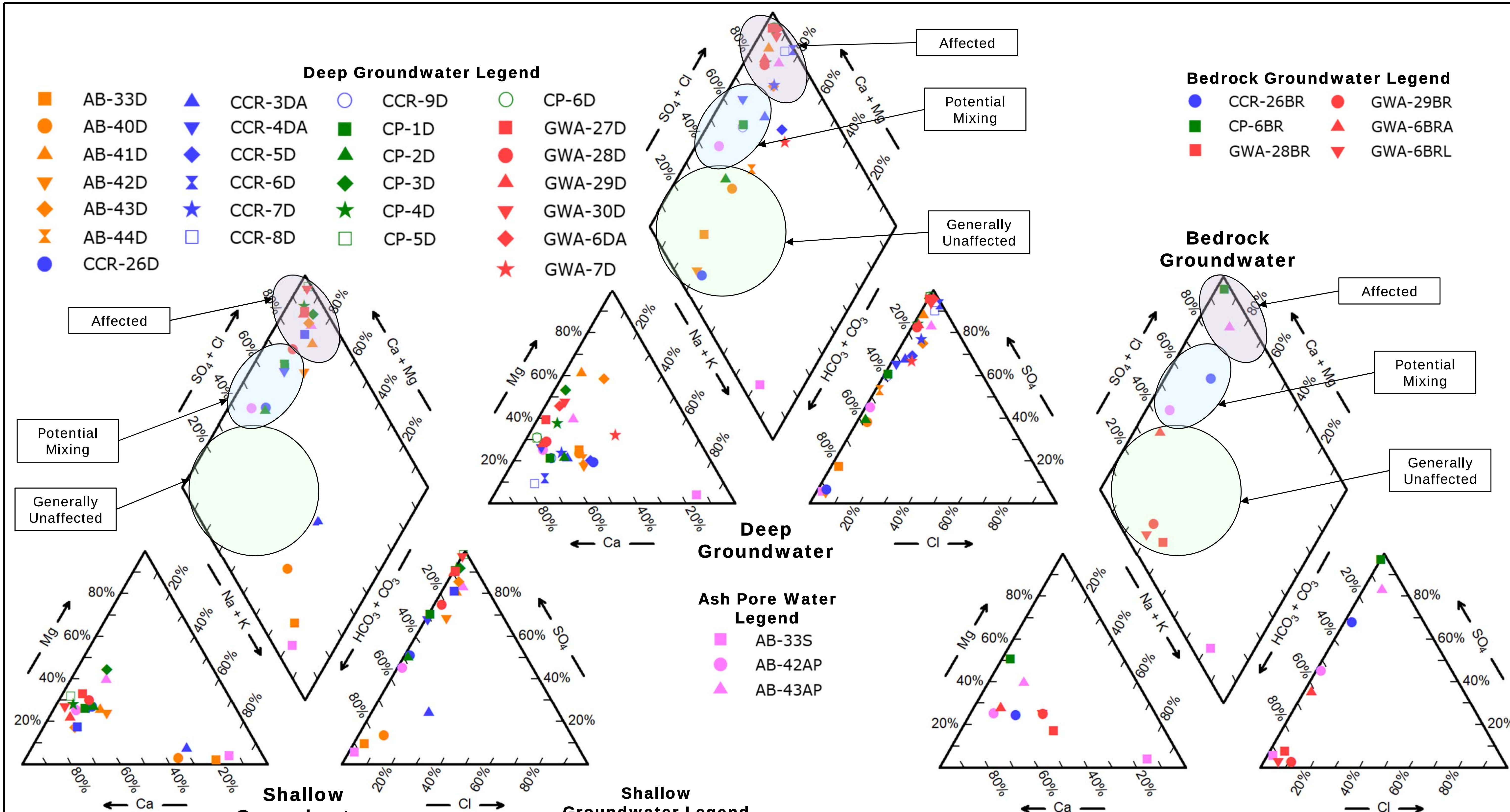
FIGURE 6-15a
ASH PORE WATER AND GROUNDWATER PIPER DIAGRAMS
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA



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DRAWN BY: R. Badum DATE: 11/25/2019
REVISED BY: R. Badum DATE: 12/10/2019
CHECKED BY: L. Drago
APPROVED BY: L. Drago
PROJECT MANAGER: C. Suttell

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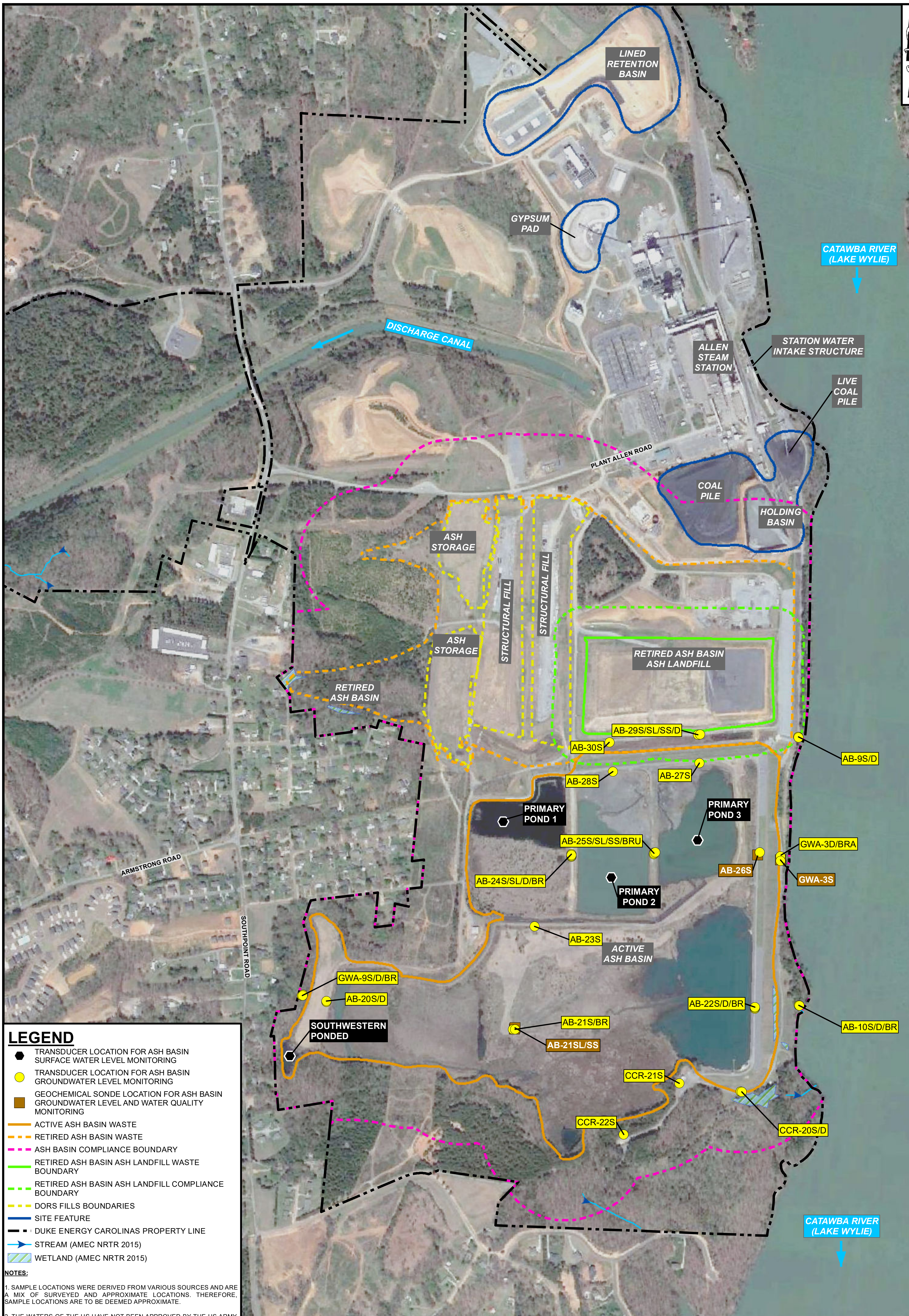
FIGURE 6-15b
ASH PORE WATER AND GROUNDWATER PIPER DIAGRAMS
LOW PH AREA AND COAL PILE AREA
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA



LEGEND

- TRANSDUCER LOCATION FOR ASH BASIN SURFACE WATER LEVEL MONITORING
- TRANSDUCER LOCATION FOR ASH BASIN GROUNDWATER LEVEL MONITORING
- GEOCHEMICAL SONDE LOCATION FOR ASH BASIN GROUNDWATER LEVEL AND WATER QUALITY MONITORING
- ACTIVE ASH BASIN WASTE
- RETIRED ASH BASIN WASTE
- ASH BASIN COMPLIANCE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL WASTE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL COMPLIANCE BOUNDARY
- DORS FILLS BOUNDARIES
- SITE FEATURE
- DUKE ENERGY CAROLINAS PROPERTY LINE
- STREAM (AMEC NRTR 2015)
- WETLAND (AMEC NRTR 2015)

NOTES:

1. SAMPLE LOCATIONS WERE DERIVED FROM VARIOUS SOURCES AND ARE A MIX OF SURVEYED AND APPROXIMATE LOCATIONS. THEREFORE, SAMPLE LOCATIONS ARE TO BE DEEMED APPROXIMATE.

2. THE WATERS OF THE US HAVE NOT BEEN APPROVED BY THE US ARMY CORPS OF ENGINEERS AT THE TIME OF THE MAP CREATION. THIS MAP IS A PRELIMINARY JURISDICTIONAL DETERMINATION ONLY. THE PRELIMINARY WETLANDS AND STREAMS BOUNDARIES WERE OBTAINED FROM AMEC FOSTER WHEELER ENVIRONMENTAL & INFRASTRUCTURE, INC. NATURAL RESOURCE TECHNICAL REPORT (NRTR) FOR ALLEN STEAM STATION DATED MAY 29, 2015.

3. ALL BOUNDARIES ARE APPROXIMATE.

4. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.

5. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON DECEMBER 13, 2018. AERIAL WAS COLLECTED ON MARCH 30, 2018.

6. DRAWING HAS BEEN SET WITH A PROJECTION OF NORTH CAROLINA STATE PLANE COORDINATE SYSTEM FIPS 3200 (NAD83).

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375 0 375 750

GRAPHIC SCALE IN FEET

DRAWN BY: C. WYATT DATE: 10/14/2019
REVISED BY: C. WYATT DATE: 12/11/2019
APPROVED BY: L. DRAGO DATE: 12/11/2019
CHECKED BY: L. DRAGO DATE: 12/11/2019
PROGRAM MANAGER: C. SUTTELL

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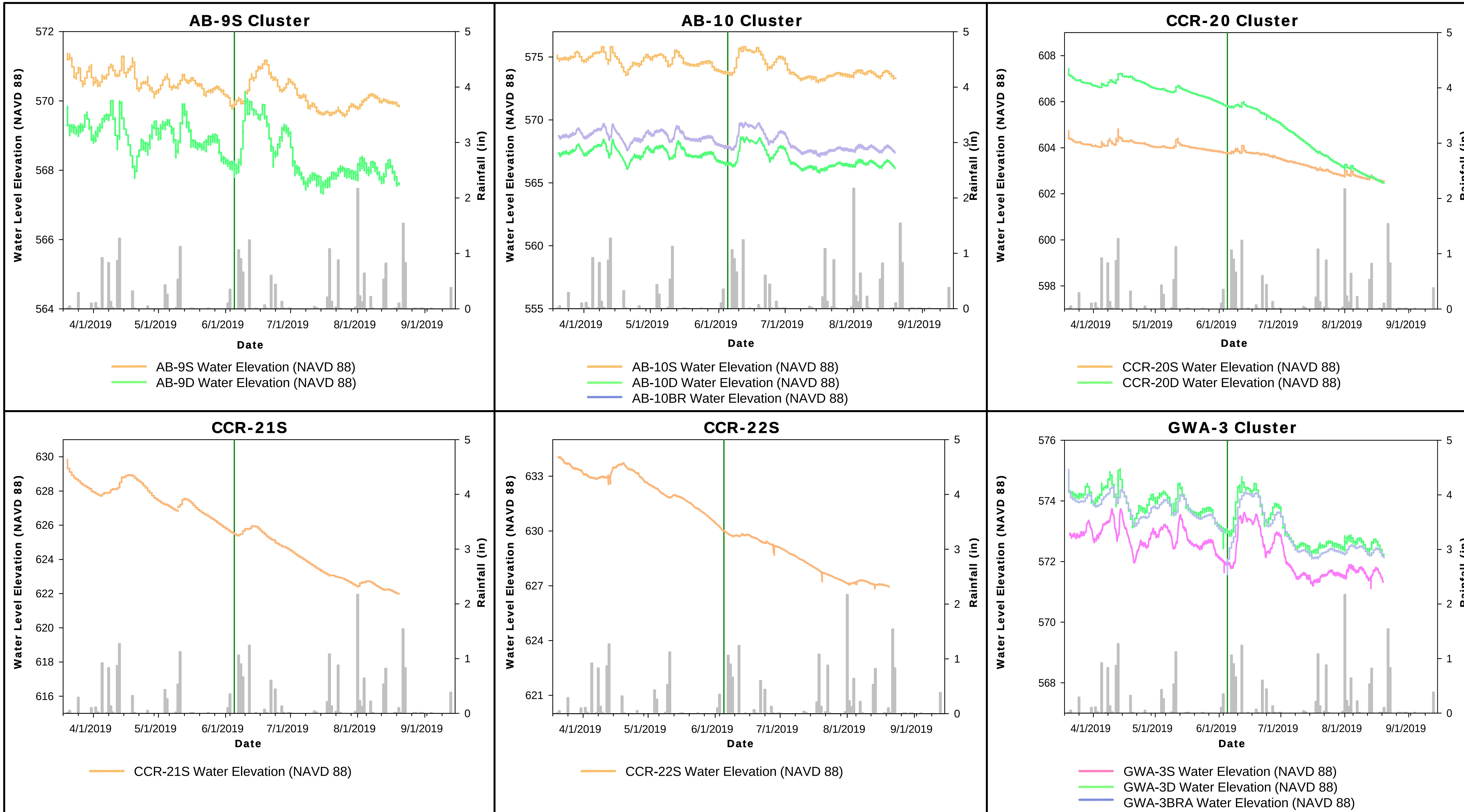
FIGURE 6-16
SITE LAYOUT
DECANTING MONITORING NETWORK
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA



LEGEND

Decanting Start (06/05/2019)
Daily Rainfall Total (inches)
Ash Pore Water
Shallow Flow Zone
Deep Flow Zone
Bedrock Flow Zone

Notes:
NAVD 88 – North American Vertical Datum 1988
in – inches
See **Figure 6-16** for monitoring locations

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DATE: 10/31/2019
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APPROVED BY: L. DRAGO
PROJECT MANAGER: C. SUTTELL

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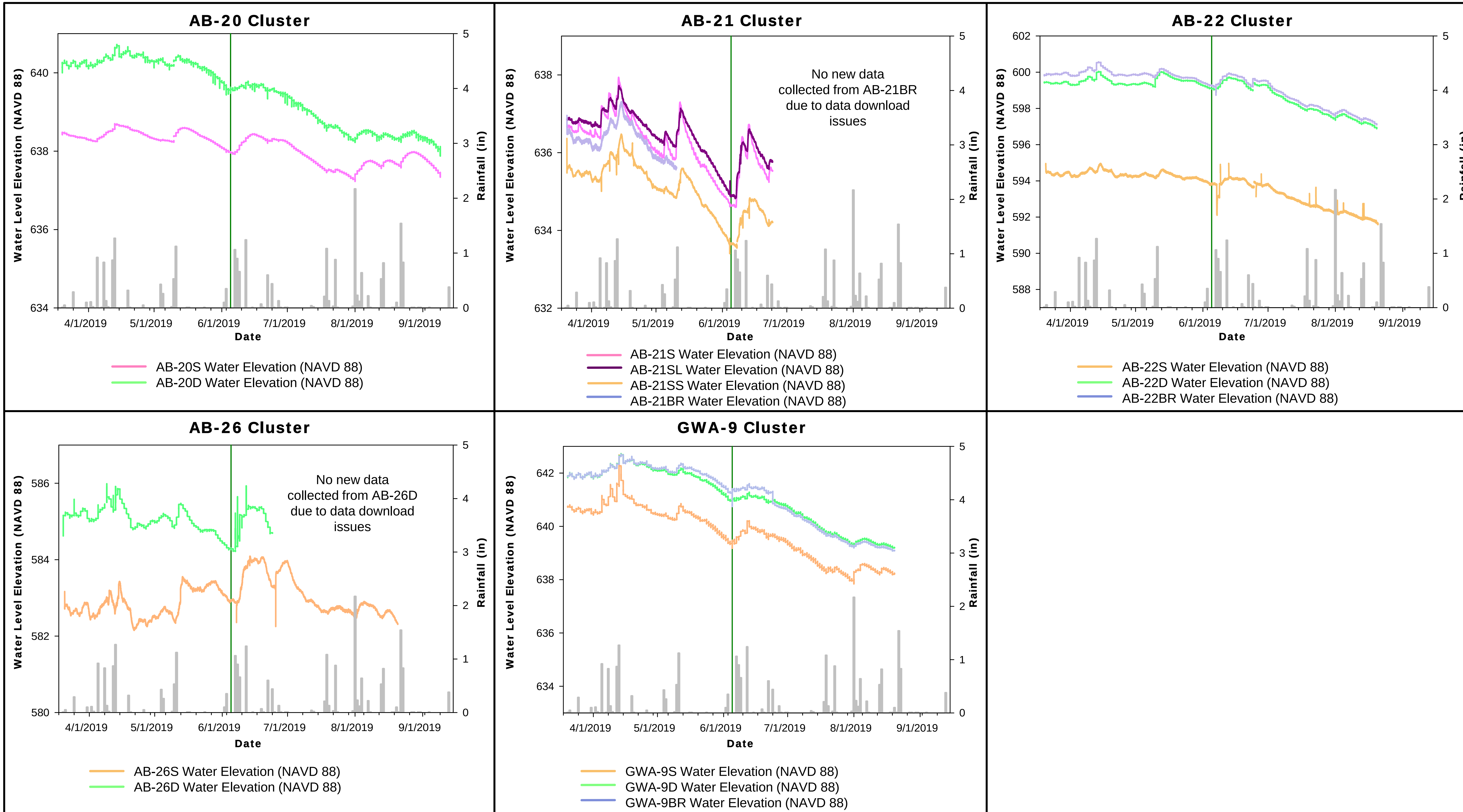
FIGURE 6-17a
HYDROGRAPHS – DOWNGRADIENT
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA



LEGEND

- Decanting Start (06/05/2019)
- Daily Rainfall Total (inches)
- Ash Pore Water
- Lower Ash Pore Water
- Shallow Flow Zone
- Deep Flow Zone
- Bedrock Flow Zone

Notes:
NAVD 88 – North American Vertical Datum 1988
in – inches
See **Figure 6-16** for monitoring locations

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REVISED BY:
CHECKED BY: L. DRAGO
APPROVED BY: L .DRAGO
PROJECT MANAGER: C. SUTTELL

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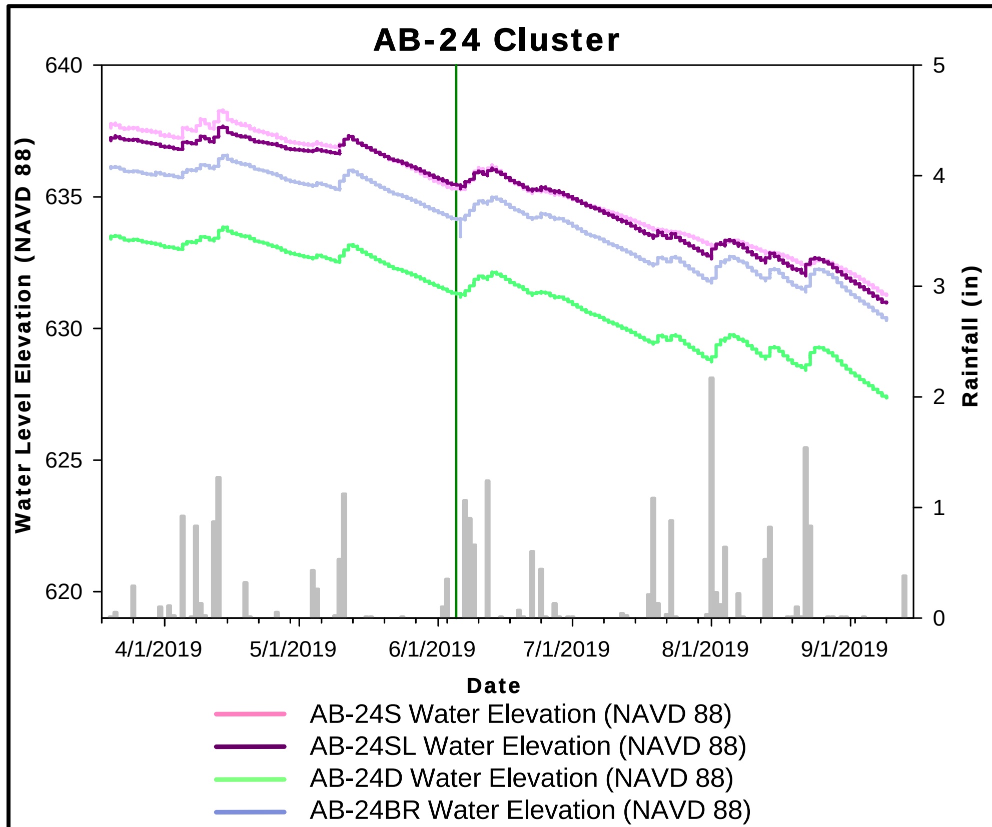
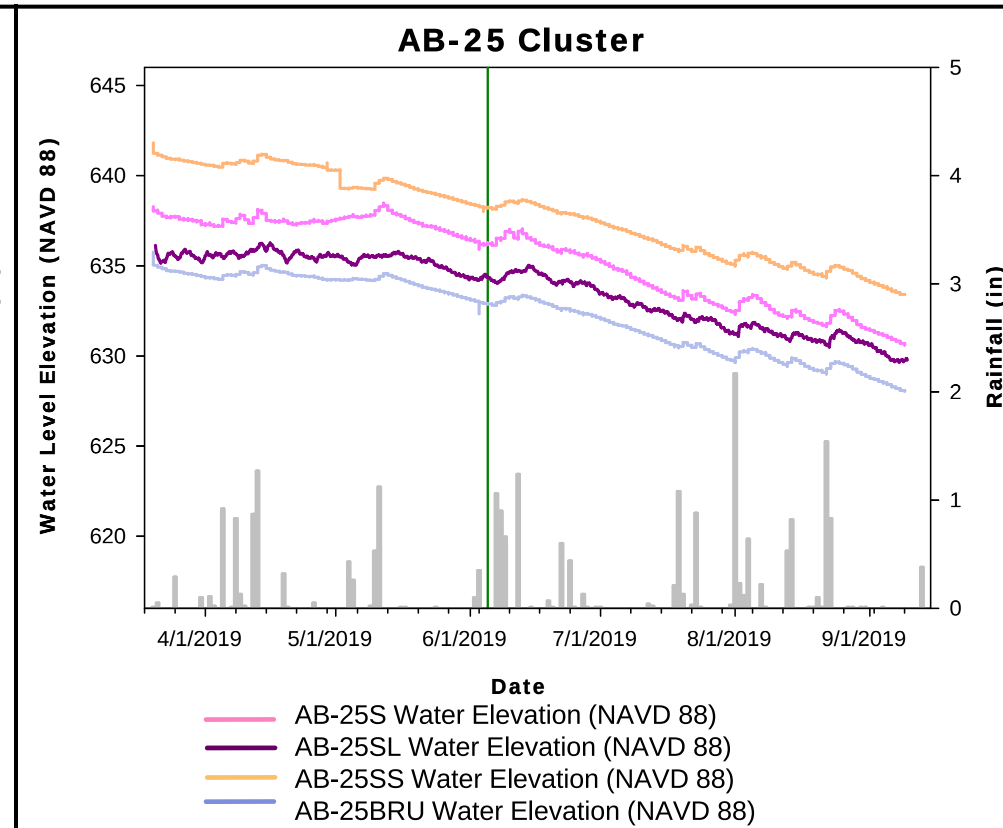
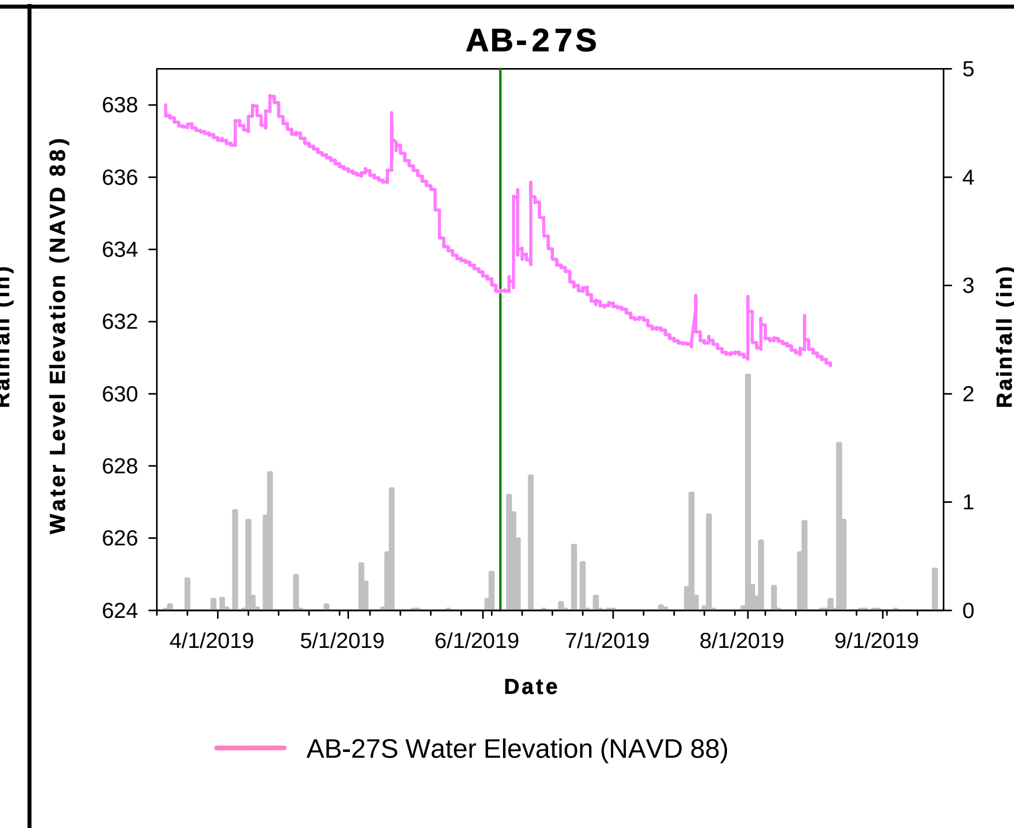
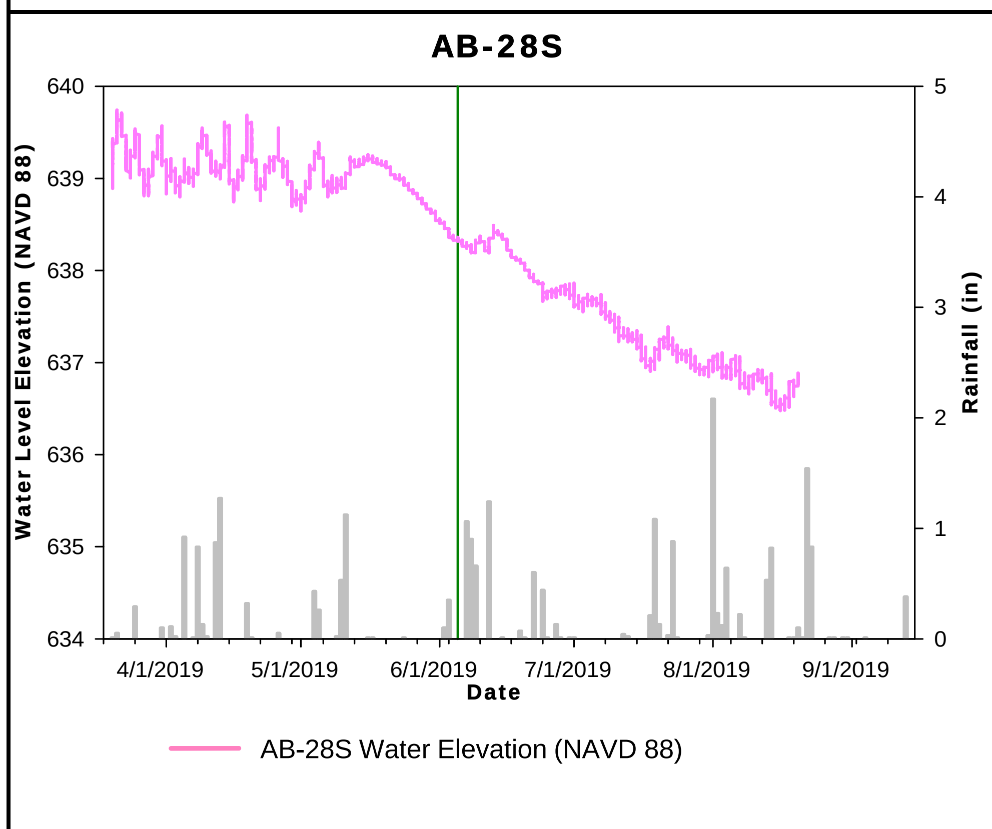
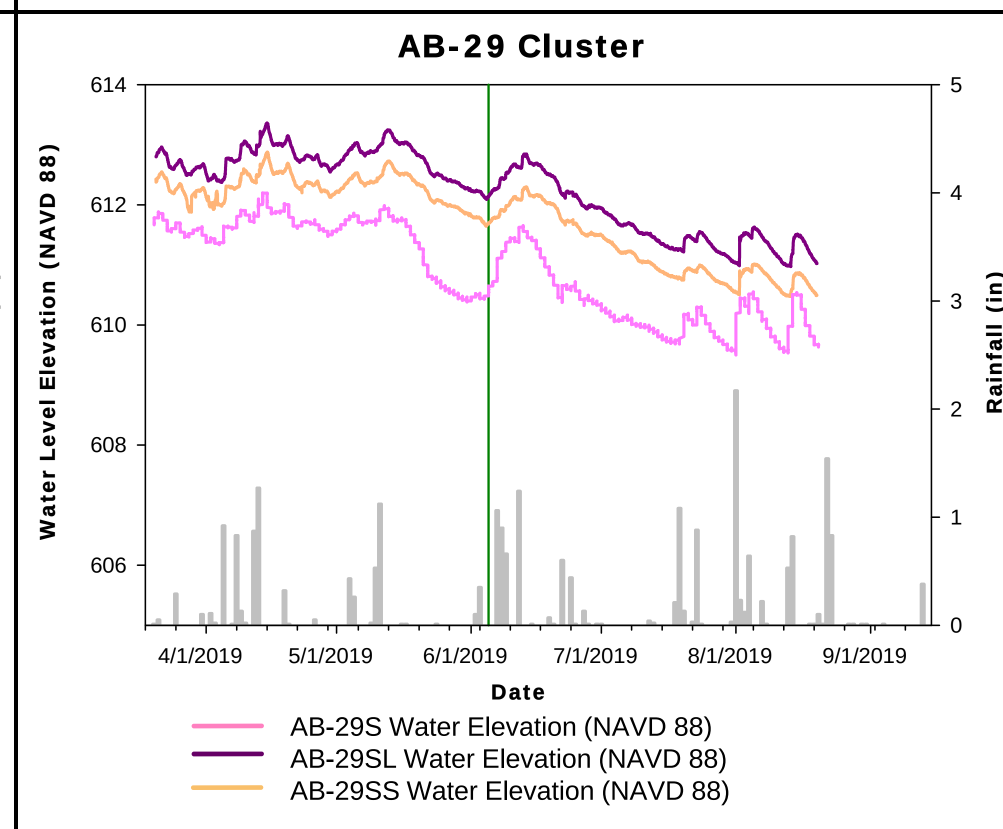
FIGURE 6-17b
HYDROGRAPHS – UPGRADIENT AND SOUTHERN ASH BASIN
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA

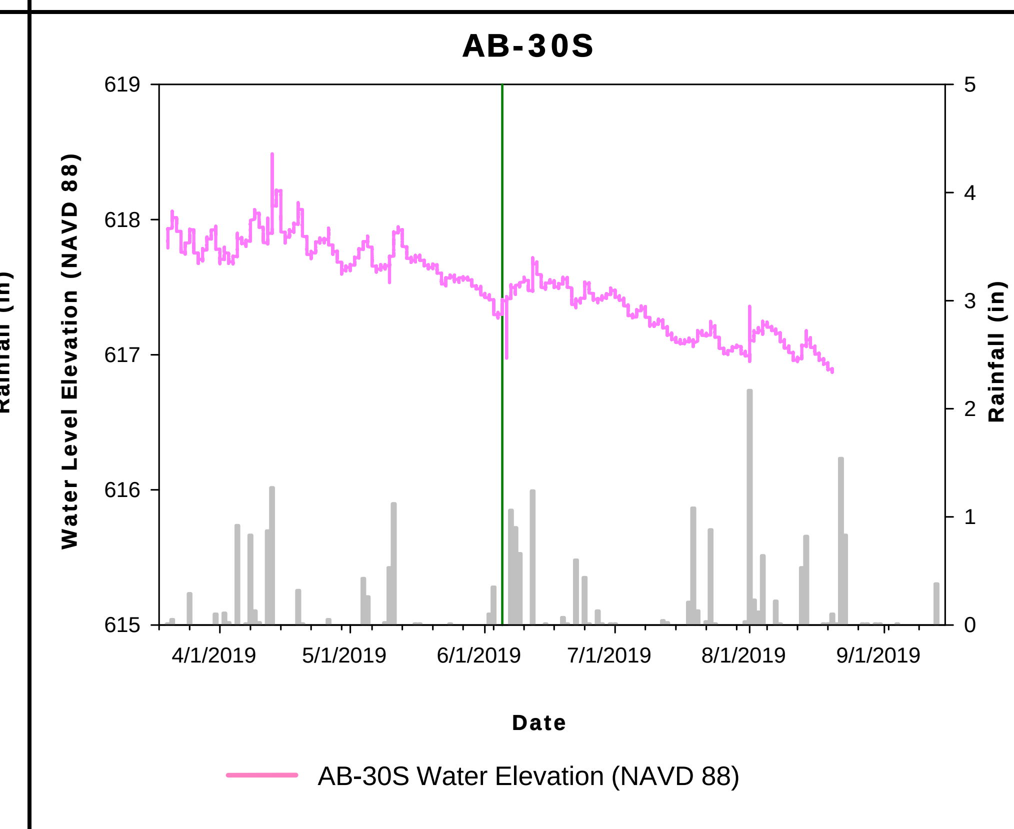












LEGEND

Decanting Start (06/05/2019)
Daily Rainfall Total (inches)

Ash Pore Water
Lower Ash Pore Water
Shallow Flow Zone
Deep Flow Zone
Bedrock Flow Zone

Notes:
NAVD 88 – North American Vertical Datum 1988
in – inches
See **Figure 6-16** for monitoring locations

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DATE: 10/31/2019
REVISED BY:
CHECKED BY: L. DRAGO
APPROVED BY: L. DRAGO
PROJECT MANAGER: C. SUTTELL

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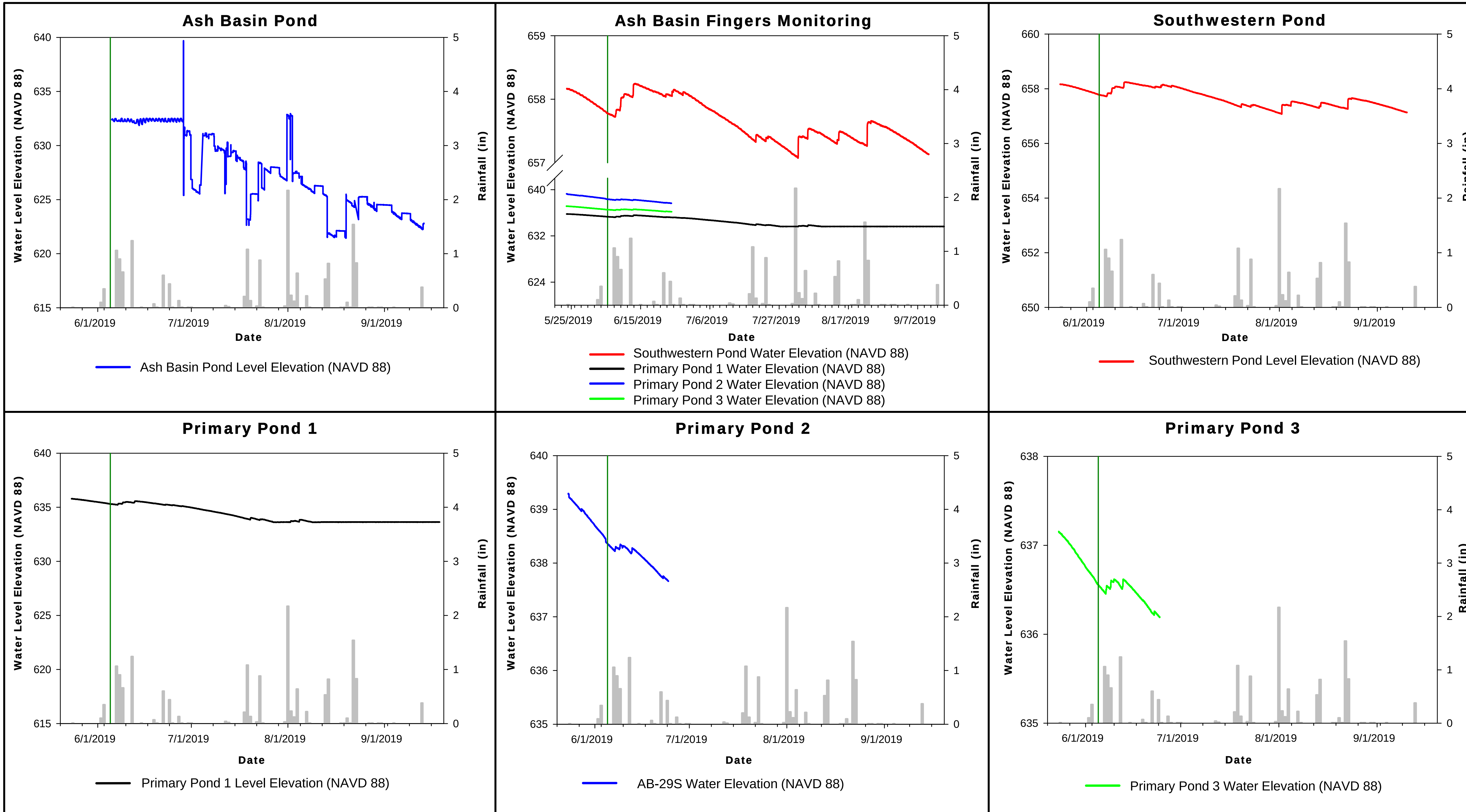
FIGURE 6-17c
HYDROGRAPHS – SIDEGRADIENT AND NORTHERN ASH BASIN
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA



LEGEND

- Decanting Start (06/05/2019)
- Daily Rainfall Total (inches)
- Ponded Ash Basin
- Ash Basin Finger Surface Water
- Ash Basin Finger Surface Water
- Ash Basin Finger Surface Water
- Ash Basin Finger Surface Water

Notes:
NAVD 88 – North American Vertical Datum 1988
in – inches
See **Figure 6-16** for monitoring locations

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CHECKED BY: L. DRAGO
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PROJECT MANAGER: C. SUTTELL

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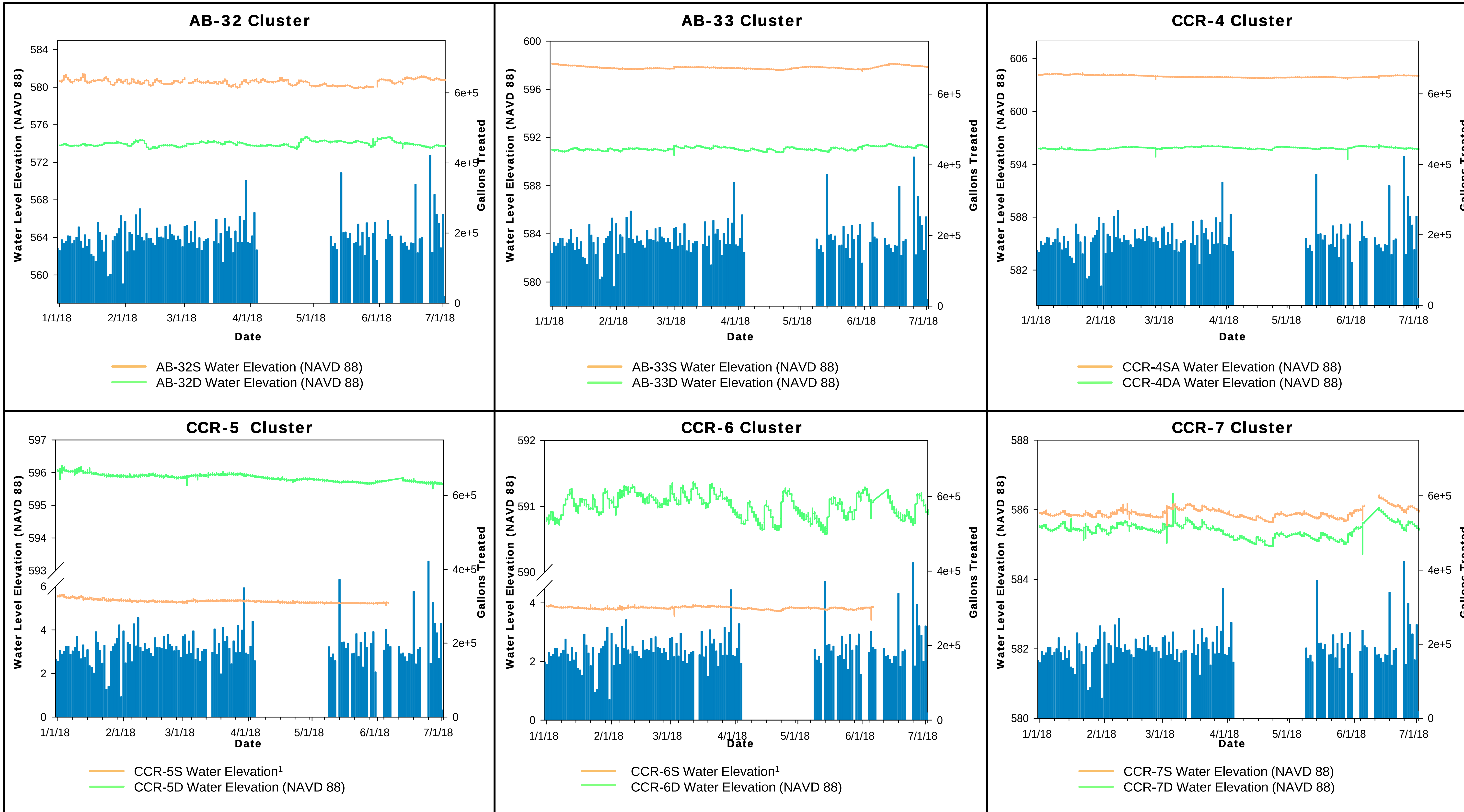
FIGURE 6-17d
HYDROGRAPHS – SURFACE WATER
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA



LEGEND

- Shallow Flow Zone
- Deep Flow Zone
- Bedrock Flow Zone

Notes:
NAVD 88 – North American Vertical Datum 1988
in – inches
[1] – Water level not corrected to NAVD 88 elevation.

DUKE ENERGY CAROLINAS

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CHECKED BY: L. DRAGO
APPROVED BY: L. DRAGO
PROJECT MANAGER: C. SUTTELL

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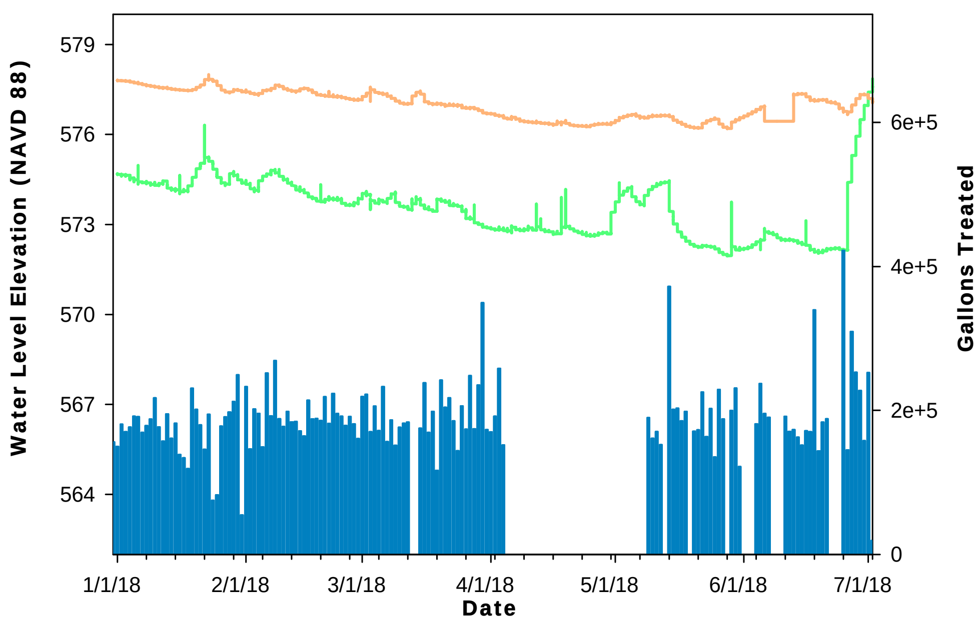
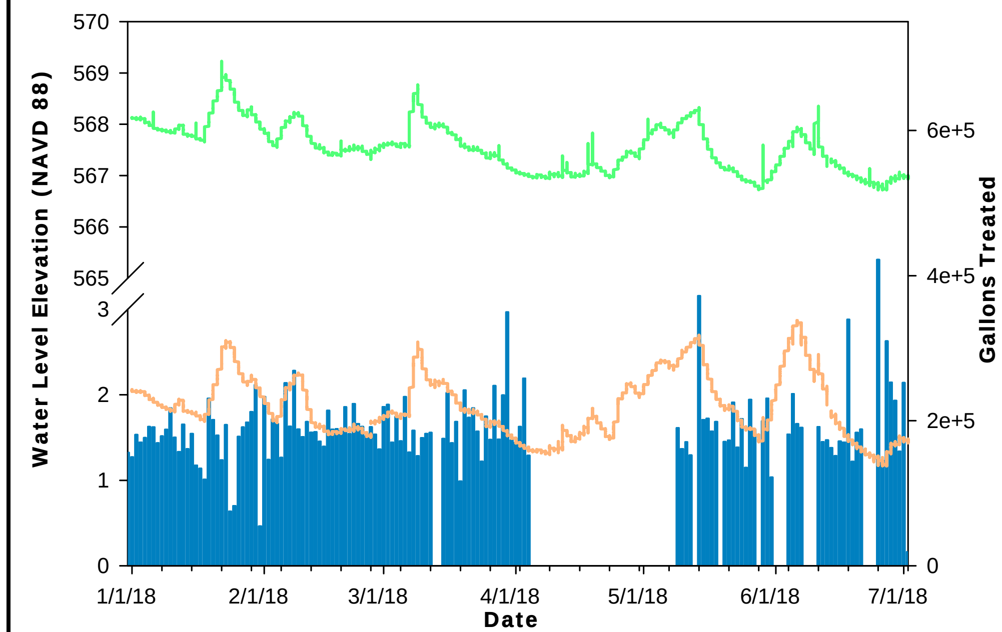
FIGURE 6-18a
HYDROGRAPHS – HOLDING BASIN
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA

CCR -8 Cluster



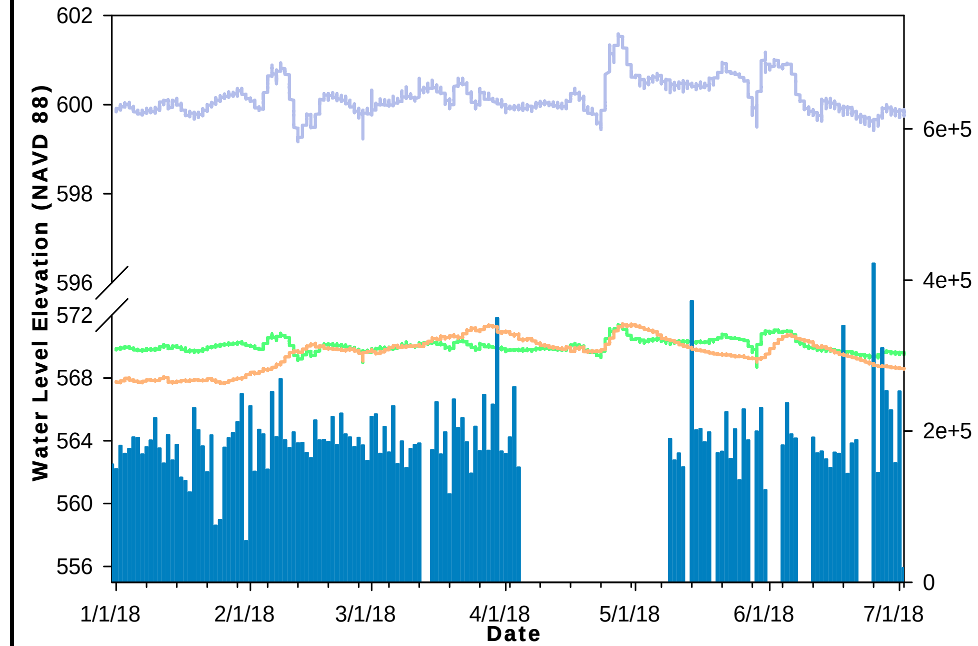
CCR-8S Water Elevation (NAVD 88)
CCR-8D Water Elevation (NAVD 88)

CCR-9 Cluster



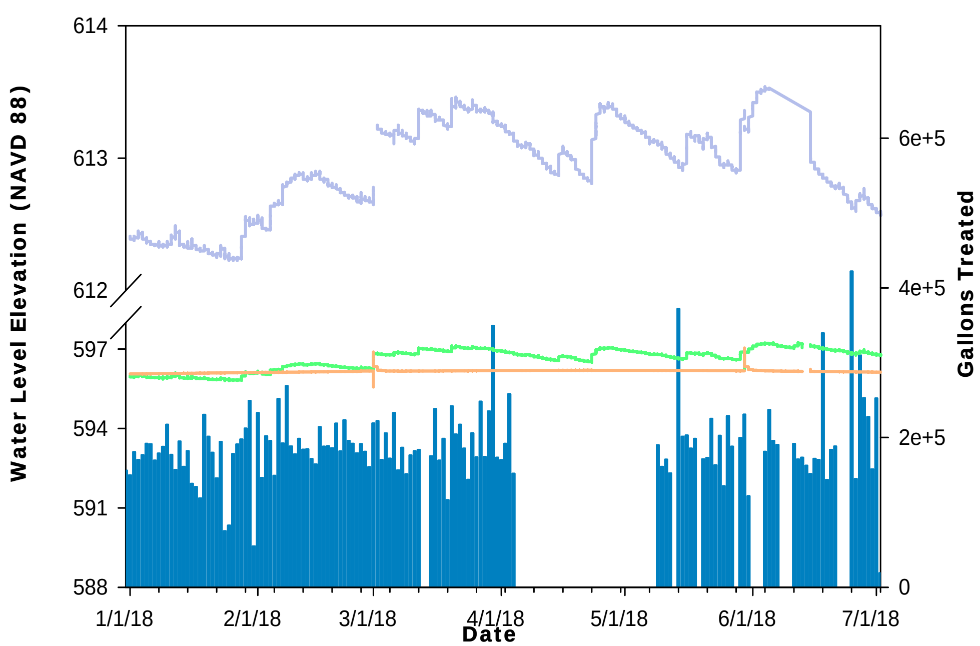
CCR-9S Water Elevation[1]
CCR-9D Water Elevation (NAVD 88)

GWA-5 Cluster



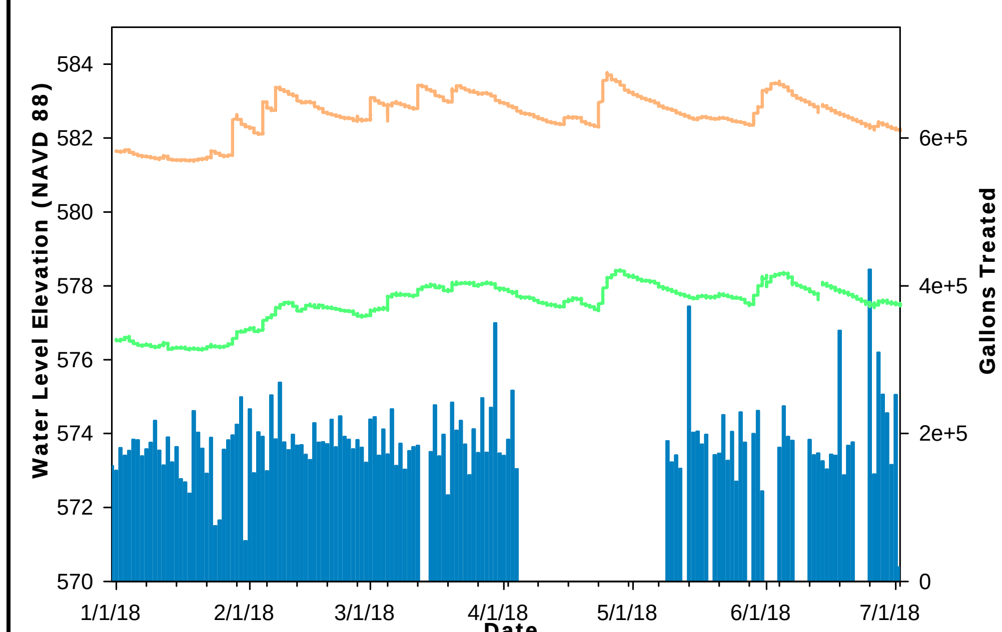
GWA-5S Water Elevation (NAVD 88)
GWA-5D Water Elevation (NAVD 88)
GWA-5BRA Water Elevation (NAVD 88)

GWA-6 Cluster



GWA-6S Water Elevation (NAVD 88)
GWA-6DA Water Elevation (NAVD 88)
GWA-6BRA Water Elevation (NAVD 88)

GWA-7 Cluster



GWA-7S Water Elevation (NAVD 88)
GWA-7D Water Elevation (NAVD 88)

LEGEND

Shallow Flow Zone
Deep Flow Zone
Bedrock Flow Zone

Notes:
NAVD 88 – North American Vertical Datum 1988
in – inches
[1] – Water level not corrected to NAVD 88 elevation.

DUKE ENERGY CAROLINAS

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DRAWN BY: D. AVARD DATE: 10/31/2019
REVISED BY:
CHECKED BY: L. DRAGO
APPROVED BY: L .DRAGO
PROJECT MANAGER: C. SUTTELL

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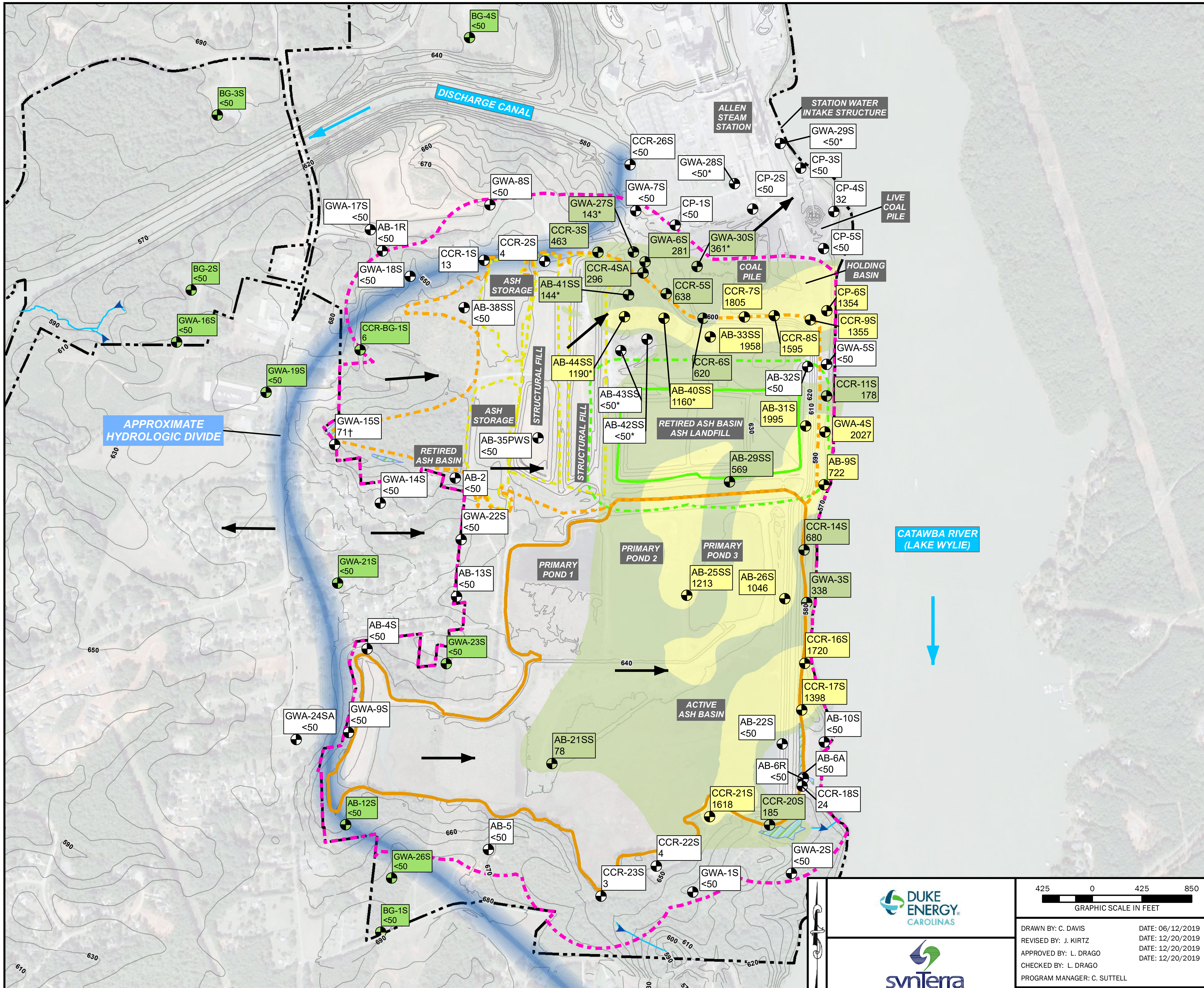
FIGURE 6-18b
HYDROGRAPHS – HOLDING BASIN
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA



LEGEND

- ASSESSMENT MONITORING WELL - GREATER THAN 15A NCAC 2L .0202 STANDARD (700 µg/L) (EFFECTIVE DATE FOR 15A NCAC 02L .0202 STANDARD IS APRIL 1. 2013)
- ASSESSMENT MONITORING WELL - GREATER THAN CONSTITUENT BACKGROUND THRESHOLD VALUE (50 µg/L)
- ASSESSMENT MONITORING WELL - LESS THAN BACKGROUND THRESHOLD VALUE
- BACKGROUND MONITORING WELL
- BORON PLUME GREATER THAN NC 02L STANDARD (700 µg/L) FROM MEAN ANALYSIS. FLOW AND TRANSPORT MODEL PREDICTED PLUME IS USED WHERE EMPIRICAL DATA IS NOT AVAILABLE.
- BORON PLUME GREATER THAN BTV (50 µg/L) FROM MEAN ANALYSIS. FLOW AND TRANSPORT PREDICTED PLUME IS USED WHERE EMPIRICAL DATA IS NOT AVAILABLE.
- ACTIVE ASH BASIN WASTE BOUNDARY
- ASH BASIN COMPLIANCE BOUNDARY
- RETIRED ASH BASIN WASTE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL WASTE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL COMPLIANCE BOUNDARY
- DORS FILLS BOUNDARIES
- DUKE ENERGY CAROLINAS PROPERTY LINE
- TOPOGRAPHIC CONTOUR (10' INTERVAL)
- STREAM (AMEC NRTR 2015)
- WETLAND (AMEC NRTR 2015)
- APPROXIMATE HYDROLOGIC DIVIDE
- GROUNDWATER FLOW DIRECTION
- SURFACE WATER FLOW DIRECTION

NOTES:

1. DATA INCLUDED IN THIS FIGURE ARE THE MEAN OR GEOMEAN RESULTS FOR WELLS BASED ON THE CENTRAL TENDENCY OF THE DATA SET FROM SAMPLES BETWEEN JANUARY 2018 AND JUNE 2019. FOR WELLS WITH DATASETS CONTAINING FEWER THAN FOUR VALID RESULTS, THE MOST RECENT VALID SAMPLE DATA WAS USED.

2. THE 02L FOR BORON IS 700 µg/L.

3. THE BACKGROUND VALUE FOR BORON IS 50 µg/L (AS SUBMITTED JUNE 2019).

4. † - CONCENTRATIONS WITHIN REASONABLE RANGE OF BACKGROUND DATA SET AND/OR NOT REPRESENTATIVE OF PLUME MIGRATION FROM SOURCE AREAS BASED ON MODELED SITE HYDRAULIC CHARACTERISTICS ARE NOT CONTOURED. DOES NOT SUGGEST IMPACT FROM SOURCE AREAS.

5. * - CONSTITUENT CONCENTRATION SHOWN IS THE MOST RECENT VALID SAMPLE AVAILABLE.

6. GROUNDWATER FLOW AND TRANSPORT BORON PLUME SIMULATION IS MODIFIED FROM MODEL LAYER 14 (MURDOCH AND OTHERS, 2019; MODEL OUTPUT PRODUCED OCTOBER 2019).

7. HYDROLOGIC DIVIDE IDENTIFIED IN CSA UPDATE (SYNTERRA, 2018) AND UPDATED GROUNDWATER FLOW AND TRANSPORT MODELING REPORT (MURDOCH AND OTHERS, 2019).

8. THE WATERS OF THE US DELINEATION HAS NOT BEEN APPROVED BY THE US ARMY CORPS OF ENGINEERS AT THE TIME OF THE MAP CREATION. THIS MAP IS NOT TO BE USED FOR JURISDICTIONAL DETERMINATION PURPOSES. THE WETLANDS AND STREAMS BOUNDARIES WERE OBTAINED FROM STREAM AND WETLAND DELINEATION CONDUCTED BY AMEC FOSTER WHEELER ENVIRONMENTAL & INFRASTRUCTURE, INC. NATURAL RESOURCE TECHNICAL REPORT (NRTR) FOR ALLEN STEAM STATION DATED MAY 29, 2015.

9. THE TOPOGRAPHY IS SHOWN FOR REFERENCE PURPOSES ONLY AND SHOULD NOT BE USED FOR DESIGN OR ENGINEERING PURPOSES. TOPOGRAPHY IS BASED ON LIDAR BARE EARTH DATA OBTAINED FROM THE NORTH CAROLINA SPATIAL DATA SITE AT https://sdd.nc.gov/sdd/DataDownload.aspx.

10. ALL BOUNDARIES ARE APPROXIMATE.

11. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.

12. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON OCTOBER 11, 2017. AERIAL WAS COLLECTED ON OCTOBER 8, 2016.

13. DRAWING HAS BEEN SET WITH A PROJECTION OF NORTH CAROLINA STATE PLANE COORDINATE SYSTEM FIPS 3200 (NAD83).

DUKE ENERGY CAROLINAS

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425 0 425 850
GRAPHIC SCALE IN FEET

DRAWN BY: C. DAVIS DATE: 06/12/2019
REVISED BY: J. KIRTZ DATE: 12/20/2019
APPROVED BY: L. DRAGO DATE: 12/20/2019
CHECKED BY: L. DRAGO DATE: 12/20/2019
PROGRAM MANAGER: C. SUTTELL

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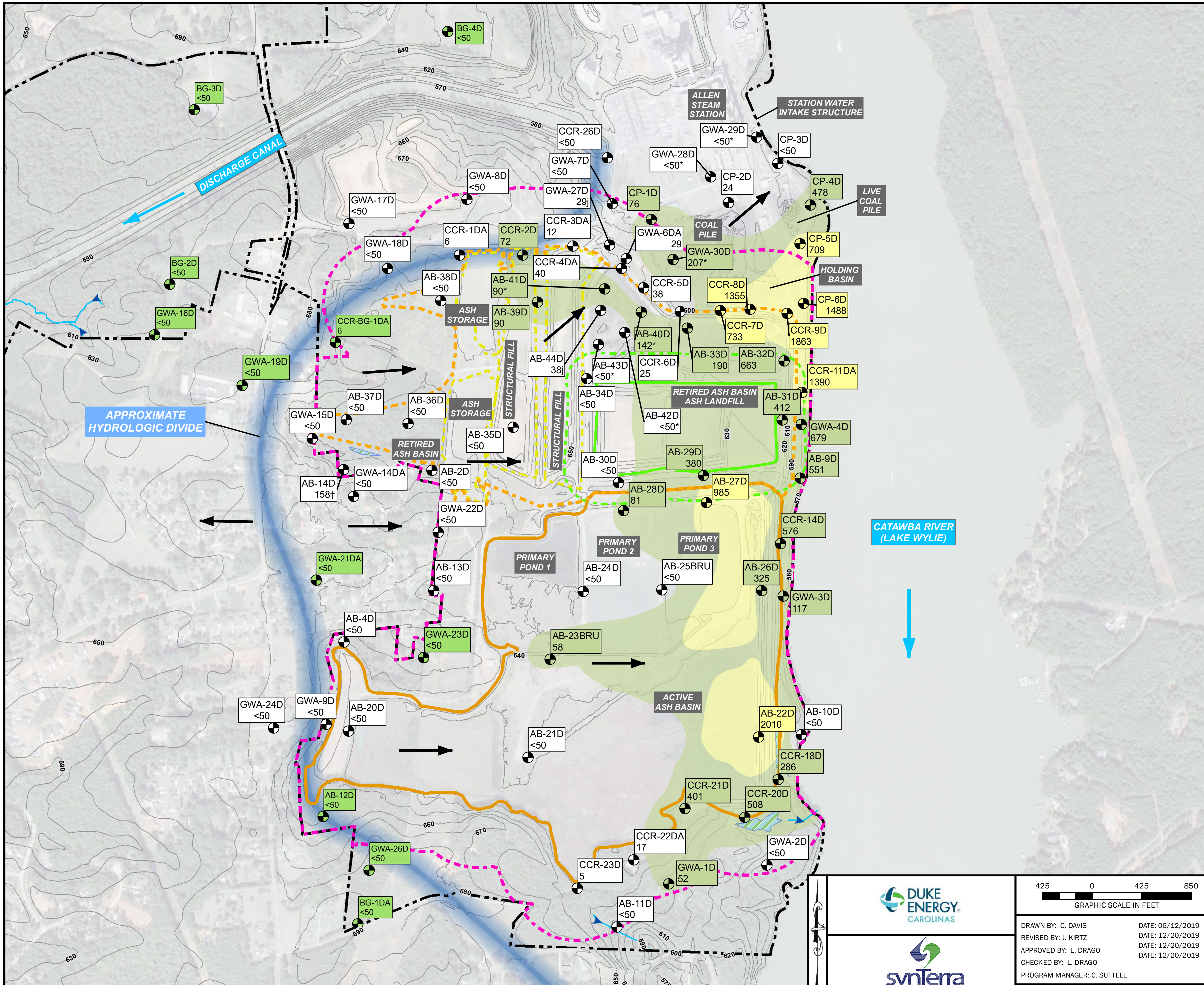
FIGURE 6-19a
ISOCONCENTRATION MAP
BORON IN SHALLOW FLOW ZONE
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA



LEGEND

- ASSESSMENT MONITORING WELL - GREATER THAN 15A NCAC 2L .0202 STANDARD (700 µg/L) (EFFECTIVE DATE FOR 15A NCAC 02L .0202 STANDARD IS APRIL 1. 2013)
- ASSESSMENT MONITORING WELL - GREATER THAN CONSTITUENT BACKGROUND THRESHOLD VALUE (50 µg/L)
- ASSESSMENT MONITORING WELL - LESS THAN BACKGROUND THRESHOLD VALUE
- BACKGROUND MONITORING WELL
- BORON PLUME GREATER THAN NC 02L STANDARD (700 µg/L) FROM MEAN ANALYSIS. FLOW AND TRANSPORT MODEL PREDICTED PLUME IS USED WHERE EMPIRICAL DATA IS NOT AVAILABLE.
- BORON PLUME GREATER THAN BTV (50 µg/L) FROM MEAN ANALYSIS. FLOW AND TRANSPORT PREDICTED PLUME IS USED WHERE EMPIRICAL DATA IS NOT AVAILABLE.
- ACTIVE ASH BASIN WASTE BOUNDARY
- ASH BASIN COMPLIANCE BOUNDARY
- RETIRED ASH BASIN WASTE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL WASTE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL COMPLIANCE BOUNDARY
- DORS FILLS BOUNDARIES
- DUKE ENERGY CAROLINAS PROPERTY LINE
- TOPOGRAPHIC CONTOUR (10' INTERVAL)
- STREAM (AMEC NRTR 2015)
- WETLAND (AMEC NRTR 2015)
- APPROXIMATE HYDROLOGIC DIVIDE
- GROUNDWATER FLOW DIRECTION
- SURFACE WATER FLOW DIRECTION

NOTES:

1. DATA INCLUDED IN THIS FIGURE ARE THE MEAN OR GEOMEAN RESULTS FOR WELLS BASED ON THE CENTRAL TENDENCY OF THE DATA SET FROM SAMPLES BETWEEN JANUARY 2018 AND JUNE 2019. FOR WELLS WITH DATASETS CONTAINING FEWER THAN FOUR VALID RESULTS, THE MOST RECENT VALID SAMPLE DATA WAS USED.

2. THE 02L FOR BORON IS 700 µg/L.

3. THE BACKGROUND VALUE FOR BORON IS 50 µg/L (AS SUBMITTED JUNE 2019).

4. † - CONCENTRATIONS WITHIN REASONABLE RANGE OF BACKGROUND DATA SET AND/OR NOT REPRESENTATIVE OF PLUME MIGRATION FROM SOURCE AREAS BASED ON MODELED SITE HYDRAULIC CHARACTERISTICS ARE NOT CONTOURED. DOES NOT SUGGEST IMPACT FROM SOURCE AREAS.

5. * - CONSTITUENT CONCENTRATION SHOWN IS THE MOST RECENT VALID SAMPLE AVAILABLE.

6. GROUNDWATER FLOW AND TRANSPORT BORON PLUME SIMULATION IS MODIFIED FROM MODEL LAYER 16 (MURDOCH AND OTHERS, 2019; MODEL OUTPUT PRODUCED OCTOBER 2019).

7. HYDROLOGIC DIVIDE IDENTIFIED IN CSA UPDATE (SYNTERRA, 2018) AND UPDATED GROUNDWATER FLOW AND TRANSPORT MODELING REPORT (MURDOCH AND OTHERS, 2019).

8. THE WATERS OF THE US DELINEATION HAS NOT BEEN APPROVED BY THE US ARMY CORPS OF ENGINEERS AT THE TIME OF THE MAP CREATION. THIS MAP IS NOT TO BE USED FOR JURISDICTIONAL DETERMINATION PURPOSES. THE WETLANDS AND STREAMS BOUNDARIES WERE OBTAINED FROM STREAM AND WETLAND DELINEATION CONDUCTED BY AMEC FOSTER WHEELER ENVIRONMENTAL & INFRASTRUCTURE, INC. NATURAL RESOURCE TECHNICAL REPORT (NRTR) FOR ALLEN STEAM STATION DATED MAY 29, 2015.

9. THE TOPOGRAPHY IS SHOWN FOR REFERENCE PURPOSES ONLY AND SHOULD NOT BE USED FOR DESIGN OR ENGINEERING PURPOSES. TOPOGRAPHY IS BASED ON LIDAR BARE EARTH DATA OBTAINED FROM THE NORTH CAROLINA SPATIAL DATA SITE AT https://sdd.nc.gov/sdd/DataDownload.aspx.

10. ALL BOUNDARIES ARE APPROXIMATE.

11. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.

12. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON OCTOBER 11, 2017. AERIAL WAS COLLECTED ON OCTOBER 8, 2016.

13. DRAWING HAS BEEN SET WITH A PROJECTION OF NORTH CAROLINA STATE PLANE COORDINATE SYSTEM FIPS 3200 (NAD83).

DUKE ENERGY CAROLINAS

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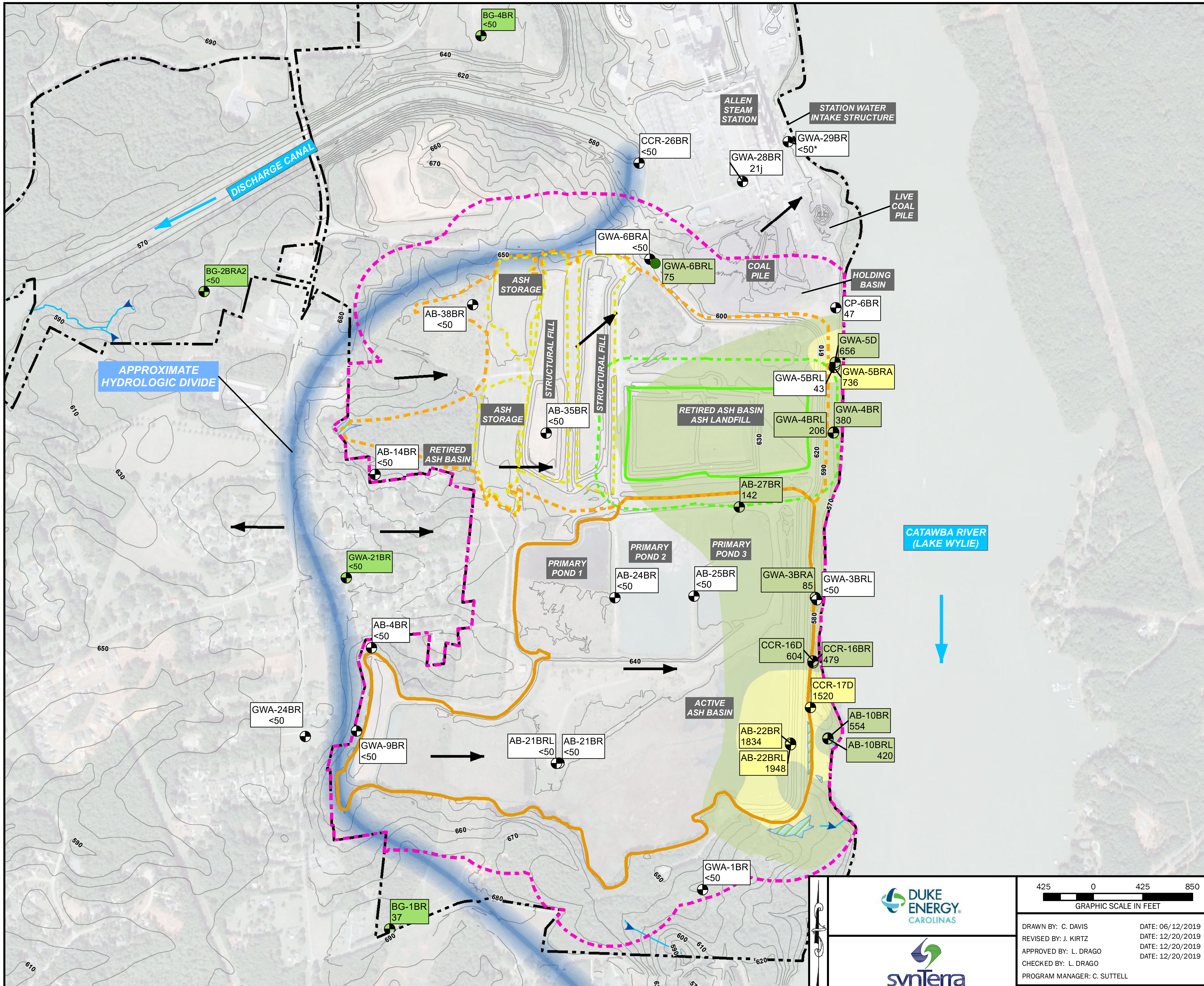
FIGURE 6-19b
ISOCONCENTRATION MAP
BORON IN DEEP FLOW ZONE
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA



LEGEND

- ASSESSMENT MONITORING WELL - GREATER THAN 15A NCAC 2L .0202 STANDARD (700 µg/L) (EFFECTIVE DATE FOR 15A NCAC 02L .0202 STANDARD IS APRIL 1. 2013)
- ASSESSMENT MONITORING WELL - GREATER THAN CONSTITUENT BACKGROUND THRESHOLD VALUE (50 µg/L)
- ASSESSMENT MONITORING WELL - LESS THAN BACKGROUND THRESHOLD VALUE
- BACKGROUND MONITORING WELL
- ISOLATED EXCEEDANCE OF BACKGROUND
- BORON PLUME GREATER THAN NC 02L STANDARD (700 µg/L) FROM MEAN ANALYSIS. FLOW AND TRANSPORT MODEL PREDICTED PLUME IS USED WHERE EMPIRICAL DATA IS NOT AVAILABLE.
- BORON PLUME GREATER THAN BTV (50 µg/L) FROM MEAN ANALYSIS. FLOW AND TRANSPORT PREDICTED PLUME IS USED WHERE EMPIRICAL DATA IS NOT AVAILABLE.
- ACTIVE ASH BASIN WASTE BOUNDARY
- ASH BASIN COMPLIANCE BOUNDARY
- RETIRED ASH BASIN WASTE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL WASTE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL COMPLIANCE BOUNDARY
- DORS FILLS BOUNDARIES
- DUKE ENERGY CAROLINAS PROPERTY LINE
- TOPOGRAPHIC CONTOUR (10' INTERVAL)
- STREAM (AMEC NRTR 2015)
- WETLAND (AMEC NRTR 2015)
- APPROXIMATE HYDROLOGIC DIVIDE
- GROUNDWATER FLOW DIRECTION
- SURFACE WATER FLOW DIRECTION

NOTES:

1. DATA INCLUDED IN THIS FIGURE ARE THE MEAN OR GEOMEAN RESULTS FOR WELLS BASED ON THE CENTRAL TENDENCY OF THE DATA SET FROM SAMPLES BETWEEN JANUARY 2018 AND JUNE 2019. FOR WELLS WITH DATASETS CONTAINING FEWER THAN FOUR VALID RESULTS, THE MOST RECENT VALID SAMPLE DATA WAS USED.

2. THE 02L FOR BORON IS 700 µg/L.

3. THE BACKGROUND VALUE FOR BORON IS 50 µg/L (AS SUBMITTED JUNE 2019).

4. * - CONSTITUENT CONCENTRATION SHOWN IS THE MOST RECENT VALID SAMPLE AVAILABLE.

5. GROUNDWATER FLOW AND TRANSPORT BORON PLUME SIMULATION IS MODIFIED FROM MODEL LAYER 17 (MURDOCH AND OTHERS, 2019; MODEL OUTPUT PRODUCED OCTOBER 2019).

6. HYDROLOGIC DIVIDE IDENTIFIED IN CSA UPDATE (SYNTERRA, 2018) AND UPDATED GROUNDWATER FLOW AND TRANSPORT MODELING REPORT (MURDOCH AND OTHERS, 2019).

7. THE WATERS OF THE US DELINEATION HAS NOT BEEN APPROVED BY THE US ARMY CORPS OF ENGINEERS AT THE TIME OF THE MAP CREATION. THIS MAP IS NOT TO BE USED FOR JURISDICTIONAL DETERMINATION PURPOSES. THE WETLANDS AND STREAMS BOUNDARIES WERE OBTAINED FROM STREAM AND WETLAND DELINEATION CONDUCTED BY AMEC FOSTER WHEELER ENVIRONMENTAL & INFRASTRUCTURE, INC. NATURAL RESOURCE TECHNICAL REPORT (NRTR) FOR ALLEN STEAM STATION DATED MAY 29, 2015.

8. THE TOPOGRAPHY IS SHOWN FOR REFERENCE PURPOSES ONLY AND SHOULD NOT BE USED FOR DESIGN OR ENGINEERING PURPOSES. TOPOGRAPHY IS BASED ON LIDAR BARE EARTH DATA OBTAINED FROM THE NORTH CAROLINA SPATIAL DATA SITE AT https://sdd.nc.gov/sdd/DataDownload.aspx.

9. ALL BOUNDARIES ARE APPROXIMATE.

10. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.

11. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON OCTOBER 11, 2017. AERIAL WAS COLLECTED ON OCTOBER 8, 2016.

12. DRAWING HAS BEEN SET WITH A PROJECTION OF NORTH CAROLINA STATE PLANE COORDINATE SYSTEM FIPS 3200 (NAD83).

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CHECKED BY: L. DRAGO	DATE: 12/20/2019
PROGRAM MANAGER: C. SUTTELL	

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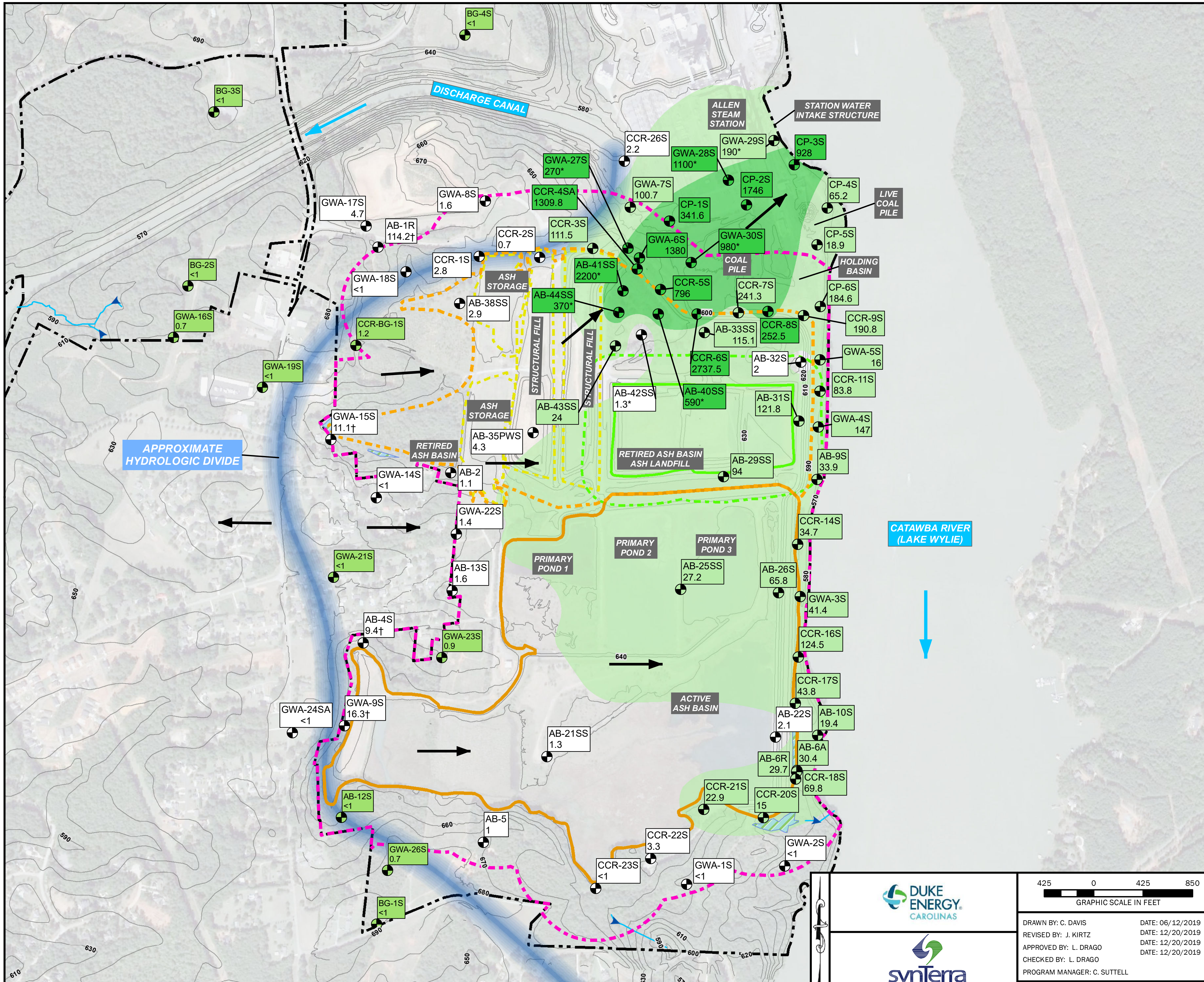
FIGURE 6-19c
ISOCONCENTRATION MAP
BORON IN BEDROCK FLOW ZONE
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA



LEGEND

- ASSESSMENT MONITORING WELL - GREATER THAN 15A NCAC 2L .0202 STANDARD (250 mg/L) (EFFECTIVE DATE FOR 15A NCAC 02L .0202 STANDARD IS APRIL 1. 2013)
- ASSESSMENT MONITORING WELL - GREATER THAN CONSTITUENT BACKGROUND THRESHOLD VALUE (5.4 mg/L)
- ASSESSMENT MONITORING WELL - LESS THAN BACKGROUND THRESHOLD VALUE
- BACKGROUND MONITORING WELL
- SULFATE PLUME GREATER THAN NC 02L STANDARD (250 mg/L) FROM MEAN ANALYSIS. FLOW AND TRANSPORT MODEL PREDICTED PLUME IS USED WHERE EMPIRICAL DATA IS NOT AVAILABLE
- SULFATE PLUME GREATER THAN BTV (5.4 mg/L) FROM MEAN ANALYSIS. FLOW AND TRANSPORT PREDICTED PLUME IS USED WHERE EMPIRICAL DATA IS NOT AVAILABLE
- ACTIVE ASH BASIN WASTE BOUNDARY
- ASH BASIN COMPLIANCE BOUNDARY
- RETIRED ASH BASIN WASTE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL WASTE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL COMPLIANCE BOUNDARY
- DORS FILLS BOUNDARIES
- DUKE ENERGY CAROLINAS PROPERTY LINE
- TOPOGRAPHIC CONTOUR (10' INTERVAL)
- STREAM (AMEC NRTR 2015)
- WETLAND (AMEC NRTR 2015)
- APPROXIMATE HYDROLOGIC DIVIDE
- GROUNDWATER FLOW DIRECTION
- SURFACE WATER FLOW DIRECTION

NOTES:

1. DATA INCLUDED IN THIS FIGURE ARE THE MEAN OR GEOMEAN RESULTS FOR WELLS BASED ON THE CENTRAL TENDENCY OF THE DATA SET FROM SAMPLES BETWEEN JANUARY 2018 AND JUNE 2019. FOR WELLS WITH DATASETS CONTAINING FEWER THAN FOUR VALID RESULTS, THE MOST RECENT VALID SAMPLE DATA WAS USED.
2. THE 02L FOR SULFATE IS 250 mg/L.
3. THE BACKGROUND VALUE FOR SULFATE IS 5.4 mg/L (AS SUBMITTED JUNE 2019).
4. † - CONCENTRATIONS WITHIN REASONABLE RANGE OF BACKGROUND DATA SET AND/OR NOT REPRESENTATIVE OF PLUME MIGRATION FROM SOURCE AREAS BASED ON MODELED SITE HYDRAULIC CHARACTERISTICS ARE NOT CONTOURED. DOES NOT SUGGEST IMPACT FROM SOURCE AREAS.
5. * - CONSTITUENT CONCENTRATION SHOWN IS MOST RECENT VALID SAMPLE AVAILABLE.
6. GROUNDWATER FLOW AND TRANSPORT SULFATE PLUME SIMULATION IS MODIFIED FROM MODEL LAYER 14 (MURDOCH AND OTHERS, 2019; MODEL OUTPUT PRODUCED OCTOBER 2019).
7. HYDROLOGIC DIVIDE IDENTIFIED IN CSA UPDATE (SYNTERRA, 2018) AND UPDATED GROUNDWATER FLOW AND TRANSPORT MODELING REPORT (MURDOCH AND OTHERS, 2019).
8. THE WATERS OF THE US DELINEATION HAS NOT BEEN APPROVED BY THE US ARMY CORPS OF ENGINEERS AT THE TIME OF THE MAP CREATION. THIS MAP IS NOT TO BE USED FOR JURISDICTIONAL DETERMINATION PURPOSES. THE WETLANDS AND STREAMS BOUNDARIES WERE OBTAINED FROM STREAM AND WETLAND DELINEATION CONDUCTED BY AMEC FOSTER WHEELER ENVIRONMENTAL & INFRASTRUCTURE, INC. NATURAL RESOURCE TECHNICAL REPORT (NRTR) FOR ALLEN STEAM STATION DATED MAY 29, 2015.
9. THE TOPOGRAPHY IS SHOWN FOR REFERENCE PURPOSES ONLY AND SHOULD NOT BE USED FOR DESIGN OR ENGINEERING PURPOSES. TOPOGRAPHY IS BASED ON LIDAR BARE EARTH DATA OBTAINED FROM THE NORTH CAROLINA SPATIAL DATA SITE AT https://sdd.nc.gov/sdd/DataDownload.aspx.
10. ALL BOUNDARIES ARE APPROXIMATE.
11. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.
12. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON OCTOBER 11, 2017. AERIAL WAS COLLECTED ON OCTOBER 8, 2016.
13. DRAWING HAS BEEN SET WITH A PROJECTION OF NORTH CAROLINA STATE PLANE COORDINATE SYSTEM FIPS 3200 (NAD83).

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425 0 425 850
GRAPHIC SCALE IN FEET

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APPROVED BY: L. DRAGO	DATE: 12/20/2019
CHECKED BY: L. DRAGO	DATE: 12/20/2019
PROGRAM MANAGER: C. SUTTELL	

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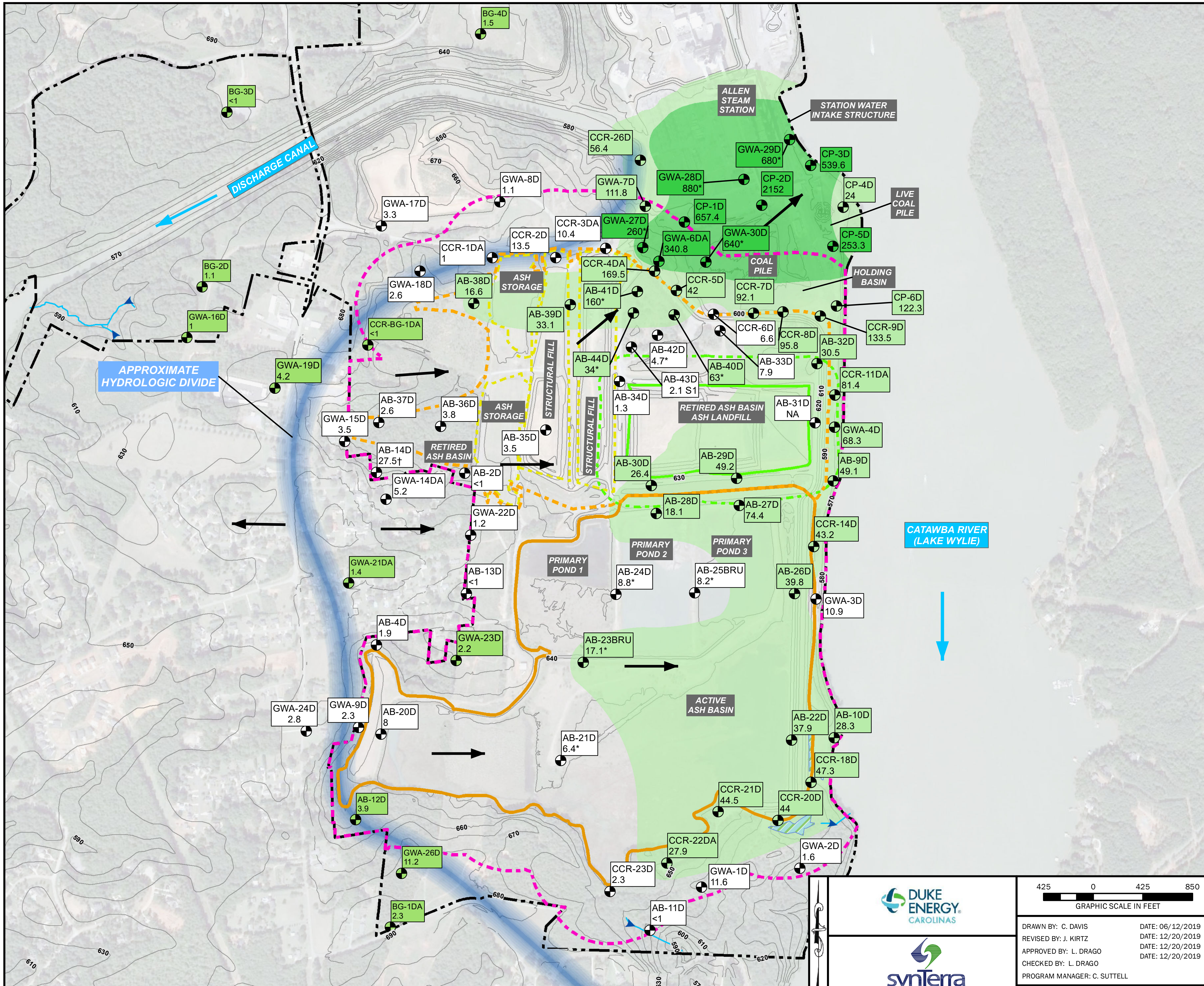
FIGURE 6-20a
ISOCONCENTRATION MAP
SULFATE IN SHALLOW FLOW ZONE
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA



LEGEND

- ASSESSMENT MONITORING WELL - GREATER THAN 15A NCAC 2L .0202 STANDARD (250 mg/L) (EFFECTIVE DATE FOR 15A NCAC 02L .0202 STANDARD IS APRIL 1. 2013)
- ASSESSMENT MONITORING WELL - GREATER THAN CONSTITUENT BACKGROUND THRESHOLD VALUE (14.5 mg/L)
- ASSESSMENT MONITORING WELL - LESS THAN BACKGROUND THRESHOLD VALUE
- BACKGROUND MONITORING WELL
- SULFATE PLUME GREATER THAN NC 02L STANDARD (250 mg/L) FROM MEAN ANALYSIS. FLOW AND TRANSPORT MODEL PREDICTED PLUME IS USED WHERE EMPIRICAL DATA IS NOT AVAILABLE
- SULFATE PLUME GREATER THAN BTV (14.5 mg/L) FROM MEAN ANALYSIS. FLOW AND TRANSPORT PREDICTED PLUME IS USED WHERE EMPIRICAL DATA IS NOT AVAILABLE
- ACTIVE ASH BASIN WASTE BOUNDARY
- ASH BASIN COMPLIANCE BOUNDARY
- RETIRED ASH BASIN WASTE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL WASTE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL COMPLIANCE BOUNDARY
- DORS FILLS BOUNDARIES
- DUKE ENERGY CAROLINAS PROPERTY LINE
- TOPOGRAPHIC CONTOUR (10' INTERVAL)
- STREAM (AMEC NRTR 2015)
- WETLAND (AMEC NRTR 2015)
- APPROXIMATE HYDROLOGIC DIVIDE
- GROUNDWATER FLOW DIRECTION
- SURFACE WATER FLOW DIRECTION

NOTES:

1. DATA INCLUDED IN THIS FIGURE ARE THE MEAN OR GEOMEAN RESULTS FOR WELLS BASED ON THE CENTRAL TENDENCY OF THE DATA SET FROM SAMPLES BETWEEN JANUARY 2018 AND JUNE 2019. FOR WELLS WITH DATASETS CONTAINING FEWER THAN FOUR VALID RESULTS, THE MOST RECENT VALID SAMPLE DATA WAS USED.

2. THE 02L FOR SULFATE IS 250 mg/L.

3. THE BACKGROUND VALUE FOR SULFATE IS 14.5 mg/L (AS SUBMITTED JUNE 2019).

4. † - CONCENTRATIONS WITHIN REASONABLE RANGE OF BACKGROUND DATA SET AND/OR NOT REPRESENTATIVE OF PLUME MIGRATION FROM SOURCE AREAS BASED ON MODELED SITE HYDRAULIC CHARACTERISTICS ARE NOT CONTOURED. DOES NOT SUGGEST IMPACT FROM SOURCE AREAS.

5. * - CONSTITUENT CONCENTRATION SHOWN IS THE MOST RECENT VALID SAMPLE AVAILABLE.

6. GROUNDWATER FLOW AND TRANSPORT SULFATE PLUME SIMULATION IS MODIFIED FROM MODEL LAYER 16 (MURDOCH AND OTHERS, 2019; MODEL OUTPUT PRODUCED OCTOBER 2019).

7. HYDROLOGIC DIVIDE IDENTIFIED IN CSA UPDATE (SYNTERRA, 2018) AND UPDATED GROUNDWATER FLOW AND TRANSPORT MODELING REPORT (MURDOCH AND OTHERS, 2019).

8. THE WATERS OF THE US DELINEATION HAS NOT BEEN APPROVED BY THE US ARMY CORPS OF ENGINEERS AT THE TIME OF THE MAP CREATION. THIS MAP IS NOT TO BE USED FOR JURISDICTIONAL DETERMINATION PURPOSES. THE WETLANDS AND STREAMS BOUNDARIES WERE OBTAINED FROM STREAM AND WETLAND DELINEATION CONDUCTED BY AMEC FOSTER WHEELER ENVIRONMENTAL & INFRASTRUCTURE, INC. NATURAL RESOURCE TECHNICAL REPORT (NRTR) FOR ALLEN STEAM STATION DATED MAY 29, 2015.

9. THE TOPOGRAPHY IS SHOWN FOR REFERENCE PURPOSES ONLY AND SHOULD NOT BE USED FOR DESIGN OR ENGINEERING PURPOSES. TOPOGRAPHY IS BASED ON LIDAR BARE EARTH DATA OBTAINED FROM THE NORTH CAROLINA SPATIAL DATA SITE AT https://sdd.nc.gov/sdd/DataDownload.aspx.

10. ALL BOUNDARIES ARE APPROXIMATE.

11. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.

12. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON OCTOBER 11, 2017. AERIAL WAS COLLECTED ON OCTOBER 8, 2016.

13. DRAWING HAS BEEN SET WITH A PROJECTION OF NORTH CAROLINA STATE PLANE COORDINATE SYSTEM FIPS 3200 (NAD83).

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APPROVED BY: L. DRAGO	DATE: 12/20/2019
CHECKED BY: L. DRAGO	DATE: 12/20/2019
PROGRAM MANAGER: C. SUTTELL	

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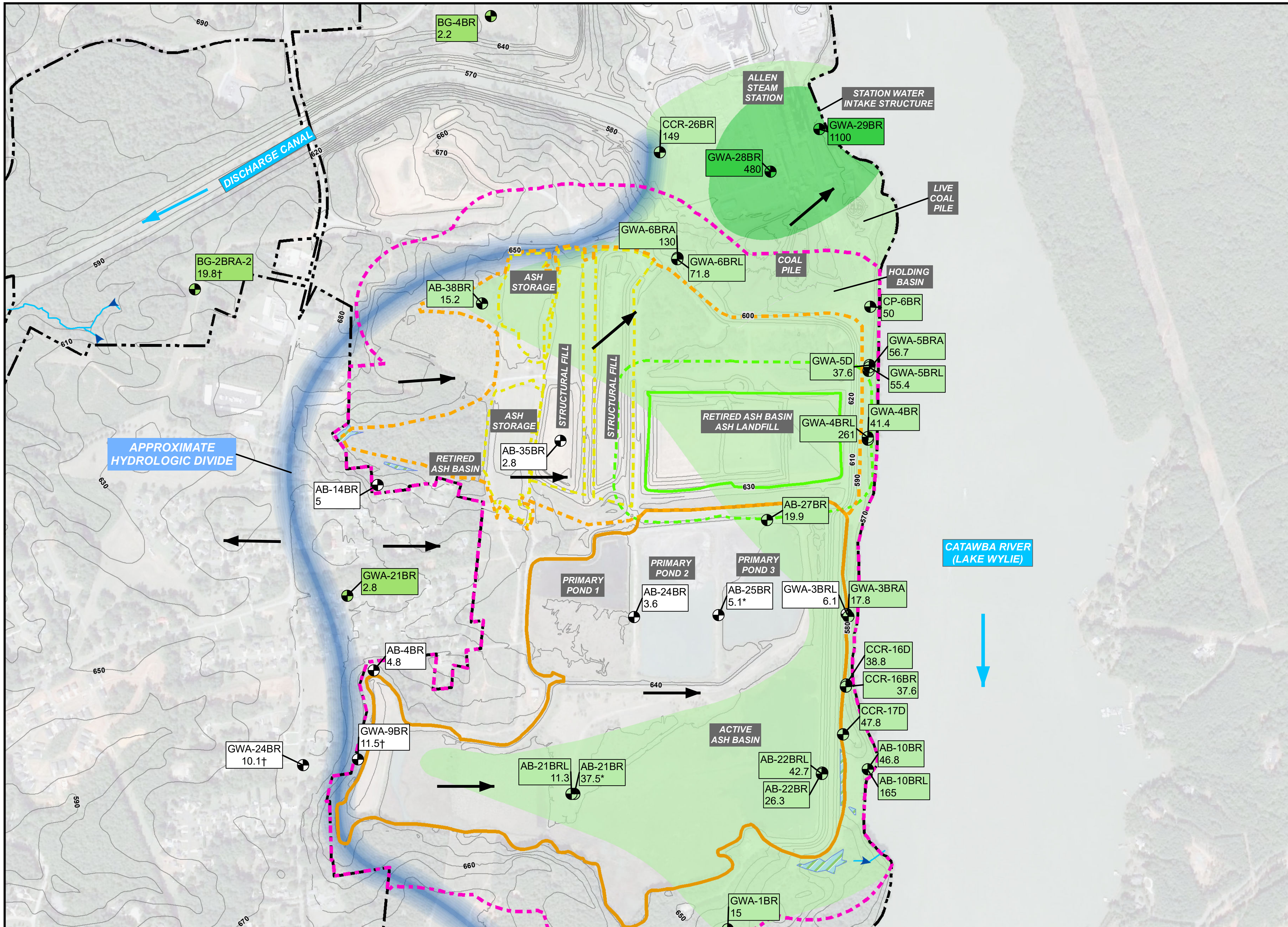
FIGURE 6-20b
ISOCONCENTRATION MAP
SULFATE IN DEEP FLOW ZONE
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA



LEGEND

- ASSESSMENT MONITORING WELL - GREATER THAN 15A NCAC 2L .0202 STANDARD (250 mg/L) (EFFECTIVE DATE FOR 15A NCAC 02L .0202 STANDARD IS APRIL 1. 2013)
- ASSESSMENT MONITORING WELL - GREATER THAN CONSTITUENT BACKGROUND THRESHOLD VALUE (7.3 mg/L)
- ASSESSMENT MONITORING WELL - LESS THAN BACKGROUND THRESHOLD VALUE
- BACKGROUND MONITORING WELL
- SULFATE PLUME GREATER THAN NC 02L STANDARD (250 mg/L) FROM MEAN ANALYSIS. FLOW AND TRANSPORT MODEL PREDICTED PLUME IS USED WHERE EMPIRICAL DATA IS NOT AVAILABLE
- SULFATE PLUME GREATER THAN BTV (7.3 mg/L) FROM MEAN ANALYSIS. FLOW AND TRANSPORT PREDICTED PLUME IS USED WHERE EMPIRICAL DATA IS NOT AVAILABLE
- ACTIVE ASH BASIN WASTE BOUNDARY
- ASH BASIN COMPLIANCE BOUNDARY
- RETIRED ASH BASIN WASTE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL WASTE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL COMPLIANCE BOUNDARY
- DORS FILLS BOUNDARIES
- DUKE ENERGY CAROLINAS PROPERTY LINE
- TOPOGRAPHIC CONTOUR (10' INTERVAL)
- STREAM (AMEC NRTR 2015)
- WETLAND (AMEC NRTR 2015)
- APPROXIMATE HYDROLOGIC DIVIDE
- GROUNDWATER FLOW DIRECTION
- SURFACE WATER FLOW DIRECTION

NOTES:

1. DATA INCLUDED IN THIS FIGURE ARE THE MEAN OR GEOMEAN RESULTS FOR WELLS BASED ON THE CENTRAL TENDENCY OF THE DATA SET FROM SAMPLES BETWEEN JANUARY 2018 AND JUNE 2019. FOR WELLS WITH DATASETS CONTAINING FEWER THAN FOUR VALID RESULTS, THE MOST RECENT VALID SAMPLE DATA WAS USED.

2. THE 02L FOR SULFATE IS 250 mg/L.

3. THE BACKGROUND VALUE FOR SULFATE IS 7.3 mg/L (AS SUBMITTED JUNE 2019).

4. † - CONCENTRATIONS WITHIN REASONABLE RANGE OF BACKGROUND DATA SET AND/OR NOT REPRESENTATIVE OF PLUME MIGRATION FROM SOURCE AREAS BASED ON MODELED SITE HYDRAULIC CHARACTERISTICS ARE NOT CONTOURED. DOES NOT SUGGEST IMPACT FROM SOURCE AREAS.

5. * - CONSTITUENT CONCENTRATION SHOWN IS THE MOST RECENT VALID SAMPLE AVAILABLE.

6. GROUNDWATER FLOW AND TRANSPORT SULFATE PLUME SIMULATION IS MODIFIED FROM MODEL LAYER 17 (MURDOCH AND OTHERS, 2019; MODEL OUTPUT PRODUCED OCTOBER 2019).

7. HYDROLOGIC DIVIDE IDENTIFIED IN CSA UPDATE (SYNTERRA, 2018) AND UPDATED GROUNDWATER FLOW AND TRANSPORT MODELING REPORT (MURDOCH AND OTHERS, 2019).

8. THE WATERS OF THE US DELINEATION HAS NOT BEEN APPROVED BY THE US ARMY CORPS OF ENGINEERS AT THE TIME OF THE MAP CREATION. THIS MAP IS NOT TO BE USED FOR JURISDICTIONAL DETERMINATION PURPOSES. THE WETLANDS AND STREAMS BOUNDARIES WERE OBTAINED FROM STREAM AND WETLAND DELINEATION CONDUCTED BY AMEC FOSTER WHEELER ENVIRONMENTAL & INFRASTRUCTURE, INC. NATURAL RESOURCE TECHNICAL REPORT (NRTR) FOR ALLEN STEAM STATION DATED MAY 29, 2015.

9. THE TOPOGRAPHY IS SHOWN FOR REFERENCE PURPOSES ONLY AND SHOULD NOT BE USED FOR DESIGN OR ENGINEERING PURPOSES. TOPOGRAPHY IS BASED ON LIDAR BARE EARTH DATA OBTAINED FROM THE NORTH CAROLINA SPATIAL DATA SITE AT https://sdd.nc.gov/sdd/DataDownload.aspx.

10. ALL BOUNDARIES ARE APPROXIMATE.

11. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.

12. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON OCTOBER 11, 2017. AERIAL WAS COLLECTED ON OCTOBER 8, 2016.

13. DRAWING HAS BEEN SET WITH A PROJECTION OF NORTH CAROLINA STATE PLANE COORDINATE SYSTEM FIPS 3200 (NAD83).

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CHECKED BY: L. DRAGO DATE: 12/20/2019
PROGRAM MANAGER: C. SUTTELL

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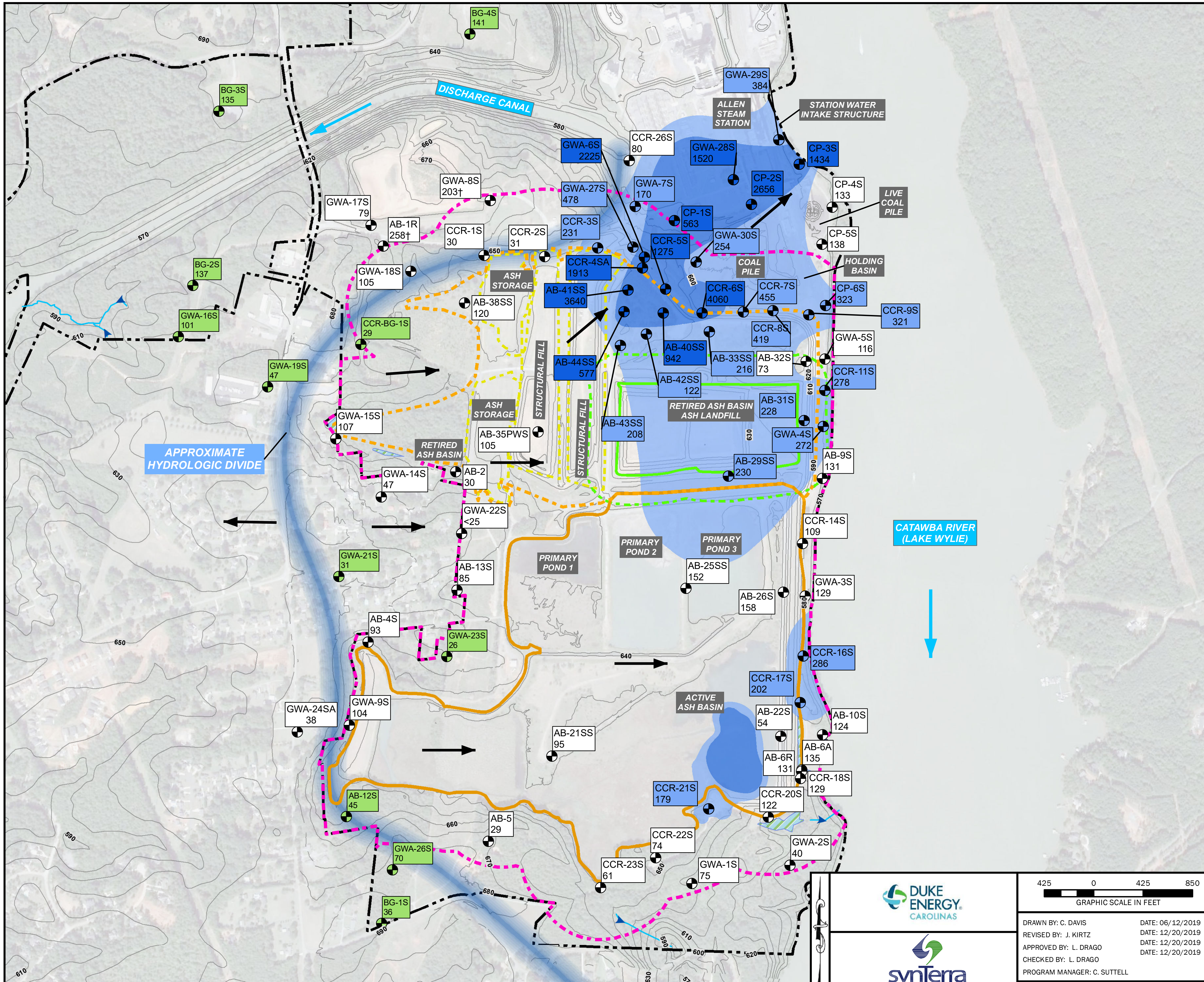
FIGURE 6-20c
ISOCONCENTRATION MAP
SULFATE IN BEDROCK FLOW ZONE
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA



LEGEND

- ASSESSMENT MONITORING WELL - GREATER THAN 15A NCAC 2L .0202 STANDARD (500 mg/L) (EFFECTIVE DATE FOR 15A NCAC 02L .0202 STANDARD IS APRIL 1. 2013)
- ASSESSMENT MONITORING WELL - GREATER THAN CONSTITUENT BACKGROUND THRESHOLD VALUE (163 mg/L)
- ASSESSMENT MONITORING WELL - LESS THAN BACKGROUND THRESHOLD VALUE
- BACKGROUND MONITORING WELL
- TOTAL DISSOLVED SOLIDS PLUME GREATER THAN NC 02L STANDARD (500 mg/L) FROM MEAN ANALYSIS. FLOW AND TRANSPORT MODEL PREDICTED PLUME IS USED WHERE EMPIRICAL DATA IS NOT AVAILABLE.
- TOTAL DISSOLVED SOLIDS PLUME GREATER THAN BTV (163 mg/L) FROM MEAN ANALYSIS. FLOW AND TRANSPORT PREDICTED PLUME IS USED WHERE EMPIRICAL DATA IS NOT AVAILABLE.
- ACTIVE ASH BASIN WASTE BOUNDARY
- ASH BASIN COMPLIANCE BOUNDARY
- RETIRED ASH BASIN WASTE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL WASTE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL COMPLIANCE BOUNDARY
- DORS FILLS BOUNDARIES
- DUKE ENERGY CAROLINAS PROPERTY LINE
- TOPOGRAPHIC CONTOUR (10' INTERVAL)
- STREAM (AMEC NRTR 2015)
- WETLAND (AMEC NRTR 2015)
- APPROXIMATE HYDROLOGIC DIVIDE
- GROUNDWATER FLOW DIRECTION
- SURFACE WATER FLOW DIRECTION

NOTES:

1. DATA INCLUDED IN THIS FIGURE ARE THE MEAN OR GEOMEAN RESULTS FOR WELLS BASED ON THE CENTRAL TENDENCY OF THE DATA SET FROM SAMPLES BETWEEN JANUARY 2018 AND JUNE 2019. FOR WELLS WITH DATASETS CONTAINING FEWER THAN FOUR VALID RESULTS, THE MOST RECENT VALID SAMPLE DATA WAS USED.
2. THE 02L FOR TDS IS 500 mg/L.
3. THE BACKGROUND VALUE FOR TDS IS 163 mg/L (AS SUBMITTED JUNE 2019).
4. † - CONCENTRATIONS WITHIN REASONABLE RANGE OF BACKGROUND DATA SET AND/OR NOT REPRESENTATIVE OF PLUME MIGRATION FROM SOURCE AREAS BASED ON MODELED SITE HYDRAULIC CHARACTERISTICS ARE NOT CONTOURED. DOES NOT SUGGEST IMPACT FROM SOURCE AREAS.
5. GROUNDWATER FLOW AND TRANSPORT TOTAL DISSOLVED SOLIDS PLUME SIMULATION IS MODIFIED FROM MODEL LAYER 14 (MURDOCH AND OTHERS, 2019; MODEL OUTPUT PRODUCED OCTOBER 2019).
6. HYDROLOGIC DIVIDE IDENTIFIED IN CSA UPDATE (SYNTERRA, 2018) AND UPDATED GROUNDWATER FLOW AND TRANSPORT MODELING REPORT (MURDOCH AND OTHERS, 2019).
7. THE WATERS OF THE US DELINEATION HAS NOT BEEN APPROVED BY THE US ARMY CORPS OF ENGINEERS AT THE TIME OF THE MAP CREATION. THIS MAP IS NOT TO BE USED FOR JURISDICTIONAL DETERMINATION PURPOSES. THE WETLANDS AND STREAMS BOUNDARIES WERE OBTAINED FROM STREAM AND WETLAND DELINEATION CONDUCTED BY AMEC FOSTER WHEELER ENVIRONMENTAL & INFRASTRUCTURE, INC. NATURAL RESOURCE TECHNICAL REPORT (NRTR) FOR ALLEN STEAM STATION DATED MAY 29, 2015.
8. THE TOPOGRAPHY IS SHOWN FOR REFERENCE PURPOSES ONLY AND SHOULD NOT BE USED FOR DESIGN OR ENGINEERING PURPOSES. TOPOGRAPHY IS BASED ON LIDAR BARE EARTH DATA OBTAINED FROM THE NORTH CAROLINA SPATIAL DATA SITE AT https://sdd.nc.gov/sdd/DataDownload.aspx.
9. ALL BOUNDARIES ARE APPROXIMATE.
10. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.
11. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON OCTOBER 11, 2017. AERIAL WAS COLLECTED ON OCTOBER 8, 2016.
12. DRAWING HAS BEEN SET WITH A PROJECTION OF NORTH CAROLINA STATE PLANE COORDINATE SYSTEM FIPS 3200 (NAD83).

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425 0 425 850

GRAPHIC SCALE IN FEET

DRAWN BY: C. DAVIS	DATE: 06/12/2019
REVISED BY: J. KIRTZ	DATE: 12/20/2019
APPROVED BY: L. DRAGO	DATE: 12/20/2019
CHECKED BY: L. DRAGO	DATE: 12/20/2019
PROGRAM MANAGER: C. SUTTELL	

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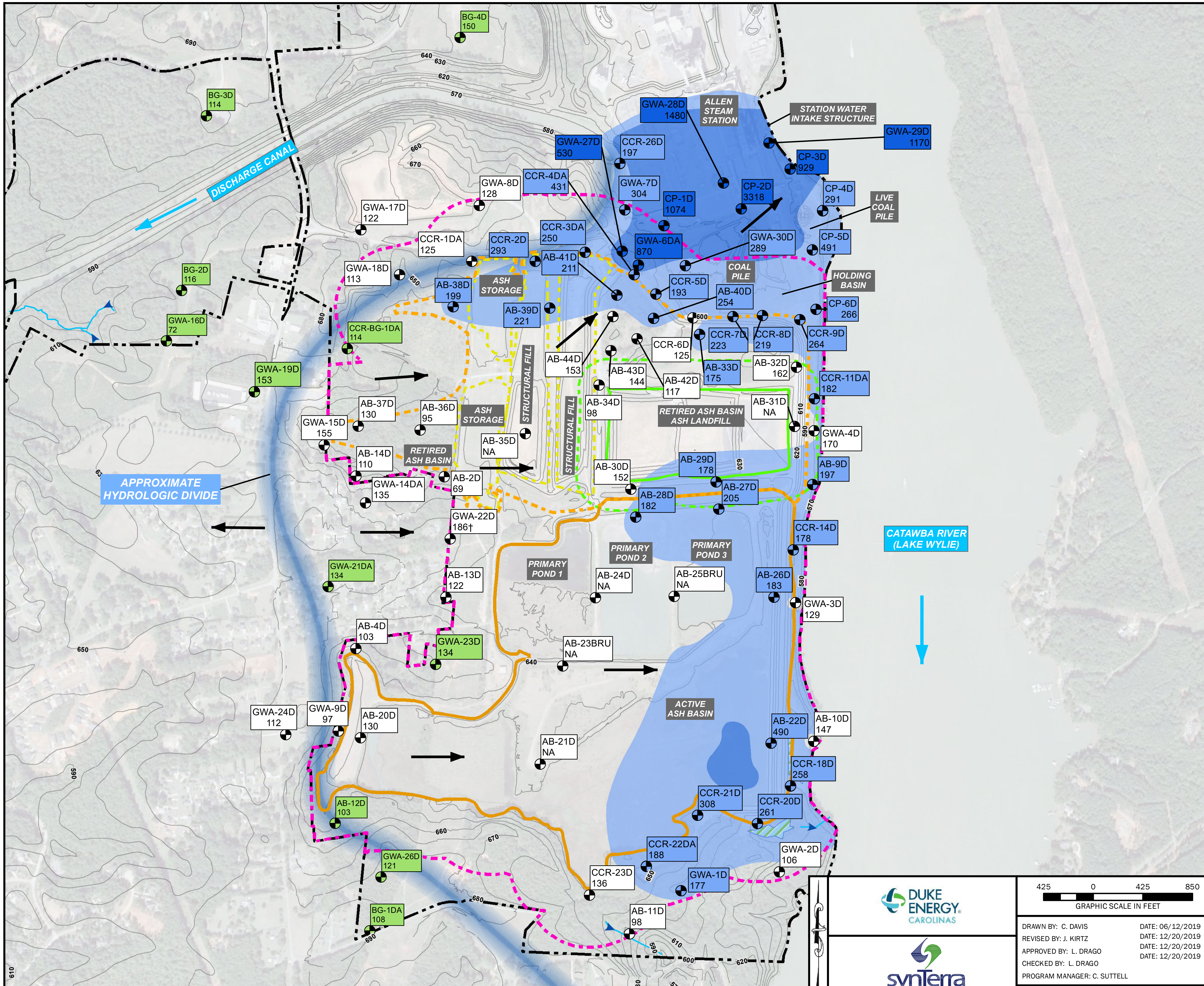
FIGURE 6-21a
ISOCONCENTRATION MAP
TOTAL DISSOLVED SOLIDS
IN SHALLOW FLOW ZONE
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA



LEGEND

- ASSESSMENT MONITORING WELL - GREATER THAN 15A NCAC 2L .0202 STANDARD (500 mg/L) (EFFECTIVE DATE FOR 15A NCAC 02L .0202 STANDARD IS APRIL 1. 2013)
- ASSESSMENT MONITORING WELL - GREATER THAN CONSTITUENT BACKGROUND THRESHOLD VALUE (173 mg/L)
- ASSESSMENT MONITORING WELL - LESS THAN BACKGROUND THRESHOLD VALUE
- BACKGROUND MONITORING WELL
- TOTAL DISSOLVED SOLIDS PLUME GREATER THAN NC 02L STANDARD (500 mg/L) FROM MEAN ANALYSIS. FLOW AND TRANSPORT MODEL PREDICTED PLUME IS USED WHERE EMPIRICAL DATA IS NOT AVAILABLE.
- TOTAL DISSOLVED SOLIDS PLUME GREATER THAN BTV (173 mg/L) FROM MEAN ANALYSIS. FLOW AND TRANSPORT PREDICTED PLUME IS USED WHERE EMPIRICAL DATA IS NOT AVAILABLE.
- ACTIVE ASH BASIN WASTE BOUNDARY
- ASH BASIN COMPLIANCE BOUNDARY
- RETIRED ASH BASIN WASTE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL WASTE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL COMPLIANCE BOUNDARY
- DORS FILLS BOUNDARIES
- DUKE ENERGY CAROLINAS PROPERTY LINE
- TOPOGRAPHIC CONTOUR (10' INTERVAL)
- STREAM (AMEC NRTR 2015)
- WETLAND (AMEC NRTR 2015)
- APPROXIMATE HYDROLOGIC DIVIDE
- GROUNDWATER FLOW DIRECTION
- SURFACE WATER FLOW DIRECTION

NOTES:

1. DATA INCLUDED IN THIS FIGURE ARE THE MEAN OR GEOMEAN RESULTS FOR WELLS BASED ON THE CENTRAL TENDENCY OF THE DATA SET FROM SAMPLES BETWEEN JANUARY 2018 AND JUNE 2019. FOR WELLS WITH DATASETS CONTAINING FEWER THAN FOUR VALID RESULTS, THE MOST RECENT VALID SAMPLE DATA WAS USED.
2. THE 02L FOR TDS IS 500 mg/L.
3. THE BACKGROUND VALUE FOR TDS IS 173 mg/L (AS SUBMITTED JUNE 2019).
4. NA - NOT AVAILABLE.
5. † - CONCENTRATIONS WITHIN REASONABLE RANGE OF BACKGROUND DATA SET AND/OR NOT REPRESENTATIVE OF PLUME MIGRATION FROM SOURCE AREAS BASED ON MODELED SITE HYDRAULIC CHARACTERISTICS ARE NOT CONTOURED. DOES NOT SUGGEST IMPACT FROM SOURCE AREAS.
6. GROUNDWATER FLOW AND TRANSPORT TOTAL DISSOLVED SOLIDS PLUME SIMULATION IS MODIFIED FROM MODEL LAYER 16 (MURDOCH AND OTHERS, 2019; MODEL OUTPUT PRODUCED OCTOBER 2019).
7. HYDROLOGIC DIVIDE IDENTIFIED IN CSA UPDATE (SYNTERRA, 2018) AND UPDATED GROUNDWATER FLOW AND TRANSPORT MODELING REPORT (MURDOCH AND OTHERS, 2019).
8. THE WATERS OF THE US DELINEATION HAS NOT BEEN APPROVED BY THE US ARMY CORPS OF ENGINEERS AT THE TIME OF THE MAP CREATION. THIS MAP IS NOT TO BE USED FOR JURISDICTIONAL DETERMINATION PURPOSES. THE WETLANDS AND STREAMS BOUNDARIES WERE OBTAINED FROM STREAM AND WETLAND DELINEATION CONDUCTED BY AMEC FOSTER WHEELER ENVIRONMENTAL & INFRASTRUCTURE, INC. NATURAL RESOURCE TECHNICAL REPORT (NRTR) FOR ALLEN STEAM STATION DATED MAY 29, 2015.
9. THE TOPOGRAPHY IS SHOWN FOR REFERENCE PURPOSES ONLY AND SHOULD NOT BE USED FOR DESIGN OR ENGINEERING PURPOSES. TOPOGRAPHY IS BASED ON LIDAR BARE EARTH DATA OBTAINED FROM THE NORTH CAROLINA SPATIAL DATA SITE AT https://sdd.nc.gov/sdd/DataDownload.aspx.
10. ALL BOUNDARIES ARE APPROXIMATE.
11. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.
12. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON OCTOBER 11, 2017. AERIAL WAS COLLECTED ON OCTOBER 8, 2016.
13. DRAWING HAS BEEN SET WITH A PROJECTION OF NORTH CAROLINA STATE PLANE COORDINATE SYSTEM FIPS 3200 (NAD83).

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GRAPHIC SCALE IN FEET

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REVISED BY: J. KIRTZ	DATE: 12/20/2019
APPROVED BY: L. DRAGO	DATE: 12/20/2019
CHECKED BY: L. DRAGO	DATE: 12/20/2019
PROGRAM MANAGER: C. SUTTELL	

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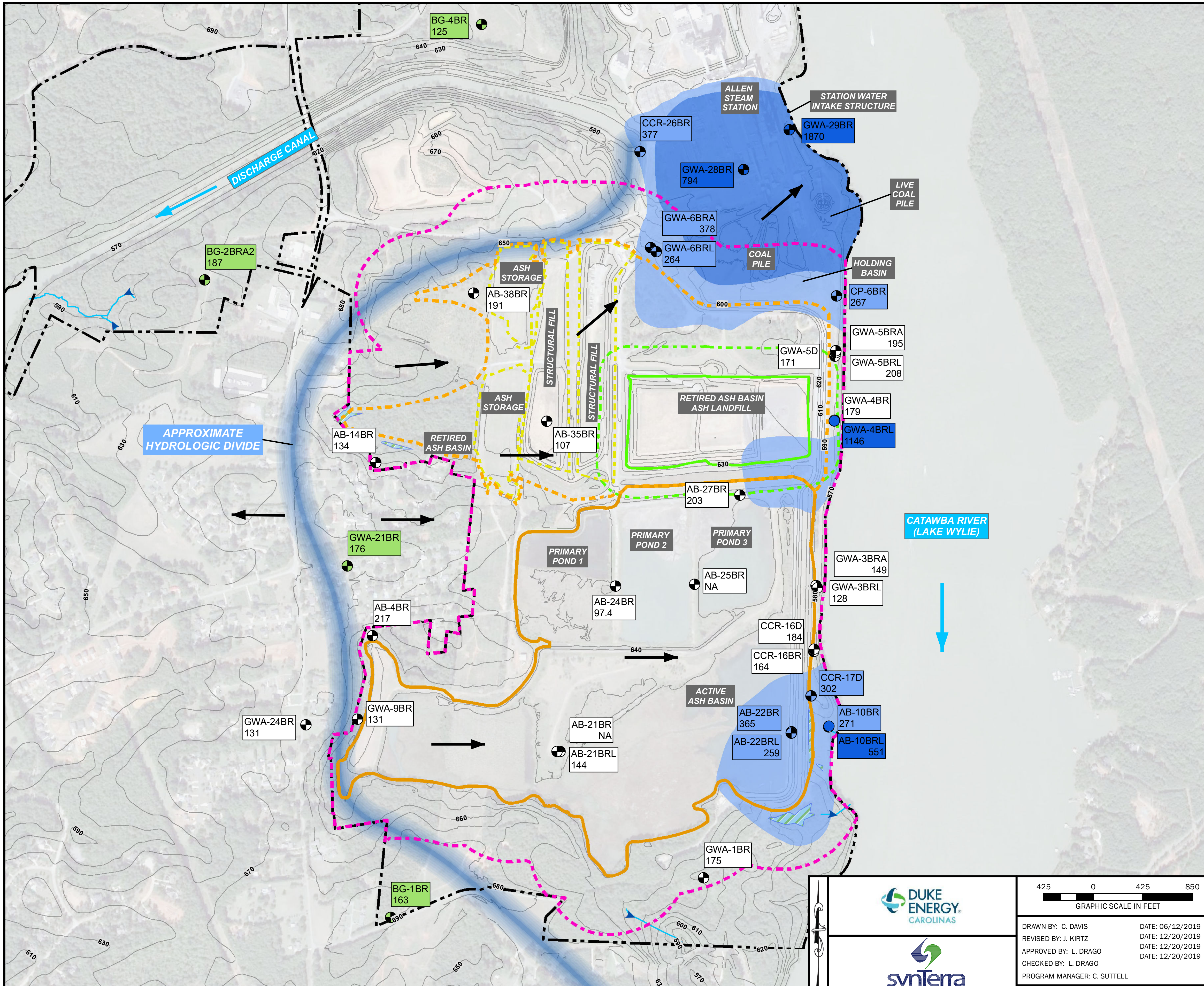
FIGURE 6-21b
ISOCONCENTRATION MAP
TOTAL DISSOLVED SOLIDS
IN DEEP FLOW ZONE
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA



LEGEND

- ASSESSMENT MONITORING WELL - GREATER THAN 15A NCAC 2L .0202 STANDARD (500 mg/L) (EFFECTIVE DATE FOR 15A NCAC 02L .0202 STANDARD IS APRIL 1. 2013)
- ASSESSMENT MONITORING WELL - GREATER THAN CONSTITUENT BACKGROUND THRESHOLD VALUE (220.7 mg/L)
- ASSESSMENT MONITORING WELL - LESS THAN BACKGROUND THRESHOLD VALUE
- BACKGROUND MONITORING WELL
- ISOLATED EXCEEDANCE OF NC 02L
- TOTAL DISSOLVED SOLIDS PLUME GREATER THAN NC 02L STANDARD (500 mg/L) FROM MEAN ANALYSIS. FLOW AND TRANSPORT MODEL PREDICTED PLUME IS USED WHERE EMPIRICAL DATA IS NOT AVAILABLE.
- TOTAL DISSOLVED SOLIDS PLUME GREATER THAN BTV (220.7 mg/L) FROM MEAN ANALYSIS. FLOW AND TRANSPORT PREDICTED PLUME IS USED WHERE EMPIRICAL DATA IS NOT AVAILABLE.
- ACTIVE ASH BASIN WASTE BOUNDARY
- ASH BASIN COMPLIANCE BOUNDARY
- RETIRED ASH BASIN WASTE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL WASTE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL COMPLIANCE BOUNDARY
- DORS FILLS BOUNDARIES
- DUKE ENERGY CAROLINAS PROPERTY LINE
- TOPOGRAPHIC CONTOUR (10' INTERVAL)
- STREAM (AMEC NRTR 2015)
- WETLAND (AMEC NRTR 2015)
- APPROXIMATE HYDROLOGIC DIVIDE
- GROUNDWATER FLOW DIRECTION
- SURFACE WATER FLOW DIRECTION

NOTES:

1. DATA INCLUDED IN THIS FIGURE ARE THE MEAN OR GEOMEAN RESULTS FOR WELLS BASED ON THE CENTRAL TENDENCY OF THE DATA SET FROM SAMPLES BETWEEN JANUARY 2018 AND JUNE 2019. FOR WELLS WITH DATASETS CONTAINING FEWER THAN FOUR VALID RESULTS, THE MOST RECENT VALID SAMPLE DATA WAS USED.
2. THE 02L FOR TDS IS 500 mg/L.
3. THE BACKGROUND VALUE FOR TDS IS 220.7 mg/L (AS SUBMITTED JUNE 2019).
4. NA - NOT AVAILABLE.
5. † - CONCENTRATIONS WITHIN REASONABLE RANGE OF BACKGROUND DATA SET AND/OR NOT REPRESENTATIVE OF PLUME MIGRATION FROM SOURCE AREAS BASED ON MODELED SITE HYDRAULIC CHARACTERISTICS ARE NOT CONTOURED. DOES NOT SUGGEST IMPACT FROM SOURCE AREAS.
6. GROUNDWATER FLOW AND TRANSPORT TOTAL DISSOLVED SOLIDS PLUME SIMULATION IS MODIFIED FROM MODEL LAYER 17 (MURDOCH AND OTHERS, 2019; MODEL OUTPUT PRODUCED OCTOBER 2019).
7. HYDROLOGIC DIVIDE IDENTIFIED IN CSA UPDATE (SYNTERRA, 2018) AND UPDATED GROUNDWATER FLOW AND TRANSPORT MODELING REPORT (MURDOCH AND OTHERS, 2019).
8. THE WATERS OF THE US DELINEATION HAS NOT BEEN APPROVED BY THE US ARMY CORPS OF ENGINEERS AT THE TIME OF THE MAP CREATION. THIS MAP IS NOT TO BE USED FOR JURISDICTIONAL DETERMINATION PURPOSES. THE WETLANDS AND STREAMS BOUNDARIES WERE OBTAINED FROM STREAM AND WETLAND DELINEATION CONDUCTED BY AMEC FOSTER WHEELER ENVIRONMENTAL & INFRASTRUCTURE, INC. NATURAL RESOURCE TECHNICAL REPORT (NRTR) FOR ALLEN STEAM STATION DATED MAY 29, 2015.
9. THE TOPOGRAPHY IS SHOWN FOR REFERENCE PURPOSES ONLY AND SHOULD NOT BE USED FOR DESIGN OR ENGINEERING PURPOSES. TOPOGRAPHY IS BASED ON LIDAR BARE EARTH DATA OBTAINED FROM THE NORTH CAROLINA SPATIAL DATA SITE AT https://sdd.nc.gov/sdd/DataDownload.aspx.
10. ALL BOUNDARIES ARE APPROXIMATE.
11. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.
12. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON OCTOBER 11, 2017. AERIAL WAS COLLECTED ON OCTOBER 8, 2016.
13. DRAWING HAS BEEN SET WITH A PROJECTION OF NORTH CAROLINA STATE PLANE COORDINATE SYSTEM FIPS 3200 (NAD83).

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DRAWN BY: C. DAVIS DATE: 06/12/2019
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CHECKED BY: L. DRAGO DATE: 12/20/2019
PROGRAM MANAGER: C. SUTTELL

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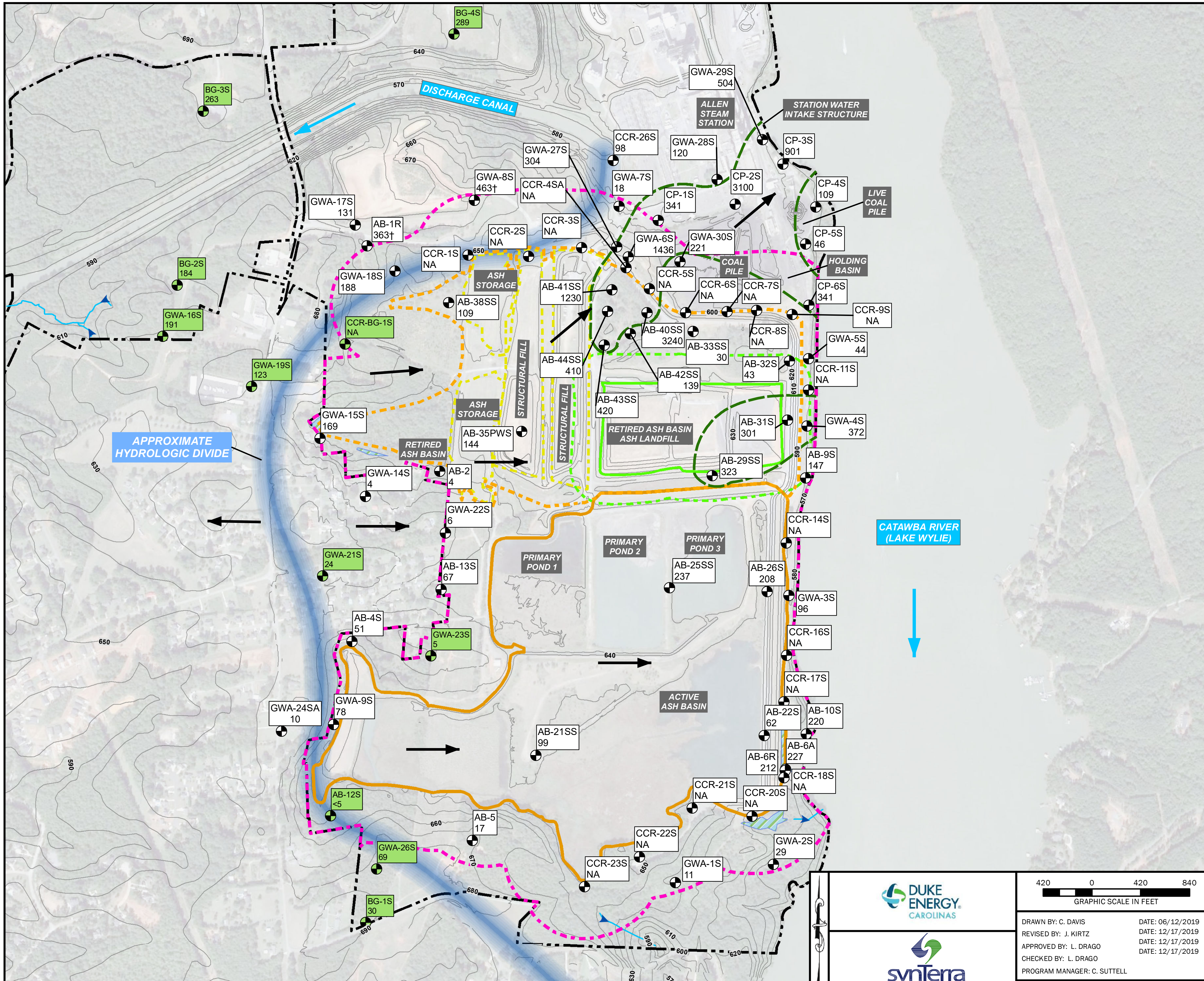
FIGURE 6-21c
ISOCONCENTRATION MAP
TOTAL DISSOLVED SOLIDS
IN BEDROCK FLOW ZONE
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA



LEGEND

- ASSESSMENT MONITORING WELL
- BACKGROUND MONITORING WELL
- STRONTIUM - INFERRED BACKGROUND CONTOUR
- ACTIVE ASH BASIN WASTE BOUNDARY
- ASH BASIN COMPLIANCE BOUNDARY
- RETIRED ASH BASIN WASTE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL WASTE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL COMPLIANCE BOUNDARY
- DORS FILLS BOUNDARIES
- DUKE ENERGY CAROLINAS PROPERTY LINE
- TOPOGRAPHIC CONTOUR (10' INTERVAL)
- STREAM (AMEC NRTR 2015)
- WETLAND (AMEC NRTR 2015)
- APPROXIMATE HYDROLOGIC DIVIDE
- GROUNDWATER FLOW DIRECTION
- SURFACE WATER FLOW DIRECTION

NOTES:

1. DATA INCLUDED IN THIS FIGURE ARE THE MEAN OR GEOMEAN RESULTS FOR WELLS BASED ON THE CENTRAL TENDENCY OF THE DATA SET FROM SAMPLES BETWEEN JANUARY 2018 AND JUNE 2019. FOR WELLS WITH DATASETS CONTAINING FEWER THAN FOUR VALID RESULTS, THE MOST RECENT VALID SAMPLE DATA WAS USED.

2. THE 02L FOR STRONTIUM IS NE.

3. THE BACKGROUND VALUE FOR STRONTIUM IS 300 μg/L (AS SUBMITTED JUNE 2019).

4. NA - NOT AVAILABLE.

5. † - CONCENTRATIONS WITHIN REASONABLE RANGE OF BACKGROUND DATA SET AND/OR NOT REPRESENTATIVE OF PLUME MIGRATION FROM SOURCE AREAS BASED ON MODELED SITE HYDRAULIC CHARACTERISTICS ARE NOT CONTOURED. DOES NOT SUGGEST IMPACT FROM SOURCE AREAS.

6. HYDROLOGIC DIVIDE IDENTIFIED IN CSA UPDATE (SYNTERRA, 2018) AND UPDATED GROUNDWATER FLOW AND TRANSPORT MODELING REPORT (MURDOCH AND OTHERS, 2019).

7. THE WATERS OF THE US DELINEATION HAS NOT BEEN APPROVED BY THE US ARMY CORPS OF ENGINEERS AT THE TIME OF THE MAP CREATION. THIS MAP IS NOT TO BE USED FOR JURISDICTIONAL DETERMINATION PURPOSES. THE WETLANDS AND STREAMS BOUNDARIES WERE OBTAINED FROM STREAM AND WETLAND DELINEATION CONDUCTED BY AMEC FOSTER WHEELER ENVIRONMENTAL & INFRASTRUCTURE, INC. NATURAL RESOURCE TECHNICAL REPORT (NRTR) FOR ALLEN STEAM STATION DATED MAY 29, 2015.

8. THE TOPOGRAPHY IS SHOWN FOR REFERENCE PURPOSES ONLY AND SHOULD NOT BE USED FOR DESIGN OR ENGINEERING PURPOSES. TOPOGRAPHY IS BASED ON LIDAR BARE EARTH DATA OBTAINED FROM THE NORTH CAROLINA SPATIAL DATA SITE AT https://sdd.nc.gov/sdd/DataDownload.aspx.

9. ALL BOUNDARIES ARE APPROXIMATE.

10. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.

11. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON OCTOBER 11, 2017. AERIAL WAS COLLECTED ON OCTOBER 8, 2016.

12. DRAWING HAS BEEN SET WITH A PROJECTION OF NORTH CAROLINA STATE PLANE COORDINATE SYSTEM FIPS 3200 (NAD83).

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420 0 420 840
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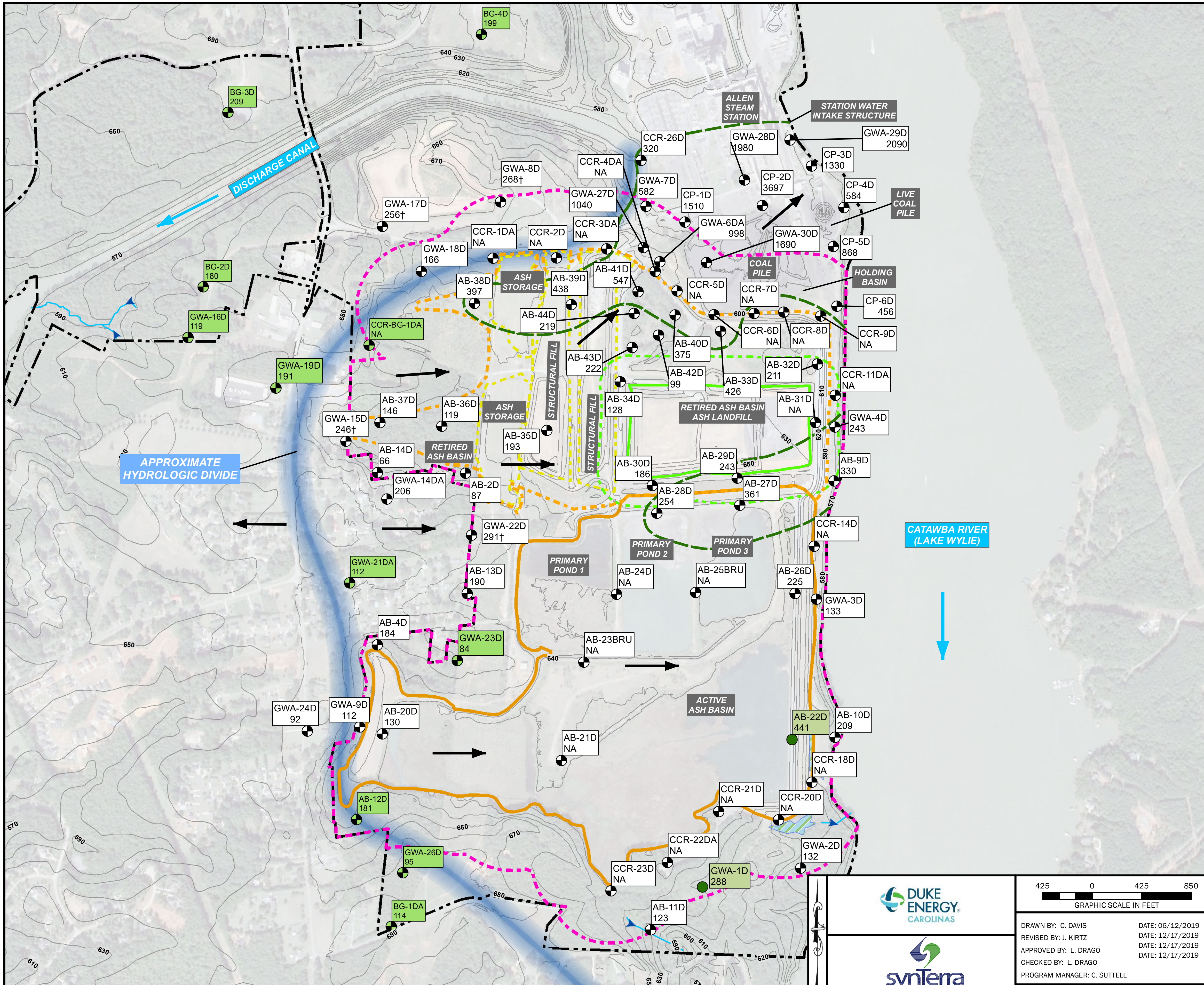
FIGURE 6-22a
ISOCONCENTRATION MAP
STRONTIUM IN SHALLOW FLOW ZONE
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA



LEGEND

- ASSESSMENT MONITORING WELL
- BACKGROUND MONITORING WELL
- ISOLATED EXCEEDANCE OF BACKGROUND
- STRONTIUM - INFERRED BACKGROUND CONTOUR
- ACTIVE ASH BASIN WASTE BOUNDARY
- ASH BASIN COMPLIANCE BOUNDARY
- RETIRED ASH BASIN WASTE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL WASTE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL COMPLIANCE BOUNDARY
- DORS FILLS BOUNDARIES
- DUKE ENERGY CAROLINAS PROPERTY LINE
- TOPOGRAPHIC CONTOUR (10' INTERVAL)
- STREAM (AMEC NRTR 2015)
- WETLAND (AMEC NRTR 2015)
- APPROXIMATE HYDROLOGIC DIVIDE
- GROUNDWATER FLOW DIRECTION
- SURFACE WATER FLOW DIRECTION

NOTES:

1. DATA INCLUDED IN THIS FIGURE ARE THE MEAN OR GEOMEAN RESULTS FOR WELLS BASED ON THE CENTRAL TENDENCY OF THE DATA SET FROM SAMPLES BETWEEN JANUARY 2018 AND JUNE 2019. FOR WELLS WITH DATASETS CONTAINING FEWER THAN FOUR VALID RESULTS, THE MOST RECENT VALID SAMPLE DATA WAS USED.

2. THE 02L FOR STRONTIUM IS NE.

3. THE BACKGROUND VALUE FOR STRONTIUM IS 240 µg/L (AS SUBMITTED JUNE 2019).

4. NA - NOT AVAILABLE.

5. † - CONCENTRATIONS WITHIN REASONABLE RANGE OF BACKGROUND DATA SET AND/OR NOT REPRESENTATIVE OF PLUME MIGRATION FROM SOURCE AREAS BASED ON MODELED SITE HYDRAULIC CHARACTERISTICS ARE NOT CONTOURED. DOES NOT SUGGEST IMPACT FROM SOURCE AREAS.

6. HYDROLOGIC DIVIDE IDENTIFIED IN CSA UPDATE (SYNTERRA, 2018) AND UPDATED GROUNDWATER FLOW AND TRANSPORT MODELING REPORT (MURDOCH AND OTHERS, 2019).

7. THE WATERS OF THE US DELINEATION HAS NOT BEEN APPROVED BY THE US ARMY CORPS OF ENGINEERS AT THE TIME OF THE MAP CREATION. THIS MAP IS NOT TO BE USED FOR JURISDICTIONAL DETERMINATION PURPOSES. THE WETLANDS AND STREAMS BOUNDARIES WERE OBTAINED FROM STREAM AND WETLAND DELINEATION CONDUCTED BY AMEC FOSTER WHEELER ENVIRONMENTAL & INFRASTRUCTURE, INC. NATURAL RESOURCE TECHNICAL REPORT (NRTR) FOR ALLEN STEAM STATION DATED MAY 29, 2015.

8. THE TOPOGRAPHY IS SHOWN FOR REFERENCE PURPOSES ONLY AND SHOULD NOT BE USED FOR DESIGN OR ENGINEERING PURPOSES. TOPOGRAPHY IS BASED ON LIDAR BARE EARTH DATA OBTAINED FROM THE NORTH CAROLINA SPATIAL DATA SITE AT https://sdd.nc.gov/sdd/DataDownload.aspx.

9. ALL BOUNDARIES ARE APPROXIMATE.

10. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.

11. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON OCTOBER 11, 2017. AERIAL WAS COLLECTED ON OCTOBER 8, 2016.

12. DRAWING HAS BEEN SET WITH A PROJECTION OF NORTH CAROLINA STATE PLANE COORDINATE SYSTEM FIPS 3200 (NAD83).

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CHECKED BY: L. DRAGO	DATE: 12/17/2019
PROGRAM MANAGER: C. SUTTELL	

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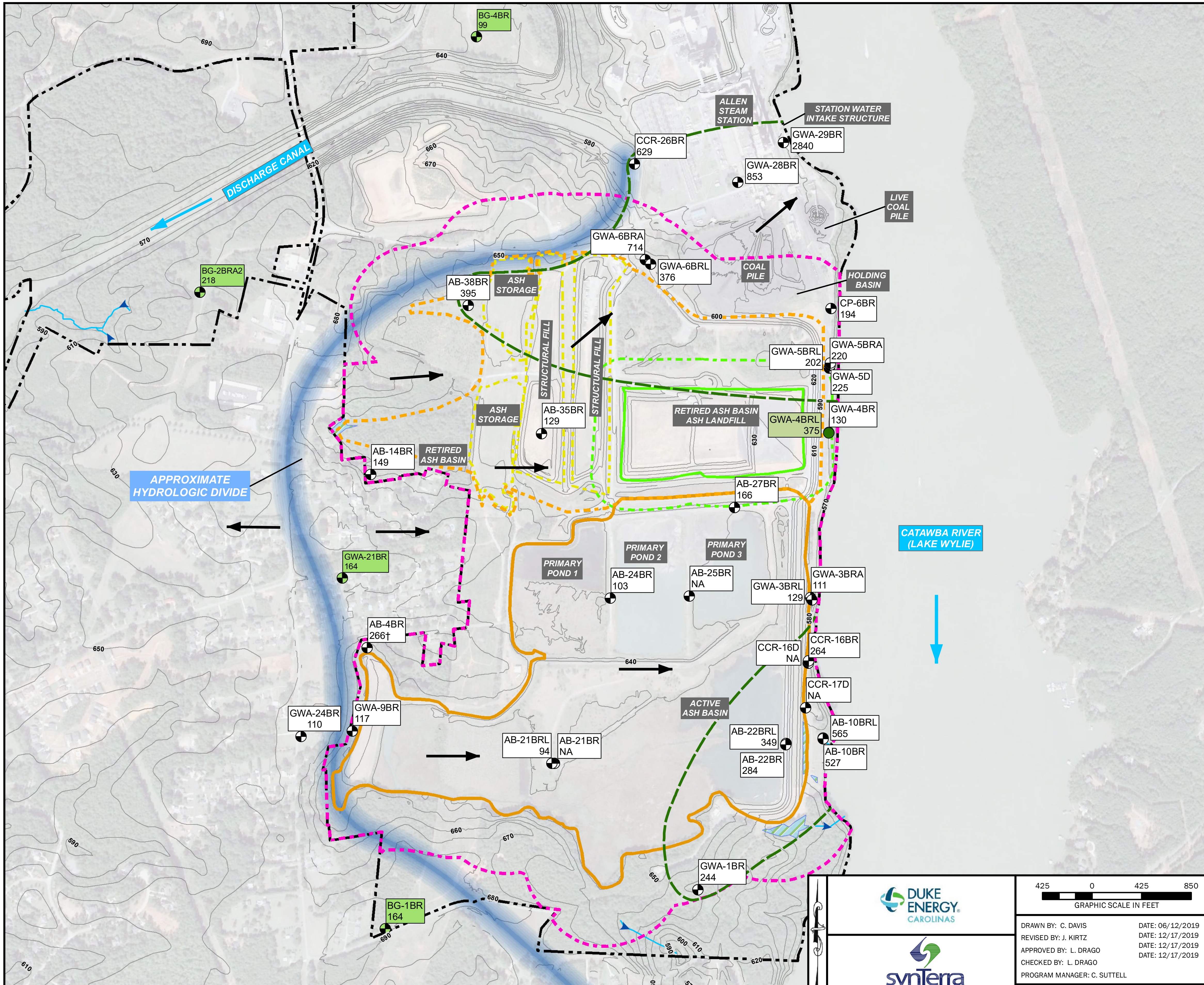
FIGURE 6-22b
ISOCONCENTRATION MAP
STRONTIUM IN DEEP FLOW ZONE
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA



LEGEND

- ASSESSMENT MONITORING WELL
- BACKGROUND MONITORING WELL
- ISOLATED EXCEEDANCE OF BACKGROUND
- STRONTIUM - INFERRED BACKGROUND CONTOUR
- ACTIVE ASH BASIN WASTE BOUNDARY
- ASH BASIN COMPLIANCE BOUNDARY
- RETIRED ASH BASIN WASTE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL WASTE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL COMPLIANCE BOUNDARY
- DORS FILLS BOUNDARIES
- DUKE ENERGY CAROLINAS PROPERTY LINE
- TOPOGRAPHIC CONTOUR (10' INTERVAL)
- STREAM (AMEC NRTR 2015)
- WETLAND (AMEC NRTR 2015)
- APPROXIMATE HYDROLOGIC DIVIDE
- GROUNDWATER FLOW DIRECTION
- SURFACE WATER FLOW DIRECTION

NOTES:

1. DATA INCLUDED IN THIS FIGURE ARE THE MEAN OR GEOMEAN RESULTS FOR WELLS BASED ON THE CENTRAL TENDENCY OF THE DATA SET FROM SAMPLES BETWEEN JANUARY 2018 AND JUNE 2019. FOR WELLS WITH DATASETS CONTAINING FEWER THAN FOUR VALID RESULTS, THE MOST RECENT VALID SAMPLE DATA WAS USED.

2. THE 02L FOR STRONTIUM IS NE.

3. THE BACKGROUND VALUE FOR STRONTIUM IS 181 µg/L (AS SUBMITTED JUNE 2019).

4. NA - NOT AVAILABLE.

5. † - CONCENTRATIONS WITHIN REASONABLE RANGE OF BACKGROUND DATA SET AND/OR NOT REPRESENTATIVE OF PLUME MIGRATION FROM SOURCE AREAS BASED ON MODELED SITE HYDRAULIC CHARACTERISTICS ARE NOT CONTOURED. DOES NOT SUGGEST IMPACT FROM SOURCE AREAS.

6. HYDROLOGIC DIVIDE IDENTIFIED IN CSA UPDATE (SYNTERRA, 2018) AND UPDATED GROUNDWATER FLOW AND TRANSPORT MODELING REPORT (MURDOCH AND OTHERS, 2019).

7. THE WATERS OF THE US DELINEATION HAS NOT BEEN APPROVED BY THE US ARMY CORPS OF ENGINEERS AT THE TIME OF THE MAP CREATION. THIS MAP IS NOT TO BE USED FOR JURISDICTIONAL DETERMINATION PURPOSES. THE WETLANDS AND STREAMS BOUNDARIES WERE OBTAINED FROM STREAM AND WETLAND DELINEATION CONDUCTED BY AMEC FOSTER WHEELER ENVIRONMENTAL & INFRASTRUCTURE, INC. NATURAL RESOURCE TECHNICAL REPORT (NRTR) FOR ALLEN STEAM STATION DATED MAY 29, 2015.

8. THE TOPOGRAPHY IS SHOWN FOR REFERENCE PURPOSES ONLY AND SHOULD NOT BE USED FOR DESIGN OR ENGINEERING PURPOSES. TOPOGRAPHY IS BASED ON LIDAR BARE EARTH DATA OBTAINED FROM THE NORTH CAROLINA SPATIAL DATA SITE AT https://sdd.nc.gov/sdd/DataDownload.aspx.

9. ALL BOUNDARIES ARE APPROXIMATE.

10. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.

11. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON OCTOBER 11, 2017. AERIAL WAS COLLECTED ON OCTOBER 8, 2016.

12. DRAWING HAS BEEN SET WITH A PROJECTION OF NORTH CAROLINA STATE PLANE COORDINATE SYSTEM FIPS 3200 (NAD83).

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CHECKED BY: L. DRAGO	DATE: 12/17/2019
PROGRAM MANAGER: C. SUTTELL	

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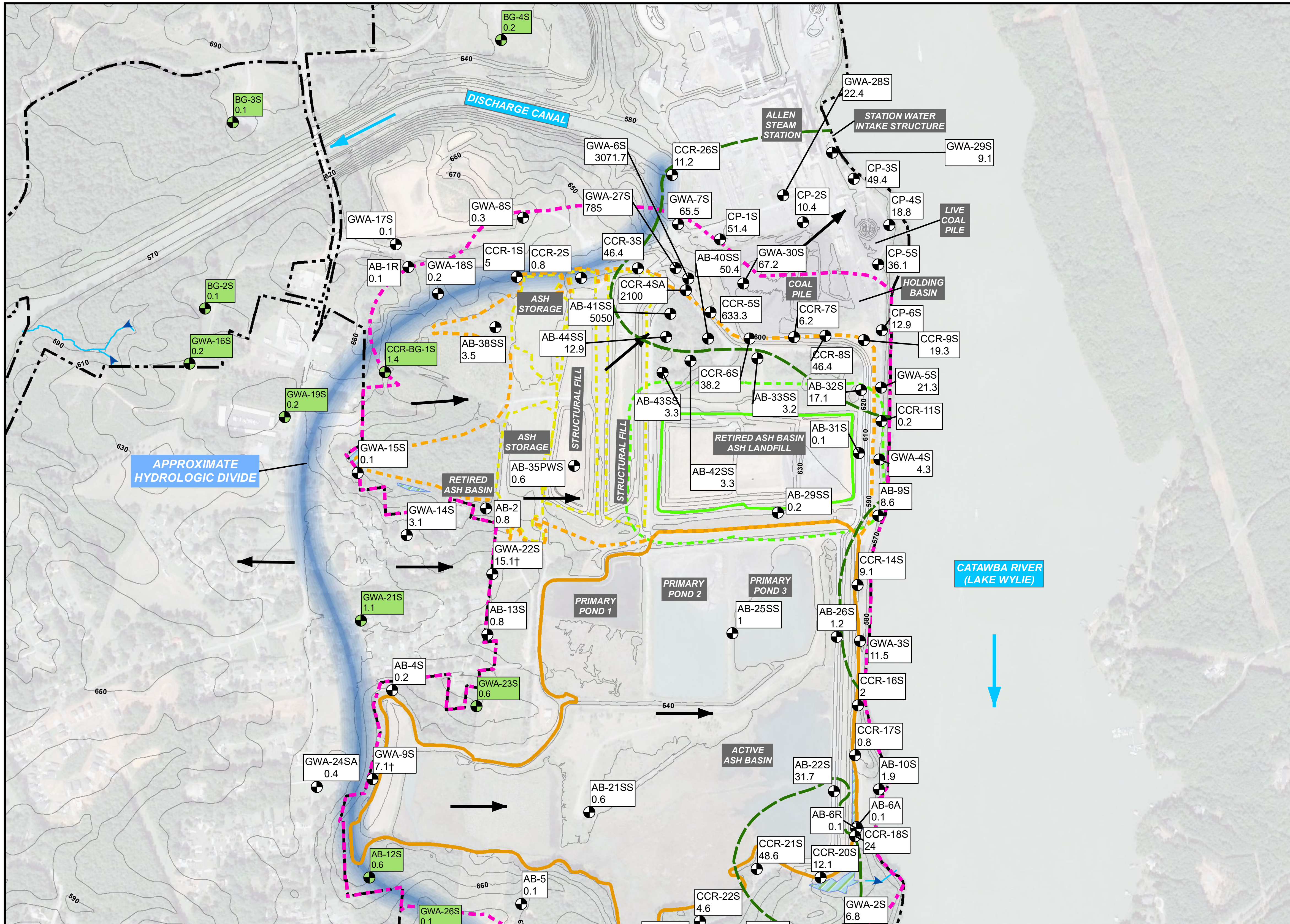
FIGURE 6-22c
ISOCONCENTRATION MAP
STRONTIUM IN BEDROCK FLOW ZONE
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA



LEGEND

- ASSESSMENT MONITORING WELL
- BACKGROUND MONITORING WELL
- COBALT - INFERRED IMAC CONTOUR
- ACTIVE ASH BASIN WASTE BOUNDARY
- ASH BASIN COMPLIANCE BOUNDARY
- RETIRED ASH BASIN WASTE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL WASTE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL COMPLIANCE BOUNDARY
- DORS FILLS BOUNDARIES
- DUKE ENERGY CAROLINAS PROPERTY LINE
- TOPOGRAPHIC CONTOUR (10' INTERVAL)
- STREAM (AMEC NRTR 2015)
- WETLAND (AMEC NRTR 2015)
- APPROXIMATE HYDROLOGIC DIVIDE
- GROUNDWATER FLOW DIRECTION
- SURFACE WATER FLOW DIRECTION

NOTES:

1. DATA INCLUDED IN THIS FIGURE ARE THE MEAN OR GEOMEAN RESULTS FOR WELLS BASED ON THE CENTRAL TENDENCY OF THE DATA SET FROM SAMPLES BETWEEN JANUARY 2018 AND JUNE 2019. FOR WELLS WITH DATASETS CONTAINING FEWER THAN FOUR VALID RESULTS, THE MOST RECENT VALID SAMPLE DATA WAS USED.

2. THE INTERIM MAXIMUM ALLOWABLE CONCENTRATION (IMAC) FOR COBALT IS 1 µg/L.

3. THE BACKGROUND VALUE FOR COBALT IS 5.7 µg/L (AS SUBMITTED JUNE 2019).

4. † - CONCENTRATIONS WITHIN REASONABLE RANGE OF BACKGROUND DATA SET AND/OR NOT REPRESENTATIVE OF PLUME MIGRATION FROM SOURCE AREAS BASED ON MODELED SITE HYDRAULIC CHARACTERISTICS ARE NOT CONTOURED. DOES NOT SUGGEST IMPACT FROM SOURCE AREAS.

5. HYDROLOGIC DIVIDE IDENTIFIED IN CSA UPDATE (SYNTERRA, 2018) AND UPDATED GROUNDWATER FLOW AND TRANSPORT MODELING REPORT (MURDOCH AND OTHERS, 2019).

6. THE WATERS OF THE US DELINEATION HAS NOT BEEN APPROVED BY THE US ARMY CORPS OF ENGINEERS AT THE TIME OF THE MAP CREATION. THIS MAP IS NOT TO BE USED FOR JURISDICTIONAL DETERMINATION PURPOSES. THE WETLANDS AND STREAMS BOUNDARIES WERE OBTAINED FROM STREAM AND WETLAND DELINEATION CONDUCTED BY AMEC FOSTER WHEELER ENVIRONMENTAL & INFRASTRUCTURE, INC. NATURAL RESOURCE TECHNICAL REPORT (NRTR) FOR ALLEN STEAM STATION DATED MAY 29, 2015.

7. THE TOPOGRAPHY IS SHOWN FOR REFERENCE PURPOSES ONLY AND SHOULD NOT BE USED FOR DESIGN OR ENGINEERING PURPOSES. TOPOGRAPHY IS BASED ON LIDAR BARE EARTH DATA OBTAINED FROM THE NORTH CAROLINA SPATIAL DATA SITE AT https://sdd.nc.gov/sdd/DataDownload.aspx.

8. ALL BOUNDARIES ARE APPROXIMATE.

9. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.

10. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON OCTOBER 11, 2017. AERIAL WAS COLLECTED ON OCTOBER 8, 2016.

11. DRAWING HAS BEEN SET WITH A PROJECTION OF NORTH CAROLINA STATE PLANE COORDINATE SYSTEM FIPS 3200 (NAD83).

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REVISED BY: J. KIRTZ DATE: 12/17/2019
APPROVED BY: L. DRAGO DATE: 12/17/2019
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PROGRAM MANAGER: C. SUTTELL

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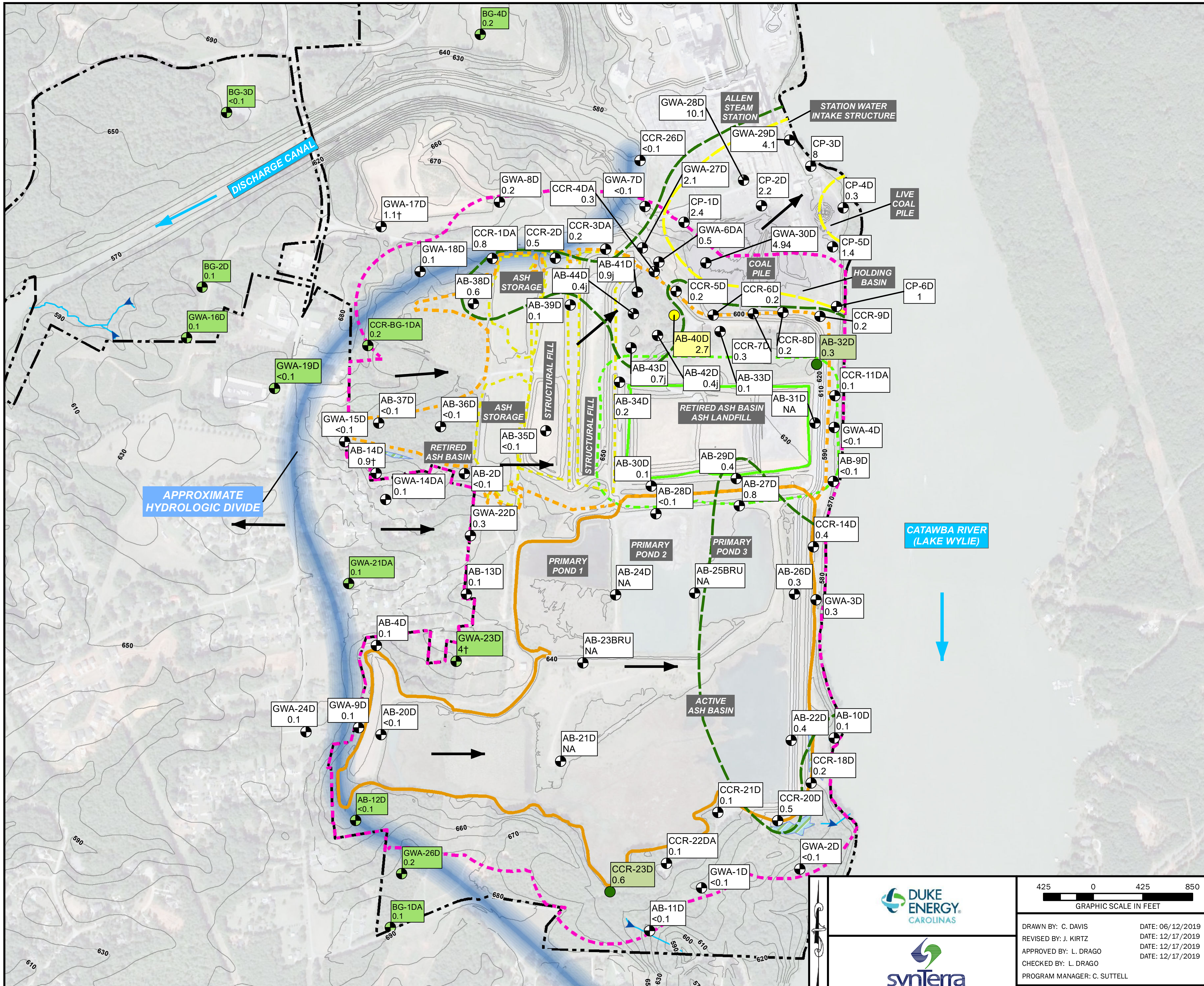
FIGURE 6-23a
ISOCONCENTRATION MAP
COBALT IN SHALLOW FLOW ZONE
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA



LEGEND

- ASSESSMENT MONITORING WELL
- BACKGROUND MONITORING WELL
- ISOLATED EXCEEDANCE OF NC 02L
- ISOLATED EXCEEDANCE OF BACKGROUND
- COBALT - INFERRED NC 02L STANDARD
- COBALT - INFERRED IMAC CONTOUR
- ACTIVE ASH BASIN WASTE BOUNDARY
- ASH BASIN COMPLIANCE BOUNDARY
- RETIRED ASH BASIN WASTE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL WASTE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL COMPLIANCE BOUNDARY
- DORS FILLS BOUNDARIES
- DUKE ENERGY CAROLINAS PROPERTY LINE
- TOPOGRAPHIC CONTOUR (10' INTERVAL)
- STREAM (AMEC NRTR 2015)
- WETLAND (AMEC NRTR 2015)
- APPROXIMATE HYDROLOGIC DIVIDE
- GROUNDWATER FLOW DIRECTION
- SURFACE WATER FLOW DIRECTION

NOTES:

1. DATA INCLUDED IN THIS FIGURE ARE THE MEAN OR GEOMEAN RESULTS FOR WELLS BASED ON THE CENTRAL TENDENCY OF THE DATA SET FROM SAMPLES BETWEEN JANUARY 2018 AND JUNE 2019. FOR WELLS WITH DATASETS CONTAINING FEWER THAN FOUR VALID RESULTS, THE MOST RECENT VALID SAMPLE DATA WAS USED.

2. THE 02L FOR COBALT IS 1 µg/L.

3. THE BACKGROUND VALUE FOR COBALT IS 0.3 µg/L (AS SUBMITTED JUNE 2019).

4. NA - NOT AVAILABLE.

5. † - CONCENTRATIONS WITHIN REASONABLE RANGE OF BACKGROUND DATA SET AND/OR NOT REPRESENTATIVE OF PLUME MIGRATION FROM SOURCE AREAS BASED ON MODELED SITE HYDRAULIC CHARACTERISTICS ARE NOT CONTOURED. DOES NOT SUGGEST IMPACT FROM SOURCE AREAS.

6. HYDROLOGIC DIVIDE IDENTIFIED IN CSA UPDATE (SYNTERRA, 2018) AND UPDATED GROUNDWATER FLOW AND TRANSPORT MODELING REPORT (MURDOCH AND OTHERS, 2019).

7. THE WATERS OF THE US DELINEATION HAS NOT BEEN APPROVED BY THE US ARMY CORPS OF ENGINEERS AT THE TIME OF THE MAP CREATION. THIS MAP IS NOT TO BE USED FOR JURISDICTIONAL DETERMINATION PURPOSES. THE WETLANDS AND STREAMS BOUNDARIES WERE OBTAINED FROM STREAM AND WETLAND DELINEATION CONDUCTED BY AMEC FOSTER WHEELER ENVIRONMENTAL & INFRASTRUCTURE, INC. NATURAL RESOURCE TECHNICAL REPORT (NRTR) FOR ALLEN STEAM STATION DATED MAY 29, 2015.

8. THE TOPOGRAPHY IS SHOWN FOR REFERENCE PURPOSES ONLY AND SHOULD NOT BE USED FOR DESIGN OR ENGINEERING PURPOSES. TOPOGRAPHY IS BASED ON LIDAR BARE EARTH DATA OBTAINED FROM THE NORTH CAROLINA SPATIAL DATA SITE AT https://sdd.nc.gov/sdd/DataDownload.aspx.

9. ALL BOUNDARIES ARE APPROXIMATE.

10. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.

11. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON OCTOBER 11, 2017. AERIAL WAS COLLECTED ON OCTOBER 8, 2016.

12. DRAWING HAS BEEN SET WITH A PROJECTION OF NORTH CAROLINA STATE PLANE COORDINATE SYSTEM FIPS 3200 (NAD83).

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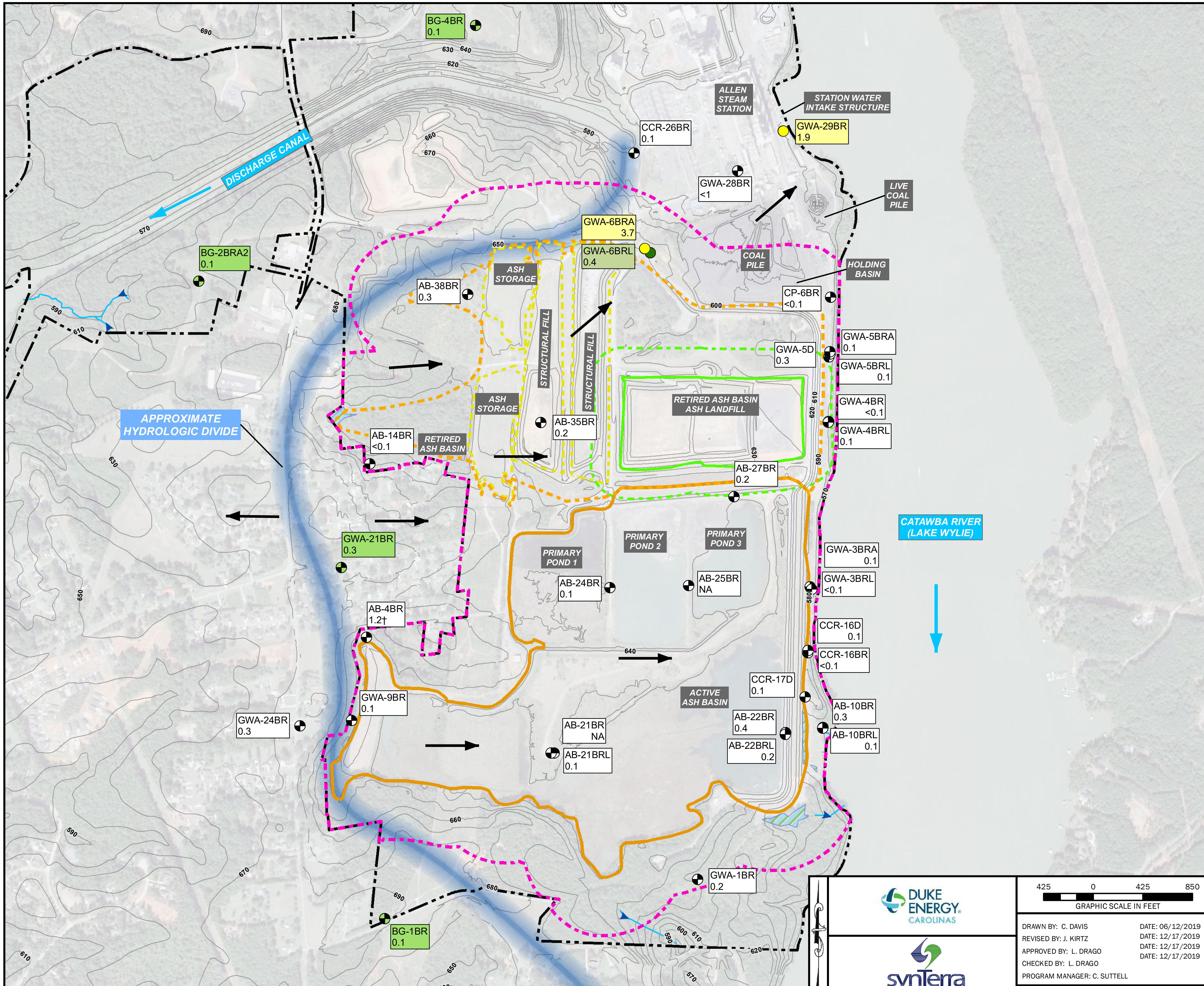
FIGURE 6-23b
ISOCONCENTRATION MAP
COBALT IN DEEP FLOW ZONE
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA



LEGEND

- ASSESSMENT MONITORING WELL
- BACKGROUND MONITORING WELL
- ISOLATED EXCEEDANCE OF NC 02L
- ISOLATED EXCEEDANCE OF BACKGROUND
- COBALT - INFERRED NC 02L STANDARD
- COBALT - INFERRED IMAC CONTOUR
- ACTIVE ASH BASIN WASTE BOUNDARY
- ASH BASIN COMPLIANCE BOUNDARY
- RETIRED ASH BASIN WASTE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL WASTE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL COMPLIANCE BOUNDARY
- DORS FILLS BOUNDARIES
- DUKE ENERGY CAROLINAS PROPERTY LINE
- TOPOGRAPHIC CONTOUR (10' INTERVAL)
- STREAM (AMEC NRTR 2015)
- WETLAND (AMEC NRTR 2015)
- APPROXIMATE HYDROLOGIC DIVIDE
- GROUNDWATER FLOW DIRECTION
- SURFACE WATER FLOW DIRECTION

NOTES:

1. DATA INCLUDED IN THIS FIGURE ARE THE MEAN OR GEOMEAN RESULTS FOR WELLS BASED ON THE CENTRAL TENDENCY OF THE DATA SET FROM SAMPLES BETWEEN JANUARY 2018 AND JUNE 2019. FOR WELLS WITH DATASETS CONTAINING FEWER THAN FOUR VALID RESULTS, THE MOST RECENT VALID SAMPLE DATA WAS USED.

2. THE 02L FOR COBALT IS 1 µg/L.

3. THE BACKGROUND VALUE FOR COBALT IS 0.348 µg/L (AS SUBMITTED JUNE 2019).

4. NA - NOT AVAILABLE.

5. † - CONCENTRATIONS WITHIN REASONABLE RANGE OF BACKGROUND DATA SET AND/OR NOT REPRESENTATIVE OF PLUME MIGRATION FROM SOURCE AREAS BASED ON MODELED SITE HYDRAULIC CHARACTERISTICS ARE NOT CONTOURED. DOES NOT SUGGEST IMPACT FROM SOURCE AREAS.

6. HYDROLOGIC DIVIDE IDENTIFIED IN CSA UPDATE (SYNTERRA, 2018) AND UPDATED GROUNDWATER FLOW AND TRANSPORT MODELING REPORT (MURDOCH AND OTHERS, 2019).

7. THE WATERS OF THE US DELINEATION HAS NOT BEEN APPROVED BY THE US ARMY CORPS OF ENGINEERS AT THE TIME OF THE MAP CREATION. THIS MAP IS NOT TO BE USED FOR JURISDICTIONAL DETERMINATION PURPOSES. THE WETLANDS AND STREAMS BOUNDARIES WERE OBTAINED FROM STREAM AND WETLAND DELINEATION CONDUCTED BY AMEC FOSTER WHEELER ENVIRONMENTAL & INFRASTRUCTURE, INC. NATURAL RESOURCE TECHNICAL REPORT (NRTR) FOR ALLEN STEAM STATION DATED MAY 29, 2015.

8. THE TOPOGRAPHY IS SHOWN FOR REFERENCE PURPOSES ONLY AND SHOULD NOT BE USED FOR DESIGN OR ENGINEERING PURPOSES. TOPOGRAPHY IS BASED ON LIDAR BARE EARTH DATA OBTAINED FROM THE NORTH CAROLINA SPATIAL DATA SITE AT https://sdd.nc.gov/sdd/DataDownload.aspx.

9. ALL BOUNDARIES ARE APPROXIMATE.

10. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.

11. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON OCTOBER 11, 2017. AERIAL WAS COLLECTED ON OCTOBER 8, 2016.

12. DRAWING HAS BEEN SET WITH A PROJECTION OF NORTH CAROLINA STATE PLANE COORDINATE SYSTEM FIPS 3200 (NAD83).

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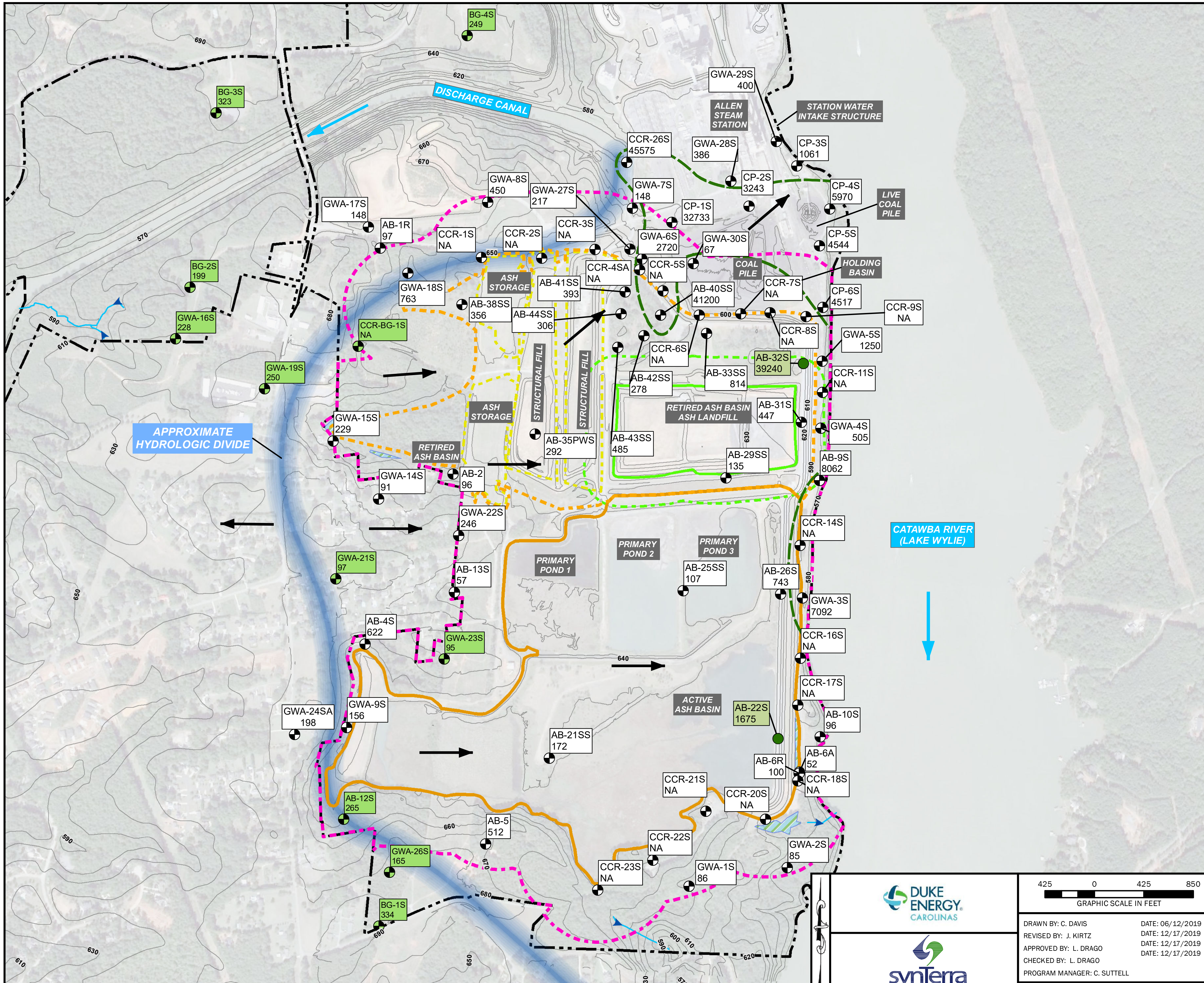
FIGURE 6-23c
ISOCONCENTRATION MAP
COBALT IN BEDROCK FLOW ZONE
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA



LEGEND

- ASSESSMENT MONITORING WELL
- BACKGROUND MONITORING WELL
- ISOLATED EXCEEDANCE OF BACKGROUND
- IRON - INFERRED BACKGROUND CONTOUR
- ACTIVE ASH BASIN WASTE BOUNDARY
- ASH BASIN COMPLIANCE BOUNDARY
- RETIRED ASH BASIN WASTE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL WASTE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL COMPLIANCE BOUNDARY
- DORS FILLS BOUNDARIES
- DUKE ENERGY CAROLINAS PROPERTY LINE
- TOPOGRAPHIC CONTOUR (10' INTERVAL)
- STREAM (AMEC NRTR 2015)
- WETLAND (AMEC NRTR 2015)
- APPROXIMATE HYDROLOGIC DIVIDE
- GROUNDWATER FLOW DIRECTION
- SURFACE WATER FLOW DIRECTION

NOTES:

1. DATA INCLUDED IN THIS FIGURE ARE THE MEAN OR GEOMEAN RESULTS FOR WELLS BASED ON THE CENTRAL TENDENCY OF THE DATA SET FROM SAMPLES BETWEEN JANUARY 2018 AND JUNE 2019. FOR WELLS WITH DATASETS CONTAINING FEWER THAN FOUR VALID RESULTS, THE MOST RECENT VALID SAMPLE DATA WAS USED.

2. THE 02L FOR IRON IS 300 µg/L.

3. THE BACKGROUND VALUE FOR IRON IS 1422 µg/L (AS SUBMITTED JUNE 2019).

4. NA - NOT AVAILABLE.

5. HYDROLOGIC DIVIDE IDENTIFIED IN CSA UPDATE (SYNTERRA, 2018) AND UPDATED GROUNDWATER FLOW AND TRANSPORT MODELING REPORT (MURDOCH AND OTHERS, 2019).

6. THE WATERS OF THE US DELINEATION HAS NOT BEEN APPROVED BY THE US ARMY CORPS OF ENGINEERS AT THE TIME OF THE MAP CREATION. THIS MAP IS NOT TO BE USED FOR JURISDICTIONAL DETERMINATION PURPOSES. THE WETLANDS AND STREAMS BOUNDARIES WERE OBTAINED FROM STREAM AND WETLAND DELINEATION CONDUCTED BY AMEC FOSTER WHEELER ENVIRONMENTAL & INFRASTRUCTURE, INC. NATURAL RESOURCE TECHNICAL REPORT (NRTR) FOR ALLEN STEAM STATION DATED MAY 29, 2015.

7. THE TOPOGRAPHY IS SHOWN FOR REFERENCE PURPOSES ONLY AND SHOULD NOT BE USED FOR DESIGN OR ENGINEERING PURPOSES. TOPOGRAPHY IS BASED ON LIDAR BARE EARTH DATA OBTAINED FROM THE NORTH CAROLINA SPATIAL DATA SITE AT https://sdd.nc.gov/sdd/DataDownload.aspx.

8. ALL BOUNDARIES ARE APPROXIMATE.

9. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.

10. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON OCTOBER 11, 2017. AERIAL WAS COLLECTED ON OCTOBER 8, 2016.

11. DRAWING HAS BEEN SET WITH A PROJECTION OF NORTH CAROLINA STATE PLANE COORDINATE SYSTEM FIPS 3200 (NAD83).

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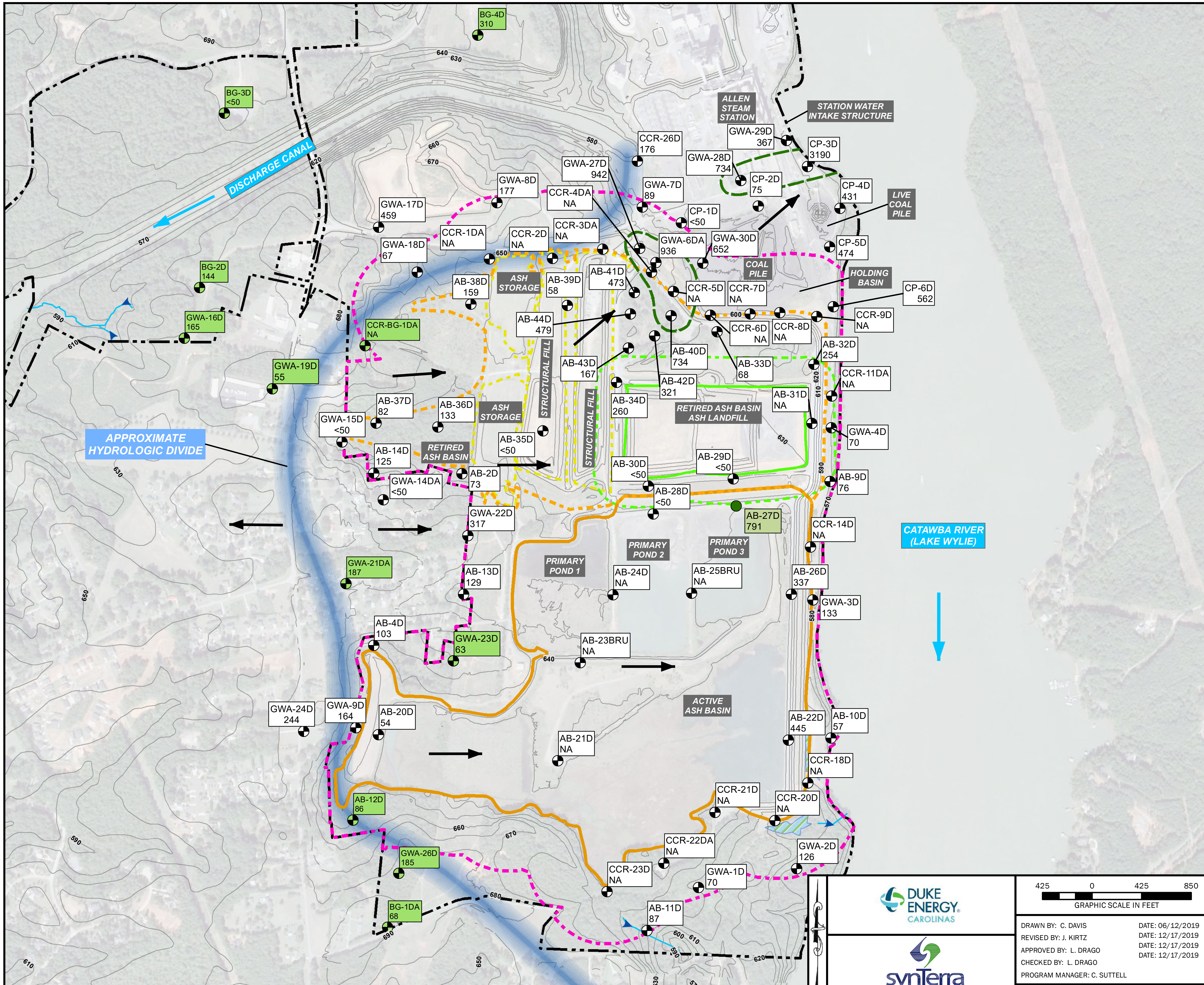
FIGURE 6-24a
ISOCONCENTRATION MAP
IRON IN SHALLOW FLOW ZONE
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA



LEGEND

- ASSESSMENT MONITORING WELL
- BACKGROUND MONITORING WELL
- ISOLATED EXCEEDANCE OF BACKGROUND
- IRON - INFERRED BACKGROUND CONTOUR
- ACTIVE ASH BASIN WASTE BOUNDARY
- ASH BASIN COMPLIANCE BOUNDARY
- RETIRED ASH BASIN WASTE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL WASTE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL COMPLIANCE BOUNDARY
- DORS FILLS BOUNDARIES
- DUKE ENERGY CAROLINAS PROPERTY LINE
- TOPOGRAPHIC CONTOUR (10' INTERVAL)
- STREAM (AMEC NRTR 2015)
- WETLAND (AMEC NRTR 2015)
- APPROXIMATE HYDROLOGIC DIVIDE
- GROUNDWATER FLOW DIRECTION
- SURFACE WATER FLOW DIRECTION

NOTES:

1. DATA INCLUDED IN THIS FIGURE ARE THE MEAN OR GEOMEAN RESULTS FOR WELLS BASED ON THE CENTRAL TENDENCY OF THE DATA SET FROM SAMPLES BETWEEN JANUARY 2018 AND JUNE 2019. FOR WELLS WITH DATASETS CONTAINING FEWER THAN FOUR VALID RESULTS, THE MOST RECENT VALID SAMPLE DATA WAS USED.

2. THE 02L FOR IRON IS 300 µg/L.

3. THE BACKGROUND VALUE FOR IRON IS 665 µg/L (AS SUBMITTED JUNE 2019).

4. NA - NOT AVAILABLE.

5. HYDROLOGIC DIVIDE IDENTIFIED IN CSA UPDATE (SYNTERRA, 2018) AND UPDATED GROUNDWATER FLOW AND TRANSPORT MODELING REPORT (MURDOCH AND OTHERS, 2019).

6. THE WATERS OF THE US DELINEATION HAS NOT BEEN APPROVED BY THE US ARMY CORPS OF ENGINEERS AT THE TIME OF THE MAP CREATION. THIS MAP IS NOT TO BE USED FOR JURISDICTIONAL DETERMINATION PURPOSES. THE WETLANDS AND STREAMS BOUNDARIES WERE OBTAINED FROM STREAM AND WETLAND DELINEATION CONDUCTED BY AMEC FOSTER WHEELER ENVIRONMENTAL & INFRASTRUCTURE, INC. NATURAL RESOURCE TECHNICAL REPORT (NRTR) FOR ALLEN STEAM STATION DATED MAY 29, 2015.

7. THE TOPOGRAPHY IS SHOWN FOR REFERENCE PURPOSES ONLY AND SHOULD NOT BE USED FOR DESIGN OR ENGINEERING PURPOSES. TOPOGRAPHY IS BASED ON LIDAR BARE EARTH DATA OBTAINED FROM THE NORTH CAROLINA SPATIAL DATA SITE AT https://sdd.nc.gov/sdd/DataDownload.aspx.

8. ALL BOUNDARIES ARE APPROXIMATE.

9. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.

10. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON OCTOBER 11, 2017. AERIAL WAS COLLECTED ON OCTOBER 8, 2016.

11. DRAWING HAS BEEN SET WITH A PROJECTION OF NORTH CAROLINA STATE PLANE COORDINATE SYSTEM FIPS 3200 (NAD83).

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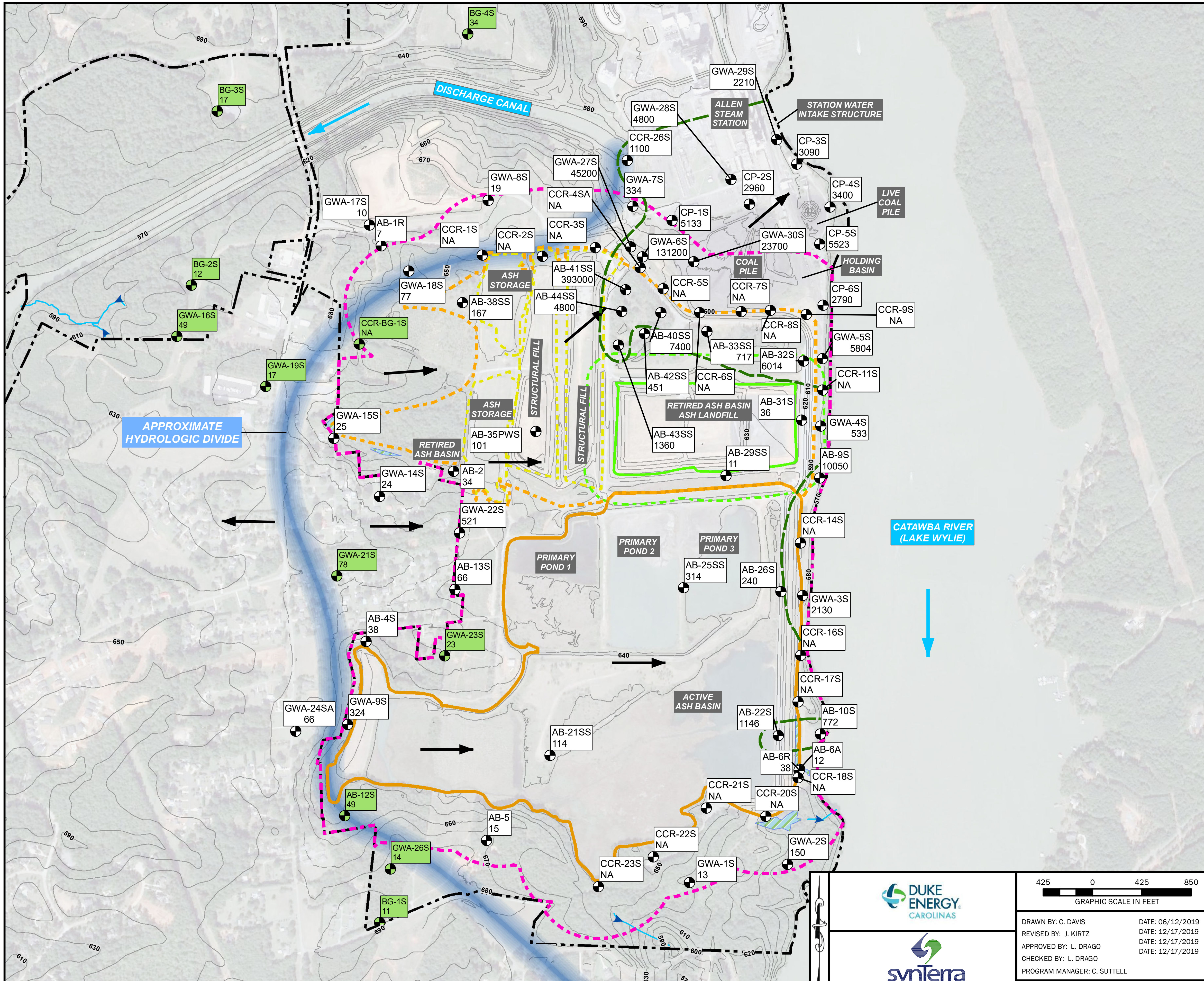
FIGURE 6-24b
ISOCONCENTRATION MAP
IRON IN DEEP FLOW ZONE
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA



LEGEND

- ASSESSMENT MONITORING WELL
- BACKGROUND MONITORING WELL
- MANGANESE - INFERRED BACKGROUND CONTOUR
- ACTIVE ASH BASIN WASTE BOUNDARY
- ASH BASIN COMPLIANCE BOUNDARY
- RETIRED ASH BASIN WASTE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL WASTE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL COMPLIANCE BOUNDARY
- DORS FILLS BOUNDARIES
- DUKE ENERGY CAROLINAS PROPERTY LINE
- TOPOGRAPHIC CONTOUR (10' INTERVAL)
- STREAM (AMEC NRTR 2015)
- WETLAND (AMEC NRTR 2015)
- APPROXIMATE HYDROLOGIC DIVIDE
- GROUNDWATER FLOW DIRECTION
- SURFACE WATER FLOW DIRECTION

NOTES:

1. DATA INCLUDED IN THIS FIGURE ARE THE MEAN OR GEOMEAN RESULTS FOR WELLS BASED ON THE CENTRAL TENDENCY OF THE DATA SET FROM SAMPLES BETWEEN JANUARY 2018 AND JUNE 2019. FOR WELLS WITH DATASETS CONTAINING FEWER THAN FOUR VALID RESULTS, THE MOST RECENT VALID SAMPLE DATA WAS USED.
2. THE 02L FOR MANGANESE IS 50 µg/L.
3. THE BACKGROUND VALUE FOR MANGANESE IS 608 µg/L (AS SUBMITTED JUNE 2019).
4. NA - NOT AVAILABLE.
5. HYDROLOGIC DIVIDE IDENTIFIED IN CSA UPDATE (SYNTERRA, 2018) AND UPDATED GROUNDWATER FLOW AND TRANSPORT MODELING REPORT (MURDOCH AND OTHERS, 2019).
6. THE WATERS OF THE US DELINEATION HAS NOT BEEN APPROVED BY THE US ARMY CORPS OF ENGINEERS AT THE TIME OF THE MAP CREATION. THIS MAP IS NOT TO BE USED FOR JURISDICTIONAL DETERMINATION PURPOSES. THE WETLANDS AND STREAMS BOUNDARIES WERE OBTAINED FROM STREAM AND WETLAND DELINEATION CONDUCTED BY AMEC FOSTER WHEELER ENVIRONMENTAL & INFRASTRUCTURE, INC. NATURAL RESOURCE TECHNICAL REPORT (NRTR) FOR ALLEN STEAM STATION DATED MAY 29, 2015.
7. THE TOPOGRAPHY IS SHOWN FOR REFERENCE PURPOSES ONLY AND SHOULD NOT BE USED FOR DESIGN OR ENGINEERING PURPOSES. TOPOGRAPHY IS BASED ON LIDAR BARE EARTH DATA OBTAINED FROM THE NORTH CAROLINA SPATIAL DATA SITE AT https://sdd.nc.gov/sdd/DataDownload.aspx.
8. ALL BOUNDARIES ARE APPROXIMATE.
9. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.
10. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON OCTOBER 11, 2017. AERIAL WAS COLLECTED ON OCTOBER 8, 2016.
11. DRAWING HAS BEEN SET WITH A PROJECTION OF NORTH CAROLINA STATE PLANE COORDINATE SYSTEM FIPS 3200 (NAD83).

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CHECKED BY: L. DRAGO DATE: 12/17/2019
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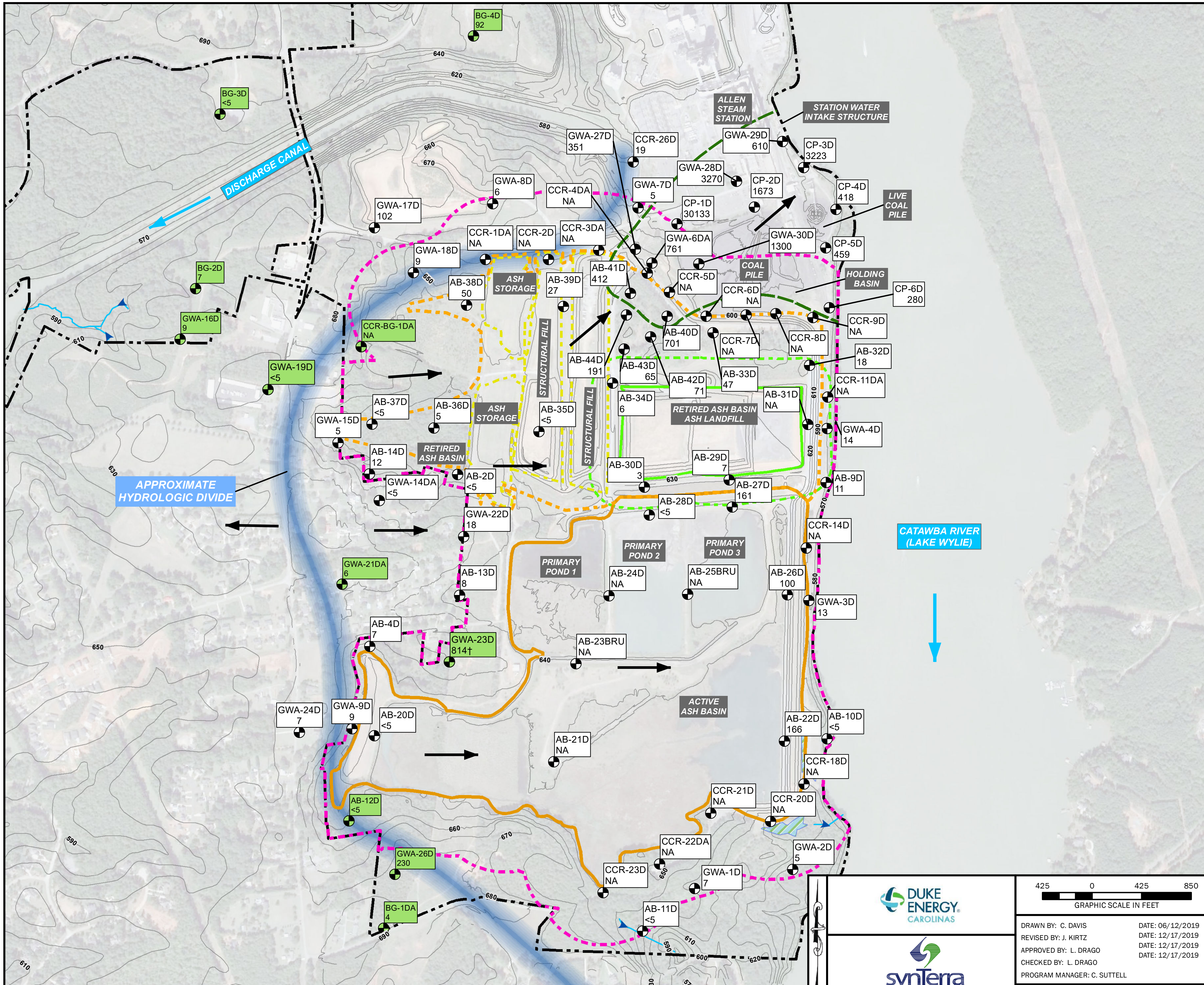
FIGURE 6-25a
ISOCONCENTRATION MAP
MANGANESE IN SHALLOW FLOW ZONE
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA



LEGEND

- ASSESSMENT MONITORING WELL
- BACKGROUND MONITORING WELL
- MANGANESE - INFERRED BACKGROUND CONTOUR
- ACTIVE ASH BASIN WASTE BOUNDARY
- ASH BASIN COMPLIANCE BOUNDARY
- RETIRED ASH BASIN WASTE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL WASTE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL COMPLIANCE BOUNDARY
- DORS FILLS BOUNDARIES
- DUKE ENERGY CAROLINAS PROPERTY LINE
- TOPOGRAPHIC CONTOUR (10' INTERVAL)
- STREAM (AMEC NRTR 2015)
- WETLAND (AMEC NRTR 2015)
- APPROXIMATE HYDROLOGIC DIVIDE
- GROUNDWATER FLOW DIRECTION
- SURFACE WATER FLOW DIRECTION

NOTES:

1. DATA INCLUDED IN THIS FIGURE ARE THE MEAN OR GEOMEAN RESULTS FOR WELLS BASED ON THE CENTRAL TENDENCY OF THE DATA SET FROM SAMPLES BETWEEN JANUARY 2018 AND JUNE 2019. FOR WELLS WITH DATASETS CONTAINING FEWER THAN FOUR VALID RESULTS, THE MOST RECENT VALID SAMPLE DATA WAS USED.
2. THE 02L FOR MANGANESE IS 50 µg/L.
3. THE BACKGROUND VALUE FOR IRON IS 256 µg/L (AS SUBMITTED JUNE 2019).
4. NA - NOT AVAILABLE.
5. HYDROLOGIC DIVIDE IDENTIFIED IN CSA UPDATE (SYNTERRA, 2018) AND UPDATED GROUNDWATER FLOW AND TRANSPORT MODELING REPORT (MURDOCH AND OTHERS, 2019).
6. THE WATERS OF THE US DELINEATION HAS NOT BEEN APPROVED BY THE US ARMY CORPS OF ENGINEERS AT THE TIME OF THE MAP CREATION. THIS MAP IS NOT TO BE USED FOR JURISDICTIONAL DETERMINATION PURPOSES. THE WETLANDS AND STREAMS BOUNDARIES WERE OBTAINED FROM STREAM AND WETLAND DELINEATION CONDUCTED BY AMEC FOSTER WHEELER ENVIRONMENTAL & INFRASTRUCTURE, INC. NATURAL RESOURCE TECHNICAL REPORT (NRTR) FOR ALLEN STEAM STATION DATED MAY 29, 2015.
7. THE TOPOGRAPHY IS SHOWN FOR REFERENCE PURPOSES ONLY AND SHOULD NOT BE USED FOR DESIGN OR ENGINEERING PURPOSES. TOPOGRAPHY IS BASED ON LIDAR BARE EARTH DATA OBTAINED FROM THE NORTH CAROLINA SPATIAL DATA SITE AT https://sdd.nc.gov/sdd/DataDownload.aspx.
8. ALL BOUNDARIES ARE APPROXIMATE.
9. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.
10. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON OCTOBER 11, 2017. AERIAL WAS COLLECTED ON OCTOBER 8, 2016.
11. DRAWING HAS BEEN SET WITH A PROJECTION OF NORTH CAROLINA STATE PLANE COORDINATE SYSTEM FIPS 3200 (NAD83).

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CHECKED BY: L. DRAGO	DATE: 12/17/2019
PROGRAM MANAGER: C. SUTTELL	

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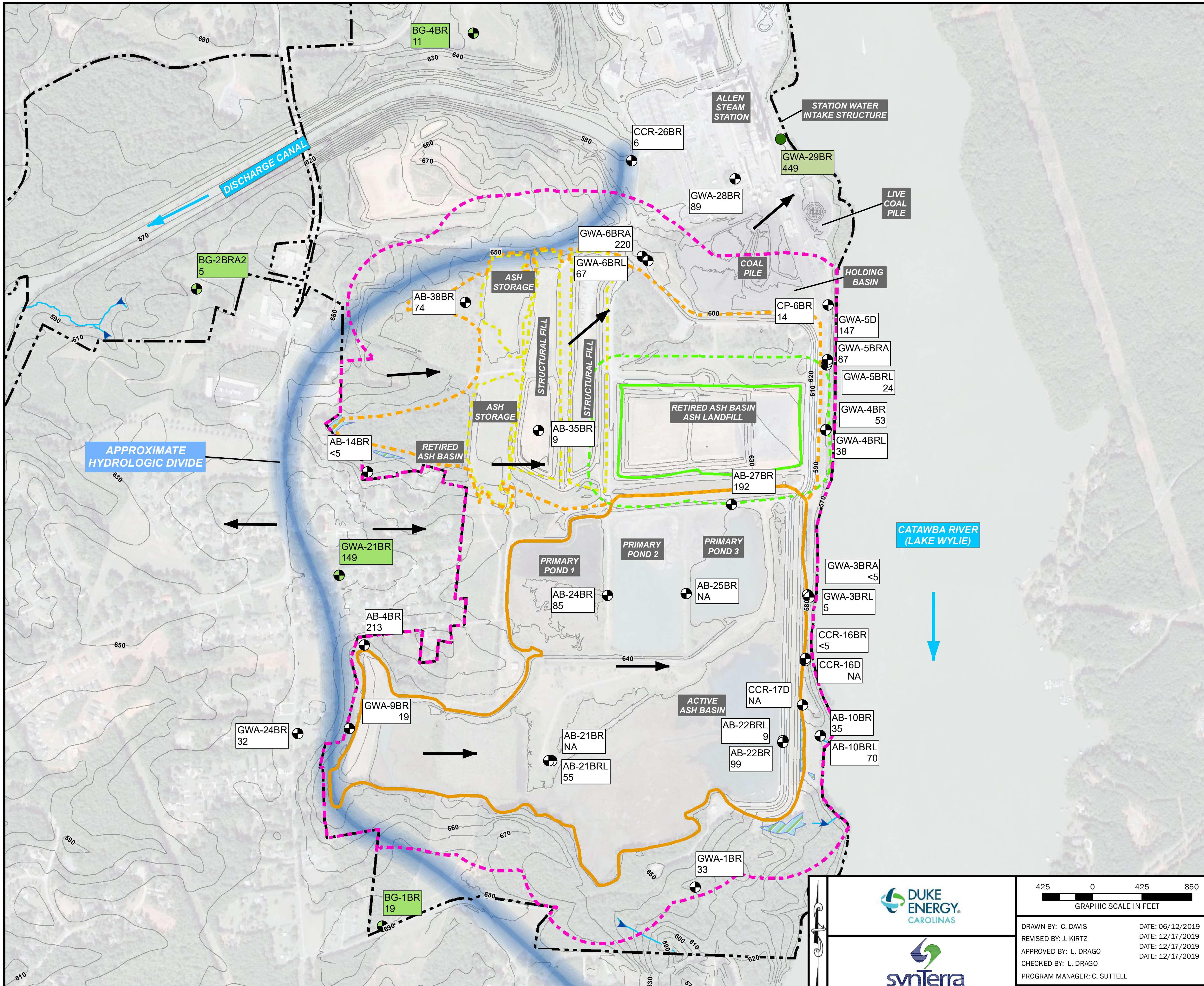
FIGURE 6-25b
ISOCONCENTRATION MAP
MANGANESE IN DEEP FLOW ZONE
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA



LEGEND

- ASSESSMENT MONITORING WELL
- BACKGROUND MONITORING WELL
- ISOLATED EXCEEDANCE OF BACKGROUND
- MANGANESE - INFERRED BACKGROUND CONTOUR
- ACTIVE ASH BASIN WASTE BOUNDARY
- ASH BASIN COMPLIANCE BOUNDARY
- RETIRED ASH BASIN WASTE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL WASTE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL COMPLIANCE BOUNDARY
- DORS FILLS BOUNDARIES
- DUKE ENERGY CAROLINAS PROPERTY LINE
- TOPOGRAPHIC CONTOUR (10' INTERVAL)
- STREAM (AMEC NRTR 2015)
- WETLAND (AMEC NRTR 2015)
- APPROXIMATE HYDROLOGIC DIVIDE
- GROUNDWATER FLOW DIRECTION
- SURFACE WATER FLOW DIRECTION

NOTES:

1. DATA INCLUDED IN THIS FIGURE ARE THE MEAN OR GEOMEAN RESULTS FOR WELLS BASED ON THE CENTRAL TENDENCY OF THE DATA SET FROM SAMPLES BETWEEN JANUARY 2018 AND JUNE 2019. FOR WELLS WITH DATASETS CONTAINING FEWER THAN FOUR VALID RESULTS, THE MOST RECENT VALID SAMPLE DATA WAS USED.

2. THE 02L FOR MANGANESE IS 50 μg/L.

3. THE BACKGROUND VALUE FOR MANGANESE IS 360.3 μg/L (AS SUBMITTTED JUNE 2019).

4. NA - NOT AVAILABLE.

5. HYDROLOGIC DIVIDE IDENTIFIED IN CSA UPDATE (SYNTERRA, 2018) AND UPDATED GROUNDWATER FLOW AND TRANSPORT MODELING REPORT (MURDOCH AND OTHERS, 2019).

6. THE WATERS OF THE US DELINEATION HAS NOT BEEN APPROVED BY THE US ARMY CORPS OF ENGINEERS AT THE TIME OF THE MAP CREATION. THIS MAP IS NOT TO BE USED FOR JURISDICTIONAL DETERMINATION PURPOSES. THE WETLANDS AND STREAMS BOUNDARIES WERE OBTAINED FROM STREAM AND WETLAND DELINEATION CONDUCTED BY AMEC FOSTER WHEELER ENVIRONMENTAL & INFRASTRUCTURE, INC. NATURAL RESOURCE TECHNICAL REPORT (NRTR) FOR ALLEN STEAM STATION DATED MAY 29, 2015.

7. THE TOPOGRAPHY IS SHOWN FOR REFERENCE PURPOSES ONLY AND SHOULD NOT BE USED FOR DESIGN OR ENGINEERING PURPOSES. TOPOGRAPHY IS BASED ON LIDAR BARE EARTH DATA OBTAINED FROM THE NORTH CAROLINA SPATIAL DATA SITE AT https://sdd.nc.gov/sdd/DataDownload.aspx.

8. ALL BOUNDARIES ARE APPROXIMATE.

9. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.

10. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON OCTOBER 11, 2017. AERIAL WAS COLLECTED ON OCTOBER 8, 2016.

11. DRAWING HAS BEEN SET WITH A PROJECTION OF NORTH CAROLINA STATE PLANE COORDINATE SYSTEM FIPS 3200 (NAD83).

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APPROVED BY: L. DRAGO	DATE: 12/17/2019
CHECKED BY: L. DRAGO	DATE: 12/17/2019
PROGRAM MANAGER: C. SUTTELL	

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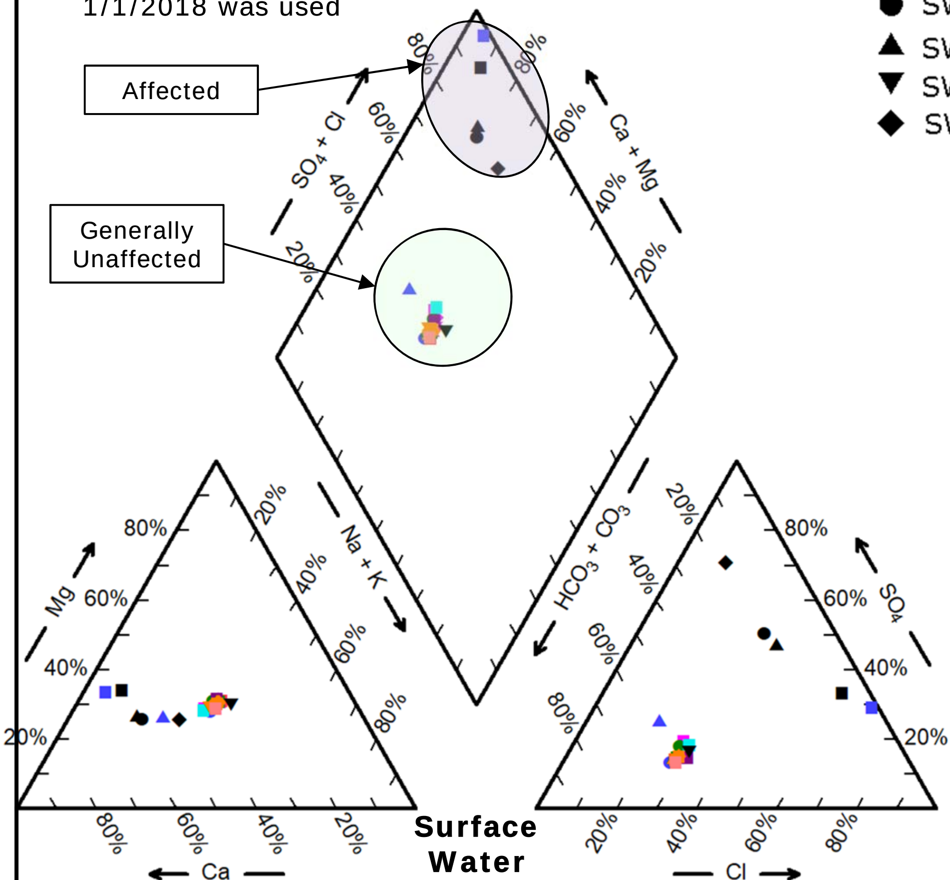
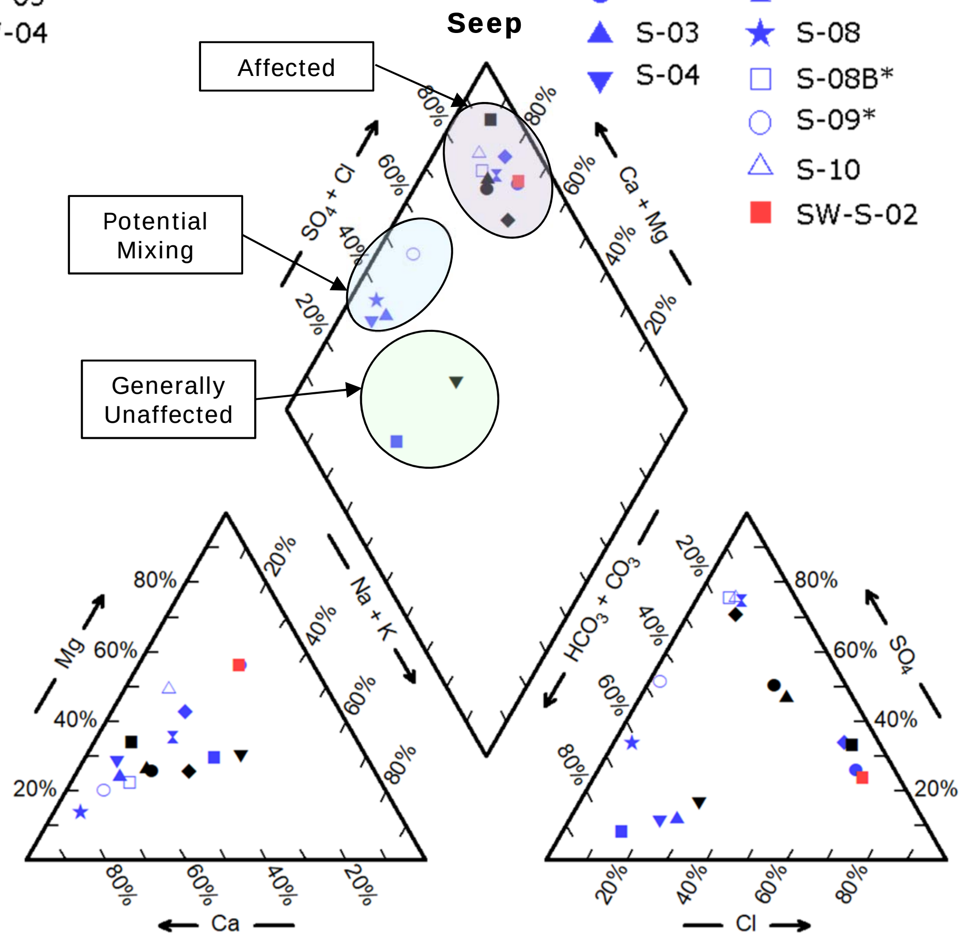
FIGURE 6-25c
ISOCONCENTRATION MAP
MANGANESE IN BEDROCK FLOW ZONE
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA

Notes:
1. See **Figure 1-2** for all seep and surface water sampling locations
2. * indicates a sampling event prior to 1/1/2018 was used



Source Water Legend
- Active Ponded 1*
- SW-01
- SW-02
- SW-03
- SW-04



Seep Legend
- S-01*
- S-02
- S-03
- S-04
- S-05*
- S-07*
- S-08
- S-08B*
- S-09*
- S-10
- SW-S-02

Surface Water Legend
- SW-05*
- SW-06
- SW-07
- SW-AB-01
- SW-AB-02
- SW-AB-03
- SW-AB-04
- SW-AB-05
- SW-AB-07
- SW-BG-01
- SW-BG-02
- SW-BG-03
- SW-CP-01
- SW-CP-02
- SW-CP-03
- SW-D1
- SW-DG-02
- SW-IAB-01
- SW-IAB-02
- SW-IAB-03
- SW-IAB-04
- SW-IAB-05
- SW-U1

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FIGURE 6-26
SEEP AND SURFACE WATER PIPER DIAGRAMS
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA

Figure 6-27

Pourbaix Diagram for Iron-Water System

Included in Section 6 text

Figure 6-28a

Remedial Alternative 3 – Well System Layout – Groundwater Remediation by Extraction Combined with Clean Water Infiltration and Treatment (Vertical)

Provided in separate electronic figure file as a large sheet size

Figure 6-28b

Remedial Alternative 3 – Well System Layout – Groundwater Remediation by Extraction Combined with Clean Water Infiltration and Treatment (Horizontal)

Provided in separate electronic figure file as a large sheet size

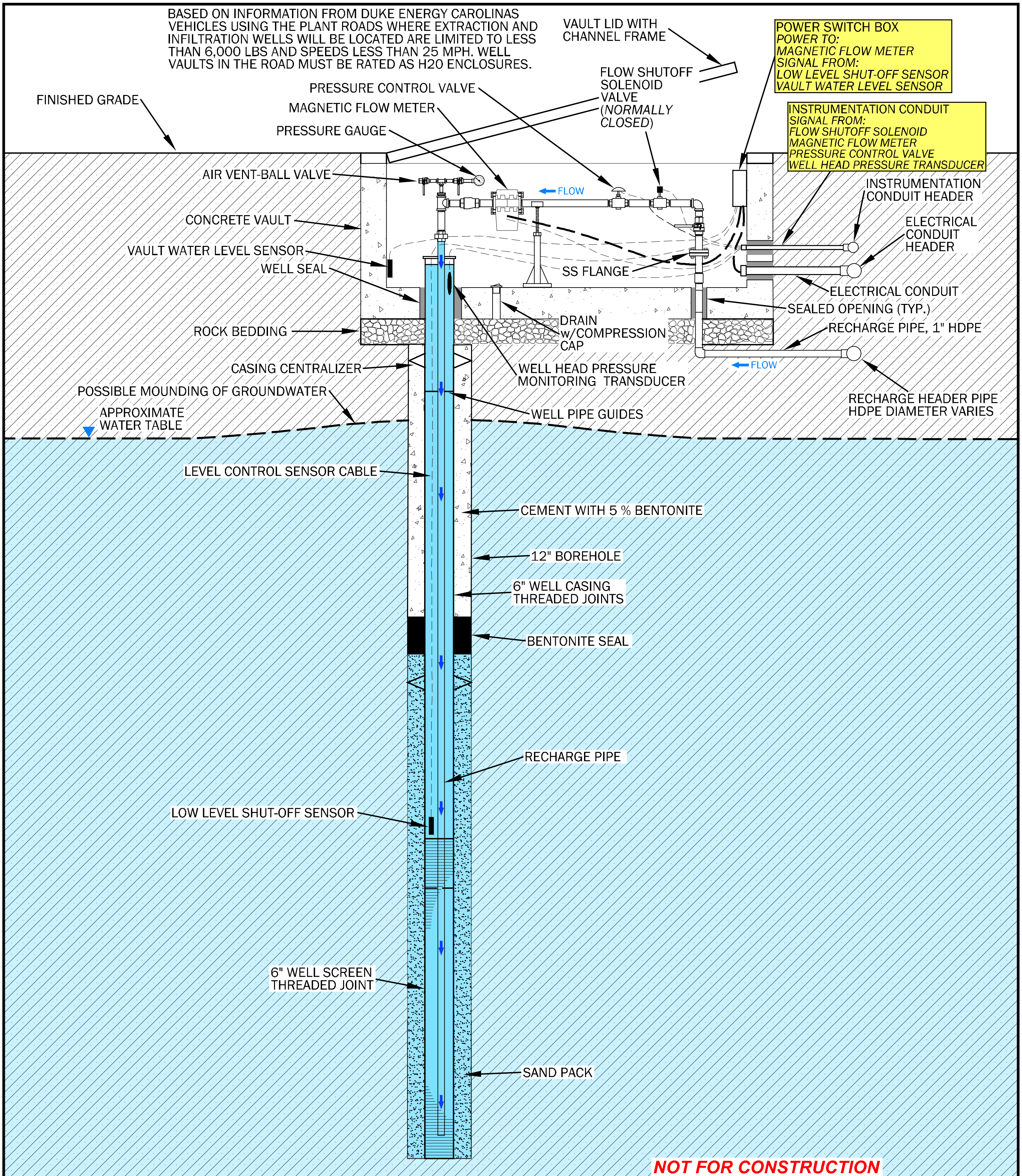

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FIGURE 6-28c
REMEDIAL ALTERNATIVE 3
CONCEPTUAL VERTICAL CLEAN WATER INFILTRATION WELL SCHEMATIC
REMEDIATION BY EXTRACTION COMBINED WITH CLEAN WATER INFILTRATION AND TREATMENT
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA

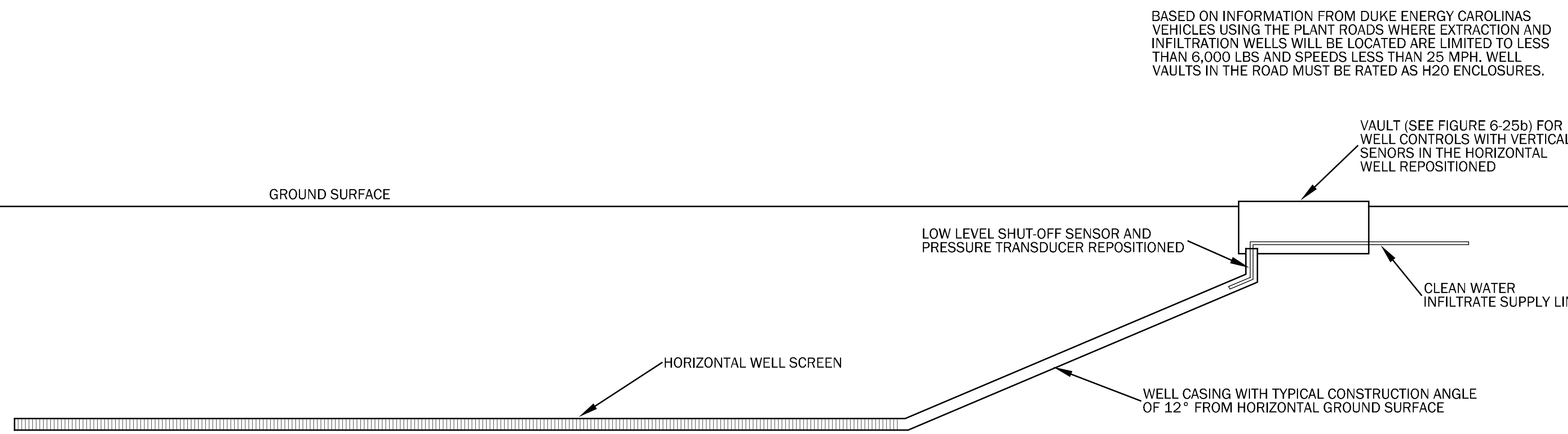

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FIGURE 6-28d
REMEDIAL ALTERNATIVE 3
CONCEPTUAL HORIZONTAL WELL
REMEDIATION BY EXTRACTION COMBINED WITH CLEAN WATER INFILTRATION AND TREATMENT
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA

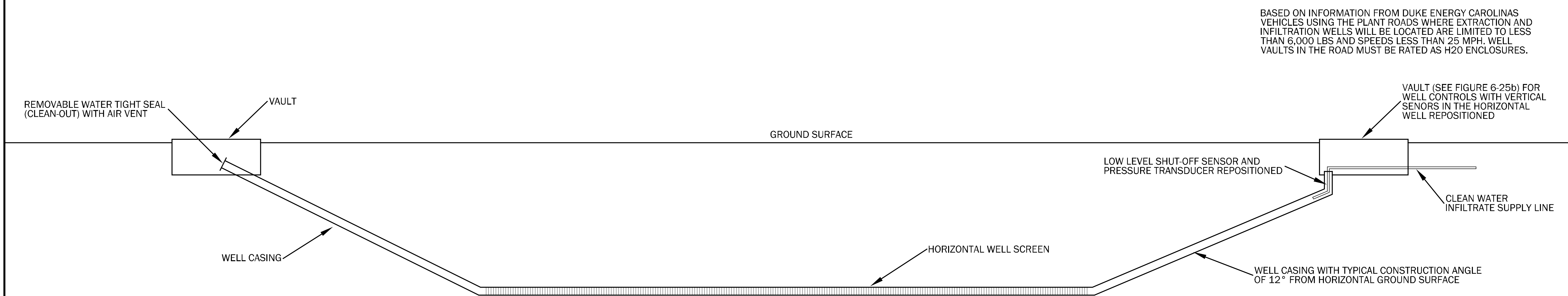

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FIGURE 6-28e
REMEDIAL ALTERNATIVE 3
CONCEPTUAL HORIZONTAL WELL
REMEDIATION BY EXTRACTION COMBINED WITH CLEAN WATER INFILTRATION AND TREATMENT
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA

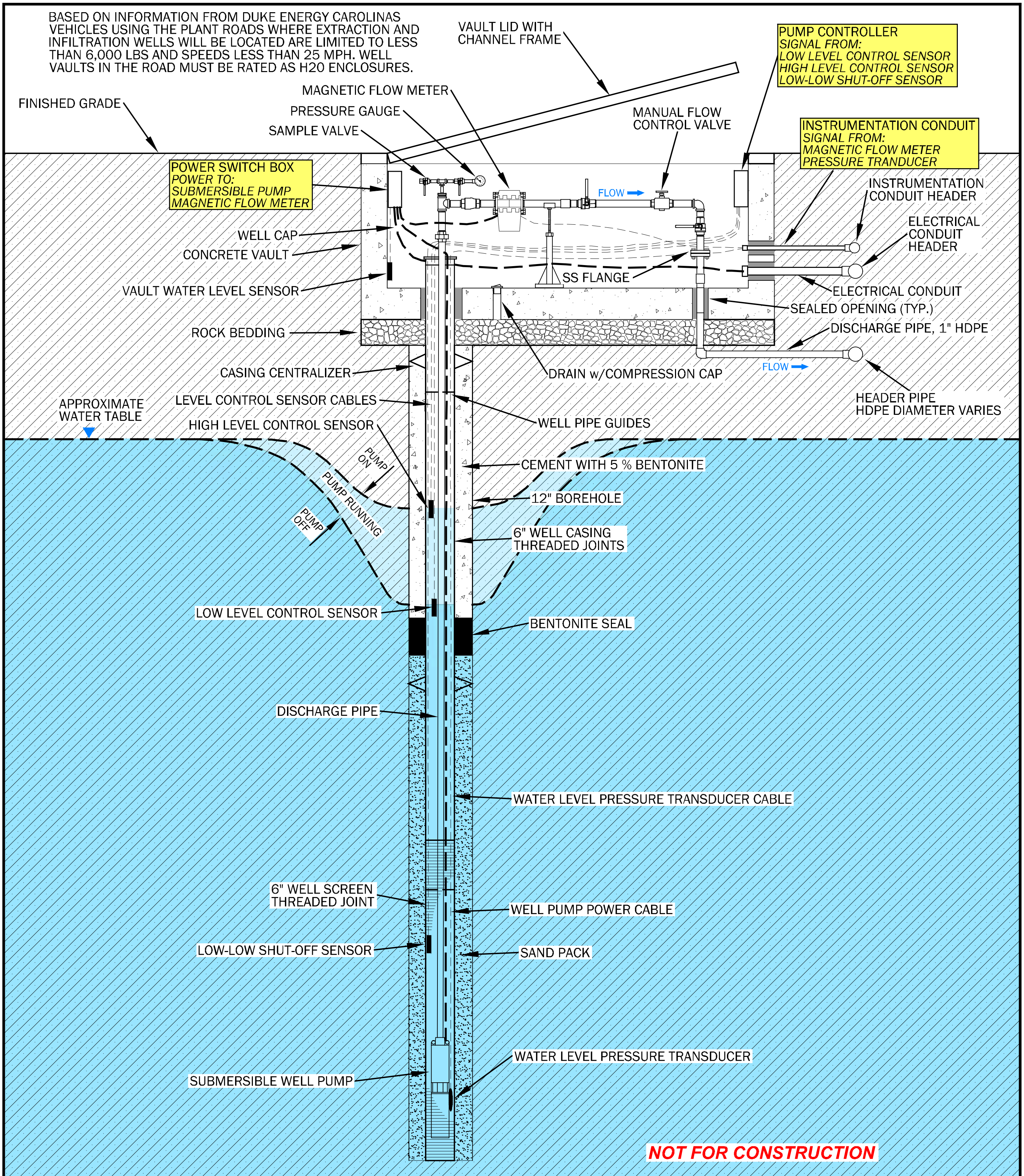

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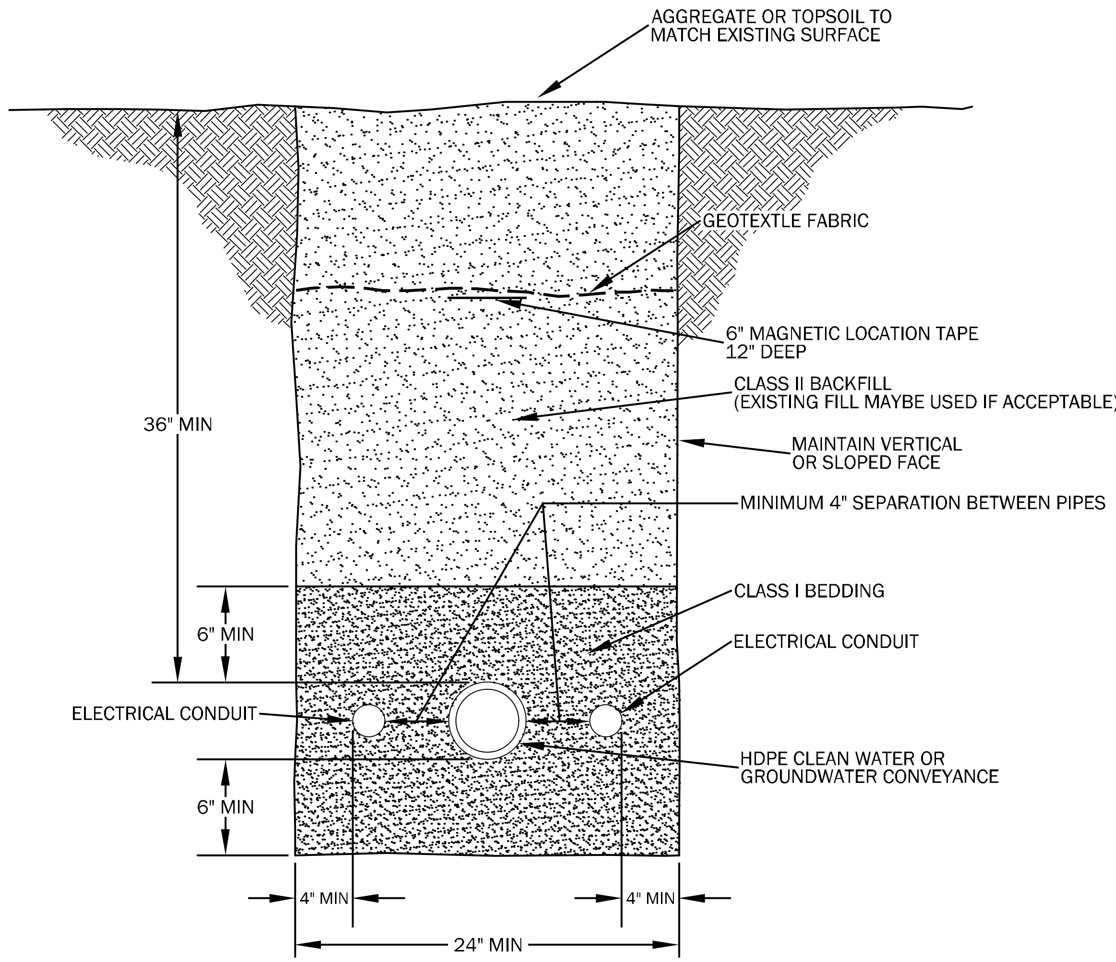
FIGURE 6-28f
REMEDIAL ALTERNATIVE 3
CONCEPTUAL VERTICAL EXTRACTION WELL SCHEMATIC
REMEDIATION BY EXTRACTION COMBINED WITH CLEAN WATER INFILTRATION AND TREATMENT
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA



NOTES:

1. 4" MINIMAL HORIZONTAL SEPARATION BETWEEN ALL PIPE AND CONDUIT.
2. 6" VERTICAL SEPARATION WHEN CROSSING OVER ALL PIPE AND CONDUIT.
3. 36" MINIMUM COVER FOR ALL PIPE AND CONDUIT.
4. PLACE BACKFILL AND FILL SOIL MATERIALS IN LAYERS NOT MORE THAN 8" IN LOOSE DEPTH FOR MATERIAL COMPACTED BY HEAVY COMPACTION EQUIPMENT AND NOT MORE THAN 4 INCHES LOOSE DEPTH FOR MATERIAL COMPACTED BY HAND OPERATED TAMPERS.
5. PLACE BACKFILL AND FILL MATERIALS EVENLY ON ALL SIDES OF STRUCTURES TO REQUIRED ELEVATIONS AND UNIFORMLY ALONG THE FULL LENGTH OF EACH STRUCTURE.
6. COMPACT SOIL MATERIALS TO NOT LESS THAN 95 PERCENT OF MAXIMUM DRY UNIT WEIGHT ACCORDING TO ASTM D 698.

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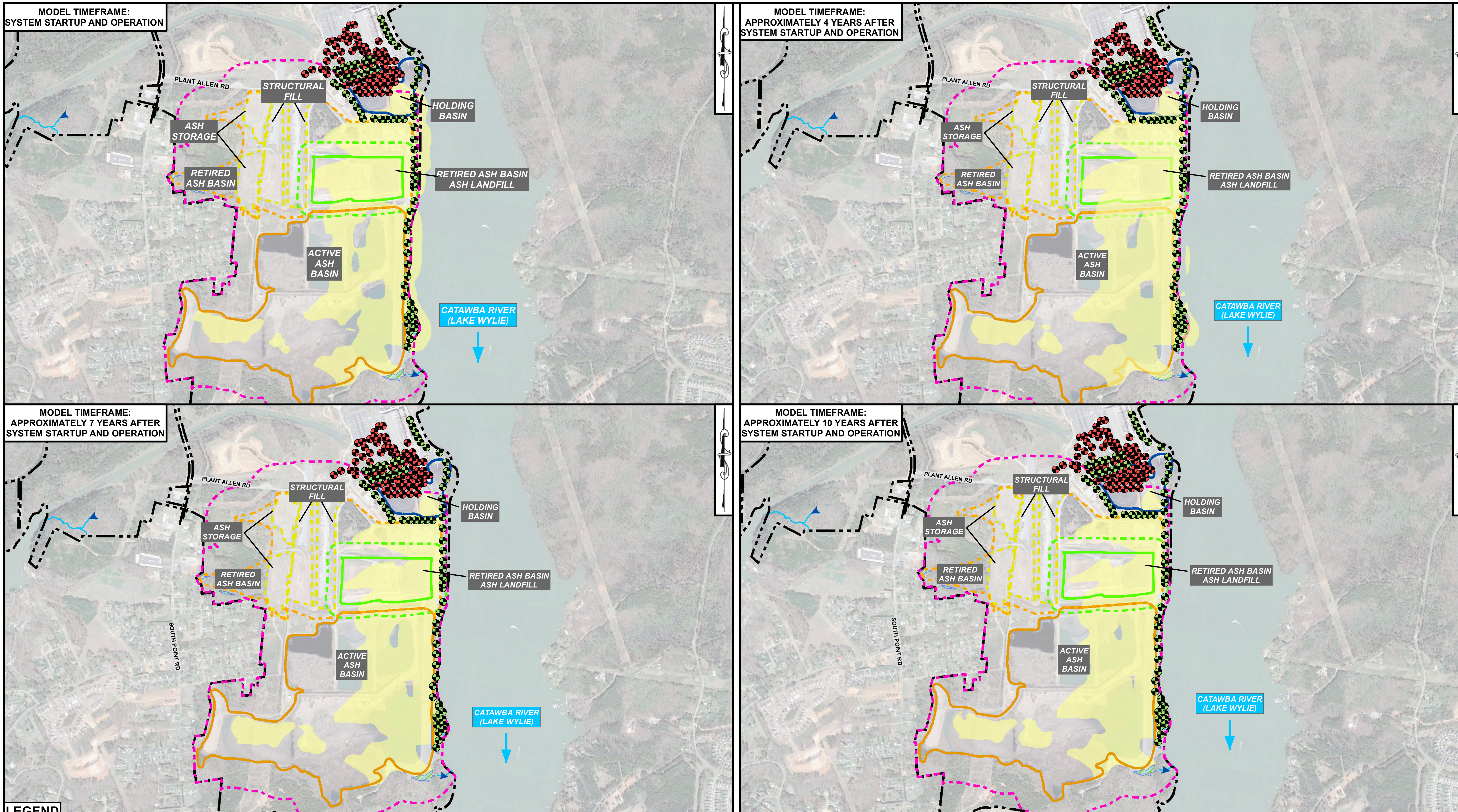
FIGURE 6-28g
REMEDIAL ALTERNATIVE 3
CONCEPTUAL TRENCH DETAIL
REMEDIATION BY EXTRACTION COMBINED WITH CLEAN WATER INFILTRATION AND TREATMENT
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA



LEGEND

- BORON CONCENTRATION RANGE (700-4000µg/L)
- PROPOSED EXTRACTION WELL
- PROPOSED CLEAN WATER INFILTRATION WELL
- ACTIVE ASH BASIN WASTE BOUNDARY
- RETIRED ASH BASIN WASTE BOUNDARY
- ACTIVE ASH BASIN COMPLIANCE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL WASTE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL COMPLIANCE BOUNDARY
- DORS FILLS BOUNDARIES
- SITE FEATURE
- DUKE ENERGY CAROLINAS PROPERTY LINE
- STREAM (AMEC NRTR 2015)
- WETLAND (AMEC NRTR 2015)

NOTES:

1. THE WATERS OF THE US DELINEATION HAS NOT BEEN APPROVED BY THE US ARMY CORPS OF ENGINEERS AT THE TIME OF THE MAP CREATION. THIS MAP IS NOT TO BE USED FOR JURISDICTIONAL DETERMINATION PURPOSES. THE WETLANDS AND STREAMS BOUNDARIES WERE OBTAINED FROM STREAM AND WETLAND DELINEATION CONDUCTED BY AMEC FOSTER WHEELER ENVIRONMENTAL & INFRASTRUCTURE, INC. NATURAL RESOURCE TECHNICAL REPORT (NRTR) FOR ALLEN STEAM STATION DATED MAY 29, 2015.

2. ALL BOUNDARIES ARE APPROXIMATE.

3. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.

4. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON OCTOBER 5, 2018. AERIAL WAS COLLECTED ON JULY 8, 2018.

5. DRAWING HAS BEEN SET WITH A PROJECTION OF NORTH CAROLINA STATE PLANE COORDINATE SYSTEM FIPS 3200 (NAD83/2011).

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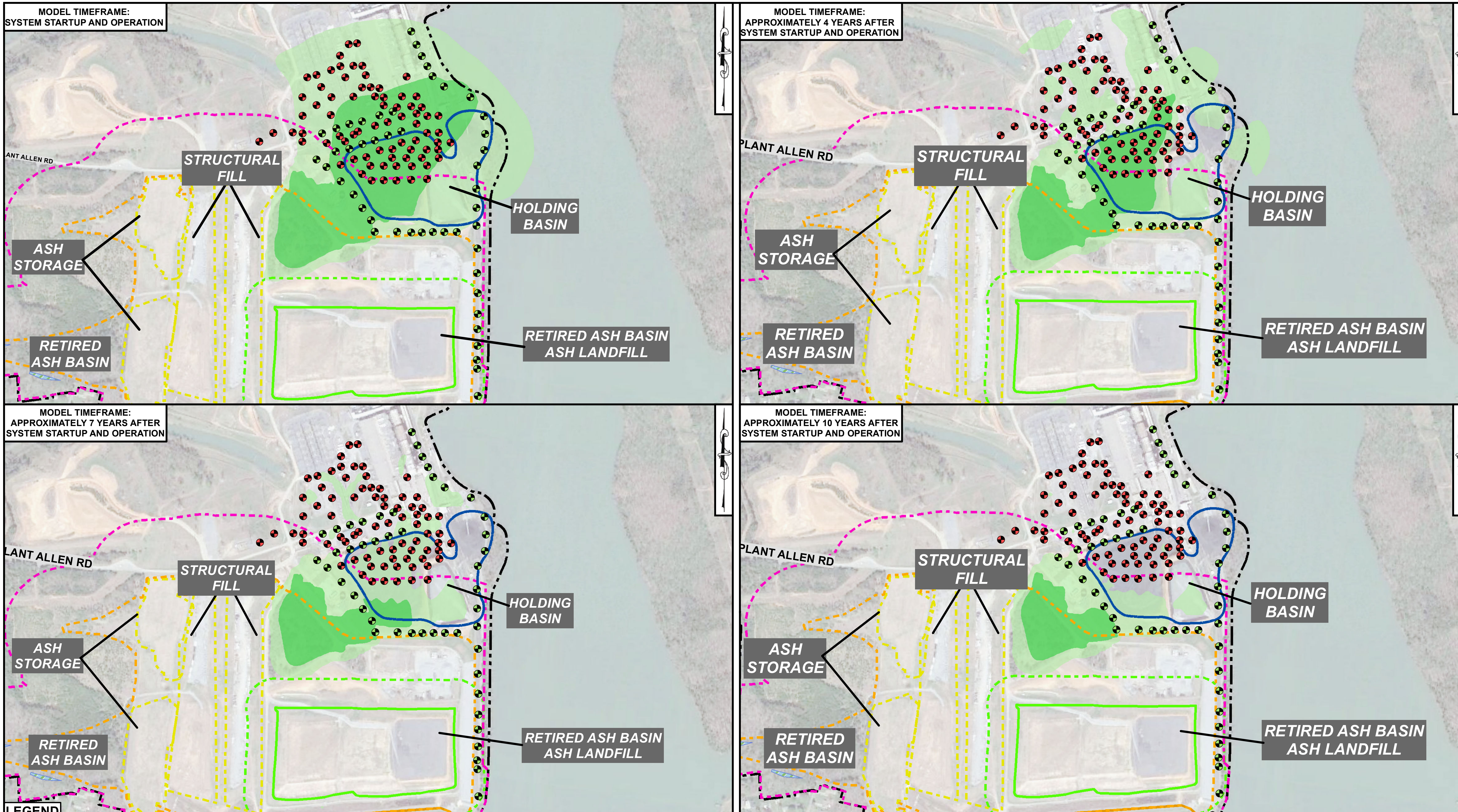
FIGURE 6-28h
REMEDIAL ALTERNATIVE 3 (VERTICAL WELLS ONLY)
GROUNDWATER REMEDIATION BY EXTRACTION
COMBINED WITH CLEAN WATER
INFILTRATION AND TREATMENT
SIMULATED BORON CONCENTRATIONS IN ALL FLOW ZONES
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA



LEGEND

- SULFATE CONCENTRATION RANGE (>1000mg/L)
- SULFATE CONCENTRATION RANGE (250-1000mg/L)
- PROPOSED EXTRACTION WELL
- PROPOSED CLEAN WATER INFILTRATION WELL
- ACTIVE ASH BASIN WASTE BOUNDARY
- RETIRED ASH BASIN WASTE BOUNDARY
- ACTIVE ASH BASIN COMPLIANCE BOUNDARY
- RETIRED ASH BASIN ASH LANDILL WASTE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL COMPLIANCE BOUNDARY
- DORS FILLS BOUNDARIES
- SITE FEATURE
- DUKE ENERGY CAROLINAS PROPERTY LINE
- STREAM (AMEC NRTR 2015)
- WETLAND (AMEC NRTR 2015)

NOTES:

1. THE WATERS OF THE US DELINEATION HAS NOT BEEN APPROVED BY THE US ARMY CORPS OF ENGINEERS AT THE TIME OF THE MAP CREATION. THIS MAP IS NOT TO BE USED FOR JURISDICTIONAL DETERMINATION PURPOSES. THE WETLANDS AND STREAMS BOUNDARIES WERE OBTAINED FROM STREAM AND WETLAND DELINEATION CONDUCTED BY AMEC FOSTER WHEELER ENVIRONMENTAL & INFRASTRUCTURE, INC. NATURAL RESOURCE TECHNICAL REPORT (NRTR) FOR ALLEN STEAM STATION DATED MAY 29, 2015.

2. ALL BOUNDARIES ARE APPROXIMATE.

3. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.

4. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON OCTOBER 5, 2018. AERIAL WAS COLLECTED ON JULY 8, 2018.

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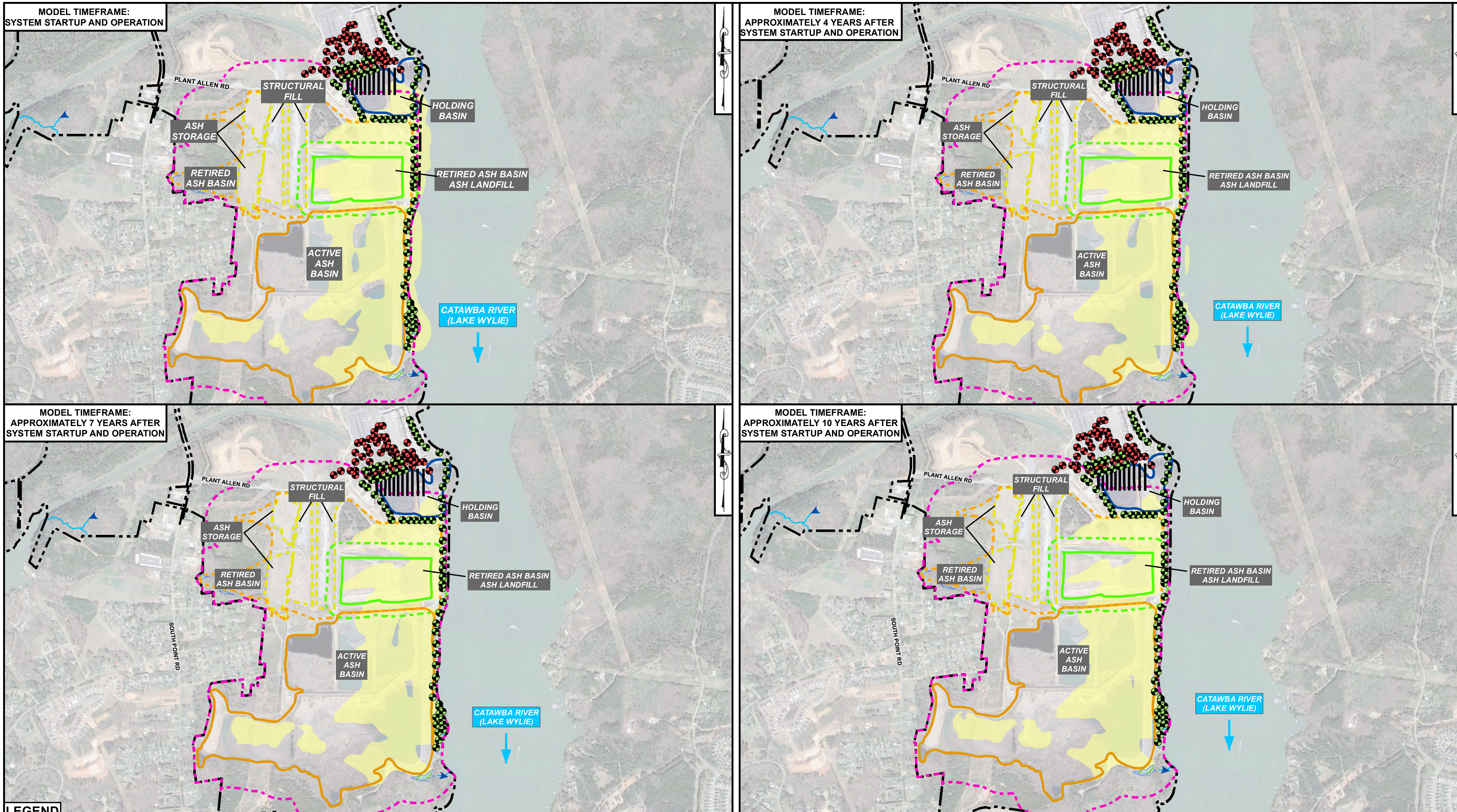
FIGURE 6-28i
REMEDIAL ALTERNATIVE 3 (VERTICAL WELLS ONLY)
GROUNDWATER REMEDIATION BY EXTRACTION COMBINED WITH CLEAN WATER INFILTRATION AND TREATMENT
SIMULATED SULFATE CONCENTRATIONS IN ALL FLOW ZONES
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA



BORON CONCENTRATION RANGE (700-4000µg/L)	RETIRED ASH BASIN ASH LANDILL WASTE BOUNDARY
PROPOSED EXTRACTION WELL	RETIRED ASH BASIN ASH LANDFILL COMPLIANCE BOUNDARY
PROPOSED CLEAN WATER INFILTRATION WELL	DORS FILLS BOUNDARIES
PROPOSED INFILTRATION HORIZONTAL WELL	SITE FEATURE
ACTIVE ASH BASIN WASTE BOUNDARY	DUKE ENERGY CAROLINAS PROPERTY LINE
RETIRED ASH BASIN WASTE BOUNDARY	STREAM (AMEC NRTR 2015)
ACTIVE ASH BASIN COMPLIANCE BOUNDARY	WETLAND (AMEC NRTR 2015)

NOTES:

1. THE WATERS OF THE US DELINEATION HAS NOT BEEN APPROVED BY THE US ARMY CORPS OF ENGINEERS AT THE TIME OF THE MAP CREATION. THIS MAP IS NOT TO BE USED FOR JURISDICTIONAL DETERMINATION PURPOSES. THE WETLANDS AND STREAMS BOUNDARIES WERE OBTAINED FROM STREAM AND WETLAND DELINEATION CONDUCTED BY AMEC FOSTER WHEELER ENVIRONMENTAL & INFRASTRUCTURE, INC. NATURAL RESOURCE TECHNICAL REPORT (NRTR) FOR ALLEN STEAM STATION DATED MAY 29, 2015.

2. ALL BOUNDARIES ARE APPROXIMATE.

3. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.

4. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON OCTOBER 5, 2018. AERIAL WAS COLLECTED ON JULY 8, 2018.

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FIGURE 6-28j
REMEDIAL ALTERNATIVE 3 (HORIZONTAL AND VERTICAL WELLS)
GROUNDWATER REMEDIATION BY EXTRACTION
COMBINED WITH CLEAN WATER
INFILTRATION AND TREATMENT
SIMULATED BORON CONCENTRATIONS IN ALL FLOW ZONES
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA

LEGEND

- SULFATE CONCENTRATION RANGE (>1000mg/L)
- SULFATE CONCENTRATION RANGE (250-1000mg/L)
- PROPOSED EXTRACTION WELL
- PROPOSED CLEAN WATER INFILTRATION WELL
- PROPOSED INFILTRATION HORIZONTAL WELL
- ACTIVE ASH BASIN WASTE BOUNDARY
- RETIRED ASH BASIN WASTE BOUNDARY
- ACTIVE ASH BASIN COMPLIANCE BOUNDARY
- RETIRED ASH BASIN ASH LANDILL WASTE BOUNDARY
- RETIRED ASH BASIN ASH LANDFILL COMPLIANCE BOUNDARY
- DORS FILLS BOUNDARIES
- SITE FEATURE
- DUKE ENERGY CAROLINAS PROPERTY LINE
- STREAM (AMEC NRTR 2015)
- WETLAND (AMEC NRTR 2015)

NOTES:

1. THE WATERS OF THE US DELINEATION HAS NOT BEEN APPROVED BY THE US ARMY CORPS OF ENGINEERS AT THE TIME OF THE MAP CREATION. THIS MAP IS NOT TO BE USED FOR JURISDICTIONAL DETERMINATION PURPOSES. THE WETLANDS AND STREAMS BOUNDARIES WERE OBTAINED FROM STREAM AND WETLAND DELINEATION CONDUCTED BY AMEC FOSTER WHEELER ENVIRONMENTAL & INFRASTRUCTURE, INC. NATURAL RESOURCE TECHNICAL REPORT (NRTR) FOR ALLEN STEAM STATION DATED MAY 29, 2015.

2. ALL BOUNDARIES ARE APPROXIMATE.

3. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.

4. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON OCTOBER 5, 2018. AERIAL WAS COLLECTED ON JULY 8, 2018.

5. DRAWING HAS BEEN SET WITH A PROJECTION OF NORTH CAROLINA STATE PLANE COORDINATE SYSTEM FIPS 3200 (NAD83/2011).

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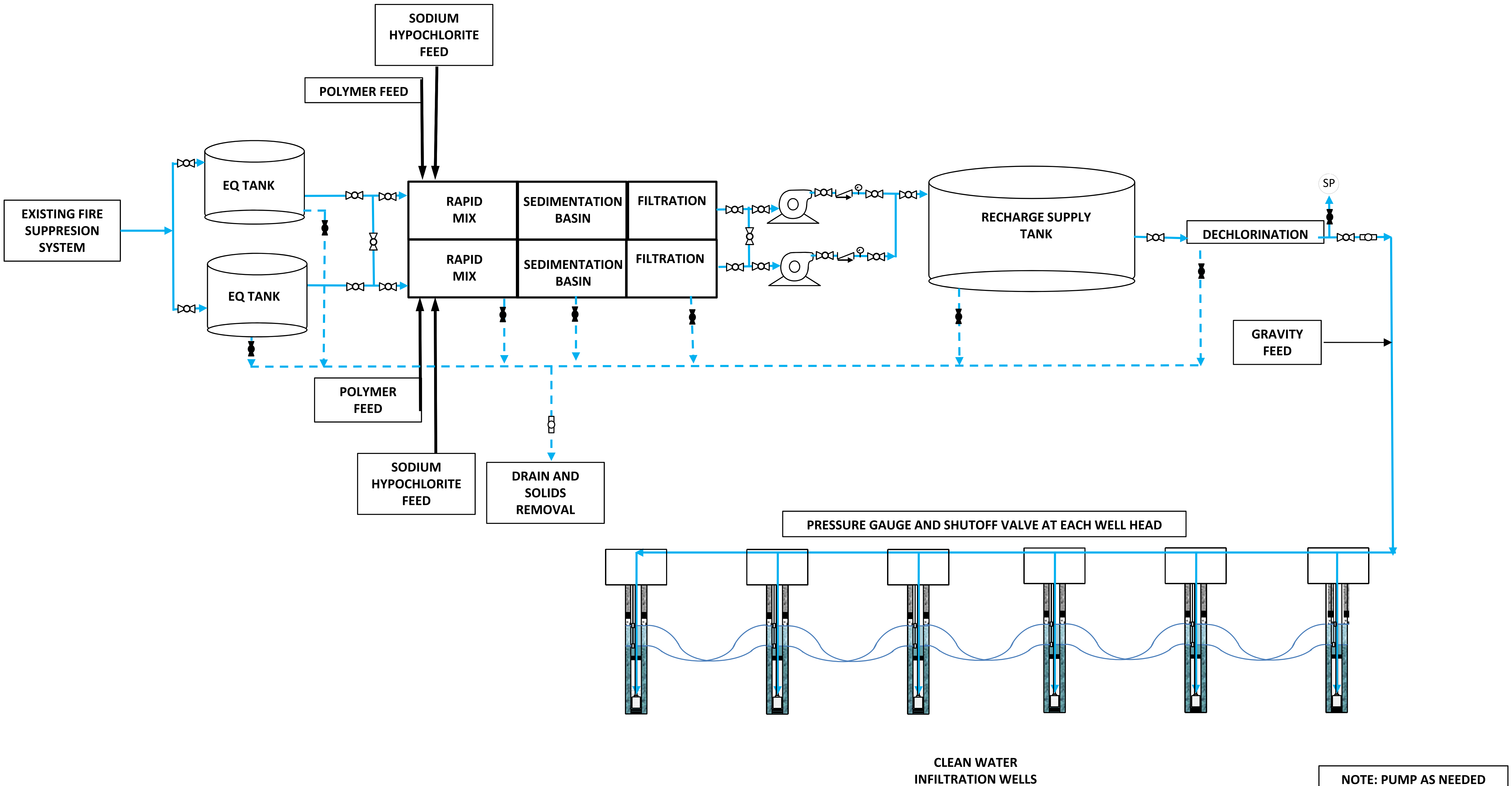
FIGURE 6-28k
REMEDIAL ALTERNATIVE 3 (HORIZONTAL AND VERTICAL WELLS)
GROUNDWATER REMEDIATION BY EXTRACTION
COMBINED WITH CLEAN WATER
INFILTRATION AND TREATMENT
SIMULATED SULFATE CONCENTRATIONS IN ALL FLOW ZONES
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA



Not to Scale

LEGEND

HH - High high
H - High low
L – Low
TYP - Typical

Flow totalizer
Pressure gauge
SP Sampling port
Check valve
Three-way valve
Ball valve, normally closed
Rotameter
Ball valve, normally open
Diaphragm valve, normally open
Diaphragm valve, normally closed

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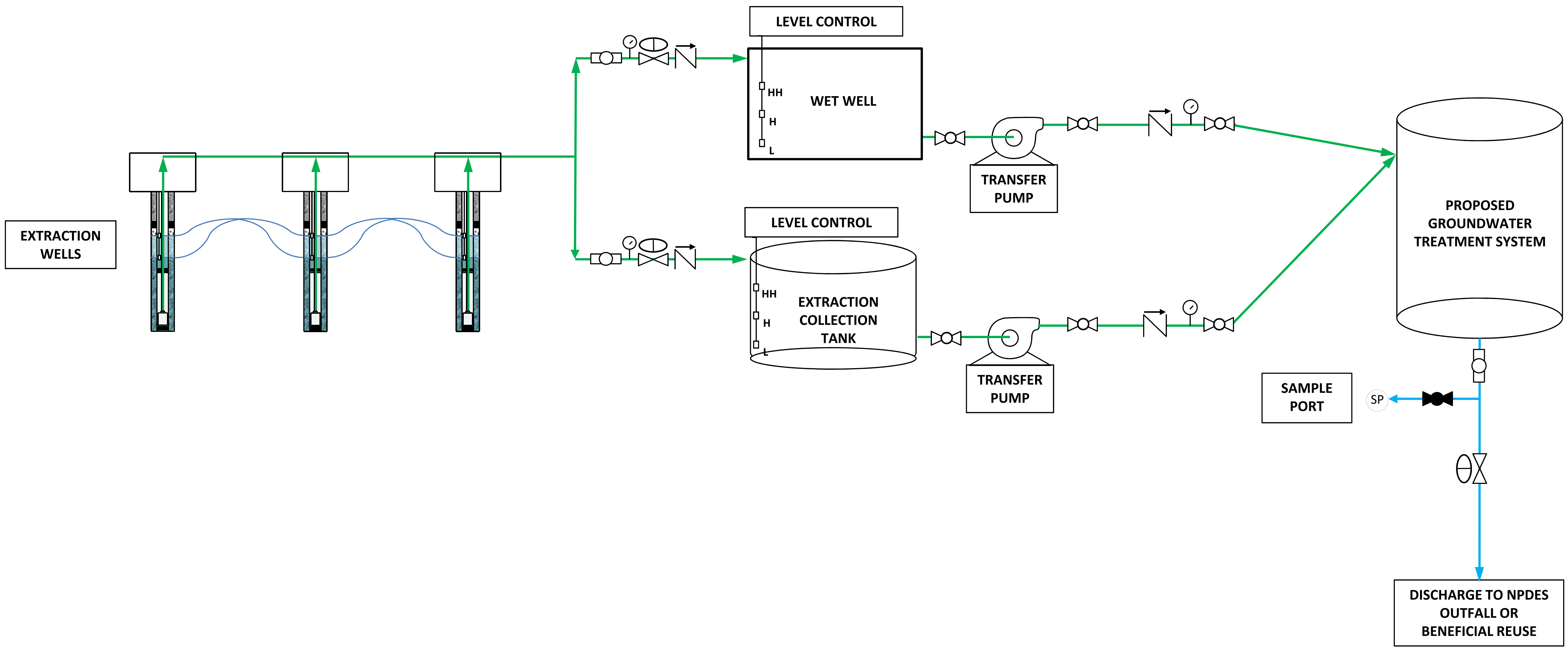
FIGURE 6-29
CONCEPTUAL PROCESS FLOW DIAGRAM
CLEAN WATER INFILTRATION SYSTEM
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA



Not to Scale

LEGEND

HH - High high
H - High low
L – Low
TYP - Typical

Flow totalizer
Pressure gauge
Sampling port
Check valve
Three-way valve
Ball valve, normally closed
Rotameter
Ball valve, normally open
Diaphragm valve, normally open
Diaphragm valve, normally closed

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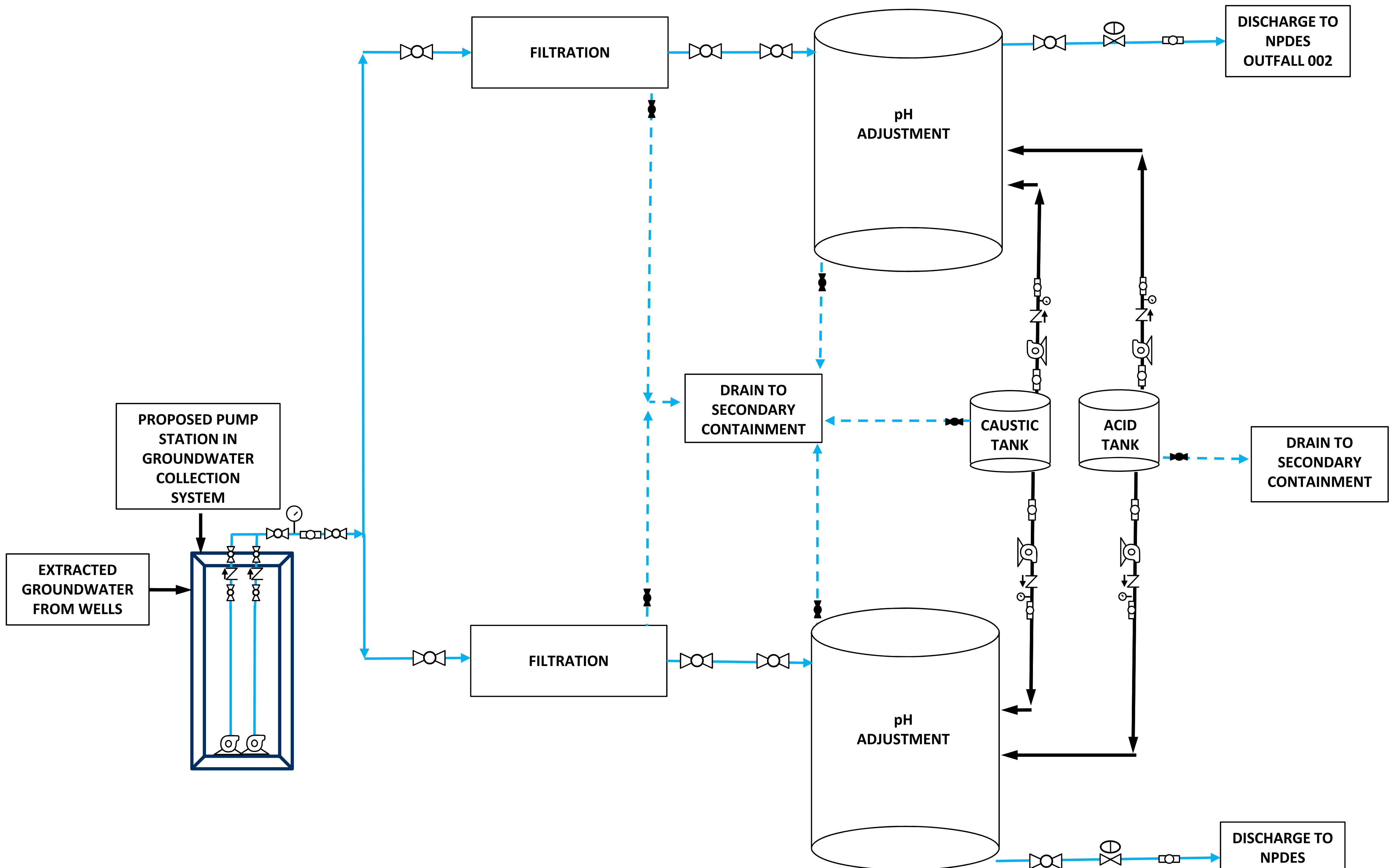
FIGURE 6-30
CONCEPTUAL PROCESS FLOW DIAGRAM
GROUNDWATER EXTRACTON SYSTEM
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA



NOTE: PUMP AS NEEDED

Not to Scale

LEGEND

HH - High high
H - High low
L – Low
TYP - Typical

Flow totalizer
Pressure gauge
SP Sampling port

Check valve
Three-way valve
Ball valve, normally closed

Rotameter
Ball valve, normally open
Diaphragm valve, normally open
Diaphragm valve, normally closed

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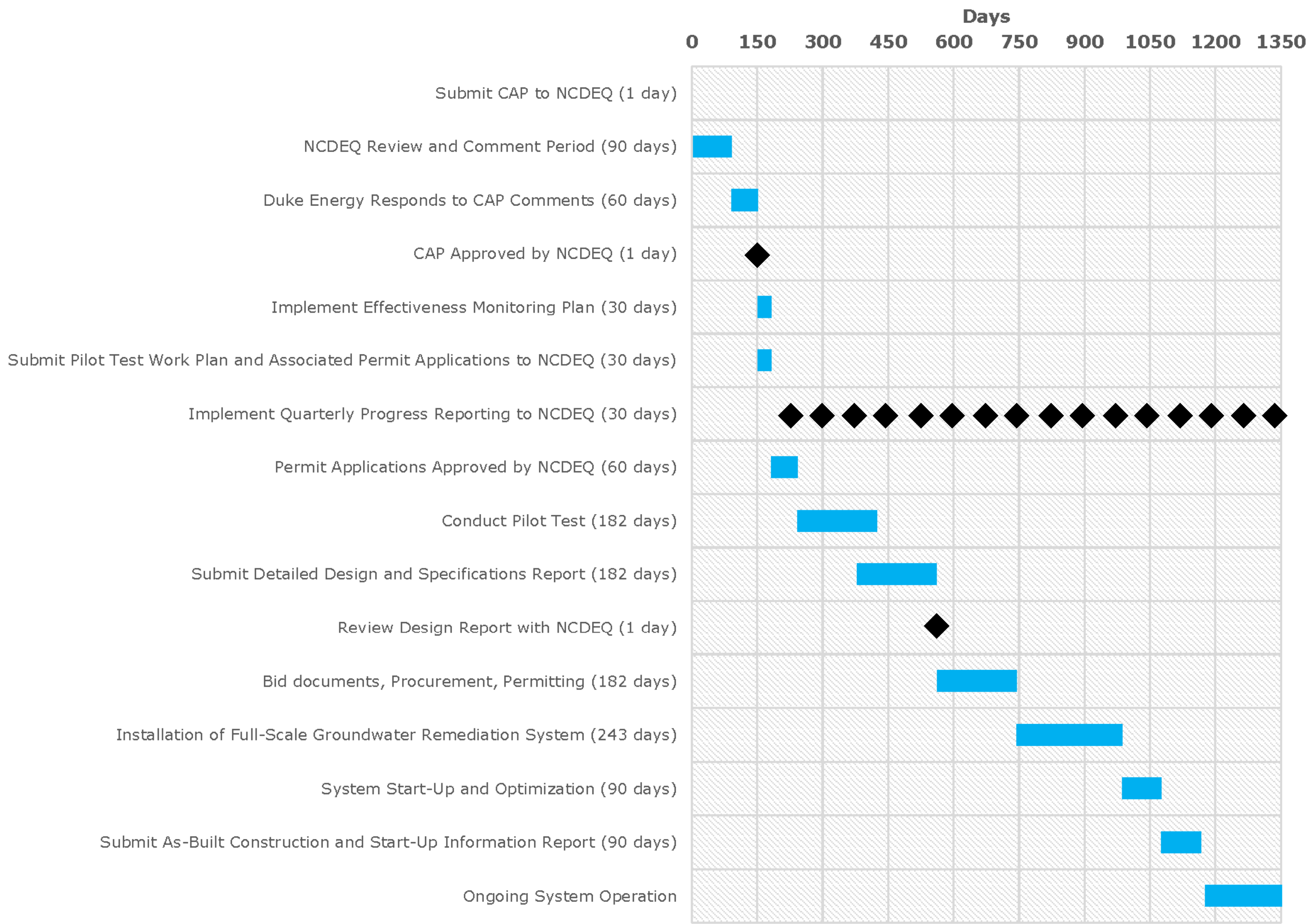
FIGURE 6-31
CONCEPTUAL PROCESS FLOW DIAGRAM
GROUNDWATER TREATMENT SYSTEM
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA



Notes:

* - Either submittal of the Effectiveness Monitoring Plan or the pilot test work plan and permit applications (as applicable) will fulfill section G.S.130A-309.209.(b)(3).

** - Actual time may vary due to a variety of factors including agency review and approvals, weather delays, equipment availability, etc.

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APPROVED BY: L. DRAGO
PROJECT MANAGER: C.SUTTELL

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FIGURE 6-32
CAP IMPLEMENTATION GANTT CHART
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA

NOTES:

1. SELECT GROUNDWATER WELLS WOULD HAVE GEOCHEMICAL SONDES INSTALLED FOR TELEMETRY MONITORING OF THE SIX GROUNDWATER FIELD PARAMETERS. SEE **TABLE 6-17** FOR GROUNDWATER FIELD PARAMETERS AND WELLS TO HAVE GEOCHEMICAL SONDES.

2. **BG-1S/DA/BR, CCR-BG-1S/DA, AND GWA-21S/DA/BR** ARE APPROVED BACKGROUND GROUNDWATER MONITORING LOCATIONS.

3. THE WATERS OF THE US DELINEATION HAS NOT BEEN APPROVED BY THE US ARMY CORPS OF ENGINEERS AT THE TIME OF THE MAP CREATION. THIS MAP IS NOT TO BE USED FOR JURISDICTIONAL DETERMINATION PURPOSES. THE WETLANDS AND STREAMS BOUNDARIES WERE OBTAINED FROM STREAM AND WETLAND DELINEATION CONDUCTED BY AMEC FOSTER WHEELER ENVIRONMENTAL & INFRASTRUCTURE, INC. NATURAL RESOURCE TECHNICAL REPORT (NRTR) FOR ALLEN STEAM STATION DATED MAY 29, 2015.

4. ALL BOUNDARIES ARE APPROXIMATE.

5. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.

6. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON DECEMBER 13, 2018. AERIAL WAS COLLECTED ON MARCH 30, 2018.

7. DRAWING HAS BEEN SET WITH A PROJECTION OF NORTH CAROLINA STATE PLANE COORDINATE SYSTEM FIPS 3200 (NAD83/2011).

DUKE ENERGY CAROLINAS

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DRAWN BY: K. KING	DATE: 06/19/2019
REVISED BY: J. KIRTZ	DATE: 12/20/2019
APPROVED BY: L. DRAGO	DATE: 12/20/2019
CHECKED BY: L. DRAGO	DATE: 12/20/2019
PROGRAM MANAGER: C. SUTTELL	

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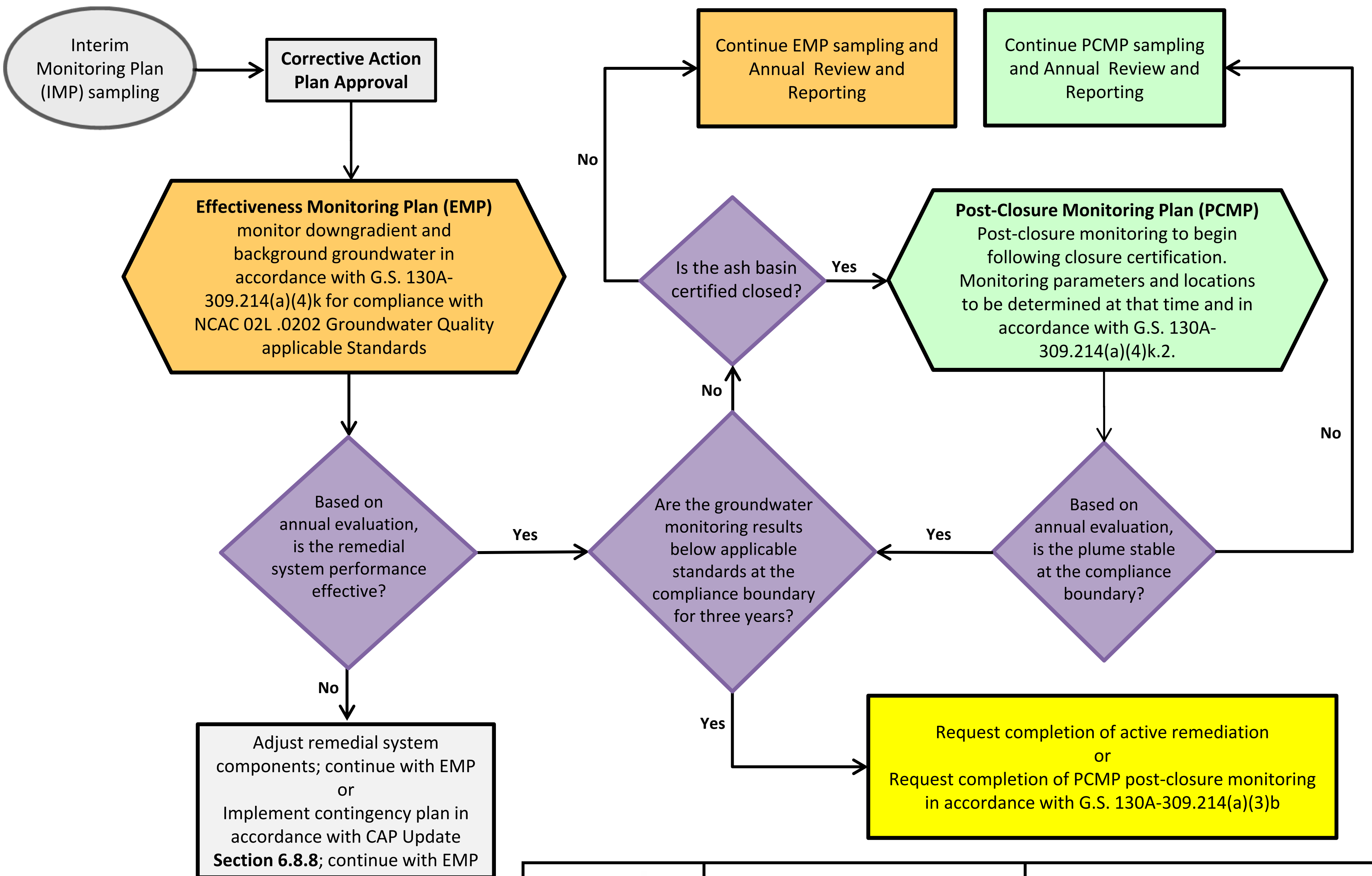
FIGURE 6-33
EFFECTIVENESS MONITORING WELL NETWORK AND FLOW PATHS
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA



Notes:

NCAC - North Carolina Administrative Code

02L - NCAC Title 15A, Subchapter 02L. Groundwater Classification and Standards

DUKE ENERGY CAROLINAS	DRAWN BY: T. PLATING DATE: 10/112019 REVISED BY: J. WYLIE & K SHECK DATE: 12/16/2019 CHECKED BY: L. DRAGO DATE: 12/19/2019 APPROVED BY: C. SUTTELL DATE: 12/19/2019 PROJECT MANAGER: C. SUTTELL	**FIGURE 6-34** **WORK FLOW FOR EFFECTIVENESS MONITORING AND OPTIMIZATION** **CORRECTIVE ACTION PLAN UPDATE** **ALLEN STEAM STATION** **BELMONT, NORTH CAROLINA**
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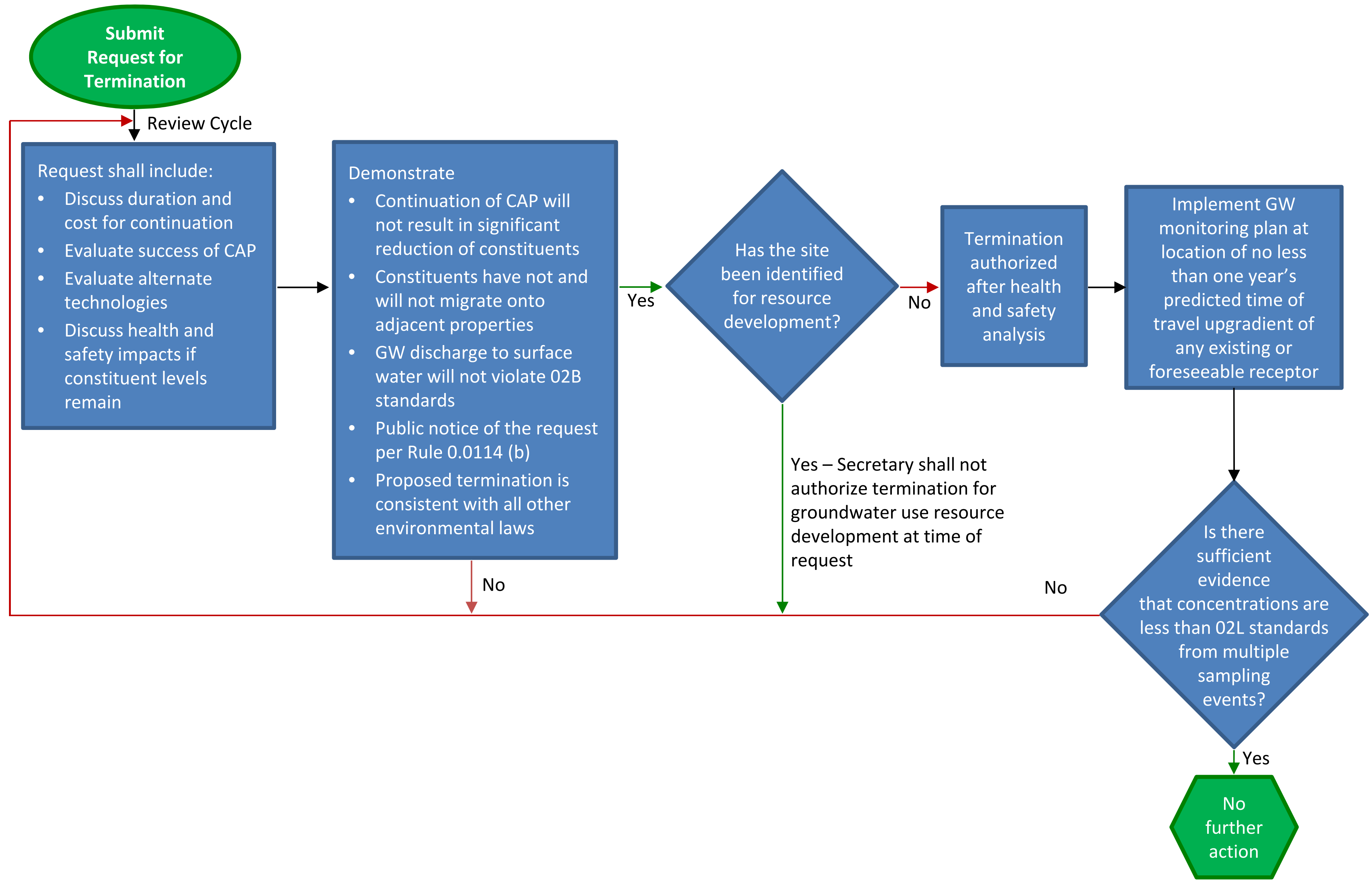

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CHECKED BY: T. PLATING DATE: 07/12/2019
APPROVED BY: L. DRAGO DATE: 12/05/2019
PROJECT MANAGER: C. SUTTELL

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FIGURE 6-35
TERMINATION OF GROUNDWATER REMEDIATION FLOW DIAGRAM
CORRECTIVE ACTION PLAN UPDATE
ALLEN STEAM STATION
BELMONT, NORTH CAROLINA