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Nov 05 2020

CORRECTIVE ACTION PLAN UPDATE

Site Name and Location:	**Belews Creek Steam Station** **3195 Pine Hall Road** **Belews Creek, NC 27009**
Groundwater Incident No.:	88227
NPDES Permit No.:	NC0024406
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, South Carolina 29601-2567 (864) 421-9999
Latitude and Longitude of Facility:	N 36.2819444/W -80.0597222

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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 Belews Creek Steam Station (BCSS) located in Stokes County, North Carolina. Since 2010, 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 BCSS coal ash basin. 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 basin at the BCSS as low-risk pursuant to CAMA.

Thousands of multi-media samples have been collected at the BCSS yielding over 175,000 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 area 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 ash basin decanting to remove the hydraulic head, thereby mitigating the risk of potential COI migration into groundwater; and (ii) complete ash basin closure. 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 a combination of groundwater extraction, clean water infiltration, and treatment. These corrective action measures will most effectively achieve remediation of the groundwater through the use of extraction wells to the north and northwest of the ash basin and clean water infiltration wells to the north and northwest of the basin. Significantly, groundwater modeling simulations indicate these measures will control COI discharge at the compliance boundary and meet the remedial objectives for COI beyond the compliance boundary.

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 the BCSS 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 the BCSS. 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 the BCSS using USEPA guidance demonstrate that risks to potential human health and ecological receptors associated with the coal ash basin are not measurably greater than risks posed by naturally occurring background conditions.**

- **Ash basin-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 170 monitoring wells over 30 separate monitoring events, and performing over 140 groundwater and geochemical modeling simulations**.

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 compliance boundary with 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 systems, including the Dan River and Belews Reservoir, confirm that these surface water systems are healthy with robust fish populations.

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 Belews Creek Steam Station (BCSS, Belews Creek, Station or Site) coal combustion residuals (CCR) ash basin. The Site is located in Stokes County, North Carolina (**Figure ES-1**). The closed Pine Hall Road (PHR) Landfill located within the ash basin drainage system and ash basin compliance boundary is 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 the 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 BCSS ash basin and the PHR Landfill.

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 of the ash basin
- Northwest of the ash basin

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

- *Corrective Action Plan Part 1 – Belews Creek Steam Station Ash Basin* (HDR 2015b)
- *Corrective Action Plan Part 2 (included CSA Supplement 1 as Appendix A) – Belews Creek Steam Station Ash Basin* (HDR 2016b)

This CAP Update considers data collected through April 2019.

Ash basin closure is detailed in separate documents prepared by AECOM. Closure scenarios include a closure-in-place (hybrid) scenario and a closure-by-excavation scenario. The groundwater remediation alternatives evaluated and recommended in this CAP Update consider both closure scenarios. Groundwater modeling simulations consistently indicate the different closure 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. 130A-309.211 (b) and Subchapter 02L .0106. The preferred groundwater remediation approach assumes source control through either basin closure-in-place or closure-by-excavation. The groundwater remediation approach presented in this CAP Update can be implemented under either closure scenario to achieve 02L .0202 groundwater quality standards at the 500 foot compliance boundary within approximately 13 years after system start up and operation, based on groundwater modeling simulations. The focus of groundwater corrective action at the BCSS 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 .0106(j). Applicable criteria in this case is defined as the 02L groundwater standard, interim maximum allowable concentration (IMAC), or background, whichever is greatest, defined as the COI criteria. 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:

Source Control Measures

- Completion of ash basin decanting, currently underway, will reduce the hydraulic head in the dam area, thereby significantly reducing the hydraulic driving force for potential COI migration in groundwater to the north and northwest. As of December 1, 2019, approximately 469,400,000 gallons water have been removed from the ash basin and the water elevation has decreased by 10.6 feet. Completion of decanting is projected to occur during or before September 2020. Groundwater modeling indicates that the average linear velocity of groundwater will decrease from 5.0 feet per day (ft/d) to 10.0 ft/d prior to decanting to 0.1 ft/day to 5.0 ft/day after decanting.

- Operation of the toe-drain water collection system at the base of the BCSS dam will lower groundwater levels and redirect water collected from the unnamed tributary, thereby improving surface water and groundwater quality in the area north of the ash basin.
- Ash basin closure is detailed in a separate document prepared by AECOM. Closure scenarios include a closure-in-place (hybrid) and closure-by-excavation.

Groundwater Remediation Measures

A robust groundwater remediation approach planned for the Site includes actively addressing COIs with concentrations greater than applicable standards at or beyond the compliance boundary using a combination of groundwater extraction combined with clean water infiltration and treatment. Site data and groundwater models were used to evaluate and optimize an effective remedial approach to reduce COI concentrations north and northwest of the ash basin. The following is a summary of components of the preferred remediation system that would be installed in areas north and northwest of the ash basin:

- 10 existing vertical extraction wells northwest of the ash basin
- 113 new vertical extraction wells north and northwest of the ash basin
- 47 vertical clean water infiltration wells north and northwest of the ash basin
- One horizontal clean water infiltration well northwest of the ash basin

Effectiveness Monitoring Plan (EMP)

- Duke Energy has prepared an effectiveness monitoring plan (EMP) summarized in **Section 6.8** and provided in **Appendix P** of this CAP Update. The EMP includes an optimized groundwater monitoring network for the ash basin based on Site-specific COI mobility and distribution. The EMP is also designed to be adaptable and to address areas where changes to groundwater conditions are likely to occur due to additional corrective action implementation or basin closure activities. The 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 rationale for CAP activities are provided within this report and summarized in the following sections.

ES.2 Background

Plant Operations

Electrical power-generation operations began at Belews Creek in 1974 with the use of two coal-fired steam units. CCR materials, composed primarily of fly ash and bottom ash, were initially deposited in the ash basin by hydraulic sluicing operations. In 1984, fly ash sluicing was replaced with a dry fly ash handling system. In 2018, a dry bottom ash collection system was installed. All bottom ash and fly ash is currently handled dry. Placement of ash in the Site ash basin ceased by the end of 2018; all ash is either used for beneficial reuse or placed in the onsite Craig Road Landfill. The Site ash basin has operated under a National Pollution Discharge Elimination System (NPDES) Permit issued by the NCDEQ Division of Water Resources (DWR) since initial operations began.

Pursuant to G.S. Section 130A-309.213(d)(1) a November 13, 2018 letter from NCDEQ to Duke Energy documented the classification of the CCR surface impoundment at the Site as low-risk (**Appendix A**). The letter cited that Duke Energy has "established permanent water supplies as required by G.S. Section 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 G.S. Section 143-215.32."

The relevant closure requirements for low-risk impoundments are in G.S. Section 130A-309.214(a)(3), which states low-risk impoundments shall be closed as soon as practicable, but no later than December 31, 2029.

Source Area

The Belews Creek coal ash basin is the primary source area evaluated in this CAP.

The ash basin, constructed from 1970 to 1972, is located approximately 3,200 feet northwest of the steam station powerhouse. The ash basin consists of a single cell impounded by the main earthen dam located on the north end of the ash basin and an embankment dam (Pine Hall Road dam) located in the northeast portion of the basin along Pine Hall Road**.** The area contained within the ash basin waste boundary is approximately 283 acres.

CCR materials, composed primarily of fly ash and bottom ash, were initially deposited in the unlined ash basin via sluice lines beginning in 1974. CCR material (both bottom ash and fly ash) was converted to dry handling in 2018. Deposition of all waste streams into the ash basin discontinued on March 27, 2019 in preparation for ash basin closure.

Decanting of the ash basin pond was initiated on March 27, 2019. The former operating elevation of the ash basin pond was 750 feet. As of December 1, 2019 approximately 469,400,000 gallons of water had been pumped from the ash basin with a corresponding reduction in hydraulic head of 10.6 feet in elevation. Completion of ash basin decanting, as part of the ash basin closure process, is scheduled to occur on or before September 30, 2020.

Additional Source Area

The closed PHR Landfill, which occupies approximately 67.2 acres, is located in the southern portion of the original ash basin footprint. The PHR Landfill received an initial permit (Permit No. 8503 – INDUS) to operate from NCDENR Division of Waste Management (DWM) in December 1984. The landfill was permitted to receive fly ash. The capacity of the landfill is approximately 3,616,800 tons. The landfill is unlined, and designed with a 1-foot-thick soil cap on the side slopes and 2-foot-thick soil cap on flatter areas. A subsequent expansion (Phase I Expansion), permitted in 2003, was also unlined but was permitted with a synthetic cap system to be applied at closure. After groundwater concentrations greater than 02L standards were detected near the landfill and adjacent to the ash basin, the placement of additional ash in the Phase I Expansion was halted and the closure design was changed to use an engineered cover system for the above-grade portion of the landfill. The PHR Landfill was closed per the approved capping-and-closure plan, which included a synthetic cover system consisting of 40-millimeter linear low-density polyethylene (LLDPE) with a geonet installed over all previously active landfill areas. It further included a minimum 2-foot soil-only cover on the area north of the landfill covering the historical ash basin and stormwater features. The construction of the engineered cover system, including the additional soil cover, was completed in December 2008. The cover system is a source control measure implemented for the landfill.

The PHR Landfill is within the ash basin drainage system (*i.e.* watershed). Groundwater monitoring data indicate constituents similar to COIs (*e.g.* boron and chloride), identified from groundwater monitoring of the ash basin, and are present in groundwater beneath and within a limited horizontal extent of the landfill footprint. The ash basin compliance boundary and landfill compliance boundary overlap, with the exception of an area of the landfill compliance boundary that is south of the ash basin compliance boundary. All groundwater COI migration from the landfill is confined within the landfill compliance boundary, with the exception of some COI migration north of the landfill and within the ash basin compliance boundary. COI migration north of the landfill has a commingled plume with the ash basin plume. Groundwater model simulations predict that groundwater COI migration from the landfill will not migrate beyond the landfill compliance boundary in the future. Groundwater from the closed landfill and the ash basin flows primarily north, where corrective action is planned; therefore, the PHR Landfill is included in the groundwater CAP.

Pre-Basin Closure Activities

To accommodate closure of the ash basin, decanting (removal) of free water from the basin began on March 27, 2019 as required by a Special Order by Consent (SOC) issued through North Carolina Environmental Management Commission (EMC) on July 12, 2018 (EMC SOC WQ S18-004; Appendix B of **Appendix K**). The SOC requires completion of decanting by September 30, 2020. Decanting of 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, approximately 469,400,000 gallons water have been removed from the ash basin and the water elevation has decreased by 10.6 feet.

Basis for CAP Development

A substantial amount of data related to the ash basin, PHR Landfill and the general Belews Creek site has been collected to date. A summary of the BCSS assessment documentation used to prepare this CAP is presented in **Table ES-1.**

TABLE ES-1
SUMMARY OF BCSS ASSESSMENT DOCUMENTATION

Comprehensive Site Assessment Report - Belews Creek Steam Station Ash Basin [HDR Engineering, Inc. of the Carolinas (HDR 2015a)].
Corrective Action Plan Part 1 - Belews Creek Steam Station Ash Basin (HDR 2015b).
Ash Basin Closure Plan Report, 100% Draft Closure Plan for CCR Posting - Belews Creek Steam Station (AECOM 2016).
Corrective Action Plan Part 2 (included CSA Supplement 1 as Appendix A) - Belews Creek Steam Station Ash Basin (HDR 2016b).
Comprehensive Site Assessment Supplement 2 - Belews Creek Steam Station Ash Basin (HDR 2016a).
Basis of Design Report (100% Submittal) - Belews Creek Steam Station (SynTerra 2017a).
Comprehensive Site Assessment Update - Belews Creek Steam Station Ash Basin (SynTerra 2017b).
Preliminary Updated Groundwater Flow and Transport Modeling Report - Belews Creek Steam Station (Falta Environmental 2018).
Human Health and Ecological Risk Assessment Summary Update - Belews Creek Steam Station (SynTerra 2018).
Community Impact Analysis of Ash Basin Closure Options at the Belews Creek Steam Station (Exponent 2018).
Belews Creek Steam Station HB 630 Provision of Permanent Water Supply Completion Documentation (Duke Energy 2018)
Closure Options Analysis (AECOM 2018)
Ash Basin Pumping Test Report - Belews Creek Steam Station (SynTerra 2019a).
Surface Water Evaluation to Assess 15A NCAC 02B - Belews Creek Steam Station (SynTerra 2019b).
2018 Annual Groundwater Monitoring Report (SynTerra 2019c).
Updated Background Threshold Values for Soil and Groundwater (SynTerra, 2019d).

Prepared by: ALA Checked by: CDE

NCDEQ reviewed the October 31, 2017 CSA Update report, and in an April 26, 2018, letter to Duke Energy, NCDEQ stated that sufficient information was provided to allow the preparation of this CAP Update (**Appendix A**).

The assessment work referenced in the documents listed in **Table ES-1** has resulted in a significantly large dataset that has informed the development of this CAP Update. As of June 2019, the following data collection and analyses activities have been completed:

TABLE ES-2
SUMMARY OF BCSS ASSESSMENT ACTIVITIES

Tasks	Total
Total Monitoring Wells Installed [CAMA and CCR Wells around basin(s)]	173
Groundwater Monitoring Events	30
Groundwater Samples Collected	2,985
Individual Analyte Results	175,726
Off-Site Water Supply Well Sampling (Total inorganic analysis) - Number of Analyses	4,753
Ash Pore Water - Number of Analyses (Total and dissolved)	8,497
Ash Pore Water Sampling Events	15
Surface Water Monitoring Events	15
Surface Water Sample Locations	25
Area of Wetness Sample Events	21
Ash Samples (Within ash basin analyzed for SPLP)	7
Soil Samples Collected	134
Soil Sample Locations	45
Sediment Sample Locations	33
Geotechnical Soil Sample Locations	74
Geochemical Ash, Soil, Partially Weathered Rock, Whole Rock Samples	80
Hydraulic Conductivity Tests (Slug Tests, Pumping Tests, Packer Tests, FLASH Analysis of Bedrock HPF Data)	79
Groundwater Flow & Transport Simulations	85
PHREEQC Geochemical Simulations	62

Prepared by: ALA Checked by: DAA

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 an understanding of the COI behavior and distribution in groundwater and to aid in the selection of the appropriate remedial approach. The COI management process consists of three steps:

1. Perform a detailed review of the applicable regulatory requirements under 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 at the Belews Creek ash basin and PHR Landfill 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 constituent behavior in the subsurface related to the ash basin and the PHR Landfill, or to identify constituents 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 an ash basin would be subject to corrective action. Constituents that are naturally occurring at concentrations greater than the 02L standard do not warrant corrective action. Details of the COI management approach are presented in **Section 6.0** and **Appendix H**.

Groundwater

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

Soil

Data indicate that unsaturated soil constituent concentrations are generally consistent with background concentrations or are less than regulatory screening values. In the few instances where unsaturated soil constituent concentrations are greater than the Preliminary Soil Remediation Goal (PSRG) Protection of Groundwater (POG) standards or background values, constituent concentrations are within range of background dataset concentrations or there are no mechanisms by which the constituent could have been transported from the ash basin or PHR Landfill to the unsaturated soils. Therefore, this CAP Update focuses on remediation of groundwater associated with ash basin and additional source area (closed PHR Landfill).

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 for the Belews Creek ash basin and PHR Landfill are presented in **Section 5.4** and **Appendix E** of this CAP Update. Data from water supply wells, Belews Reservoir and the Dan River indicate no evidence of increased risk posed by groundwater migration associated with the ash basin and PHR Landfill based on evaluation of concentrations of CCR constituents in environmental media and potential receptors.

Risk Ranking

In accordance with G.S. Section 130A-309.211(c1) of House Bill 630 (2016) Duke Energy installed 36 water filtration systems at surrounding properties within a 0.5-mile radius of the ash basin compliance boundary. Installation of filtration systems, along with certain improvements to the Belews Creek dam completed by Duke Energy, resulted in the ash basin 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 constituent interactions specific to the Site and is critical to understanding the subsurface conditions related to the ash basin and PHR Landfill. The updated CSM developed for the BCSS included in this CAP is based on a U.S. Environmental Protection Agency (USEPA) document titled “Environmental Cleanup Best Management Practices: Effective Use of the Project Life Cycle Conceptual Site Model” (EPA, 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 become available. The current BCSS CSM is consistent with Stage 4 “Design CSM”, Stage 4 allows for iterative improvement of the site CSM during design of the remedy while also supporting the development of the basis for the remedy design (USEPA, 2011).

Multiple lines of evidence have been used to develop the CSM based on the large BCSS data set generated. The remedial action evaluation to meet the effectiveness criteria in the CAP guidance provided by NCDEQ is also based on the updated CSM (NCDEQ, 2019).

The following provides an overview of the updated CSM for the BCSS ash basin, PHR Landfill and the surrounding area 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 basin and PHR Landfill have been identified.** The Site-specific risk assessment conducted for the ash basin and PHR Landfill indicates no measurable difference between evaluated Site-related risks and risks imposed by background concentrations. Site-specific risk assessments indicate incomplete potential exposure pathways and no risk to residential receptors near the ash basin and the PHR Landfill (no completed exposure pathways).
- **The ash basin and PHR Landfill do not increase risks to ecological receptors.** The assessment did not indicate an increase of risks to ecological receptors (mallard duck, great blue heron, muskrat, river otter, and killdeer bird) that might access surface water and sediments downgradient of the ash basin and PHR Landfill.
- **Based on groundwater flow patterns, the location of water supply wells in the area, and an evaluation of groundwater analytical data, groundwater from the source area does not flow toward water supply wells.** Groundwater data collected from water supply wells and on-Site monitoring wells, groundwater elevation measurements from 30 monitoring events, and groundwater flow and transport modeling results all indicate that Site COIs are not affecting, and have not affected, water supply wells.
- **The permanent water solution program implemented by Duke Energy provides water filtration systems to private and public surrounding properties with water supply wells within a 0.5-mile radius of the ash basin compliance boundary.** The hydrogeologic data collected at Belews Creek confirms that Site-related COIs have not affected off-Site water supply users. Groundwater modeling predicts that Site-related COIs will not affect off-Site water supply users. However, Duke Energy installed 36 water filtration systems at surrounding properties in accordance with G.S. Section 130A-309.211(c1).

- **The hydrogeologic setting of the BCSS ash basin and PHR Landfill 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. As of December 1, 2019, approximately 469,400,000 gallons of water have been removed from the ash basin and the water elevation has decreased by 10.6 feet.
- **The physical setting and hydraulic processes control the COI flow pattern within the ash basin, underlying groundwater system, and downgradient areas.** The ash basin is predominantly a horizontal water flow-through system. Groundwater enters the upgradient side of the ash basin; it is supplemented by rainfall infiltration and flows laterally through the middle of the ash basin 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 saprolite upgradient from the dam. 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 unnamed tributary discharge zone, limiting downward migration of COIs to the area proximate to the dam. The exception is near the northwest corner of the basin, where the hydraulic head from the operating water level of the basin caused COI migration west of the dam. Bedrock wells installed at various depths within the basin footprint and downgradient of the dam structure support the flow characteristics. However, ash basin decanting will re-establish a hydraulic divide along the topographic ridge to the northwest, preventing groundwater flow and additional COI migration.
- **Horizontal distribution of COIs in groundwater at or beyond the ash basin compliance boundary is limited to areas north and northwest of the ash basin.** The physical extent of constituent migration north and northwest of the ash basin is controlled by hydrologic divides, dilution from unaffected groundwater and the groundwater-to-surface water discharge zones. All groundwater COI migration from the PHR Landfill occurs within with the landfill compliance boundary, with the exception of some COI migration north of the landfill, but within the ash basin compliance boundary.

- **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), a response to changing geochemical parameters (*i.e.*, pH and Eh) and the sorption capacity of the soil and/or rock. Based on geochemical modeling:
  - Non-conservative, reactive COIs (i.e., arsenic and beryllium) will remain in mineral phase assemblages that are stable under variable Site conditions north and northwest of the basin, demonstrating sorption as an effective attenuation mechanism.
  - Variably reactive COIs (*e.g.*, cobalt and manganese) can exhibit mobility depending on pore water geochemical conditions and availability of sorption sites.
  - Conservative, non-reactive COIs (*e.g.*, boron, chloride, and total dissolved solids) 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 slightly alkaline to alkaline pH values. Maximum boron sorption occurs at pH values between 7.5 standard units (S.U.) and 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, with the exception of Parcel A, an unoccupied 2.67-acre property located northwest of the ash basin.** The plume associated with the ash basin has been characterized and is stable with exceptions to the north and northwest of the ash basin. A 10-well groundwater extraction system was installed upgradient of Parcel A as an accelerated interim remedial action to hydraulically reduce COI transport from the ash basin toward Parcel A. The system became operational in March 2018. Flow and transport groundwater model predictions indicate the decanting of the water in the ash basin will lower the hydraulic head within the ash basin and reduce or eliminate additional COI migration northwest of the ash basin.

- **Groundwater-to-surface water interaction has not caused, and is not predicted to cause, concentrations of COIs greater than NCAC, Title 15A Subchapter 02B,**

Surface Water and Wetland Standards (02B). Analytical results for surface water samples collected from the Dan River and Belews Reservoir indicate that these water bodies meet 02B standards under current conditions. 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 (Dan River and Belews Reservoir) surrounding the BCSS ash basin are healthy, based on multiple lines of evidence including robust fish populations, species variety, and other indicators based on years of sampling data.** Multiple water quality and biological assessments conducted by Duke Energy as part of the NDPES monitoring program, combined with the results of the ecological risk assessment, indicate that there are no adverse ecological effects to the main surface water systems proximate to the ash basin or PHR Landfill 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 BCSS naturally contains cadmium, cobalt, iron, and vanadium at concentrations greater than 02L standard or IMAC. The occurrence of inorganic constituents in groundwater of the Piedmont Physiographic Province is well documented in the literature. For example, iron has natural background concentrations in the shallow flow zone at the Site greater than 02L and vanadium has natural background concentrations in all flow zones at the Site greater than its IMAC. For the BCSS CAP Update, vanadium is evaluated based on its Site-specific statistically derived background value and on additional lines of evidence to determine whether constituent concentrations represent migration from the ash basin or are naturally occurring.

These CSM aspects, combined with the updated human health and ecological risk assessments, provide the basis for the corrective action plan developed for the ash basin and the closed Pine Hall Road Landfill.

ES.4 Corrective Action Approach

Corrective Action Objectives and Zones Requiring Corrective Action

Migration of COIs related to the ash basin in groundwater at or beyond the compliance boundary occurs in localized areas to the north and northwest of the ash basin. Groundwater corrective action was also evaluated for the PHR Landfill. It was determined that groundwater flow from the landfill is primarily to the north and that no migration of COIs related to the PHR Landfill has occurred at or beyond the portion of the landfill compliance boundary that is not included in the ash basin compliance boundary. Because the PHR Landfill is within the drainage network of the ash basin, and groundwater flow from the landfill and the ash basin is northward, groundwater from the landfill will be captured through the planned groundwater remediation system, north of the ash basin. To satisfy G.S. and maintain compliance with 02L, the corrective action approach planned for the ash basin focuses on restoring ash basin-affected groundwater at or beyond the compliance boundary. The following remedial objectives address the regulatory requirements of NCAC Title 15A Subchapter 02L for the BCSS 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 close 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 for the ash basin is shown in **Figure ES-1**. Groundwater concentrations greater than 02L/IMAC/applicable background concentration values occur locally at or beyond the ash basin compliance boundary north and northwest of the ash basin. COI concentrations are less than 02L groundwater standards typically within 500 and 750 feet of the waste boundary, north and northwest of the ash basin. The area proposed for corrective action is shown in **Figure ES-2.**

Summary of Source Control and Corrective Measures

It is critical to take into account the various activities Duke Energy has/will perform to improve subsurface conditions related to the ash basin and PHR Landfill at the BCSS. The remedial program incorporates source control by basin decanting and closure, 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 ash basin. Decanting will lower the hydraulic head within the basin 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 steam valley, then northward. Decanting was initiated on March 27, 2019. As of December 1, 2019, approximately 469,400,000 gallons of water have been pumped from the ash basin with a corresponding reduction in hydraulic head of 10.6 feet in elevation. Decanting is scheduled to be completed on or before September 30, 2020. In addition, ash basin decanting will be effective in reducing or eliminating seeps identified under the SOC.
Ash Basin Closure	The ash basin closure-in-place option and closure- by-excavation options are considered source control activities. Extensive groundwater modeling indicates that either method results in similar effects with respect to groundwater remediation.
Toe-Drain Water Collection System	A toe-drain water collection system that consists of a 16-inch diameter by 18 foot deep wet well has been installed below the ash basin dam adjacent to the unnamed tributary. The wet well storage capacity is approximately 2,000 cubic feet. The wet well and pump station storage capacity is approximately 2,000 cubic feet. The system construction and testing is complete and will begin operation in January 2020. Once in operation, the toe-drain system will collect water from the toe of the ash basin dam and route it to the Dan River through new discharge piping to a permitted NPDES outfall.

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

Groundwater Remedy Component	Rationale
Active Groundwater Remediation Activities	
Interim Action Plan Accelerated Remediation Groundwater Extraction System	A 10-well groundwater extraction system was installed adjacent to Parcel A in the area northwest of the ash basin. The system was activated on March 14, 2018. The system currently operates at approximately 12 gallons per minute (gpm) extraction flow rate. As of November 2019, approximately 9,900,000 gallons of water have been extracted by the system. Post-decanting, the 10 interim action extraction wells are expected to have reduced extraction rates as a result of the reduced hydraulic head of the ash basin. The system is predicted to remove a total of 2.5 gpm. Continued operation of the system is included in the remedial alternatives evaluated.
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 the area north and northwest of the ash basin, where COIs are detected at concentrations greater than applicable criteria. To meet the above-referenced CAP objectives, 10 existing extraction wells with the addition of 113 extraction wells, 47 clean water infiltration wells, and one horizontal clean water infiltration well are planned to be placed in areas to reduce COI concentrations based on actual Site data and groundwater modeling simulations.
Institutional Controls and Monitoring	
Maintain Ownership and Institutional Controls (ICs) Consisting of a Land Use Restriction	ICs in the form of a Declaration of Perpetual Land Use Restrictions might be requested in the future based on the results of groundwater remediation activities
Permanent Water Solution for Water Supply Well Users within a 0.5-mile radius of the Coal Ash Basin Compliance Boundary and Associated Water Filtration System Maintenance	Groundwater data from the Site indicate that surrounding water supply wells have not been affected by Site-related COIs. However, the installation of water filtration systems by Duke Energy for 36 surrounding properties has been completed and approved by NCDEQ to address current and future stakeholder concerns. Duke Energy maintains these systems on behalf of the property owners.

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

Groundwater Remedy Component	Rationale
Effectiveness Groundwater Monitoring	Duke Energy plans to monitor 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, if needed. The CAP Update includes a comprehensive review of groundwater data collected through April 2019 and a plan to optimize the monitoring program. Within thirty (30) days of CAP approval, Duke Energy would implement the effectiveness monitoring program.
Provision for Adaptive Management of Groundwater Remedies	The BCSS ash basin and surrounding area is a complex site; therefore, Duke Energy believes it is important to allow for an adaptive approach during implementation of this CAP. This approach is consistent with the Interstate Technology and Regulatory Council (ITRC) document titled *Remediation Management of Complex Sites* (ITRC, 2017). This approach might 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 MCDEQ's authority under 15A NCAC 02L .0106(k).

Prepared by: ALA Checked by: CDE

Notes:
COI – Constituents of Interest
NCDEQ – North Carolina Department of Environmental Quality
ICs – Institutional Controls
CAP – Corrective Action Plan

Corrective Action at Remediation Zones

The area proposed for groundwater remediation in accordance with 02L requirements is to the north and northwest of the ash basin at or beyond the compliance boundary (**Figure ES-2**). Multiple potential groundwater remedial technologies were initially screened as part of this CAP Update to identify the most applicable remedial methods based on Site specific hydrogeologic conditions and COI distribution in groundwater. After the 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 clean water infiltration and treatment

These remedial alternatives were further screened against the following criteria outlined in Section 6.D.iv. (1-10) of the CAP guidance (NCDEQ, 2019):

- 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

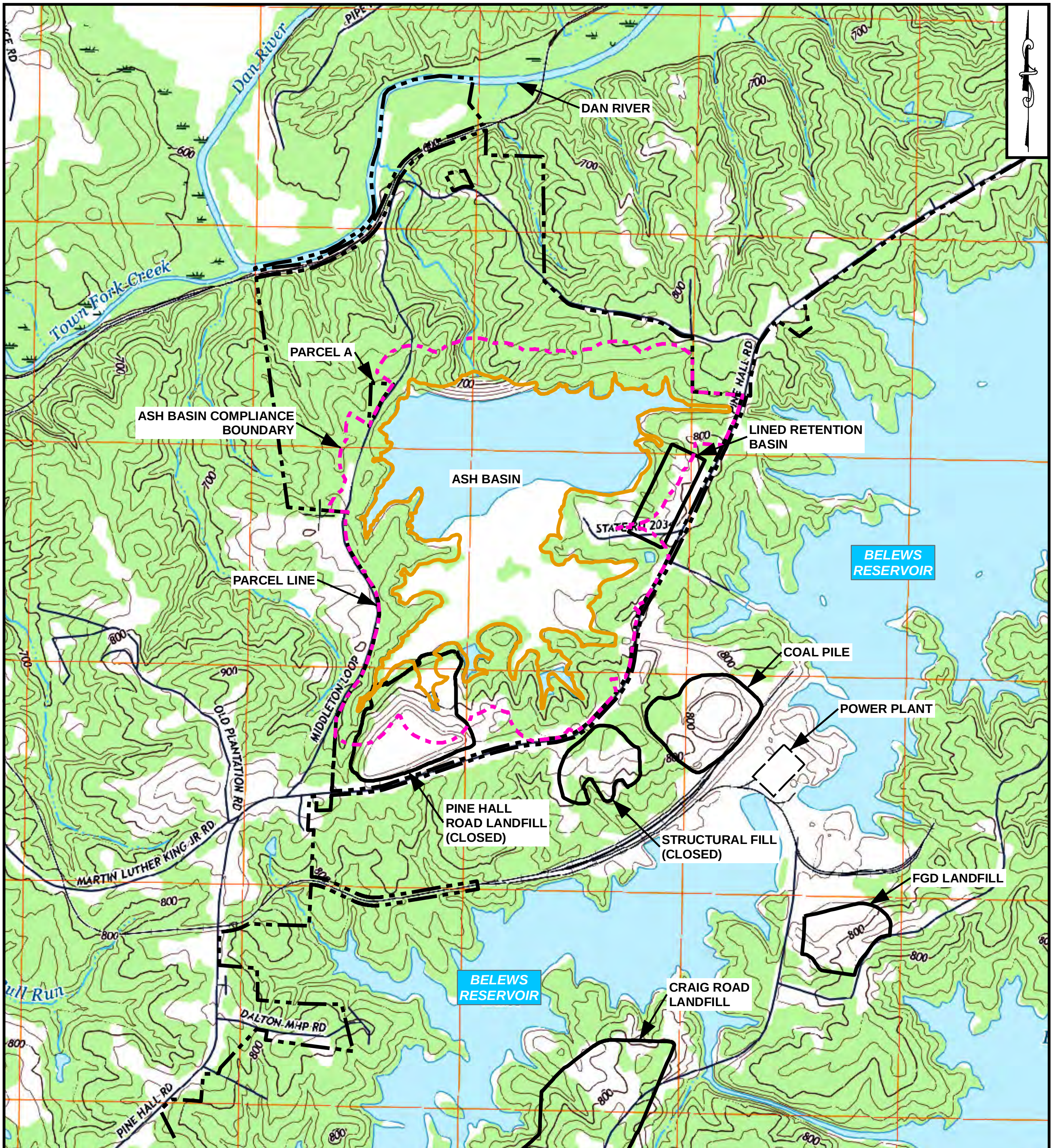
Groundwater modeling simulations were performed to evaluate the effectiveness of the alternatives and to develop the most effective approach. The results of the analysis indicate that Alternative 3: groundwater extraction combined with clean water infiltration and treatment would most effectively achieve the remedial objectives presented above. The well layout for Alternative 3 is depicted in **Figure ES-3**. This alternative consists of:

- 10 existing vertical extraction wells to the northwest of the ash basin
- 113 new vertical extraction wells to the north and northwest of the ash basin
- 47 vertical clean water infiltration wells north and northwest of the ash basin
- One horizontal clean water infiltration well northwest of the ash basin

It is anticipated that the new clean water infiltration and extraction wells will be screened within the saprolite, transition, and bedrock flow zones, with depths ranging from approximately 30 feet below ground surface (bgs) to 180 feet bgs.

The flow and transport model predicts the groundwater remediation system will have a total infiltration flow rate of approximately 165 gpm and a total groundwater extraction flow rate of approximately 90 gpm. The extracted water is planned to be treated and then discharged through an existing permitted NPDES outfall location. Details on this approach are presented in **Section 6.0**. Remedial performance monitoring will be performed to evaluate remedy effectiveness as described in **Section 6.8** of this CAP Update.

It is recommended that prior to implementation, pilot testing of the proposed alternative will be conducted at the areas north and northwest of the dam. 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. Planned activities prior to full-scale implementation, where either submittal of the remedial performance monitoring plan (*i.e.*, effectiveness monitoring plan), or the pilot test work plan and permit applications (as applicable) will be submitted to NCDEQ within 30 days of CAP approval to fulfill G.S. Section 130A-309.211(b)(3)



SOURCE:
2016 USGS TOPOGRAPHIC MAP, BELEWS LAKE QUADRANGLE, OBTAINED FROM THE USGS STORE AT https://store.usgs.gov/map-locator.

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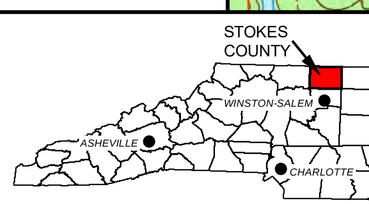

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FIGURE ES-1
USGS LOCATION MAP
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA

DRAWN BY: B. YOUNG	DATE: 05/15/2019
REVISED BY: B. YOUNG	DATE: 07/08/2019
CHECKED BY: A. ALBERT	DATE: 07/08/2019
APPROVED BY: A. ALBERT	DATE: 07/08/2019
PROJECT MANAGER: A. ALBERT	

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

NOTES:

1. THE BOUNDARY OF THE AREA PROPOSED FOR GROUNDWATER REMEDIATION REPRESENTS THE MAXIMUM AREA OF COI CONCENTRATION IN GROUNDWATER GREATER THAN CRITERIA (FALTA ENVIRONMENTAL, 2019).

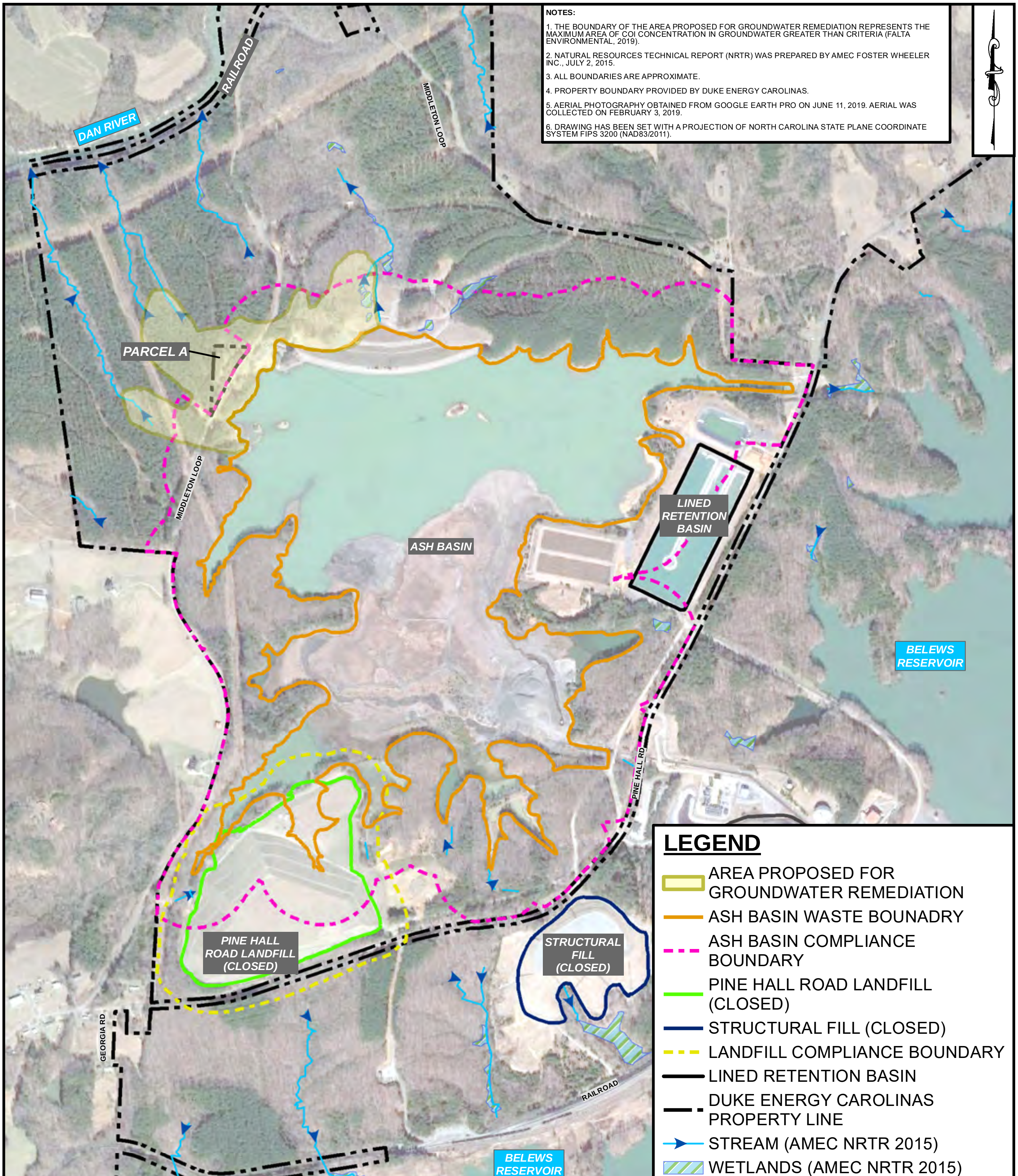
2. NATURAL RESOURCES TECHNICAL REPORT (NRTR) WAS PREPARED BY AMEC FOSTER WHEELER INC., JULY 2, 2015.

3. ALL BOUNDARIES ARE APPROXIMATE.

4. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.

5. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON JUNE 11, 2019. AERIAL WAS COLLECTED ON FEBRUARY 3, 2019.

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



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GRAPHIC SCALE
600 0 600 1,200
(IN FEET)

DRAWN BY: J. KIRTZ DATE: 05/16/2019
REVISED BY: C. WYATT DATE: 12/16/2019
CHECKED BY: C. EADY DATE: 12/16/2019
APPROVED BY: C. EADY DATE: 12/16/2019
PROJECT MANAGER: A. ALBERT

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

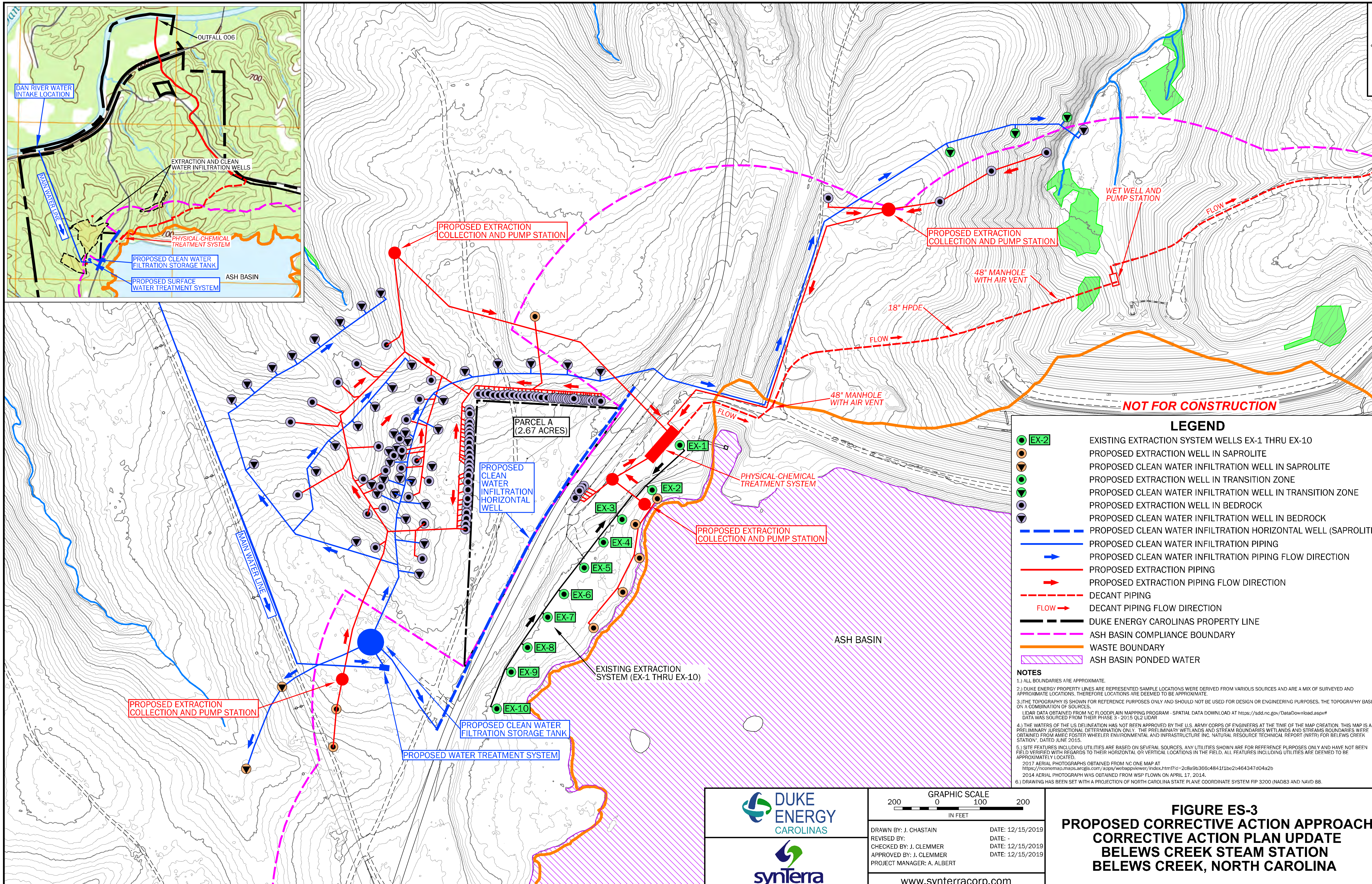

FIGURE ES-3
PROPOSED CORRECTIVE ACTION APPROACH
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA

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6.0 Source Area Evaluation - Ash Basin (Continued)

LIST OF FIGURES (CONTINUED)

LIST OF TABLES

LIST OF TABLES (CONTINUED)

LIST OF APPENDICES

LIST OF ACRONYMS

02B	NCDEQ Title 15A, Subchapter 02B. Surface Water and Wetland Standards
02L	NCDEQ Title 15A, Subchapter 02L. Groundwater Classification and Standards
AOW	Area of Wetness
ASTM	American Society for Testing and Materials
BCSS	Belews Creek Steam Station
BGS	Below Ground Surface
BOD	Basis of Design
BR	Bedrock
BTV	Background Threshold Value
CAMA	Coal Ash Management Act
CAP	Corrective Action Plan
CCR	Coal Combustion Residuals
CFR	Code of Federal Register
COI	Constituent of Interest
CSA	Comprehensive Site Assessment
CSM	Conceptual Site Model
CWTS	Constructed Wetlands Treatment System
cy	cubic yards
Duke Energy	Duke Energy Carolinas, LLC
DWM	Division of Waste Management
Eh	Oxidation Reduction Potential
FLASH	Flow-Log Analysis of Single Holes
EMP	Effectiveness Monitoring Program
EPRI	Electric Power Research Institute
FGD	Flue Gas Desulfurization
GPM	Gallons per minute
G.S.	North Carolina General Statute
GTB	Geotechnical Borings
HAO	Hydrous Aluminum Oxide
HB	Highway Business District
HDPE	High-Density Polyethylene
HFO	Hydrous Ferric Oxide
HPF	Heat Pulse Flow Meter
IAP	Interim Action Plan
IMAC	Interim Maximum Allowable Concentration

LIST OF ACRONYMS (CONTINUED)

IMP	Interim Monitoring Plan
ISV	In-situ Vitrification
K_d	Partition Coefficient
LEAF	Leaching Environmental Assessment Framework
LRB	Lined Retention Basin
MAROS	Monitoring and Remediation Optimization System
mg/L	Milligrams per liter
Mil	Thousandths of Inch
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
ORP	Oxidation Reduction Potential
OSWER	Office of Solid Waste and Emergency Response
PRB	Permeable Reactive Barrier
PHR	Pine Hall Road
Plant/Site	Belews Creek Steam Station
POG	Protection of Groundwater
PSRG	Preliminary Soil Remediation Goal
S.U	Standard Units
SOC	Special Order by Consent
SPLP	Synthetic Precipitation Leaching Procedure
SW	Surface Water
TCLP	Toxicity Characteristic Leaching Procedure
TDS	Total Dissolved Solids
TOC	Total Organic Carbon
UMC	United Methodist Church
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
Work Plan	Groundwater Assessment Work Plan

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 Belews Creek Steam Station (BCSS or Site) coal combustion residual (CCR) ash basin. Duke Energy owns and operates BCSS, located in Belews Creek, Stokes County, North Carolina (**Figure 1-1**).

In accordance with Section 130A-309.211 (b) of the of the North Carolina General Statutes (G.S.), as amended 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. The CAP 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 BCSS was previously submitted to the North Carolina Department of Environmental Quality (NCDEQ) in two parts:

- *Corrective Action Plan Part 1 – Belews Creek Steam Station Ash Basin* (HDR 2015b)
- *Corrective Action Plan Part 2 (included CSA Supplement 1 as Appendix A) – Belews Creek Steam Station Ash Basin* (HDR 2016b)

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 CAP deliverable schedules and requested assessment of additional potential sources of constituents to groundwater at Belews Creek stating that sources hydrologically connected to the ash basin are to be assessed and included in an updated CAP. The Pine Hall Road (PHR) Landfill is included as an additional source hydrologically connected to the ash basin.

In addition to the CAP Update, Duke Energy will be submitting CCR Surface Impoundment Closure Plans (Closure Plan) to NCDEQ on/before December 31, 2019 under separate cover. This CAP has been developed to be effective with the various closure scenarios developed for the Site.

The CAP content and submittal schedule 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, *Corrective Action Plan Content for Duke Energy Coal Ash Facilities* (provided in **Appendix A**), beneath report section headings and within 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 BCSS ash basin and the closed PHR Landfill to support this CAP Update. Site assessment was performed and the BCSS Comprehensive Site Assessment (CSA) Update Report, dated October 31, 2017 (SynTerra, 2017b) 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 hydrogeological 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 April 26, 2018 and stated that the information provided sufficiently warranted preparation of this CAP Update (**Appendix A**). This CAP Update builds on 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, 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 – Belews Creek Steam Station Ash Basin* (HDR Engineering, Inc. of the Carolinas (HDR 2015a).
- *Corrective Action Plan Part 1 – Belews Creek Steam Station Ash Basin* (HDR 2015b).

- *Corrective Action Plan Part 2* (included CSA Supplement 1 as Appendix A) – Belews Creek Steam Station Ash Basin (SynTerra 2016a).
- *Comprehensive Site Assessment Supplement 2 – Belews Creek Steam Station Ash* Basin (HDR 2016a).
- *Basis of Design Report (100% Submittal) – Belews Creek Steam Station* (SynTerra 2017a).
- *Comprehensive Site Assessment Update – Belews Creek Steam Station Ash Basin* (SynTerra 2017b).
- *Ash Basin Pumping Test Report – Belews Creek 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) – Belews Creek 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 basin and PHR Landfill at or beyond the 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 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. The 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 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 constituents associated with the ash basin at or beyond the compliance boundary, north and northwest of the ash basin. 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 Closure and 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 basin and the related contiguous unit — the closed PHR Landfill — have demonstrated that constituent concentrations in groundwater greater than applicable regulatory standards are and will remain contained within the ash basin compliance boundary with the exception of the areas immediately north and northwest of ash basin. In these areas, constituent concentrations return to below standards within 500 to 750 feet north and northwest of the waste boundary.

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 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 the interim of CAP development and implementation, a Settlement Agreement between NCDEQ and Duke Energy signed on September 29, 2015, required that accelerated remediation be implemented at sites that demonstrate off-site affected groundwater migration, including BCSS. Historical and ongoing assessment information indicates the potential for off-Site affected groundwater migration northwest of the BCSS ash basin in the area of Parcel A. After correspondence with NCDEQ and conditional approval of an Interim Action Plan (IAP), Duke Energy began interim action activities to target Parcel A in 2016 with a pilot test for a groundwater extraction system along the northwest corner of the ash basin. The primary objective of the groundwater extraction system is to reduce groundwater migration of source area constituents from the ash basin toward the area northwest of the ash basin and to achieve a hydraulic boundary proximal to the extraction well network. A Basis of Design (BOD) report was submitted to the NCDEQ Division of Water Resources (DWR) on September 1, 2017. In a letter with comments dated October 31, 2017, NCDEQ granted permission for Duke Energy to proceed with installation of the extraction well network. Duke Energy provided responses to NCDEQ comments along with report and figure revisions on December 14, 2017. Operation of the extraction system began in March 2018 and continues, with weekly system monitoring and annual effectiveness monitoring reporting, through present day.

In addition to the IAP and groundwater CAP, the Belews Creek ash basin is 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. It is important to note that the Belews Creek ash basin meets the low-risk classification criteria set forth in CAMA for CCR surface impoundments. On October 12, 2018, NCDEQ confirmed that Duke Energy satisfactorily completed the alternate water provision under CAMA, G.S. Section 130A-309.211(c1). On November 13, 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, NCDEQ issued a determination that the Belews Creek coal ash basin is 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 closure scenario, closure-by-excavation or closure-in-place (hybrid).

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

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

Potential active remedial alternatives were developed using the criteria included in the NCDEQ's CAP Guidance (NCDEQ, 2019). 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 effects 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 effects 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 6.7** for use in evaluating remedial alternatives in **Section 6.8**.

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)

The BCSS is situated in the Piedmont physiographic province of north-central North Carolina. Duke Energy owns approximately 600 acres around the BCSS. The station is located on the northwest side of Belews Reservoir on Pine Hall Road in Belews Creek, Stokes County, North Carolina (**Figure 1-1**). BCSS is a two-unit coal-fired electricity generating plant with a combined capacity of 2,240 megawatts (MW). The station began commercial operations in 1974 with Unit 1 (1,120 MW) followed by Unit 2 (1,120 MW) in 1975. Cooling water for BCSS is provided by Belews Reservoir, which was created to serve this purpose.

The area surrounding the ash basin generally consists of residential properties, farm land, undeveloped land, the Dan River and Belews Reservoir (**Figure 1-2**). Natural topography associated with the ash basin ranges from an approximate high elevation of 878 feet North American Vertical Datum of 1988 (NAVD 88) southeast of the ash basin near the intersection of Pine Hall Road and Middleton Loop to an approximate low elevation of 646 feet at the base of the ash basin dam located at the north end of the ash basin. An unnamed tributary, situated beginning approximately 300 feet from the base of the ash basin dam, extends 4,300 feet from southeast to northwest where it enters the Dan River. The elevation at the discharge point to the Dan River is approximately 578 feet. The elevation of Belews Reservoir is approximately 725 feet.

Based on a review of available historical aerial photography, the area historically consisted of a combination of agricultural land, rural residential, and woodlands prior to the impoundment of Belews Creek for the formation of Belews Reservoir and construction of the station. **Figure 1-3** presents an aerial photograph from 1966 prior to development of the station and construction of Belews Reservoir.

1.5.2 Operations and Waste Streams Coincident with the Ash Basin

(CAP Content Section 1.E.b)

Coal-Related Operations and Waste Streams Coincident with the Ash Basin

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.

Coal has arrived at BCSS through rail transportation since operations began. Coal storage has historically occurred at the Site's coal pile located immediately northwest of the powerhouse. The coal pile is located within a groundwater drainage area separate from and southeast of the ash basin (**Figure 1-2**). The coal pile is not within the scope of this CAP Update (see **Section 3.0**). The coal is stored on the pile then conveyed via transfer belts to the station where it is pulverized before being utilized in the boilers. Coal ash and other CCRs are produced from coal combustion. The smaller ash particles (fly ash) are carried upward in the flue gas and are captured by an air pollution control device, such as an electrostatic precipitator. The larger ash particles (bottom ash) fall to the bottom of the boiler.

Approximately 70 percent to 80 percent of ash produced during coal combustion is fly ash (EPRI 1995). Typically, 65 percent 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 percent 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).

Non-Coal-Related Operations and Waste Streams Coincident with the Ash Basin

Environmental incidents at the BCSS site have occurred only in the vicinity of the Plant area. Incidents that initiated notifications to NCDEQ and subsequent remediation under NCDEQ's DWM mainly consisted of motor/lubrication or transformer oil. These incidents had no effect on the ash basin constituent distribution in groundwater because the Plant area is separated from the ash basin by a hydrogeologic divide (**Figure 1-2**) and is not considered a component of this CAP. No non-coal or environmental incidents (*i.e.,* releases that initiated notification to NCDEQ) are known to have occur in the vicinity of, or coincident to, the ash basin. Therefore, no environmental incidents at the BCSS are relevant to 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 BCSS ash basin to the Dan River (Outfall 006) in accordance with NPDES Permit NC0024406. The sources of wastewater managed under the NPDES permit include non-contact cooling water, ash basin discharge, sanitary waste, cleansing and polishing water, low volume wastes, groundwater and stormwater from process areas. The facility operates the following outfalls:

- ***Outfall 001:*** *Once-through cooling water; includes screen backwash, recirculating cooling water, station equipment cooling water, and once-through cooling water. This outfall discharges to Belews Reservoir.*
- ***Internal Outfall 002:*** *FGD wastewater (discharging to ash pond)*
- ***Internal Outfall 006A:*** *Ash basin discharge consisting of waste streams from the powerhouse and yard holding sumps, ash sluice lines, chemical holding pond, coal yard sumps, stormwater, coal pile collection basins (collecting contact stormwater from coal piles), remediated groundwater, emergency release of anhydrous ammonia, seepage from coal ash basin, emergency overflow from the retention basin, emergency overflows from the existing designated effluent channel, and treated flue gas desulfurization (FGD) wastewater from internal outfall 002. The wastewater from Outfall 006A discharges to the Dan River.*

  Ash basin discharges are to be conveyed through a toe-drain water collection system at the base of BCSS dam, which will redirect water from the unnamed tributary. Once in operation, the toe-drain water collection system at the base of the BCSS dam will lower groundwater levels and redirect water collected from the unnamed tributary, thereby improving surface water and groundwater quality in the area north of the ash basin.

- ***Outfall 006:*** *Waste streams that previously flowed to the ash basin have been rerouted to the new lined retention basin (LRB). The LRB accepts wastes from the holding basin, various sumps, coal pile runoff, stormwater runoff, cooling tower blowdown, FGD wastewater, groundwater and various low volume wastes. Discharge from the new LRB flows to Outfall 006. Outfall 006 flows to the Dan River.*
- ***Outfall 005:*** *Formerly stormwater outfall SW002, this outfall consists of once-through non-contact chiller water and storm water. This outfall discharges to Belews Reservoir.*
- ***Outfall 007:*** *This is an emergency spillway for the South Coal Basin. This outfall discharges to Belews Reservoir. The spillway is designed for a flood greater than a 100-year event. Sampling of this spillway is waived due to unsafe conditions associated with sampling during overflow event.*
- ***Internal Outfall 009:*** *Domestic wastewater plant. The wastewater from this outfall discharges to the Dan River via Outfall 006.*
- ***Toe Drain Outfall 111:*** *Ash basin discharge through toe drains at the base of the ash basin dam. This outfall discharges to the unnamed tributary to Dan River.*

Toe drain outfall 111 will be rerouted to outfall 006A by March 31, 2020.

Special Order by Consent

A Special Order by Consent (SOC) was issued to Duke Energy on July 19, 2018 (Appendix B of **Appendix K**), to address the elimination of seeps from Duke Energy's coal ash basins during the separate and independent process of ash basin closure. The locations included in the SOC are subject to the monitoring and evaluation requirements contained in the SOC. 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 under way, is expected to substantially reduce or eliminate discharge from 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. Basin decanting at BCSS began on March 27, 2019. As of December 1, 2019, approximately 469,400,000 gallons water have been removed from the ash basin and the water elevation has decreased by 10.6 feet. The SOC requires completion of decanting by September 30, 2020.

Permitted Solid Waste Facilities

There are four solid waste facilities associated with BCSS:

1. Craig Road Landfill (NCDEQ Permit No. 8504-INDUS)
2. FGD Residue Landfill (NCDEQ Permit No. 8505-INDUS)
3. Closed Structural Fill (NCDEQ Permit No. CCB0070)
4. Closed Pine Hall Road Landfill (NCDEQ Permit No. 8503-INDUS)

The Craig Road Landfill and the FGD Residue Landfill are located south of the ash basin on the south side of Belews Reservoir (**Figure 1-1**). The closed structural fill, constructed by using fly ash generated from BCSS, is located south of the ash basin on the south side of Pine Hall Road. The closed PHR Landfill is located south of the ash basin and north of Pine Hall Road. Only the PHR Landfill is located within the ash basin compliance boundary and is addressed as part of this CAP Update.

Additional Permits

In addition to NPDES wastewater discharge permit NC0024406, the facility also holds NPDES stormwater discharge permit NC000573, air permit #01983 (for two coal/No. 2 fuel oil-fired electric utility boilers), a hazardous wastes permit NCD000856591 as a RCRA small quantity generator, and industrial landfill permits 85-03, 85-04, and 85-05.

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 Site, 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 IN SUPPORT OF CAP DEVELOPMENT

(CAP Content Section 2)

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

(CAP Content Section 2.A)

On October 31, 2017, Duke Energy submitted a CSA Update to NCDEQ. In a letter from NCDEQ to Duke Energy dated April 26, 2018, NCDEQ stated that sufficient information had been provided in the 2017 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**).

On May 23, 2018, NCDEQ Winston Salem Regional Office (WSRO) submitted an email with the subject: *Duke Coal: Belews Creek Full Draft Comments for Discussion Friday (19 pages in total) and to the report titled 'Draft Comments about the CSA Update Report, October 31, 2017, Belews Creek Steam Station'* to Duke Energy (**Appendix A**). The email outlines additional draft comments to the 2017 CSA Update.

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 April, 2018 letter are summarized in **Appendix B**. Responses to the May 23, 2018 emailed additional draft comments are provided in **Appendix B**. Responses provide references to sections and elements of the CAP Update where the specific comments are addressed and/or provides additional supporting information to address the comments. Additional content related to NCDEQ's comments are either included within sections of this CAP Update or as standalone appendices to this CAP Update, such as the groundwater modeling report and surface water evaluation reports.

Activities that directly addressed NCDEQ comments include:

- An additional monitoring well was installed within the shallow flow zone beneath the ash basin to address the pre-existing data gap. Discussion of data acquired from the groundwater monitoring wells beneath the ash basin is presented in **Section 6.1**.
- Groundwater samples continued to be collected on a quarterly basis as part of the Belews Creek Interim Monitoring Plan (IMP). Additional sampling results

augmented the groundwater quality database. Comprehensive groundwater analytical data are included in **Appendix C**, Table 1.

- An additional groundwater monitoring well cluster was installed northwest, downgradient of the ash basin to evaluate horizontal and vertical delineation of the northwest groundwater plume. Discussion of groundwater constituent extent in included in **Section 6.1**.
- Characterization of fractured bedrock based on additional evaluation of lineaments, the bedrock fracture system, and the bedrock matrix. A report summarizing the evaluation and implications for bedrock groundwater flow and transport is included in **Appendix F**.
- Additional assessment of the Dan River and Belews Reservoir surface water and sediment was performed in February 2018. There were no constituent concentrations greater than 02B surface water standards attributable to the groundwater plume(s). 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 K**.
- An evaluation of potential affected groundwater migration to surface water under future conditions was conducted and the results of the evaluation are presented in **Appendix K**. There were no constituent concentrations predicted to be greater than 02B surface water standards attributable to the groundwater plume(s).
- Background soil dataset and BTVs were updated. Information about background determinations is presented in **Section 4.0**. Updated soil BTVs are listed on **Table 4-2**.
- Background groundwater dataset and BTVs was updated to include data through December 2018. Information about background determinations is presented in **Section 4.0**. Updated groundwater BTVs are listed on **Table 4-3**.
- The Belews Creek flow and transport model and geochemical model were updated to incorporate additional assessment data and information. The models were used to evaluate current and predicted future Site conditions. The flow and transport model report is provided as **Appendix G**. The geochemical model report is provided as **Appendix H**.

- The Belews Creek Conceptual Site Model (CSM) was updated to reflect the most recent understanding of Site conditions 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 basin is the only CAMA-regulated unit at the Site. The only additional source located within or adjacent to the ash basin and is addressed under this CAP Update is the closed PHR Landfill. **Figure 1-2** shows the location of the ash basin waste boundary and compliance boundary, and the PHR Landfill waste boundary (*CAP Content Section 3.A and 3.A.a*).

Other facilities at the Site are not part of the source area addressed herein. A consensus reached with the NCDEQ DWR regarding sources not considered for corrective action as part of this CAP Update and 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 **Table 3-1** (*CAP Content Section 3.B*).

The Belews Creek ash basin and closed PHR Landfill are the two sources carried forward as part of this CAP Update. Three onsite facilities, including the PHR Landfill, Chemical Pond, and Constructed Wetlands Treatment System (CWTS), are identified as hydrologically connected within the drainage systems (i.e. watershed) of the ash basin, two of which were formerly part of the ash basin waste water treatment system: Chemical Pond and CWTS. There is no evidence that source material associated with the Chemical Pond and CWTS have contributed to any constituent migration in groundwater, and therefore these facilities are not carried forward for corrective action as part of this CAP Update.

The closed PHR Landfill is under NCDEQ DWM regulatory oversight and is monitored on a semiannual basis. Groundwater sampling data indicate constituents similar to COIs identified from groundwater monitoring of the ash basin [*e.g.* boron, total dissolved solids (TDS)] are present in groundwater beneath and within a limited horizontal extent of the landfill footprint. The ash basin compliance boundary and landfill compliance boundary overlap, with the exception of an area of the landfill south of the ash basin compliance boundary (**Figure 1-2**). All groundwater constituent migration from the landfill occurs within with the landfill compliance boundary, with the exception of some constituent migration north of the landfill, within the ash basin compliance boundary. Constituent migration north of the landfill has a comingled plume with the ash basin plume. Groundwater constituent migration from the landfill is predicted to not migrate beyond the landfill compliance boundary in the future.

Groundwater from the closed landfill and the ash basin primarily flows north, where corrective action is planned. Corrective action approach for the ash basin and PHR Landfill 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 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 constituents from a source area. If the assessment data concentrations are less than background, it is likely constituent migration from the source area 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
- Evaluation of concentration patterns (i.e., do the patterns represent a discernable plume or migration pattern?)
- Consideration of natural variations in Site geology or geochemical conditions between upgradient (background locations) and downgradient area
- Consideration of other constituents present at concentrations greater than background values

The BCSS and nine other Duke Energy facilities (Allen 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 120-mile radius from Belews Creek. 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 BTVs 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 Site coal ash basin 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 background datasets for each media, statistically calculated background threshold values (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 migration to surface water (**Appendix K**) and are detailed in **Sections 4.3** and **4.4.**

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 BCSS background soil boring locations, unsaturated soil depth interval and number of discrete samples collected from the unsaturated soil depth interval are presented 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 (NCDEQ, 2017). BTVs were calculated using data from background unsaturated soil samples collected June 2015 to April 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).

Duke Energy previously submitted soil provisional background threshold values (PBTVs) — *Proposed Background Threshold Values for Naturally Occurring Concentrations in Groundwater and Soil* (SynTerra, 2017) and subsequent updated soil BTVs to NCDEQ — *Updated Background Threshold Values for Soil Technical Memorandum* (SynTerra, 2017). NCDEQ provided comments on PBTVs in a response letter dated September 1, 2017; and NCDEQ provided approval of updated BTVs in a response letter dated May 14, 2018. Responses letters are provided in **Appendix A**. Soil background values for Belews Creek were updated in 2019 and are provided, along with the original soil BTVs 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 June 2015 to April 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 provided as an attachment to the *Updated Background Threshold Values for Constituent Concentrations in Groundwater* (SynTerra, 2019). 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 to the Site is divided into the following three flow zones to distinguish the interconnected groundwater system: the shallow flow layer, deep (transition zone) flow layer, and the bedrock flow layer. The BCSS flow zones and background groundwater monitoring wells installed within each flow zone include:

- Shallow flow zone: BG-1S, BG-2S, BG-3S, MW-202S, and MW-3
- Deep flow zone: BG-1D, BG-2D, BG-3D, and MW-202D
- Bedrock flow zone: BG-2BRA and MW-202BR

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 4 (*CAP Content Section 4.C*). The suitability of each of these locations for background purposes was evaluated in the *Updated Background*

Threshold Values for Groundwater 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 (NCDEQ, 2017) provided in **Appendix A**.

Duke Energy previously submitted groundwater PBTVs — *Proposed Background Threshold Values for Naturally Occurring Concentrations in Groundwater and Soil* (SynTerra, 2017) and subsequent updated groundwater BTVs to NCDEQ — *Updated Background Threshold Values for Groundwater Technical Memorandum* (SynTerra, 2017). NCDEQ provided comments, on the initial PBTVs in a response letter dated September 1, 2017; and approval of updated BTVs in a response letter dated May 14, 2018. Responses letters are provided in **Appendix A**. Groundwater background values for each groundwater flow zone at BCSS were updated in 2019 and are provided, along with the original groundwater BTVs and North Carolina Piedmont groundwater BTV ranges for comparison, in **Table 4-3** (*CAP Content Section 4.C*).

The updated background dataset was calculated using concentration data from background groundwater samples collected from 2011 to 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 updated groundwater BTVs is currently under appeal.

4.3 Background Concentrations for Surface Water

Background surface water sample locations in the Dan River and Belews Reservoir are located upstream, or outside potential affected groundwater migration 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.

Background surface water sample locations include three locations from the Dan River and four locations from Belews Reservoir. Surface water sample locations are shown on **Figure 4-1**. Locations are summarized below with the surface water body and spatial distribution relative to the source area:

- Dan River sample locations upstream of potential groundwater migration to surface water from the ash basin area: SW-DR-BG, SW-DR-BG2, and SW-DR-TFC
- Belews Reservoir sample location downstream, northeast of potential groundwater migration to surface water from the ash basin: SW-BL-D
- Belews Reservoir sample location on the southern (opposite) side of the reservoir from the source area: SW-BL-BG
- Belews Reservoir sample locations on the southern (opposite) side of the reservoir from the source area, downgradient of the lined Craig Road Landfill: SW-BL-U2 and SW-BL-U3

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 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 from each location include data from five or more samples. 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 February 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 all constituent concentrations are less than 02B standards with the exception of turbidity in the Dan River.

4.4 Background Concentrations for Sediment

All background sediment sample locations are co-located with background surface water sample locations in the Dan River and Belews Reservoir. Background sediment sample locations are located upstream, or outside potential groundwater migration from the source area to sediment. Sediment background sample locations remain outside of future migration areas as determined by groundwater predictive modeling.

Background sediment sample locations (**Figure 4-1**) include:

- Dan River: SD-DR-BG, SD-DR-BG2, and SD-DR-TFC
- Belews Reservoir: SD-BL-BG, SD-BL-D, SD-BL-U2, and SD-BL-U3

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 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 (CSM) is a descriptive and illustrative representation of the hydrogeologic conditions and constituent interactions specific to the Site. The purpose of the CSM pertaining to the Belews Creek ash basin and PHR Landfill 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 constituents in various media. This information is also considered with respect to exposure pathways to potential human and ecological receptors.

The CSM presented in this section is based on an 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). That document describes six CSM stages for an environmental project life cycle and is an iterative tool to assist in 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 BCSS 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 basin and PHR Landfill 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 (S):** Shallow flow zone includes fill, regolith, and saprolite. Fill material was used in the construction of the ash basin dam and generally consisted of reworked silts, clays, and sands. The range of fill thickness observed at four locations on the ash basin main dam was 23 feet to 69 feet. The regolith is in-place soil that develops by weathering. The soil consists primarily of silt with sand, clayey sand, sandy clay, clay with gravel, and clayey silts. The range of regolith thickness observed was 5 feet to 68 feet. Saprolite is soil developed by in-place weathering of rock that retains remnant bedrock structure (such as a planar fabric associated with relict foliation). Saprolite consists primarily of medium dense to very dense silty sand, sandy silt, sand, sand with gravel, sand with clay, clay with sand, and clay. Sand particle size ranges from fine- to coarse-grained. The range of saprolite/weathered rock observed was less than 1 foot to 49 feet. The shallow flow zone might or might not be saturated depending on the topographic area of the Site.
- **Deep flow zone (D)**: 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 0 feet to 30 feet.

- **Bedrock flow zone (BR)**: 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 main rock type in the immediate vicinity of the ash basin is mica schist. Rock core samples have been identified as metamorphic rock with a foliated fabric (*i.e.,* the elongated minerals are oriented parallel to each other or form some bands). The principal minerals are biotite, quartz, muscovite, and plagioclase (**Appendix F**, Attachment D). Groundwater movement in the bedrock flow zone occurs in secondary porosity represented by fractures. Water-bearing fractures encountered are only mildly productive (providing water to wells). The majority of water-producing fracture zones were found within the top 50 feet of competent rock. Belews Creek 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 factures of varying orientations, gradients, pressure, and size. A detailed evaluation of bedrock conditions is located in **Appendix F**.

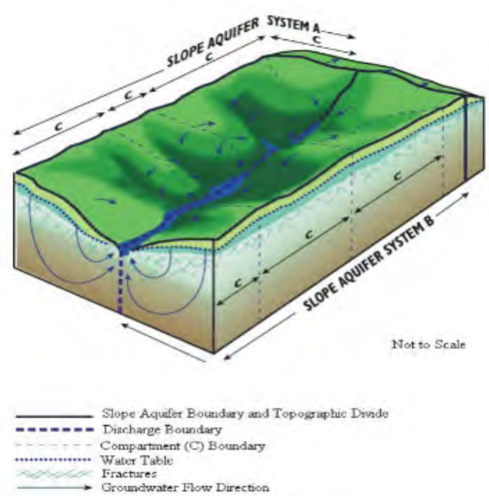
5.1.2 Site Hydrogeologic Setting

(CAP Content Section 5.A.a)

The groundwater system in the natural materials (saprolite/transition zone/bedrock) is consistent with the regolith-fractured rock system and is characterized as an unconfined, interconnected groundwater system typical of the Piedmont Physiographic Province.

A conceptual model of groundwater flow in the Piedmont, which applies to the BCSS site, was developed by LeGrand (1988, 1989) and Daniel and Harned (2017a) (**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).

FIGURE 5-2
LEGRAND SLOPE AQUIFER SYSTEM



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 Belews Creek ash basin and PHR Landfill, 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

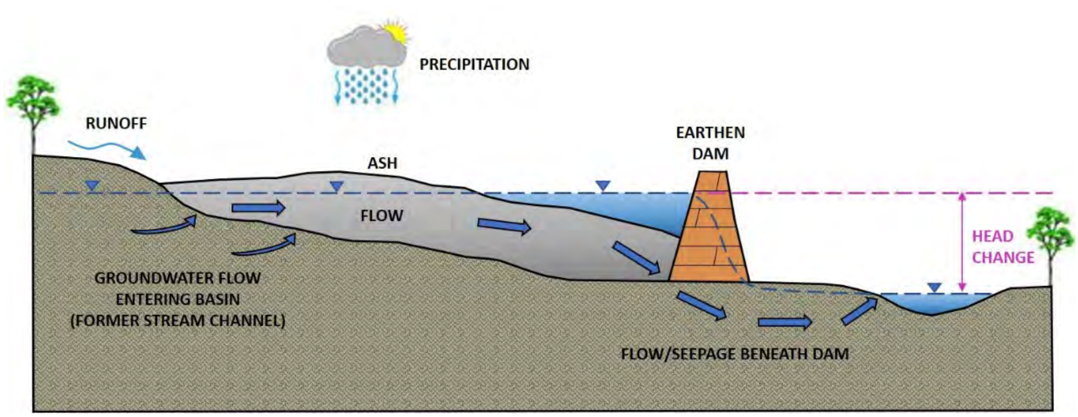
(CAP Content Section 5.A.a.i)

A groundwater divide is located east of the ash basin and PHR Landfill represented by a topographical ridge approximated by Pine Hall Road and a topographical ridge west of the ash basin and PHR Landfill along Middleton Loop. Another groundwater divide exists north of the ash basin along a ridgeline that extends from the east of the basin dam toward the northeast. An exception is a localized area near the northwest corner of the ash basin, where the hydraulic head created by the operational water level in the ash basin causes groundwater from the ash basin to flow beyond a thin pre-basin topographical divide along Middleton Loop.

With the exception of the northwest corner of the ash basin, groundwater on the basin side of each ridge flows toward the basin while groundwater on the opposite side of the ridge flows away from the basin. The hydraulic divides provide natural hydraulic control of ash basin constituent migration within the stream valley system, with the predominant direction of groundwater flow being to the north. Groundwater model simulations indicate that lowering the hydraulic head in the ash basin by decanting and subsequent closure will re-establish the groundwater divide along Middleton Loop Road to the northwest of the ash basin (**Appendix G**).

The ash basin and PHR Landfill were constructed within a former perennial stream valley. The ash basin's physical setting is a horizontal flow-through water system with groundwater movement into the upgradient end, flowing generally north through the middle regions and downward near the dam (**Figure 5-3**). Near the dam, vertical hydraulic gradients, imposed by hydraulic pressure of basin free water, promote downward vertical gradients into the groundwater system. The hydraulic pressure and downward vertical gradient of the ponded water in the basin near the dam is the most important factor contributing to constituent migration in groundwater. Beyond the dam, groundwater flows upward. Generally, the physical setting of the ash basin within a perennial stream valley limits the horizontal and vertical migration of constituents to areas near and directly downgradient of the basin's dam. The primary flow path of the groundwater remains in the ash basin and PHR Landfill's stream valley system. Therefore, areas upgradient and side-gradient of the ash basin and PHR Landfill have groundwater divides that limit groundwater flow in these directions.

FIGURE 5-3
GENERAL 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 April 2019 (**Figures 5-4a, 5-4b** and **5-4c**). April 2019 water level measurements and elevations are presented in **Table 5-1**. General groundwater flow directions can be inferred from the water-level contours. The groundwater flow direction for each flow zone associated with the basin is generally from south to north. Groundwater flow directions developed from water-level elevations measured in the shallow, deep, and bedrock wells indicate groundwater flow from the ash basin is generally to the north and northwest toward the Dan River.

Predictive flow and transport model simulations indicate that the cessation of sluicing and subsequent decanting in the ash basin will reduce the potential for constituent transport prior to complete closure of the basin. Model simulations predict downward migration of groundwater below the dam north of the ash basin will be limited without the presence of ponded water in the basin.

The following are conclusions pertaining to groundwater flow beneath the Site:

- Horizontal groundwater flow velocities in areas with free ponded water within the ash basin are less than those seen upgradient of the ash basin and below the ash basin dam.
- Downward vertical gradients occur just upstream of the ash basin dam.
- Upward vertical gradients occur beyond or downstream of the dam, which is the main groundwater discharge zone.

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 ash basin and the pumping wells used for water supply in the vicinity of the Site. Domestic and public water supply wells now connected to a filtration system are outside, or upgradient of the groundwater flow system containing the ash basin and the PHR Landfill.

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 April 2019 (**Table 5-1**). Hydraulic conductivity and effective porosity (n_e) values were taken from the updated flow and transport model (**Appendix G**). Calibrated conductivity and porosity values for each flow zone were used in an effort 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. Conductivity values ranged from 0.05 to 4.0 feet per day (feet/day) for the shallow flow zone, from 0.01 to 7.0 feet/day for the deep flow zone, and from 0.0002 to 0.7 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 provided an effective porosity of 30 percent for the shallow and deep flow zone, and 1 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:

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

Using the April 2019 groundwater elevation data, the average horizontal groundwater flow velocity in the vicinity of the ash basin is:

- 0.19 feet/day (approximately 70 ft/yr) in the shallow flow zone
- 0.41 feet/day (approximately 149 ft/yr) in the deep flow zone
- 0.25 feet/day (approximately 92 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, east and west of the Belews Creek ash basin and PHR Landfill. As of December 1, 2019, approximately 469,400,000 gallons water have been removed from the ash basin. The water elevation in the ash basin has decreased by 10.6 feet in response to decanting, indicating significant water level changes in the ash basin 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 future condition maps were created using predicted flow fields for the excavation closure scenario. Saturated conditions in the deep flow zone are relatively constant across the Site; therefore, the deep flow zone was selected for the velocity vector maps.

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

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

- Differences between the closure-in-place and closure-by-excavation closure scenarios velocity vecotors are minimal north of the ash basin, and nearly no differences are observed northwest of the ash basin (**Figure 5-5b** and **Figure 5-5c**).
- North of the ash basin, velocity vectors under pre-decanting conditions indicate groundwater velocity is greatest (5.0 to 10.0 feet/day) beneath and immediately downstream of the ash basin dam and flows predominantly north (**Figure 5-5a**). Post ash basin closure, the velocity vector directions turn inward, simulating the natural funneling system of the historical stream valley, and the flow velocities are reduced to 0.1 to 5.0 feet/day (**Figure 5-5b** and **Figure 5-5c**). Under both pre-decanting and post-closure site conditions, in the area immediately north of the current dam location, the velocity vectors turn sharply toward the perennial stream, where groundwater discharges. This flow pattern has limited

the northward movement of groundwater plumes, and will continue to do so after ash basin closure.

- Northwest of the basin, velocity vectors under pre-decanting conditions, which include the interim action groundwater extraction system, indicate groundwater flow from the ash basin toward the northwest with a flow velocity that ranges from 0.1 to 1.0 feet/day (**Figure 5-5a**). Post ash basin closure, a hydraulic divide is predicted northwest of the ash basin boundary, where the velocity vector directions diverge and the velocity decreases several orders of magnitude from 0.001 to 0.01 feet/day (**Figure 5-5b** and **Figure 5-5c**). The groundwater flow from the ash basin to the northwest area is reversed, indicating that post-closure conditions will limit any movement of constituents farther northwest from the current ash basin location.
- East of the basin, velocity vectors under pre-decanting conditions indicate a groundwater flow direction is divided along a topographic ridge with a relatively low velocity of 0.01 to 0.1 feet/day (**Figure 5-5a).** Post ash basin closure, limited change from pre-decanting Site conditions is observed ((**Figure 5-5b** and **Figure 5-5c**).
- South and southwest of the ash basin and PHR Landfill, velocity vectors under pre-decanting conditions demonstrate groundwater flow within the basin does not cross the hydraulic divide represented by the topographic ridge along Pine Hall Road (**Figure 5-5a**) Post ash basin closure, the hydraulic divide remains and is enhanced (**Figure 5-5b** and **Figure 5-5c**). In both cases, groundwater flow within the basin and PHR Landfill remains to the north-northwest toward the perennial stream with no flow toward Belews Reservoir.
- Velocity vectors depictions for pre-deanting and post-closure site conditions support that groundwater flow from the ash basin and PHR Landfill does not, and will not, flow in the direction of residential areas and water supply wells to the southwest and to the east-northeast.

5.1.2.3 Hydraulic Gradients

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

Hydraulic gradients are nearly flat across large areas of the ash basin due to the influence of standing water. The average horizontal hydraulic gradients (measured in feet/foot) for each flow zone is: 0.065 ft/ft (shallow flow zone), 0.069 ft/ft (deep flow zone), and 0.056 ft/ft (bedrock flow zone) based on hydraulic gradient calculations using April 2019 groundwater elevation data and are consistent with gradients calculated from other monitoring events, including data presented in the 2018 CAMA Annual Interim Monitoring Report (SynTerra, 2019c).

Vertical hydraulic gradients were calculated at clustered wells from the water level data and the midpoint elevations of the well screens. Within the ash basin, an upward vertical gradient was observed between the ash pore water and the deep flow zone at well cluster AB-7S/-7D (-0.707 ft/ft). Farther to the north in the ash delta, a small downward, near neutral, vertical gradient occurred between the ash pore water and shallow flow zone at well cluster AB-4SL/-4SAP (0.001 ft/ft). At the ash basin dam, an upward gradient occurred at the well pair AB-1D/-1BR between the deep and bedrock flow zones (-0.007 ft/ft). A downward vertical gradient is indicated in the shallow, deep, and bedrock flow zones on the upstream side of the ash basin dam based on the groundwater flow and transport modeling results, which are supported by over 170 monitoring wells monitored at the Belews Creek ash basin and PHR Landfill.

Beyond the ash basin dam, an upward gradient is observed at groundwater monitoring well cluster MW-200 S/D/BR. Between the shallow flow zone (MW-200S) and the bedrock flow zone the upward vertical gradient is calculated to be approximately -0.3 ft/ft. Bedrock well MW-200BR is a free flowing artesian well. Well cluster MW-200S/D/BR is positioned at the ash basin compliance boundary. The upward component of groundwater flow to the groundwater discharge zone minimizes the horizontal extent of constituent migration downgradient of the ash basin compliance boundary. The vertical gradient shifts to a downward direction further downstream of the ash basin dam in the stream valley north of the ash basin dam due to upland recharge from the topographic ridge along Middleton Loop. This is downward vertical gradient is observed at well cluster GWA-24S/D/BR, where the upward vertical gradient is calculated to be 0.2 ft/ft between the deep and bedrock flow zones.

Northwest of the ash basin, a downward vertical gradient is observed at well pair GWA-11S/D (0.588 ft/ft). Further downgradient, smaller downward vertical gradients are observed at well pairs GWA-27S/D (0.086 ft/ft) and GWA-21S/D (0.088 ft/ft). The vertical gradient shifts to an upward direction farther to the north between the shallow and deep flow zones. This is observed at well pairs GWA-30S/D (-0.013 ft/ft) and GWA-31S/D (-0.179 ft/ft) located upgradient or adjacent to streams northwest of the ash basin.

5.1.2.4 Particle Tracking Results

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

Particle tracking is not available for Belews Creek.

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 basin 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 shallow water table and bedrock water-bearing zones are interconnected. The saprolite, where saturated thickness is sufficient, acts as a reservoir for supplying groundwater to the fractures and joints in the bedrock. Based on the orientations of lineaments and open bedrock fractures at Belews Creek, horizontal groundwater flow within the bedrock should occur approximately parallel to the hydraulic gradient, with no preferential flow direction (**Appendix F**). Consistent with this interpretation, the current groundwater flow model for BCSS does not simulate plan-view anisotropy.

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. (CSA Update, 2017). Based on groundwater flow direction at the Site and identified subsurface underground utilities present at the site, there are no potential preferential pathways for contaminant 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 unaffected 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 chloride and boron. 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., 2006). 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 at the Site 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 and 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 BCSS. 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 BCSS does not simulate plan-view anisotropy.

Rock core samples from bedrock locations which represent areas of affected groundwater migration, north and northwest of the ash basin 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 0.50 percent to 0.73 percent with an average of 0.62 percent. Bulk density ranged from 2.80 grams per cubic centimeter (g/cm^3) to 2.84 g/cm^3 with an average of 2.82 g/cm^3 (**Appendix F**). Petrographic evaluation classified both samples as mica schist with a foliated fabric (*i.e.,* the elongated minerals are oriented parallel to each other or form some bands). The principal minerals are biotite, quartz, muscovite, and plagioclase (**Appendix F**).

The bedrock beneath the BCSS site is crystalline, and consists of and granite, diorite, gneiss and schist. Solid samples of unfractured metamorphic rock and plutonic igneous rock have low porosities - rarely larger than 2%. In general, crystallite rock porosity is much lower than that of sedimentary rocks. 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). The influences of matrix diffusion and sorption are implicitly included in the groundwater fate and transport model as a component of the 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)

Current onsite pumping within the groundwater flow system containing the ash basin include interim actions ash basin decanting the accelerated remediation groundwater extraction system. Decanting was initiated on March 27, 2019. As of December 1, 2019, approximately 469,400,000 gallons water have been removed from the ash basin and the water elevation has decreased by 10.6 feet. The accelerated remediation groundwater extraction system currently operates at approximately 12 gpm extraction flow rate. As of November 2019, approximately 9,900,000 gallons of water have been extracted by the system. Post-decanting, the 10 interim action extraction wells are expected to have reduced extraction rates as a result of the reduced hydraulic head of the ash basin. Effects of interim actions on the groundwater system are discussed more in **Section 6.1**.

Because much of the area surrounding the ash basin is either residential properties, farm land, or undeveloped land, potential offsite pumping influences would be limited to domestic and public water supply wells. Water supply wells are outside, or upgradient of the groundwater flow system containing the ash basin. 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 Groundwater Balance

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

The ash basin and PHR Landfill are located within a single watershed and groundwater flow system. 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 basin hydraulic conditions prior to decanting, post decanting and post closure (both closure-in-place and closure-by-excavation). Each scenario water balance was developed for using the results from flow and transport model current and predicted groundwater simulations (**Appendix G**). The approximate groundwater flow budget in the ash basin watershed under each simulated scenario is summarized in the **Table 5-2**.

Pre-Decanting Conditions Groundwater Balance

Under pre-decanting conditions, the watershed area contributing flow toward the basin is estimated to be approximately 620 acres. Removing the areas that do not contribute recharge to the groundwater system, including the closed PHR Landfill, former constructed wetlands area, and the free water surface of the ash basin pond, the remaining area is approximately 270 acres.

- Groundwater recharge from the ash basin pond is estimated to be 200 gallons per minute (gpm), and is the primary water balance component for groundwater recharge under pre-decanting conditions.
- Groundwater recharge from the 270 acres of uncapped watershed is estimated to be 120 gpm.
- Groundwater recharge from limited downward vertical flow from the southern, upgradient portion of the ash basin is estimated to be 20 gpm.
- Drains in the simulation, primarily located upgradient of the ash basin pond, receive an estimated groundwater discharge of approximately 70 gpm.
- Groundwater that flows through and immediately under the dam within the saprolite, transition zone and shallow bedrock, and then discharges to surface water downstream of the dam, is estimated to be 150 gpm.

The remaining 120 gpm of groundwater discharge, not accounted for in the directly related ash basin categories in the table above, is assumed to be divided between water that flows through the ridge to the northwest and flow through the deep bedrock under the dam to the north.

Post-Decanting Conditions Groundwater Balance

The flow and transport model was used to evaluate the ash basin and PHR Landfill hydraulic conditions that would occur after decanting of the ash basin. A water balance was developed for the simulated groundwater system under post-decanting conditions (**Table 5-2**). The groundwater simulation during post-decanting includes the interim extraction system wells northwest of the ash basin that remove groundwater from the system.

Groundwater divide depths and widths are expected to change due to decanting and closure activities. The extent of the ash basin and PHR Landfill watershed under pre-decanting conditions does not include the interim extraction system, however under post-decanting conditions the watershed extent expands to include the interim extraction system. Under simulated post-decanting conditions, the watershed area contributing flow towards the basin is estimated at approximately 650 acres. Removing the areas that do not contribute recharge to the groundwater system, including the closed PHR Landfill, and former constructed wetlands area, and the free water surface of the ash basin pond through decanting, the remaining area is approximately 570 acres.

- Groundwater recharge from the 570 acres of uncapped watershed is estimated to be 100 gpm.
- Groundwater recharge occurring in the footprint of the former ash basin is estimated to be 119 gpm.
- Drains in the simulation receive an estimated groundwater discharge of approximately 174 gpm.
- Groundwater that flows through and immediately under the dam within the saprolite, transition zone and shallow bedrock, and then discharges to surface water downstream of the dam, is estimated to be 45 gpm.
- Existing interim action groundwater extraction wells discharge 2 gpm.

The estimated discharge to streams downgradient of the ash basin dam is reduced from approximately 150 gpm during pre-decanting conditions to 45 gpm after decanting. All other groundwater flow that is assumed to contribute to groundwater flowing through the ridge to the northwest and flow through the deep bedrock under the dam to the north is reduced from 120 gpm during pre-decanting conditions to almost indiscernible flow (-2 gpm). The reestablished groundwater divide northwest of the ash basin is expected to significantly reduce or eliminate groundwater flow to the northwest. The remaining groundwater flows north. Decanting the ash basin has the greatest impact on the water balance, reducing the total groundwater flow budget by more than 120 gpm from pre-decanting conditions.

Post-Closure Conditions Groundwater Balances

The flow and transport model was used to evaluate the ash basin and PHR Landfill hydraulic conditions that would occur after two ash basin closure scenarios. A water balance was developed for the simulated groundwater system under post-closure conditions (**Table 5-2**). The groundwater simulation during post- closure includes the interim extraction system wells northwest of the ash basin that remove groundwater from the system.

The extent of the ash basin watershed under post-closure conditions is expected to remain the same as post-decanting conditions. The largest hydraulic differences between post-decanting and post-closure Site conditions is the area of capped surfaces and lowering or removal of the ash basin dam. Removing the areas that do not contribute recharge to the groundwater system, including the closed PHR Landfill, and former constructed wetlands area, and the closure option resulting landfill, the remaining area is approximately 430 acres for closure-in-place and 510 acres for closure-by-excavation.

- Groundwater recharge from the acres of uncapped watershed is estimated to be either 92 or 120 gpm, depending on the selected closure option.
- Groundwater recharge occurring in the footprint of the former ash basin is estimated to be either 56 or 119 gpm, depending on the selected closure option.

- Drains in the simulation receive an estimated groundwater discharge of approximately 157 or 195 gpm, depending on the selected closure option.
- Because it is expected the dam will be significantly lowered or removed during the ash basin closure process, there is no estimated groundwater flow through and immediately under the dam under post-closure conditions.
- Existing interim action groundwater extraction wells discharge 2 gpm. These scenarios do not include additional groundwater remediation.

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-central North Carolina. The metals and inorganic constituents occur in soil, bedrock, groundwater, surface water, and sediment. During the Belews Creek CSA assessment, samples of soil and rock were collected during drilling activities and analyzed for metals and inorganic constituents. Results indicate that soil and rock at Belews Creek contain naturally occurring constituents that are also typically related to CCR material and likely effect the chemistry of groundwater at the Site. Arsenic, total chromium, cobalt, iron, manganese, selenium and thallium were present in background soil and rock samples at concentrations greater than the preliminary soil remediation goals (PSRGs) for protection of groundwater (POG) values (**Table 4-2**).

These results suggest that arsenic, total chromium, cobalt, iron, manganese, selenium and thallium might occur naturally in groundwater at the Site. Analytical results for groundwater at background locations indicate that hexavalent chromium, total chromium, cobalt, iron, lithium, manganese, molybdenum, strontium, and vanadium are present at concentrations greater than 02L/IMAC standards in one or more flow zones (**Table 4-3**). Therefore, downgradient concentrations of these constituents are compared to background values for corresponding flow zone. Generally, downgradient concentrations of hexavalent chromium, total chromium, molybdenum, and vanadium concentrations are within background concentration ranges.

The horizontal flow-through water system related to the ash basin described in the CSM has resulted in limited transport of constituents from the ash basin into underlying groundwater. Near the dam, affected groundwater flows under the dam and either discharges to the ash basin toe drain systems or flows downward to the underlying groundwater system. Beyond the dam, groundwater flows upward toward the unnamed tributary, limiting downward migration of constituents to the area in close proximity north of the dam. There is a component of groundwater flow northwest of the ash basin where the hydraulic head created by the operational water level in the ash basin causes groundwater from the ash basin to flow beyond a thin pre-basin topographical divide along Middleton Loop. The constituent management process, and a detailed discussion of constituent migration and distribution is presented in **Section 6.0**.

5.2 Source Area Location

(CAP Content Section 5.A.b)

The ash basin, located across Pine Hall Road to the northwest of the station, is generally bounded by an earthen dam and a natural ridge to the northeast, Middleton Loop to the west, and Pine Hall Road to the south and east (**Figure 1-2**). Middleton Loop and Pine Hall Road, located along topographic ridges, represent hydrogeologic divides that affect groundwater flow within an area approximately 0.5 miles northeast, east, south, and west of the ash basin. Topography to the west of Middleton Loop generally slopes downward toward the Dan River to the north. Topography to the south and east of Pine Hall Road generally slopes downward toward Belews Reservoir to the south and southeast.

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 basin and PHR Landfill indicates no measurable difference between evaluated Site-related risks and 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 basin and PHR Landfill.

Additionally, multiple lines of evidence support that groundwater from the ash basin 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 surrounding properties with water supply wells within a 0.5-mile radius of the ash compliance boundary with water filtration systems.

The site-specific risk assessment conducted for the ash basin also indicates that there is no increase in risks to ecological receptors. The Dan River and Belews Reservoir aquatic systems surrounding the BCSS are 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 Roanoke River watershed. The ash basin and PHR Landfill are located between Belews Reservoir to the south and east and the Dan River to the north. Associated North Carolina surface water classifications for Belews Reservoir and the Dan River are summarized in **Table 5-3**.

Surface water intakes associated with BCSS plant operations include:

- An intake from Belews Reservoir used to pump water for BCSS plant operations
- An intake from Belews Reservoir used to pump water for landfill operations at the Craig Road Landfill
- A backup intake from the Dan River to pump water from the Dan River for Belews Reservoir makeup water, if needed (for example, under drought conditions)

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 from the Natural Resources Technical Report (NRTR) prepared by AMEC Foster Wheeler (July, 2015). In addition, permitted outfalls under the NPDES and the SOC locations are shown on **Figure 5-6**. Non-constructed and dispositioned seep sample locations between the ash basin and the Dan River and Belews Reservoir 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 Belews Reservoir and the Dan River

The NPDES permit for Belews Creek Steam Station requires Duke Energy to conduct monthly outfall and instream water quality monitoring at 10 locations including within the Dan River. Trace elements (arsenic, selenium) monitoring in fish muscle tissue is also conducted annually in accordance with a study plan approved by the NCDEQ.

Belews Reservoir and the Dan River have been monitored by Duke Energy since 1969. 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 Belews Reservoir and the Dan River have been environmentally healthy and functioning ecosystems, 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 30 years. More information related environmental health assessments conducted for the Dan River and Belews Reservoir, 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

No municipal water supply lines are available to residents within a 0.5-mile radius of the ash basin compliance boundary.

The BCSS plant is supplied with municipal water from the City of Winston-Salem; however, the water supply line enters the Duke property from the south along Craig Road. The water supply line does not extend beyond that location. The nearest available municipal water supply line, provided by the Town of Walnut Cove, is located at the intersection of Martin Luther King Jr. Road and Crestview Drive, approximately 4.5 miles to the west of the Duke Power Steam Plant Road entrance to the Station.

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 basin. A total of 50 private water supply wells and one public supply well were identified within the 0.5-mile radius of the ash basin compliance boundary (**Figure 5-7a**). Most of these water supply wells are located northeast of the ash basin along Pine Hall Road and Middleton Loop, and west and southwest of the ash basin along Middleton Loop, Old Plantation Road, Pine Hall Road, and Martin Luther King Jr. Road. 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**.

5.3.4 Future Groundwater Use Area

Duke Energy owns the land and controls the use of groundwater on the land downgradient of the Belews Creek ash basin and PHR Landfill at and beyond the predicted area of potential affected groundwater, with the exception of a 2.67 parcel northwest of the ash basin. Therefore, no future groundwater use areas are anticipated downgradient of the basin and PHR Landfill.

Under G.S. Section 130A-309.211(c1), Duke Energy provided permanent water solutions to all eligible households within a 0.5-mile radius of the ash basin compliance boundary. Duke Energy also voluntarily provided permanent water solutions to business, schools, and churches within a 0.5-mile radius not connected to a public water supply. It is anticipated that public and private properties 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 installed 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 Belews Creek was prepared and is included in **Appendix E**. The risk assessment focuses on the potential effects of CCR constituents from the Belews Creek ash basin 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 might have migrated from the ash basin; and 2) there is no evidence of risks to ecological receptors potentially exposed to CCR constituents that might 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 AOW locations and soil beneath the ash basin are not subject to this assessment and will be evaluated independent from the CAP. Consistent with the iterative risk assessment process and guidance, updates to the risk assessment have been made to the original 2016 risk assessment (HDR, 2016b) 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, 2016b)
2. *Comprehensive Site Assessment (CSA) Update* (SynTerra, 2017b)
3. *Human Health and Ecological Risk Assessment Summary Update for Belews Creek Steam Station*, Appendix B of *Community Impact Analysis of Ash Basin Closure Options at the Belews Creek 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, 2016b), and is based on NCDENR, 2003; NCDEQ, 2017; and USEPA risk assessment guidance (USEPA, 1989; 1991a; 1998).

Human health and ecological CSM 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 COPOC are those elements in which the maximum detected concentrations exceeded human health or ecological screening values. COPCs are carried forward for further evaluation in the deterministic risk assessment. Constituents remaining as a result of the screening were carried forward in the baseline 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 associated with the construction worker exposure scenario.
- On- and off-Site surface water and sediment pose no unacceptable risks for recreational receptors (swimmer, wader, boater, and recreational fisher).
- Consumption of fish in the Dan River by a subsistence fisher resulted in Hazard Quotients (HQs) greater than 1 for cobalt and zinc. However, the exposure model used assumed rates for bioconcentration and fish consumption, which resulted in overestimated risks for the subsistence fisher.
- Consumption of fish by a subsistence fisher resulted in an estimated Excess Lifetime Cancer Risk (ELCR) that is within the risk range of 1×10^{-4} to 1×10^{-6} for hexavalent chromium for the Dan River and Belews Reservior; however, the EPC used in the risk model was comparable to upgradient hexavalent chromium concentrations.

Findings of the baseline ecological risk assessment include the following:

Ecological Exposure Area 1:

- No HQs based on NOAELS or LOAELs were greater than unity for wildlife receptors (mallard duck, great blue heron, river otter) exposed to surface water and sediments.
- Modeled risk estimates resulted in aluminum HQs greater than 1 based on the NOAEL and LOAEL for the killdeer and based on NOAELs for the muskrat. The modeled risk is considered negligible given the natural occurrence of aluminum in surface water, sediment, and soil in the region.

Ecological Exposure Area 3:

- No HQs based on NOAELS or LOAELs were greater than unity for wildlife receptors (mallard duck, great blue heron, river otter) exposed to surface water and sediments.
- Modeled risk estimates resulted in aluminum HQs greater than 1 based on the NOAEL and LOAEL for the killdeer and based on NOAELs for the muskrat. The modeled risk is considered negligible given the natural occurrence of aluminum in surface water, sediment, and soil in the region.

In summary, there is no evidence of unacceptable risks to human and ecological receptors exposed to environmental media potentially affected by CCR constituents at Belews Creek. 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 Belews Creek 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 geological/hydrogeological and geochemical processes that control the transport and potential effects of constituents in various media and potential exposure pathways to human and ecological receptors.

In summary, the ash basin and PHR Landfill were constructed within a former perennial stream valley 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 dam. The upward flow of water into the basin minimizes downward vertical constituent migration to groundwater immediately underlying saturated ash in the upgradient ends of the basin. Due to the prevailing horizontal flow within the ash basin, there is limited vertical flow of ash basin pore water into the underlying groundwater. The elevated constituent concentrations found in groundwater near the dam 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.

Based on 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 ash basin and the pumping wells used for water supply in the vicinity of the Site.

Through ash basin decanting and closure, the hydraulic head and the rate of constituent migration from the ash basin 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 basin is expected to be further contained within the stream valley and continue flowing north 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 Belews Creek. This CSM provides the basis for this CAP Update developed for the Belews Creek ash basin to comply with G.S. Section 130A-309.211, amended by CAMA.

6.0 CORRECTIVE ACTION APPROACH FOR SOURCE AREA 1 (ASH BASIN AND CLOSED PHR LANDFILL)

(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 affected groundwater migration from the source unit. Constituents with concentrations above corresponding standards were evaluated to determine if the level of concentration is present due to the source area. Constituents of interest (COI) are those constituents identified from the "constituent management process" described below and are specific to the source area, not the Site. This evaluation assists in identifying constituents and areas that warrant corrective action under G.S. Section 130A-309.211 and 15A NCAC 02L .0106.

A constituent management process was developed by Duke Energy at the request and acceptance of NCDEQ (NCDEQ letter dated October 24, 2019, **Appendix A**), to gain a thorough understanding of constituent behavior and distribution in site groundwater and to aid in identifying COIs that warrant corrective action. The constituent management process consists of three steps:

1. Perform a detailed review of the applicable regulatory requirements under NCAC, Title 15A, Subchapter 02L
2. Understand the potential mobility of unit-related constituents in groundwater based on Site hydrogeology and geochemical conditions
3. Determine the constituent distribution at the unit under current and predicted future conditions.

This constituent management process is supported by multiple lines of evidence including empirical data collected at the site, geochemical modeling, and groundwater flow and transport modeling. The management process uses a matrix evaluation to identify those constituents that have migrated downgradient of the source unit, in the direction of groundwater flow at concentrations greater than 02L/IMAC/background value with a discernable plume. The matrix evaluation considers the following per constituent:

- Regulatory criteria,
- Site and Piedmont background values,

- Maximum mean constituent concentrations,
- Exceedance ratios,
- Number and distribution of wells at or beyond the compliance boundary with constituent concentrations greater than criterion,
- constituent presence in ash pore water at concentrations greater than criterion, and
- constituent geochemical mobility

This approach has been used to identify constituents that have migrated from the Belews Creek ash basin and PHR Landfill and warrant corrective action. The results of the constituent management process (described in detail in **Section 6.1.3**) identify 11 groundwater COIs for the Belews Creek ash basin and PHR Landfill: arsenic, beryllium, boron, chloride, cobalt, lithium, iron, manganese, strontium, TDS, and thallium.

Data indicate unsaturated soil constituent concentrations are generally consistent with background concentrations or are less than regulatory screening values. In the few instances where unsaturated soil constituent concentrations are greater than Preliminary Soil Remediation Goal (PSRG) Protection of Groundwater (POG) standards or background values, constituent concentrations are within range of background dataset concentrations or there are no mechanisms by which the constituent could have been transported from the ash basin or PHR Landfill to the unsaturated soils, therefore, no soil constituents were identified for the Belews Creek ash basin and PHR Landfill.

6.1 Extent of Constituent Distribution

This section provides an in-depth review of constituent characteristics associated with source area 1 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)

The ash basin and the PHR Landfill waste boundaries are shown on **Figure 1-2**. An overview of the material within the ash basin and PHR Landfill is presented in the following subsections.

6.1.1.1 Description of Waste Material and History of Placement

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

The ash basin consists of a single cell impounded by the main earthen dam located on the north end of the ash basin and an embankment dam (Pine

Hall Road dam) located in the northeast portion of the basin along Pine Hall Road (**Figure 1-2**)**.** The main dam is approximately 2,000 feet long with a maximum height of approximately 140 feet. The top of the dam is at an elevation of 770 feet, and the crest is 20 feet wide. The ash basin, constructed from 1970 to 1972, is located approximately 3,200 feet northwest of the BCSS powerhouse. The area contained within the ash basin waste boundary is approximately 283 acres. The normal operating elevation of the BCSS ash basin pond is 750 feet, while full pond elevation is approximately 768.2 feet. The full pond capacity of the ash basin is estimated to be 17,656,000 cubic yards (cy) or approximately 10,940 acre feet.

CCR materials, composed primarily of fly ash and bottom ash, were initially deposited in the unlined ash basin via sluice lines beginning in 1974. In 1984, BCSS converted from a wet fly ash handling system to a dry fly ash handling system. After 1984, fly ash was handled dry and was only sluiced to the ash basin during maintenance or abnormal conditions. Bottom ash continued to be sluiced to the ash basin until May 2018 when the facility converted to a dry bottom ash handling system. Deposition of all waste streams into the ash basin ceased on March 27, 2019 in preparation for ash basin closure.

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.

Seventeen (17) borings (AB-4S/SL/D/BR, AB-5S/D/GTB[1], AB-6S/SL/D/GTB, AB-7S/D/GTB, and AB-8S/SL/D) were advanced within the ash basin waste boundary to obtain ash samples for chemical analyses (**Figure 1-2**). Borings at the AB-1, AB-2, and AB-3 locations were advanced through the main earthen dam without encountering ash, and three borings at the AB-9

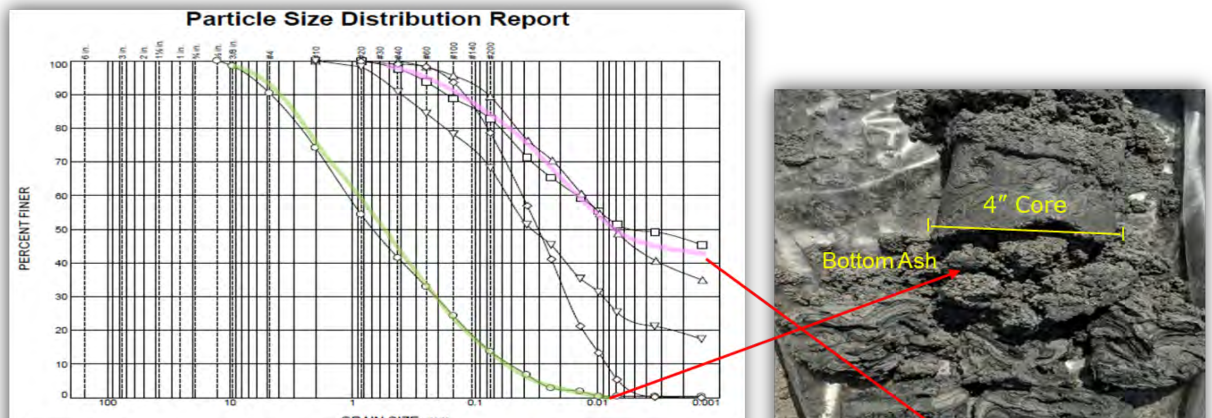
[1] Geotechnical boring

location drilled through the chemical pond dike (one of which was advanced into bedrock) did not encounter ash. Ash was encountered in borings AB-4, AB-5, AB-6, AB-7, and AB-8 at varying intervals. Ash was not observed in borings outside the ash basin perimeter.

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 seven ash samples from the ash basin 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 two values reported from 1.7 (AB-6GTB) to 2.2 (AB-7SL). Moisture content of the ash samples ranges from 11.2 percent to 65.4 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 can be found below (**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



Symbol	% +3"	% Gravel Coarse	% Gravel Fine	% Sand Coarse	% Sand Medium	% Sand Fine	% Fines Silt	% Fines 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)

The full pond capacity of the ash basin is estimated to be 17,656,000 cy. Based on CCR inventory data through July 31 2019, topographic and bathymetric surveys, the ash basin is estimated to contain approximately 9,975,800 cy of ash (AECOM, 2018). The horizontal limits of the source material is depicted by the waste boundaries as shown on **Figure 1-2**. Based on borings located within the ash basin, the maximum depth of CCR within the ash basin is estimated to be approximately 80 feet. Volume and physical horizontal and vertical extent of ash material within the basin as a cross-section transect (A-A') along the centerline, from south to north, is presented in **Figure 6-2**. Volume and physical vertical extent of ash material at the basin northern portion as a cross-section transect (B-B') along the ridgeline, from west to east, is presented in **Figure 6-3**.

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 basin in plan-view is presented in **Figure 6-4.** Water levels of ash pore water wells under pre-decanting conditions range from 3 feet to 7 feet below grade surface. Ash basin decanting was initiated in March 2019. As of December 1, 2019, 469,400,000 million gallons of water has been decanted and the corresponding pond water elevation has decreased by 10.6 significantly reducing areas of saturated ash. The range of saturated ash thickness is between a few feet to 80 feet, with greatest volume of saturated ash in the central portion of the ash basin and a lesser volume of saturated ash in other areas of the basin, including a majority of the portion of the basin covered by ponded water (**Figure 6-4**). Using modeled potentiometric levels of the saturated ash surface compared to pre-ash basin historical topographic contours, the volume of saturated ash within the basin under pre-decanting conditions was approximately 9,180,000 cy (AECOM, 2018).

Under ash basin closure by closure-in-place part of the ash is excavated and moved to the southern part of the ash basin where it is capped with a final cover system. The anticipated range of saturated ash thickness after closure by closure-in-place is between a few feet to 50 feet, with the greatest volume of anticipated saturated ash in the south central portion of the ash basin and a lesser volume of anticipated saturated ash in the southern ash basin fingers (**Figure 6-4**). The estimate is based on the approximated bottom of ash from the flow and transport model simulation (**Appendix G**) and simulated hydraulic heads. Closure-in-place simulated saturated ash thickness is based on closure model results with an underdrain system installed.

Under the closure-by-excavation option, it is anticipated all of the ash in the ash basin would be excavated, and therefore no saturated ash would remain in the ash basin footprint.

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, further reducing the potential for downward flow of pore water into underlying residual material. The horizontal flow-through ash basin system results in low to non-detectable constituent concentrations in groundwater underlying saturated ash within the basin except in the vicinity of the dam where downward vertical hydraulic gradients are observed. The horizontal flow-through system is consistent with Site-specific data, as observed with boron concentration data from groundwater below the source area (**Table 6-1**).

In summary, the data from five well cluster locations within the ash basin demonstrate low (less than 260 μg/L and below the 02L groundwater standard) to non-detectable boron concentrations consistent with the flow-through system and suggests there is no correlation between the thickness of saturated ash and the underlying groundwater quality (**Table 6-1**).

A technical memorandum, titled *Saturated Ash Thickness and Underlying Groundwater Boron Concentrations – Allen, Belews Creek, Cliffside, Marshall, Mayo, and Roxboro Sites* (Arcadis, 2019), 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 Belews Creek.

The statistical evaluation was performed using a dataset which included 89 monitoring wells completed in shallow, transition, and bedrock groundwater zones directly beneath ash basins and 54 ash pore water monitoring wells completed in saturated ash. Linear regression results indicated that 87% 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 constituents.

Under pre-decanting conditions, the analysis demonstrates saturated ash and ash pore water are not significantly contributing constituent concentrations to underlying groundwater except near dikes and dams, where downward vertical gradients exist. Pre-decanting conditions represent the greatest opportunity for constituent 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 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 boundary were analyzed for total extractable inorganics using EPA Methods 6010/6020. For information purposes, ash samples were compared to soil background values and preliminary soil remediation goals (PSRGs) for protection of groundwater (POG). The ash analytical data do not represent soil conditions outside of or beneath the ash basin. Concentrations of arsenic, boron, chromium, cobalt, iron, manganese, selenium, and vanadium in ash samples were greater than concentrations of the same constituents in soil background samples. The concentrations of these constituents in ash samples also were greater than PSRG for POG (**Appendix C**, Table 4).

In addition, seven ash samples collected from borings completed within the ash basin were analyzed for leachable inorganics using synthetic precipitation leaching procedures 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 or IMAC comparative values to evaluate potential source contribution; the data do not represent groundwater conditions. The results of the SPLP analyses indicated that concentrations of antimony, arsenic, chromium, cobalt, iron, manganese, selenium, thallium, and vanadium were greater than the 02L or IMAC comparative value.

Ash Leaching Environmental Assessment Framework

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

Ash samples were analyzed for extractable metals analysis, including HFO (hydrous ferric oxide)/HAO (hydrous aluminum oxide), 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 Belews Creek ash basin were conducted using two LEAF tests, USEPA LEAF methods 1313 and 1316 (USEPA, 2012a, b). The data are presented and discussed in the Geochemical Modeling Report in **Appendix H,** Attachment C.

Leaching test results, using USEPA LEAF method 1316, indicate that, even for conservative constituents, such as boron, the leachable concentration of boron present in ash from Belews Creek is considerably lower than the total boron concentration (**Appendix H,** Attachment C). Belews Creek data indicate that there is a process by which the constituents might become stable within the ash and would make the constituent unavailable for leaching. The exact mechanisms of this process are unknown, however, literature suggests that incorporating constituents, such as boron, into the silicate mineral phases is a potential mechanism (Boyd, 2002). The leaching behavior of several constituents as a function of pH, examined using USEPA LEAF method 1313, demonstrated that for anionic constituents, the leaching increased with increasing pH and the cationic constituents 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 boundary include samples collected from beneath the ash basin and samples collected from the fill material within the ash basin dam and chemical pond dike. Soil samples beneath the ash basin were saturated. Saturated soil samples collected within the waste boundary are from borings associated with AB-2D/GTB, AB-3D, AB-4D, AB-5D, AB-6D/GTB, AB-7D, AB-8D, AB-9S/D and SB-3. Temporary geotechnical borings (GTB) 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 from the Belews Creek CSA Update (SynTerra, 2017), since soil impacts would be related to ash pore water interaction to the underlying soils within the basin and groundwater migration beyond the ash basin. The range of constituent concentrations in saturated soils within the waste boundary, along with a comparison with soil background values and North Carolina PSRG POG standards (NCDEQ, May 2019), whichever is greater, is provided in **Appendix C**, Table 4. For constituents lacking an established target concentration for soil remediation (*i.e.* chloride and 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**. Resulting PSRG POG calculated values for chloride and sulfate were 938 mg/kg and 1,438 mg/kg, respectively (**Appendix C**, Table 4).

Saturated soil and rock is considered a component of the groundwater flow system and can serve as a source for constituents in groundwater 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 constituent concentrations over time in the saprolite, transition zone, and bedrock materials throughout the models. Historical transport models simulate the migration of constituents through the soil and rock from the ash basin, 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 (*i.e*. dam construction material) samples were collected from borings associated with AB-1 and AB-3S (**Figure 6-5**).

Analytical results for unsaturated soil data within the waste boundary can be found on **Table 6-3.** Only unsaturated fill material sample AB-01S [20-21.5 feet below ground surface (bgs)], collected from the ash basin dam, have concentrations of arsenic (61.1 mg/kg) and iron (40,600 mg/kg) greater than the PSRG for POG or background values, whichever is greater. Arsenic and iron concentrations are within range of background soil concentrations (**Table 6-3**). Additionally, source control and ash basin closure activities will lower water elevation in this area, reducing the potential for leaching constituents into the groundwater system. No other unsaturated soil samples within the waste boundary had concentrations greater than PSRG POG or background values.

No saturated soils beneath the ash basin have been analyzed for leachable inorganics using SPLP procedures EPA Method 1312.

Ash Pore Water

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

The ash basin is a permitted waste water treatment system. Water within the ash basin is not groundwater; therefore, ash pore water isoconcentration maps are not prepared. Ash pore water data is provided for general information purposes only in **Appendix C**, Table 1. **Figures 6-6a, 6-6b,** and **6-6c** represent ash pore water constituent distribution in cross section (A-A′) from south to north. This cross-section represents the greatest horizontal and vertical extent and volume of source material in relation to a hydrologic divide (GWA-8S/D) and in ash pore water and in groundwater below the ash basin (AB-4S/SL/SAP/D/BR/BRD). 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 Site 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 (two locations only), are monitored using multi parameter (or geochemical) sondes. Locations monitored with multi parameter sondes are depicted on **Figure 6-7**, and include:

- AB-4 LOWER ASH: ash pore water well located central to the ash basin delta
- AB-4SAP: shallow flow zone monitoring well located within the footprint of the ash basin, below ash pore water well AB-4 LOWER ASH
- AB-2D: deep flow zone well located downgradient of the ash basin, below the ash basin dam
- GWA-20D: deep flow zone well located downgradient and northwest of the ash basin

Hydrographs and geochemical water quality parameter time series plots for each location are included on **Figure 6-7**. Observations of water elevation and multi parameter records from monitored locations include:

- Ash pore water and shallow flow zone monitoring locations within the waste boundary show a response to ash basin decanting by reduced groundwater elevation levels (**Figure 6-7**).
- Deep flow zone monitoring locations less than 500 feet downgradient of the ash basin show a response to ash basin decanting by reduced groundwater elevation levels (**Figure 6-7**).

- Geochemical parameters pH and ORP do not show significant shifts or variability in records since ash basin decanting commenced (**Figure 6-7**). This suggests geochemical conditions have remained stable under changing Site conditions at locations within the waste boundary and downgradient of the source area.
- Geochemical parameter specific conductivity is monitored at the two deep flow zone monitoring locations (AB-2D and GWA-20D) downgradient of the ash basin. Specific conductivity has increased at each location, however the increasing trend appears to be consistent with the trends prior to reduction of water levels, therefore, 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 (**Figure 6-8**) are used to assess 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. Data used for the piper diagrams include ash pore water data between January 2018 and April 2019 with a charge balance between -10 and 10%.

- Ash pore water results tend to plot with higher proportions of sulfate chloride calcium and magnesium, which is generally characteristic of ash pore water (EPRI, 2006). The area where ash pore water tends to plot on the piper diagram is identified as "affected" on **Figure 6-8.**

6.1.1.7 Other Potential Source Material – Pine Hall Road Landfill

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

The NCDENR DWM issued an initial permit (No. 8503 – INDUS) to operate the now-closed PHR Landfill (**Figure 1-2**) in December 1984. The landfill was permitted to receive fly ash. The landfill is unlined and designed with a 1-foot thick soil cap on the side slopes and 2 feet thick on flatter areas. A subsequent expansion (Phase I Expansion), permitted in 2003, was also unlined but was permitted with a synthetic cap system to be applied at closure. The landfill was permitted to receive fly ash. The capacity of the landfill is approximately 3,616,800 tons. After groundwater monitoring indicated CCR constituent concentrations greater than 02L standards near the landfill and adjacent to the ash basin, the placement of additional ash in the Phase I Expansion was discontinued and the closure design was changed to include an engineered cover system for the above-grade portion of the landfill. The engineered cover system consists of a 40-mil linear low-density polyethylene geomembrane, a geonet composite, 18 inches of compacted soil, and 6 inches of vegetative soil cover. The total footprint of the landfill is approximately 67.2 acres. A total of approximately 8,500,000 cy of ash was placed within the PHR Landfill from December 1984 to March 2008. The construction of the engineered cover system for the Phase I Expansion, including the additional soil cover on the 14.5-acre section, was completed in December 2008. The cover system is a source control measure implemented for the landfill.

6.1.1.8 Interim Response Actions

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

Interim response actions to date include ash basin decanting, the installation of an interim action accelerated remediation groundwater extraction system, source area stabilization, and operation of a toe-drain water collection system at the base of the Belews Creek ash basin dam. A summary of each interim action and the intended remedy are described in **Table 6-4**.

Ash Basin Decanting

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

Ash basin decanting commenced on March 27, 2019, and is scheduled to be completed by September 2020. Decanting is a form of active source remediation by removing ponded water in the ash basin, which is considered a critical component of reducing constituent migration from the ash basin. Reduction of constituent migration occurs through decanting by significantly reducing the hydraulic head and gradients, thereby reducing the groundwater seepage velocity and constituent transport potential.

Prior to ash basin closure, the operating level of the ash basin was maintained at 750 feet. From predictive flow and transport modeling, a hydraulic divide is expected to reform, along the topographic ridge represented by Middleton Loop, as a result of lowering and removing the ash basin hydraulic head. Water elevation of the ash basin was reduced by approximately four feet between the commencement of decanting in March 2019 and April 2019. Water level data from April 8, 2019 depicts early stages of the hydraulic divide reforming (**Figures 5-4a** through **5-4c**).

Four ponded water points from the ash basin fingers, one ash pore water point, one shallow groundwater point located beneath the ash basin, and 19 groundwater monitoring wells located north, east, south, and west of the ash basin were selected for monitoring water elevations using pressure transducers to record changing site conditions from ash basin decanting (**Figure 6-9**). Ash basin finger ponded water, ash pore water, and groundwater decanting network hydrographs, using water elevations recorded between January or February 2019 (May 2019 for ash basin fingers only) through November 2019 are depicted on **Figures 6-10a** through **6-10c**. Observations from hydrographs include:

- By December 1, 2019, water level in the ash basin pond has decreased by 10.6 feet since decanting started (**Figure 6-10a**). Note that water elevations displayed on **Figures 6-10a** through **6-10c** are not current to December 1, 2019.
- Ash basin finger water levels on average have decreased by approximately one foot (**Figure 6-10a**). The minimal drawdown of water levels observed in the ash basin fingers suggests the fingers are only weakly connected to the pond.
- All groundwater monitoring locations show a response to ash basin decanting by reduced groundwater elevation levels (**Figures 6-10a** through **6-10c**).

- Groundwater monitoring wells northwest of the ash basin (*i.e.* CCR-2S/D, GWA-20SA/D, GWA-21, and GWA-27D) and north of the ash basin (*i.e.,* AB-1BR and AB-2D) show the largest degree of response from decanting by greatest reduction in water levels relative to wells south, east and west of the ash basin (**Figures 6-10a** through **6-10c**).
- Water elevation records from groundwater monitoring wells CCR-2S, CCR-11S and GWA-20SA indicate water levels decreased below the transducer elevation in July 2019 (**Figures 6-10a** through **6-10c**). Transducers were installed at elevations approximately in the middle of the monitoring well's 10-foot screened interval. Water levels recorded below transducer elevations suggests the monitoring well is nearly dry (*i.e.,* insufficient water available for monitoring purposes).

Interim Action Accelerated Remediation Groundwater Extraction System

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

A Settlement Agreement between NCDEQ and Duke Energy signed on September 29, 2015, requires accelerated remediation to be implemented at sites that demonstrate off-site affected groundwater migration. BCSS is included in that agreement. Historical and ongoing assessment indicates the potential for off-Site groundwater flow northwest of the BCSS ash basin in the area of Parcel A. After correspondence with NCDEQ and conditional approval of an Interim Action Plan (IAP), Duke Energy began interim action activities to target Parcel A in 2016. Interim action activities associated with Parcel A consisted of pilot testing a groundwater extraction system along the northwest corner of the ash basin.

The primary objective of the groundwater extraction system is to reduce migration of constituents in groundwater from the ash basin toward the area northwest of the ash basin and to achieve a hydraulic boundary proximal to the extraction well network. As required by NCDEQ, Duke Energy submitted draft basis of design (BOD) reports for review and comments in 2016 and 2017. A 100 percent BOD report was submitted to NCDEQ DWR on September 1, 2017. In a letter with comments dated October 31, 2017, NCDEQ granted permission for Duke Energy to proceed with installation of the extraction well network. Operation of the extraction system began in March 2018. As of April 30, 2019, the system has pumped over 6,900,000 gallons of groundwater and approximately 500 pounds of boron based on the data collected (**Appendix J**). As of November 25, 2019, the system has pumped over 9,800,000 gallons of groundwater.

Based on pumping test information and groundwater modeling scenarios, 10 extraction wells (EX-1 through EX-10) were installed between the ash basin and Parcel A. The groundwater extraction well system, which started operating in March 2018, is currently pumping at a combined rate of approximately 12 gpm.

Post-decanting, the 10 interim action extraction wells are predicted to have a combined pumping rate of approximately 2.5 gpm, due to the reduction in groundwater elevation in the area.

Water-level monitoring of the extraction system is conducted using data logging pressure transducers on a continual basis with water-level monitoring on an hourly basis at select monitoring wells near the groundwater extraction system. The *Interim Action Plan Accelerated Remediation Groundwater Extraction System 2018 Startup and Effectiveness Monitoring Report* and the *Interim Action Plan 2019 Effectiveness Monitoring Report* can be found in **Appendix J**.

Source Area Stabilization

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

In an April 2, 2015 correspondence, NCDEQ provided a notice of deficiencies related to the ash basin dam including excessive seepage, bare/sparse vegetation, outlet pipe abandonment, slope improvements and weighted filter overlay. In response, Duke Energy undertook activities in 2016 to correct the deficiencies (see letter dated August 5, 2016, **Appendix A**). The activities included:

- Installation of an aggregate seepage collection and filter overlay system and earth fill buttress (weighted filer overlay) graded to match previous embankment slopes
- Removal of stumps of felled trees and woody vegetation
- Installation of 8-inch solid and perforated pipes to transport seepage captured within existing horizontal and new filter aggregate
- Installation of two trapezoidal flumes for measure/monitor seepage flows conveyed by the weighted filter overlay

- Installation of a new riprap lined outlet channel, stormwater culverts, riprap lined ditches, seepage collection berm and concrete ditch
- Permanent grouting of outlet pipe from former discharge structure, and
- Restoration of bare/sparse vegetated areas.

Pursuant to G.S. Section 130A-309.213(d)(1) and based upon determinations in a letter dated November 13, 2018, NCDEQ has classified the CCR surface impoundment at BCSS as low-risk (**Appendix A**). The relevant closure requirements for low-risk impoundments are in G.S. Section 130A-309.214(a)(3), which states low-risk impoundments shall be closed as soon as practicable, but no later than December 31, 2029.

Toe-Drain Water Collection System

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

A toe-drain water collection system that consists of a wet well and pump station has been installed below the ash basin dam adjacent to the unnamed tributary. The wet well details consist of a 16 inch diameter by 18 feet deep well has been installed below the ash basin dam adjacent to the unnamed tributary. The toe-drain collect system is designed to hydraulically control and maintain groundwater levels at the base of the dam between approximately 624 and 629 feet NAVD 88. This is approximately 15 feet below current groundwater elevations (**Figures 5-4a** through **5-4c**) based on April 2019 water elevation data. The wet well and pump station storage capacity is approximately 2,000 cubic feet. The system construction and testing is complete and will begin operation in January 2020. Once in operation, the toe-drain system will collect water from the toe of the ash basin dam and route it to the Dan River through new discharge piping to a permitted NPDES outfall. Therefore, water from the ash basin will no longer discharge to the unnamed tributary, which will improve surface water and groundwater quality.

6.1.2 Extent of Constituent Migration beyond the Compliance Boundary

(CAP Content Section 6.A.b)

This section is an overview of constituent occurrences at or beyond the point of compliance. The point of compliance at Belews Creek is the ash basin compliance boundary. 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 PHR Landfill also has a waste boundary and a compliance boundary approximately 250 feet from the landfill waste boundary. The ash basin compliance boundary and landfill compliance boundary overlap, with the exception of an area of the landfill compliance boundary that is south of the ash basin compliance boundary (**Figure 1-2**). All groundwater constituent migration from the landfill occurs within with the landfill compliance boundary, with the exception of some constituent migration north of the landfill, within the ash basin compliance boundary. Based on predictive modeling, groundwater constituent migration from the landfill will not migrate beyond the landfill compliance boundary, outside of the ash basin compliance boundary.

Analytical sampling results associated with the source area: ash basin and PHR Landfill 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 *(CAP Content Section 6.A.b.ii.3)*
- Surface water: **Appendix C**, Table 2 and **Appendix K** *(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 constituent concentrations at or beyond the compliance boundary are generally consistent with background concentrations or are less than regulatory screening values (**Table 6-3**). Horizontal and vertical extent of constituent 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/ background values occur locally at or beyond the compliance boundary in two areas:

1. Northwest of the ash basin

2. North of the basin dam

The maximum extent of affected groundwater migration for all flow zones is represented by boron concentration greater than the 02L standard. Boron has migrated from the ash basin to areas north and northwest, at or beyond the compliance boundary. The boron plume is approximately 750 feet beyond the northwest portion of the ash waste boundary, and approximately 500 feet beyond the northern portion of the ash basin waste boundary. The PHR Landfill boron plume is within the landfill compliance boundary south, east and west of the source area, but has migrated approximately 100 feet north of the landfill's compliance boundary; this portion of the boron plume is within the ash basin waste boundary and compliance boundary. Boron has not migrated at or beyond the point of compliance in any other areas. This is because groundwater divides in areas upgradient and side-gradient of the basin limit constituent transport to primary flow paths consistent with the site CSM. Additionally, stream valleys and streams downgradient of the basin (tributaries to the Dan River north and northwest of the ash basin) are groundwater discharge zones that limit the horizontal transport of constituents downgradient of the basin. Also, due to the limited presence and mobility of most constituents in the groundwater system, constituent concentrations in groundwater have not caused, and will not cause, current surface water quality standards to be exceeded (**Appendix K**).

Chloride, lithium, and TDS have concentrations that are greater than their respective groundwater regulatory standards, or background values (lithium), at or beyond the compliance boundary. The distributions of chloride, lithium, and TDS occur as continuous plumes and are confined within the extent of the 02L boron plume and also have a smaller footprint than boron, and occur in an area that is more localized to the ash basin's north and northwest waste boundary.

Other constituents, including arsenic, beryllium, chromium (VI), cobalt, iron, manganese, molybdenum, strontium, and thallium, have concentrations greater than their respective groundwater regulatory standards at or beyond the compliance boundary north and northwest of the ash basin. Generally, non-conservative and variable constituents exhibit little migration from the ash basin north and northwest of the ash basin. Some constituents, such as arsenic, beryllium, iron, and thallium do not have concentrations greater than applicable criteria with distributions that represent a continuous discernable plume in all flow zones. The extent and maximum concentrations of non-conservative and variable constituents which have a discernable plume correlate to the migration of boron at concentrations greater than the 02L standard. The distribution of non-conservative and variable constituents are generally confined within the extent of the 02L boron plume with distributions in highly localized footprints relative to the ash basin's north and northwest waste boundary.

There are few exceptions where non-conservative and variable constituents occur in areas where boron is non-detect or less than the 02L standards at or beyond the compliance. One exception is arsenic and iron concentrations at an isolated location northeast of the ash basin dam. Location is adjacent to a wetland, where reducing conditions might enhance arsenic and iron solubility. The constituent concentrations of arsenic and iron at this location do not exhibit a discernable plume with other occurrences of arsenic and iron greater than 02L standards. Other exceptions include one, or up to four (molybdenum in bedrock), isolated detections of chromium (VI) and molybdenum concentrations that do not exhibit a discernable plume within the flow zone.

Section 6.1.3 includes a constituent management process for determining which groundwater constituents warrant corrective action, and **Section 6.1.4** provides isoconcentration maps and cross-sections depicting groundwater flow and constituent distribution and extent in groundwater *(CAP Content Section 6.A.b.i)*.

Seep Constituent Extent

(CAP Content Section 6.A.b.ii.3)

Seeps at Belews 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-6, S-8, S-9, and S-10
- Non-constructed seeps dispositioned — S-1, S-3, S-4, S-5, S-7, S-12, S-13, S-14, S-15, and S-16
- Constructed seep to be monitored per terms of the NPDES Permit – S-11 [non-constructed seep S-18 flow to a portion of the NPDES wastewater treatment system (*i.e.*, seep S-11) and is monitored per terms of the NPDES Permit]

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 constituents over four consecutive sampling events;
4. An engineering solution has eliminated the seep.

Non-dispositioned seeps, where monitoring conducted has indicated the presence of CCR affects, include: S-2, S-6, S-8, S-9, S-10, S-11, and S-18 (**Figure 5-6**). **Table 6-8** provides a summary of seep general location and approximate flow rate. Analytical results for these seep samples are included in **Appendix C**, Table 3. Seeps at Belews Creek are contained within well-defined channels. Therefore, potential constituent migration related to seep flow are constrained in localized areas along the channel. Surface water sampling conducted downstream of non-dispositioned seeps S-2 and S-6, near the point where the channels confluence with the Dan River and Belews Reservoir, demonstrate that flow from seeps has not caused constituent concentrations greater than 02B standards in the river or reservoir. Surface water samples that were collected at or near the confluence of seeps S-2 and S-6 with the Dan River and Belews Reservoir are shown on **Figure 5-6.** Applicable Dan River surface water samples, collected at or near the confluence of seep S-2 with the river include SW-DR-1 and S-2-D. The applicable Belews Reservoir surface water sample collected at or near the confluence of the seep S-6 with the reservoir includes SW-BL-S-06. Analytical results for these surface water samples are included in **Appendix C**, Table 2.

Seeps S-8 and S-9 confluence with Belews Reservoir have limited accessibility. Seeps S-10, S-11, S-15, and S-18 are comingled and all flow into the unnamed tributary. Prior to 2019, the unnamed tributary was the designated effluent channel for the ash basin. For these reasons these channels were not included in conducted surface water sampling at the time.

Surface Water Constituent Extent

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

Surface water samples have been collected from NCDEQ approved locations over multiple events from the Dan River and Belews Reservoir to confirm groundwater downgradient of the ash basin has not resulted in surface water concentrations greater than 02B water quality standards. Groundwater monitoring data consistently indicate the ash basin constituent plume does not extend to either the Dan River or the Belews Reservoir and that there are no surface water quality exceedances related to the BCSS ash basin. 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 Dan River, and Belews Reservoir. Analytical results were evaluated with respect to 02B water quality standards and background data. Surface water conditions is further discussed in **Section 6.2.1** and the full report for BCSS surface water current conditions can be found in **Appendix K**.

Additionally, environmental assessments of the Dan River and Belews Reservoir have all demonstrated that Belews Reservoir and the Dan River have been environmentally healthy and functioning ecosystems, 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 30 years. More information related environmental health assessments conducted for the Dan River and Belews Reservoir, 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)

All sediment sample locations are 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 seidment inorganic constituents, both background sediment constituent 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 per water body. Analytical results for all sediment samples are provided in **Appendix C,** Table 5**.**

Assessment of constituents in sediment from surface waters, including the Dan River, Belews Reservoir, and seeps, was conducted through a comparison evaluation between sediment sample constituent analytical results, from one-time grab samples, and constituent concentration ranges from background sediment datasets. Samples collected from Belews Reservoir and the Dan River were compared with background dataset ranges from the respective surface water body. No background sediment locations from either Belews Reservoir or Dan River tributary stream channels are sampled at Belews Creek, therefore ranges of constituent concentrations from both Belews Reservoir and the Dan River background sediment results are used to compare sediment sample results collected from tributary stream channels.

Sediments Collected from the Dan River and Belews Reservoir

The risk assessment concludes that on- and off-Site sediment, collected from the Dan River and Belews Reservoir, pose no unacceptable risks for recreational receptors (*i.e.,* swimmer, wader, boater, and recreational fisher; **Appendix E**)

Eight sediment samples have been collected from the Dan River and Belews Reservoir. Downstream sediment sample locations (**Figure 1-2**) per water body included:

- Four locations downstream of seeps, along the bank of the Dan River include sediment samples: SD-DR-01, SD-DR-02, SD-DR-03, SD-DR-04
- Four locations downstream of seeps, along the banks of Belews Reservoir include sediment samples: SD-BL-GWA-04D/S, SD-BL-S-06, SD-BL-S-07, SD-BL-S-13/14

Of the eight sediment samples, co-located with surface water sample locations in the Dan River or Belews Reservoir, four samples have constituent concentrations greater than the maximum detected concentrations in background sediment. Constituent concentrations from Dan River or Belews Reservoir sediment samples detected greater than background concentrations include arsenic, beryllium, chloride, cobalt, iron, strontium, and thallium.

Of the four sediment samples collected along the bank of the Dan River, one sample, SD-DR-02, has results of constituent concentrations greater than the maximum detected constituent concentrations in background sediment. Sediment sample SD-DR-02 is located at the confluence of seep S-2 stream and the Dan River (**Figure 1-2**). Sediment sample SD-DR-02 has constituent concentrations greater than background concentrations of arsenic, beryllium, cobalt, iron, strontium, and thallium. Sediment sample results collected further downstream of SD-DR-02 along the bank of the Dan River are within the background concentration ranges, suggesting the constituent concentrations greater than background ranges at SD-DR-02 are localized affects. Surface water sample results co-located with SD-DR-02 sediment sample are less than 02B surface water standards and generally within surface water background constituent concentration ranges (**Appendix K**).

Of the four sediment samples collected in association with the Belews Reservoir, three samples SD-BL-GWA-04D/S, SD-BL-S-07 and SD-BL-S-13/14, located east of the ash basin (**Figure 1-2**), have concentrations of chloride greater than the maximum detected concentration of chloride in Belews Reservoir background sediment results. Sediment sample SD-BL-S-07 has a concentration of arsenic greater than the maximum background concentration of arsenic. Surface water samples co-located with samples SD-BL-GWA-04D/S, SD-BL-S-07 and SD-BL-S-13/14 sediment samples are less than 02B surface water standards and generally within surface water background constituent concentration ranges (**Appendix K**).

Sediment Collected from Seeps

There are 11 sediment samples (S-1 through S-11), co-located with seep sample locations around the ash basin (**Figure 1-2**). Several seeps have been dispositioned per the SOC; of the seeps not dispositioned and are regulated per the SOC, only four have sediment samples with constituents detected greater than background concentrations. Constituents detected in sediment with concentrations greater than background include arsenic, cobalt, iron, and strontium.

- Sediment sample S-2 has a concentration of arsenic detected greater than background concentrations. Decanting has been effective in reducing flow at seep S-2. Further decanting, and groundwater corrective action proposed in this CAP Update might cause seep to become dry.
- Sediment sample S-6 has a concentration of strontium detected greater than background concentrations. Decanting has been effective in reducing flow at seep S-6. Further decanting, and ash basin closure might cause seep to become dry.
- Sediment sample S-10 has a concentration of arsenic detected greater than background concentrations. Decanting has been effective in reducing flow at seep S-10. Further decanting, and groundwater corrective action proposed in this CAP Update might cause seep to become dry.
- Sediment sample S-11 has arsenic, cobalt, iron, and strontium detected greater than background concentrations. Since sediment was collected at S-11 location, seep S-11 has been modified by a toe-drain collection system. Water discharging from the ash basin will be collected by the toe-drain collection system, therefore water from the ash basin no longer discharges to seep S-11 and then downstream unnamed tributary, which

will improve surface water quality at this location. The toe-drain collection system is part of the Belews Creek NPDES ash basin wastewater treatment system.

After completion of decanting, all seeps, constructed and non-constructed and if not dispositioned in accordance with the SOC, are to be characterized post-decanting for determination of seep disposition by the decanting process. If a seep is dispositioned, no corrective action for the location would be proposed. After seep characterization, an amendment to this CAP Update and submitted based on the schedule outlined in the SOC, may be required to address non-dispositioned seeps. Corrective action strategies for seeps, including seeps S-2, S-6, and S-10, are discussed in **Section 6.8**. Seep corrective action measures target reducing flow and the saturated zone at seeps and therefore reduces the potential for additional leaching and sorption of constituents to occur with sediment.

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 background locations and downgradient of the ash basin locations are included on **Figure 6-8**. Data used for the piper diagrams include groundwater data between January 2018 and April 2019 with a charge balance between -10 and 10%.

- Background groundwater from each flow zone tends to plot central to the diagram indicating water quality is more balanced between major anions and cations. The area where background groundwater (or native groundwater) tends to plot on the piper diagram is identified as “generally unaffected” on **Figure 6-8.**
- Shallow groundwater monitoring wells GWA-01S, GWA-17S, GWA-27S, and MW-200S plot near ash pore water points indicating water quality proportions of major anions and cations are more similar to ash pore water than background groundwater (**Figure 6-8**). Boron

concentrations from each of these shallow monitoring wells, with the exception of GWA-17S, are greater than the 02L standard, which supports that groundwater in these areas is affected by the source area (**Appendix C**, Table 1).

- Deep groundwater monitoring wells GWA-01D, GWA-11D, GWA-20D, GWA-21D, and MW-200D plot near ash pore water points indicating water quality more similar to ash pore water than background groundwater (**Figure 6-8**). Boron is detected at each of these deep monitoring well locations with the exception of GWA-01D. The concentration of boron at GWA-20D is greater than the 02L standard (**Appendix C**, Table 1).
- Bedrock groundwater monitoring well MW-200BR plots in the region of between the ash pore water and background results. This area is identified as "potential mixing" on **Figure 6-8**. This bedrock monitoring location is below the ash basin dam, north of the basin, and exhibits artesian conditions. Boron detected at MW-200BR is below the 02L standard (geometric mean of 155 µg/L), however the well exhibits the greatest concentration of boron in bedrock at or beyond the compliance boundary (**Appendix C**, Table 1).

Seep and Surface Water Piper Diagrams

Piper diagrams of seep, Dan River and Belews Reservoir surface water data are included on **Figure 6-23.** Data used for the piper diagrams include most recent available seep and surface water data (**Appendix C**, Table 2) with a charge balance between -10 and 10%. From ash pore water and groundwater piper diagrams (**Figure 6-23**), 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".

- Seeps S-2, S-4, S-6, S-9, and S-10 plot within the area where ash pore water tends to plot (**Figure 6-23**). Each of these seeps, with the exception of S-4, are covered by the SOC. No surface water samples from the Dan River or Belews Reservoir plot within the area of ash pore water quality (**Figure 6-23**).
- Surface water samples S-02D and SW-BL-S-07 plot within the region of between the affected and generally unaffected water quality. This area is identified as "potential mixing" on **Figure 6-23**. Surface water

sample S-02D is collected from the Dan River at the point of confluence between the stream where SOC seep S-02 is located and the Dan River. Sample results from S-02D are less than 02B standards (**Appendix C**, Table 2). Surface water sample SW-BL-S-07 is collected from the Belews Reservoir downstream of seep S-07. Sample results from SW-BL-S-07 are less than 02B standards (**Appendix C**, Table 2).

- Remaining seep and surface water samples plot with water quality in the region of generally unaffected (**Figure 6-23**). Surface water sample results are less than 02B standards with the exception of turbidity for some Dan River samples (**Appendix C**, Table 2).

6.1.3 Constituents of Interest

(CAP Content Section 6.A.c)

This CAP Update evaluates the extent of, and remedies for constituents associated with the BCSS ash basin and PHR Landfill that warrant corrective action, which are those that are at or beyond the compliance boundary to the north and northwest of the source area 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. The distribution of constituents in relation to the source area, co-occurrence with CCR indicator constituents, such as boron, 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 Belews Creek (SynTerra, 2017):

- Antimony
- Arsenic
- Barium
- Beryllium
- Boron
- Cadmium
- Chloride
- Chromium (Total)
- Chromium (Hexavalent)
- Cobalt
- Iron
- Manganese
- Molybdenum
- pH
- Selenium
- Strontium
- Sulfate
- Total Dissolved Solids
- Thallium
- Vanadium

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 basin, since soil impacts would be related to ash pore water interaction to the underlying soils within the basin and groundwater migration at or beyond the ash basin.

Belews Creek samples of background soil and rock media indicate that some naturally occurring constituents that are also typically related to CCR material and likely effect 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 arsenic, total chromium, cobalt, iron, manganese, selenium and thallium.

Data indicate unsaturated soil constituent concentrations are generally consistent with background concentrations or are less than regulatory screening values (**Table 6-3**). In the few instances where unsaturated soil constituent concentrations are greater than Preliminary Soil Remediation Goal (PSRG) Protection of Groundwater (POG) standards or background values, constituent concentrations are within range of background dataset concentrations or there are no mechanisms by which the constituent could have been transported from the ash basin to the unsaturated soils. Horizontal and vertical extent of constituent 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 of groundwater COI data (January 2018 to April 2019) was conducted and means were calculated to support the analysis of groundwater conditions to provide a basis for defining the extent of the COI migration at or beyond the compliance boundary. A measure of central tendency analysis was completed to capture the appropriate measure of central tendency (arithmetic mean, geometric mean, or median) for each dataset of constituent concentrations. Constituent concentrations in a single well might vary over orders of magnitude; therefore, a single sample result might not be an accurate representation of the concentrations observed over several months to years of groundwater monitoring. Evaluating COI plume geometries with central tendency data minimizes the potential for incorporating occasions where COIs are reported at concentrations outside of the typical concentration range, and potentially greater, or substantially less than enforceable groundwater standards. Previous Site assessments might have overrepresented areas affected by the ash basin 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 use of a lower confidence limit (LCL95) rather than the central tendency value. LCL95 concentration 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 – Belews Creek Steam Station* (Arcadis, 2019b) included within **Appendix H**. The mean is typically higher than the LCL95 value, and therefore, is a more conservative approach for evaluation and comparison to applicable criteria.

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 at or 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. Less than four quarters of valid data were not available either because the well was recently installed or sample results from one or more quarters were excluded. For use in calculating means, non-detect values were assigned the laboratory reporting limit and estimated (J-flag) values were treated as the reported value. Procedures for excluding data from calculating means are based on USEPA's National Functional Guidelines (USEPA, 2017a, 2017b), 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) is equal to the RL, and the geometric mean or mean value is 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)
- Records where pH was greater than 10 standard units (S.U.). Data with pH greater than 10 S.U might be related to grout from well construction.
- Data flagged as unusable (R0 qualified)
- Data reported as non-detect with a reporting limit (RL) greater than the normal laboratory reporting limit
- Negative values for total radium were set equal to 0.

Table 6-5 presents the mean analysis results of the COI data using groundwater monitoring sampling results from January 2018 to April 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 basin.

Constituent Management Approach

A COI Management Plan was developed at the request of NCDEQ to evaluate and summarize constituent 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 constituent concentrations on figures based on the actual distribution of each constituent 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 constituent management matrix for determining COIs subject to corrective action.
- 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 constituents that do not exhibit a discernable plume or constituents that have no correlation with other soluble constituents associated with coal ash or another primary source (*e.g.*, boron).

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

1. An evaluation of the applicable regulatory context
2. An evaluation of the mobility of target constituents
3. 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 constituent 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, described in **Section 5** as shown in **Table ES-2.** 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 constituent list identified in the CSA Update (SynTerra, 2017) and 2019 IMP submitted by Duke Energy, March 20, 2019, and approved by NCDEQ April 4, 2019 (**Appendix A**). Constituent concentrations were screened against their respective constituent criterion defined as the maximum of the 02L groundwater quality standard, IMAC, and background. COI concentrations were screened against their respective constituent criterion for groundwater monitoring locations at or beyond the compliance boundary. Groundwater constituent concentrations used in the screening are based on a calculated central tendency value (mean) including data from 2018 through the 2nd quarter of 2019.

NCDEQ (October 24, 2019 letter; **Appendix A**) recommended use of a lower confidence limit (LCL95) concentration rather than the central tendency value. LCL95 concentrations were calculated for each constituent and the LCL95 concentration for the sample with the highest COI LCL95 concentration is provided in **Table 1** of the COI Management Plan in **Appendix H**. for comparison to the maximum constituent mean concentration. **Table 2** of the COI Management Plan in **Appendix H** provides a comparison of the maximum constituent central tendency concentrations compared with the maximum constituent LCL95 concentrations for wells located at or beyond the compliance boundary for the Allen Steam Station, Belews Creek Stream Station, Cliffside Steam Station, Marshall Steam Station, Mayo Steam Electric Plant, and Roxboro Steam Electric Plant Sites. The constituent LCL95 concentrations were typically lower than the constituent central tendency value with very few exceptions. The number of wells exceeding constituent criteria using the constituent LCL95 concentration was typically equal to or less than the number of wells exceeding constituent criteria using the constituent central tendency concentration. There were no increases in the number of wells exceeding constituent criteria for the Site when comparing the LCL95 to the constituent criterion and the number of exceedances was typically less for LCL95. Use of the constituent central tendency concentrations in the COI Management Plan process provides a conservative estimate of the extent of constituents in Site groundwater.

Step 2: COI Mobility

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

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

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

Step 3: COI Distribution

Step 3 of the COI Management Plan process evaluates the relative presence of constituents in Site groundwater. Descriptions of the horizontal and vertical distribution of constituents with mean concentrations above their respective COI criterion at and beyond the compliance boundary are summarized in **Table 1** of the COI Management Plan in **Appendix H** and provided in more detail in **Table 6-6** (*CAP Content Section 6.A.c.i.2*). The COI Management Plan approach considers the distribution of constituents on a Site-wide basis. These distributions are used for planning appropriate corrective action, as well as determining which constituents to map on figures.

Primary descriptions of constituent distributions include plume-like distributions for relatively mobile constituents such as boron and isolated location(s) for constituents that do not exhibit plume-like distributions. Boron is the constituent with the most plume-like distribution. Some constituents with isolated exceedances of constituent 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 constituents from mapping on figures in the 2019 CAP Update is based on the horizontal and vertical distribution of constituents with concentrations greater than their respective constituent criterion. All wells that have constituent mean concentration(s) greater than the constituent criterion are listed in **Table 6-6**.

Outcome of COI Management Plan Process

Constituents with concentrations greater than the constituent 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 constituent 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 constituent criterion with a discernable plume that correlates with other soluble constituents.

Constituents were assigned to mobility categories based on geochemical modeling results and information derived from peer-reviewed literature. Constituent mobility categories are based on the concept of conservative versus non-conservative constituents introduced by NCDEQ in the January 23, 2019 CAP content guidance document. The use of three mobility categories for constituents 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, constituent mobility categories were expanded from conservative versus non-conservative to include the following:

- Conservative, Non-Reactive COI: antimony, boron, chloride, lithium, and total dissolved solids. 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: arsenic, barium, beryllium, cadmium, total chromium, strontium, and 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: hexavalent chromium, cobalt, iron, manganese, molybdenum, selenium, sulfate, and 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 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, 2017) and the 2018 CAMA Annual Interim Monitoring Report (SynTerra, 2019), 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 and vertical distribution of COI-affected groundwater migration from the ash basin.

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

Using the constituent management process, nine of 19 inorganic groundwater COIs (not including pH) identified in the CSA Update (CSA Update, 2017), exhibit mean concentrations that are currently less than background values, 02L standard, or IMAC at or beyond the compliance boundary, or have few concentrations greater than comparison criteria but with no discernable plume characteristics (*e.g.* molybdenum in bedrock flow zone). These nine constituents include:

- Antimony
- Barium
- Cadmium
- Chromium
- Chromium (IV)
- Molybdenum
- Selenium
- Sulfate
- Vanadium

These constituents are not expected to migrate distances at or beyond the compliance boundary or migrate distances that would present risk to potential receptors, and are predicted, based on geochemical modeling, to remain at stable concentrations, typically less than background values, 02L standard, or IMAC (**Appendix H**).

The remaining 10 inorganic groundwater COIs exhibit mean concentrations greater than background values, 02L standard, or IMAC downgradient of the ash basin at or beyond the compliance boundary. These constituents are as follows:

- Arsenic
- Beryllium
- Boron
- Chloride
- Cobalt
- Iron
- Manganese
- Strontium
- Total Dissolved Solids
- Thallium

Lithium has been added to the constituent list at the Belews Creek ash basin. Lithium was not previously analyzed for in collected groundwater samples until the second quarterly sampling event in 2018 (April 2018). This was after the submission of the CSA (CSA Update, 2017) and therefore lithium was not evaluated in that submittal.

As discussed in the CSA Update (SynTerra, 2017), not all constituents with results greater than background values can be attributed to the 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 affected groundwater migration from the source area.

6.1.4 Horizontal and Vertical Extent of COIs

(CAP Content Section 6.A.d)

The COIs at the BCSS have been delineated horizontally and vertically in groundwater based on sampling and analysis data collected from 173 monitoring wells present at the site. 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 basin in groundwater. The presence of COIs downgradient of the ash basin waste boundary is limited to between 500 and 750 feet. 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, although boron concentrations decline below its 02L standard within 500 to 750 feet beyond the ash basin waste boundary BCSS. Boron typically has greater concentrations in CCR than in native soil and is relatively soluble and mobile in groundwater (Chu, 2017). Chloride, lithium, and TDS are also conservative constituents and have a similar geometry, but smaller in extent, plume footprint as boron. 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 basin, are confined within the extent of the 02L boron plume at the Site. Non-conservative and variable constituents have smaller, and generally isolated, plume geometries relative to boron 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) was used to determine the maximum extent of COI-affected groundwater migration.

Since naturally occurring COIs might be present at concentrations greater than background values, isoconcentration maps of the primary CCR indicator COI (*i.e*. boron; **Figures 6-13a** through **6-13c**) is the most representative of the groundwater COI plume extent in three-dimensional space.

Isoconcentration maps and cross-sections use groundwater analytical data to spatially and visually define areas where groundwater COI concentrations are greater than background values and/or 02L/IMAC. Geometric means of groundwater COI monitoring sampling results from January 2018 to April 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 (**Figures 6-11a** through **6-21b**). Non-conservative constituents, boron, chloride and TDS, are mapped with empirical Site data and supplemented with flow and transport model simulated plume depictions where no data is available.

The flow and transport model calibration targets are boron concentrations measured in 157 monitoring wells in the second quarter of 2019. All sampled wells are included in the calibration. Data that has been collected since that timeframe were not included in the updated model calibration process. Fall 2019 data from relatively newly installed wells suggest the model predictions are accurate, or conservative; the model over-predicts the actual groundwater concentrations in some areas.

Vertical extent of the COI plume is depicted on two generalized cross-sectional depictions of the Site. Cross-section A-A′ is oriented south to north and displays the general basin footprint topography and depth of saturated ash in the basin's delta and free water near the dam (**Figures 6-6a** through **6-6c**). Cross section B-B′ is orientated west to east and displays the areas evaluated for corrective actions, the areas northwest of the basin and near the dam (**Figures 6-22a** through **6-22c**).

At or beyond the compliance boundary, the maximum extent of COI-groundwater affected by the ash basin occurs north and northwest of the ash basin.

6.1.4.1 COIs in Unsaturated Soil

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

Unsaturated soil at or near the compliance boundary 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. Therefore, constituents considered for unsaturated soil evaluation as related to the ash basin and PHR Landfill were the same constituents identified as COIs in groundwater for the ash basin and PHR Landfill.

Belews Creek samples of background soil and rock media indicate that some naturally occurring constituents that are also typically related to CCR material and likely effect 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 arsenic, total chromium, cobalt, iron, manganese, selenium and thallium.

Unsaturated soils samples at or near the compliance boundary were collected from borings during well installation activities upgradient of the ash basin from wells GWA-05S, GWA-07S, GWA-08D, GWA-09GTB, and MW-202BR; and downgradient of the ash basin from wells GWA-01S, GWA-10D, and MW-200BR (**Figure 6-5**). 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 concentraitons with background values or PSRG POG standards, whichever is greater [(**Table 6-3**) (*CAP Content Section 6.A.d.i*)]. PSRG POG standards were calculated for chloride (938 mg/kg) and sulfate (1,438 mg/kg) **(Table 6-2**).

Constituents detected at concentrations greater than either background values or the PSRG POG standard, whichever is greater, in unsaturated soil samples (depth), upgradient or downgradient of the ash basin, at or beyond compliance boundary include:

- pH: GWA-05S (25-26.5), MW-202BR (60-61.5)
- Arsenic: GWA-01S (20-21.5), GWA-10D (2-3), MW-200BR (0-1.5)
- Barium: GWA-09GTB (40-41.5)
- Chromium: GWA-09GTB (40-41.5)
- Selenium: GWA-07S (30-31.5)

No necessary corrective action for soils is identified at the Site because there is no potential secondary source to groundwater from leaching of unsaturated soil constituent concentrations that are greater than either background values or the PSRG POG standard, for the following reasons:

- Background soil and rock indicate that arsenic, chromium, and selenium occur at natural concentrations greater than the PSRGs POG values. Although greater than background values or PSRG POG, arsenic, chromioum, and selenium detections at or beyond the compliance boundary are within the range of concentrations detected in soil samples from background locations as shown in **Table 6-3**.
- Additionally, all unsaturated soil samples with values reported greater than the PSRG POG standard or background values, including barium detected at GWA-09GTB (40-41.5), are vertically delineated by groundwater constituent concentrations in the corresponding flow layer of the soil sample depth (**Table 6-3**).
- In the two locations upgradient of the ash basin, where unsaturated soil COI concentrations are greater than the PSRG POG standards or background values [*i.e.* GWA-07S (30-31.5) and GWA-09GTB (40-41.5), **Table 6-3**], there are no mechanisms by which the COI could have been transported from the ash basin to the unsaturated soils,

since groundwater from the ash basin primarily flows north and the ash basin is bound by hydraulic divides south, east, and west, as depicted by the pre-decanting vector velocity map (**Figure 5-5a**).

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 and northwest of the ash basin. Groundwater is not in need of restoration adjacent to the ash basin to the south, east, and west due to the lack of COIs above applicable standards in these areas. A limited number of COIs in groundwater are present at or beyond the compliance boundary to the north and northwest of the BCSS ash basin. Additional detail for these two areas is provided below.

Northern Extent of COI-Affected Groundwater

Boron, chloride, lithium, and TDS mean concentrations near the compliance boundary support the following observations regarding the northern extent COI-affected by the ash basin groundwater:

- The shallow and deep flow zone groundwater COIs north of the ash basin are within the compliance boundary and have relatively similar geometries (**Figures 6-13a** and **Figure 6-13b**). This supports the interpretation that these two zones are hydraulically connected. Differences between the groundwater COIs are related to hydraulic conditions; the shallow flow zone has limited saturated thickness in the area near the center of the dam (*i.e.*, AB-2S) and directly downgradient of the dam (*i.e.*, CCR-6S is a dry well).
- Based on Site empirical data, COI-affected groundwater in shallow and deep bedrock at concentrations greater than 02L standards is horizontally limited to the area beneath the western portion of the ash basin dam, within the compliance boundary, however, groundwater flow and transport modeling indicates the bedrock 02L plume extends northwest of the ash basin beyond the compliance boundary (**Figure 6-13c**). The vertical extent of 02L bedrock groundwater plume is generally limited to the top 50 feet of bedrock (**Figure 6-6a)**.

- North of the ash basin, COI-affected groundwater is vertically and horizontally delineated downgradient, beyond the compliance boundary. Delineation is demonstrated by groundwater COIs that are not detected or are detected at concentrations less than regulatory standard at monitoring wells GWA-24D/BR (**Figures 6-11b** and **6-21b**).

The north groundwater COI plume shape relates to hydraulic conditions associated with the flow-through system described in the CSM (**Section 5.0**). Upward and neutral gradients limit COI migration from the ash pore water to groundwater below ash and below the basin, except near the dam where a downward vertical hydraulic gradient promotes downward COI migration in groundwater.

Downgradient of the dam, groundwater flows upward toward the unnamed tributary channel discharge zone, limiting downward migration of COIs to the area just upstream from the dam. The extent of COI-affected groundwater north of the dam is limited by hydraulic conditions in that area:

- Below the ash basin dam and near the compliance boundary, a strong upward gradient is observed between the bedrock and the upper flow zones at well pair MW-200S/BR (-0.295 ft/ft). Bedrock well MW-200BR is a flowing artesian well.
- At the compliance boundary, mean concentrations of boron, chloride, and TDS, at groundwater monitoring wells MW-200S/D/BR, are greater than background values, but less than the 02L standards (**Figures 6-13a-c**, **6-14a-b,** and **6-20a-b**). Lithium is only slightly greater than background in bedrock monitoring well MW-200BR (**Appendix C**, Table 1).

At or beyond the compliance boundary, mean concentrations of boron, chloride, and TDS, from groundwater monitoring wells GWA-24S/D/BR, are less than background values, except for TDS (value) at GWA-24D (**Figures 6-20a** and **6-20b**); all of these analytes are less than the 02L standards at this well cluster. Additionally, water discharging from the ash basin will be collected by a toe-drain collection system, therefore water from the ash basin will no longer discharge to the unnamed tributary, which will improve surface water quality; and a groundwater-to-surface water evaluation concludes that groundwater migration from the ash basin source area has not resulted in exceedances of 02B surface water quality standards in the Dan River.

Northwestern Extent of COI-Affected Groundwater

Boron, chloride, lithium, and TDS mean concentrations at or beyond the compliance boundary support the following observations regarding the northwest extent of COI-affected by the ash basin groundwater:

- Shallow and deep flow zones have similar COI plume geometries northwest of the ash basin. This supports the interpretation that these flow zones are hydraulically connected (**Figures 6-13a-b, 6-14a-b, 6-17a-b, and 6-20a-b**).
- Empirical data from the Site indicates no groundwater with boron concentrations greater than 02L standards extends in the bedrock northwest of the ash basin. However, flow and transport modeling suggests that the 02L boron plume has migrated to shallow bedrock (**Figure 6-13c**). Other conservative constituents, chloride and TDS, have also migrated to the bedrock flow zone at concentrations greater than 02L (**Figure 6-14c** and **Figure 6-20c**). Bedrock plumes tend to be smaller than shallow and deep flow zone plumes, which is consistent with the overall lower hydraulic conductivity of the bedrock compared to the shallow and deep zones (**Figures 6-6a** and **Figure 6-22a**).
- Groundwater affected by COIs from the ash basin is vertically and horizontally delineated downgradient of the compliance boundary based on COI concentrations less than regulatory standard or below detection from groundwater monitoring wells CCR-13S/D/BR, GWA-2S/D, GWA-30S/D, and GWA-31S/D (**Figures 6-13a-c, Figures 6-14a-b, Figure 6-17a-b,** and **Figures 6-20a-b**).

The northwest groundwater COI plume shape relates to hydraulic conditions associated with a partial hydraulic divide along Middleton Loop, convergence of groundwater flow toward natural stream valleys, and vertical hydraulic gradients. The extent of COI-affected groundwater migration related to hydraulic conditions is supported by the following observations:

- Groundwater monitoring wells GWA-20SA/D and GWA-27S/D are centrally located within the groundwater COI plume. GWA-20SA/D is located at the compliance boundary, and GWA-27S/D is located downgradient of the reduced (approximately 250 foot) compliance boundary. These wells are located in relatively permeable zones of higher conductance (2.0 feet/day in saprolite and 0.3 feet/day in the transition zone from calibrated conductivities), compared to the mean hydraulic conductivity values identified at the Site (**Appendix G**).
- Mean concentrations of boron, chloride, lithium, and TDS, from groundwater monitoring wells GWA-20SA/D and GWA-27S/D, are generally greater than the regulatory standards or background values (lithium does not have a regulatory standard). GWA-20SA/D boron, chloride, lithium, and TDS concentrations provide the greatest extent relative to other groundwater monitoring results from wells at or beyond the compliance boundary (**Figures 6-13a-b, 6-14a-b, 6-17a-b, and 6-20a-b**). Downgradient of GWA-20SA/D, concentrations of boron, chloride, lithium, and TDS at GWA-27S/D are generally less, but still greater than those at other groundwater monitoring wells at or beyond the compliance boundary (**Figures 6-13a-b, 6-14a-b, 6-17a-b, and 6-20a-b**).
- Groundwater monitoring wells GWA-11S/D and GWA-21S/D are near or at the perimeter of the groundwater COI plume beyond the compliance boundary (200 feet). These wells are located downgradient of the compliance boundary in low permeability zones of lower conductance (0.5 feet/day in saprolite and 0.1 feet/day in the transition zone from calibrated conductivities) that are adjacent to zones of higher conductance identified at the Site (**Appendix G**).
- Mean concentrations of boron, chloride, lithium, and TDS, at groundwater monitoring wells GWA-11S/D and GWA-21S/D, are less than the 02L standards or background values, with the exception of GWA-11S (boron and lithium), GWA-11D and GWA-21S (lithium) (**Figures 6-13a-b, 6-14a-b, 6-17a-b, and 6-20a-b**).
- Shallow and deep groundwater monitoring wells CCR-13S/D, GWA-30S/D, and GWA-31S/D delineate the downgradient extent of boron, chloride, and TDS COI-affected groundwater northwest of the ash basin (**Figures 6-13a-b, 6-14a-b, and 6-20a-b**).

6.1.5 COI Distribution in Groundwater

(CAP Content Section 6.A.e)

Constituents distribution in groundwater is discussed based on constituent groupings, determined by alike geochemical behavior and mobility. Constituent groupings and COIs that are subject to corrective action, and discussed in this section, are as follows:

- **Conservative, non-reactive constituents:** boron, chloride, lithium, and TDS
- **Non-conservative, reactive constituents:** arsenic, beryllium, thallium, and strontium
- **Variably reactive constituents:** cobalt, iron, and manganese

COIs identified in the CSA that are not mapped in this CAP Update generally not only have limited spatial occurrences within the compliance boundary, but are further spatially limited to isolated areas within the compliance boundary that do not have a discernable plume geometry.

6.1.5.1 Conservative Constituents

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

Boron, chloride, lithium, and TDS mean isoconcentration maps and cross sections support the following observations regarding the extent of COI-affected groundwater represented by these conservative constituents:

- Shallow and deep flow zone groundwater COI plumes northeast of the ash basin are within the compliance boundary.
- Shallow and deep flow zone groundwater COI plumes north and northwest of the ash basin extend beyond the compliance boundary, but concentrations decline to below applicable standards within 500 to 750 feet of the waste boundary.
- The shallow and deep flow zone groundwater COI plumes have relatively similar COI plume geometries (**Figures 6-13a-b, 6-14a-b, 6-17a-b,** and **6-20a-b**). This supports a connected, unconfined flow system between the shallow and deep flow zones.

- Empirical data from the Site indicates no groundwater with boron concentrations greater than 02L standards extends in the bedrock northwest of the ash basin. However, flow and transport modeling suggests that the 02L boron plume has migrated to shallow bedrock (**Figure 6-13c**). Other conservative constituents, chloride and TDS, have also migrated to the bedrock flow zone at concentrations greater than 02L (**Figure 6-14c** and **Figure 6-20c**). Bedrock plumes tend to be smaller than shallow and deep flow zone plumes, which is consistent with the overall lower hydraulic conductivity of the bedrock compared to the shallow and deep zones **(Figures 6-6a** and **Figure 6-22a**).
- COI-affected groundwater migration is vertically and horizontally bounded downgradient of the basin, beyond the compliance boundary. COI-affected groundwater delineation is demonstrated by detected constituent concentrations that are less than regulatory standard or -are not detected at non-detect from groundwater monitoring wells CCR-13S/D/BR, GWA-2S/D, GWA-24S/D/BR, GWA-30S/D, and GWA-31S/D (**Figures 6-13a-c, 6-14a-b, 6-17a-b,** and **6-20a-b**).

The maximum extent of COI-affected groundwater migration for all flow zones is represented by boron. Chloride, lithium, and TDS concentrations identified as being greater than their respective groundwater regulatory standards are associated with COI-affected groundwater migration from the ash basin but are generally confined within the extent of the 02L boron plume and have a more localized footprint to the ash basin's north and northwest waste boundary (**Figures 6-13a** through **6-14c**).

Plume Behavior and Stability

(*CAP Content Section 6.A.e.i.1*)
Mann-Kendall trend analysis was performed using conservative constituent 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 are prepared by Arcadis U.S. Inc. and included in a technical memorandum titled *Plume Stability Evaluation – Belews Creek Steam Station* (Arcadis, 2019). The technical memorandum is included as in **Appendix I** as Attachment A.

The analysis was performed using analytical results for samples collected from 2011 through 2019. 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)

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

- Over 50% of ash pore water trend results indicate no trends for boron, chloride, lithium and TDS and approximately 25% of trend results indicate stable trends for conservative constituents (*i.e*. boron, chloride, lithium and TDS) (**Table 6-7**).
- Only one constituent at one well has an increasing trend, lithium at AB-4S (**Table 6-7**).
- Over 50% trend results for groundwater within the waste boundary, indicate stable trends for conservative constituents (**Table 6-7**).
- No boron trends are increasing from groundwater wells within the waste boundary. Boron trends are decreasing in two of three deep flow wells below the as basin dam (**Table 6-7**). This is consistent with information presented in the CSM in **Section 5.0**

Groundwater monitoring wells north of the ash basin, between the waste boundary and compliance boundary, include CCR-4S/D, CCR-5S/D, CCR-6S/D, CCR-7S/D, CCR-8S/D/AD, and GWA-2S/D; and groundwater monitoring wells northwest of the ash basin, between the waste boundary and compliance boundary, include wells CCR-1S/D, CCR-2S/D, and GWA-18S/D. Mann-Kendall results for groundwater wells between the waste boundary and compliance boundary indicate:

- Approximately 36% of trend results for groundwater wells between the waste boundary and compliance boundary have stable trends for conservative constituents (**Table 6-7**).
- Only 18% of groundwater wells between the waste boundary and compliance boundary have increasing trends of boron concentrations. Wells with increasing trends are CCR-2D, CCR-4S/D, and CCR-7S/D, and are located downgradient north and northwest of the ash basin (**Table 6-7**).
- For wells between the waste boundary and compliance, located east and west of the ash basin, boron results are non-detect (*e.g.* CCR-1S/D, CCR-11S/D, CCR-12S/DA, GWA-2S/D, GWA-18D) (**Table 6-7**).

Groundwater monitoring wells north of the ash basin and at or beyond the compliance boundary include GWA-1S/D/BR, GWA-24S/D/BR, GWA-32S/D, and MW-200S/D/BR. Groundwater monitoring wells northwest of the ash basin and at or beyond the compliance boundary include GWA-10S/DA, GWA-11S/D, GWA-19SA/D/BR, GWA-20SA/D/BR, GWA-21S/D, GWA-27S/D/BR, GWA-30S/D, GWA-31S/D. Corrective action implementation will address areas where the these wells are located. Mann-Kendall results for groundwater wells downgradient, at or beyond the compliance boundary indicate:

- Only 17% of trend results for groundwater wells at or beyond the compliance boundary have increasing trends for conservative constituents (**Table 6-7**). Majority of increasing trends occur in wells northwest of the ash basin.
- Approximately 38% of trends results for groundwater wells at or beyond the compliance boundary have stable trends. Majority of stable trends occur in deep flow zone wells for constituents lithium and TDS (**Table 6-7**).
- Majority (75%) of increasing trends occur for constituents boron and chloride. Of the majority, 72% of increasing trends occur in wells along primary groundwater flow paths from the ash basin (*i.e.* shallow and deep wells GWA-1S/D, GWA-10S/D, GWA-11S/D,

GWA-20SA/D, GWA-21S/D, GWA-27S/D) (**Table 6-7**). This is consistent with information presented in the CSM in **Section 5.0**

- Bedrock well MW-200BR is the only bedrock well with increasing trends (boron and chloride), where groundwater has an upward vertical gradient in bedrock below the dam from the pressure head of the ash basin pond water elevation (**Table 6-7**). This is consistent with information presented in the CSM in **Section 5.0**.

The north and northwest groundwater plume appear unstable, with several conservative constituents indicating increasing concentrations trends that suggest the plume is still expanding. Some locations with increasing trends have concentrations greater than comparative criteria.

6.1.5.2 Non-Conservative Constituents

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

Arsenic, beryllium, thallium, and strontium isoconcentration maps and cross-sections support the following observations regarding the extent of COI-affected groundwater represented by these non-conservative constituents:

- Arsenic within the deep flow zone occurs at a single isolated location, GWA-19D, within the extent of the 02L boron plume. Shallow and bedrock groundwater arsenic occurrences are single isolated locations, GWA-32S and GWA-20BR, and are outside the extent of the 02L boron plume. GWA-32S is located downgradient of a wetland; where reducing conditions might enhance arsenic solubility (**Figures 6-11a** through **6-11b**).
- Beryllium exhibits a localized plume-like distribution in shallow groundwater in the northwest corner of ash basin. Isolated single detection of beryllium greater than IMAC in deep groundwater in the northwest corner of ash basin. Beryllium within the deep flow zone occurs at a single isolated location, GWA-21D, within the extent of the 02L boron plume. Beryllium is not detected greater than IMAC in bedrock groundwater (**Figures 6-12a** through **6-12b**).
- Thallium in shallow groundwater exhibits a localized plume-like distribution north and northwest of the ash basin. Thallium within the deep flow zone occurs at two locations, GWA-21D and GWA-27D, within the extent of the 02L boron plume. There are no

detections of thallium in bedrock groundwater above IMAC (**Figures 6-21a** through **6-21b**).

- Localized plume-like distributions of strontium greater than background concentrations occur in shallow and deep groundwater north and northwest of the ash basin. Occurrences of strontium in shallow and deep groundwater occur primarily within the extent of the 02L boron plume. The only three occurrences of strontium greater than background in bedrock do not exhibit a plume-like pattern; none of the three locations are concurrent with boron greater than the 02L standard (**Figures 6-19a** through **6-19c**).

6.1.5.3 Variably Conservative Constituents

Cobalt, iron, and manganese isoconcentration maps and cross-sections support the following observations regarding the extent of COI-affected groundwater represented by these variable constituents:

- Localized plume-like distributions of cobalt greater than the IMAC standard occur in shallow and deep groundwater north and northwest of the ash basin. Occurrences of cobalt in shallow and deep groundwater occur primarily within the extent of the 02L boron plume. There are no detections of cobalt in bedrock groundwater greater than IMAC (**Figures 6-15a** through **6-15b**).
- Iron in deep groundwater occurs at four isolated locations northwest and north of the ash basin. With the exception of on location (GWA-32D), the remaining locations are within the extent of the 02L boron plume. Shallow groundwater has a single (GWA-32S), isolated occurrence or iron greater than the background value (**Figure 6-16)**. Monitoring wells GWA-32S/D are downgradient of a wetlands area to the northeast and both have iron concentrations greater than comparative criteria but boron significantly less than the 02L standard. Reducing conditions of the upstream wetland area might enhance iron solubility in a localized area.
- Localized plume-like distributions of manganese concentrations occur in shallow and deep groundwater north and northwest of the ash basin. Occurrences of manganese in shallow and deep groundwater occur primarily within the extent of the 02L boron plume. Bedrock groundwater has a single (MW-200BR), isolated

occurrence of manganese greater than the 02L standard (**Figures 6-18a** through **6-18c**).

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 500 and 750 feet immediately downgradient of the ash basin Groundwater migration from the ash basin and PHR Landfill is limited to Duke Energy property except for an unoccupied 2.67 parcel located northwest of the ash basin. Groundwater migration from the ash basin and PHR Landfill does not reach any water supply wells, and modeling indicates this will remain the case in the future. Therefore, potential receptors are limited to nearby surface water bodies, including the Dan River, Belews Reservoir, and their tributary streams, including the unnamed tributary.

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 **Figure 5-6,** is greater than the required 0.5 mile radius of the waste boundary. The ash basin and PHR Landfill are located between Belews Reservoir to the south and east and the Dan River to the north. Associated North Carolina surface water classifications for Belews Reservoir and the Dan 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 Subchapter .02L .0106(k), groundwater discharge to surface water cannot result in exceedances of standards for surface waters contained in 15A NCAC 02B .0200 (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 Dan River and Belews Reservoir to confirm groundwater downgradient of the ash basin has not resulted in surface water concentrations greater than 02B water quality standards.

Groundwater monitoring data consistently indicate the ash basin constituent plume does not extend to either the Dan River or the Belews Reservoir. 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 Dan River, and Belews Reservoir. 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; 2018a; 2018b) was conducted on surface water samples from the Belews Reservoir and Dan 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. 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, with the exception of alkalinity in Dan River downstream samples and aluminum in two Belews Reservoir upstream samples. Dan River downstream samples have alkalinity concentrations greater than USEPA criteria and greater than background Dan River concentrations. Two Belews Reservoir upstream samples, SW-BL-U2 and SW-BL-U3, have greater concentrations of aluminum greater than USEPA criteria and greater than other Belews Reservoir upstream and downstream samples.

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 BCSS groundwater discharge to surface water and the evaluation of surface waters to evaluate compliance with 15A NCAC 02B .0200 was submitted to NCDEQ on March 23, 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 K**.

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

- Groundwater migration from the ash basin source area has not resulted in exceedances of the 02B surface water quality standards at the Dan River or Belews Reservoir.
- Previously identified seeps are deemed covered by Special Order by Consent EMC SOC WQ S18-004 (SOC).

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 basin might intersect surface water in the future. Predictive groundwater modeling using boron as a proxy for COI plume migration demonstrated the area to the north and northwest of the ash basin (specifically jurisdictional streams associated with seeps S-3, S-4, S-5, S-11, S-15, and S-18) 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. The full report for BCSS groundwater discharge to surface water under future conditions can be found in **Appendix K**.

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 Subchapter 02L .0106 (k) or (l)
- Modeling scenarios illustrate the maximum extent of COI-affected groundwater occurs during years 2032 through 2100. The predicted extent of COI-affected groundwater migration is anticipated to encompass an area outside the ash basin footprint that reaches jurisdictional streams, as identified in the NRTR (AMEC Foster Wheeler, 2015), associated with non-disposition seeps S-3, S-4, S-5, S-11, S-15, and S-18.

- The predicted extent of COI-affected groundwater migration from the ash basin would not reach the Dan River or migrate toward Belews Reservoir post ash basin closure, based on predicted future hydraulic head elevations and groundwater flow direction.
- 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.

6.2.2 Water Supply Wells

(CAP Content Section 6.B.b)

A total of 50 private water supply wells and one public supply well were identified within the 0.5-mile radius of the ash basin compliance boundary (**Figure 5-7a** and **Figure 5-7b**). The 0.5-mile radius from the ash basin compliance boundary, for which data is evaluated and depicted on figures, is greater than the required 0.5-mile radius from the waste boundary and is consistent with the drinking water well and receptor surveys.

Most of these water supply wells are located northeast of the ash basin along Pine Hall Road and Middleton Loop, and west and southwest of the ash basin along Middleton Loop, Old Plantation Road, Pine Hall Road, and Martin Luther King Jr. Road. No public or private drinking water wells or wellhead protection areas were found to be located downgradient of the ash basin as discussed in **Section 5.3**. This finding has been supported by field observations, 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 supply wells located upgradient or side-gradient of the facility, within 0.5 miles of the ash basin compliance boundary, were included in drinking water supply well survey reports.

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 area, private and public water supply wells identified within the 0.5-mile radius from ash basin compliance boundary have been offered a water treatment system, per G.S. Section 130A-309.211(c1) requirements.

Duke Energy identified a total of 45 private resident properties eligible for connections for a water treatment system near BCSS. A property eligibility was contingent that the property did not include:

- A business
- A church
- A school
- Connection to the public water supplier
- An empty lot

Of the 45 eligible connections, 11 either opted out of the option to connect to a water treatment system or did not respond to the offer. Duke Energy also voluntarily provided permanent water solutions to business, schools, and churches within a 0.5-mile radius not connected to a public water supply that were otherwise not eligible per G.S. Section 130A-309.211(c1). At Belews Creek, this included providing water treatment systems to one business, LCW Associates LLC, and one church, Withers Chapel United Methodist Church (UMC). Duke Energy installed 36 water filtration systems at surrounding properties in accordance with G.S. Section 130A-309.211(c1).

On August 31, 2018, Duke Energy provided completion documentation to NCDEQ to fulfill the requirements of House Bill 630. NCDEQ provided correspondence, dated October 12, 2018, to confirm that Duke Energy satisfactorily completed the alternate water provisions under G.S. Section 130A-3099.211(c1) at BCSS. Both documents are provided in **Appendix D**.

Figure 5-7a and **Figure 5-7b** (*CAP Content Section 6.B.b.i*) shows the private and public water supply well locations with reference to water treatment systems installed along with vacant parcels and residential properties whose owners have either decided to opt out of the water treatment system program or did not respond to the offer. As discussed in **Section 5.0**, all of the private water supply wells are located either upgradient or side-gradient of the ash basin (in separate drainage systems) and all water supply wells are outside of the area of groundwater affected by the ash basin and PHR Landfill.

6.2.2.2 Findings of Drinking Water Supply Well Surveys
(CAP Content Section 6.B.b.ii)

The location and information pertaining to water supply wells located upgradient or side-gradient of the facility, within 0.5 miles of the ash basin compliance boundary, were included in drinking water supply well 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 – Belews Creek Steam Station* (HDR 2014a)
- *Supplement to Drinking Water Well and Receptor Survey – Belews Creek Steam Station* (HDR 2014b)
- *Comprehensive Site Assessment Report – Belews Creek Steam Station Ash Basin* (HDR 2015a)
- *Comprehensive Site Assessment Update Report – Belews Creek Steam Station Ash Basin* (SynTerra 2017)

The survey identified two public supply wells within a 0.5-mile radius of the ash basin compliance boundary. The LCW Associates LLC public water supply well is located approximately 1,700 feet (0.3 miles) southwest and upgradient of the ash basin. The Withers Chapel UMC public water supply well is located approximately 1,750 feet (0.3 miles) northeast and upgradient of the ash basin.

As documented in the 2017 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 groundwater samples from seven private water supply wells within a 0.5 mile radius of the BCSS ash basin compliance boundary. NCDEQ continued to collect and analyze samples from water supply wells within a 0.5 mile radius of the BCSS ash basin compliance boundary during the latter part 2015 and early 2016. A total of 36 samples from 36 private water supply wells were collected by NCDEQ. Duke Energy collected samples from private water supply wells in 2016 and 2017 after the NCDEQ sampling effort. For many of the wells sampled in this program, as with standard practice, samples were split for analysis by Duke Energy's certified (North Carolina Laboratory Certification #248) laboratory.

Table 6-9 (*CAP Content Section 6.B.b.ii*) provides tabulated results for the NCDENR and Duke Energy sampling results as well as identified exceedances of 02L Standards, IMACs, and bedrock background values. A well-by-well summary of COI exceedances and characterization is presented in **Table 6-9.** 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 bedrock flow zone. Groundwater concentrations of boron, which is a constituent that conservatively indicates influence from the Belews Creek ash basin or closed PHR Landfill, is not detected in the vicinity of the water supply wells and is only detected in bedrock monitoring wells at locations within the compliance boundary, approximately over 3,000 feet from the closest water supply well.

The major findings from the water supply well evaluation include:

- All water supply wells west of the ash basin and PHR Landfill are in a separate drainage system separated by a hydrologic divide represented by Middleton Loop. Vector velocities depict groundwater flowing away, on either side of the hydraulic divide represented by Middleton Loop (**Figure 5-5a**).
- All water supply wells to the southwest are upgradient of the ash basin, not within the direction of groundwater flow from the ash basin and PHR Landfill (**Figure 5-4c**).
- All water supply wells to the north and northeast are upgradient of the ash basin, not within the direction of groundwater flow from the ash basin and PHR Landfill (**Figure 5-4c**).
- Groundwater modeling simulation indicated as source control (*i.e.* decanting and ash basin closure) continues, a hydraulic divide is expected to be reestablished northwest of the ash basin, along the topographic ridge represented by Middleton Loop (**Figure 5-5b** and **Figure 5-5c**).
- All water supply wells are outside of the conservative constituent 02L groundwater plumes from the ash basin and PHR Landfill.

Isoconcentration contour maps for boron, chloride, and TDS of all flow zones support water supply wells are not within the footprint of conservative concentration groundwater plumes (**Figures 6-13a-c, 6-14a-b, 6-17a-b,** and **6-20a-b**).

- Ten of the 20 COIs identified in the CSA Update (SynTerra, 2017) were present greater than 02L standards or bedrock background values including: antimony, arsenic, hexavalent chromium, total chromium, cobalt, iron, manganese, molybdenum, strontium and vanadium. With the exception of antimony, these metals are characterized as non-conservative or variably conservative geochemical behavior and generally migrate within a short distance of the ash basin waste boundary. Of these metals, only cobalt, iron, manganese and strontium are detected at concentrations greater than comparative criteria downgradient of the ash basin, at or beyond the compliance boundary in a plume configuration; however, these constituents are not associated with the ash basin based on the local hydrogeology as described above. The other constituents (antimony, arsenic, hexavalent chromium, total chromium, molybdenum, and vanadium) are not detected at or beyond the compliance boundary at concentrations greater than comparative criteria downgradient of the ash basin.
- The conservative, highly mobile constituents, boron, chloride and TDS were not present greater than 02L standards or background values in any water supply well, which is consistent with the local hydrogeology as described above.
- Concentrations of antimony greater than IMAC values were observed in two water supply wells west of the ash basin. No discernable plume associated with the ash basin and PHR Landfill was identified. This finding has been confirmed by 30 consecutive onsite groundwater monitoring events.
- Arsenic is only present in groundwater in the shallow and deep flow zones greater than the 02L standard north of the ash basin at isolated locations (**Figure 6-11a** and **6-11b**). Concentrations of arsenic greater than 02L standards were observed in nine water supply wells, to the west and southwest of the ash basin, approximately 4,000 feet from the nearest location with arsenic greater than the 02L standard, downgradient of the source area. No discernable plume associated

with the ash basin and PHR Landfill is identified in water supply wells with arsenic concentrations greater than 02L. This finding has been confirmed by 30 consecutive onsite groundwater monitoring events.

- Concentrations of chromium greater than background values were observed in one water supply wells west of the ash basin. No discernable plume associated with the ash basin and PHR Landfill was identified. This finding has been confirmed by 30 consecutive onsite groundwater monitoring events.
- Concentrations of cobalt greater than IMAC values were observed in two wells. Both wells were located to the northeast of the ash basin. No discernable plume associated with the ash basin and PHR Landfill was identified. This finding has been confirmed by 30 consecutive onsite groundwater monitoring events.
- Hexavalent chromium is only present in groundwater in one bedrock monitoring well, within the compliance boundary, greater than the 02L standard north of the ash basin. Concentrations of hexavalent chromium greater than background values were observed in nine water supply wells, to the northeast and southwest of the ash basin. No discernable plume associated with the ash basin and PHR Landfill was identified in water supply wells with hexavalent chromium concentrations greater than background. This finding has been confirmed by 30 consecutive onsite groundwater monitoring events.
- Iron is only present in groundwater in the deep flow zone greater than the 02L standard north of the ash basin at isolated locations (**Figure 6-16**). Concentrations of iron greater than background values were observed in seven water supply wells. The wells are located to the north, northeast and west of the ash basin, approximately 1,100 feet from the nearest location with iron greater than the 02L standard, downgradient of the source area. No discernable plume associated with the ash basin and PHR Landfill was identified in water supply wells with iron concentrations greater than 02L. This finding has been confirmed by 30 consecutive onsite groundwater monitoring events.

- Manganese is present in groundwater shallow, deep, and bedrock flow zones downgradient, north and northwest of the source area, at concentrations greater than comparative criteria (**Figure 6-18 a through c**). Concentrations of manganese greater than background values were observed in seven water supply wells. The wells are located to the northeast and southwest of the ash basin, approximately 3,300 feet from the nearest location with manganese greater than the 02L standard, downgradient of the source area. No discernable plume associated with the ash basin and PHR Landfill was identified in water supply wells with manganese concentrations greater than background. This finding has been confirmed by 30 consecutive onsite groundwater monitoring events.
- Molybdenum is found greater than background values north and northwest of the ash basin at isolated locations that do no exhibit a plume configuration. Concentrations of molybdenum greater than background values were observed in five water supply wells west and southwest of the ash basin. No discernable plume associated with the ash basin and PHR Landfill was identified in water supply wells with molybdenum concentrations greater than background. This finding has been confirmed by 30 consecutive onsite groundwater monitoring events.
- Strontium is present in groundwater shallow, deep, and bedrock flow zones downgradient, north and northwest of the source area, at concentrations significantly greater than background (**Figure 6-19a though c**). Concentrations of strontium greater than background values were observed in nine water supply wells, approximately 3,000 feet from the nearest location with strontium greater than the background, downgradient of the source area. No discernable plume associated with the ash basin and PHR Landfill is identified in water supply wells with strontium concentrations greater than background. This finding has been confirmed by 30 consecutive onsite groundwater monitoring events.
- Concentrations of vanadium greater than background values were observed in two water supply wells. The wells are located to the west of the ash basin. No discernable plume associated with the ash basin and PHR Landfill was identified. This finding has been confirmed by 30 consecutive onsite 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 basin and PHR Landfill within and beyond the predicted area of potential groundwater COI influence. Therefore, no future groundwater use areas are anticipated downgradient of the ash basin or PHR Landfill.

It is anticipated that private and public properties within a 0.5-mile radius of the ash basin compliance boundary will continue to rely on groundwater resources for water supply for the foreseeable future; therefore, Duke Energy will provide periodic maintenance of the provided water treatment systems for each property that accepted the alternative water supply [(**Figure 5-7a** and **Figure 5-7b**) *(CAP Content Section 6.B.c.i)*].

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 north 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 the BCSS 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 assessment update include: (1) the ash basin does not cause an increase in risks to potential human receptors located on-Site or off-Site; and (2) the ash basin does not cause an increase in risks to ecological receptors. 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 basin can be found in **Section 5.4**. An update to the BCSS human health and ecological risk assessment is included in **Appendix E**.

6.4 Description of Remediation Technologies

(Supplemental Information for CAP Content Section 6.D.a.iv)

This section provides supplemental information beyond the 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 Belews Creek. The most feasible remedial options identified will form the basis, in whole or in part, for the remedial alternatives evaluated in **Section 6.6**. Groundwater remediation technologies will be evaluated based upon two primary criterion:

- Can a technology be effective when addressing one or more site-specific COIs?
- 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 6.7**.

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 less than regulatory standards (USEPA, 1999).

MNA processes potentially applicable to inorganic constituents include:

- Dispersion
- Dilution
- Transformation
- Sorption
- Radioactive decay
- Phytoremediation
- 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 to 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 (NCDEQ, 2017). 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 Belews Creek, 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 Belews Creek 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 groundwater flow. Materials used to construct LPBs are either impermeable (*e.g.*, steel sheet pile) or have a permeability that is two orders of magnitude or lower than 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 reactive 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 Belews Creek would involve installation by means of drilling because bedrock is approximately 50 feet (or greater) below ground surface downgradient of the ash basin.

Construction of a LPB at Belews Creek 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 the BCSS. Installation of an effective low permeability barrier to depths approaching 50 feet would be technically challenging and costly, therefore LPB technology will not be 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 the infiltration or injection of clean water into groundwater to accelerate flushing of targeted 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 or 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 a clean water into groundwater enhances physical groundwater flow by increasing the hydraulic gradient between the point of infiltration 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 Belews Creek to enhance the capture of mobile constituents. Groundwater flushing by infiltration 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°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). Two additional considerations associated with this technology are permanence of the reaction product insolubility and the ability to distribute reactants sufficiently to ensure adequate contact with the COIs.

Contact between the encasing material and affected media could propose a challenge in the transition zone and fractured rock formations. It is difficult to ensure that encasing material are uniformly distributed in transition zone and fractured bedrock to assure adequate encapsulation of affected media.

Microencapsulation and ISV would not be feasible for the areas north and northwest of the ash basin that would need to be encapsulated, due to the size and depths of the areas requiring groundwater remediation.

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 in 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, 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 media for raising the pH of acidic groundwater like that are found in mine runoff (Indraratna, 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. This technology was considered during the evaluation process for the interim action system northwest of the basin. However, upon evaluation, it was not chosen as the most effective remedial approach for the area. Permeable reactive barriers are not carried forward for further evaluation for the same reasons this technology was not chosen for the interim action system. 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.

6.4.3 Groundwater Extraction

Groundwater extraction is often used when remediating mobile constituents in groundwater. Groundwater extraction can be used to withdraw effected 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 effected groundwater and mitigate groundwater constituent migration. Groundwater extraction can be conducted using a variety of methods that are discussed in the following sub-sections.

Groundwater extraction is currently being used at BCSS to capture COI-affected groundwater downgradient, northwest of the ash basin. A more comprehensive system of groundwater extraction wells could be added to the existing system to capture COI-affected groundwater near or beyond the ash basin compliance boundary (*e.g.*, to the north of the ash basin main dam).

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 GeoProbe® direct push technology, to hollow stem auger, mud rotary, air rotary, and 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. 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 (deep well single- or multi-stage centrifugal pumps) can be used to extract groundwater from larger diameter wells with deeper groundwater levels. Also, deep well jet pumps can be used, and they have the advantage of mechanical equipment above grade; therefore, 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 for Belews Creek indicates that vertical groundwater extraction wells can produce sufficient yield for effective constituent mass removal. The use of vertical groundwater extraction wells is retained for further consideration.

Additionally, shallow groundwater extraction wells installed near seep locations can be an effective surface water protection supplement to a groundwater management system. If applied at Belews Creek, shallow groundwater extraction effectiveness would be best applied as corrective action to address seep(s) located north of the ash basin dam, if not dispositioned after completion of decanting.

Horizontal/Angular Well 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 shallow or near subsurface 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 groundwater 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 for Belews Creek 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 than horizontal wells and therefore 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. 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 (< 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.

Although this technology is not capable of achieving depths necessary to remediate groundwater, shallow groundwater extraction trenches are easy to install and can be an effective surface water protection supplement to a groundwater management system. If applied at Belews Creek, trench technology effectiveness would be best applied as corrective action to address seep(s) located north of the ash basin dam, if not dispositioned after completion of decanting. The use of shallow groundwater extraction trenches is retained for further consideration.

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. Pumping of a slurry of water, sand, oa thick gel at high pressure into the borehole to propagates the fracture. The residual gel biodegrades and the resultant fracture is a 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 Belews Creek 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.

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 tree well 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.

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 (US EPA, 1982).

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 tree wells which are targeted to deep soil and/or groundwater. The typical range of effectiveness for phytoremediation groundcovers is 1–2 feet below ground surface; 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 wetland plants with robust root systems and 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 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 would be an effective surface water protection supplement to a groundwater management system. If applied at Belews Creek, phytoremediation technology effectiveness would be best applied as corrective action to address low flowing seeps north of the ash basin dam and in remote locations of the Site, if not dispositioned after completion of decanting. Therefore, the use of phytoremediation is retained for further consideration for shallow groundwater extraction as a corrective action strategy for seeps.

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

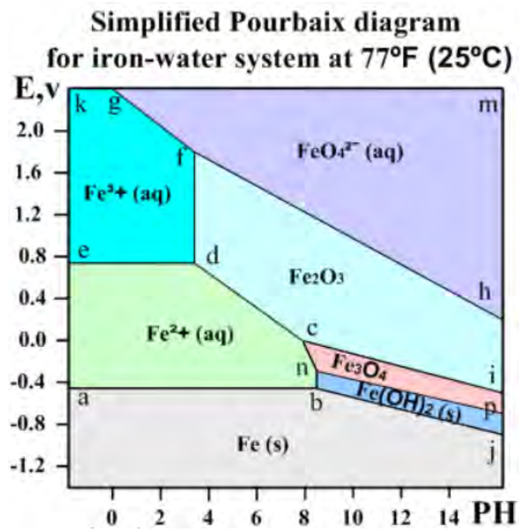
Adjustment of the pH of extracted groundwater, if required prior to discharge, is a proven technology. Permitted discharges will impose specific limits on the pH of discharged wastewater. The NPDES permitted outfalls at Belews Creek maintain a pH between 6.0 and 9.0 S.U. Facilities and equipment to adjust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

The pH adjustment of extracted groundwater is not expected but is retained due to the average value for pH in shallow (saprolite) groundwater at the Belews Creek Site is 5.3 S.U which is below the permit limit. However, extracted groundwater would consist of mixed shallow, deep, and bedrock groundwater. The average pH of groundwater downgradient of the ash basin from all flow zones is approximately 6.8 S.U, which is within the current permit requirement, however, 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 6-24
POURBAIX DIAGRAM FOR IRON-WATER SYSTEM



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

As illustrated in the Pourbaix diagram (**Figure 6-24**), 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 redox potential 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. This technology involves adding a flocculent to extracted water and then removing (through sedimentation or filtration) formed particulates to reduce concentrations, such as total suspended solid (TSS).

Precipitation technology might be warranted as a means 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 disposal. 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 can achieve low effluent concentrations. However, permeable membrane filtration technologies are also 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 disposal. These technologies typically have high capital costs.

Membrane filtration at Belews Creek 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 disposal make this technology costly and high maintenance.

6.4.5 Groundwater Management

Extracted groundwater must be managed of 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 BCSS has an NPDES permit that authorizes the discharge of specific waste streams to the Dan River via NPDES Outfall 006. The ash basin is closed (*i.e.* does not receive waste inputs); however, discharge, via Outfall 006A, from the ash basin remains active, as basin closure activities remain in progress (*i.e.,* ash basin decanting and dewatering). The wastewater from Outfall 006A discharges Outfall 006, which then discharge to the Dan River.

Active waste streams that previously discharged to the ash basin have been re-routed to the new lined retention basin (LRB). Outfall 006 is constructed for the LRB and replaces Outfall 003A. Outfall 006 discharges to the Dan River and is the ultimate disposal of extracted groundwater.

Anticipated groundwater remediation parameter levels are within NPDES permit limits for Outfall 006A/006 as summarized on **Table 6-10**. Therefore, disposal of extracted groundwater utilizing the NPDES discharge system will be retained for further consideration.

Publicly Owned Treatment Works (POTW)

This groundwater disposal option involves the discharge of extracted groundwater to a sewer that discharges to the local POTW. The feasibility of this disposal 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 disposal fees.

The Town of Madison wastewater treatment plant (WWTP) is located at 403 Lindsey Bridge Rd, Madison, NC 27025, or about 9.5 miles northeast of Belews Creek near the shoreline of the Dan River. The Madison WWTP uses a process in treating and purifying water for the Town of Madison and Rockingham County.

The treatment process consists of five steps, including coagulation, flocculation, sedimentation, filtration and disinfection. The Town of Madison WWTP limits their influent a daily flow rate of 1.5 million gallons per day (MGD).

Discharge of extracted groundwater to the Town of Madison WWTP is not retained for further consideration at this time because of the extensive distance required to pipe extracted groundwater from the Belews Creek site to the WWTP. Disposal of extracted groundwater via NPDES Internal Outfall 006A and Outfall 006 is considered the most viable option.

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 extracted water by way of an infiltration gallery must not result in concentrations greater than 02L groundwater standards or affect the model predictions. Consequently, groundwater treatment must reliably produce an effluent waste stream that does not result in groundwater concentrations greater than the 02L standard.

The construction and use of infiltration galleries are permitted under 15A NCAC 02T .0700. The effectiveness of an infiltration system will depend 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 a half of the native soil is FpC2 (Fairview-Poplar Forest complex), RpE (Rhodhiss, Fairview, and Stott Knob), and others similar in properties, and consist of a sandy clay loam to fine sandy loam (USDA, 2019). The capacity of the most limiting layer of this soil type to transmit water is described as ranging from moderately high to high (0.57 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 a 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, June 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, November 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 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 groundwater 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.
- Disposal 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, groundwater, 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 disposal 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 NCDEQ 2018 Annual Water Use Report for the BCSS indicated that water was withdrawn from Belews Reservoir every day in 2018. The average daily withdrawal in a given month ranged from 588.7 MGD to 1459.0 MGD. The average daily discharge in a given month ranged from 585.7 to 1455.0 MGD (NCDEQ, 2018). Beneficial reuse of extracted groundwater will not be retained for further consideration at Belews Creek, but this might be reconsidered in the future.

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. This beneficial reuse option is a potential application for Belews Creek, but only as a system improvement and supplemental source of water for fire protection. It will be determined at a later date whether the extracted water is appropriate for beneficial reuse based on actual extraction rates of operational system.

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 Belews Reservoir. This beneficial reuse option is a potential application for Belews Creek, but only as a system improvement and supplemental source of water for non-contact cooling water. It will be determined at a later date whether the extracted water is appropriate for beneficial reuse based on actual extraction rates of operational system.

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 basin 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 disposal. 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 plant water intake on Belews Reservoir. 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 several groundwater extraction technologies including vertical extraction wells, horizontal extraction wells, extraction trenches, and phytoremediation. 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 disposal of extracted groundwater. No beneficial reuse technology is retained at this time.

6.5 Evaluation of Remedial Alternatives

(CAP Content Section 6.D)

These groundwater remedial alternatives are presented and described in the following subsections. Information to address *CAP content section 6.D.a.iv* is provided in **Section 6.6** and **6.7.** Technologies evaluated and retained for consideration as discussed in **Section 6.5** were used to formulate the following three groundwater remedial alternatives to remediate Site groundwater:

- Remedial Alternative 1: Monitored Natural Attenuation
- Remedial Alternative 2: Groundwater extraction and treatment
- Remedial Alternative 3: Groundwater extraction combined with clean water infiltration and treatment

6.5.1 Remedial Alternative 1 – Monitored Natural Attenuation

(CAP Content Section 6.D.a)

Alternative 1 is the use of MNA as a remedial alternative to address groundwater COI concentrations at or beyond the ash basin compliance boundary. Under this alternative the groundwater plume could continue to migrate beyond the current compliance boundary north and northwest of the ash basin for more than 100 years; compliance is predicted to be achieved in approximately 700 years after ash basin closure completed (**Appendix G**). 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 CCR constituents in groundwater associated with the Belews Creek ash basin and PHR Landfill occur at or beyond the compliance boundary to the north and northwest of the ash basin 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 the BCSS *(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**: arsenic, beryllium, boron, chloride, cobalt, iron, lithium, manganese, strontium, thallium, and TDS *(CAP Content Section 6.D.a.i.1).* These are the COIs that indicate a discernable plume associated with the source area.

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 ash basin, with the exception of the area to the northwest of the dam.

Source control is a primary component of MNA as a remedial strategy. Ash basin decanting commenced on March 27, 2019, and is scheduled to be completed by September 2020. As of December 1, 2019, approximately 469,400,000 gallons water have been removed from the ash basin and the water elevation has decreased by 10.6 feet. 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 basin. After decanting and basin closure, the groundwater divides that control the migration of COI will become more pronounced (along Pine Hall Road) or will be re-established (along Middleton Loop). The decanting will reduce the potentiometric head responsible for the downward vertical gradient upstream of the ash basin dam. A lower downward gradient would reduce downward COI migration. As a result, constituent concentration reductions through natural attenuation processes are anticipated following decanting.

The following five physical natural attenuation mechanisms are an effective corrective action approach north and northwest of the Site because they control the migration and distribution of all or some COIs, particularly boron, chloride, lithium, 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 without exceeding 02B standards
- **Groundwater flow control within the stream valley system**: Control COI migration within hydraulic divide boundaries south, east and west of the ash basin
- **Phyto-attenuation:** Uptake of the COI by plants or organisms

The following three chemical natural attenuation mechanisms are also an effective corrective action approach north and northwest of the Site because they aid in stabilizing control of reactive and variable reactive COI's arsenic, beryllium, cobalt, iron, manganese, strontium, and thallium 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

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 the point of compliance, in sentinel areas prior to receptors, and near the maximum predicted extent of migration. There are 175 monitoring wells installed associated with the ash basin. 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 concentrations would be reduced to 02L standards using MNA alone (primarily relying on natural attenuation by dilution). The simulation suggests that the groundwater plume could continue to migrate beyond the current compliance boundary north and northwest of the ash basin for more than 100 years; compliance is predicted to be achieved in approximately 700 years after ash basin closure completed with an MNA approach to corrective action. The time to achieve compliance is likely conservative because the area of remediation northwest of the compliance boundary has been calibrated in the flow and transport model with a low hydraulic conductivity zone in order to simulate boron transport in the bedrock flow zone that matches empirical Site data.

The flow and transport modeling report that provides the predictions for boron is presented in **Appendix G.** The simulated boron concentrations for the years 2050, 2100, 2150, and 2200 for each closure scenario with MNA are depicted in **Appendix G**, Figures 6-7a through 6-7d and Figures 6-14a through 6-14d. Similarly, a geochemical modeling report is presented in **Appendix H.** It 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 and northwest of the ash basin 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 300 years after system startup and operation.

6.5.2.1 Problem Statement and Remediation Goals

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

CCR constituents in groundwater associated with the Belews Creek ash basin and PHR Landfill occur at or beyond the compliance boundary to the north and northwest of the ash basin 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 the BCSS *(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**: arsenic, beryllium, boron, chloride, cobalt, iron, lithium, manganese, strontium, thallium, and TDS *(CAP Content Section 6.D.a.i.1).* These are the COIs that indicate a discernable plume associated with the source area.

The conceptual model and predictive modeling discussions summarize the foundations for development of the groundwater extraction combined with clean water infiltration 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:

- 10 existing extraction wells, which are part of the current interim action system
- Approximately 103 new extraction wells to the north and northwest of the ash basin
- Pumps, associated piping, and control systems
- Discharge piping and structure
- pH adjustment or other treatment systems

The flow and transport model predicts each extraction well to have a flow rate of approximately 0.1 gpm, for a total groundwater extraction system flow rate of approximately 10 gpm. Post-decanting, the 10 interim action extraction wells are predicted to remove a total of about 2.5 gpm. The number of extraction wells is estimated based on multiple groundwater extraction simulations of flow and transport modeling results. Results generally provide a similar conclusion for flow rate, number of wells, and time to meet compliance.

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 basin, with the exception of the area to the northwest of the dam, which will be remedied by the planned remediation system.

The distribution of conservative COIs (boron, chloride 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 area, and are not expected to do so due to constituent geochemical characteristics and Site geochemical and hydrogeologic conditions as detailed in **Appendix G** and **H**.

It is expected that extracted water would be treated and discharge through the existing NPDES Internal Outfall 006A and Outfall 006 locations based on currently available groundwater data and the current permit. Initially, the groundwater would be treated by pH adjustment and flocculation in the system used to treat the water from decanting and dewatering the ash basin. Post-decanting and dewatering of the ash basin provides an intervening period, where modifications to the decanting/dewatering treatment system or alternatives, including beneficial reuse, will be considered. If necessary a modified treatment method will 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 the table *NPDES Permit Limits and Anticipated Groundwater Remediation Parameter Levels* in **Section 6.5**.

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 result in localized groundwater extraction and removal of COI mass. The low permeability of the formations might limit extraction flow rates. Groundwater flow and transport simulated groundwater extraction flow rates, with an assumed 50 percent well efficiency, are approximately 0.1 gpm. The flow and transport report (**Appendix G**) and geochemical modeling report (**Appendix H)** provide detailed predictions, descriptions, and explanations of the effects of groundwater extraction.

The flow and transport model predicts the maximum extent of the boron plume at any point in time will be approximately 1,500 feet beyond the compliance boundary. Simulations indicate that boron concentrations in groundwater would meet the 02L boron standard of 700 μg/L at the compliance boundary in excess of 300 years after system startup and operation. The time to achieve compliance is likely conservative because the area of remediation northwest of the compliance boundary has been calibrated in the flow and transport model with a low hydraulic conductivity zone in order to simulate boron transport in the bedrock flow zone that matches empirical Site data.

6.5.3 Remedial Alternative 3 – Groundwater Extraction Combined with Clean Water Infiltration and Treatment *(CAP Content Section 6.D.a)*

Alternative 3 consists of groundwater extraction combined with clean water infiltration for remediation of the groundwater north and northwest of the ash basin at or beyond the compliance boundary. This alternative provides an effective combination of technology for groundwater remediation at or beyond the compliance boundary.

Under this alternative, flow and transport modeling indicates compliance with 02L can be achieved in approximately 13 years after system startup and operation along the majority of the compliance boundary.

Near the northwest perimeter of the ash basin waste boundary, the 500 foot compliance boundary is reduced by approximately 250 feet. The reduced compliance boundary follows a 500 foot section of the Duke Energy property boundary. The reduced compliance boundary results in a longer timeframe to achieve compliance in the small area. The predicted timeframe to achieve compliance for the small area is approximately 36 years after system startup and operation.

6.5.3.1 Problem Statement and Remediation Goals

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

CCR constituents in groundwater associated with the Belews Creek ash basin and PHR Landfill occur at or beyond the compliance boundary to the north and northwest of the ash basin 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 the BCSS *(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**: arsenic, beryllium, boron, chloride, cobalt, iron, lithium, manganese, strontium, thallium, and TDS *(CAP Content Section 6.D.a.i.1).* These are the COIs that indicate a discernable plume associated with the source area.

The conceptual model and predictive modeling discussions summarize the foundations for development of the groundwater extraction combined with clean water infiltration 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:

- 10 existing extraction wells, which are part of the current interim action system
- 113 new extraction wells to the north and northwest of the ash basin
- 47 clean water infiltration wells north and northwest of the ash basin
- One 900 foot horizontal clean water infiltration well
- Pumps, associated piping, and control systems

- An infiltration water intake structure and distribution piping
- Infiltration and discharge piping and structure
- pH adjustment or other treatment systems, if necessary

The proposed design and well locations are shown on **Figure 6-25a**. The flow and transport model predicts a total groundwater infiltration system flow rate of approximately 165 gpm will be required and a total groundwater extraction system flow rate of approximately 90 gpm. Post-decanting, the 10 interim action extraction wells are predicted to remove a total of about 2.5 gpm. The number of extraction and clean water infiltration wells is estimated based on flow and transport modeling results (**Appendix G**). A general summary of the systems anticipated number of groundwater extraction wells and clean water infiltration wells per flow zone with corresponding depth ranges, and system flow rate and operation assumptions is included in **Table 6-13**.

The system's design includes a large number of extraction wells to be completed into the shallow bedrock to allow full drawdown within the transition zone. Depths of shallow bedrock extraction wells are dependent on the transition zone and bedrock contact depth and ranges from 60 feet bgs to 120 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 ash basin, with the exception of the area to the northwest of the dam.

The distribution of conservative COIs (boron, chloride 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 area, and are not expected to do so due to constituent geochemical characteristics and Site geochemical and hydrogeologic conditions as detailed in **Appendix G** and **H**.

It is expected that infiltration water 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 Internal Outfall 006A and Outfall 006 locations based on currently available groundwater data and the current permit. Initially, the groundwater would be treated by pH adjustment and flocculation in the system used to treat the water from decanting and dewatering the ash basin. Post-decanting and dewatering of the ash basin provides an intervening period, where modifications to the decanting/dewatering treatment system or alternatives, including beneficial reuse, will be considered. If necessary a modified treatment method will 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 the table *NPDES Permit Limits and Anticipated Groundwater Remediation Parameter Levels* in **Section 6.4**.

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 low permeability of the formations will still 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. Groundwater flow and transport simulated groundwater extraction flow rates, with an assumed 50 percent well efficiency, are approximately 0.8 gpm. Groundwater flow and transport simulated groundwater infiltration flow rates, with an assumed 25 percent well efficiency, are approximately 0.8 gpm. 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 boron plume at any point in time will be approximately 1,500 feet beyond the compliance boundary. Simulations indicate that boron concentrations in groundwater can meet the 02L boron standard of 700 µg/L at a majority of the compliance boundary in approximately 13 years after system startup and operation. The area where the compliance boundary is reduced has a longer timeframe, approximately 36 years after system startup and operation, to achieve compliance (**Appendix G**). The time to achieve compliance is likely conservative because the area of remediation northwest of the compliance boundary has been calibrated in the flow and transport model with a low hydraulic conductivity zone in order to simulate boron transport in the bedrock flow zone that matches empirical Site data.

6.6 Remedial Alternatives Screening Criteria

(Supplemental Information for CAP Content Section 6.D.a.iv)

This section provides supplemental information beyond the CAP content criteria used to evaluate groundwater remediation alternatives at BCSS. These screening criteria are based on the criteria outlined in 15A NCAC 02L .0106(i) and 40 CFR 300.430. The source of the screening criteria descriptions is 40 CFR 300.430. These screening criteria will be used in evaluating 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
- Cost
- 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) exposed to surface water and sediments associated with the ash basin. 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)
- CCR (40 CFR § 257.96)
- Well construction and maintenance standards (NCAC Title 15A Subchapter 02C)
- NPDES (40 CFR Part 122)
- Sediment erosion and control (NCAC Title 15A Chapter 04)

Appendix I includes a detailed evaluation of the applicability of Alternative 1: MNA as a remedial alternative for the Site.

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 disposal 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
- Procurement
- System installation
- System startup

These activities may be requisite to finalizing the system design, attaining regulatory approval, or initiating construction. Therefore, these activities may dictate the time needed to initiate and fully implement a groundwater 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

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-related constituents, including boron as allowed under 15A NCAC 02L .0106(k). Alternate standards are appropriate at the BCSS 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 environmental benefit of cleanup activities through reductions of the environmental 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 environmental 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 environmental footprint. SiteWise™ estimates collateral environmental 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 in **Section 6.6**. The groundwater remediation alternatives formulated in **Section 6.5** will undergo detailed comparative analysis in the following subsections. A summary of the remediation alternatives detailed analysis is also included in **Appendix N**.

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 ash basin 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 ash basin. Water supply wells are located upgradient of the ash basin and water supply filtration systems have been provided to those who selected this option. Surface water quality standards downgradient of the COI-affected plume 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, the hydraulic divide along Middleton Loop will be re-established and additional COI migration from the source area toward the area northwest of the ash basin will be reduced or eliminated.

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 installed 36 water filtration systems within a half-mile of the ash basin compliance boundary in accordance with G.S. Section 130A-309.211(c1). Furthermore, institutional controls (provided by the restricted designation) to limit access to groundwater use are proposed.

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 175 monitoring wells installed associated with the ash basin. Although some within the immediate area of the basin 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)

There are 175 monitoring wells installed associated with the ash basin. 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 MNA purposes. Therefore, the technology could be implemented easily and immediately. Other than the abandonment of select wells within the ash basin from closure and potential installation of additional monitoring wells, 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.

Time Required to Meet Remediation Goals

(CAP Content Section 6.D.a.iv.8)

The flow and transport model predicts that the groundwater plume could continue to migrate beyond the current compliance boundary north and northwest of the ash basin for more than 100 years; compliance is predicted to be achieved in approximately 700 years after ash basin closure completed. This estimate is based on boron reaching a concentration of 700 µg/L at the existing compliance boundary.

Cost

(CAP Content Section 6.D.a.iv.9)

The Belews Creek ash basin and PHR Landfill have extensive groundwater monitoring well networks in place. MNA performance monitoring would utilize a subset of existing wells on Site with approximately 10 additional wells installed within the ash basin footprint, post-closure. Procedures for collection, analysis, and communication of results are also established and currently in place. Because there would be less required materials and therefore a smaller capital cost and annual cost, the costs of Alternative 1 would be comparatively less, when compared to Alternatives 2 and 3. Despite this, the significantly longer lifetime of the Alternative 1 system operating (approximately 700 years) indicates that life cycle costs could be significant. A detailed cost estimate for this Alternative is provided in **Appendix L**.

Community Acceptance

(CAP Content Section 6.D.a.iv.10)

It is expected that there will be positive and negative sentiment about implementation of an MNA program. No landowner is affected, with the exception of Parcel A, where active remediation is ongoing. The remaining property is owned by Duke Energy which is anticipated to have institutional controls. However, until the final corrective action is developed and comments are received and reviewed, assessment of community acceptance will not be fully informed.

MNA as a remedial alternative would be protective of human health and the environment. Consistent with the USEPA Office of Solid Waste and Emergency Response (OSWER) Directive 9200.4-17P (April 21, 1999) the use of MNA "does not imply that EPA or the responsible parties are 'walking away' from cleanup or financial responsibility at a site."

Adaptive Site Management and Remediation Considerations

MNA is an adaptable process and can be an effective tool in identifying the need for alternative approaches if unexpected changes in Site conditions occur. An MNA program would not hinder or preempt the use of other remedial approaches in the future if conditions change. In fact, an effectiveness monitoring program is an essential part of any future remedial strategy. An MNA effectiveness monitoring program would provide information about changing Site conditions during and after source control measures.

Sustainability

Sustainability analysis was completed as described in **Section 6.6**. The footprint was quantified based on energy use and associated emissions, during the construction phase (e.g., well installations) and groundwater monitoring activities (e.g., transportation). The results of the footprint calculations for MNA are summarized in **Table 6-14**. A summary of sustainability calculations for Alternative 1 can be found in **Appendix M**.

The footprint of the MNA alternative is the least energy-intensive of the remedial alternatives being considered, providing reduced, comparative footprint metrics in overall energy use and across all air emission parameters. The MNA alternative utilizes significantly fewer resources during construction and throughout the cleanup timeframe when compared to the other alternatives.

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 ash basin 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 ash basin. Water supply wells are located upgradient of the ash basin and water supply filtration systems have been provided to those who selected this option. 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.

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 area. However, modeling results for this alternative, for both the north and northwest areas, predict that the extraction flow rate per well would be approximately 0.1 gpm after basin decanting and after implementation of source control measures. Modeling results indicate that the 02L standard for boron could be achieved in excess of 300 years following full-scale implementation. Thus, groundwater remediation under this alternative would be slow compared with that of Alternative 3.

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. 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)

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, which is a significant factor 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 outfalls 006A/006. 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 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 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 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, depending on the discharge permit timeframe.

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. The flow and transport model predicts that boron concentrations in groundwater would meet the 02L boron standard of 700 μg/L at the compliance boundary in excess of 300 years after system startup and operation.

Cost

(CAP Content Section 6.D.a.iv.9)
The estimated costs for this alternative have not been 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. A detailed cost estimate for this Alternative is provided in **Appendix L**.

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, with the exception of Parcel A, where interim action remediation is ongoing. The remaining affected property is owned by Duke Energy. It is anticipated that the extracted groundwater would be discharged through a NPDES permitted outfall that flows to the Dan River and that the discharge would be treated as necessary to meet permit limits. An expanded groundwater extraction system which addresses potential COI plume expansion across the entire north and northwest perimeter of the basin 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

Sustainability analysis was completed as described in **Section 6.6**. The environmental footprint 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 environmental footprint calculations for Alternative 2 are summarized in **Table 6-14**. A summary of sustainability calculations for Alternative 2 can be found in **Appendix M**.

The environmental footprint of Alternative 2 is the most emission-intensive remedial alternative being considered. Alternative 1 (MNA) requires significantly less materials and energy than Alternative 2 and is therefore characterized by a dramatically smaller footprint. Alternative 2 presents dramatically higher energy-consumption metrics when measured against Alternative 3. Alternative 2 utilizes a similar number of extraction wells as Alternative 3 with no clean-water infiltration-wells or, which will generate a lower material-related environmental footprint for the construction phase. However, the extended timeframe of remediation system operation for Alternative 2 (at least 300 years) when compared to Alternative 3 (13 years) requires energy usage and produces air emissions far exceeding the levels of Alternative 3. The quantitative analysis of the environmental footprints of the remedial alternatives under consideration for this CAP indicates Alternative 2 to be the least sustainable option.

6.7.3 Remedial Alternative 3 – Groundwater Extraction Combined with 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 ash basin 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 ash basin. Water supply wells are located upgradient of the ash basin and water supply filtration systems have been provided to those who selected this option. 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.

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 low permeability of the formations will still 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 area.

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, clean water 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 outfalls 006A/006. 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. Groundwater remediation that implements 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 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.

The 900-foot long horizontal clean water infiltration well in the right-of-way of Middleton Loop would require the approval of the NC DOT.

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, depending on the discharge permit timeframe.

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. The flow and transport model predicts that boron concentrations in groundwater can meet the 02L boron standard of 700 μg/L at a majority of the compliance boundary in approximately 13 years after system startup and operation. The area where the compliance boundary is reduced has a longer timeframe, approximately 36 years after system startup and operation, to achieve compliance.

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. A detailed cost estimate for this Alternative is provided in **Appendix L**.

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, with the exception of Parcel A, where interim action remediation is ongoing. The remaining affected property is owned by Duke Energy. It is anticipated that the extracted groundwater would be discharged through a NPDES permitted outfall that flows to the Dan River and that the discharge would be treated as necessary to meet permit limits. An expanded groundwater extraction system which addresses potential COI plume expansion across the entire north and northwest perimeter of the basin 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.

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

Sustainability analysis was completed as described in **Section 6.6**. The environmental footprint 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 environmental footprint calculations for Alternative 3 are summarized in **Table 6-14**. A summary of sustainability calculations for Alternative 3 can be found in **Appendix M**.

The footprint of Alternative 3 is the second-most, emission-intensive remedial alternative 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 utilizes the same number of extraction wells as Alternative 2, but also utilizes one 900 foot horizontal and 47 vertical clean-water infiltration wells, which Alternative 2 does not employ. The additional remediation system components required by Alternative 3 will generate higher material-related footprint emissions for the construction phase than Alternative 2. The analysis indicates operating the infiltration-well network to be more energy-intensive in Alternative 3 than Alternative 2, as well. However, the reduced timeframe of remediation system operation for Alternative 3 (13 to 36 years) when compared to Alternative 2 (at least 300 years) produces air emissions less than half of the levels of Alternative 3. 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 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 preferred 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).*

This alternative meets the correction action objectives described in **Section 1.0** of this CAP in the expeditious timeframe through groundwater extraction combined with flushing effect of clean water infiltration. Although there are no significant risks to human or ecological receptors, the alternative will meet the regulatory requirements most effectively and provide further protection for downgradient surface water.

The groundwater remediation system includes 10 existing extraction wells, 113 vertical extraction wells, 47 vertical clean water infiltration wells, and one 900 foot horizontal clean water infiltration well. It also includes all associated piping and controls, and, as necessary, pH adjustment and other treatment facilities for both infiltration and extraction water. **Figure 6-25a** provides a conceptual layout of the proposed groundwater extraction combined with clean water infiltration remediation system. Model results predict the 02L standard of 700 μg/L for boron can be achieved at a majority of the BCSS ash basin compliance boundary in approximately 13 years after system startup and operation. The area where the compliance boundary is reduced has a longer timeframe, approximately 36 years after system startup and operation, to achieve compliance (**Figure 6-25g**).

All three groundwater remedial alternatives evaluated contribute to continued protection of human health and the environment, however, 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 Belews Creek, 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 700 years, which does not meet the criteria of achieving the standards at a timeframe similar to more active remedies.
- Historical and ongoing assessment indicates the potential for off-Site groundwater flow northwest of the BCSS ash basin.
- The maximum extent of the 02L bedrock groundwater plumes has migrated at or beyond the compliance boundary, and is predicted, based on the groundwater model, to continue expanding in the bedrock flow zone in the future, at or beyond the compliance boundary northwest of the ash basin.

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**.

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 infiltration 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 13 years) relative to Alternative 2 (greater than 300 years). Alternative 3 includes clean water infiltration wells, with groundwater infiltration rates of 1.2 gpm for vertical wells and 110 gpm for the one horizontal well, for a total system infiltration rate of approximately 165 gpm. The extraction rate per well for

Alternative 3 is approximately 0.8 gpm, for a total system extraction rate of approximately 90 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 0.1 gpm, for a total system extraction rate of approximately 10 gpm. By supplementing the natural groundwater system with clean water infiltration, extraction rates increase by approximately eight-fold, and therefore, increases 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 the clean water infiltration and extraction and the groundwater extraction system 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 a 500 foot 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 Belews Creek.

This alternative is readily implementable, although it is the most costly alternative due to the addition of the clean water infiltration wells. The long-term effectiveness would be documented through an effectiveness monitoring program detailed in **Section 6.8.5**. The system would be adaptable based on effectiveness monitoring field data results.

Seep Corrective Action

As stated in the SOC, decanting of the ash basin is expected to substantially reduce or eliminate the seeps. After completion of decanting, remaining seeps, (constructed and non-constructed), would to be characterized post-decanting 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 has already taken steps to address non-dispositioned seep(s) directly downstream the ash basin dam. Duke Energy is aware of other currently non-dispositioned seeps around the Belews Creek ash basin, PHR Landfill and other facilities onsite that might not be dispositioned by source control measures.

Non-dispositioned seeps, where monitoring conducted has indicated the presence of CCR affects (S-2, S-6, S-8, S-9, S-10, S-11, and S-18), are evaluated for whether corrective action would be anticipated for the seep location, and if so, potential corrective action technologies that would be feasible for the location. The evaluation considers seep location, effects of decanting on seep thus far, approximate average flow rate, and predicted change in water elevations after decanting is complete from flow and transport model simulations. Corrective action strategies for seep locations are included in **Table 6-8** and discussed herein.

Decanting has been effective in reducing flow at seep S-2, located in a channel northwest of ash basin that flow to the Dan River, and seep S-6, located east of ash basin downstream of the former ash basin permitted outfall to Belews Reservoir. In August 2019, flow at seep S-2 was insufficient for measuring and flow at seep S-6 was recorded as 0.005 cubic feet per second (cfs), approximately half of the average flow rate. To date, water elevation of the ash basin has decreased by 9.5 feet, and is expected to continue decreasing until decanting is completed in September 2020. Groundwater corrective action via groundwater extraction and ash basin decanting are anticipated corrective action strategies for seep S-2. Ash basin closure will address the former ash basin outfall channel, west of Pine Hall road and upstream of seep S-6, by excavating and regrading the channel to slope away from Belews Reservoir and towards the interior of ash basin footprint. Decanting and ash basin closure are anticipated corrective action strategies for seep S-6.

Source control measures (*i.e.* decanting and ash basin closure) associated with the ash basin are not anticipated to reduce flow seep location S-8, because it is not within the ash basin and PHR Landfill drainage system. Because of the seeps relatively remote location and low flowing conditions, corrective action using phytoremediation technology would be considered. Phytoremediation would capture and extract shallow groundwater to reduce or eliminate flow at the seep location.

Seep S-9 is associated with the Structural Fill, therefore corrective action for this location will be addressed in the corrective action plan for the Structural Fill. Source control measures associated with the ash basin are not anticipated to reduce flow at this location because it is not within the ash basin and PHR Landfill drainage system.

No corrective action is necessary for seep S-11 because this seep is a permitted NPDES outfall (Toe Drain Outfall 111). Duke Energy has constructed a toe-drain collection system to collect ash basin discharge at this location. Flow from this location will be collected by the toe-drain collection system and discharged via permitted Outfalls 006A/006. Non-constructed seep S-18 flows to S-11 and is monitored per terms of the NPDES Permit

As of August 2019, decanting has been effective in reducing flow at seep S-10, such that flow is reported as 0.02 cfs, approximately 0.1 cfs less than average flow. Decanting and groundwater corrective action via groundwater extraction are anticipated corrective action strategies for seep S-10. If seep S-10 continues have low flow conditions, and is not disposition after decanting is complete, phytoremediation technology could be implemented to capture and extract shallow groundwater to reduce or eliminate flow at the seep location. If seep S-10 sustains nears its average flow rate after ash basin decanting is complete, seep S-10 is proximate to the area requiring groundwater corrective action, which provides the flexibility to integrate seep corrective action into an adaptable groundwater remedy system. Under these circumstances, potential corrective action remedies include, but not limited to, a shallow groundwater extraction trench or shallow groundwater extraction well(s). An extraction trench or well(s) would capture shallow groundwater flow to reduce or eliminate flow at the seep location. Seep S-18 flows to the S-11; if S-18 is not dispositioned after decanting is complete, seep S-18 could be managed as part of the remedy for seep S-10. It is expected that water collected from shallow groundwater extraction would be managed as part of the proposed groundwater remedy system.

In summary, decanting, ash basin closure, and groundwater extraction are the anticipated corrective action strategies to address seeps S-2, S-6, S-10 and S-18.

An engineering solution has been applied to seep S-11. No corrective action is necessary for this location, because the location is part of the ash basin waste water treatment system (Toe Drain Outfall 111) and under the NPDES permit. Should additional corrective action measures be needed to address flow at seeps S-10 and S-18, applicable technologies include, but not limited to, phytoremediation and/or shallow groundwater extraction with either trench or extraction well technology. Seeps S-8 and S-9 are anticipated to potentially require additional corrective action measures. Seep S-9 will be addressed in the corrective action plan for the Structural Fill. Based on available data and information, the best fit technology for corrective action of seep S-8 is phytoremediation technology. Description and screening of specific remedial technologies, including phytoremediation and extraction trenches and wells, is included in **Section 6.4**.

Final corrective action plans for seeps that are not dispositioned after completion of 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 models 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 remedial alternative design is be to maximize pore volume exchange (*i.e.* groundwater flushing) and establish groundwater flow control and capture in areas downgradient of the ash basin. Basic installation components of the recommended remedial alternative include:

- 10 existing extraction wells, which are part of the current interim action system
- 113 new extraction wells and appurtenances
- 47 clean water infiltration wells and appurtenances

- One 900 foot horizontal clean water infiltration well 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
- Upgrades to the existing physical-chemical wastewater treatment system, if needed
- Clean water infiltration water treatment system
- Piping to transfer water from the Dan River to the clean water infiltration water treatment system
- Clean water infiltration water distribution system
- Electric power supply
- Groundwater remediation telemetry system

6.8.2.1 Process Flow Diagrams for Major Components of Proposed Remedy

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

Conceptual process flow diagrams for clean water infiltration, extraction, and treatment systems are provided on **Figure 6-26** through **Figure 6-28.** The detailed design elements presented below may be adjusted based on a final technical review.

Below is 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. 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, anticipated to include somewhat extensive tree and brushy vegetation removal and grubbing, will require erosion and sedimentation control (ESC) to be implemented and likely reviewed and approved by a regulatory agency. Adaptable ESC should be planned to limit project delays by avoiding formal modifications of plans.

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. Design elements would be adapted from the existing 10-well pumping system including any lessons learned from its operation. Clean water infiltration tests would be conducted to determine the 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 calibration predictive flow and transport modeling, if 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 conveyances for extracted groundwater
- 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
- Refine calibration predictive flow and transport modeling, if needed
- If warranted, make adjustments to the clean water infiltration system design
- If warranted, make design adjustments to conveyances for recharge 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 47 vertical clean water infiltration wells, one 900 foot horizontal well, and 113 extraction wells (**Figure 6-25a**). The new clean water infiltration and extraction wells would be installed to the north and northwest of the ash basin. 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**).

Clean water infiltration and extraction wells would be completed in the saprolite, transition zone and bedrock at depths ranging from <30 feet bgs to 180 feet bgs. The number and depth of clean water infiltration and extraction wells is estimated based on flow and transport modeling results (**Appendix G**). Modeled clean water infiltration well details are provided on **Table 6-15**; and modeled extraction well details are provided on **Table 6-16**.

All groundwater clean water 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). The clean water infiltration and extraction wells might be drilled using hollow stem auger, air percussion/hammer, sonic drilling technologies, or a combination thereof. The drilling method would depend on Site conditions. Completed wells would be at least 6 inches in diameter to facilitate the installation of pumps and instrumentation (e.g., level control) in groundwater extraction wells. The top of the sand pack would extend to approximately 2 feet above the top of well screens. A bentonite well seal at least 2 feet thick would be installed on top of the sand pack. 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. The groundwater clean water infiltration wells and extraction wells would be constructed with threaded casings. Materials of construction and screen lengths and slot sizes will be based on pilot testing. Wound wedge wire screens might be used to enhance hydraulic efficiency and facilitate rehabilitation. All materials and installations would be in accordance with 15A NCAC 02C. Typical well construction schematics for vertical clean water infiltration, horizontal clean water infiltration wells, and extraction wells are included as **Figure 6-25b, Figure 6-25c,** and **Figure 6-25d**.

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. 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 6-25e**).

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 sent to the operator, who can 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 6-28**). A seal at the top of the well through which the 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 6-25b**).

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.

A double-ended horizontal injection well would be installed along Middleton Loop by certified North Carolina well driller as shown conceptually on **Figure 6-25c**. A typical horizontal environmental well is installed at an angle approximately minus 12 degrees from horizontal (Ellington-DTD, 2004). The equipment would 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 would be developed. One end of the well would be capped with a water-tight seal. The well head would be completed in a manner similar to the vertical injection wells. (Ellington-DTD, 2019).

Extraction Wells (Step 4B)

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

A pump would be installed in each groundwater extraction well. Selection of pump type (*e.g.,* electric submersible or pneumatic) would be determined in the final design. 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 disposal (**Figure 6-27**). 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 6-25d**)

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.

Groundwater Clean Water Infiltration Water Treatment (Step 5 – Build Infiltration Treatment)

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

Based on water quality and implementation access and feasibility, water used for clean water infiltration will be obtained from the Dan River rather than Belews Reservoir. 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 raw water intake would be located along the southeast bank of the Dan River which is located on the north side of the Duke property. A general water intake station and pump schematic is depicted in **Figure 6-25f**. The raw water intake would consist of a wet well connected to the river. Raw water would travel through screens before entering the wet well. Duplex pumps would be used for redundancy and for operation and maintenance. Once in the wet well, vertical turbine pumps would pump the raw water from an elevation of approximately 577 feet NAVD 88 to equalization tanks followed by a modular treatment system **(Figure 6-28**). The equalization tanks and the modular treatment systems would be located on the northwest side of Middleton Loop at an elevation of approximately 757 feet NAVD 88. The treatment system would condition the water prior to storage and distribution to the clean water infiltration wells.

The Dan River is a dynamic source of water and would provide water of varying quality. Prior to infiltration, treatment of the water would address suspended particulates and 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 might 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 infiltration water would be stored prior to distribution to the clean water infiltration wells. Water leaving the holding tank would undergo dechlorination (*e.g.*, sulfur dioxide or sodium metabisulfite) as it enters the clean water infiltration water distribution system (**Figure 6-28**).

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 physical-chemical treatment plant on the southeast side of Middleton Loop. 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 using the treatment system that is currently being used to treat decanted water from the ash pond. This treatment system uses a flocculation process called CoMag® provided by Evoqua Water Technologies (**Figure 6-28**). With the CoMag® system, the traditional process of flocculation, coagulation and clarification remain the same. However, more rapid settling of the floc is attained by the addition of magnetite, a rock mineral made up of oxides of iron, as ballast.

A flocculent, such as alum, ferric chloride or poly-aluminum chloride is currently being added to the influent. The resultant chemical floc is infused with magnetite, which increases solids density. The floc then travels to a conventional clarifier that separates the treated water from the sludge. The treated water would discharged through the permitted outfall. Extracted groundwater would undergo this same treatment process to satisfy applicable NPDES discharge requirements.

Clean Water Infiltration Well Distribution System (Step 7 – Conceptual Clean Water Infiltration System Considerations)

The purpose of the groundwater clean water infiltration distribution system is to convey water from the Dan River to the clean water infiltration water treatment system and to convey water from the clean water infiltration water treatment system to the clean water infiltration wells. The distribution system design would have features similar to a drinking water distribution system. For example, distribution lines would be constructed with blowoffs so that the system may be flushed to remove sediment that may collect in the pipes.

Infiltration water would be transferred from the Dan River to a treatment and storage plant located at an elevation higher than the clean water infiltration wells. The positive hydraulic head of the infiltration water treatment system relative to the clean water infiltration wells would enable distribution of infiltration water to the clean water infiltration well network via gravity drain and maintain positive pressures for the clean water infiltration wells. Pressure regulating valves would be installed at each clean water infiltration well to control groundwater infiltration rate.

Groundwater infiltration might create the potential for matrix saturation near the ground surface, with the potential for surface discharges. Based on pilot tests, final well placement, modeling, and observations, lysimeters, piezometers or other moisture detection devices are anticipated to be part of routine monitoring. The details associated with the monitoring in and around the clean water infiltration wells will be provided with the system design package.

The 900-foot long horizontal infiltration well in the right-of-way of Middleton Loop would require the approval of the NC DOT.

Groundwater Extraction Well Discharge Piping (Step 8 – Conceptual Extraction System Considerations)

The proposed groundwater extraction system would consist of 113 new groundwater extraction wells. Based upon predictive groundwater flow and transport modeling, the groundwater extraction wells would generate on average 1.8 gpm of extracted groundwater per well or approximately 90 gpm of extracted groundwater collectively. One hundred nine (109) of the new wells would be in the area northwest of the ash pond (**Figure 6-25a**), four would be in the area near toe drains of the ash pond dam **(Figure 6-25a**); and there are 10 existing extraction wells on the ash basin side of Middleton Loop.

Each of the groundwater extraction wells northwest of the ash pond would discharge into one of a series of headers. Extracted groundwater in these headers then would flow by gravity to a pump station with a wet well. From the wet well, collected groundwater would be pumped to the decanted ash water physical-chemical treatment system located on the southeast side of Middleton Loop. This would require that the groundwater discharge piping cross Middleton Loop below grade.

The pumps in four extraction wells near the toe drains of the ash pond dam would discharge to a small pump station with a wet well. From the wet well, the extracted groundwater would be pumped to the to the decanted ash water treatment system.

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)

HDPE piping will be used for water conveyance in most case where buried piping will be installed. Polyvinyl Chloride (PVC) and/or Ductile Iron Pipe (DIP) may be used for gravity sewer and where unusual circumstance occur. Water conveyance will include:

- Groundwater pumped from extraction wells and conveyed to the physical-chemical wastewater treatment system
- Surface water pumped from the Dan River and conveyed to a clean water infiltration water treatment system

- Clean water 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 clean water infiltration 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 165 gpm for the clean water infiltration system and 90 gpm for the groundwater extraction system. Infiltration water distribution lines would connect to each well part of the groundwater clean water infiltration system. Likewise, each groundwater extraction well will be connected to a header that ultimately conveys extracted groundwater to the physical-chemical water treatment on the southeast side of Middleton Loop. Preliminary calculations pertaining to the piping design (e.g., pipe sizing, pressures, flow, friction losses, etc.) are provided in **Appendix O**.

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 O**.

The extraction network consists of 10 existing extraction wells and 113 new extraction wells with trunk lines for conveyance and branching pipes providing connections to the wells. The network largely operates in gravity flow, collecting the majority of the flow from the extraction wells and conveying under pressure from a common collection point to the 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 clean water infiltration network consists of 47 vertical clean water infiltration wells and one 900 foot horizontal clean water infiltration well. Clean water infiltration wells flow via gravity from an elevated infiltration tank at the natural high point of the site's topography. The clean water 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 over a hundred additional submersible pumps, two vertical turbine pumps, and 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 might be needed for the proposed remedy include:

- Erosion and Sediment Control permit
- In Situ Groundwater Remediation Injection Well permit
- NPDES Stormwater permit
- Right-of-Way (ROW) encroachment agreement with North Carolina Department of Transportation
- Water Withdrawal and Transfer registration
- Wetlands permit

The schedule for obtaining permits is based off the project implementation schedule included in **Section 6.8.2**.

6.8.2.4 Schedule and Cost of Implementation

(CAP Content Section 6.E.b.iv)

A Gantt chart (**Figure 6-29**) is provided for outlining a general timeline of implementation tasks following CAP Update submittal. 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.

A detailed cost estimate for this Alternative is provided in **Appendix L**.

The cost estimate 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.

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 ash basin 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 ash basin. Water supply wells are located upgradient of the ash basin and water supply filtration systems have been provided to those who selected this option. 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 basin and the additional source area hydrologically connected to the ash basin, the PHR Landfill, 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 Belews Creek 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. 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*

Because historical and ongoing assessment indicates the potential for off-Site groundwater flow northwest of the ash basin, Belews Creek does not meet requirements for implementing corrective action under 02L .0106(k) at this time.

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 the BCSS 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 Interim Monitoring Plan (IMP) after the plan was that was submitted to NCDEQ on October 23, 2018. Additional modifications to the plan were approved by NCDEQ on April 4, 2019 (**Appendix A**). 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 P**, 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 with area of groundwater remediation
- Within areas of observed or anticipated changing Site conditions, and/or have increasing constituent concentration trends
- Will effectively monitor COIs plume stability and model simulation verification

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 6-30**. 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 6-31**.

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).

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 adjustments and optimization 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.

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 6-30**). 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 59 groundwater monitoring wells (**Table 6-17**). Several of the existing monitoring wells at the site might be abandoned from ash basin and landfill 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 along three primary groundwater flow paths within the groundwater remediation 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 6-30** and described below:

1. At waste boundary
2. 250 feet downgradient from waste boundary. If the waste boundary and compliance boundary are located sufficiently close to evaluate COI trends over time, this interval location would not be monitored.
3. 500 feet downgradient of waste boundary (CAMA compliance boundary)
4. No less than one year travel time upgradient of receptor or potential receptor and no greater than the distance groundwater is expected to travel in five years

Multi parameters sondes would be installed in 31 wells along the three primary flow paths in the remedy area (**Figure 6-30**). 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 6-30**) 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 59 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 P**. 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, 11 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:
    - Arsenic
    - Beryllium
    - Boron
    - Chloride
    - Cobalt
    - Iron
    - Lithium
    - Manganese
    - Strontium
    - Total Dissolved Solids
    - Thallium
    -

  Geochemically conservative, non-reactive constituents boron, chloride, 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 6-32** *(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 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
- Submittal of permit and registration applications to NCDEQ.

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 will 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 6.8.5**. 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 clean water 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 will be installed with the system to provide timely information to the Site Operator regarding key operational features, particularly clean water infiltration and extraction well water levels and flow rates. The control system will have remote monitoring capability to alert key personnel as to the nature and urgency of the issue. The system will be programmed with expected values for measured parameters. Alerts will be sent when actual values are outside the programmed range. Based on the alerts, the functional problem will 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 will help ensure effective operations:

- Processes to ensure effective operation of each clean water infiltration and extraction well is maintained. Maintaining target flow rates and water levels for each well is important to minimize the potential for loss of groundwater flow control. Each well will 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.

- If the system detects a leak related to pumping, piping and/or wells, the respective element of the system will 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.
- If pH adjustment or other water treatment technology is employed, continuous monitoring of key parameters will ensure proper operation of the system. Variances between prescribed ranges will alert the operator and other key personnel and may result in automatic system shut down.
- The operator inspection schedule, completion, and notes for key systems will be documented.
- A system maintenance schedule will be established to ensure effective operation. 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.

A foreseeable potential interruption in system operations will be an intervening period between startup of the groundwater extraction and clean water infiltration system and the end of ash basin decanting/dewatering. Initially, the extracted groundwater will be treated in the system that is currently operating to treat the water from dewatering of the ash basin. This is a CoMag® system provided by Evoqua Water Technologies and the treatment system is designed for 850 gpm. Prior to this intervening period, an assessment of the requirement to treat the extracted groundwater will be performed. Modifications to the decanting/dewatering treatment system or alternatives, including beneficial reuse, will be considered. The assessment and modifications will be based on the quality and quantity of extracted groundwater and the anticipated discharge limitations.

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 deleting clean water 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 clean water 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 BCSS coal ash basin that are beyond the Site's compliance boundary to the north and northwest of the ash basin.

Remedial Alternative 3, groundwater extraction combined with clean water infiltration and treatment, is selected as the preferred groundwater corrective action option for Belews Creek. This alternative meets the correction action objectives described in **Section 1.0** of this CAP in the expeditious timeframe through groundwater extraction combined with flushing effect of clean water infiltration. Although there are no significant risks to human or ecological receptors, the alternative will meet the regulatory requirements most effectively and provide further protection for downgradient surface water. This alternative is readily implementable, although it is the most costly alternative due to the addition of the clean water infiltration wells. The system would be adaptable based on effectiveness monitoring field data results.

In addition to the selection and description of the preferred corrective action groundwater remedy, this CAP Update also 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.
- 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, where either submittal of the EMP, or the pilot test work plan and permit applications (as applicable) 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:** 28202-1803

Site Name: Belews Creek Steam Station

Address: 3195 Pine Hall Road

City: Belews Creek **State:** NC **Zip Code:** 27009

Groundwater Incident Number (applicable): 88227

We, Ashley L. Albert **Professional Geologist** and James E. Clemmer, a **Professional Engineer** (circle one) for SynTerra Corporation (firm or company of employment) do hereby certify that the information herein as part of the required Corrective Action Plan (CAP) and that to the best of our knowledge the data, assessments, conclusions, recommendations and other associated materials are correct, complete and accurate.

(Affix Seal and Signature)

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 SEAL 2615 GEOLOGIST ASHLEY LISBETH ALBERT

Ashley L. Albert, NC LG 2615
Project Manager

NORTH CAROLINA PROFESSIONAL SEAL 18675 ENGINEER JAMES E. CLEMMER

12-23-2019

James E. Clemmer, NC PE 18675
Project Engineer

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TABLES

(CAP Content Section 9)

Table ES-1

Summary of BCSS Assessment Documentation

Included in Executive Summary text

Table ES-2

Summary of BCSS Assessment Activities

Included in Executive Summary text

Table ES-3

Components of Source Control, Active Remediation, and Monitoring

Included in Executive Summary text

TABLE 3-1
SUMMARY OF ONSITE FACILITIES
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELEWS CREEK, NC

Facility Name	Evaluated as Source Area in CAP Update	CSA Schedule	Operational Status	Source Material	Area or Capacity	Rationale For Evaluation
Ash Basin	Yes	NA	Inactive	Coal Ash/NPDES Permitted waste streams	17,676,000 cy	CAMA regulated unit
Pine Hall Road Landfill	Yes	NA	Closed	Fly ash	8,500,000 cy	Hydrologically connected to the ash basin
Chemical Pond	No	NA	Closed	Steam station boiler and filter chemical cleaning wastes	2.9 acres	Former part of the ash basin treatment system and hydrologically connected to the ash basin, no evidence of groundwater COI migration from source area
Constructed Wetlands Treatment System	No	NA	Closed	FGD wastewater/ Landfill contact water/sanitary wastewater	25 acres	Former part of the ash basin treatment system and hydrologically connected to the ash basin, no evidence of groundwater COI migration from source area
Structural Fill	No	Mar-20	Closed	Fly ash	968,000 cy	Not hydrologically connected to the ash basin and with NCDEQ DWM regulatory oversight
Craig Road Landfill	No	NA	Operational	CCR and operational waste	67.1 acres	Not hydrologically connected to the ash basin and with NCDEQ DWM regulatory oversight
FGD Residue Landfill	No	NA	Operational	CCR and operational waste	24 acres	Not hydrologically connected to the ash basin and with NCDEQ DWM regulatory oversight
Coal Pile	No	Mar-20	Operational	Coal	42 acres	Not hydrologically connected to the ash basin
Gypsum Storage Pad	No	Mar-20	Operational	Gypsum	5 acres	Not hydrologically connected to the ash basin

Prepared by: ALA Checked by: CDE

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)

CAMA – North Carolina Coal Ash Management Act of 2014

CAP – Corrective Action Plan

cy – cubic yards

DWM – Division of Waste Management

NA – not applicable

NCDEQ – North Carolina Department of Environmental Quality

NPDES – National Pollutant Discharge Elimination System

TABLE 4-1
BACKGROUND SOIL SAMPLE SUMMARY
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELEWS CREEK, NC

Soil Boring	Depth Range (ft bgs)	Number of Sampled Intervals
BG-1D	(1-31)	4
BG-2D	(1-32)	4
BG-3S	(1-22)	3
GWA-3D	(34-35.5)	1
GWA-4S	(45-47)	1
GWA-12D	(10-27)	4
BGSB-01	(1-22)	5
BGSB-02	(1-32)	6
BGSB-03	(1-22)	5
GWASB-12	(5-27)	5

Prepared by: ALA Checked by: CDE

Note:

ft bgs – feet below ground surface

TABLE 4-2
BACKGROUND VALUES FOR SOIL
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELEWS CREEK, 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	4.3 - 5.8	4.6 - 7.0	2.3 - 9.8
Aluminum	mg/kg	110,000	31,253	28,880	25,978 - 81,619
Antimony	mg/kg	0.9	0.6	0.6	0.177 - 0.9
Arsenic	mg/kg	5.8	13	43	1.2 - 43.13
Barium	mg/kg	580	139	122	122.2 - 1,063
Beryllium	mg/kg	63	19	2.9	1.2 - 4.52
Boron	mg/kg	45	17	35	14.4 - 56.3
Cadmium	mg/kg	3	0.03	0.9	0.03 - 1
Calcium	mg/kg	NE	450	1,000	410 - 8,769
Chloride	mg/kg	938^	14	402	12 - 423
Chromium	mg/kg	3.8	36	47	20 - 440
Cobalt	mg/kg	0.9	51	60	27 - 81.68
Copper	mg/kg	700	28	32	17.4 - 216
Iron	mg/kg	150	40,400	61,967	24,500 - 85,345
Lead	mg/kg	270	40	52	7.5 - 95.23
Magnesium	mg/kg	NE	3,600	4,492	760 - 51,829
Manganese	mg/kg	65	1,117	1,257	370 - 3,388
Mercury	mg/kg	1	0.1	0.1	0.04 - 0.113
Molybdenum	mg/kg	71	9.8	4	1.83 - 12
Nickel	mg/kg	130	12	21	9.2 - 237
Nitrate (as N)	mg/kg	NE	0.3	0.3	0.25 - 31.2
Nitrate	mg/kg	NE	---	40.3	40.3 - 48.8
Potassium	mg/kg	NE	2,114	3,458	427 - 35,600
Selenium	mg/kg	2.1	5	5	1.58 - 6.857
Sodium	mg/kg	NE	393	393	338 - 1,500
Strontium	mg/kg	1,500	9	7	7.1 - 200
Sulfate	mg/kg	1,438^	12	403	12 - 437
Thallium	mg/kg	0.28	0.7	0.8	0.166 - 2.132
Total Organic Carbon	mg/kg	NE	---	4,070	742 - 4,960
Vanadium	mg/kg	350	114	231	42 - 230.9
Zinc	mg/kg	1,200	52	71	60.5 - 325.5

Prepared by: JHG Checked by: ALA

Notes:

2018 Background values approved by 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 June 2015 to April 2017.

[2] - Updated background threshold values were calculated using data from background unsaturated soil samples collected June 2015 to April 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]).

--- - 2017 background threshold value was not calculated for constituent.

mg/kg - milligrams per kilogram

NE - Not Established

S.U. - Standard Unit

PSRG - Preliminary Soil Remediation Goal

TABLE 4-3
BACKGROUND VALUES FOR GROUNDWATER
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELEWS CREEK, 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	5.1 - 6.0	5.2 - 7.0	6.3 - 6.5	5.2 - 6.0	5.6 - 7.0	6.2 - 8.4	3.6 - 9
Alkalinity	mg-$CaCO_3$/L	NE	23	64	81	20	53	91	19 - 379
Aluminum	µg/L	NE	860	140	100	805	204	120	100 - 1,238
Antimony	µg/L	1*	1	1	1	1	1	1	0.5 - 2.9
Arsenic	µg/L	10	1	1	1	1	1	2	0.2 - 6.35
Barium	µg/L	700	58	13	6	123	16	11	10.52 - 840
Beryllium	µg/L	4*	0.4	0.2	0.2	0.3	0.1	0.2	0.0625 - 1
Bicarbonate	mg-$CaCO_3$/L	NE	22	63	78	24	54	91	19 - 388
Boron	µg/L	700	50	50	50	50	50	50	50 - 176.8
Cadmium	µg/L	2	1	1	0.08	1	0.08	0.08	0.08 - 1
Calcium	mg/L	NE	4	13	10	8	14	26	4 - 111
Carbonate	mg-$CaCO_3$/L	NE	5	5	5	5	5	5	5 - 10
Chloride	mg/L	250	15	21	3	19	19	3	3.34 - 250
Chromium	µg/L	10	5	3	5	11	3	11	1-26
Chromium (VI)	µg/L	NE	2	0.4	0.3	4	0.6	0.4	0.03 - 12
Cobalt	µg/L	1*	0.5	2	0.8	0.6	2	0.8	0.088 - 88.85
Copper	µg/L	1000	3	5	10	2	5	17	0.5 - 17.15
Fluoride	mg/L	2	---	---	---	0.1	0.1	0.6	0.1 - 1.8
Iron	µg/L	300	750	240	228	1,600	226	341	56.3 - 37,500
Lead	µg/L	15	1	1	0.1	1	0.6	0.2	0 - 2
Lithium	µg/L	NE	---	---	---	2	95	30	2 - 95.39
Magnesium	mg/L	NE	3	7	3	4	7	4	1 - 45
Manganese	µg/L	50	23	13	10	40	57	64	7-9,170
Mercury	µg/L	1	0.2	0.2	0.2	0.2	0.2	0.2	0.05 - 0.5
Methane	µg/L	NE	3	3	10	3	10	10	1 - 2,505
Molybdenum	µg/L	NE	1	1	4	0.5	2	6	0.5 - 26.2
Nickel	µg/L	100	4	5	3	8	5	7	0.87 - 48
Nitrate + Nitrite	mg-N/L	NE	4	4	0.2	3	4	0.2	0.02 - 6.3
Potassium	mg/L	NE	5	5	5	5	19	5	1.609 - 18.8
Selenium	µg/L	20	0.5	0.5	0.5	1	0.5	0.5	0.5 - 2.4
Sodium	mg/L	NE	6	11	12	7	11	15	6 - 190
Strontium	µg/L	NE	57	69	100	46	73	99	27 - 2,120
Sulfate	mg/L	250	2	6	10	2	8	15	1.2 - 510
Sulfide	mg/L	NE	0.1	0.1	0.1	0.1	0.1	0.1	0.1 - 2
TDS	mg/L	500	85	148	133	93	134	181	50 - 1,200
Thallium	µg/L	0.2*	0.2	0.2	0.1	0.2	0.1	0.1	0.1 - 0.2
TOC	mg/L	NE	1	1	10	3	6	4	1 - 12.3
Total Radium	pCi/L	5^	9	1	0.5	2	4	4	0.494 - 35
Total Uranium	µg/mL	0.03^	0.0005	0.0005	0.0005	0.0005	0.0005	0.002	0.0002 - 0.864
Vanadium	µg/L	0.3*	1	1	1	3	2	2	0.33 - 25.8
Zinc	µg/L	1000	10	43	16	39	23	41	5 - 140

Prepared by: HES Checked by: JHG
Revised by: DAA

Notes:

[1] - Background threshold values were calculated using data from background groundwater samples collected June 2015 to April 2017

[2] - Updated background threshold values were calculated using data from background groundwater samples collected October 2010 to December 2018 and submitted to NCDEQ June 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 values approved by North Carolina Department of Environmental Qualtity(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).

--- - 2017 background threshold value was not calculated for constituent.

* - IMAC of the 15A NCAC 02L Standard, Appendix 1, April 1, 2013.

^ - Federal Maximimum Contaminant Level

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
BELEWS CREEK STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELEWS CREEK NC

Constituent	Reporting Unit	Comparison Criteria	Belews Reservoir Background Ranges	Dan River Background Ranges
Constituents with 15A NCAC 02B (Class C1, Water Supply: WS-IV1, WS-V1)[1] Standards				
pH	S.U.	6.0-9.0	6.8 - 7.9	6.5 - 7.7
Dissolved Oxygen	mg/L	≤ 4	5.3 - 10.8	4.4 - 8.8
Temperature	deg C	≥ 32	7 - 26.8	9 - 32.9
Turbidity	NTU	Lake and Reservoirs: ≥ 25 Streams: ≥ 50	5.2 - 137	0.01 - 33.5
Arsenic	µg/L	10	0.15 - 0.27	0.19 - 0.78
Arsenic (Dissolved)	µg/L	acute: 340, chronic: 150	0.15 - <1	0.16 - 0.76
Barium	µg/L	1000	20.8 -51	13.9 - 35.9
Beryllium (Dissolved)	µg/L	acute: 65, chronic: 6.5	<0.1 - <1	0.012 - 0.058
Cadmium (Dissolved)[2]	µg/L	acute: 0.82, chronic: 0.15	<0.08 - <0.1	<0.08 - 0.22
Chloride	mg/L	230	2.9 -26	5.3 - 8.5
Chromium (III) (Dissolv	µg/L	acute: 183, chronic: 24	NA	NA
Chromium (VI) (Dissolv	µg/L	acute: 16, chronic: 11	NA	NA
Copper (Dissolved)[2]	µg/L	acute: 3.6, chronic: 2.7	0.51 - 1.99	0.72 - 8.7
Fluoride	mg/L	1.8	0.066 - 0.11	0.074 - <1
Lead (Dissolved)[2]	µg/L	acute: 14, chronic: 0.54	0.061 - <1	0.028 - <1
Mercury	µg/L	chronic: 0.012	0.00078 - 0.00906	0.00004 - 0.0022
Nickel	µg/L	25	0.14 - 2.11	0.19 - 1
Nickel (Dissolved)[2]	µg/L	acute:140, chronic: 16	0.16 - <1	0.13 - 2.1
Nitrate + Nitrite	mg-N/L	10	0.084 - 0.529	0.0200 - 0.17
Selenium	µg/L	chronic: 5	<0.5 - <1	0.25 - 0.63
Silver (Dissolved)[2]	µg/L	acute: 0.3, chronic: 0.06	<0.3	<0.3
Sulfate	mg/L	250	2.4 - 13	2.4 - 10.7
Thallium	µg/L	2	<0.1 - <0.2	<0.1 - <0.2
Total Dissolved Solids	mg/L	500	37 - 130	43 - 174
Total Hardness	mg/L	100	12.9 - 36.8	20.3 - 32.9
Zinc (Dissolved)[2]	µg/L	acute: 36, chronic: 36	<5 - <10	2.8 - 11
Constituents with USEPA National Recommended Water Quality Criteria				
Alkalinity	mg/L	chronic: 20	7.6 - 47	16 - 33
Aluminum	µg/L	acute: 620, chronic: 300	81 - 4,170	53 - 1,820
Antimony	µg/L	5.6	<0.5 - <1	0.11 - 0.12
Iron	µg/L	1000	436 - 5,700	27.1 - 1,740
Manganese	µg/L	50	26 - 123	5.1 - 76
Constituents without 02B or USEPA Criteria				
Bicarbonate	mg-$CaCO_3$/L	NE	7.6 - 47	16 - 33
Boron	µg/L	NE	<50	25.4 - 72
Cadmium	µg/L	NE	<0.08 - <0.1	<0.08 - <0.1
Calcium	mg/L	NE	2.99 - 8.94	3.4 - 8.11
Carbonate Alkalinity	mg-$CaCO_3$/L	NE	<0.5	<5
Chromium	µg/L	NE	0.27 - 4.5	0.12 - 1.55
Chromium (VI)	µg/L	NE	0.034 - 0.064	0.027 - 0.12

TABLE 4-4
BACKGROUND DATASET RANGES FOR SURFACE WATER
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELEWS CREEK NC

Constituent	Reporting Unit	Comparison Criteria	Belews Reservoir Background Ranges	Dan River Background Ranges
Constituents without 02B or USEPA Criteria (Continued)				
Cobalt	µg/L	NE	0.1 - 1.79	0.01 - 0.19
Copper	µg/L	NE	0.5 - 3.74	0.3 - 5.5
Lead	µg/L	NE	0.15 - 2.91	0.059 - 0.49
Lithium	µg/L	NE	1.1 - 1.3	0.3 - 0.37
Magnesium	mg/L	NE	1.31 - 3.52	1.8 - 3.67
Methane	µg/L	NE	<10	2.1 - 561
Molybdenum	µg/L	NE	<0.5 - 1.9	1.12 - 1.8
Potassium	mg/L	NE	1.68 - 2.98	1.59 - 3.86
Sodium	mg/L	NE	<0.3	4.09 - 7.38
Strontium	µg/L	NE	22 - 75	23 - 74
Sulfide	mg/L	NE	<0.1	<0.1
Total Organic Carbon	mg/L	NE	1.9 - 5.5	0.57 - 4.9
Total Radium	pCi/L	NE	NA	NA
Total Uranium	µg/mL	NE	NA	NA
Vanadium	µg/L	NE	0.49 - 8.77	0.32 - 3.85
Zinc	µg/L	NE	6 - 14	2.9 - 20.5

Prepared by: DAA Checked by: ALA

Notes:

Background locations, which were part of the evaluation of potential groundwater to surface water impacts, were approved by North Carolina Department of Environmental

[1]15A NCAC 02B .0101 WS-IV (Water Supply) = Waters protected as water supplies which are generally in moderately to high developed watersheds. Suitable for all Class C uses. Based on sample location, samples SW-BL-D, SW-BL-GWA-04S/D, SW-BL-S-06, SW-BL-S-07, SW-BL-S-13/14, SW-DR-01, SW-DR-02, SW-DR-03 and SW-DR-04 are subject to WS-IV water quality standards.

[1]15A NCAC 02B .0101 WS-V (Water Supply) = Waters protected as water supplies which are generally upstream of and draining to Class WS-IV waters. Suitable for all Class C uses. Based on sample location, samples SW-DR-BG, SW-DR-BG2, SW-DR-TFC are subject to WS-V water quality standards.

[1]15A NCAC 02B .0101 Class C (Aquatic Life) = Freshwaters protected for secondary recreation, fishing, aquatic life including propagation and survival and wildlife; All freshwaters shall be classified to protect these at a minimum. All samples collected from the Dan River and Belews Reservoir are subject to Class C

[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.

< - Concentration not detected at or above the adjusted reporting limit.

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

USEPA - Unitesd States Environmental Protection Agency

TABLE 4-5
BACKGROUND DATASET RANGES FOR SEDIMENT
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELEWS CREEK, NC

Constituent	Reporting Unit	PSRG Protection of Groundwater	Belews Reservoir Background Dataset Range	Dan River Background Dataset Range
pH	S.U.	NE	5.8 - 6.7	5.1 - 6.3
Aluminum	mg/kg	110,000	3,200 - 28,000	13,000 - 16,000
Antimony	mg/kg	0.9	0.16 - <0.72	<0.64 - <0.83
Arsenic	mg/kg	5.8	0.52 - <6.7	0.76 - 3.6
Barium	mg/kg	580	12 - 82	61 - 92
Beryllium	mg/kg	63	0.22 - 3.5	0.8 - 1.3
Boron	mg/kg	45	<2.9 - <16.8	<3.5 - <4.9
Cadmium	mg/kg	3	0.022 - <0.81	0.034 - 0.091
Calcium	mg/kg	NE	437 - 1,600	480 - 820
Chloride	mg/kg	NE	6 - <338	11 - <20
Chromium	mg/kg	3.8	2.2 - 29	16 - 19
Chromium (III)	mg/kg	360,000	2.2	7.7 - 8.5
Cobalt	mg/kg	0.9	<6.7 - 16	7.7 - 8.5
Copper	mg/kg	700	2.3 - 26	8.1 - 11
Iron	mg/kg	150	3,100 - 20,000	13,000 - 15,000
Lead	mg/kg	270	2.3 - 13	9.6 - 13
Magnesium	mg/kg	NE	260 - 4,700	1,800 - 2,500
Manganese	mg/kg	65	20 - 670	130 - 240
Mercury	mg/kg	1	0.0075 - <0.12	<0.13 - <0.16
Molybdenum	mg/kg	7.1	<2.3 - <3.4	<2.8 - <3.9
Nickel	mg/kg	130	1.4 - 16	7.6 - 8.5
Nitrate (as N)	mg/kg	NE	<0.28 - <0.31	0.16 - <0.4
Nitrate	mg/kg	NE	<33.8	NE
Potassium	mg/kg	NE	260 - 2,200	1,200 - 2,300
Selenium	mg/kg	2.1	<6.7 - <30	<11 - <20
Silver	mg/kg	3.4	<0.59 - <0.68	<0.69 - <0.99
Sodium	mg/kg	NE	<290 - <340	47 - <490
Strontium	mg/kg	1500	0.7 - 14	6 - 7.8
Sulfate	mg/kg	1438^	<14 - <338	<16 - 34
Sulfide	mg/kg	NE	<30.2 - <39.4	<36.9 - <42.2
Thallium	mg/kg	0.28	0.05 - 0.28	0.18 - 0.19
Total Organic Carbon	mg/kg	NE	940 - 8,070	5,980 - 12,300
Vanadium	mg/kg	350	14.6 - 80	40 - 42
Zinc	mg/kg	1,200	4.8 - 40	31 - 44

Prepared by: DAA Checked by: ALA

Notes:

Background locations, which were part of the evaluation of potential groundwater to surface water impacts, were approved by North Carolina Department of Environmental Quality (NCDEQ).

^ - PSRG Protection of Groundwater value was calculated using the equation shown in **Section 6**

mg/kg - milligrams per kilogram

NE - not established

S.U. - standard unit

PSRG - Preliminary Soil Remediation Goals

TABLE 5-1
APRIL 2019 WATER LEVEL MEASUREMENTS AND ELEVATIONS
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELEWS CREEK, NC

Well ID	Top of Well Casing (ft. NAVD 88)	Top of Screen Elevation (ft. NAVD 88)	Bottom of Screen Elevation (ft. NAVD 88)	April 2019 Measured Water Level[1] (ft. BTOC)	April 2019 Water Elevation (ft. NAVD 88)	Monitoring Flow Zone
AB-1BR	772.83	675.52	670.5	40.74	732.09	Bedrock
AB-1BRD	769.53	469	459	97.42	672.11	Bedrock
AB-1D	772.47	696.47	691.5	40.44	732.03	Deep
AB-1S	772.42	734.49	719.5	42.21	730.21	Shallow
AB-2BR	770.57	605.81	595.8	43.73	726.84	Bedrock
AB-2BRD	770.64	501.85	491.9	94.63	676.01	Bedrock
AB-2D	773.84	638.71	633.7	43.01	730.83	Deep
AB-2S	773.94	739.69	724.7	31.59	742.35	Shallow
AB-3BR	769.91	506.69	496.7	95.45	674.46	Bedrock
AB-3D	772.51	658.8	653.8	50.60	721.91	Deep
AB-3S	772.62	733.92	718.9	38.23	734.39	Shallow
AB-4 Ash Well	761.29	704.67	694.7	6.35	754.94	Ash Pore Water
AB-4 Lower Ash	761.68	700.48	695.5	6.63	755.05	Ash Pore Water
AB-4 Medium Ash	761.59	725.87	720.87	6.57	755.02	Ash Pore Water
AB-4 Medium Ash 30	761.74	725.07	720.07	6.64	755.1	Ash Pore Water
AB-4 SAP2	761.47	685.69	668.69	6.46	755.01	Shallow
AB-4 Saprolite Well	NA	NA	NA	6.18	NA	Shallow
AB-4 Upper Ash	761.77	744.86	739.86	6.74	755.03	Ash Pore Water
AB-4BR	761.99	621.74	616.74	7.01	754.98	Bedrock
AB-4BRD	762.5	601.53	596.53	7.71	754.79	Bedrock
AB-4D	762.21	669.75	664.75	7.19	755.02	Deep
AB-4S	762.18	756.36	741.36	6.41	755.77	Ash Pore Water
AB-4SAP	761.92	674.17	684.17	6.87	755.05	Shallow
AB-4SL	762.25	707.85	697.85	7.11	755.14	Ash Pore Water
AB-5D	762.13	661.94	656.94	7.06	755.07	Deep
AB-5S	761.9	755.86	740.86	6.51	755.39	Ash Pore Water
AB-5SL	761.85	725.01	715.01	6.33	755.52	Ash Pore Water
AB-6D	765.33	677.22	672.22	7.89	757.44	Deep
AB-6S	765.55	760.46	750.46	7.58	757.97	Ash Pore Water
AB-6SL	765.5	749.08	744.08	7.67	757.83	Ash Pore Water
AB-7D	771.14	683.72	678.72	13.31	757.83	Deep
AB-7S	771.09	762.91	752.91	13.79	757.3	Ash Pore Water
AB-8D	765.38	690.1	685.1	8.27	757.11	Deep
AB-8S	765.1	758.16	743.16	7.61	757.49	Ash Pore Water
AB-8SL	765.29	725.04	715.04	8.42	756.87	Ash Pore Water
AB-9BR	782.84	649.84	644.84	23.81	759.03	Bedrock
AB-9BRD	783.26	589.2	584.2	23.78	759.48	Bedrock
AB-9D	782.84	689.69	684.69	23.23	759.61	Deep
AB-9S	783.15	766.74	751.74	22.53	760.62	Shallow
BG-1D	808.48	758.63	753.63	40.07	768.41	Deep
BG-1S	808.75	779.08	763.88	40.19	768.56	Shallow
BG-2BRA	813.59	713.17	708.17	43.94	769.65	Bedrock
BG-2D	812.13	739.95	734.95	43.78	768.35	Deep
BG-2S	811.8	769.72	754.72	45.84	765.96	Shallow
BG-3D	844.61	779.72	774.72	24.4	820.21	Deep
BG-3S	845.64	817.46	802.46	26.98	818.66	Shallow
CCR-11D	790.11	736.7	721.7	37.32	752.79	Deep
CCR-11S	790.16	747.59	742.59	36.54	753.62	Shallow
CCR-12D	772.3	718.79	713.79	20.54	751.76	Deep
CCR-12DA	776.07	725.1	720.1	21.31	754.76	Deep
CCR-12S	772.24	756.8	741.8	20.69	751.55	Shallow
CCR-13BR	705.36	656.8	646.8	16.78	688.58	Bedrock
CCR-13D	705.61	682.15	677.15	15.73	689.88	Deep
CCR-13S	704.27	694.81	689.81	14.45	689.82	Shallow
CCR-1D	774.44	728.04	723.04	25.17	749.27	Deep
CCR-1S	774.59	746.74	736.74	25.47	749.12	Shallow
CCR-2D	767.4	702.23	697.23	20.3	747.1	Deep
CCR-2S	768.66	750.46	735.46	21.58	747.08	Shallow
CCR-4D	773.96	721.05	716.05	33.08	740.88	Deep
CCR-4S[2]	773.78	733.55	728.55	BP	NA	Shallow
CCR-5D	727.62	668.14	663.14	20.01	707.61	Deep
CCR-5S	727.12	699.48	684.48	5.04	722.08	Shallow
CCR-6D	658.05	632.49	627.49	14.16	643.89	Deep
CCR-6S[3]	658.43	646.46	641.46	BP	NA	Shallow
CCR-7D	688.88	635.43	630.43	13.76	675.12	Deep

TABLE 5-1
APRIL 2019 WATER LEVEL MEASUREMENTS AND ELEVATIONS
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELEWS CREEK, NC

Well ID	Top of Well Casing (ft. NAVD 88)	Top of Screen Elevation (ft. NAVD 88)	Bottom of Screen Elevation (ft. NAVD 88)	April 2019 Measured Water Level[1] (ft. BTOC)	April 2019 Water Elevation (ft. NAVD 88)	Monitoring Flow Zone
CCR-7S	688.9	677.76	662.76	12.34	676.56	Shallow
CCR-8AD	773.56	685.46	680.46	38.09	735.47	Deep
CCR-8D	728.18	652.55	647.55	25.32	702.86	Deep
CCR-8S[4]	727.9	711.06	696.06	BP	NA	Shallow
CCR-9D	773.4	719.34	714.34	33.5	739.9	Deep
CCR-9S	773.1	747.45	732.45	24.62	748.48	Shallow
EX-OB-1	770.96	725.38	715.38	29.11	741.85	Deep
EX-OB-2	762.8	732.77	722.77	16.26	746.54	Deep
GWA-01BR	743.72	631.1	621.1	63.41	680.31	Deep
GWA-01D	743.03	682.9	677.9	20.18	722.85	Deep
GWA-01S	743.08	721.72	706.72	17.29	725.79	Shallow
GWA-02D	787.51	726.58	721.58	39.46	748.05	Deep
GWA-02S	787.58	750.5	735.5	38.96	748.62	Shallow
GWA-03D	769.5	721.68	716.68	40.89	728.61	Deep
GWA-03S	769.14	739.51	724.51	40.54	728.6	Shallow
GWA-06D	793.25	689.93	684.93	37.19	756.06	Deep
GWA-06S	793.37	762.95	747.95	31.07	762.3	Shallow
GWA-07D	822.7	741.39	736.39	34.6	788.1	Deep
GWA-07SA	822.87	792.87	777.87	33.34	789.53	Shallow
GWA-08D	831.15	739.61	734.61	28.47	802.68	Deep
GWA-08S	832.01	808.27	793.27	25.76	806.25	Shallow
GWA-09BR	794.53	675.78	670.78	46.81	747.72	Bedrock
GWA-09D	794.28	708.25	703.25	42.46	751.82	Deep
GWA-09S	793.99	754.77	739.77	39.44	754.55	Shallow
GWA-10DA	749.54	NA	NA	8.02	741.52	Deep
GWA-10S	749.11	742.78	727.78	6.93	742.18	Shallow
GWA-11D	757.04	691.61	686.61	26.21	730.83	Deep
GWA-11S	757.03	731.49	716.49	22.11	734.92	Shallow
GWA-12BR	836.46	727.35	722.35	59.78	776.68	Bedrock
GWA-12D	837.16	771.04	766.04	54.61	782.55	Deep
GWA-12S	835.79	792.65	777.65	53.39	782.4	Shallow
GWA-16BR	783.66	682.03	677.03	36.22	747.44	Bedrock
GWA-16DA	783.78	729.27	724.27	35.74	748.04	Deep
GWA-16S	784.41	752.51	737.51	35.23	749.18	Shallow
GWA-17D	787.37	735.07	730.07	36.11	751.26	Deep
GWA-17S[5]	787.61	760.07	745.07	BP	NA	Shallow
GWA-18D	774.54	715.34	710.34	26.1	748.44	Deep
GWA-18SA	774.59	760.33	745.33	26.5	748.09	Shallow
GWA-19BR	743.06	661.00	656	23.58	719.48	Bedrock
GWA-19D	743.24	702.19	697.19	13.25	729.99	Deep
GWA-19SA	743.33	735.06	720.06	8.51	734.82	Shallow
GWA-20BR	773.69	689.27	684.27	32.64	741.05	Bedrock
GWA-20D	773.72	715.44	710.44	22.98	750.74	Deep
GWA-20SA	773.53	743.65	728.65	27.57	745.96	Shallow
GWA-21D	734.79	707.07	702.07	13.60	721.19	Deep
GWA-21S	735.01	725.88	715.88	12.77	722.24	Shallow
GWA-22D	735.73	703.23	698.23	8.58	727.15	Deep
GWA-22S	738.1	729.23	719.23	11.54	726.56	Shallow
GWA-23D	811.79	755.19	750.19	22.82	788.97	Deep
GWA-23S	811.57	787.17	772.17	25.17	786.4	Shallow
GWA-24BR	641.78	580	570	23.55	618.23	Bedrock
GWA-24D	642.21	626.11	621.11	13.61	628.6	Deep
GWA-24S	643.21	635.28	630.28	11.38	631.83	Shallow
GWA-25BR	855.76	757.48	752.48	37.77	817.99	Bedrock
GWA-26BR	854.99	768.86	763.86	37.66	817.33	Bedrock
GWA-26D	856.8	791.01	786.01	39.37	817.43	Deep
GWA-26S	856.16	819.87	804.87	38.37	817.79	Shallow
GWA-27BR	758.32	647.46	642.46	30.72	727.6	Bedrock
GWA-27D	758.3	717.73	712.73	13.68	744.62	Deep
GWA-27S	758.42	748.79	733.79	12.3	746.12	Shallow
GWA-30D	738.49	703	698	17.52	720.97	Deep
GWA-30S	738.43	726.1	711.1	18.24	720.19	Shallow
GWA-31D	715.67	657.8	652.8	4.66	711.01	Deep
GWA-31S	714.26	707.2	692.2	12.87	701.39	Shallow
GWA-32D	706.84	630.4	625.4	21.15	685.69	Deep

TABLE 5-1
APRIL 2019 WATER LEVEL MEASUREMENTS AND ELEVATIONS
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELEWS CREEK, NC

Well ID	Top of Well Casing (ft. NAVD 88)	Top of Screen Elevation (ft. NAVD 88)	Bottom of Screen Elevation (ft. NAVD 88)	April 2019 Measured Water Level[1] (ft. BTOC)	April 2019 Water Elevation (ft. NAVD 88)	Monitoring Flow Zone
GWA-32S	707.68	691.3	676.3	18	689.68	Shallow
LRB-1BR	809.07	712.21	707.21	55.21	753.86	Bedrock
LRB-1D	809.16	730.32	725.32	54.52	754.64	Deep
LRB-1S	809.12	760.34	745.34	53.6	755.52	Shallow
LRB-2BR	804.28	721.6	716.6	40.93	763.35	Bedrock
LRB-2D	804.32	736.54	731.54	40.47	763.85	Deep
LRB-2S	804.20	761.83	746.83	39.27	764.93	Shallow
MW-1	852.69	815.49	805.49	31.45	821.24	Shallow
MW-104BR	798.56	652.2	647.2	38.7	759.86	Bedrock
MW-104BRA	798.96	654.35	634.35	39.24	759.72	Bedrock
MW-104D	798.34	717.81	712.81	38.54	759.8	Deep
MW-104S	798.68	760.49	750.49	40.06	758.62	Shallow
MW-1D	854.15	768.62	763.62	41	813.15	Bedrock
MW-2	858.05	818.05	808.05	45.42	812.63	Shallow
MW-200BR[6]	636.42	588.7	583.7	0	NA	Bedrock
MW-200D	636.05	618.8	613.8	5.54	630.51	Deep
MW-200S	635.89	631.18	623.18	4.25	631.64	Shallow
MW-201BR	783.77	683.37	678.37	35.92	747.85	Bedrock
MW-201D	783.98	747.12	737.12	35.33	748.65	Deep
MW-202BR	789.63	688.87	683.87	38.2	751.43	Bedrock
MW-202D	790.78	701.47	696.47	39.73	751.05	Deep
MW-202S	789.97	742.6	727.6	41.15	748.82	Shallow
MW-203BR	787.26	690.09	685.09	33.55	753.71	Bedrock
MW-203D	785.57	696.51	691.51	31.9	753.67	Deep
MW-203S	786.14	755.95	740.95	31.9	754.24	Shallow
MW-204D	776.78	737.85	732.85	28.16	748.62	Deep
MW-204S	776.29	754.55	739.55	27.67	748.62	Shallow
MW2-7	777.64	762.02	747.02	13.27	764.37	Deep
MW2-9	797.38	792.77	782.77	4.91	792.47	Deep
MW-3	842.81	803.31	793.31	37.93	804.88	Shallow
MW-4	767.58	737.38	727.38	11.68	755.9	Shallow
MW-5	786.77	736.57	726.57	23.47	763.3	Shallow
MW-6	836.91	810.07	800.07	30.18	806.73	Shallow
MW-7	815.57	811.31	801.31	4.62	810.95	Shallow
OB-4	777.6	762.57	747.57	21.68	755.92	Shallow
OB-5	780.93	759.33	744.33	23.94	756.99	Shallow
OB-9	799.59	760.42	751.02	36.79	762.8	Deep
SFMW-1D	823.62	779.62	774.62	35.25	788.37	Deep
SFMW-2D	848.62	798.62	793.62	42.22	806.4	Deep
SFMW-3D	794.99	748.23	743.23	34.91	760.08	Deep
SFMW-4D	781.28	743.5	738.5	23.38	757.9	Deep
SFMW-5D	808.46	774.09	769.09	35.89	772.57	Deep

Prepared by: DAA Checked by: ALA

Notes:

1 - Manual water levels collected on April 8, 2019

2 - CCR-4S pump intake is approximately 43 feet below top of casing

3 - CCR-6S pump intake is approximately 12 feet below top of casing

4 - CCR-8S pump intake is approximately 29.34 feet below top of casing

5 - GWA-17S pump intake is approximately 41 feet below top of casing

6 - Artesian conditions present

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

NA - not applicable due to no available data

* - Abandoned sampling location

** - Survey information incomplete/not available

TABLE 5-2
GROUNDWATER BALANCE SUMMARY
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELEWS CREEK, 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 ash basin	20		119		56		119	
Direct recharge to the watershed outside of the ash basin	120		100		120		92	
Ash basin pond	200							
Drainage inside the ash basin[1]		70		174		157		195
Drainage outside of the ash basin						16		11
Domestic water supply wells								
Remediation wells (*i.e.* IAP extraction system)				2		2		2
Flow through and under the dam		150		45				
Other[2]		120	2			1		3

Prepared by: YG Checked by: ALA

Notes:

[1] Drainage includes streams, seeps, ditch, channel, canal, etc. Drainage streams included are depending on the scenario, where the pre-decanting scenario includes streams present prior to closure and closure-by excavation includes streams that form within the excavated ash basin footprint after closure.

[2] Other refers to groundwater flow in/out the watershed that are not accounted in the above categories

Flow in refers to recharge to the groundwater system

Flow out refers to discharge from the groundwater system

Remediation wells (i.e. interim extraction system) were installed in late 2018, however the extent of the ash basin watershed under pre-decanting conditions does not include the interim extraction system. Under post-decanting conditions the watershed extent expands to include

gpm - gallons per minute

TABLE 5-3
SURFACE WATER CLASSIFICATIONS
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELEWS CREEK, NC

Adjacent Surface Water Body	Surface Water Classification (15A NCAC 02B .0300)
Belews Reservoir	Class C, WS-IV
Dan River	Class WS-IV, WS-V

Prepared by: ALA Checked by: CDE

Notes:

1. Class C waters are protected for uses such as secondary recreation, fishing, wildlife, fish consumption, aquatic life including propagation, and survival.
2. Class WS-IV waters are protected as water supplies that are generally in moderately to highly developed watersheds. WS-IV waters are also subject to Class C water quality standards.
3. 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
CORRECTION ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELEWS CREEK, 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-04BR (bedrock)	14	07/16/2015 – 10/18/2018	25.7 j – 54	< 50 – 21,900 (~60' saturated ash)
AB-04BRD (deep bedrock)	7	05/13/2016 – 10/18/2018	27.6 j – < 50	
AB-04D (Deep)	14	07/16/2015 – 10/18/2018	37.6 j – 212	
AB-04SAP (shallow)	4	03/21/2018 – 10/18/2018	31.6 j – 258 M1	
AB-05D (deep)	14	07/14/2015 – 10/17/2018	30.4 j – < 50	926 – 17,100 (~45' saturated ash)
AB-06D (deep)	14	07/08/2015 – 10/16/2018	27.5 j – < 50	69.2 – 1,600 (~13' saturated ash)
AB-07D (deep)	15	06/16/2015 – 10/15/2018	26.9 j – 54	294 – 20,800 (~13' saturated ash)
AB-08D (deep)	15	06/17/2015 – 10/16/2018	26.8 j – < 50	123 – 13,800 (~44' saturated ash)

Prepared by: ALA Checked by: CDE

Notes:

< - concentration not detected at or above the adjusted reporting limit.

j - Estimated concentration above the adjusted method detection limit and below the adjusted reporting limit.

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
BELEWS CREEK STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELEWS CREEK, 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: ALA Checked by: CDE

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

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
BELEWS CREEK STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELEWS CREEK, NC

Analytical Parameter		pH	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Chloride	Chromium	Cobalt	Iron	Manganese	Molybdenum	Selenium	Strontium	Sulfate	Thallium	Vanadium
Reporting Units		S.U.	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	mg/kg
PSRG Protection of Groundwater		**NE**	**0.9**	5.8	**580**	**63**	**45**	**3**	**938‡**	3.8*	0.9	150	65	**7.1**	2.1	**1,500**	**1438‡**	0.28	**350**
2018 Background Threshold Values[1]		4.3-5.8	0.6	13	139	19	17	0.03	14	36	51	40,400	1,117	9.8	5	9	12	0.7	114
2019 Background Threshold Values[2]		**4.6 - 7.0**	0.6	**43**	122	2.9	35	0.9	402	**47**	**60**	**61,967**	**1,257**	4	**5**	7	403	**0.8**	231
Sample ID	**Sample Collection Date**	**Analytical Results**																	
Background Unsaturated Soil																			
BG-01D (1-2)	03/26/2015	4.8 j	<3.1	35	42	0.89	<15.5	<0.37	<305	29	1.7 j	38,100	58	<3.1	<3.1	1.9 j	<305	<3.1	55
BG-01D (11-11)	03/27/2015	5.7 j	<3.9	11	27	0.68	12 j	<0.47	<396	4.7	29 j-	12,200	1,010	**8.9**	<3.9	<3.9	<396	<3.9	14
BG-01D (21-21)	03/27/2015	5.4 j	<3.9	7.5	50	0.88	13 j	<0.47	<400	2.3	6.8	12,400 j+	257 j+	<3.9	2.2 j	<3.9	<400	<3.9	16
BG-01D (31-31)	03/27/2015	5.6 j	<3.5	31	42	2.8	39	<0.42	<358	17	38	40,400	871	<3.5	2.9 j	<3.5	<358	<3.5	51
BG-02D (1-2)	03/23/2015	5.5 j	<3.8	3.3 j	25	0.32 j	<18.9	<0.45	<363	8.5	<3.8	24,100	53	<3.8	<3.8	<3.8	<363	<3.8	47
BG-02D (10-12)	03/24/2015	5.0 j	<3.5	2.7 j	71	0.86	35 j	<0.42	<352	5.3	5.5	32,300	245	<3.5 j	3 j	<3.5 j	<352	<3.5	105
BG-02D (20-22)	03/24/2015	5.1 j	<3.7	<3.7	89	0.29 j	<18.5	<0.45	<367	<1.9 j	5	9,570	450	<3.7 j	<3.7	<3.7 j	<367	<3.7	20
BG-02D (30-32)	03/24/2015	5.2 j	<4	<4	92	0.33 j	<20.1	<0.48	<403	<2 j	5	13,000	680	<4 j	<4	<4 j	<403	<4	27
BG-03S (1-2)	05/12/2015	5.4 j	<6.4	<6.4	30	0.37	14 j	<0.77	<329	16	<6.4	27,800	40	<3.2	<4.8	<3.2	<329	<6.4	60
BG-03S (10-12)	05/12/2015	4.9 j	<7.6	<7.6	32	0.75	21	<0.91	<362	22	16	44,200	513	<3.8	<5.7	<3.8	<362	<7.6	141
BG-03S (20-22)	05/12/2015	5.0 j	<6.1	<6.1	68	0.76	17	<0.73	<308	15	8.1	36,800	216	<3	<4.6	<3	<308	<6.1	55
BGSB-01 (1-2)	07/26/2017	4.8	<0.46	**59 B**	38	1.6	<8.1	<0.023	3.4 j	37	3.5	49,000	66 B	0.98 j	1.5	2.5 j	<12	0.38	64
BGSB-01 (5-7)	07/26/2017	4.6	<0.47	22 B	18	1.6	<2.4	<0.023	1.9 j	19	1.1	21,000	39 B	<1.9	0.84 j	0.82 j	<12	0.15	42
BGSB-01 (10-12)	07/26/2017	4.7	<0.6	9.1 B	47	1.4	<1.6	<0.03	1.2 j	6.9	5.8	12,000	180 B	0.56 j	1 j	0.76	<12	0.39	13
BGSB-01 (15-17)	07/26/2017	5.0	<0.4	5.6 B	46	1.3	<3.8	<0.02	<12	6.7	16	8,700	230 B	<3	1.9	1.9	<12	0.66	9.8
BGSB-01 (20-22)	07/26/2017	4.8	<0.52	6.3 B	62	1.3	1.2 j	<0.026	<11	5	21	11,000	250	0.97 j	1.5	2.8	<11 M	0.6	8.6
BGSB-02 (1-2)	07/26/2017	4.9	<0.37	3.9 B	14	0.28	<2.8	<0.019	4.2 j	10	1.8	22,000	59 B	<2.2	0.71 j	1.5	8 j	0.14	65
BGSB-02 (10-12)	07/26/2017	4.6	<0.51	0.5 j,B	27	0.27	<10	<0.026	<12	1.1 j	4.8	11,000	110 B	<8.1	1.8	<4	<12	0.066 j	35
BGSB-02 (15-17)	07/26/2017	5.0	<0.45	0.54 B	42	0.37	<17	0.025	<11	2.6 j	7.2	12,000	490	<13	2.7	<6.7	<11	0.19	24
BGSB-02 (20-22)	07/26/2017	5.0	<0.57	1.2 B	70	0.51	<22	<0.029	<12	7.8	7.2	17,000	480	<18	4.5	<9	<12	0.26	35
BGSB-02 (25-27)	07/26/2017	5.0	<0.38	0.85 B	140	0.57	<23	<0.019	<12	1.2 j	6.2	14,000	490	<19	4.1	<9.3	<12	0.27	18
BGSB-02 (30-32)	07/26/2017	5.3	<0.38	0.77 B	71	0.47	<8.8	0.033	<12	3.6	17	14,000	550 B	<7.1	2.2	<7.1	<12	0.34	23
BGSB-03 (1-2)	07/26/2017	5.0	<0.41	3.2 B	22	0.39	<3.7	0.032	<11	20	1.4	22,000	42 B	0.5 j	0.56 j	1.7	<11	0.1 j	37
BGSB-03 (5-7)	07/26/2017	5.0	<0.3	2.8 B	38	0.56	<2.3	<0.015	1.8 j	5.1	6.7	9,800	170 B	0.81 j	0.96	0.33 j	<11	0.27	28
BGSB-03 (10-12)	07/26/2017	5.2	<0.39	2.2 B	64	0.66	<13	<0.02	<12	27	31	25,000	540 B	<10	2.8	<5	<12	0.32	95
BGSB-03 (15-17)	07/26/2017	4.9	<0.43	3.6 B	82	1.1	<12	0.032	<14	4.4	32	18,000	470 B	<9.8	5	<4.9	<14	0.65	99
BGSB-03 (20-22)	07/26/2017	4.9	0.14 j	4.9 B	53	5.9	<10 M	0.013 j	<14	43 M	22	51,000 M	630 B,M	<8.2 M	2.5	<4.1	<14	0.2	280
GWA-03D (34-35.5)	05/04/2015	7.0 j	<7.7	<7.7	108	0.97	<19.3	<0.93	<366	1.1 j	<7.7	9,110	460	<3.9 j	<7.7	11	<366	<7.7	18
GWA-04S (45-47)	03/05/2015	6.4 j	<2.8	<2.8	80	0.52	5	<0.33	<284	1 j+	2.2 j	7,760	383	<0.56	<2.8	4.3	<284	<2.8	9.4
GWA-12D (10-12)	04/15/2015	5.6 j	<6.2	<6.2	27	<0.31	<15.4	<0.74	<315	<1.5 j	6.5	912	296	<3.1	<6.2	<3.1 j	<315	<6.2 j	<6.2
GWA-12D (15-17)	04/15/2015	5.4 j	<5.6	<5.6	99	0.39	<13.9	<0.67	<281	<1.4 j	2.9 j	7,740	187	<2.8	<5.6	<2.8 j	<281	<5.6 j	<5.6
GWA-12D (20-22)	04/15/2015	5.3 j	<5.8	<5.8	91	0.43	<14.5	<0.69	<285	0.97 j	3.5 j	7,870	135	<2.9	<5.8	<2.9 j	<285	<5.8 j	8.2
GWA-12D (25-27)	04/15/2015	NA	<7.9	<7.9	83	0.59	<19.6	<0.94	<402	4.7	4.5 j	9,790	247	<3.9	<7.9	<3.9 j	<402	<7.9 j	10.6
GWASB-12 (5-7)	07/26/2017	**4.4**	<0.42 M	6.7 B	16	0.36	<2.1	<0.021	2.2 j	9.4	1	11,000	43 B	1.2 j	1.1	1	<13 M	0.14	20 M
GWASB-12 (10-12)	07/26/2017	4.6	0.09 j	3.2 B	20	0.42	<2.9	<0.019	7 j	6.8	2	7,100	130 B	1.1 j	1.7	1.6	8.7 j,M	0.099 j	12
GWASB-12 (15-17)	07/26/2017	5.0	<0.31	3.2 B	51	0.53	<9.2	<0.015	<12	3.1	7	7,200	200 B	<7.4	2.8	<3.7	<12	0.22	12
GWASB-12 (20-22)	07/26/2017	5.1	<0.36	2 B	30	0.48	<42	0.016 j	1.2 j	6.6 j	2.7	9,900	380	<34	**7.7**	<17	<12	0.17	8.4

TABLE 6-3
SUMMARY OF UNSATURATED SOIL ANALYTICAL RESULTS
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELEWS CREEK, NC

Analytical Parameter		pH	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Chloride	Chromium	Cobalt	Iron	Manganese	Molybdenum	Selenium	Strontium	Sulfate	Thallium	Vanadium
Reporting Units		S.U.	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	mg/kg
PSRG Protection of Groundwater		**NE**	**0.9**	5.8	**580**	**63**	**45**	**3**	**938‡**	3.8*	0.9	150	65	**7.1**	2.1	**1,500**	**1438‡**	0.28	**350**
2018 Background Threshold Values[1]		4.3-5.8	0.6	13	139	19	17	0.03	14	36	51	40,400	1,117	9.8	5	9	12	0.7	114
2019 Background Threshold Values[2]		**4.6 - 7.0**	0.6	**43**	122	2.9	35	0.9	402	**47**	**60**	**61,967**	**1,257**	4	**5**	7	403	**0.8**	231
Sample ID	Sample Collection Date	Analytical Results																	
GWASB-12 (25-27)	07/26/2017	5.5	<0.32	1.2 B	46	0.59	<23	<0.016	<12	5.9	6.1	9,500	230 B	<9.1	**5.1**	<9.1	<12	0.18	9.9
Upgradient of Ash Basin Unsaturated Soil																			
GWA-05S (25-26.5)	03/18/2015	**4.2 j**	<3.4	2.4 j	121	0.42	<17.1	<0.41	<332	<1.7 j	3.3 j	4,590	450	<0.68 j	2.6 j	3.8	<332	<3.4	7.9
GWA-07S (30-31.5)	03/10/2015	5.4 j	<3.5	3.4 j	488	2.7	17 j	<0.42	<362	3	11	26,100	226	<3.5	**5.6**	9.6	<362	<3.5	76
GWA-08D (20-21.5)	04/07/2015	5.1 j	<7.6	<7.6	83	0.74	<19	<0.91	<387	2.2	<7.6	7,910	103	<3.8	<7.6	6.2	<387	<7.6	11
GWA-09GTB (40-41.5)	05/27/2015	5.9 j	<6.1 j	10.2 j-	**620 j-**	5.1 j-	31 j-	<0.74	<325 j	**55 j-**	16 j-	44,100 j-	640 j	<3.1 j	3.6 j-	3.2 j-	<325 j	<6.1	96 j-
MW-202BR (40-42)	03/20/2015	5.2 j	<2.8	1.6 j	33	0.64	5.6	<0.34	<278	2 j+	12	6,870	156	<0.57	2.3 j	1.5	<278	<2.8	7.3
MW-202BR (47-49)	03/20/2015	6.0 j	<3.2	<3.2	28	0.33	<3.2	<0.38	<306	0.63 j+	<3.2 j	1,130	18.5	<0.64	<3.2	1.9	<306	<3.2	<3.2
MW-202BR (60-61.5)	03/09/2015	6.0 j	<3.4	<3.4	117	1.9	10	0.24 j	<329	10.1	8.7	12,000	213	<0.69	<3.4	7.3	<329	<3.4	25
MW-203BR (20-21.5)	03/18/2015	**4.2 j**	<3.4	<3.4	62	0.38	11 j	<0.41	<331	1.8	7.9	9,350	281	<0.69 j	<3.4	0.86	<331	<3.4	32
Within Ash Basin Waste Boundary Unsaturated Soil (Fill Material)																			
AB-01S (20-21.5)	05/09/2015	5.7 j	<6	**61**	54	3.1	<15.1	<0.72	<290	25	23	40,600	583	<3	<6	<3	<290	<6	45
AB-03D (40-41.5)	04/14/2015	6.5 j	<6.8	5.6 j	45	2.4	<16.9 j	<0.81	173 j	9.6	18	18,400	306	<3.4 j	<6.8	4.7	<338	<6.8	13
Downgradient of Ash Basin Unsaturated Soil																			
GWA-01S (20-21.5)	03/26/2015	5.2 j	<2.9	**57**	85	5.3	<14.6	<0.35	<283	33	13	34,400	358	<2.9	<2.9	<2.9	<283	<2.9	44
GWA-10D (2-3)	04/13/2015	5.2 j	<7.6	**62**	39	1.9	<19.1 j	<0.92	<364 j	19	27	32,600	689	2 j	<7.6	<3.8 j	<364	<7.6	29
MW-200BR (0-1.5)	04/24/2015	4.9 j	<6.8	**44**	36	1.3	26	<0.81	<332	40	4.3 j	25,100	68	<3.4	<6.8	<3.4	<332	<6.8	25

Notes:

Prepared by: DAA Checked by: ALA

[1] - Background threshold values were calculated using data from background unsaturated soil samples collected June 2015 to April 2017. Background values approved by NCDEQ on May 14, 2018.

[2] - Updated background threshold values were calculated using data from background unsaturated soil samples collected June 2015 to April 2017. The background threshold value updates retained extreme outlier concentrations in background unsaturated soil datasets (SynTerra, 2019).

- bold highlighted concentration indicates value is greater than applicable regulatory standarad (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 within range of background threshold values for constituents where there is no regulatory standard, or a background threshold value greater than regulatory standard

*NC PSRG for POG is for hexavalent chromium, soil analytical is for total chromium

< - concentration not detected at or above the adjusted reporting limit.

‡Calculated PSRG for POG; Using NCDEQ IHSB Preliminary Soil Remediation Goals companion notes (February 2018)

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.

BTV - background threshold value

mg/kg - milligrams per kilograms

NA - not applicable due to no available data

NE - Not Established

PSRG - Preliminary Soil Remediation Goals for the Protection of Groundwater (POG); NCDEQ Inactive Hazardous Sites Branch (IHSB) Preliminary Soil Remediation Goals table (February 2018)

POG - Protection of Groundwater

S.U. - Standard Unit

TABLE 6-4
SOURCE AREA INTERIM ACTIONS
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELEWS CREEK, NC

Groundwater and Surface Water Interim Actions	Groundwater and Surface Water Remedy
Ash Basin Decanting	Active source remediation by removing ponded water in the ash basin. Decanting will lower the hydraulic head within the coal ash basin and reduce hydraulic gradients, reducing groundwater seepage velocities and COI transport potential. Decanting will return the groundwater flow system to its approximate condition, prior to construction of the ash basin, with the re-establishment of groundwater flow divides and groundwater flowing toward the perennial stream and then northward.
Interim Action Plan Accelerated Remediation Groundwater Extraction System	A 10-well groundwater extraction was installed adjacent to Parcel A in the area northwest of the ash basin. The system was activated on March 14, 2018. The system currently operates at approximately 12 gpm extraction flow rate. As of November 2019, approximately 9,900,000 gallons of water have extracted by the system. Post-decanting, the 10 interim action extraction wells are expected to have reduced extraction rates as a result of the reduced hydraulic head of the ash basin. The system is predicted to remove a total of 2.5 gpm. Continued operation of the system is included in the remedial alternatives evaluated.
Source Area Stabilization	Modifications to the BCSS dam include tree removal, installation of an aggregate seepage collection and filter overlay system, and installation of flumes, riprap channels, and stormwater culverts, riprap lined ditches, seepage collection berm and a concrete ditch among other items that can be found in an August 5, 2016 letter of record documentation (**Appendix A**).
Toe-Drain Water Collection System	A toe-drain water collection system that consists of a 16-inch diameter by 18-feet deep wet well has been installed below the ash basin dam adjacent to the un-named tributary. The wet well storage capacity is approximately 2,000 cubic feet. The system construction and testing is complete and will begin operation in January 2020. Once in operation, the toe-drain system will collect water from the toe of the ash basin dam and route it to the Dan River through new discharge piping to a permitted NPDES outfall.

Prepared by: ALA Checked by: CDE

TABLE 6-5
MEANS OF GROUNDWATER COIs - JANUARY 2018 TO APRIL 2019
CORRECTIVE ACTIVE PLAN UPDATE
BELEWS CREEK STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELEWS CREEK, NC

Analytical Parameter		pH	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Chloride	Chromium (VI)	Chromium	Cobalt	Iron	Lithium	Manganese	Molybdenum	Selenium	Strontium	Sulfate	Thallium	Total Dissolved Solids	Vanadium
Reporting Units		S.U.	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/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		**6.5-8.5**	**1***	**10**	**700**	**4***	**700**	**2**	**250**	NE	**10**	**1***	**300**	NE	**50**	NE	**20**	NE	**250**	**0.2***	**500**	0.3*
2018 Background Threshold Values (Shallow Flow Zone)[1]		5.1-6.0	1	1	58	0.362	50	1	15	1.75	4.72	0.509	750	NE	22.9	**1**	0.5	**56.5**	1.93	0.2	85	1.33
2019 Background Threshold Values (Shallow Flow Zone)[2]		5.2-6.0	1	1	123	0.3	50	1	19	**4**	**11**	0.6	**1600**	**2**	40	0.5	1	46	2.043	0.2	93	**3**
2019 Background Dataset Range (Shallow Flow Zone)[2]		5.3-5.9	0.1-1.1	0.04-1	19-124	0.03-0.6	2.5-50	0.03-1.0	1.2-18.8	0.2-2.7	0.5-11.7	0.02-1.3	22-11,100	0.39-2	3-189	0.1-1.3	0.1-1.4	7.9-48	0.1-2.4	0.02-0.2	20-90	0.1-6.4
2018 Background Threshold Values (Deep Flow Zone)[1]		5.2-7.0	1	1	12.6	0.219	50	1	20.9	0.411	3.3	1.6	240	NE	13	1	0.5	68.5	6.35	0.2	148	1.45
2019 Background Threshold Values (Deep Flow Zone)[2]		5.6-7.0	1	1	16	0.1	50	0.08	19	**0.6**	3	**2**	226	**95**	**57**	**2**	0.5	**73**	8.447	0.1	134	**2**
2019 Background Dataset Range (Deep Flow Zone)[2]		5.6-7.0	0.1-1.5	0.05-1.1	0.004-0.2	0.01-0.02	11.9-58.8	0.03-0.2	2.0-20.3	0.03-0.5	0.1-5.0	0.02-1.8	13-850	2.2-52.2	2.5-104	0.1-5.3	0.2-3.7	29.3-87.8	0.5-11	0.02-0.1	25-126	0.1-1.4
2018 Background Threshold Values (Bedrock Flow Zone)[1]		6.2-8.4	0.5	0.51	6.2	0.2	50	0.08	3	0.33	5.3	0.76	228	NE	9.9	3.7	0.5	100	9.6	0.1	133	0.82
2019 Background Threshold Values (Bedrock Flow Zone)[2]		6.3-6.5	1	2	11	0.2	50	0.08	3	**0.4**	**11**	0.8	**341**	**30**	**64**	**6**	0.5	**99**	15.4	0.1	181	**2**
2019 Background Threshold Values (Bedrock Flow Zone)[2]		6.2-8.4	0.1-1.4	0.1-1.5	3.0-11	0.01-0.2	33.3-50	0.03-0.1	2.3-3.2	0.03-0.3	0.5-34.7	0.03-0.8	27-228	3.9-30	3.9-87.1	0.5-3.7	0.4-0.5	32.6-100	2.5-22.5	0.1-0.1	52-250	0.2-2.3
Sample ID	**Flow Zone**	**Mean, Geomean, or Median Result[3]**																				
Background Locations[4]																						
BG-01D	Transition Zone	7.5	<0.5	0.52	13	0.10	51	0.096	12	0.29	0.74	0.49	135	52.4	**64**	<0.5	<0.5	**89**	6.7	<0.1	209	<0.3
BG-01S	Shallow	5.5	<0.5	0.083	9.8	0.18	3.6	<0.08	7.6	-	**50**	**1.1**	-	**4.4**	-	**1.3**	<0.5	-	0.87	0.14	49	-
BG-02BRA	Bedrock	8.7	0.65	0.93	5.5	<0.1	<50	<0.08	3.1	0.12	1.5	0.19	103	**35**	39	**8.4**	<0.5	79	14	<0.1	154	0.69
BG-02D	Transition Zone	6.6	<0.5	<0.1	5.8	<0.1	<50	<0.08	18	0.20	0.69	0.11	<50	15	<5	**2.0**	<0.5	38	2.6	<0.1	123	1.2
BG-02S	Shallow	5.8	<0.5	0.11	77	0.10	<50	<0.08	13	2.2	2.3	0.11	357	**2.5**	12	0.72	<0.5	34	0.76	<0.1	71	0.98
BG-03D	Transition Zone	6.0	<0.5	0.084	12	<0.1	<50	<0.08	4.9	0.045	<0.5	<0.1	75	2.5	5.8	<0.5	<0.5	46	<1	<0.1	70	0.51
BG-03S	Shallow	5.4	<0.5	<0.1	40	0.25	<50	<0.08	2	0.42	1.1	0.12	261	1.5	14	<0.5	<0.5	27	<1	<0.1	52	0.48
MW-202BR	Bedrock	6.4	<0.5	0.17	<5	<0.1	<50	<0.08	2.7	0.21	1.4	<0.1	<50	4.2	<5	0.57	<0.5	34	3.7	<0.1	<250	0.48
MW-202D	Transition Zone	6.0	<0.5	<0.1	<5	<0.1	<50	<0.08	2.5	0.25	0.60	<0.1	<50	3.3	<5	<0.5	<0.5	38	1.5	<0.1	<250	0.39
MW-202S	Shallow	5.7	<0.5	<0.1	24	0.19	<50	<0.08	1.4	1.0	1.2	<0.1	<50	<0.5	<5	<0.5	<0.5	11	<1	<0.1	<250	0.30
At or Within the Waste Boundary Locations																						
AB-01BR	Bedrock	7.2	<0.5	1.0	129	0.11	**5,630**	<0.08	**340**	0.033	2.5	**1.0**	**2,400**	**93**	**707**	3.7	<0.5	**824**	7.6	<0.1	**723**	0.21
AB-01BRD	Bedrock	**12.3**	-	-	-	-	422	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AB-01D	Transition Zone	**5.6**	<0.5	3.3	160	0.63	**9,265**	0.53	**396**	0.034	2.0	**35**	156	5.9	**1,833**	0.68	1.5	**590**	117	**0.37**	**914**	0.13
AB-01S	Shallow	**5.9**	<0.5	3.9	86	0.094	**10,240**	0.25	**392**	0.032	1.3	**29**	231	0.9	**1,865**	0.31	1.0	**680**	141	**0.32**	**962**	0.21
AB-02BR	Bedrock	**8.0**	-	-	103	0.48	**8,870**	1.0	**410**	**1.1**	1.4	**83**	8.5	**104**	**12,200**	1.5	-	**1,660**	53	0.17	**1,100**	0.33
AB-02BRD	Bedrock	**12.2**	-	-	-	-	20.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AB-02D	Transition Zone	**5.8**	**1.1**	2.2	92	0.57	**9,552**	0.49	**408**	<0.025	1.6	**70**	**1,012**	11.3	**9,030**	0.76	0.67	**678**	75	**0.50**	**922**	<0.3
AB-02S	Shallow	6.6	<0.5	1.7	23	<0.1	50.7	<0.08	6.3	0.14	1.0	**1.2**	231	0.7	**528**	**2.0**	<0.5	34	6.9	0.15	95.4	**10**
AB-03BR	Bedrock	**11.1**	-	-	-	-	538	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AB-03D	Transition Zone	7.2	<0.5	**15.4**	8.0	<0.1	**2,836**	<0.08	**292**	<0.025	1.9	**2.8**	**445**	**198**	**91**	**5.3**	<0.5	**436**	33	<0.1	**721**	0.24
AB-03S	Shallow	**6.3**	<0.5	0.97	131	0.087	**10,510**	<0.08	**378**	<0.025	0.76	**9.0**	412	0.7	**3,538**	**5.6**	0.41	**666**	118	**0.49**	**919**	0.37
AB-04BR	Bedrock	7.5	<0.5	0.48	6	<0.1	<50	<0.08	1.8	0.15	<0.5	<0.1	<50	11	17	3.9	<0.5	86	5.5	<0.1	<250	**2.4**
AB-04BRD	Bedrock	**8.9**	<0.5	0.75	5.4	<0.1	<50	<0.08	1.1	0.035	<0.5	<0.1	<50	6.6	11	**7.3**	<0.5	64	14	<0.1	143	<0.3
AB-04D	Transition Zone	**6.2**	0.21	3.4	23	<0.1	56	<0.08	3.3	**0.69**	0.72	0.094	71.4	12	**162**	**4.3**	0.64	**159**	3.0	<0.1	172	**4.2**
AB-04LOWERASH	Ash Pore Water	9	7.1	409	47	<0.1	1,015	0.14	18	0.063	<0.5	0.10	176	26	22	963	2.7	498	77	<0.1	361	2.4
AB-04S	Ash Pore Water	7.1	<0.5	101	135	<0.1	15,850	<0.08	544	0.025	0.57	0.071	10,564	76	819	16	<0.5	1476	214	<0.1	1,376	<0.3
AB-04SAP	Shallow	**5.7**	0.37	2.6	99	0.17	91	<0.08	3.9	0.52	0.88	0.67	94	**7.5**	**131**	**1.5**	1.1	**195**	3.7	**0.38**	158	**5.3**
AB-04SL	Ash Pore Water	10.8	-	-	-	-	14,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AB-05D	Transition Zone	6.6	<0.5	0.90	10	<0.1	<50	<0.08	0.88	0.43	0.71	0.095	79	4.5	6.6	**2.3**	0.67	50	4.4	<0.1	<250	**3.4**
AB-05S	Ash Pore Water	8.1	<0.5	100	224	0.11	7323	<0.08	327	<0.025	<0.5	0.11	1,002	75	1,098	26	<0.5	1,260	186	<0.1	849	0.24
AB-05SL	Ash Pore Water	10.1	6.6	57	197	<0.1	12,008	<0.08	330	<0.025	0.97	0.045	<50	217	<5	304	4.1	3475	206	0.038	1465	157
AB-06D	Transition Zone	6.6	<0.5	0.088	19	<0.1	<50	<0.08	1.4	0.31	0.43	<0.1	50	3.5	<5	1.3	<0.5	56	3.4	<0.1	<250	**3.5**
AB-06S	Ash Pore Water	6.6	0.81	3.9	209	<0.1	115	<0.08	4.7	0.085	0.70	1.1	582	12	15	4.5	2.2	124	20	<0.1	<250	3.2
AB-06SL	Ash Pore Water	6.9	<0.5	5.9	223	<0.1	507	<0.08	7.4	<0.025	0.57	<0.1	2,482	43	116	0.85	<0.5	735	<1	<0.1	<250	0.67
AB-07D	Transition Zone	6.7	<0.5	0.19	20	<0.1	<50	<0.08	4.8	0.069	0.25	0.09	153	9.3	25	1.1	<0.5	42	12.0	<0.1	<250	1.0
AB-07S	Ash Pore Water	5.1	<0.5	30	30	1.2	2,315	0.68	108	0.030	1.2	34	53,040	56	2,768	1.9	1.7	494	320	3.1	765	0.61
AB-08D	Transition Zone	**6.1**	<0.5	0.92	8.2	<0.1	<50	0.04	15.6	0.029	0.79	0.36	66	15	37	0.22	<0.5	71.6	<1	<0.1	<250	0.41
AB-08S	Ash Pore Water	5.6	0.74	2.1	125	0.32	3,871	0.51	128	0.028	0.45	12	1,254	37	165	6.9	11	467	69	4.3	401	1.4
AB-08SL	Ash Pore Water	6.8	0.22	259	335	0.11	6,733	<0.08	7.4	<0.025	1.8	0.52	56,475	45	1,030	80	0.56	1,187	6.8	0.064	376	23
AB-09BR	Bedrock	7.7	<0.5	**16**	14	<0.1	<50	<0.08	4.4	0.029	0.54	0.071	**1,024**	12	**585**	1.9	<0.5	**115**	4.8	<0.1	179	<0.3
AB-09D	Transition Zone	7.3	0.25	3.3	5.3	<0.1	72.3	<0.08	5	<0.025	0.45	0.18	289	6.6	**95**	**8.2**	<0.5	71.2	13	<0.1	205	0.22
AB-09S	Shallow	**5.2**	<0.5	0.094	52	0.11	<50	<0.08	6.2	0.066	0.46	**16**	241	0.7	**559**	<0.5	<0.5	6.8	<1	0.12	34	<0.3
CCR-01D	Transition Zone	6.9	<0.5	9.1	5.7	<0.1	11	<0.08	26	-	1.3	0.78	-	78	-	**3.8**	0.57	-	20.1	<0.1	155	-
CCR-01S	Shallow	**4.8**	<0.5	0.47	54	0.38	28	0.083	17	-	1.0	**8.7**	-	**7.3**	-	<0.5	0.30	-	<1	0.14	45	-
CCR-02D	Transition Zone	**5.2**	<0.5	1.4	16	1.2	**3,862**	0.97	237	0.060	<0.5	**7.5**	<50	72	**2,605**	<0.5	<0.5	**621**	3.0	<0.1	477	<0.3
CCR-02S	Shallow	**4.3**	<0.5	**15**	411	2.7	**6,266**	0.36	**292**	0.028	4.3	**256**	109	**9.1**	**6,350**	<0.5	15	25	36	**0.80**	**575**	<0.3
CCR-04D	Transition Zone	7.1	<0.5	1.8	49	<0.1	**6,685**	<0.08	**386**	-	1.8	1.7	-	**218**	-	**2.3**	<0.5	-	27	<0.1	**866**	-
CCR-04S	Shallow	**5.2**	<0.5	1.3	275	2.4	**7,793**	0.65	**291**	-	1.5	**9.0**	-	**12**	-	<0.5	1.8	-	46	**0.65**	**563**	-
CCR-05D	Transition Zone	**12**	-	-	-	-	55	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CCR-05S	Shallow	**5.5**	<0.5	2.3	164	0.28	**10,630**	0.1	**398**	-	<0.5	**35**	-	**3.6**	-	<0.5	2.5	-	125	**0.36**	**941**	-
CCR-06D	Transition Zone	**5.5**	<0.5	0.80	195	0.88	**10,825**	0.51	**404**	-	0.54	**15**	-	10	-	<0.5	1.4	-	110	**0.52**	**892**	-
CCR-07D	Transition Zone	6.5	<0.5	0.26	17	<0.1	**5,148**	<0.08	**317**	-	<0.5	1.1	-	59	-	<0.5	<0.5	-	32	<0.1	**761**	-

TABLE 6-5
MEANS OF GROUNDWATER COIs - JANUARY 2018 TO APRIL 2019
CORRECTIVE ACTIVE PLAN UPDATE
BELEWS CREEK STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELEWS CREEK, NC

Analytical Parameter		pH	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Chloride	Chromium (VI)	Chromium	Cobalt	Iron	Lithium	Manganese	Molybdenum	Selenium	Strontium	Sulfate	Thallium	Total Dissolved Solids	Vanadium
Reporting Units		S.U.	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/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		**6.5-8.5**	**1***	**10**	**700**	**4***	**700**	**2**	**250**	NE	**10**	**1***	**300**	NE	**50**	NE	**20**	NE	**250**	**0.2***	**500**	0.3*
2018 Background Threshold Values (Shallow Flow Zone)[1]		5.1-6.0	1	1	58	0.362	50	1	15	1.75	4.72	0.509	750	NE	22.9	**1**	0.5	**56.5**	1.93	0.2	85	1.33
2019 Background Threshold Values (Shallow Flow Zone)[2]		5.2-6.0	1	1	123	0.3	50	1	19	**4**	**11**	0.6	**1600**	**2**	40	0.5	1	46	2.043	0.2	93	**3**
2019 Background Dataset Range (Shallow Flow Zone)[2]		5.3-5.9	0.1-1.1	0.04-1	19-124	0.03-0.6	2.5-50	0.03-1.0	1.2-18.8	0.2-2.7	0.5-11.7	0.02-1.3	22-11,100	0.39-2	3-189	0.1-1.3	0.1-1.4	7.9-48	0.1-2.4	0.02-0.2	20-90	0.1-6.4
2018 Background Threshold Values (Deep Flow Zone)[1]		5.2-7.0	1	1	12.6	0.219	50	1	20.9	0.411	3.3	1.6	240	NE	13	1	0.5	68.5	6.35	0.2	148	1.45
2019 Background Threshold Values (Deep Flow Zone)[2]		5.6-7.0	1	1	16	0.1	50	0.08	19	**0.6**	3	**2**	226	**95**	**57**	**2**	0.5	**73**	8.447	0.1	134	**2**
2019 Background Dataset Range (Deep Flow Zone)[2]		5.6-7.0	0.1-1.5	0.05-1.1	0.004-0.2	0.01-0.02	11.9-58.8	0.03-0.2	2.0-20.3	0.03-0.5	0.1-5.0	0.02-1.8	13-850	2.2-52.2	2.5-104	0.1-5.3	0.2-3.7	29.3-87.8	0.5-11	0.02-0.1	25-126	0.1-1.4
2018 Background Threshold Values (Bedrock Flow Zone)[1]		6.2-8.4	0.5	0.51	6.2	0.2	50	0.08	3	0.33	5.3	0.76	228	NE	9.9	3.7	0.5	100	9.6	0.1	133	0.82
2019 Background Threshold Values (Bedrock Flow Zone)[2]		6.3-6.5	1	2	11	0.2	50	0.08	3	**0.4**	**11**	0.8	**341**	**30**	**64**	**6**	0.5	**99**	15.4	0.1	181	**2**
2019 Background Threshold Values (Bedrock Flow Zone)[2]		6.2-8.4	0.1-1.4	0.1-1.5	3.0-11	0.01-0.2	33.3-50	0.03-0.1	2.3-3.2	0.03-0.3	0.5-34.7	0.03-0.8	27-228	3.9-30	3.9-87.1	0.5-3.7	0.4-0.5	32.6-100	2.5-22.5	0.1-0.1	52-250	0.2-2.3
Sample ID	**Flow Zone**	**Mean, Geomean, or Median Result[3]**																				
At or Within the Waste Boundary Locations (Continued)																						
CCR-07S	Shallow	**4.8**	<0.5	0.13	162	3.9	84	0.26	82	-	<0.5	**16**	-	**7.4**	-	<0.5	<0.5	-	<1	**0.26**	183	-
CCR-08AD	Transition Zone	**5.6**	<0.5	0.69	204	1.1	**9,363**	1.8	**415**	-	0.70	0.81	-	29	-	<0.5	<0.5	-	84	0.17	**788**	-
CCR-08D	Transition Zone	**5.8**	<0.5	0.48	50	0.32	**10,017**	0.73	**430**	-	<0.5	**43**	-	60	-	<0.5	<0.5	-	80	0.13	**773**	-
CCR-08S	Shallow	**5.5**	<0.5	0.60	175	1.6	**9,793**	1.2	**377**	-	3.7	**18**	-	**4.8**	-	0.54	0.83	-	104	**0.45**	**746**	-
CCR-09D	Transition Zone	**6.2**	<0.5	0.17	5.1	<0.1	42	<0.08	18	-	1.1	0.14	-	16	-	0.86	0.61	-	18	<0.1	150	-
CCR-09S	Shallow	**6.0**	<0.5	<0.1	21	<0.1	289	<0.08	25	-	1.8	<0.1	-	**5.2**	-	<0.5	0.51	-	8.7	<0.1	152	-
CCR-11S	Shallow	**6.3**	<0.5	2.4	221	<0.1	6.9	<0.08	22	-	0.76	**32**	-	<2.5	-	0.66	<0.5	-	7.4	<0.1	377	-
CCR-11D	Transition Zone	**5.8**	0.5	0.25	42	0.063	4.5	0.08	16	-	0.61	0.96	-	7.6	-	1.11	0.5	-	17	0.1	250	-
CCR-12DA	Transition Zone	**9.0**	0.95	1.4	11	<0.1	4.7	<0.08	2.3	-	1.1	0.11	-	27.7	-	**6.0**	<0.5	-	21	<0.1	147	-
CCR-12S	Shallow	**5.4**	<0.5	<0.1	85	0.18	12	<0.08	2.8	-	0.68	<0.1	-	0.8	-	<0.5	<0.5	-	<1	<0.1	41	-
EXOB-01	Transition Zone	6.7	<0.5	**25**	24	<0.1	**7,845**	0.13	**381**	<0.025	4.3	**192**	**12,772**	70	**3,180**	**2.4**	<0.5	**797**	37	<0.1	**864**	<0.3
EXOB-02	Transition Zone	**5.2**	<0.5	4.9	218	1.6	**8,083**	0.69	**423**	0.043	1.0	**139**	99	11	**4,600**	<0.5	5.6	**390**	93	**0.84**	**989**	<0.3
At or Beyond the Compliance Boundary Locations																						
Upgradient or the Ash Basin																						
GWA-03D	Transition Zone	**6.1**	<0.5	0.12	22.3	<0.1	<50	<0.08	9.7	**1.0**	3.0	0.095	201	2.4	10.3	0.54	<0.5	**97.7**	<1	<0.1	94	0.79
GWA-03S	Shallow	**5.8**	<0.5	0.05	64.5	<0.1	<50	<0.08	9	0.23	1.2	0.15	104	<2.5	10.2	**1.7**	<0.5	**109**	<1	<0.1	101	0.44
GWA-06D	Transition Zone	7.0	<0.5	2.0	19.5	<0.1	<50	<0.08	4.9	<0.025	0.69	1.2	**1,570**	7.6	**514**	**5.1**	<0.5	**120**	17.3	<0.1	<250	0.24
GWA-06S	Shallow	**5.1**	<0.5	0.15	124	1.6	37.6	0.62	8.6	0.89	3.4	0.52	260	**3.6**	**250**	0.7	<0.5	34.3	14.1	**0.26**	<250	0.47
GWA-07D	Transition Zone	7.5	0.78	1.1	14.5	<0.1	<50	<0.08	23.0	**0.71**	1.1	0.056	100	26.7	<5	**8.6**	<0.5	**251**	2.2	<0.1	<250	**2.5**
GWA-07SA	Shallow	**4.8**	<0.5	<0.1	189	3.2	69.3	0.13	23.8	1.1	2.0	**12.7**	357	**4.2**	**261**	<0.5	<0.5	37.8	18.4	0.084	<250	0.68
GWA-08D	Transition Zone	6.9	<0.5	0.29	6.5	<0.1	<50	<0.08	5.5	0.059	0.63	0.10	122	13.1	37.4	**4.6**	<0.5	59.1	11.9	<0.1	126	0.81
GWA-08S	Shallow	**5.4**	<0.5	0.12	53.1	0.79	210	0.10	2.8	0.11	0.69	0.16	237	1.1	37.0	<0.5	11.2	**230**	55.9	<0.1	141	0.48
GWA-09BR	Bedrock	6.6	<0.5	0.26	<5	<0.1	223	<0.08	57.0	0.22	1.8	0.26	128	18.3	**135**	1.7	<0.5	89.3	2.4	<0.1	<250	0.72
GWA-09D	Transition Zone	**6.2**	0.30	0.25	9.8	<0.1	<50	<0.08	43.2	0.058	3.1	1.1	126	12.9	17.1	**2.7**	<0.5	**106**	4.8	<0.1	<250	0.43
GWA-09S	Shallow	**5.3**	<0.5	0.47	83.5	0.45	<50	0.075	2.5	0.22	2.0	0.59	647	**2.5**	19.1	<0.5	<0.5	6.3	<1	0.14	49.5	0.74
GWA-22D	Transition Zone	**8.9**	<0.5	0.91	16.1	<0.1	<50	<0.08	10.9	0.23	0.72	<0.1	56.6	33.6	13.5	**5.1**	0.51	**86.7**	7.7	<0.1	146	**5.3**
GWA-22S	Shallow	**5.9**	<0.5	<0.1	<5	<0.1	<50	<0.08	2.2	0.31	1.1	0.15	<50	**3.0**	5.6	<0.5	<0.5	42.2	8.4	<0.1	64.4	1.2
GWA-25BR	Bedrock	8.4	<0.5	0.67	7.3	<0.1	<50	<0.08	2.3	0.034	0.95	<0.1	54.7	4.8	9.7	**12.8**	<0.5	48.2	23.1	<0.1	134	<0.3
GWA-26BR	Bedrock	7.7	<0.5	0.60	12.9	<0.1	<50	<0.08	10.0	0.026	1.0	**2.9**	228	2.2	**104**	**11.3**	<0.5	46.2	3.8	<0.1	<250	0.71
GWA-26D	Transition Zone	**5.6**	<0.5	<0.1	41.9	0.17	<50	0.19	10.2	0.076	0.76	0.100	140	2.3	17.4	0.58	<0.5	30.3	0.77	<0.1	<250	0.17
GWA-26S	Shallow	**5.5**	<0.5	<0.1	39.3	0.14	<50	<0.08	6.5	0.057	0.54	<0.1	101	**2.6**	13.0	<0.5	<0.5	16.2	0.54	<0.1	<250	0.19
LRB-01BR	Bedrock	7.4	<0.5	0.34	5.5	<0.1	<50	<0.08	1.8	0.17	0.51	0.38	70.2	15.4	**120**	1.1	<0.5	46.1	1.4	<0.1	105	**4.1**
LRB-01D	Transition Zone	**6.4**	<0.5	0.11	20.8	<0.1	<50	<0.08	2.4	**22.3**	**15.0**	<0.1	<50	3.0	<5	<0.5	0.61	67.3	21.6	<0.1	128	**6**
LRB-01S	Shallow	**6.3**	<0.5	0.13	73.2	<0.1	<50	<0.08	1.1	**8.0**	7.9	0.44	196	1.0	23.3	0.29	<0.5	**73.1**	<1	<0.1	100	2.8
LRB-02BR	Bedrock	7.0	<0.5	0.091	4.6	<0.1	<50	<0.08	4.2	0.083	<0.5	<0.1	<50	14.5	21.1	2	<0.5	**106**	2.2	<0.1	156	1.5
LRB-02D	Transition Zone	**6.2**	<0.5	0.10	15.3	<0.1	<50	<0.08	6.2	0.14	0.73	1.4	59.4	6.8	10.1	0.88	<0.5	**149**	1.2	<0.1	135	1.1
LRB-02S	Shallow	**5.8**	<0.5	0.053	82.1	0.083	<50	<0.08	13.8	0.15	0.90	0.27	116	<2.5	**59.9**	<0.5	<0.5	**80.1**	<1	<0.1	119	0.32
MW-01	Shallow	**5.2**	-	-	20.5	0.11	<50	-	2.2	-	0.65	**1.0**	263	-	34.0	-	-	-	0.57	0.14	<25	-
MW-01D	Bedrock	6.5	-	-	3.5	0.028	<50	-	8.1	-	0.83	0.72	28.0	-	28.1	-	-	-	0.86	0.11	76.3	0.51
MW-02	Shallow	**5.9**	0.37	-	73.4	0.36	60.3	-	3.7	-	2.4	0.36	724	-	31.9	-	-	-	0.41	0.16	60.5	0.81
MW-03	Shallow	**5.6**	<0.5	0.22	54.4	0.17	<50	<0.08	7.5	1.5	4.2	0.19	127	1.8	8.0	<0.5	<0.5	34.3	1.0	<0.1	44.7	0.65
MW-04	Shallow	**5.9**	<0.5	0.10	3.9	<0.1	**746**	<0.08	2.7	**10.7**	**13.3**	0.23	432	<2.5	8.5	<0.5	15.5	**76.1**	80.7	0.10	183	2.6
MW-05	Shallow	**5.6**	-	0.59	32.3	0.22	<50	-	2.1	-	0.77	-	199	-	6.1	-	-	-	0.083	-	35.0	0.58
MW-06	Shallow	**5.7**	-	-	62.8	0.68	<50	-	7.8	-	0.28	-	54.7	-	2.4	-	-	-	<0.1	-	54.7	0.35
MW-07	Shallow	**5.5**	-	-	34.1	0.30	**1,309**	-	6.2	-	0.77	-	111	-	9.8	-	13.4	-	89.9	-	173	0.40
MW-104BRA	Bedrock	7.9	0.27	1.4	22	<0.1	<50	<0.08	3.6	0.27	**23.9**	0.57	186	4.8	38.8	**10.5**	<0.5	**291**	9.5	<0.1	135	**6.5**
MW-104D	Transition Zone	6.9	<0.5	0.12	5.6	<0.1	<50	<0.08	1.2	**0.89**	1.8	0.057	167	5.2	8.2	**2.9**	<0.5	**73.8**	1.0	<0.1	109	**4.2**
MW-104S	Shallow	**5.4**	<0.5	<0.1	67.7	0.15	<50	<0.08	0.94	1.4	3.9	0.12	139	0.9	8.4	**1.3**	<0.5	28.4	<1	<0.1	42.3	0.32
MW-203BR	Bedrock	6.7	<0.5	0.12	<5	<0.1	<50	<0.08	9.8	**0.74**	1.8	0.05	89.7	11.7	6.1	2.3	<0.5	48.6	2.1	<0.1	117	**2.7**
MW-203D	Transition Zone	6.6	<0.5	0.11	8.7	<0.1	<50	<0.08	3.6	**1.5**	1.8	<0.1	89.4	9.6	6.8	1.4	<0.5	34.7	1.0	<0.1	94.8	**3.4**
MW-203S	Shallow	**5.6**	<0.5	<0.1	48.8	0.17	<50	<0.08	1.4	0.30	1.1	<0.1	<50	0.8	<5	<0.5	<0.5	19.7	<1	<0.1	35.4	<0.3

TABLE 6-5
MEANS OF GROUNDWATER COIs - JANUARY 2018 TO APRIL 2019
CORRECTIVE ACTIVE PLAN UPDATE
BELEWS CREEK STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELEWS CREEK, NC

Analytical Parameter		pH	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Chloride	Chromium (VI)	Chromium	Cobalt	Iron	Lithium	Manganese	Molybdenum	Selenium	Strontium	Sulfate	Thallium	Total Dissolved Solids	Vanadium
Reporting Units		S.U.	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/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		**6.5-8.5**	**1***	**10**	**700**	**4***	**700**	**2**	**250**	NE	**10**	**1***	**300**	NE	**50**	NE	**20**	NE	**250**	**0.2***	**500**	0.3*
2018 Background Threshold Values (Shallow Flow Zone)[1]		5.1-6.0	1	1	58	0.362	50	1	15	1.75	4.72	0.509	750	NE	22.9	**1**	0.5	**56.5**	1.93	0.2	85	1.33
2019 Background Threshold Values (Shallow Flow Zone)[2]		5.2-6.0	1	1	123	0.3	50	1	19	**4**	**11**	0.6	**1600**	**2**	40	0.5	1	46	2.043	0.2	93	**3**
2019 Background Dataset Range (Shallow Flow Zone)[2]		5.3-5.9	0.1-1.1	0.04-1	19-124	0.03-0.6	2.5-50	0.03-1.0	1.2-18.8	0.2-2.7	0.5-11.7	0.02-1.3	22-11,100	0.39-2	3-189	0.1-1.3	0.1-1.4	7.9-48	0.1-2.4	0.02-0.2	20-90	0.1-6.4
2018 Background Threshold Values (Deep Flow Zone)[1]		5.2-7.0	1	1	12.6	0.219	50	1	20.9	0.411	3.3	1.6	240	NE	13	1	0.5	68.5	6.35	0.2	148	1.45
2019 Background Threshold Values (Deep Flow Zone)[2]		5.6-7.0	1	1	16	0.1	50	0.08	19	**0.6**	3	**2**	226	**95**	**57**	**2**	0.5	**73**	8.447	0.1	134	**2**
2019 Background Dataset Range (Deep Flow Zone)[2]		5.6-7.0	0.1-1.5	0.05-1.1	0.004-0.2	0.01-0.02	11.9-58.8	0.03-0.2	2.0-20.3	0.03-0.5	0.1-5.0	0.02-1.8	13-850	2.2-52.2	2.5-104	0.1-5.3	0.2-3.7	29.3-87.8	0.5-11	0.02-0.1	25-126	0.1-1.4
2018 Background Threshold Values (Bedrock Flow Zone)[1]		6.2-8.4	0.5	0.51	6.2	0.2	50	0.08	3	0.33	5.3	0.76	228	NE	9.9	3.7	0.5	100	9.6	0.1	133	0.82
2019 Background Threshold Values (Bedrock Flow Zone)[2]		6.3-6.5	1	2	11	0.2	50	0.08	3	**0.4**	**11**	0.8	**341**	**30**	**64**	**6**	0.5	**99**	15.4	0.1	181	**2**
2019 Background Threshold Values (Bedrock Flow Zone)[2]		6.2-8.4	0.1-1.4	0.1-1.5	3.0-11	0.01-0.2	33.3-50	0.03-0.1	2.3-3.2	0.03-0.3	0.5-34.7	0.03-0.8	27-228	3.9-30	3.9-87.1	0.5-3.7	0.4-0.5	32.6-100	2.5-22.5	0.1-0.1	52-250	0.2-2.3
Sample ID	**Flow Zone**	**Mean, Geomean, or Median Result[3]**																				
Upgradient or the Ash Basin (Continued)																						
MW2-07	Transition Zone	**5.2**	-	0.33	19.7	2.35	**13,600**	0.59	10.1	-	0.22	0.44	18.8	-	**298**	-	**120**	-	**681**	-	**1,123**	0.46
MW2-09	Transition Zone	**6.1**	-	0.35	59.4	0.023	292	-	3.5	-	1.6	1.0	**564**	-	**288**	-	0.60	-	32.1	0.10	141	0.80
OB-05	Shallow	**5.3**	-	0.51	113	0.52	<50	-	3.8	-	1.3	0.32	687	-	34.7	-	-	-	0.079	0.12	<25	1.3
OB-09	Transition Zone	**5.1**	-	0.71	13.6	2.0	**26,233**	1.7	9.9	-	1.1	0.36	26.8	-	**1,079**	-	**277**	-	**955**	-	**1,493**	0.54
Downgradient of the Ash Basin																						
CCR-13BR	Bedrock	7.6	0.41	1.7	10	<0.1	<50	<0.08	22	0.21	2.5	0.18	107	**30**	31	**9.4**	<0.5	**133**	87	<0.1	300	1.5
CCR-13D	Transition Zone	**6.0**	<0.5	0.72	13	0.13	<50	<0.08	14	<0.025	0.58	**2.8**	70	4.8	**92**	0.20	<0.5	52	13	0.077	73	<0.3
CCR-13S	Shallow	**5.6**	<0.5	0.12	14	0.23	<50	<0.08	13	0.074	<0.5	0.78	134	**4.2**	34	<0.5	<0.5	44	0.78	0.076	54	0.33
GWA-01BR	Bedrock	**10.0**	0.26	0.34	5.9	<0.1	<50	<0.08	2.4	<0.025	2.4	0.15	153	**64**	9.1	**7.3**	<0.5	75	6.4	<0.1	110	0.28
GWA-01D	Transition Zone	**6.1**	0.70	0.99	9.7	<0.1	<50	<0.08	89	0.040	4.8	**9.0**	198	36	40	**6.4**	<0.5	**120**	4.2	0.053	233	0.63
GWA-01S	Shallow	**4.7**	0.44	0.22	192	**4.5**	633	0.16	55	0.17	0.87	**3.7**	186	**11**	**131**	0.4	0.4	**68**	0.99	**0.25**	102	0.25
GWA-02D	Transition Zone	**6.2**	<0.5	3.3	<5	0.072	<50	<0.08	1.8	0.16	2.4	0.31	73.5	29	12	0.62	<0.5	24	0.82	<0.1	55	0.30
GWA-02S	Shallow	**5.3**	<0.5	0.69	17	0.21	<50	<0.08	1.5	0.078	0.63	0.33	553	**4.7**	16	<0.5	<0.5	3.2	<1	0.082	<25	0.29
GWA-10DA	Transition Zone	7.7	<0.5	2.4	10	<0.1	<50	<0.08	8.4	0.22	1.1	0.24	243	45	12	0.33	<0.5	45	9.0	<0.1	128	0.63
GWA-10S	Shallow	**4.0**	<0.5	5.5	583	0.91	327	0.45	116	0.026	1.2	**14**	153	**5.0**	**2,753**	<0.5	3.3	**90**	46	<1	**0.24**	200	0.32
GWA-11D	Transition Zone	**6.0**	<0.5	3.0	17	0.56	419	<0.08	**251**	<0.025	4.6	**3.4**	**3,743**	**117**	**153**	0.56	<0.5	**538**	4.2	<0.1	**553**	0.38
GWA-11S	Shallow	**4.6**	<0.5	1.9	547	**11**	**1,338**	0.81	203	0.032	2.4	**10**	377	**33**	**162**	<0.5	1.4	**432**	<1	**0.38**	415	0.44
GWA-16BR	Bedrock	**9.6**	0.91	1.7	8.1	<0.1	<50	<0.08	0.95	0.079	0.64	<0.1	50	17	<5	1.6	<0.5	**136**	14	<0.1	130	0.54
GWA-16DA	Transition Zone	6.5	<0.5	0.11	5.7	<0.1	<50	<0.08	0.99	0.051	0.80	0.92	**1,972**	4.3	19	0.63	<0.5	42	8.5	<0.1	<250	<0.3
GWA-16S	Shallow	**5.0**	<0.5	<0.1	38	0.10	<50	<0.08	0.78	0.25	0.58	**1.2**	65	2.0	**50**	<0.5	<0.5	7.1	<1	<0.1	34	<0.3
GWA-17D	Transition Zone	6.9	<0.5	0.11	8.1	<0.1	51	<0.08	1.1	<0.025	1.3	0.31	**2,090**	1.0	43	0.47	<0.5	41	12	<0.1	100	0.34
GWA-17S	Shallow	**5.3**	<0.5	0.12	52	<0.1	55	0.079	1.1	0.037	0.66	**11**	237	**2.4**	**167**	<0.5	<0.5	10	19	<0.1	52	0.33
GWA-18D	Transition Zone	**6.4**	<0.5	0.56	<5	<0.1	<50	<0.08	21	**1.4**	1.7	0.12	<50	12	30	0.86	<0.5	62	6.4	<0.1	<250	0.49
GWA-18SA	Shallow	**4.4**	<0.5	2.6	644	**5.9**	693	0.94	145	0.026	1.1	**89**	188	**36**	**1,937**	<0.5	1.3	**138**	<1	**1.2**	<250	<0.3
GWA-19BR	Bedrock	**10.4**	0.77	0.32	7.9	<0.1	<50	<0.08	1.3	0.10	1.1	<0.1	53	**57**	<5	2.3	<0.5	51	14	<0.1	136	0.19
GWA-19D	Transition Zone	7.2	<0.5	**15**	6.3	<0.1	<50	<0.08	3.6	0.043	<0.5	0.33	**2,449**	60	**87**	1.2	<0.5	**80**	13	<0.1	<250	0.20
GWA-19SA	Shallow	**4.7**	<0.5	6.1	686	**9.5**	**2,225**	0.82	191	0.030	1.2	**48**	137	**20**	**2,033**	<0.5	5.9	**153**	<1	**0.48**	331	<0.3
GWA-20BR	Bedrock	**9.6**	0.67	**30**	<5	<0.1	63	<0.08	27	0.047	1.7	<0.1	92	**93**	6.6	**50**	<0.5	55	15	<0.1	<250	0.43
GWA-20D	Transition Zone	**5.2**	<0.5	4.1	42	1.5	**9,690**	1.9	**425**	0.030	1.1	**2.9**	54	63	**1,987**	<0.5	<0.5	**863**	68	0.2	**885**	<0.3
GWA-20SA	Shallow	**5.1**	<0.5	3.0	198	**5.8**	**11,176**	1.1	**415**	0.050	0.92	**17**	148	**18**	**5,000**	<0.5	0.70	**494**	87	**0.44**	**919**	<0.3
GWA-21D	Transition Zone	**5.1**	0.5	0.23	220	**5.0**	**507**	0.96	**238**	0.03	0.68	0.9	47	17	48	0.5	0.45	**643**	1	**0.29**	468	0.23
GWA-21S	Shallow	**4.7**	<0.5	1.8	400	**9.9**	364	0.7	137	0.036	1.1	**20**	101	**15**	**208**	<0.5	1.3	**194**	1.9	**0.27**	247	<0.3
GWA-24BR	Bedrock	7.7	<0.5	2.3	<5	<0.1	<50	<0.08	2.0	0.034	2.1	0.17	227	29	15	3.7	<0.5	**108**	5.3	<0.1	144	0.35
GWA-24D	Transition Zone	**5.4**	0.58	<0.1	9.5	0.16	<50	0.089	56	0.16	4.0	0.22	105	1.8	13	0.59	<0.5	**110**	1.6	<0.1	157	<0.3
GWA-24S	Shallow	**5.8**	-	-	-	-	<50	-	-	-	-	-	-	-	-	-	-	-	1.1	-	105	-
GWA-27BR	Bedrock	**11.5**	-	-	-	-	<50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GWA-27D	Transition Zone	**5.1**	<0.5	2.5	91	3.2	**7,663**	1.9	**431**	0.079	0.72	**9.6**	<50	58	**2,810**	0.4	0.42	**833**	23	**0.37**	**834**	<0.3
GWA-27S	Shallow	**4.6**	<0.5	2.4	111	1.6	533	0.25	47	0.035	1.3	**41**	228	**13**	**884**	<0.5	1.3	38	4.1	**0.25**	154	<0.3
GWA-30D	Transition Zone	7.4	<0.5	1.3	31	<0.1	<50	<0.08	4.3	0.14	<0.5	0.087	<50	25	**70**	**3.2**	<0.5	70	1.0	<0.1	116	0.58
GWA-30S	Shallow	**5.1**	<0.5	0.34	18	0.54	<50	<0.08	5.2	0.042	<0.5	**1.4**	58	**7.9**	19	<0.5	<0.5	35	<1	<0.1	46	<0.3
GWA-31D	Transition Zone	7.4	<0.5	0.28	4.2	0.16	<50	<0.08	2.3	<0.025	0.73	<0.1	**819**	26.2	33	0.34	<0.5	54	5.5	<0.1	104	<0.3
GWA-31S	Shallow	**5.5**	<0.5	0.23	17	0.37	<50	<0.08	2.7	0.057	1.1	0.19	304	**2.3**	9.7	<0.5	<0.5	13	<1	<0.1	31	0.40
GWA-32D	Transition Zone	8.0	0.56	0.49	9.7	<0.1	42	<0.08	71	0.073	0.80	0.050	**1,004**	64	**213**	1.4	<0.5	**145**	48	<0.1	356	<0.3
GWA-32S	Shallow	**6.3**	<0.5	**53**	27	0.24	87	<0.08	50	0.034	1.2	**58**	**34,820**	1	**9,180**	0.67	<0.5	6.4	<1	**0.70**	128	<0.3
MW-200BR	Bedrock	7.3	<0.5	1.3	<5	0.21	156	<0.08	62	<0.025	<0.5	0.08	237	**42**	**132**	0.43	<0.5	**191**	6.5	<0.1	273	<0.3
MW-200D	Transition Zone	**6.1**	<0.5	0.79	<5	0.077	159	<0.08	39	0.10	0.54	0.064	56	13	13	0.29	<0.5	**113**	3.2	<0.1	156	<0.3
MW-200S	Shallow	**5.6**	<0.5	1.6	48	0.32	62	<0.08	26	0.063	1.3	**4.0**	953	1.7	**123**	<0.5	<0.5	55	6.4	<0.1	107	0.67
MW-201BR	Bedrock	7.6	0.54	0.46	<5	<0.1	<50	<0.08	5.0	0.080	0.85	0.054	63	14	44	**11**	<0.5	40	8.1	<0.1	127	0.32
MW-201D	Transition Zone	**6.1**	<0.5	0.064	<5	<0.1	<50	<0.08	4.9	**3.1**	4.0	0.043	64	4.5	6.4	0.47	<0.5	62	1.1	<0.1	99	1.3
MW-204D	Transition Zone	**5.6**	<0.5	<0.1	45	<0.1	<50	<0.08	1.9	0.098	<0.5	**26**	104	1.8	38	<0.5	<0.5	15	4.9	0.068	<250	0.39
MW-204S	Shallow	**5.6**	<0.5	0.17	253	0.069	<50	0.15	2.9	<0.025	0.68	**14**	**4,621**	**2.6**	**503**	<0.5	<0.5	21	2.4	0.12	<250	0.43

TABLE 6-5
MEANS OF GROUNDWATER COIs - JANUARY 2018 TO APRIL 2019
CORRECTIVE ACTIVE PLAN UPDATE
BELEWS CREEK STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELEWS CREEK, NC

Analytical Parameter		pH	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Chloride	Chromium (VI)	Chromium	Cobalt	Iron	Lithium	Manganese	Molybdenum	Selenium	Strontium	Sulfate	Thallium	Total Dissolved Solids	Vanadium
Reporting Units		S.U.	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/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		**6.5-8.5**	**1***	**10**	**700**	**4***	**700**	**2**	**250**	NE	**10**	**1***	**300**	NE	**50**	NE	**20**	NE	**250**	**0.2***	**500**	0.3*
2018 Background Threshold Values (Shallow Flow Zone)[1]		5.1-6.0	1	1	58	0.362	50	1	15	1.75	4.72	0.509	750	NE	22.9	**1**	0.5	**56.5**	1.93	0.2	85	1.33
2019 Background Threshold Values (Shallow Flow Zone)[2]		5.2-6.0	1	1	123	0.3	50	1	19	**4**	**11**	0.6	**1600**	**2**	40	0.5	1	46	2.043	0.2	93	**3**
2019 Background Dataset Range (Shallow Flow Zone)[2]		5.3-5.9	0.1-1.1	0.04-1	19-124	0.03-0.6	2.5-50	0.03-1.0	1.2-18.8	0.2-2.7	0.5-11.7	0.02-1.3	22-11,100	0.39-2	3-189	0.1-1.3	0.1-1.4	7.9-48	0.1-2.4	0.02-0.2	20-90	0.1-6.4
2018 Background Threshold Values (Deep Flow Zone)[1]		5.2-7.0	1	1	12.6	0.219	50	1	20.9	0.411	3.3	1.6	240	NE	13	1	0.5	68.5	6.35	0.2	148	1.45
2019 Background Threshold Values (Deep Flow Zone)[2]		5.6-7.0	1	1	16	0.1	50	0.08	19	**0.6**	3	**2**	226	**95**	**57**	**2**	0.5	**73**	8.447	0.1	134	**2**
2019 Background Dataset Range (Deep Flow Zone)[2]		5.6-7.0	0.1-1.5	0.05-1.1	0.004-0.2	0.01-0.02	11.9-58.8	0.03-0.2	2.0-20.3	0.03-0.5	0.1-5.0	0.02-1.8	13-850	2.2-52.2	2.5-104	0.1-5.3	0.2-3.7	29.3-87.8	0.5-11	0.02-0.1	25-126	0.1-1.4
2018 Background Threshold Values (Bedrock Flow Zone)[1]		6.2-8.4	0.5	0.51	6.2	0.2	50	0.08	3	0.33	5.3	0.76	228	NE	9.9	3.7	0.5	100	9.6	0.1	133	0.82
2019 Background Threshold Values (Bedrock Flow Zone)[2]		6.3-6.5	1	2	11	0.2	50	0.08	3	**0.4**	**11**	0.8	**341**	**30**	**64**	**6**	0.5	**99**	15.4	0.1	181	**2**
2019 Background Threshold Values (Bedrock Flow Zone)[2]		6.2-8.4	0.1-1.4	0.1-1.5	3.0-11	0.01-0.2	33.3-50	0.03-0.1	2.3-3.2	0.03-0.3	0.5-34.7	0.03-0.8	27-228	3.9-30	3.9-87.1	0.5-3.7	0.4-0.5	32.6-100	2.5-22.5	0.1-0.1	52-250	0.2-2.3
Sample ID	**Flow Zone**	**Mean, Geomean, or Median Result[3]**																				
IMP Extraction System																						
EX-01	Transition Zone	**5.3**	**1.1**	2.8	102	**4.3**	**9,877**	1.6	**412**	0.071	1.9	**10**	121	38	**3,940**	0.30	<0.5	**853**	69	**0.37**	**893**	<0.3
EX-02	Transition Zone	**5.0**	<0.5	3.0	146	**7.1**	**10,157**	1.5	**538**	0.18	4.5	**17**	<50	24	**3,843**	0.30	0.71	**592**	116	**0.37**	**922**	<0.3
EX-03	Transition Zone	**5.2**	<0.5	3.2	210	2.7	**9,663**	0.48	**540**	0.078	0.55	**43**	28	12	**4,523**	0.22	1.3	**507**	112	**0.63**	**958**	<0.3
EX-04	Transition Zone	**5.2**	<0.5	2.5	259	1.9	**9,897**	0.47	**461**	0.13	0.69	**81**	26	13	**6,073**	0.22	1.3	**475**	76	**0.60**	**998**	<0.3
EX-05	Transition Zone	**5.3**	<0.5	3.0	229	0.86	**10,083**	0.37	**450**	0.069	0.82	**100**	36	10	**5,060**	0.14	1.9	**492**	118	**0.74**	**980**	<0.3
EX-06	Transition Zone	**5.5**	<0.5	1.1	278	1.2	**9,983**	0.84	**463**	0.078	0.97	**124**	<50	16	**7,313**	<0.5	0.73	**709**	74	**0.86**	**984**	<0.3
EX-07	Transition Zone	**5.3**	<0.5	1.7	192	1.5	**6,140**	0.86	**329**	0.069	1.0	**57**	86	32	**3,510**	0.12	0.36	**711**	24	**0.59**	**705**	<0.3
EX-08	Transition Zone	**5.2**	<0.5	0.63	371	1.8	**2,790**	0.80	235	0.100	<0.5	**9.7**	<50	24	**1,570**	<0.5	<0.5	**534**	1.9	**0.76**	464	<0.3
EX-09	Transition Zone	**5.1**	-	0.97	471	2.4	**2,600**	1.1	**285**	0.073	-	**7.0**	153	43	**1,365**	-	-	**795**	0.97	**0.56**	**595**	<0.3
EX-10	Transition Zone	**5.6**	<0.5	1.0	7.5	1.3	**3,970**	0.38	**264**	0.038	4.3	**7.3**	31	**125**	**1,450**	0.29	<0.5	**553**	3.3	0.095	**569**	<0.3

Prepared by: ALA/LWD Checked by: DAA/MCR

Notes:

[1] - Background threshold values were calculated using data from background groundwater samples collected June 2015 to April 2017

[2] - Background threshold values were calculated using data from background groundwater samples collected October 2010 to December 2018 and sumbmitted to NCDEQ June 2019

[3] - Statistical mean, geomean, or median calculated from data ranging from January 2018 to April 2019. Ash pore water results are not compared to groundwater standards or criteria.

[4] - Background groundwater results are not compared to compartive criteria. Background concentrations greater than background threshold values are within background dataset ranges or piedmont setting background ranges. Groundwater flow directions across the Site indicate all approved background locations are representative of naturally occuring conditions.

Mean or geomean results were used based on the central tendency of the data set. Median results were used for total radium only.

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 applicable regulatory standarad (02L or IMAC)

- 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 within range of background threshold values for constituents where there is no regulatory standard, or background threshold values are greater than 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

S.U. Standard unit

TABLE 6-6
COI MANAGEMENT MATRIX
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
DUKE ENERGY CAROLINA, LLC, BELEWS CREEK, NC

Constituents of Interest (2017 CSA Update)	Reporting Unit	02L or IMAC Criterion	Groundwater Zone Statistically Derived Background Threshold Value[2,3]			Belews Creek Steam Station Flow Zone Background Dataset Range	Belews Creek Steam Station Background Dataset Range	Piedmont Background Value Range	Maximum Mean Concentration at or Beyond Compliance Boundary	Groundwater Exceedance Ratio[4]	Number of Wells Greater Than Comparative Criteria At 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 Provence Background Range	Downgradient of Source Area at Concentrations Greater than Criteria	Geochemical Mobility[5]	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 area, no corrective action is warranted)
			Flow Zone	2018	2019														
Constituent Standards and Values - 02L Criterion													Lines of Evidence (LOE) - 02L Criterion						Rationale - 02L Criterion
Arsenic	µg/L	10	Shallow	1	1	0.04-1.5	0.04 - 1.5	0.1 - 6.35	52.54	5.25	1	GWA-32S	Y	9	9	1	Y	Non-Conservative	Single location with mean greater than 02L at or beyond the compliance boundary. Does not exhibit a discernable plume and is not within the 02L boron plume footprint. Location is adjacent to a wetland; reducing conditions may enhance constituent solubility. No means of constituent greater than 02L in deep flow zone at this location.
			Transition Zone	1	1				14.56	1.46	1	GWA-19D		7	6	1	Y		Single location with mean greater than background value at or beyond the compliance boundary. Does not exhibit a discernable plume but is within the 02L boron plume footprint.
			Bedrock	1	2				30.42	3.04	1	GWA-20BR*		3	3	1	Y		Single location with mean greater than background value at or beyond the compliance boundary. Does not exhibit a discernable plume but is within the 02L boron plume. Bedrock location exhibits slightly alkaline pH conditions which may enhance constituent solubility.
Barium	µg/L	700	Shallow	58	123	0.004-124	0.004 - 124	11 - 840	685.50	0.98	0		N	6	6	0	N	Non-Conservative	No means greater than 02L at or beyond the compliance boundary. Does not warrant corrective action.
			Transition Zone	13	16				220.83	0.32	0			15	0	0	N		No means greater than 02L at or beyond the compliance boundary. Does not warrant corrective action.
			Bedrock	6	11				10.35	0.01	0			0	0	0	N		No means greater than 02L at or beyond the compliance boundary. Does not warrant corrective action.
Boron	µg/L	700	Shallow Zone	50	50	2.5-58.8	2.5 - 58.8	49.09 - 176.8	11176	15.97	4	GWS-1S, GWA-11S, GWA-19SA, GWA-20SA	Y	9	9	7	Y	Conservative	Mulitple locations with means greater than 02L at or beyond the compliance boundary and which exhibit a discernable plume.
			Transition Zone	50	50				9690	13.84	2	GWA-20D, GWA-27D		4	4	3	Y		Mulitple locations with means greater than 02L at or beyond the compliance boundary and which exhibit a discernable plume.
			Bedrock Zone	50	50				156	0.22	0			2	2	0	N		No means greater than 02L at or beyond the compliance boundary, however, flow and transport modeling predicts 02L plume migration at or beyond the compliance boundary.
Cadmium	µg/L	2	Shallow Zone	1	1	0.03-1.0	0.03 - 1.0	0.08 - 1	1.10	0.55	0		N	1	1	1	N	Non-Conservative	No means greater than 02L at or beyond the compliance boundary. Does not warrant corrective action.
			Transition Zone	1	0.08				1.92	0.96	0			2	2	2	N		No means greater than 02L at or beyond the compliance boundary. Does not warrant corrective action.
			Bedrock Zone	0.8	0.08				<0.08	NA	0			0	0	0	N		No means greater than 02L at or beyond the compliance boundary. Does not warrant corrective action.
Chloride	mg/L	250	Shallow Zone	15	19	1.2-20.3	1.2 - 20.3	3 - 250	415	1.66	1	GWA-20SA	Y	9	9	1	Y	Conservative	Single location with mean greater than background value at or beyond the compliance boundary. Does not exhibit a discernable plume but is within the 02L boron plume footprint.
			Transition Zone	21	19				431	1.72	3	GWA-11D, GWA-20D, GWA-27D		8	8	3	Y		Mulitple locations with means greater than 02L at or beyond the compliance boundary and which exhibit a discernable plume.
			Bedrock Zone	3	3				62	0.25	0			4	3	0	N		No means greater than 02L at or beyond the compliance boundary, however, flow and transport modeling predicts 02L plume migration at or beyond the compliance boundary.
Chromium (Total)	µg/L	10	Shallow Zone	5	11	0.1-34.7	0.1 - 34.7	1 - 26	2	0.22	0		N	0	0	0	N	Non-Conservative	No means greater than background value at or beyond the compliance boundary. Does not warrant corrective action.
			Transition Zone	3	3				5	0.48	0			0	0	0	N		No means greater than 02L at or beyond the compliance boundary. Does not warrant corrective action.
			Bedrock Zone	5	11				2	0.22	0			0	0	0	N		No means greater than background value at or beyond the compliance boundary. Does not warrant corrective action.
Iron	µg/L	300 (Deep Flow Zone only)	Shallow Zone	750	1600	13-11,100	13 - 11,100	56.3 - 37,500	34820	21.76	1	GWA-32S	Y	1	1	0	Y	Variable	Single location with mean greater than background value at or beyond the compliance boundary. Does not exhibit a discernable plume and is not within the 02L boron plume footprint. Location is adjacent to a wetland; reducing conditions may enhance constituent solubility.
			Transition Zone	24	226				3743	12.48	4	GWA-11D, GWA-19D, GWA-31D, GWA-32D		3	0	0	Y		Mulitple locations with means greater than 02L at or beyond the compliance boundary and which exhibit a discernable plume.
			Bedrock Zone	228	341				237	0.70	0			1	0	0	N		No means greater than background value at or beyond the compliance boundary. Does not warrant corrective action.
Manganese	µg/L	50 (Shallow Flow Zone only)	Shallow Zone	23	40	2.5-189	2.5 - 189	7 - 9,170	9180	183.60	12	GWA-01S, GWA-10S, GWA-11S, GWA-16S, GWA17S, GWA-19SA, GWA-20SA, GWA-21S, GWA-27S, GWA-32S, MW-200S, MW-204S	Y	7	7	1	Y	Variable	Mulitple locations with means greater than 02L at or beyond the compliance boundary and which exhibit a discernable plume.
			Transition Zone	13	57				2810	49.30	7	CCR-13D, GWA-11D, GWA-19D, GWA-20D, GWA-27D, GWA-30D, GWA-32D		4	3	0	Y		Mulitple locations with means greater than background value at or beyond the compliance boundary and which exhibit a discernable plume.
			Bedrock Zone	10	64				132	2.06	1	MW-200BR		1	0	0	Y		Single location with mean greater than background value at or beyond the compliance boundary. Does not exhibit a discernable plume but is within the predicted 02L boron plume footprint.
Selenium	µg/L	20	Shallow Zone	0.5	1	0.1-3.7	0.1 - 3.7	0.5 - 2	6	0.30	0		N	3	1	2	N	Variable	No means greater than 02L at or beyond the compliance boundary. Does not warrant corrective action.
			Transition Zone	0.5	0.5				0	0.02	0			0	0	0	N		No means greater than 02L at or beyond the compliance boundary. Does not warrant corrective action.
			Bedrock Zone	0.5	0.5				<0.5	NA	0			0	0	0	N		No means greater than 02L at or beyond the compliance boundary. Does not warrant corrective action.

TABLE 6-6
COI MANAGEMENT MATRIX
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
DUKE ENERGY CAROLINA, LLC, BELEWS CREEK, NC

Constituents of Interest (2017 CSA Update)	Reporting Unit	02L or IMAC Criterion	Groundwater Zone Statistically Derived Background Threshold Value[2,3] Flow Zone	2018	2019	Belews Creek Steam Station Flow Zone Background Dataset Range	Belews Creek Steam Station Background Dataset Range	Piedmont Background Value Range	Maximum Mean Concentration at or Beyond Compliance Boundary	Groundwater Exceedance Ratio[4]	Number of Wells Greater Than Comparative Criteria At 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 Provence Background Range	Downgradient of Source Area at Concentrations Greater than Criteria	Geochemical Mobility[5]	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 area, no corrective action is warranted)
Sulfate	mg/L	250	Shallow Zone	2	2	0.1-22.5	0.1 - 22.5	1.2 - 510	87	0.35	0		Y	3	1	0	N	Variable	No means greater than 02L at or beyond the compliance boundary. Does not warrant corrective action.
			Transition Zone	6	8				68	0.27	0			5	3	0	N		No means greater than 02L at or beyond the compliance boundary. Does not warrant corrective action.
			Bedrock Zone	10	15				87	0.35	0			1	1	0	N		No means greater than 02L at or beyond the compliance boundary. Does not warrant corrective action.
Total Dissolved Solids	mg/L	500	Shallow Zone	85	93	20-250	20 - 250	50 - 1,200	919	1.84	1	GWA-20SA	Y	10	3	0	Y	Conservative	Single location with mean greater than background value at or beyond the compliance boundary. Does not exhibit a discernable plume but is within the 02L boron plume footprint.
			Transition Zone	148	134				885	1.77	3	GWA-11D, GWA-20D, GWA-27D		10	4	0	Y		Mulitple locations with means greater than 02L at or beyond the compliance boundary and which exhibit a discernable plume.
			Bedrock Zone	133	181				300	0.60	0			2	2	0	N		No means greater than 02L at or beyond the compliance boundary, however, flow and transport modeling predicts 02L plume migration at or beyond the compliance boundary.
Constituent Standards and Values - IMAC Criterion													**Lines of Evidence (LOE) - IMAC Criterion**						**Rationale - IMAC Criterion**
Antimony	µg/L	1	Shallow Zone	1	1	0.1-1.5	0.1 - 1.5	0.5 - 4.247	<0.5	NA	0		Y	0	0	0	N	Conservative	No means greater than IMAC value at or beyond the compliance boundary. Does not warrant corrective action.
			Transition Zone	1	1				1	0.70	0			1	0	0	N		No means greater than IMAC value at or beyond the compliance boundary. Does not warrant corrective action.
			Bedrock Zone	1	1				1	0.77	0			1	0	0	N		No means greater than IMAC value at or beyond the compliance boundary. Does not warrant corrective action.
Beryllium	µg/L	4	Shallow Zone	0.4	0.3	0.01-0.6	0.01 - 0.6	0.053 - 1	11	2.74	5	GWA-01S, GWA-11S, GWA-19SA, GWA-20SA, GWA-21S	N	0	0	0	Y	Non-Conservative	Mulitple locations with means greater IMAC value at or beyond the compliance boundary and which exhibit a discernable plume.
			Transition Zone	0.2	0.1				5	1.24	1	GWA-21D		0	0	0	Y		Single location with mean greater than background value at or beyond the compliance boundary. Does not exhibit a discernable plume but is within the 02L boron plume footprint.
			Bedrock Zone	0.2	0.2				0	0.05	0			0	0	0	N		No means greater than IMAC value at or beyond the compliance boundary. Does not warrant corrective action.
Cobalt	µg/L	1	Shallow Zone	0.5	0.6	0.02-1.8	0.02 - 1.8	0.2 - 88.85	58	58.00	13	GWA-01S, GWA-10S, GWA-11S, GWA-16S, GWA-17S, GWA-19SA, GWA-20SA, GWA-21S, GWA-27S, GWA-30S, GWA-32S, MW-200S, MW-204S	Y	18	6	0	Y	Variable	Mulitple locations with means greater than IMAC value at or beyond the compliance boundary and which exhibit a discernable plume.
			Transition Zone	2	2				25	12.30	6	CCR-13D, GWA-01D, GWA-11D, GWA-20D, GWA-27D, MW-204D		5	0	0	Y		Mulitple locations with means greater than background value at or beyond the compliance boundary and which exhibit a discernable plume.
			Bedrock Zone	0.8	0.8				0	0.18	0			0	0	0	N		No means greater than IMAC value at or beyond the compliance boundary. Does not warrant corrective action.
Thallium	µg/L	0.2	Shallow Zone	0.2	0.2	0.02-0.2	0.02 - 0.1	0.1 - 0.2	0.7	3.48	8	GWA-01S, GWA-10S, GWA-11S, GWA-19SA, GWA-20SA, GWA-21S, GWA-27S, GWA-32S	Y	0	0	0	Y	Variable	Mulitple locations with means greater than IMAC value at or beyond the compliance boundary and which exhibit a discernable plume.
			Transition Zone	0.2	0.1				0.4	1.87	2	GWA-21D, GWA-27D		0	0	0	Y		Mulitple locations with means greater than IMAC value at or beyond the compliance boundary and which exhibit a discernable plume.
			Bedrock Zone	0.1	0.1				<0.1	NA	0			0	0	0	N		No means greater than IMAC value at or beyond the compliance boundary. Does not warrant corrective action.
Vanadium	µg/L	0.3	Shallow Zone	1	3	0.1-6.4	0.1 - 6.4	0.38 - 26	0.7	0.22	0		Y	0	0	0	N	Non-Conservative	No means greater than background value at or beyond the compliance boundary. Does not warrant corrective action.
			Transition Zone	1	2				1.3	0.63	0			0	0	0	N		No means greater than background value at or beyond the compliance boundary. Does not warrant corrective action.
			Bedrock Zone	1	2				1.5	0.75	0			0	0	0	N		No means greater than background value at or beyond the compliance boundary. Does not warrant corrective action.
Constituent Standards and Values - Background Criterion													**Lines of Evidence (LOE) - Background Criterion**						**Rationale - Background Criterion**
Chromium (Hexavalent)	µg/L	NE	Shallow Zone	2	4	0.03-2.7	0.03 - 2.7	0.03 - 12	0.2	0.04	0		N	5	5	0	N	Variable	No means greater than background value at or beyond the compliance boundary. Does not warrant corrective action.
			Transition Zone	0.4	0.6				3.1	5.13	1	MW-201D		7	2	0	Y		Single location with mean greater than background value at or beyond the compliance boundary. Does not exhibit a discernable plume and is not within the 02L boron plume footprint.
			Bedrock Zone	0.3	0.4				0.2	0.52	0			2	0	0	N		No means greater than background value at or beyond the compliance boundary. Does not warrant corrective action.

TABLE 6-6
COI MANAGEMENT MATRIX
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
DUKE ENERGY CAROLINA, LLC, BELEWS CREEK, NC

Constituents of Interest (2017 CSA Update)	Reporting Unit	02L or IMAC Criterion	Groundwater Zone Statistically Derived Background Threshold Value[2,3]			Belews Creek Steam Station Flow Zone Background Dataset Range	Belews Creek Steam Station Background Dataset Range	Piedmont Background Value Range	Maximum Mean Concentration at or Beyond Compliance Boundary	Groundwater Exceedance Ratio[4]	Number of Wells Greater Than Comparative Criteria At 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 Provence Background Range	Downgradient of Source Area at Concentrations Greater than Criteria	Geochemical Mobility[5]	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 area, no corrective action is warranted)
			Flow Zone	2018	2019														
			Shallow Zone	NE	2				33	16.71	14	CCR-9S, CCR-13S, GWA-1S, GWA-10S, GWA-11S, GWA-16S, GWA-17S, GWA-19SA, GWA-20SA, GWA-21S, GWA-27S, GWA-30S, GWA-31S, MW-204S		11	0	0	Y		Mulitple locations with means greater than background value at or beyond the compliance boundary and which exhibit a discernable plume.
Lithium	mg/L	NE	Transition Zone	NE	95	2 - 95	2 - 95	2 - 95.39	117	1.23	1	GWA-11D	Y	1	1	0	Y	Conservative	Single location with mean greater than background value at or beyond the compliance boundary. Does not exhibit a discernable plume but is within the 02L boron plume footprint.
			Bedrock Zone	NE	30				93	3.09	5	CCR-13BR, GWA-01BR*, GWA-19BR*, GWA-20BR*, MW-200BR		5	0	0	Y		Mulitple locations with means greater than background value at or beyond the compliance boundary and which exhibit a discernable plume. Several bedrock locations exhibit slightly alkaline pH conditions which may enhance constituent solubility. Remaining bedrock wells are within the 02L boron plume footprint.
			Shallow Zone	1	0.5				1	0.67	1	GWA-32S		1	0	0	Y		Single location with mean greater than background value at or beyond the compliance boundary. Does not exhibit a discernable plume and is not within the 02L boron plume footprint.
Molybdenum	µg/L	NE	Transition Zone	1	2	0.1-5.3	0.1 - 5.3	0.5 - 26	6	3.21	2	GWA-01D, GWA-30D	Y	0	0	0	Y	Variable	Isolated locations with means greater than background value at or beyond the compliance boundary. Do not exhibit a discernable plume and are not within the 02L boron plume footprint.
			Bedrock Zone	4	6				50	8.32	4	CCR-13BR, GWA-01BR*, GWA-20BR*, MW-201BR		2	0	0	Y		Isolated locations with means greater than background value at or beyond the compliance boundary. Do not exhibit a discernable plume and are not within the 02L boron plume footprint. Several bedrock locations exhibit slightly alkaline pH conditions which may enhance constituent solubility.
			Shallow Zone	57	46				494	8.67	7	GWA-01S, GWA-10S, GWA-11S, GWA-19SA, GWA-20SA, GWA-21S, MW-200S		7	7	1	Y		Mulitple locations with means greater than background value at or beyond the compliance boundary and which exhibit a discernable plume.
Strontium	µg/L	NE	Transition Zone	69	73	7.9-100	7.9 - 100	27 - 2272	863	11.82	10	GWA-01D, GWA-10DA, GWA-11D, GWA-19D, GWA-20D, GWA-21D, GWA-24D, GWA-27D, GWA-32D, MW-200D	Y	12	9	1	Y	Non-Conservative	Mulitple locations with means greater than background value at or beyond the compliance boundary and which exhibit a discernable plume.
			Bedrock Zone	100	99				191	1.93	4	CCR-13BR, GWA-16BR, GWA-24BR, MW-200BR		10	4	0	Y		Mulitple locations with means greater than background value at or beyond the compliance boundary and which exhibit a discernable plume.

Prepared by: DAA Checked by: ALA

Notes:

- Reference Criterion

- Evidence supports inclusion

- Evidence supports exclusion

1 - Constituent list reflects the COI list identified in the 2017 CSA Update (SynTerra, 2017), with the addition of lithium.

2 - Background threshold values were calculated using data from background groundwater samples collected June 2015 to April 2017

3 - Updated background threshold values are in the third column and were calculated using data from background groundwater samples collected October 2010 to December 2018 and sumbmitted to NCDEQ June 2019

4 - Arithmetic mean was used for COI with concentration range less than or equal to one order of magnitude. Geometric mean was used for COI with concentration range greater than one order of magnitude.

5 - Assignment of conservative, non-conservative, or variable behavior is based on geochemical modeling results.

> - greater than

< - less than

* - Bedrock well that exhibits slightly alkline pH (≥10 S.U.) water quality. Slightly alkaline conditions appear localized and uncharacteristic of bedrock flow zone and might be attributable to well installation activities.

38 wells were used in the evaluation, including: CCR-13BR, CCR-13D, CCR-13S, GWA-11D, GWA-11S, GWA-16BR, GWA-16DA, GWA-16S, GWA-17D, GWA-17S, GWA-19BR, GWA-19D, GWA-19SA, GWA-1BR, GWA-1D, GWA-1S, GWA-20BR, GWA-20D, GWA-20SA, GWA-21D, GWA-21S, GWA-24BR, GWA-24D, GWA-24S, GWA-27BR, GWA-27D, GWA-27S, GWA-30D, GWA-30S, GWA-31D, GWA-31S, GWA-32D, GWA-32S, MW-200BR, MW-200D, MW-200S, MW-201D, MW-201BR, MW-204D, MW-204S

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

S.U. Standard units

Y - Yes

N - No

TABLE 6-7
SUMMARY TREND ANALYSIS RESULTS
FOR MONITORING WELLS
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELEWS CREEK, NC

Wells Within the Waste Boundary

Well ID	Boron	Chloride	Lithium	Total Dissolved Solids
Ash Pore Water Wells				
AB-04S	NT	NT	I	NT
AB-04SL	S	NE	NE	NE
AB-05S	NT	NT	S	NT
AB-05SL	S	D	NE	NT
AB-06S	NT	D	S	NT
AB-06SL	D	S	NT	S
AB-07S	NT	NT	NT	NT
AB-08S	NT	NT	S	NT
AB-08SL	NT	S	NT	S
Shallow Flow Zone				
AB-01S	S	S	S	S
AB-02S	D	D	ND	D
AB-03S	D	D	S	D
AB-04SAP	D	S	S	S
AB-09S	ND	I	S	I
Deep Flow Zone				
AB-01D	D	D	S	D
AB-02D	D	D	S	D
AB-03D	S	S	S	S
AB-04D	D	S	S	S
AB-05D	ND	S	S	S
AB-06D	ND	S	S	S
AB-07D	ND	I	D	S
AB-08D	ND	I	S	S
AB-09D	S	D	S	I
Bedrock Flow Zone				
AB-01BR	S	S	S	S
AB-04BR	S	I	S	S
AB-04BRD	ND	D	NT	S
AB-09BR	ND	D	S	S
AB-09BRD	NE	NE	NE	NE

Wells Between Waste Boundary and Compliance Boundary

Well ID	Boron	Chloride	Lithium	Total Dissolved Solids
Shallow Flow Zone				
CCR-01S	ND	I	I	NT
CCR-02S	NT	NT	S	NT
CCR-04S	I	S	D	D
CCR-05S	S	D	D	S
CCR-06S	NE	NE	NE	NE
CCR-07S	I	I	I	I
CCR-08S	D	D	S	D
CCR-09S	NT	NT	S	S
CCR-11S	ND	S	D	S
CCR-12S	ND	I	S	S
EXOB-01	S	D	S	S
EXOB-02	S	S	S	S
GWA-02S	ND	S	D	ND
GWA-18S	NE	NE	NE	NE
Deep Flow Zone				
CCR-01D	ND	I	I	I
CCR-02D	I	S	S	D
CCR-04D	I	S	S	D
CCR-05D	D	S	S	S
CCR-06D	S	D	S	D
CCR-07D	I	S	I	S
CCR-08AD	S	D	D	D
CCR-08D	S	D	S	D
CCR-09D	NT	S	NT	S
CCR-11D	ND	I	NT	D
CCR-12D	ND	NE	NE	NE
CCR-12DA	ND	D	I	S
GWA-02D	ND	S	S	S
GWA-18D	ND	I	S	S

Wells Downgradient of the Source Area At or Beyond Compliance Boundary

Well ID	Boron	Chloride	Lithium	Total Dissolved Solids
Shallow Flow Zone				
CCR-13S	NE	NE	NE	NE
GWA-01S	I	NT	S	NT
GWA-10S	I	I	NT	I
GWA-11S	I	S	D	S
GWA-19SA	S	S	D	D
GWA-20SA	S	D	D	D
GWA-21S	I	S	D	S
GWA-24S	NE	NE	NE	NE
GWA-27S	NT	NT	D	NT
GWA-30S	ND	S	I	NT
GWA-31S	ND	S	S	S
GWA-32S	I	NT	S	S
MW-200S	NT	NT	S	I
Deep Flow Zone				
CCR-13D	NE	NE	NE	NE
GWA-01D	ND	I	S	I
GWA-10DA	ND	I	S	I
GWA-11D	I	I	S	S
GWA-19D	ND	S	S	S
GWA-20D	I	D	D	D
GWA-21D	I	I	S	S
GWA-24D	ND	I	S	S
GWA-27D	S	S	S	S
GWA-30D	ND	I	S	S
GWA-31D	ND	I	S	S
GWA-32D	S	S	I	S
MW-200D	D	D	S	D
MW-201D	ND	NT	S	D
Bedrock Flow Zone				
CCR-13BR	NE	NE	NE	NE
GWA-01BR	ND	S	NE	S
GWA-19BR	ND	NE	NE	NE
GWA-20BR	S	S	S	S
GWA-24BR	ND	S	S	S
GWA-27BR	S	NE	NE	NE
MW-200BR	I	I	S	S
MW-201BR	ND	S	D	S

Notes:

1. Summary of results and trends are presented for samples collected from 2011 - 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 90% 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)

Mann-Kendall trend analysis and results are prepared by Arcadis U.S. Inc. and included in a technical memorandum titled *Plume Stability Evaluation – Belews Creek Steam Station* (Arcadis 2019)

TABLE 6-8
SEEP CORRECTIVE ACTION STRATEGY
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELEWS CREEK, NC

Seep ID	Regulatory Program	General Location	Approximate Average Present Flow (cfs)	Seep Corrective Action Strategy
S-02	SOC	Channel flow northwest of ash basin to the Dan River	0.07	Further decanting, and groundwater corrective action might cause seep to become dry. Besides source control measures (i.e. decanting and ash basin closure), no additional corrective action for this location is anticipated.
S-06	SOC	East of ash basin; former ash basin permitted outfall to Belews Reservoir	0.01	Further decanting and ash basin closure might cause flow to cease in the future Besides source control measures (i.e. decanting and ash basin closure), no additional corrective action for this location is anticipated.
S-08	SOC	South of Pine Hall Road Landfill	0.05	Because of the seeps relatively remote location and low flowing conditions, corrective action using phytoremediation technology would be considered.
S-09	SOC	South of ash basin and hydraulic divide, west of Structural Fill	0.1	Location is associated with the Structural Fill, therefore corrective action for this location will be addressed in the corrective action plan for the Structural Fill.
S-11	NPDES	North of ash basin, at toe of ash basin dam	0.75	No corrective action necessary. This location is part of the ash basin waste water treatment system and included in the NPDES permit.
S-10 and S-18*	SOC and NPDES	Seeps are comingled. North of ash basin, downstream of ash basin dam	0.15	Further decanting and groundwater corrective action might cause flow to cease. Potential corrective action remedies to address seeps include, but not limited to, phytoremediation and/or an extraction trench or shallow extraction well(s).

Prepared by: ALA Checked by: JEC

Notes:

cfs- cubic feet per second

NPDES – National Pollution Discharge Elimination System

SOC – Special Order by Consent

*Seep S-18 flows into seep S-11

TABLE 6-9
WATER SUPPLY WELL ANALYTICAL RESULTS SUMMARY
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELEWS CREEK, NC

Analytical Parameter			Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Chloride	Chromium (VI)	Chromium	Cobalt	Iron	Lithium	Manganese	Molybdenum	Selenium	Strontium	Sulfate	Thallium	Total Dissolved Solids	Vanadium	Impacted by Coal Ash ?	Comments
Reporting Units			ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	mg/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	mg/L	ug/L	mg/L	ug/L		
15A NCAC 02L Standard			1*	10	700	4*	700	2	250	NE	10	1*	300	NE	50	NE	20	NE	250	0.2*	500	0.3*		
2017 Background Threshold Values (Bedrock Unit)[1]			1	1	6	0.2	50	0.8	3	0.3	5	0.8	228	NE	10	4	0.5	100	10	0.1	133	1		
2019 Background Threshold Values (Bedrock Unit)[2]			1	2	11	0.2	50	0.08	3	0.4	11	0.8	341	30	64	6	0.5	99	15	0.1	181	2		
2019Background Data Set Range (Bedrock Unit)[2]			0.1 - 1.4	0.1 - 1.5	3.0 - 11	0.01 - 0.2	33 -50	0.03 - 0.1	2.3 - 3.2	0.03 - 0.3	0.5 - 34.7	0.03 - 0.8	27 - 228	3.9-30	3.9 - 87.1	0.5 - 3.7	0.4 - 0.5	32.6 - 100	2.5 - 22.5	0.1 - 0.1	52 - 250	0.2 - 2.3		
SynTerra Map ID	Sample ID	Sample Collection Date	Analytical Results																					
BC-1002	BC-1002	10/27/2016	<0.5	<0.1	16.5	0.1	<25	<0.08	1.4	<0.03	<0.5	<0.1	<50	NA	1.8	<0.5	<0.5	13.5	<2	<0.1	<25	<0.3	No	Southwest and upgradient of the ash basin. Not within the direction of groundwater flow from the ash basin and PHR Landfill. Outside of the ash basin drainage system, separated by hydrologic divides.
BC-2000	BC2000-RAW	07/18/2017	<0.5	0.44	18.7	<0.1	<25	<0.08	2.1	<0.075	<5	<0.1	743	NA	8.7	10.6	<0.5	32.5	9.2	<0.1	87	<0.3	No	West and upgradient of the ash basin. Not within the direction of groundwater flow from the ash basin and PHR Landfill. Outside of the ash basin drainage system, separated by hydrologic divides.
BC-2002	BC2002-RAW	02/01/2018	<0.5	2	0.42	<0.1	5.5	<0.08	4.3	<0.025	<0.5	<0.1	<50	NA	1.8	3.6	<0.5	54.3	9.5	<0.1	107	0.46	No	Southwest and upgradient of the ash basin. Not within the direction of groundwater flow from the ash basin and PHR Landfill. Outside of the ash basin drainage system, separated by hydrologic divides.
		06/12/2018	<0.5	2	0.59	<0.1	<5	<0.08	4.6	<0.025	<0.5	<0.1	<50	NA	1.8	6.8	<0.5	63.3	8.3	<0.1	108	<0.3	No	
BC-2003	BC2003-RAW	11/14/2017	<0.5	0.39	0.74	<0.1	<25	<0.08	1.6	<0.025	<0.5	<0.1	<50	NA	52.8	1.5	<0.5	24.5	2	<0.1	74	<0.3	No	Southwest and upgradient of the ash basin. Not within the direction of groundwater flow from the ash basin and PHR Landfill. Outside of the ash basin drainage system, separated by hydrologic divides.
		02/01/2018	<0.5	<0.1	7.5	<0.1	<5	0.085	1.6	<0.025	<0.5	<0.1	<50	NA	2.3	<0.5	<0.5	24.3	2.4	<0.1	55	<0.3	No	
		05/15/2018	<0.5	<0.1	7.2	<0.1	<5	<0.08	1.5	0.065	<0.5	<0.1	<50	NA	2	<0.5	<0.5	23.4	2.2	<0.1	58	<0.3	No	
BC-2004	BC2004-RAW	07/18/2017	<0.5	0.66	20.1	0.11	<25	<0.08	1.8	<0.025	<0.5	<0.1	<50	NA	7.5	0.58	<0.5	15.2	1.2	<0.1	48	<0.3	No	Southwest and upgradient of the ash basin. Not within the direction of groundwater flow from the ash basin and PHR Landfill. Outside of the ash basin drainage system, separated by hydrologic divides.
		03/25/2018	<0.5	0.2	18.4	0.1	<25	<0.08	2	<0.025	<0.5	<0.1	<50	NA	7.6	0.72	<0.5	17	1.4	<0.1	38	<0.3	No	
		04/10/2018	<0.5	0.2	20.5	0.1	<25	<0.08	2	<0.025	<0.5	<0.1	<50	NA	7.7	0.59	<0.5	17.4	1.3	<0.1	47	<0.3	No	
BC-2005	BC2005-RAW	10/05/2017	<0.5	0.2	0.94	<0.1	<25	<0.08	1.5	0.037	<0.5	<0.1	<50	NA	1.7	<0.5	<0.5	24.3	1	<0.1	49	0.34	No	Southwest and upgradient of the ash basin. Not within the direction of groundwater flow from the ash basin and PHR Landfill. Outside of the ash basin drainage system, separated by hydrologic divides.
Bc-2006	BC2006-RAW	05/14/2018	<0.5	1.8	4.5	<0.1	<5	0.24	11.9	<0.025	<0.5	<0.1	<50	NA	<0.5	2.1	<0.5	75	3.6	<0.1	170	0.37	No	Southwest and upgradient of the ash basin. Not within the direction of groundwater flow from the ash basin and PHR Landfill. Outside of the ash basin drainage system, separated by hydrologic divides.
		06/13/2018	<0.5	0.49	1.2	<0.1	<10	<0.08	62.8	<0.025	<0.5	<0.1	<50	NA	6.6	<0.5	<0.5	33.8	<1	<0.1	155	<0.3	No	
BC-2007	BC2007-RAW	01/29/2018	<5	2	2.6	<0.1	<5	<0.08	1.2	0.4	0.5	<0.1	<50	NA	0.62	<0.5	<0.5	45.6	<1	<0.1	81	1	No	West and upgradient of the ash basin. Not within the direction of groundwater flow from the ash basin and PHR Landfill. Outside of the ash basin drainage system, separated by hydrologic divides.
BC-2008	BC2008-RAW	02/06/2018	<0.5	11.4	21.7	<0.1	<5	0.081	7.4	<0.025	<0.5	<0.1	<50	NA	10.4	1.9	<0.5	55.7	2.4	<0.1	89	0.52	No	West and upgradient of the ash basin. Not within the direction of groundwater flow from the ash basin and PHR Landfill. Outside of the ash basin drainage system, separated by hydrologic divides.
		06/12/2018	<0.5	12.8	18.9	<0.1	<5	<0.08	6.4	<0.025	<0.5	<0.1	<50	NA	8.4	2.7	0.58	54.8	3.4	<0.1	110	0.58	No	
BC-2009	BC2009-RAW	01/25/2018	<0.5	19.4	1.9	<0.1	5.8	<0.08	2.8	<0.025	<0.5	<0.1	<50	NA	8.5	3	<0.5	135	8.2	<0.1	121	<0.3	No	West and upgradient of the ash basin. Not within the direction of groundwater flow from the ash basin and PHR Landfill. Outside of the ash basin drainage system, separated by hydrologic divides.
		05/03/2018	<0.5	17.4	2.3	<0.1	5.6	<0.08	2.8	<0.025	<0.5	<0.1	<50	NA	3	2.8	<0.5	126	6.9	<0.1	116	<0.3	No	
BC-2011	BC25	10/13/2016	<0.5	0.39	0.61	<0.1	<25	<0.08	3.7	0.049	<0.5	<0.1	<50	NA	0.74	0.56	<0.5	24.8	3	<0.1	69	0.46	No	Southwest and upgradient of the ash basin. Not within the direction of groundwater flow from the ash basin and PHR Landfill. Outside of the ash basin drainage system, separated by hydrologic divides.
	BC-1001	10/13/2016	<0.5	<0.1	16.5	0.13	<25	<0.08	1.1	1	1.3	<0.1	<50	NA	6.1	<0.5	<0.5	25.2	<2	<0.1	39	0.68	No	
	BC-1006	08/11/2015	<0.5	<1	<5	<0.2	<50	<0.08	3	NA	<5	<1	<10	NA	<5	<1	<1	25	2.8	<0.2	61	0.396	No	
	BC2011-RAW	08/11/2015	<1	<0.5	0.46	<1	<5	<1	3.1	0.037	<0.5	<0.5	<50	NA	1.4	0.68	<0.5	23.3	3.5	<0.1	76	<1	No	
		09/19/2017	<0.5	0.81	1.4	<0.1	29	<0.08	3.5	0.079	0.72	<0.1	<50	NA	3	1.3	0.97	60.9	4.2	<0.1	72	0.76	No	
BC-2010	BC2010-RAW	01/25/2018	<0.5	2.4	33.2	0.17	<5	<0.08	1.7	<0.025	<0.5	0.11	3,010	NA	487	0.7	<0.5	73.9	9.6	<0.1	143	<0.3	No	West and upgradient of the ash basin. Not within the direction of groundwater flow from the ash basin and PHR Landfill. Outside of the ash basin drainage system, separated by hydrologic divides.
BC-2012	BC2012-RAW	10/03/2017	<0.5	0.15	7.7	0.21	<25	<0.08	2.1	0.8	1.2	<0.1	<50	NA	1.5	<0.5	<0.5	28.1	<1	<0.1	73	0.95	No	Southwest of and upgradient of ash basin. Not within the direction of groundwater flow from the ash basin and PHR Landfill. Outside of the ash basin drainage system, separated by hydrologic divides.
		05/03/2018	<0.5	0.11	9.5	0.32	<5	<0.08	3.9	0.66	0.98	<0.1	<50	NA	1.8	<0.5	<0.5	34.3	<1	<0.1	63	0.59	No	
BC-2013	BC2013-RAW	01/16/2018	<0.5	31.8	59.7	0.2	<5	<0.08	10.9	0.032	<0.5	<0.1	<50	NA	0.93	2.2	<0.5	81.4	3.2	<0.1	144	0.37	No	Southwest and upgradient of the ash basin. Not within the direction of groundwater flow from the ash basin and PHR Landfill. Outside of the ash basin drainage system, separated by hydrologic divides.
BC-2014	BC2014-RAW	11/14/2017	<0.5	<0.1	7	<0.1	<25	<0.08	1.5	<0.025	<0.5	<0.1	<50	NA	1.8	<0.5	<0.5	21.9	9.9	<0.1	95	<0.3	No	Southwest of and upgradient of ash basin. Not within the direction of groundwater flow from the ash basin and PHR Landfill. Outside of the ash basin drainage system, separated by hydrologic divides.
		01/25/2018	<0.5	0.41	0.89	<0.1	<5	<0.08	1.6	<0.025	0.74	<0.1	74.1	NA	64.8	1.5	<0.5	23.9	9.5	<0.1	102	<0.3	No	
		05/15/2018	<0.5	0.49	0.75	<0.1	<5	<0.08	1.3	<0.025	<0.5	<0.1	57.2	NA	55.5	1.5	<0.5	22.4	8.9	<0.1	83	<0.3	No	
BC-2015	BC2015-RAW	07/28/2017	<0.5	15.1	5.9	<0.1	<25	<0.08	5.8	<0.025	<0.5	<0.1	<50	NA	0.9	3.2	<0.5	190	6.3	<0.1	141	<0.3	No	Southwest and upgradient of the ash basin. Not within the direction of groundwater flow from the ash basin and PHR Landfill. Outside of the ash basin drainage system, separated by hydrologic divides.
BC-2016	BC13	08/31/2017	<0.5	9.3	2.3	<0.1	64.2	<0.08	19.9	0.028	<0.5	<0.1	<50	NA	3.3	1.5	<0.5	<0.1	7.5	<0.1	179	3.3	No	West and upgradient of the ash basin. Not within the direction of groundwater flow from the ash basin and PHR Landfill. Outside of the ash basin drainage system, separated by hydrologic divides.
	BC2016-RAW	01/25/2018	<0.5	5.7	2.6	<0.1	85.7	<0.08	25.7	0.033	<0.5	<0.1	<50	NA	5.3	1.7	0.54	<0.1	8.6	<0.1	197	4	No	
	BC2016-RAW	03/03/2018	<0.5	6	2.4	<0.1	86.8	<0.08	25.7	<0.025	<0.5	<0.1	<50	NA	3.7	1.7	0.5	<0.1	7.8	<0.1	200	4.1	No	
	BC2016-RAW	05/15/2018	2	4.9	2.9	<0.1	80.5	<0.08	26.4	0.027	0.64	<0.1	<50	NA	9.7	1.9	<0.5	<0.1	7.9	<0.1	223	4.3	No	
BC-2017	BC2017-RAW	11/21/2017	<0.5	<0.1	19	<0.1	<25	0.12	5.9	<0.025	3.6	<0.1	50.9	NA	4.4	<0.5	<0.5	41.7	3	<0.1	74	<0.3	No	Southwest and upgradient of the ash basin. Not within the direction of groundwater flow from the ash basin and PHR Landfill. Outside of the ash basin drainage system, separated by hydrologic divides.
	BC2017-RAW	05/30/2018	<0.5	<0.1	16.9	<0.1	<5	<0.08	5.4	<0.025	<0.5	<0.1	<50	NA	2.4	<0.5	<0.5	37.2	3.3	<0.1	79	<0.3	No	
BC-2019	BC2019-RAW	07/18/2017	<0.5	<0.1	10.6	<0.1	<25	<0.08	1.8	0.65	<0.5	0.13	2,140	NA	16	1.7	<0.5	48.9	8.1	<0.1	96	0.32	No	West and upgradient of the ash basin. Not within the direction of groundwater flow from the ash basin and PHR Landfill. Outside of the ash basin drainage system, separated by hydrologic divides.

TABLE 6-9
WATER SUPPLY WELL ANALYTICAL RESULTS SUMMARY
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELEWS CREEK, NC

		Analytical Parameter	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Chloride	Chromium (VI)	Chromium	Cobalt	Iron	Lithium	Manganese	Molybdenum	Selenium	Strontium	Sulfate	Thallium	Total Dissolved Solids	Vanadium	Impacted by Coal Ash ?	Comments
		Reporting Units	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	mg/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	mg/L	ug/L	mg/L	ug/L		
		15A NCAC 02L Standard	1*	10	700	4*	700	2	250	NE	10	1*	300	NE	50	NE	20	NE	250	0.2*	500	0.3*		
		2017 Background Threshold Values (Bedrock Unit)[1]	1	1	6	0.2	50	0.8	3	0.3	5	0.8	228	NE	10	4	0.5	100	10	0.1	133	1		
		2019 Background Threshold Values (Bedrock Unit)[2]	1	2	11	0.2	50	0.08	3	0.4	11	0.8	341	30	64	6	0.5	99	15	0.1	181	2		
		2019Background Data Set Range (Bedrock Unit)[2]	0.1 - 1.4	0.1 - 1.5	3.0 - 11	0.01 - 0.2	33 -50	0.03 - 0.1	2.3 - 3.2	0.03 - 0.3	0.5 - 34.7	0.03 - 0.8	27 - 228	3.9-30	3.9 - 87.1	0.5 - 3.7	0.4 - 0.5	32.6 - 100	2.5 - 22.5	0.1 - 0.1	52 - 250	0.2 - 2.3		
SynTerra Map ID	Sample ID	Sample Collection Date	Analytical Results																					
BC-2020	BC4 Well A	01/24/2018	<0.5	0.17	5.6	<0.1	<5	<0.08	2.5	0.11	<0.5	<0.1	<50	NA	<0.5	3.4	<0.5	43.7	4.3	<0.1	99	2.2	No	West and upgradient of the ash basin. Not within the direction of groundwater flow from the ash basin and PHR Landfill. Outside of the ash basin drainage system, separated by hydrologic divides.
	BC4 Well A	03/08/2018	<0.5	<0.1	9.1	<0.1	<5	<0.08	1.8	0.12	<0.5	<0.1	<50	NA	<0.5	2.1	<0.5	41.3	2.6	<0.1	81	2.4	No	
	BC2020-RAW	02/18/2015	<0.5	<2	6.9	<0.5	<50	<0.15	1	<5	<2	<1	<25	NA	<2	2.98	<2	43	5	<0.5	112	2	No	
		02/18/2015	<1	<1	7	<1	<50	<1	1.5	NA	<5	<1	18	NA	<5	2.78	<1	41	3.9	<0.2	91	2.22	No	
		8/26/2015	<0.5	<0.5	3.6	<0.2	<5	<0.08	1.6	0.085	<0.5	<0.5	<50	NA	NA	4.1	<0.5	44.8	4.8	<0.1	102	2.4	No	
BC-2021	BC9	03/05/2015	<1	2.2	<5	<1	<50	<1	5.7	NA	<5	<1	374	NA	37	<1	<1	72	9.3	<0.2	120	<0.3	No	North and upgradient of the ash basin. Not within the direction of groundwater flow from the ash basin and PHR Landfill. Outside of the ash basin drainage system, separated by hydrologic divides.
	BC9	08/11/2015	<0.5	1.8	0.74	<0.2	<5	<0.08	6.3	<0.03	<0.5	<0.5	322	NA	19.5	<0.5	<0.5	73.2	9.8	<0.1	119	<1	No	
	BC2021-RAW	06/27/2017	<0.5	1.8	0.72	0.11	<25	<0.08	5.7	<0.025	<0.5	0.1	321	NA	34.7	<0.5	<0.5	67.6	9.7	<0.1	124	<0.3	No	
BC-2022	BC6	10/16/2017	<0.5	0.2	4.1	0.25	<25	0.12	9.7	<0.025	1.6	0.11	576	NA	30.8	<0.5	<0.5	63.9	6.6	<0.1	106	<0.3	No	Northeast and upgradient of the ash basin. Not within the direction of groundwater flow from the ash basin and PHR Landfill. Outside of the ash basin drainage system, separated by hydrologic divides.
	BC2022-RAW	06/27/2018	<0.5	0.16	3.9	0.24	<10	<0.08	12.8	<0.025	<0.5	<0.1	762	NA	35.3	<0.5	<0.5	65.2	9.1	<0.1	109	<0.3	No	
	BC2022-RAW	03/04/2015	<1	<1	<5	<1	<50	<1	12	NA	<5	<1	354	NA	43	<1	<1	65	10	<0.2	110	<0.3	No	
BC-2025	BC2025-RAW	01/16/2018	<0.5	1	0.5	<0.1	<5	<0.08	2.3	<0.025	<0.5	<0.1	<50	NA	9.2	0.87	<0.5	98	9.4	<0.1	123	<0.3	No	North and upgradient of the ash basin. Not within the direction of groundwater flow from the ash basin and PHR Landfill. Outside of the ash basin drainage system, separated by hydrologic divides.
		06/06/2018	<0.5	1	0.46	<0.1	6	<0.08	2.1	<0.025	<0.5	<0.1	<50	NA	9.1	0.91	<0.5	93.4	9.4	<0.1	135	<0.3	No	
BC-2026	BC2026-RAW	07/18/2017	<0.5	3.5	<0.1	<0.1	<25	<0.08	1.2	0.2	<0.5	0.21	217	NA	17.5	1	<0.5	45.9	2	<0.1	105	1.6	No	West and upgradient of the ash basin. Not within the direction of groundwater flow from the ash basin and PHR Landfill. Outside of the ash basin drainage system, separated by hydrologic divides.
BC2027	BC15	09/19/2017	1.9	0.88	0.19	0.19	<25	<0.08	5.2	0.62	3.9	1.5	1,240	NA	32.5	<0.5	<0.5	61	1.1	<0.1	53	1.1	No	Northeast and upgradient of the ash basin. Not within the direction of groundwater flow from the ash basin and PHR Landfill. Outside of the ash basin drainage system, separated by hydrologic divides.
	BC2027-RAW	05/30/2018	<0.5	0.42	<0.1	<0.1	<5	<0.08	5.8	0.24	0.64	0.22	<50	NA	6.9	<0.5	<0.5	60.6	1	<0.1	81	<0.3	No	
BC-2031	BC2031-RAW	02/01/2018	<0.5	<0.1	22.3	0.13	<5	<0.08	5	0.048	<0.5	<0.1	103	NA	2.7	<0.5	<0.5	36.6	<1	<0.1	66	<0.3	No	Southwest and upgradient of the ash basin. Not within the direction of groundwater flow from the ash basin and PHR Landfill. Outside of the ash basin drainage system, separated by hydrologic divides.
		06/12/2018	<0.5	<0.1	23.8	0.12	<5	<0.08	5	0.031	<0.5	<0.1	194	NA	2.9	<0.5	<0.5	39.7	<1	<0.1	60	<0.3	No	
BC-2034	BC2034-RAW	02/01/2018	<0.5	0.62	<0.1	<0.1	<5	<0.08	3.9	0.062	<0.5	<0.1	<50	NA	1.3	0.94	<0.5	53.4	2.2	<0.1	74	0.52	No	Southwest and upgradient of the ash basin. Not within the direction of groundwater flow from the ash basin and PHR Landfill. Outside of the ash basin drainage system, separated by hydrologic divides.
	BC2034-RAW	04/25/2018	<0.5	0.48	<0.1	<0.1	<5	<0.08	3.7	0.06	<0.5	<0.1	<50	NA	0.69	0.93	<0.5	54.9	2.5	<0.1	96	0.38	No	
BC-2036	BC2036-RAW	09/19/2017	<0.5	<0.1	0.13	0.13	<25	<0.08	1.2	0.97	1.3	<0.1	<50	NA	3.4	<0.5	<0.5	24.4	<1	<0.1	27	0.48	No	Southwest and upgradient of the ash basin. Not within the direction of groundwater flow from the ash basin and PHR Landfill. Outside of the ash basin drainage system, separated by hydrologic divides.
BC-2037	BC2037-RAW	03/06/2018	<0.5	<0.1	<0.1	<0.1	9.1	<0.08	3.9	1.1	1.5	<0.1	<50	NA	1	1.5	<0.5	59.7	3	<0.1	97	1.3	No	Northeast and upgradient of the ash basin. Not within the direction of groundwater flow from the ash basin and PHR Landfill. Outside of the ash basin drainage system, separated by hydrologic divides.
BC-2040	BC2040-RAW	05/18/2018	<0.5	0.84	29.3	0.12	<5	<0.08	1.9	0.58	0.79	<0.1	<50	NA	0.7	<0.5	<0.5	21.7	<1	<0.1	67	0.85	No	Southwest and upgradient of the ash basin. Not within the direction of groundwater flow from the ash basin and PHR Landfill. Outside of the ash basin drainage system, separated by hydrologic divides.
BC-1	BC1	10/07/2015	<0.5	1.3	2.4	<0.2	<5	<0.08	7	0.093	1.4	<0.5	261	NA	173	<0.5	<0.5	165	12.2	<0.1	95	<1	No	Northeast and upgradient of the ash basin. Not within the direction of groundwater flow from the ash basin and PHR Landfill. Outside of the ash basin drainage system, separated by hydrologic divides.
BC-8	BC8	04/09/2015	<1	<1	7	<1	<50	<1	3.4	NA	<5	<1	<10	NA	<5	<1	<1	51	2.5	<0.2	80	0.451	No	Southwest and upgradient of the ash basin. Not within the direction of groundwater flow from the ash basin and PHR Landfill. Outside of the ash basin drainage system, separated by hydrologic divides.
		08/25/2015	<0.5	0.77	6.1	<0.2	<5	<0.08	3.2	0.06	<0.5	<0.5	<50	NA	NA	1.1	<0.5	51.9	3	<0.1	64	<1	No	
		09/15/2015	<0.5	0.77	6.6	<0.2	<5	<0.08	3.5	0.06	0.91	<0.5	<50	NA	1.4	1	<0.5	53.8	3.1	<0.1	71	<1	No	
		09/15/2015	<1	<1	7	<1	<50	<1	3.5	NA	<5	<1	<10	NA	<5	<1	<1	53	2.3	<0.2	75	0.489	No	
BC-10	BC10	09/15/2015	<0.5	<0.5	18.6	<0.2	<5	<0.08	3	0.057	1.6	<0.5	56.8	NA	4	<0.5	<0.5	33.6	<2	<0.1	42	<1	No	Southwest and upgradient of the ash basin. Not within the direction of groundwater flow from the ash basin and PHR Landfill. Outside of the ash basin drainage system, separated by hydrologic divides.
BC-20	BC20	08/10/2015	<0.5	10.8	3	<0.2	<5	<0.08	2.2	<0.3	<0.5	<0.5	<50	NA	3.6	20.2	<0.5	94.2	8.1	<0.1	136	<1	No	West and upgradient of the ash basin. Not within the direction of groundwater flow from the ash basin and PHR Landfill. Outside of the ash basin drainage system, separated by hydrologic divides.
		08/10/2015	<1	10.6	<5	<1	<50	<1	2.1	NA	<5	<1	28	NA	<5	19.4	<1	98	8	<0.2	150	<0.3	No	
BC-21	BC21	02/23/2016	<1	<1	11	<1	<50	<1	4	NA	<5	<1	11	NA	<5	<1	<1	19	1	<0.2	71	0.365	No	West and upgradient of the ash basin. Not within the direction of groundwater flow from the ash basin and PHR Landfill. Outside of the ash basin drainage system, separated by hydrologic divides.
BC-23-1	BC23-1	08/12/2015	<0.5	<0.5	5.8	<0.2	<5	<0.08	1.6	2.1	2.5	<0.5	<50	NA	<0.5	1.1	<0.5	25.2	3.2	<0.1	74	1.7	No	Northeast and upgradient of the ash basin. Not within the direction of groundwater flow from the ash basin and PHR Landfill. Outside of the ash basin drainage system, separated by hydrologic divides.
		08/12/2015	<1	<1	6	<1	<50	<1	1.4	NA	<5	<1	11	NA	<5	1.21	<1	27	1	<0.2	52	1.69	No	
BC-23-2	BC23-2	08/12/2015	<0.5	1.6	8.3	<0.2	<5	<0.08	18.6	1.9	2.3	<0.5	<50	NA	0.62	0.76	<0.5	87.7	3.5	<0.1	166	1.3	No	Northeast and upgradient of the ash basin. Not within the direction of groundwater flow from the ash basin and PHR Landfill. Outside of the ash basin drainage system, separated by hydrologic divides.
		08/12/2015	<1	1.7	9	<1	<50	<1	17	NA	<5	<1	14	NA	<5	<1	<1	99	1.5	<0.2	150	1.33	No	
BC-23-3	BC23-3	08/12/2015	<0.5	0.69	1	<0.2	<5	<0.08	14.1	<0.03	<0.5	<0.5	<50	NA	148	<0.5	<0.5	122	16.8	<0.1	223	<1	No	Northeast and upgradient of the ash basin. Not within the direction of groundwater flow from the ash basin and PHR Landfill. Outside of the ash basin drainage system, separated by hydrologic divides.
		08/12/2015	<1	<1	<5	<1	<50	<1	13	NA	<5	<1	14	NA	159	<1	<1	133	16	<0.2	210	<0.3	No	
BC-23-4	BC23-4	08/12/2015	<0.5	1.5	1.2	0.22	<5	<0.08	8.3	<0.03	<0.5	<0.5	155	NA	144	1.4	<0.5	92.7	20.2	<0.1	169	<1	No	Northeast and upgradient of the ash basin. Not within the direction of groundwater flow from the ash basin and PHR Landfill. Outside of the ash basin drainage system, separated by hydrologic divides.
		08/12/2015	<1	1.6	<5	<1	<50	<1	7.8	NA	<5	<1	164	NA	150	1.59	<1	103	19	<0.2	150	<0.3	No	
BC-23-5	BC23-5	08/12/2015	<0.5	<0.5	7.2	0.3	<5	<0.08	14.6	<0.03	<0.5	4.3	<50	NA	23.8	<0.5	<0.5	102	17.4	<0.1	122	<1	No	Northeast and upgradient of the ash basin. Not within the direction of groundwater flow from the ash basin and PHR Landfill. Outside of the ash basin drainage system, separated by hydrologic divides.
		08/12/2015	<1	<1	7	<1	<50	<1	13	NA	<5	4.06	<10	NA	26	<1	<1	110	17	<0.2	120	<0.3	No	

TABLE 6-9
WATER SUPPLY WELL ANALYTICAL RESULTS SUMMARY
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELEWS CREEK, NC

		Analytical Parameter	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Chloride	Chromium (VI)	Chromium	Cobalt	Iron	Lithium	Manganese	Molybdenum	Selenium	Strontium	Sulfate	Thallium	Total Dissolved Solids	Vanadium	Impacted by Coal Ash ?	Comments
		Reporting Units	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	mg/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	mg/L	ug/L	mg/L	ug/L		
		15A NCAC 02L Standard	**1***	**10**	**700**	**4***	**700**	**2**	**250**	NE	10	**1***	300	NE	50	NE	**20**	NE	**250**	**0.2***	**500**	0.3*		
		2017 Background Threshold Values (Bedrock Unit)[1]	1	1	6	0.2	50	0.8	3	0.3	5	0.8	228	NE	10	4	0.5	**100**	10	0.1	133	1		
		2019 Background Threshold Values (Bedrock Unit)[2]	1	2	11	0.2	50	0.08	3	**0.4**	**11**	0.8	**341**	**30**	**64**	**6**	0.5	99	15	0.1	181	**2**		
		2019Background Data Set Range (Bedrock Unit)[2]	0.1 - 1.4	0.1 - 1.5	3.0 - 11	0.01 - 0.2	33 -50	0.03 - 0.1	2.3 - 3.2	0.03 - 0.3	0.5 - 34.7	0.03 - 0.8	27 - 228	3.9-30	3.9 - 87.1	0.5 - 3.7	0.4 - 0.5	32.6 - 100	2.5 - 22.5	0.1 - 0.1	52 - 250	0.2 - 2.3		
SynTerra Map ID	Sample ID	Sample Collection Date	Analytical Results																					
BC-28	BC28	10/07/2015	<1	3.03	<5	<1	<50	<1	1.5	NA	<5	<1	17	NA	<5	3.49	<1	**175**	19	<0.2	120	<0.3	No	West and upgradient of the ash basin. Not within the direction of groundwater flow from the ash basin and PHR Landfill. Outside of the ash basin drainage system, separated by hydrologic divides.
BC-29	BC29	10/07/2015	<1	<1	12	<1	<50	<1	3.2	NA	<5	<1	17	NA	<5	<1	<1	23	1.3	<0.2	78	0.557	No	West and upgradient of the ash basin. Not within the direction of groundwater flow from the ash basin and PHR Landfill. Outside of the ash basin drainage system, separated by hydrologic divides.
BC-30	BC30	10/07/2015	<0.5	**108**	2.2	<0.2	<5	<0.08	7.5	<0.03	<0.5	<0.5	<50	NA	0.7	**10.5**	1.8	64.6	8.7	<0.1	152	<1	No	West and upgradient of the ash basin. Not within the direction of groundwater flow from the ash basin and PHR Landfill. Outside of the ash basin drainage system, separated by hydrologic divides.
		10/07/2015	<1	**114**	<5	<1	<50	<1	6.9	NA	<5	<1	<10	NA	<5	**11.7**	2.22	76	8.7	<0.2	160	0.468	No	
BC-32	BC32	10/07/2015	<0.5	**22.5**	3.1	<0.2	<5	<0.08	4.1	<0.03	<0.5	<0.5	<50	NA	23.8	**6.8**	<0.5	**210**	9.2	<0.1	127	<1	No	West and upgradient of the ash basin. Not within the direction of groundwater flow from the ash basin and PHR Landfill. Outside of the ash basin drainage system, separated by hydrologic divides.
		10/07/2015	<1	**23.7**	<5	<1	<50	<1	3.6	NA	<5	<1	13	NA	29	**7.21**	<1	**238**	9.4	<0.2	140	<0.3	No	
BC-33	BC33	11/03/2015	<0.5	1.9	7.7	<0.2	<5	<0.08	2.8	<0.03	**19.3**	<0.5	269	NA	**67.6**	1.9	<0.5	85.2	9.1	<0.1	148	<1	No	West and upgradient of the ash basin. Not within the direction of groundwater flow from the ash basin and PHR Landfill. Outside of the ash basin drainage system, separated by hydrologic divides.
		11/03/2015	<1	1.97	17	<1	<50	<1	2.5	NA	**21**	<1	262	NA	**79**	1.46	<1	94	11	<0.2	130	<0.3	No	
BC34	BC34	12/29/2015	<0.5	**40.3**	<0.2	<0.2	<5	<0.08	8.3	<0.03	0.52	<0.5	<50	NA	0.8	4.5	<0.5	94.4	6.1	<0.1	156	<1	No	Soutwest and upgradient of the ash basin. Not within the direction of groundwater flow from the ash basin and PHR Landfill. Outside of the ash basin drainage system, separated by hydrologic divides.
		12/29/2015	<1	**42.9**	<1	<1	<50	<1	8.1	NA	<5	<1	13	NA	<5	4.89	<1	**110**	6.2	<0.2	180	0.748	No	
BC-35	BC35	12/29/2015	<0.5	**15.7**	3.9	<0.2	<5	<0.08	7.2	0.18	1.6	<0.5	**365**	NA	**253**	2.1	<0.5	44.7	14.2	<0.1	143	<1	No	West and upgradient of the ash basin. Not within the direction of groundwater flow from the ash basin and PHR Landfill. Outside of the ash basin drainage system, separated by hydrologic divides.
		12/29/2015	<1	**16.7**	<5	<1	<50	<1	7.1	NA	<5	<1	**447**	NA	**332**	3.15	<1	52	15	<0.2	160	0.489	No	

Prepared by: DAA Checked by: JHC

Notes:

[1] - Background threshold values were calculated using data from background groundwater samples collected June 2015 to April 2017

[2] - Updated background threshold values were calculated using data from background groundwater samples collected October 2010 to December 2018 and sumbmitted to NCDEQ June 2019

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).

Bold text - greatest comparative value

- Bold highlighted concentration indicates exceedance of 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 exceedance BTV from April 2017 or December 2018, whichever is greater.

- 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

Bold text - Constituent concentration exceeds applicable comparison criteria.

* - 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.

COI - constituent of Interest

NA - not available

NE - not established

NM - Not measured

mg/L - Milligrams Per Liter

µg/L - Micrograms Per Liter

S.U. - standard units

TABLE 6-10
NPDES PERMIT LIMITS AND ANTICIPATED GROUNDWATER REMEDIATION PARAMETER LEVELS
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELEWS CREEK, NC

NPDES Outfalls	Internal Outfall 006A		Outfall 006		IAP System Mean Concentration	Groundwater Mean Concentration by Flow Zone[1]		
Effluent Limitations and Monitoring Requirements					Deep Flow Zone	Shallow Flow Zone	Deep Flow Zone	Bedrock Flow Zone
Parameter	Monthly Average	Daily Maximum	Monthly Average	Daily Maximum				
Flow[2]	2.0 MGD	NS	NS	NS	13 GPM	NA	NA	NA
Oil and Grease	15.0 mg/L	20.0 mg/L	15.0 mg/L	20.0 mg/L	NA	NA	NA	NA
TSS	30.0 mg/L	50.0 mg/L	30.0 mg/L	50.0 mg/L	5.0 mg/L	6 mg/L	5 mg/L	4 mg/L
Total Copper	211.3 µg/L	231.4 µg/L	1.0 mg/L	1.0 mg/L	0.001 mg/L	0.002 mg/L	0.001 mg/L	0.0009 mg/L
Total Lead	78.9 µg/L	1668 µg/L	16.9 µg/L	367.7 µg/L	0.8 µg/L	0.3 µg/L	0.2 µg/L	0.1 µg/L
Total Selenium	134 µg/L	1237 µg/L	NS	NS	1 µg/L	5 µg/L	1 µg/L	0.7 µg/L
Total Molybdenum	4289 µg/L	4289 µg/L	NS	NS	3 µg/L	1 µg/L	2 µg/L	8 µg/L
Total Aluminum	174.2 mg/L	174.2 mg/L	NS	NS	0.1 mg/L	0.7 mg/L	0.2 mg/L	0.2 mg/L
Ammonia[3]	1.0 mg/L	5.0 mg/L	1.0 mg/L	5.0 mg/L	NA	NA	NA	NA
Total Iron[4]	1.0 mg/L	1.0 mg/L	1.0 mg/L	1.0 mg/L	0.2 mg/L	0.3 mg/L	0.2 mg/L	0.1 mg/L
Chronic Toxicity[5]	See Note 5		See Note 5		NA	NA	NA	NA
Turbidity[6]	See Note 6		See Note 6		NA	NA	NA	NA
pH	Between 6.0 and 9.0 S.U.		Between 6.0 and 9.0 S.U.		5.3 S.U.	5.3 S.U.	6.3 S.U.	8.9 S.U.

Prepared by: ALA Checked by: CDE

Notes:

[1] – Downgradient groundwater monitoring wells in the area of groundwater remediation; Q1 2018 through Q2 2019 data.
[2] – The flow limit for Internal Outfall 006A is only applicable to interstitial water.
[3] – Ammonia limit and monitoring only applicable in the event of the emergency release of anhydrous ammonia.
[4] – Limits apply only when chemical metal cleaning wastewaters are being discharged.
[5] – Whole effluent toxicity shall be monitored by chronic toxicity (Ceriodaphnia) Pass/Fail at 3.7% for Outfall 006A and 17.4% for Outfall 006.
[6] – The discharge from this facility shall not cause turbidity in the receiving stream to exceed 50 NTU.
GPM – gallons per minute
IAP – Interim Action Plan
MGD - million gallons per day
NA – not analyzed
NS – not specified
mg/L - milligrams per liter
TSS – total suspended solids
µg/L - micrograms per liter
S.U. – standard units

TABLE 6-11
FEATURE IRRIGATION SYSTEM SETBACK
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELEWS CREEK, 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: CDE

Note:
References: 15A NCAC 02T.056

TABLE 6-12
REMEDIAL TECHNOLOGY SCREENING SUMMARY
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
DUKE ENERGY CAROLINAS, LLC BELEWS CREEK, NC

Summary of Remedial Technology Screening	Retain Technology for Further Consideration	
Technology	**Yes/No**	**Rationale**
Monitored Natural Attenuation	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	No	Installation to depths greater than 50 feet would be technically challenging and costly.
Groundwater Infiltration and 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	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. This technology will be considered for corrective action of seep(s) north of the ash basin dam.
Horizontal/Angular Extraction Wells	No	Although, applicable for groundwater extraction of mobile COIs, vertical extraction wells are just as effective in achieving hydraulic control and are cost effective than horizontal wells.
Extraction Trenches	Yes	This technology is not capable of achieving depths necessary to remediate groundwater, however this technology will be considered for corrective action of seep(s) north of the ash basin dam.
Hydraulic Fracturing	No	Not warranted based on the limited concern about COIs in bedrock.
Phytoremediation	Yes	This technology is not capable of achieving extraction rates necessary to achieve groundwater remediation at depths greater than 50 feet within reasonable timeframes, however this technology will be considered for corrective action of low flowing seep(s) north of the ash basin dam and in remote locations of the Site.
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 groundwater clean water infiltration or extraction.
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.
Disposal of Extracted Groundwater		
NPDES Permitted Discharge	Yes	Existing permitted discharges for wastewater are already in place.
POTW	No	There is extensive distance between the WWTS and the Site.
Non-Discharge Permit/Infiltration Gallery	No	Treatment prior to application could result in a complicated systems with significant operation and maintenance efforts.
Non-Discharge Permit/Land Application	No	Treatment prior to application could result in a complicated systems with significant operation and maintenance efforts
Beneficial Reuse		
Fire Protection	No	Potential application, but only as a system improvement and supplemental source of water. To be determined at a later date, and based on actual extraction rates of operational system.
Non-Contact Cooling Water	No	Potential application, but only as a system improvement and supplemental source of water. To be determined at a later date, and based on actual extraction rates of operational system.
Dust Suppression and Truck Wash	No	Limited use, and effort is not justified to substituent extracted groundwater for currently established procedures.

Prepared by: ALA Checked by: CDE

TABLE 6-13
ALTERNATIVE 3 GROUNDWATER EXTRACTION AND CLEAN WATER INFILTRATION SUMMARY
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELEWS CREEK, NC

Groundwater Extraction Well System		
Vertical Wells		
Number of Wells	**Flow Zone**	**Total Depth (ft bgs)**
4	Shallow	<30
3	Shallow	30-59
19	Deep/Bedrock	60-89
87	Bedrock	90-119
Total Well Count: 113		
System flow and operation assumptions: Flow rate: 0.8 gpm per well. Total system extraction flow rate of approximately 90 gpm. Extraction wells operate to maintain water level near bottom of the well. The groundwater extraction well system also includes 10 already existing extraction wells, as part of the interim action system. Post-decanting, the 10 interim action extraction wells are predicted to remove a total of about 2.5 gpm.		

Clean Water Infiltration Well System		
Vertical Wells		
Number of Wells	**Flow Zone**	**Total Depth (ft bgs)**
2	Shallow	30-59
22	TRZ/Bedrock	60-89
15	Bedrock	90-119
0	Bedrock	120-149
1	Bedrock	150-179
7	Bedrock	180+
Total Well Count: 47		
System flow and operation assumptions: Flow rate: 1.2 gpm per well. Total system infiltration flow rate of approximately 55 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 10 feet above the ground surface.		
Horizontal Well		
Number of Wells	**Flow Zone**	**Total Depth (ft bgs)**
1 (900 foot long)	Shallow	60
System flow and operation assumptions: Flow rate: Total infiltration flow rate of 110 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 10 feet above the ground surface.		

Prepared by: ALA Checked by: CDE

Notes:
ft bgs – feet below ground surface
gpm – gallons per minute

TABLE 6-14
ENVIRONMENTAL SUSTAINABILITY COMPARISONS FOR REMEDIATION ALTERNATIVES
CORRECTIVE ACTION PLAN UPDATE
BELEW'S CREEK STEAM STATION
DUKE ENERGY CAROLINAS LLC, BELEW'S CREEK, NC

Remedial Alternative		Remedial Alternative 1 – Monitored Natural Attenuation	Remedial Alternative 2 – Groundwater Extraction and Treatment	Remedial Alternative 3 – Groundwater Extraction combined with Clean Water Infiltration and Treatement
Emissions	**Units**			
CO_2 Emissions	metric ton	5.36E+01	4.88E+04	1.65E+04
Onsite NO_x Emissions	metric ton	6.79E-02	1.45E+00	3.30E+01
Onsite SO_x Emissions	metric ton	6.93E-03	1.49E-01	3.37E+00
Onsite PM_{10} Emissions	metric ton	6.11E-03	1.31E-01	2.97E+00
Total NO_x Emissions	metric ton	1.00E-01	1.77E+02	7.55E+01
Total SO_x Emissions	metric ton	3.67E-02	1.63E+02	3.81E+01
Total PM_{10} Emissions	metric ton	1.07E-02	1.92E+01	1.58E+01
Total Energy Used	MMBTU	1.11E+04	2.84E+06	6.26E+06
Total Emissions	**metric ton**	**5.38E+01**	**4.92E+04**	**1.66E+04**

Prepared by: GTC Checked by: CBC

Notes:

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
BELEWS CREEK STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELEWS CREEK, NC

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							
IW-1	1681274.70	929063.70	727	10	160	Saprolite/Transition Zone/Bedrock	1.2
IW-2	1681230.20	929033.40	714	10	148	Saprolite/Transition Zone/Bedrock	1.2
IW-3	1681179.70	928997.00	717	10	148	Saprolite/Transition Zone/Bedrock	1.2
IW-4	1681121.10	928956.60	726	10	156	Saprolite/Transition Zone/Bedrock	1.2
IW-5	1681068.60	928918.30	717	10	145	Saprolite/Transition Zone/Bedrock	1.2
IW-6	1681022.10	928890.00	715	10	144	Saprolite/Transition Zone/Bedrock	1.2
IW-7	1680963.50	928851.60	725	10	153	Saprolite/Transition Zone/Bedrock	1.2
IW-8	1680927.20	928815.20	736	10	162	Saprolite/Transition Zone/Bedrock	1.2
IW-9	1681420.93	928813.43	753	10	171	Saprolite/Transition Zone/Bedrock	1.2
IW-10	1681409.13	928745.43	761	10	176	Saprolite/Transition Zone/Bedrock	1.2
IW-11	1681394.33	928659.73	763	10	174	Saprolite/Transition Zone/Bedrock	1.2
IW-12	1681379.53	928571.13	761	10	172	Saprolite/Transition Zone/Bedrock	1.2
IW-13	1681376.63	928479.53	755	10	164	Saprolite/Transition Zone/Bedrock	1.2
IW-14	1681364.83	928408.63	757	10	166	Saprolite/Transition Zone/Bedrock	1.2
IW-15	1681471.13	928881.33	748	10	172	Saprolite/Transition Zone/Bedrock	1.2
IW-16	1681547.93	928899.03	753	10	178	Saprolite/Transition Zone/Bedrock	1.2
IW-17	1681624.83	928899.03	752	10	172	Saprolite/Transition Zone/Bedrock	1.2
IW-18	1681710.43	928896.13	754	10	172	Saprolite/Transition Zone/Bedrock	1.2
IW-19	1681787.23	928881.33	758	10	170	Saprolite/Transition Zone/Bedrock	1.2
IW-20	1681217.80	928484.70	763	10	176	Saprolite/Transition Zone/Bedrock	1.2
IW-21	1681312.20	928701.50	753	10	168	Saprolite/Transition Zone/Bedrock	1.2
IW-22	1681323.40	928683.80	753	10	168	Saprolite/Transition Zone/Bedrock	1.2
IW-23	1681337.40	928717.90	750	10	166	Saprolite/Transition Zone/Bedrock	1.2
IW-24	1681296.60	928669.20	743	10	159	Saprolite/Transition Zone/Bedrock	1.2
IW-25	1681282.10	928630.10	745	10	159	Saprolite/Transition Zone/Bedrock	1.2
IW-26	1681254.00	928617.00	745	10	159	Saprolite/Transition Zone/Bedrock	1.2
IW-27	1681266.30	928595.70	745	10	159	Saprolite/Transition Zone/Bedrock	1.2
IW-28	1681294.50	928694.00	743	10	159	Saprolite/Transition Zone/Bedrock	1.2
IW-29	1681305.50	928735.90	750	10	166	Saprolite/Transition Zone/Bedrock	1.2
IW-30	1681332.30	928737.90	750	10	166	Saprolite/Transition Zone/Bedrock	1.2
IW-31	1681347.10	928624.70	755	10	168	Saprolite/Transition Zone/Bedrock	1.2
IW-32	1681333.50	928537.00	750	10	161	Saprolite/Transition Zone/Bedrock	1.2
IW-33	1681308.60	928595.90	754	10	166	Saprolite/Transition Zone/Bedrock	1.2
IW-34	1682913.20	929443.20	635	10	126	Saprolite/Transition Zone/Bedrock	1.2
IW-35	1681319.48	928632.14	755	10	59	Saprolite/Transition Zone/Bedrock	1.2
IW-36	1681044.90	928145.50	761	10	71	Saprolite	1.2
IW-37	1680961.30	927954.30	744	10	59	Saprolite	1.2
IW-38	1682874.47	929473.17	649	10	43	Saprolite/Transition Zone	1.2
IW-39	1682753.44	929435.93	704	10	84	Saprolite/Transition Zone	1.2
IW-40	1682602.16	929391.71	740	10	108	Saprolite/Transition Zone	1.2
IW-41	1681347.30	928895.70	729	10	223	Saprolite/Transition Zone/Bedrock	1.2
IW-42	1681302.20	928843.10	737	10	229	Saprolite/Transition Zone/Bedrock	1.2
IW-43	1681262.10	928798.00	740	10	232	Saprolite/Transition Zone/Bedrock	1.2
IW-44	1681222.10	928752.90	734	10	225	Saprolite/Transition Zone/Bedrock	1.2
IW-45	1681169.40	928707.80	742	10	232	Saprolite/Transition Zone/Bedrock	1.2
IW-46	1681124.30	928647.70	755	10	244	Saprolite/Transition Zone/Bedrock	1.2
IW-47	1680979.30	928664.80	751	10	242	Saprolite/Transition Zone/Bedrock	1.2
Horizontal Injection Wells							
HZ-1	NA	NA	595	10	60	Saprolite/Transition Zone/Bedrock	110

Prepared by: GTC Checked by: YG

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

TABLE 6-16
MODELED GROUNDWATER EXTRACTION WELL DETAILS
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELEWS CREEK, NC

Well ID	Easting	Northing	Approximate Ground Surface Elevation (feet)	Operational DTW Maintained In Well (ft BGS)	Well Depth (ft BGS)	Targeted Flow Zones	Total Simulated Flow (gpm)
Vertical Extraction Wells							
EX-1	1681288.20	928942.50	722	129	149	Saprolite/Transition Zone/Bedrock	0.8
EX-2	1681219.00	928898.70	728	132	152	Saprolite/Transition Zone/Bedrock	0.8
EX-3	1681175.30	928855.00	725	129	149	Saprolite/Transition Zone/Bedrock	0.8
EX-4	1681115.30	928808.90	731	133	153	Saprolite/Transition Zone/Bedrock	0.8
EX-5	1681064.60	928762.80	742	143	163	Saprolite/Transition Zone/Bedrock	0.8
EX-6	1681392.71	928860.30	740	140	160	Saprolite/Transition Zone/Bedrock	0.8
EX-7	1681365.20	928815.70	749	147	167	Saprolite/Transition Zone/Bedrock	0.8
EX-8	1681334.50	928768.00	750	146	166	Saprolite/Transition Zone/Bedrock	0.8
EX-9	1681319.20	928723.80	750	146	166	Saprolite/Transition Zone/Bedrock	0.8
EX-10	1681305.60	928684.60	753	148	168	Saprolite/Transition Zone/Bedrock	0.8
EX-11	1681274.90	928611.40	745	139	159	Saprolite/Transition Zone/Bedrock	0.8
EX-12	1681244.30	928548.40	755	148	168	Saprolite/Transition Zone/Bedrock	0.8
EX-13	1681081.30	928592.80	762	158	178	Saprolite/Transition Zone/Bedrock	0.8
EX-14	1681324.50	928696.70	753	148	168	Saprolite/Transition Zone/Bedrock	0.8
EX-15	1681358.90	928672.60	761	154	174	Saprolite/Transition Zone/Bedrock	0.8
EX-16	1681339.80	928587.80	754	146	166	Saprolite/Transition Zone/Bedrock	0.8
EX-17	1681387.50	928624.90	763	154	174	Saprolite/Transition Zone/Bedrock	0.8
EX-18	1681375.70	928526.10	757	146	166	Saprolite/Transition Zone/Bedrock	0.8
EX-19	1681286.40	928649.60	745	139	159	Saprolite/Transition Zone/Bedrock	0.8
EX-20	1681234.30	928629.70	740	136	156	Saprolite/Transition Zone/Bedrock	0.8
EX-21	1681269.70	928705.60	743	139	159	Saprolite/Transition Zone/Bedrock	0.8
EX-22	1681262.60	928470.20	756	149	169	Saprolite/Transition Zone/Bedrock	0.8
EX-23	1681371.80	928444.20	757	146	166	Saprolite/Transition Zone/Bedrock	0.8
EX-24	1681322.90	928655.20	755	148	168	Saprolite/Transition Zone/Bedrock	0.8
EX-25	1681282.00	928561.90	745	139	159	Saprolite/Transition Zone/Bedrock	0.8
EX-26	1682318.20	929284.60	755	168	188	Saprolite/Transition Zone/Bedrock	0.8
EX-27	1681482.22	928678.80	770	125	145	Saprolite/Transition Zone/Bedrock	0.8
EX-28	1681481.12	928700.52	770	125	145	Saprolite/Transition Zone/Bedrock	0.8
EX-29	1681482.20	928722.49	765	123	143	Saprolite/Transition Zone/Bedrock	0.8
EX-30	1681474.86	928550.68	766	116	136	Saprolite/Transition Zone/Bedrock	0.8
EX-31	1681478.54	928595.60	768	119	139	Saprolite/Transition Zone/Bedrock	0.8
EX-32	1681478.54	928630.94	771	123	143	Saprolite/Transition Zone/Bedrock	0.8
EX-33	1681474.49	928537.43	766	116	136	Saprolite/Transition Zone/Bedrock	0.8
EX-34	1681477.43	928584.18	768	119	139	Saprolite/Transition Zone/Bedrock	0.8
EX-35	1681478.54	928623.21	771	123	143	Saprolite/Transition Zone/Bedrock	0.8
EX-36	1681481.12	928667.39	770	125	145	Saprolite/Transition Zone/Bedrock	0.8
EX-37	1681480.75	928713.78	770	125	145	Saprolite/Transition Zone/Bedrock	0.8
EX-38	1681481.51	928750.91	765	123	143	Saprolite/Transition Zone/Bedrock	0.8
EX-39	1681481.51	928790.91	758	120	140	Saprolite/Transition Zone/Bedrock	0.8
EX-40	1681525.32	928803.55	762	123	143	Saprolite/Transition Zone/Bedrock	0.8
EX-41	1681571.72	928801.45	764	124	144	Saprolite/Transition Zone/Bedrock	0.8
EX-42	1681611.56	928797.98	764	124	144	Saprolite/Transition Zone/Bedrock	0.8
EX-43	1681648.46	928794.95	767	125	145	Saprolite/Transition Zone/Bedrock	0.8
EX-44	1681682.52	928794.22	771	127	147	Saprolite/Transition Zone/Bedrock	0.8
EX-45	1681724.62	928792.12	774	129	149	Saprolite/Transition Zone/Bedrock	0.8
EX-46	1681775.22	928787.82	777	131	151	Saprolite/Transition Zone/Bedrock	0.8
EX-47	1681602.90	928798.57	764	124	144	Saprolite/Transition Zone/Bedrock	0.8
EX-48	1681582.10	928800.65	764	124	144	Saprolite/Transition Zone/Bedrock	0.8
EX-49	1681473.02	928524.17	766	116	136	Saprolite/Transition Zone/Bedrock	0.8
EX-50	1681475.96	928573.51	768	119	139	Saprolite/Transition Zone/Bedrock	0.8
EX-51	1681478.17	928614.37	771	123	143	Saprolite/Transition Zone/Bedrock	0.8
EX-52	1681472.65	928512.76	766	116	136	Saprolite/Transition Zone/Bedrock	0.8
EX-53	1681475.59	928560.99	766	116	136	Saprolite/Transition Zone/Bedrock	0.8
EX-54	1681478.17	928604.80	768	119	139	Saprolite/Transition Zone/Bedrock	0.8
EX-55	1681480.38	928648.61	771	123	143	Saprolite/Transition Zone/Bedrock	0.8
EX-56	1681481.48	928689.48	770	125	145	Saprolite/Transition Zone/Bedrock	0.8
EX-57	1681481.91	928733.61	765	123	143	Saprolite/Transition Zone/Bedrock	0.8
EX-58	1681482.91	928771.41	758	120	140	Saprolite/Transition Zone/Bedrock	0.8
EX-59	1681549.02	928799.75	762	123	143	Saprolite/Transition Zone/Bedrock	0.8
EX-60	1681593.72	928798.75	764	124	144	Saprolite/Transition Zone/Bedrock	0.8
EX-61	1681632.36	928797.28	767	125	145	Saprolite/Transition Zone/Bedrock	0.8
EX-62	1681667.32	928794.02	771	127	147	Saprolite/Transition Zone/Bedrock	0.8

TABLE 6-16
MODELED GROUNDWATER EXTRACTION WELL DETAILS
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELEWS CREEK, NC

Well ID	Easting	Northing	Approximate Ground Surface Elevation (feet)	Operational DTW Maintained In Well (ft BGS)	Well Depth (ft BGS)	Targeted Flow Zones	Total Simulated Flow (gpm)
Vertical Extraction Wells							
EX-63	1681704.12	928792.02	771	127	147	Saprolite/Transition Zone/Bedrock	0.8
EX-64	1681750.82	928789.02	774	129	149	Saprolite/Transition Zone/Bedrock	0.8
EX-65	1681640.23	928796.83	767	125	145	Saprolite/Transition Zone/Bedrock	0.8
EX-66	1681502.33	928802.75	758	120	140	Saprolite/Transition Zone/Bedrock	0.8
EX-67	1681662.04	928794.19	767	125	145	Saprolite/Transition Zone/Bedrock	0.8
EX-68	1681673.38	928793.83	771	127	147	Saprolite/Transition Zone/Bedrock	0.8
EX-69	1681678.52	928793.66	771	127	147	Saprolite/Transition Zone/Bedrock	0.8
EX-70	1681688.27	928792.41	771	127	147	Saprolite/Transition Zone/Bedrock	0.8
EX-71	1681693.76	928792.59	771	127	147	Saprolite/Transition Zone/Bedrock	0.8
EX-72	1681698.90	928791.88	771	127	147	Saprolite/Transition Zone/Bedrock	0.8
EX-73	1681708.82	928791.18	771	127	147	Saprolite/Transition Zone/Bedrock	0.8
EX-74	1681714.85	928791.00	771	127	147	Saprolite/Transition Zone/Bedrock	0.8
EX-75	1681719.63	928791.00	774	129	149	Saprolite/Transition Zone/Bedrock	0.8
EX-76	1681730.44	928790.11	774	129	149	Saprolite/Transition Zone/Bedrock	0.8
EX-77	1681735.40	928790.11	774	129	149	Saprolite/Transition Zone/Bedrock	0.8
EX-78	1681739.65	928790.11	774	129	149	Saprolite/Transition Zone/Bedrock	0.8
EX-79	1681745.68	928788.87	774	129	149	Saprolite/Transition Zone/Bedrock	0.8
EX-80	1681754.89	928788.87	774	129	149	Saprolite/Transition Zone/Bedrock	0.8
EX-81	1681759.68	928787.99	774	129	149	Saprolite/Transition Zone/Bedrock	0.8
EX-82	1681763.93	928787.81	774	129	149	Saprolite/Transition Zone/Bedrock	0.8
EX-83	1681767.65	928787.81	774	129	149	Saprolite/Transition Zone/Bedrock	0.8
EX-84	1681771.90	928787.63	777	131	151	Saprolite/Transition Zone/Bedrock	0.8
EX-85	1681779.35	928786.92	777	131	151	Saprolite/Transition Zone/Bedrock	0.8
EX-86	1681783.78	928786.57	777	131	151	Saprolite/Transition Zone/Bedrock	0.8
EX-87	1681787.14	928786.21	777	131	151	Saprolite/Transition Zone/Bedrock	0.8
EX-88	1681481.48	928657.45	771	123	143	Saprolite/Transition Zone/Bedrock	0.8
EX-89	1681622.63	928798.26	767	125	145	Saprolite/Transition Zone/Bedrock	0.8
EX-90	1681479.27	928638.30	771	123	143	Saprolite/Transition Zone/Bedrock	0.8
EX-91	1681560.75	928800.36	762	123	143	Saprolite/Transition Zone/Bedrock	0.8
EX-92	1681481.70	928741.62	765	123	143	Saprolite/Transition Zone/Bedrock	0.8
EX-93	1681482.33	928761.83	765	123	143	Saprolite/Transition Zone/Bedrock	0.8
EX-94	1681537.71	928800.05	762	123	143	Saprolite/Transition Zone/Bedrock	0.8
EX-95	1681482.33	928782.11	758	120	140	Saprolite/Transition Zone/Bedrock	0.8
EX-96	1681515.48	928803.17	762	123	143	Saprolite/Transition Zone/Bedrock	0.8
EX-97	1681748.09	928612.99	774	124	144	Saprolite/Transition Zone/Bedrock	0.8
EX-98	1681738.09	928602.19	774	124	144	Saprolite/Transition Zone/Bedrock	0.8
EX-99	1681731.75	928591.70	774	124	144	Saprolite/Transition Zone/Bedrock	0.8
EX-100	1681742.60	928607.00	774	124	144	Saprolite/Transition Zone/Bedrock	0.8
EX-101	1681734.30	928596.20	774	124	144	Saprolite/Transition Zone/Bedrock	0.8
EX-102	1681728.50	928585.40	774	124	144	Saprolite/Transition Zone/Bedrock	0.8
EX-103	1682698.22	929347.70	722	86	106	Saprolite/Transition Zone/Bedrock	0.8
EX-104	1682578.24	929276.28	751	99	119	Saprolite/Transition Zone/Bedrock	0.8
EX-105	1682826.77	929390.55	650	26	46	Saprolite/Transition Zone/Bedrock	0.8
EX-106	1681930.81	928557.94	742	20	40	Saprolite	0.8
EX-107	1681911.35	928500.94	747	25	45	Saprolite	0.8
EX-108	1681770.94	928282.67	748	32	52	Saprolite	0.8
EX-109	1681839.06	928366.08	750	32	52	Saprolite	0.8
EX-110	1681877.98	928445.33	745	25	45	Saprolite	0.8
EX-111	1681634.40	929008.60	745	36	56	Saprolite	0.8
EX-112	1681171.64	928093.38	765	54	74	Saprolite	0.8
EX-113	1681164.012	928005.4152	758	49	69	Saprolite	0.8

Prepared by: GTC Checked by: YG

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
BELEWS CREEK STEAM STATION
DUKE ENERGY CAROLINAS, LLC, BELEWS CREEK, 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 (flow paths downgradient, locations downgraident and sidegradient, and background of ash basin)

Downgradient Flow Path 1	Downgradient Flow Path 2	Downgradient Flow Path 3	Downgradient and Sidegradient	Background[1]
CCR-2D	GWA-20BR	CCR-6S	EXOB-1	BG-1S
CCR-2S	GWA-20SA	CCR-6D	EXOB-2	BG-1D
GWA-10SA	GWA-20D	CCR-6BR*	GWA-16S	BG-2S
GWA-10D	GWA-11S	MW-200BR	GWA-16DA	BG-2D
GWA-19D	GWA-11D	MW-200D	GWA-16BR	BG-2BRA
GWA-19SA	GWA-21S	MW-200S	GWA-17S	BG-3S
GWA-19BR	GWA-21D	GWA-24BR	GWA-17D	BG-3D
GWA-31S	GWA-27S	GWA-24D	GWA-18SA	MW-202S
GWA-31D	GWA-27D	GWA-24S	GWA-18D	MW-202D
	GWA-27BR		GWA-1S	MW-202BR
	CCR-13S		GWA-1D	
	CCR-13D		GWA-1BR	
	CCR-13BR		GWA-30S	
			GWA-30D	
			GWA-32S	
			GWA-32D	
			MW-204S	
			MW-204D	

PCMP Groundwater Well Monitoring Network (background, downgradient of ash basin)

A PCMP will be implemented at the Site in accordance with G.S. Section 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	Boron[5]	*Iron*	Nitrate + Nitrite	*Sulfate*
Aluminum	*Calcium*	*Lithium*	*Potassium*	Thallium
Arsenic	*Chloride*[5]	*Magnesium*	*Sodium*	Total Dissolved Solids[5]
Beryllium	Cobalt	*Manganese*	*Strontium*	*Total Organic Carbon*
Bicarbonate Alkalinity	*Ferrous Iron*			

PCMP Groundwater Quality (Sampling frequency to be determined)

Parameters and sampling frequency to be included in the PCMP in accordance with G.S. Section 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 termination 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. Section 130A-309.214(4)(k)(2).

Request for termination:

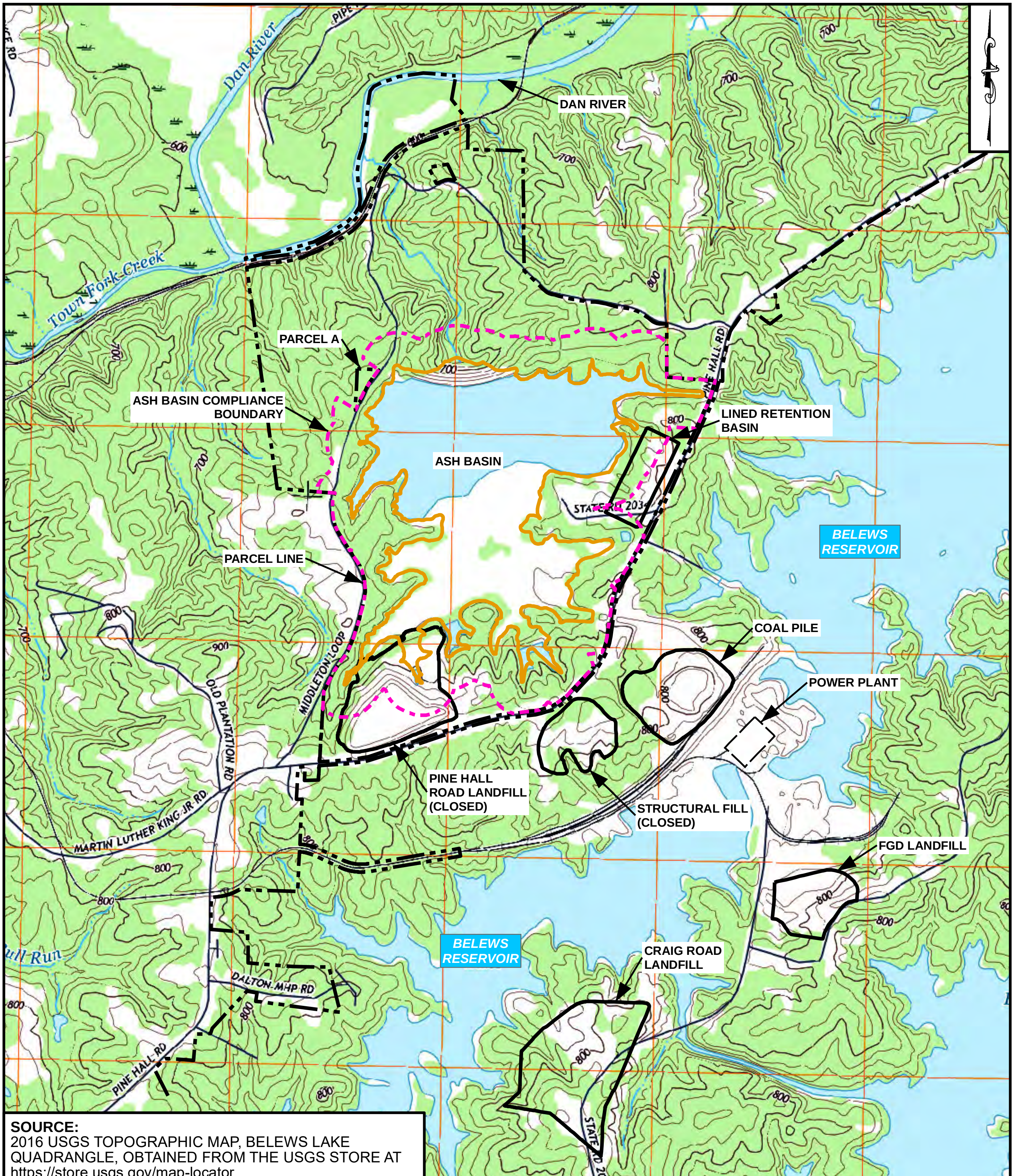
If groundwater monitoring results are below applicable Standards at the compliance boundary for three years, Duke Energy will request completion of corrective action in accordance with G.S. Section 130A-309.214(a)(3)b. If groundwater monitoring results are above applicable Standards, the PCMP will continue.

Prepared by: ALA Checked by: CDE

[1] Approved background groundwater monitoring locations
[2] Geochemically non-reactive constituents (i.e., conservative corrective action COIs) that best depict 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] Constituents to assess effectiveness of corrective action in the source area
* Proposed new well for effectiveness monitoring
Italicized parameters - parameters for water quality to evaluate monitoring data quality

FIGURES

(CAP Content Section 10)



SOURCE:
2016 USGS TOPOGRAPHIC MAP, BELEWS LAKE QUADRANGLE, OBTAINED FROM THE USGS STORE AT https://store.usgs.gov/map-locator.

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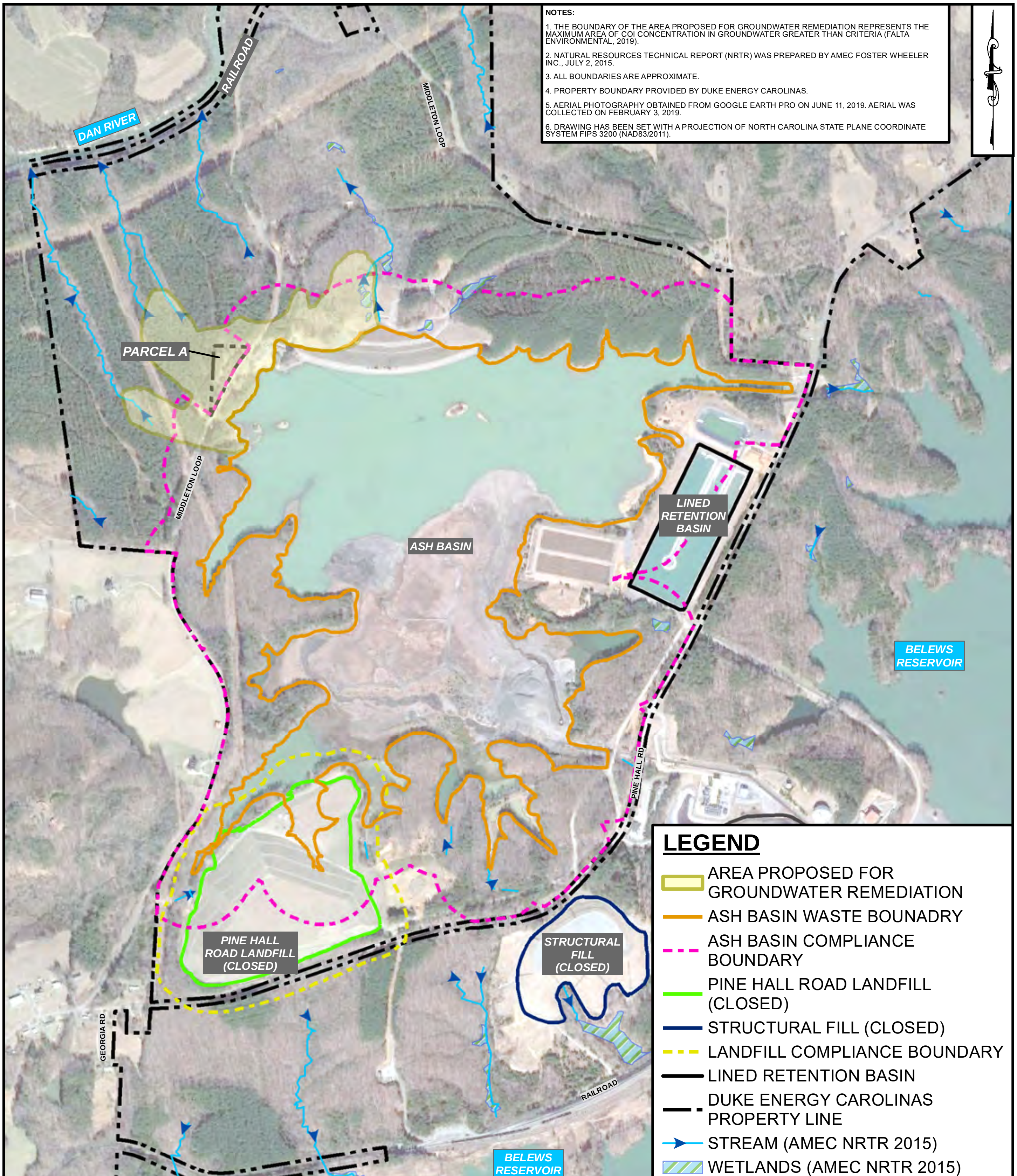
FIGURE ES-1
USGS LOCATION MAP
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA

DRAWN BY: B. YOUNG	DATE: 05/15/2019
REVISED BY: B. YOUNG	DATE: 07/08/2019
CHECKED BY: A. ALBERT	DATE: 07/08/2019
APPROVED BY: A. ALBERT	DATE: 07/08/2019
PROJECT MANAGER: A. ALBERT	

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



NOTES:

1. THE BOUNDARY OF THE AREA PROPOSED FOR GROUNDWATER REMEDIATION REPRESENTS THE MAXIMUM AREA OF COI CONCENTRATION IN GROUNDWATER GREATER THAN CRITERIA (FALTA ENVIRONMENTAL, 2019).

2. NATURAL RESOURCES TECHNICAL REPORT (NRTR) WAS PREPARED BY AMEC FOSTER WHEELER INC., JULY 2, 2015.

3. ALL BOUNDARIES ARE APPROXIMATE.

4. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.

5. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON JUNE 11, 2019. AERIAL WAS COLLECTED ON FEBRUARY 3, 2019.

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

LEGEND

- AREA PROPOSED FOR GROUNDWATER REMEDIATION
- ASH BASIN WASTE BOUNADRY
- ASH BASIN COMPLIANCE BOUNDARY
- PINE HALL ROAD LANDFILL (CLOSED)
- STRUCTURAL FILL (CLOSED)
- LANDFILL COMPLIANCE BOUNDARY
- LINED RETENTION BASIN
- DUKE ENERGY CAROLINAS PROPERTY LINE
- STREAM (AMEC NRTR 2015)
- WETLANDS (AMEC NRTR 2015)

DUKE ENERGY CAROLINAS

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GRAPHIC SCALE
600 0 600 1,200
(IN FEET)

DRAWN BY: J. KIRTZ DATE: 05/16/2019
REVISED BY: C. WYATT DATE: 12/16/2019
CHECKED BY: C. EADY DATE: 12/16/2019
APPROVED BY: C. EADY DATE: 12/16/2019
PROJECT MANAGER: A. ALBERT

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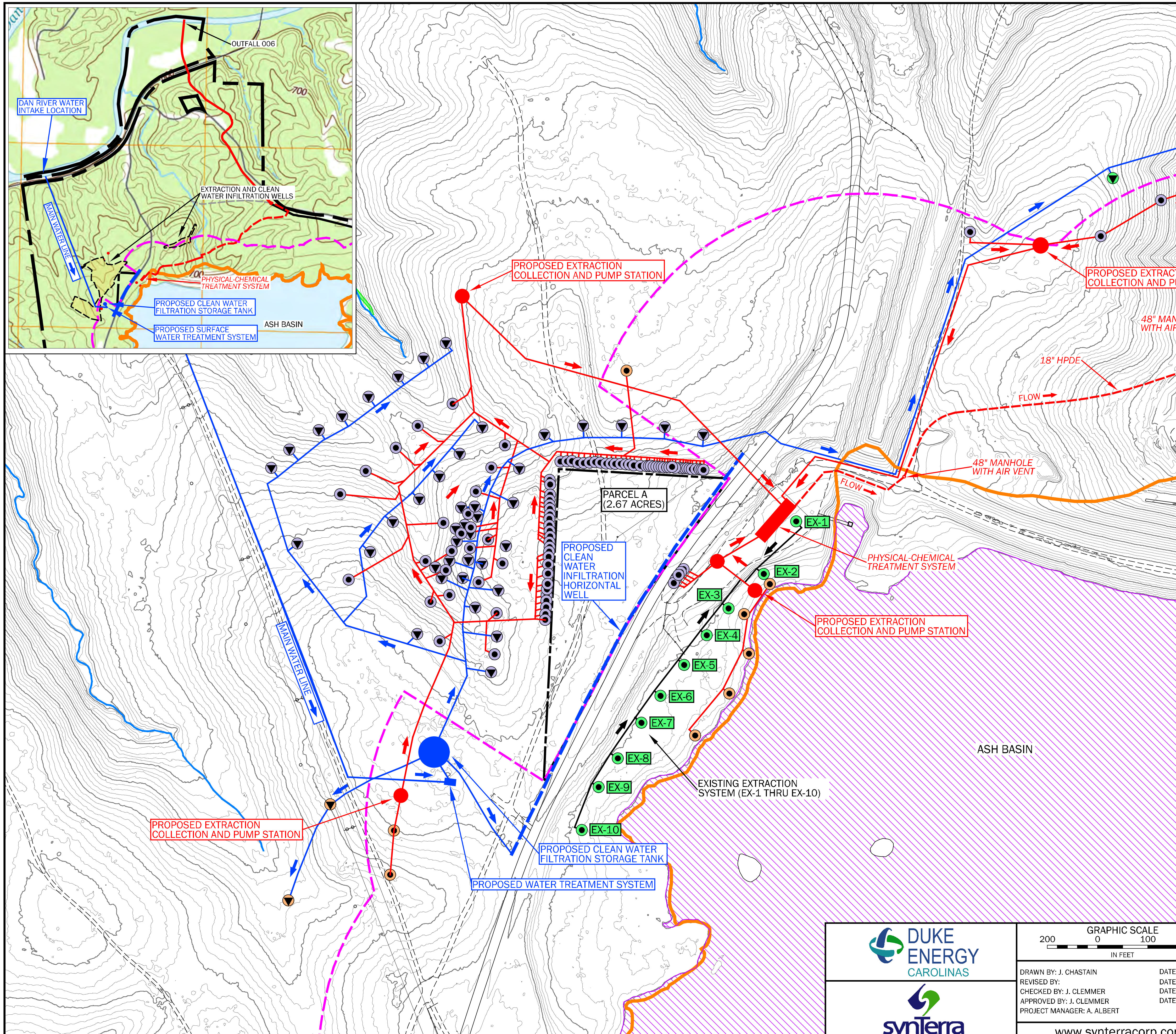
FIGURE ES-2
AREA PROPOSED FOR CORRECTIVE ACTION
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA



LEGEND

EX-2	EXISTING EXTRACTION SYSTEM WELLS EX-1 THRU EX-10
	PROPOSED EXTRACTION WELL IN SAPROLITE
	PROPOSED CLEAN WATER INFILTRATION WELL IN SAPROLITE
	PROPOSED EXTRACTION WELL IN TRANSITION ZONE
	PROPOSED CLEAN WATER INFILTRATION WELL IN TRANSITION ZONE
	PROPOSED EXTRACTION WELL IN BEDROCK
	PROPOSED CLEAN WATER INFILTRATION WELL IN BEDROCK
	PROPOSED CLEAN WATER INFILTRATION HORIZONTAL WELL (SAPROLITE)
	PROPOSED CLEAN WATER INFILTRATION PIPING
	PROPOSED CLEAN WATER INFILTRATION PIPING FLOW DIRECTION
	PROPOSED EXTRACTION PIPING
	PROPOSED EXTRACTION PIPING FLOW DIRECTION
	DECANT PIPING
FLOW	DECANT PIPING FLOW DIRECTION
	DUKE ENERGY CAROLINAS PROPERTY LINE
	ASH BASIN COMPLIANCE BOUNDARY
	WASTE BOUNDARY
	ASH BASIN PONDED WATER

NOTES

1.) ALL BOUNDARIES ARE APPROXIMATE.

2.) DUKE ENERGY PROPERTY LINES ARE REPRESENTED SAMPLE LOCATIONS WERE DERIVED FROM VARIOUS SOURCES AND ARE A MIX OF SURVEYED AND APPROXIMATE LOCATIONS. THEREFORE LOCATIONS ARE DEEMED TO BE APPROXIMATE.

3.)THE TOPOGRAPHY IS SHOWN FOR REFERENCE PURPOSES ONLY AND SHOULD NOT BE USED FOR DESIGN OR ENGINEERING PURPOSES. THE TOPOGRAPHY BASED ON A COMBINATION OF SOURCES.
LIDAR DATA OBTAINED FROM NC FLOODPLAIN MAPPING PROGRAM - SPATIAL DATA DOWNLOAD AT https://sdd.nc.gov/DataDownload.aspx#
DATA WAS SOURCED FROM THEIR PHASE 3 - 2015 QL2 LIDAR

4.) THE WATERS OF THE US DELINEATION HAS NOT BEEN APPROVED BY THE U.S. ARMY CORPS OF ENGINEERS AT THE TIME OF THE MAP CREATION. THIS MAP IS A PRELIMINARY JURISDICTIONAL DETERMINATION ONLY. THE PRELIMINARY WETLANDS AND STREAM BOUNDARIES WETLANDS AND STREAMS BOUNDARIES WERE OBTAINED FROM AMEC FOSTER WHEELER ENVIRONMENTAL AND INFRASTRUCTURE INC. NATURAL RESOURCE TECHNICAL REPORT (NRTR) FOR BELEWS CREEK STATION", DATED JUNE 2015.

5.) SITE FEATURES INCLUDING UTILITIES ARE BASED ON SEVERAL SOURCES. ANY UTILITIES SHOWN ARE FOR REFERENCE PURPOSES ONLY AND HAVE NOT BEEN FIELD VERIFIED WITH REGARDS TO THEIR HORIZONTAL OR VERTICAL LOCATIONS IN THE FIELD. ALL FEATURES INCLUDING UTILITIES ARE DEEMED TO BE APPROXIMATELY LOCATED.
2017 AERIAL PHOTOGRAPHS OBTAINED FROM NC ONE MAP AT
https://nconemap.maps.arcgis.com/apps/webappviewer/index.html?id=2c8a9b366c4841f1be2b464347d04a2b
2014 AERIAL PHOTOGRAPH WAS OBTAINED FROM WSP FLOWN ON APRIL 17, 2014.

6.) DRAWING HAS BEEN SET WITH A PROJECTION OF NORTH CAROLINA STATE PLANE COORDINATE SYSTEM FIP 3200 (NAD83 AND NAVD 88.

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GRAPHIC SCALE
200 0 100 200
IN FEET

DRAWN BY: J. CHASTAIN DATE: 12/15/2019
REVISED BY: DATE: -
CHECKED BY: J. CLEMMER DATE: 12/15/2019
APPROVED BY: J. CLEMMER DATE: 12/15/2019
PROJECT MANAGER: A. ALBERT

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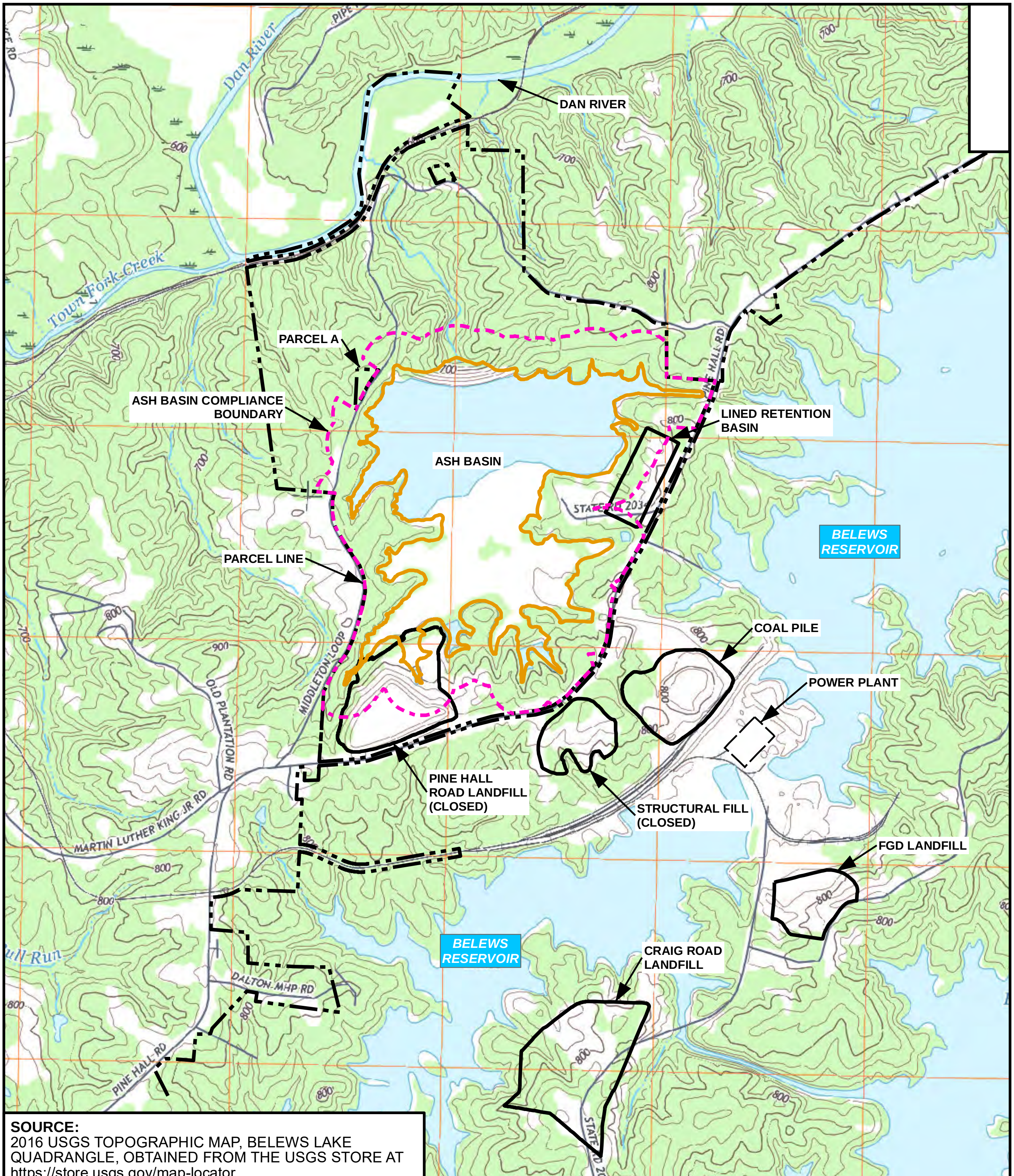
FIGURE ES-3
PROPOSED CORRECTIVE ACTION APPROACH
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA



SOURCE:
2016 USGS TOPOGRAPHIC MAP, BELEWS LAKE QUADRANGLE, OBTAINED FROM THE USGS STORE AT https://store.usgs.gov/map-locator.

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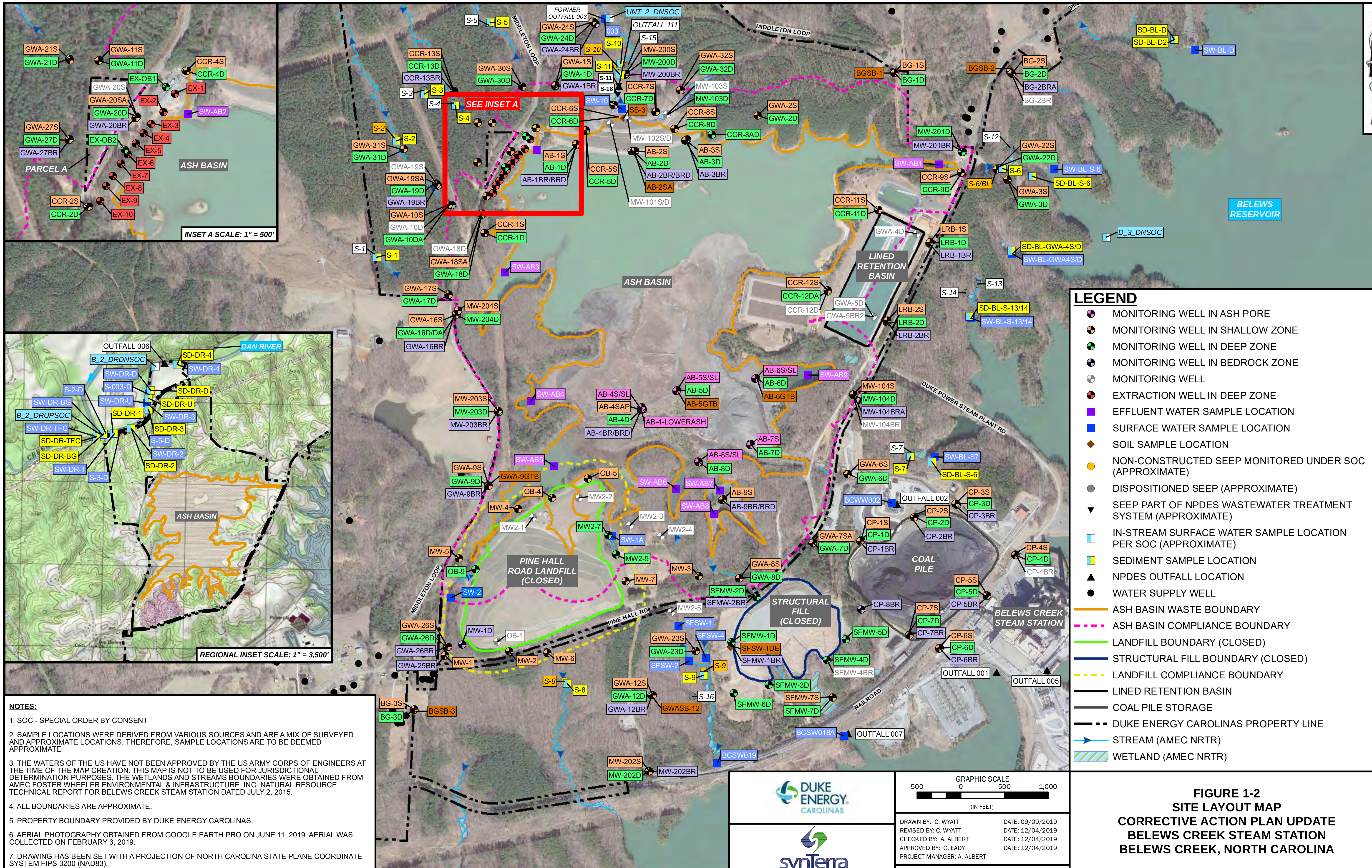
FIGURE 1-1
USGS LOCATION MAP
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA

DRAWN BY: C. WYATT — DATE: 09/11/2019
REVISED BY: C. WYATT — DATE: 12/04/2019
CHECKED BY: A. ALBERT — DATE: 12/04/2019
APPROVED BY: A. ALBERT — DATE: 12/04/2019
PROJECT MANAGER: A. ALBERT

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



LEGEND

- MONITORING WELL IN ASH PORE
- MONITORING WELL IN SHALLOW ZONE
- MONITORING WELL IN DEEP ZONE
- MONITORING WELL IN BEDROCK ZONE
- MONITORING WELL
- EXTRACTION WELL IN DEEP ZONE
- EFFLUENT WATER SAMPLE LOCATION
- SURFACE WATER SAMPLE LOCATION
- SOIL SAMPLE LOCATION
- NON-CONSTRUCTED SEEP MONITORED UNDER SOC (APPROXIMATE)
- DISPOSITIONED SEEP (APPROXIMATE)
- SEEP PART OF NPDES WASTEWATER TREATMENT SYSTEM (APPROXIMATE)
- IN-STREAM SURFACE WATER SAMPLE LOCATION PER SOC (APPROXIMATE)
- SEDIMENT SAMPLE LOCATION
- NPDES OUTFALL LOCATION
- WATER SUPPLY WELL
- ASH BASIN WASTE BOUNDARY
- ASH BASIN COMPLIANCE BOUNDARY
- LANDFILL BOUNDARY (CLOSED)
- STRUCTURAL FILL BOUNDARY (CLOSED)
- LANDFILL COMPLIANCE BOUNDARY
- LINED RETENTION BASIN
- COAL PILE STORAGE
- DUKE ENERGY CAROLINAS PROPERTY LINE
- STREAM (AMEC NRTR)
- WETLAND (AMEC NRTR)

NOTES:

1. SOC - SPECIAL ORDER BY CONSENT
2. SAMPLE LOCATIONS WERE DERIVED FROM VARIOUS SOURCES AND ARE A MIX OF SURVEYED AND APPROXIMATE LOCATIONS. THEREFORE, SAMPLE LOCATIONS ARE TO BE DEEMED APPROXIMATE
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 NOT TO BE USED FOR JURISDICTIONAL DETERMINATION PURPOSES. THE WETLANDS AND STREAMS BOUNDARIES WERE OBTAINED FROM AMEC FOSTER WHEELER ENVIRONMENTAL & INFRASTRUCTURE, INC. NATURAL RESOURCE TECHNICAL REPORT FOR BELEWS CREEK STEAM STATION DATED JULY 2, 2015.
4. ALL BOUNDARIES ARE APPROXIMATE.
5. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.
6. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON JUNE 11, 2019. AERIAL WAS COLLECTED ON FEBRUARY 3, 2019.
7. DRAWING HAS BEEN SET WITH A PROJECTION OF NORTH CAROLINA STATE PLANE COORDINATE SYSTEM FIPS 3200 (NAD83).

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GRAPHIC SCALE
500 0 500 1,000
(IN FEET)

DRAWN BY: C. WYATT DATE: 09/09/2019
REVISED BY: C. WYATT DATE: 12/04/2019
CHECKED BY: A. ALBERT DATE: 12/04/2019
APPROVED BY: C. EADY DATE: 12/04/2019
PROJECT MANAGER: A. ALBERT

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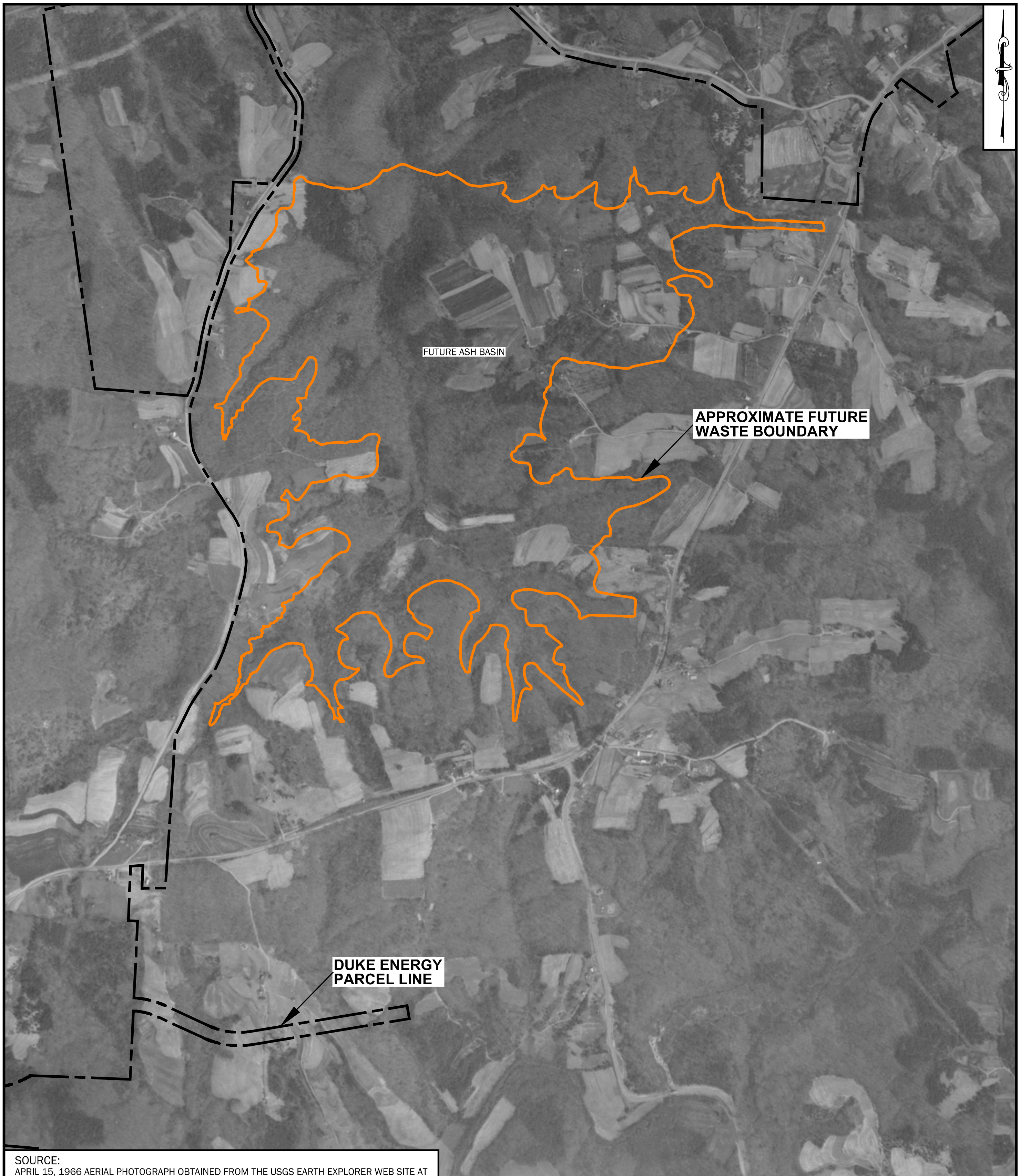
FIGURE 1-2
SITE LAYOUT MAP
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA



SOURCE:
APRIL 15, 1966 AERIAL PHOTOGRAPH OBTAINED FROM THE USGS EARTH EXPLORER WEB SITE AT http://earthexplorer.usgs.gov/

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GRAPHIC SCALE
275 0 275 550
IN FEET

DRAWN BY: J. CHASTAIN DATE: 8/16/2017
REVISED BY: C. NEWELL DATE: 12/20/2019
CHECKED BY: D. AVARD DATE: 12/20/2019
APPROVED BY: A. ALBERT DATE: 12/20/2019
PROJECT MANAGER: A. ALBERT

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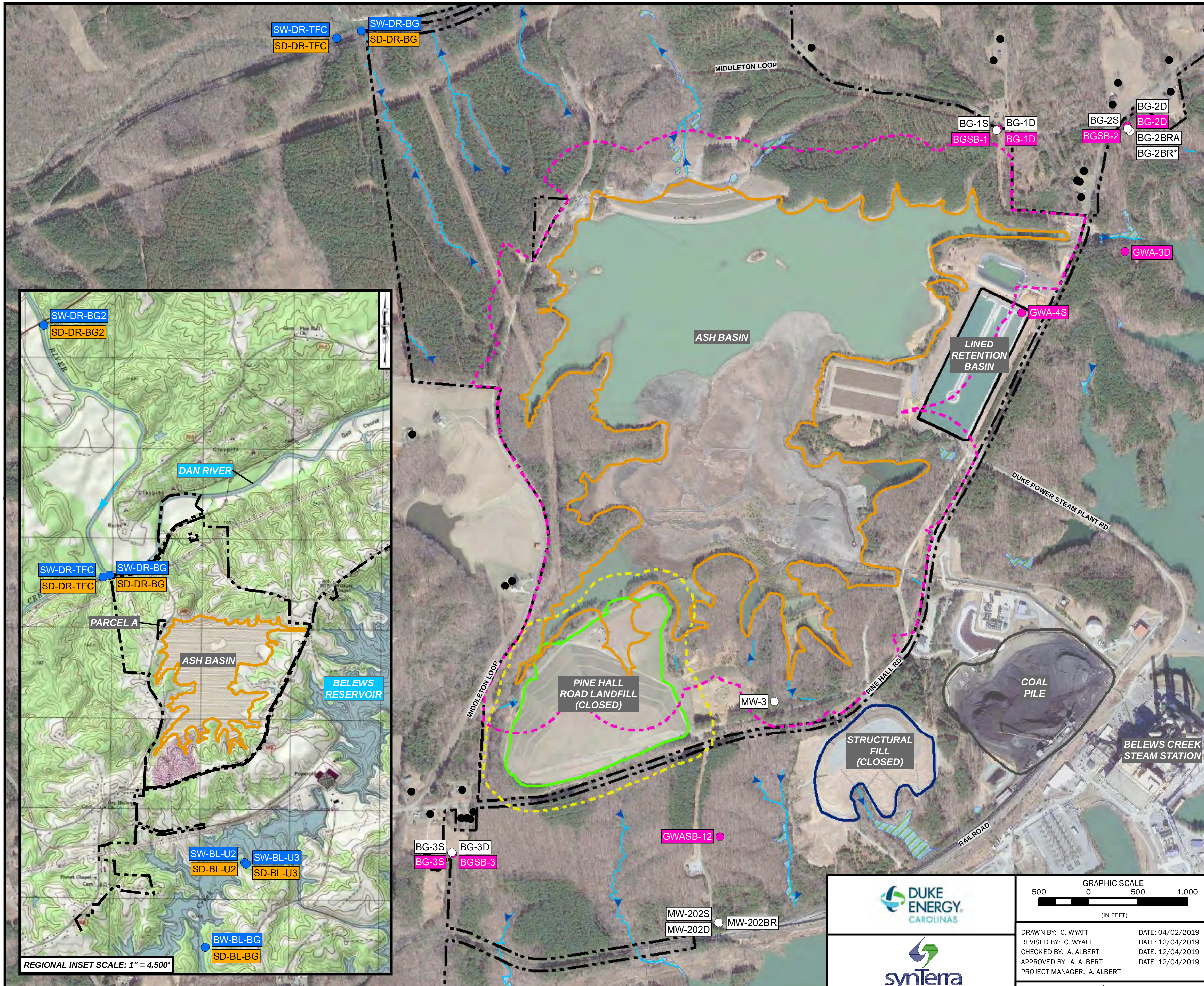
FIGURE 1-3
1966 AERIAL PHOTOGRAPH
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA



LEGEND

- GROUNDWATER SAMPLE
- SOIL SAMPLE LOCATION
- SURFACE WATER SAMPLE
- SEDIMENT SAMPLE
- WATER SUPPLY WELL
- ASH BASIN WASTE
- ASH BASIN COMPLIANCE
- LANDFILL BOUNDARY
- STRUCTURAL FILL BOUNDARY
- LANDFILL COMPLIANCE
- LINED RETENTION BASIN
- COAL PILE STORAGE
- DUKE ENERGY CAROLINAS PROPERTY
- STREAM (AMEC NRTR)
- WETLAND (AMEC NRTR)

NOTES:

1. *ABANDONED MONITORING WELL LOCATION.
2. SD PREFIX INDICATES A SEDIMENT SAMPLE ID.
3. SW INDICATES SURFACE WATER.
4. 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 NOT TO BE USED FOR JURISDICTIONAL DETERMINATION PURPOSES. THE WETLANDS AND STREAMS BOUNDARIES WERE OBTAINED FROM AMEC FOSTER WHEELER ENVIRONMENTAL & INFRASTRUCTURE, INC. NATURAL RESOURCE TECHNICAL REPORT FOR BELEWS CREEK STEAM STATION DATED JULY 2, 2015.
5. ALL BOUNDARIES ARE APPROXIMATE.
6. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.
7. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON JUNE 11, 2019. AERIAL WAS COLLECTED ON FEBRUARY 3, 2019.
8. DRAWING HAS BEEN SET WITH A PROJECTION OF NORTH CAROLINA STATE PLANE COORDINATE SYSTEM FIPS 3200 (NAD83/2011).

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GRAPHIC SCALE
500 0 500 1,000
(IN FEET)

DRAWN BY: C. WYATT	DATE: 04/02/2019
REVISED BY: C. WYATT	DATE: 12/04/2019
CHECKED BY: A. ALBERT	DATE: 12/04/2019
APPROVED BY: A. ALBERT	DATE: 12/04/2019
PROJECT MANAGER: A. ALBERT	

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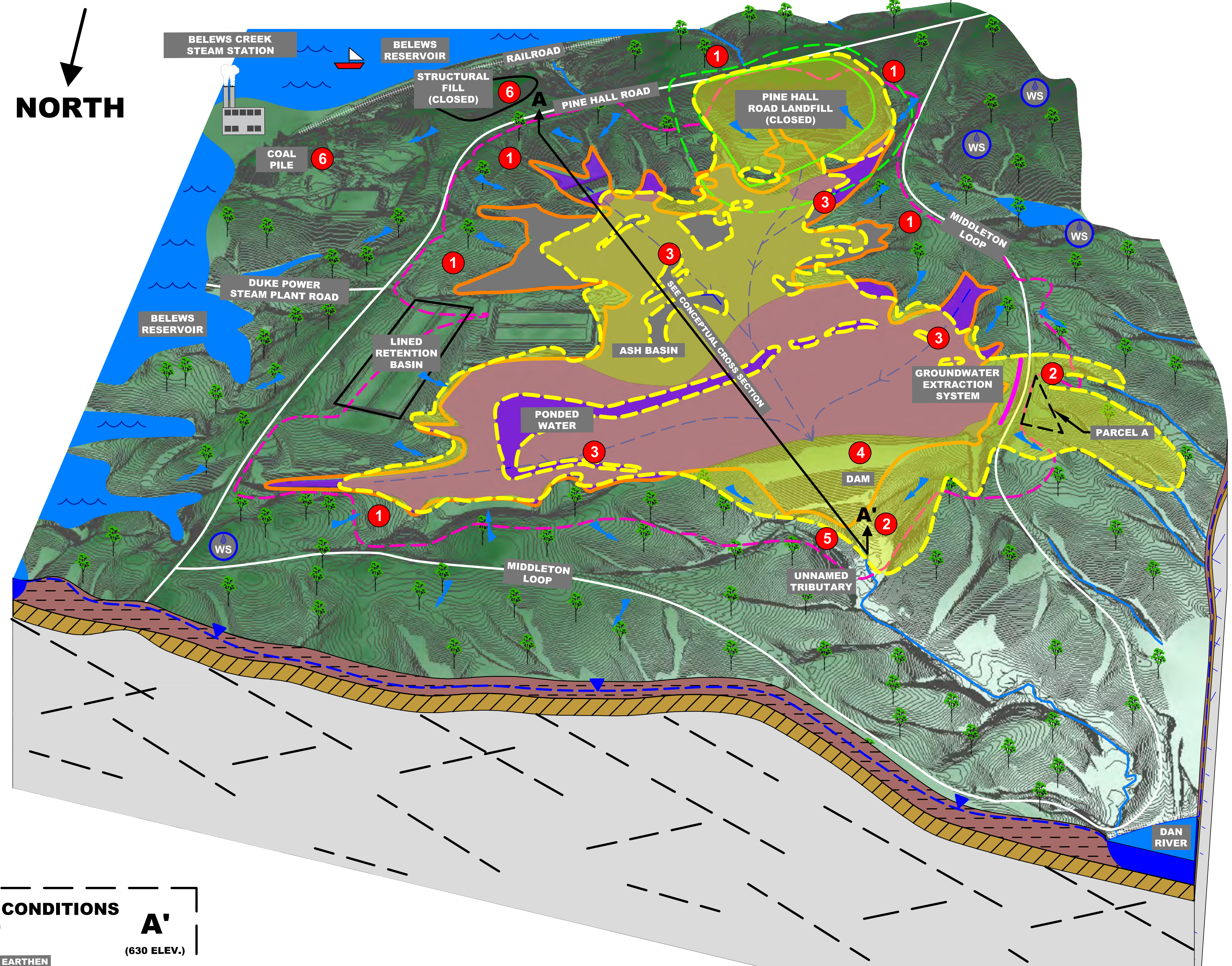
FIGURE 4-1
BACKGROUND SAMPLE LOCATION MAP
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA

SITE FEATURES KEY

1. GROUNDWATER FLOWS FROM RIDGES THAT COINCIDE WITH GROUNDWATER DIVIDES WHICH PROVIDE HYDRAULIC CONTROL WITHIN THE FORMER STREAM VALLEY AND AWAY FROM POTENTIAL RECEPTORS AND WATER SUPPLY WELLS
2. LIMITED COI MIGRATION THROUGH INTERCONNECTED BEDROCK FRACTURES. BEDROCK FRACTURE OCCURRENCE AND APERTURE DIMINISHES WITH DEPTH
3. FORMER STREAM CHANNELS IN ASH BASIN
4. PONDED WATER IN THE ASH BASIN 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 DAM LIMIT VERTICAL MIGRATION OF CONSTITUENTS
6. UNITS NOT CONSIDERED HYDRAULICALLY ASSOCIATED WITH ASH BASIN DUE TO GROUNDWATER DIVIDES. ADDITIONAL ASSESSMENT BEING CONDUCTED UNDER NCDEQ OVERSIGHT. COAL PILE AND STRUCTURAL FILL ASSESSMENTS ONGOING AND ARE THEREFORE NOT ADDRESSED IN THE CORRECTIVE ACTION PLAN UPDATE.

- AREA OF COI CONCENTRATION IN GROUNDWATER GREATER THAN CRITERIA (SEE GENERAL NOTE 1)
- GENERALIZED GROUNDWATER FLOW DIRECTION
- GENERALIZED ASH PORE WATER FLOW DIRECTION
- STREAM
- APPROXIMATE FORMER STREAM
- ASH BASIN WASTE BOUNDARY
- ASH BASIN COMPLIANCE BOUNDARY
- LANDFILL WASTE BOUNDARY
- LANDFILL COMPLIANCE BOUNDARY
- SITE FEATURES
- WS GENERAL AREA OF WATER SUPPLY WELL USERS (SEE GENERAL NOTE 2)
- INTERIM ACTION GROUNDWATER EXTRACTION SYSTEM
- BEDROCK FRACTURE ORIENTATION

NORTH



GENERAL NOTES

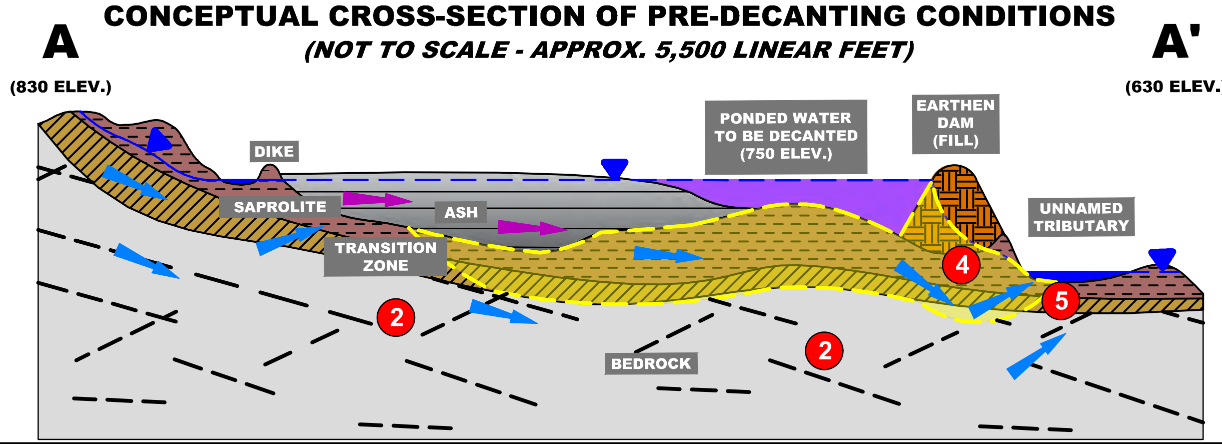
1) GENERALIZED AREAL EXTENT OF MIGRATION REPRESENTED BY NCAC 02L, IMAC, OR APPROVED BACKGROUND THRESHOLD VALUE EXCEEDANCE OF BORON CONSTITUENT IN MULTIPLE FLOW ZONES. OTHER CONSTITUENT OF INTEREST THAT EXCEED THE CRITERIA ABOVE ARE WITHIN THE BORON CONSTITUENT AREA.

2) PERMANENT WATER SUPPLY HAS BEEN IMPLEMENTED PROVIDING 36 SURROUNDING WELL USERS WITH WATER TREATMENT SYSTEMS, THIS WORK WAS COMPLETED IN ACCORDANCE WITH HB630 AND SUBSEQUENTLY APPROVED BY NCDEQ ON OCTOBER 12, 2018.

3) ALL BOUNDARIES ARE APPROXIMATE.

CONCEPTUAL CROSS-SECTION OF PRE-DECANTING CONDITIONS

(NOT TO SCALE - APPROX. 5,500 LINEAR FEET)



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VISUAL AID ONLY - DEPICTION NOT TO SCALE

DRAWN BY: A. FEIGL	DATE: 6/2/2019
REVISED BY: C. NEWELL	DATE: 12/13/2019
CHECKED BY: D. AVARD	DATE: 12/13/2019
APPROVED BY: A. ALBERT	DATE: 12/13/2019
PROJECT MANAGER: A. ALBERT	

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FIGURE 5-1
CONCEPTUAL SITE MODEL - PRE-DECANTING CONDITIONS
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA

Figure 5-2

Legrand Slope Aquifer System

Included in Section 5 text

Figure 5-3

General 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 (April 8, 2019)

Provided in separate electronic figure file as a large sheet size

Figure 5-4b

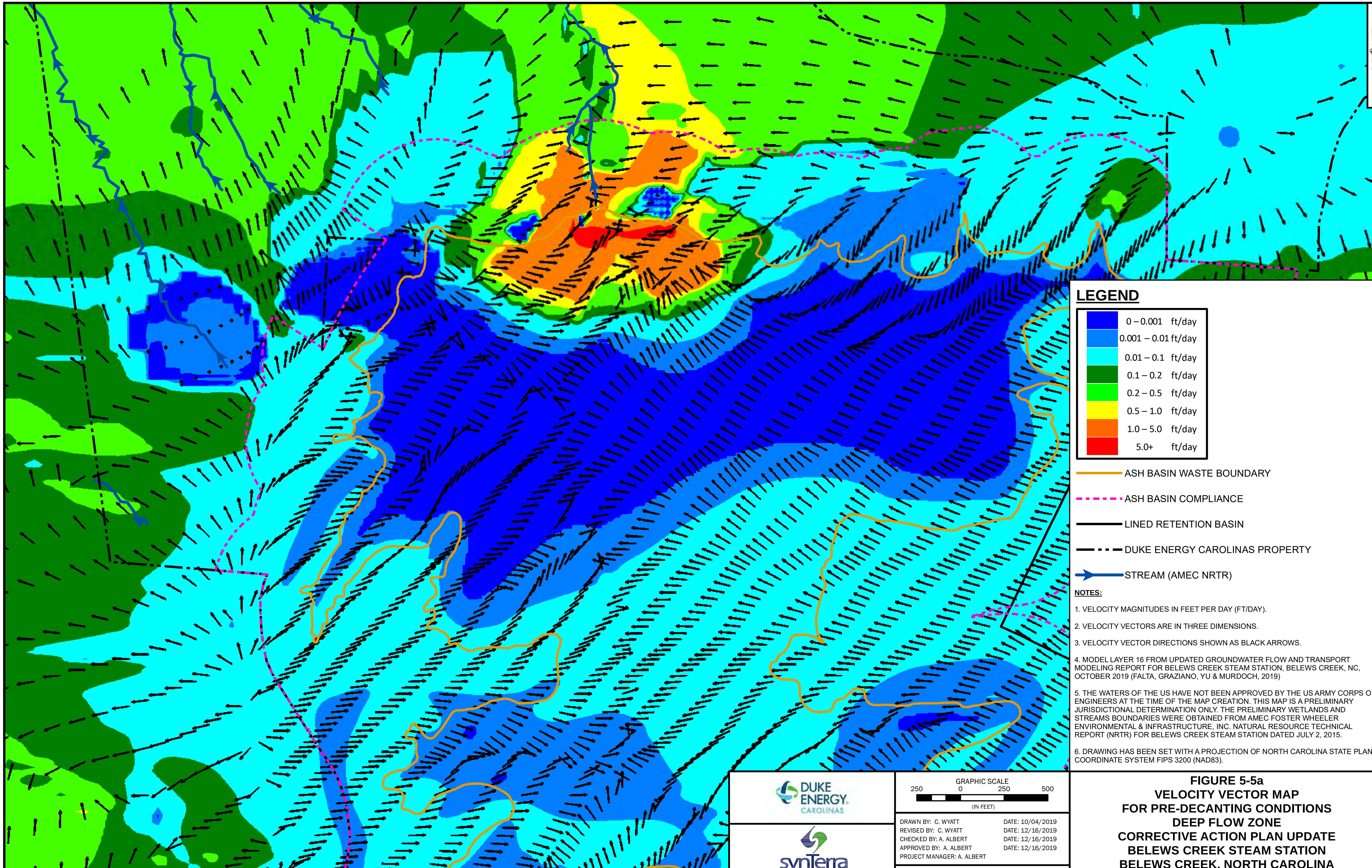
Water Level Map – Transition Flow Zone (April 8, 2019)

Provided in separate electronic figure file as a large sheet size

Figure 5-4c

Water Level Map – Bedrock Flow Zone (April 8, 2019)

Provided in separate electronic figure file as a large sheet size



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 16 FROM UPDATED GROUNDWATER FLOW AND TRANSPORT MODELING REPORT FOR BELEWS CREEK STEAM STATION, BELEWS CREEK, NC, OCTOBER 2019 (FALTA, GRAZIANO, YU & MURDOCH, 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 BELEWS CREEK STEAM STATION DATED JULY 2, 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: 12/16/2019
CHECKED BY: A. ALBERT	DATE: 12/16/2019
APPROVED BY: A. ALBERT	DATE: 12/16/2019
PROJECT MANAGER: A. ALBERT	

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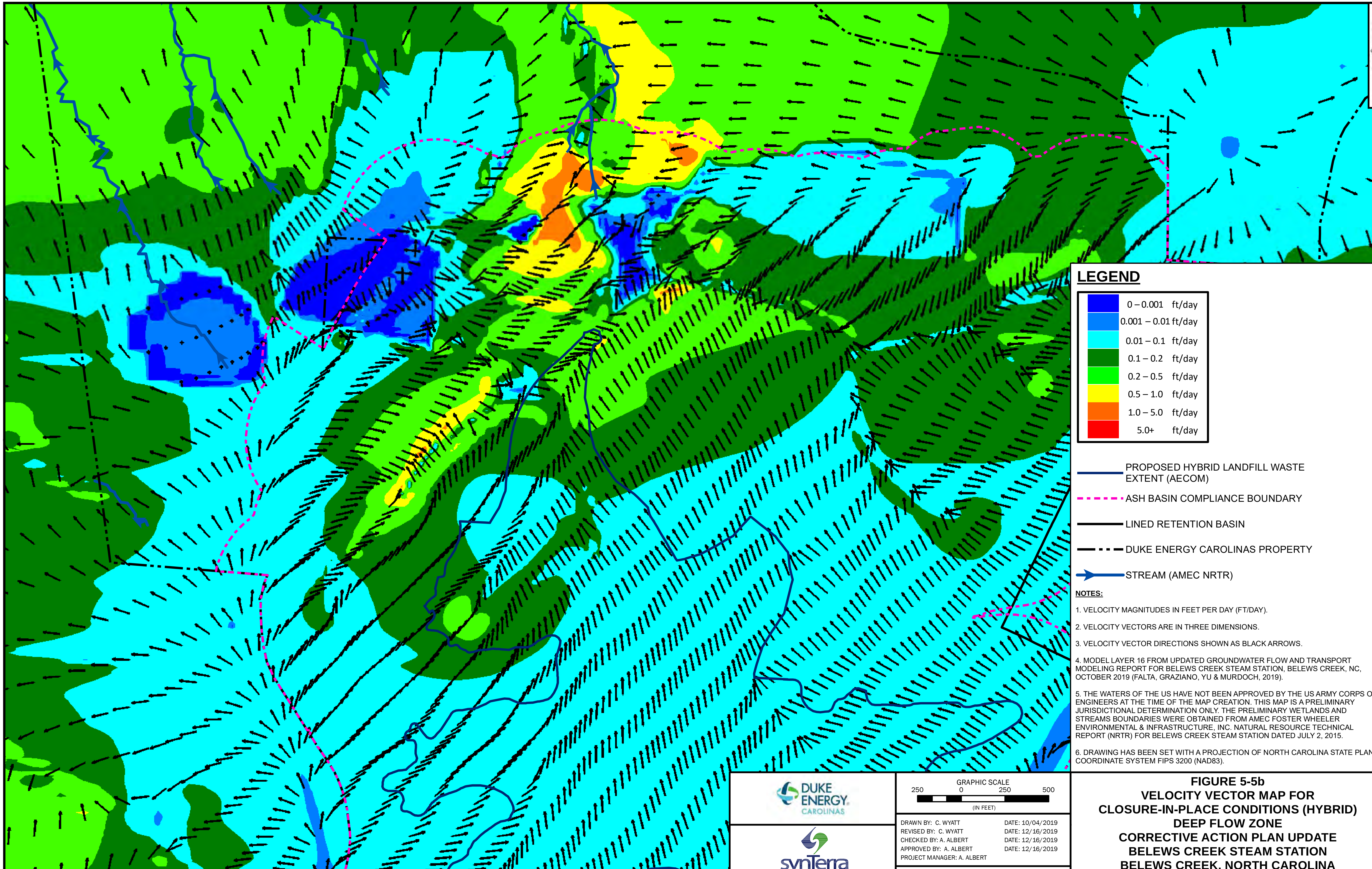
FIGURE 5-5a
VELOCITY VECTOR MAP
FOR PRE-DECANTING CONDITIONS
DEEP FLOW ZONE
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA



LEGEND

Dark blue	0 – 0.001 ft/day
Blue	0.001 – 0.01 ft/day
Cyan	0.01 – 0.1 ft/day
Dark green	0.1 – 0.2 ft/day
Green	0.2 – 0.5 ft/day
Yellow	0.5 – 1.0 ft/day
Orange	1.0 – 5.0 ft/day
Red	5.0+ ft/day

PROPOSED HYBRID LANDFILL WASTE EXTENT (AECOM)

ASH BASIN COMPLIANCE BOUNDARY

LINED RETENTION BASIN

DUKE ENERGY CAROLINAS PROPERTY

STREAM (AMEC NRTR)

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 16 FROM UPDATED GROUNDWATER FLOW AND TRANSPORT MODELING REPORT FOR BELEWS CREEK STEAM STATION, BELEWS CREEK, NC, OCTOBER 2019 (FALTA, GRAZIANO, YU & MURDOCH, 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 BELEWS CREEK STEAM STATION DATED JULY 2, 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
250 0 250 500
(IN FEET)

DRAWN BY: C. WYATT DATE: 10/04/2019
REVISED BY: C. WYATT DATE: 12/16/2019
CHECKED BY: A. ALBERT DATE: 12/16/2019
APPROVED BY: A. ALBERT DATE: 12/16/2019
PROJECT MANAGER: A. ALBERT

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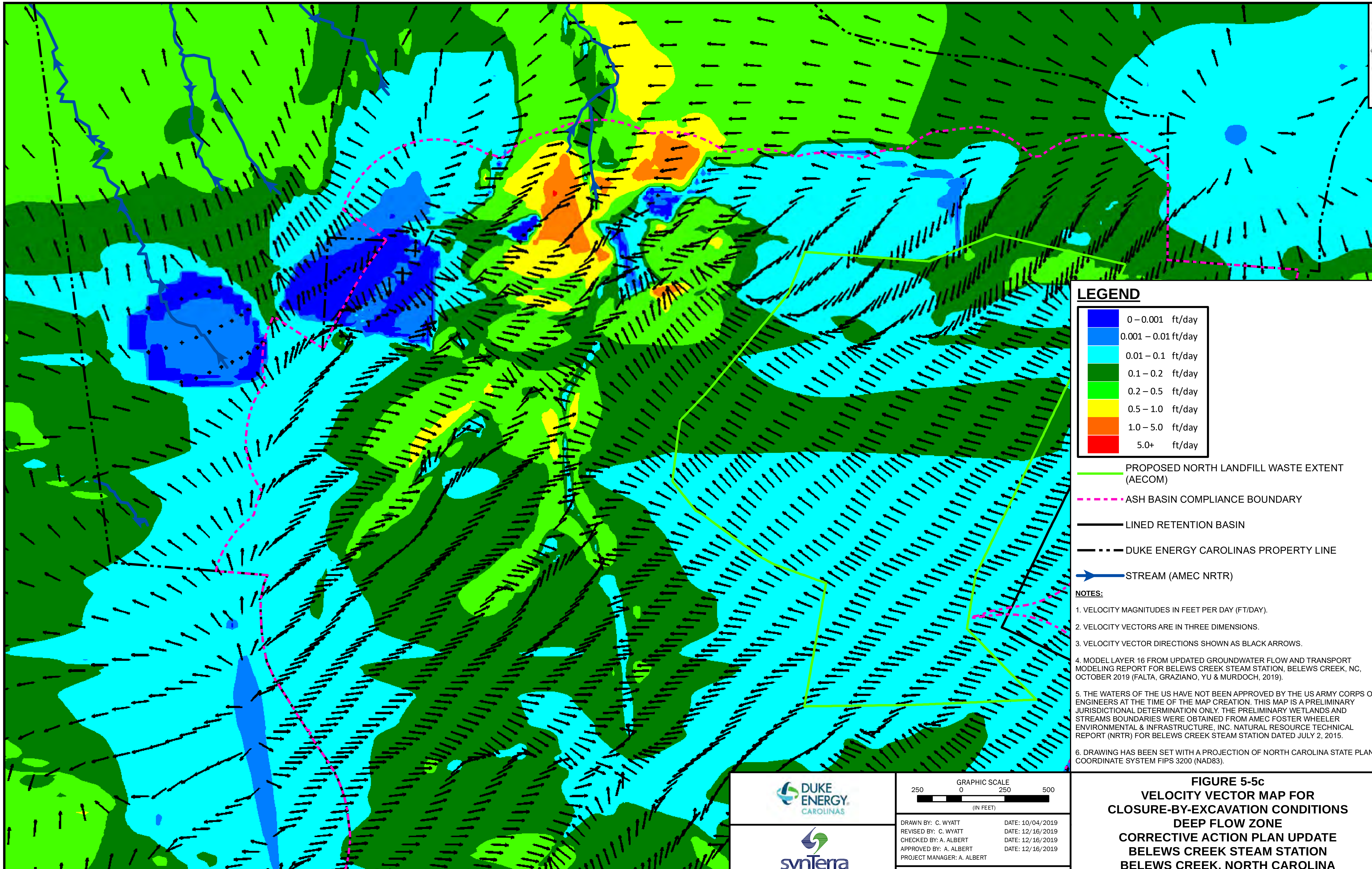
FIGURE 5-5b
VELOCITY VECTOR MAP FOR CLOSURE-IN-PLACE CONDITIONS (HYBRID)
DEEP FLOW ZONE
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA



LEGEND

Dark blue	0 – 0.001 ft/day
Blue	0.001 – 0.01 ft/day
Cyan	0.01 – 0.1 ft/day
Dark green	0.1 – 0.2 ft/day
Green	0.2 – 0.5 ft/day
Yellow	0.5 – 1.0 ft/day
Orange	1.0 – 5.0 ft/day
Red	5.0+ ft/day

PROPOSED NORTH LANDFILL WASTE EXTENT (AECOM)

ASH BASIN COMPLIANCE BOUNDARY

LINED RETENTION BASIN

DUKE ENERGY CAROLINAS PROPERTY LINE

STREAM (AMEC NRTR)

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 16 FROM UPDATED GROUNDWATER FLOW AND TRANSPORT MODELING REPORT FOR BELEWS CREEK STEAM STATION, BELEWS CREEK, NC, OCTOBER 2019 (FALTA, GRAZIANO, YU & MURDOCH, 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 BELEWS CREEK STEAM STATION DATED JULY 2, 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

250 0 250 500

(IN FEET)

DRAWN BY: C. WYATT	DATE: 10/04/2019
REVISED BY: C. WYATT	DATE: 12/16/2019
CHECKED BY: A. ALBERT	DATE: 12/16/2019
APPROVED BY: A. ALBERT	DATE: 12/16/2019
PROJECT MANAGER: A. ALBERT	

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FIGURE 5-5c
VELOCITY VECTOR MAP FOR CLOSURE-BY-EXCAVATION CONDITIONS DEEP FLOW ZONE
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA

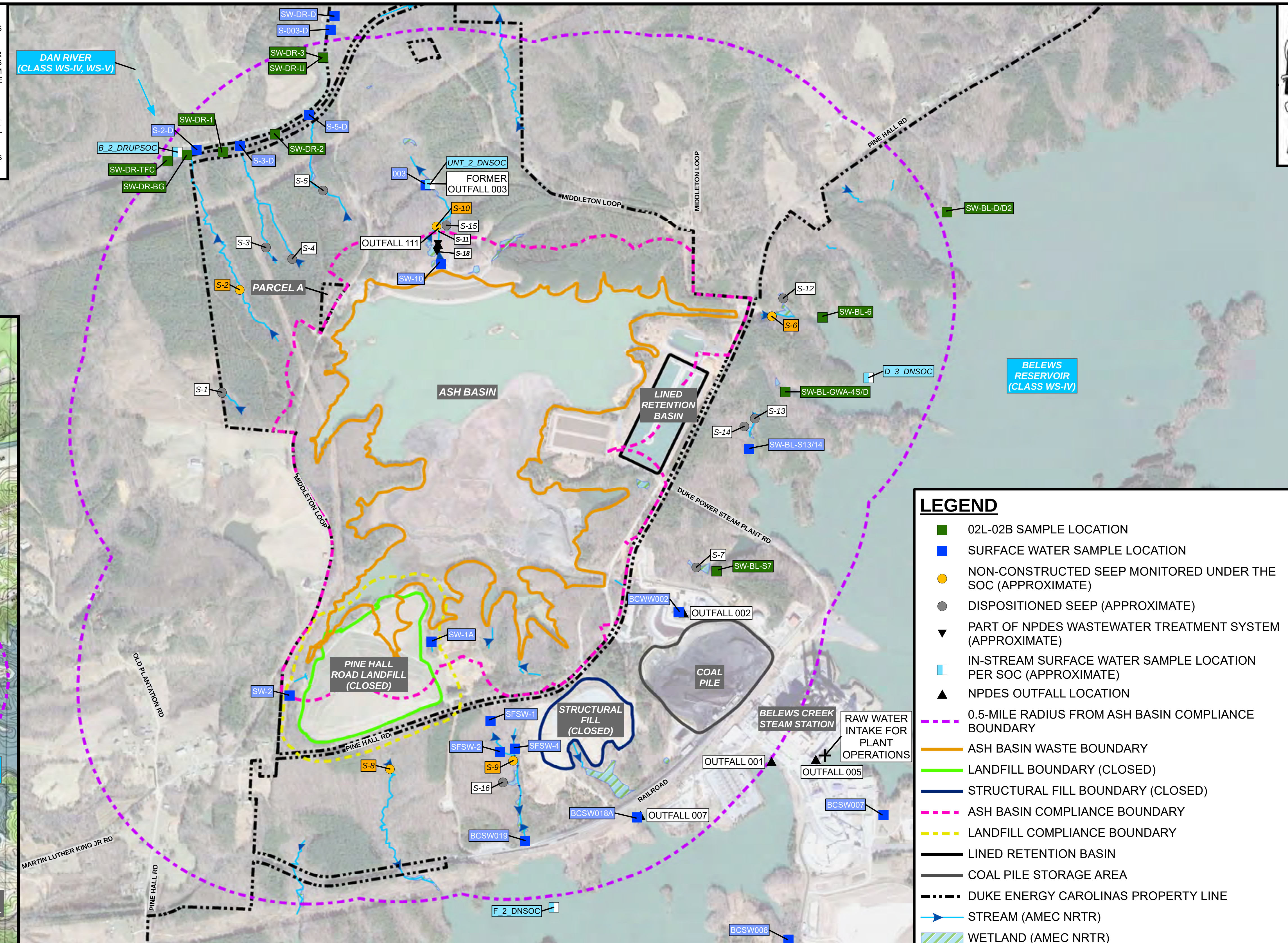
NOTES:

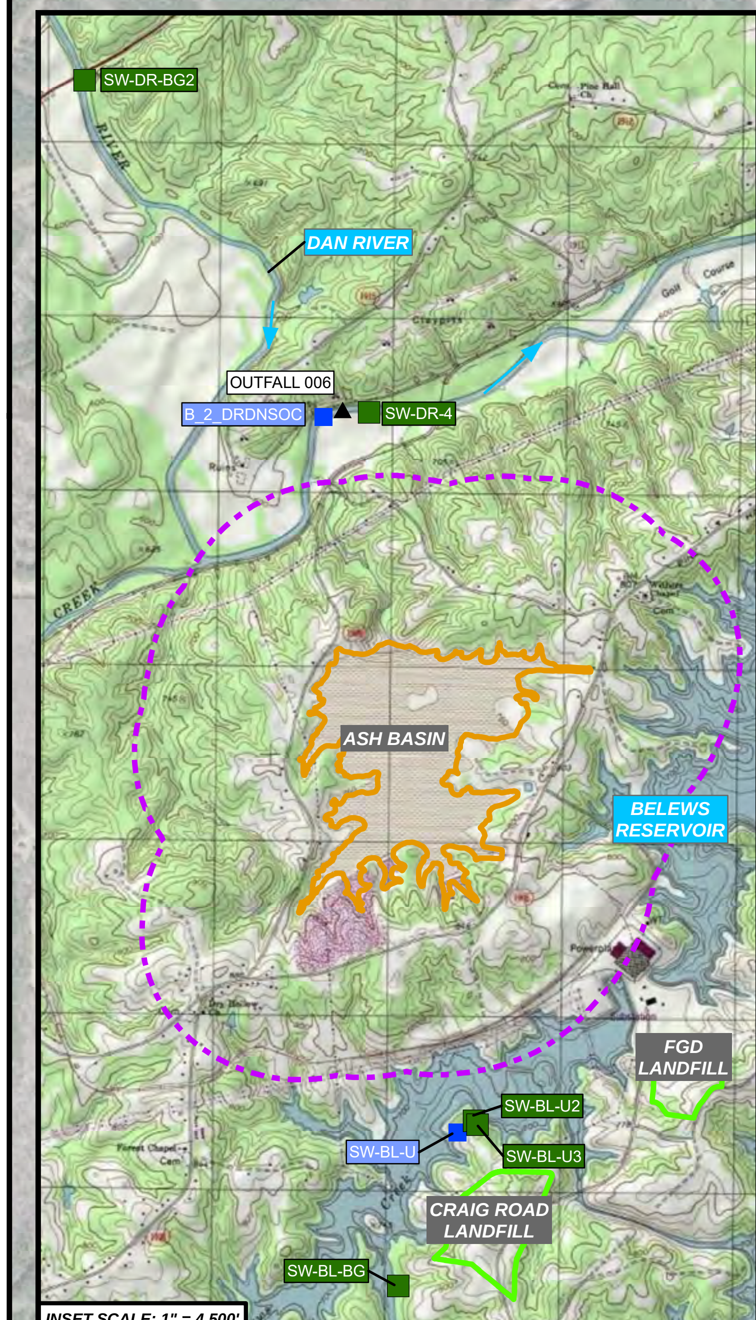
1. THE DAN RIVER (CLASS WS-IV, WS-V) AND BELEWS RESERVOIR (CLASS WS-IV) ARE WATERBODIES LOCATED WITHIN 0.5 MILES OF THE ASH BASIN COMPLIANCE BOUNDARY.

2. GROUNDWATER-TO-SURFACE WATER (02L- 02B) SAMPLE WERE COLLECTED TO ASSESS WHETHER GROUNDWATER MIGRATION IS CAUSING CONSTITUENT CONCENTRATIONS IN THE DAN RIVER AND BELEWS RESERVOIR TO BE GREAT THAN APPLICABLE 02B STANDARDS. 02L- 02B SAMPLING WAS CONDUCTED FROM FEBRUARY 12 THROUGH 15, 2018 FOLLOWING DIVISION APPROVED LOCATION AND PROTOCOLS. IN THE FIVE DAYS PRIOR TO SAMPLING A TOTAL OF 2.38 INCHES OF RAINFALL WAS OBSERVED AT THE BELEWS CREEK STEAM STATION. DURING THE FOUR DAY SAMPLING EVEN A TOT OF 0.04 INCHES OF RAINFALL WAS OBSERVED AT THE BELEWS CREEK STEAM STATION.

3. TURBIDITY WAS GREAT THAN THE APPLICABLE 02B STANDARDS AT THE FOLLOWING 02L- 02B SAMPLE LOCATIONS DURING THE FIRST THREE DAYS OF SAMPLING: SW-DR-BG, SW-DR-BG2, AND SW-DR-TFC, SW-DR-1, SW-DR-2, SW-DR-3, AND SW-DR-4

4. NO COI CONCENTRATION WERE GREATER THAN THE APPLICABLE 02B STANDARDS IN 02L- 02B SAMPLES COLLECTED AT THE BELEWS CREEK STEAM STATION.





NOTES:

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 NOT TO BE USED FOR JURISDICTIONAL DETERMINATION PURPOSES. THE WETLANDS AND STREAMS BOUNDARIES WERE OBTAINED FROM AMEC FOSTER WHEELER ENVIRONMENTAL & INFRASTRUCTURE, INC. NATURAL RESOURCE TECHNICAL REPORT FOR BELEWS CREEK STEAM STATION DATED JULY 2, 2015.

6. ALL BOUNDARIES ARE APPROXIMATE.

7. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.

8. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON JUNE 11, 2019. AERIAL WAS COLLECTED ON FEBRUARY 3, 2019.

9. 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

700 0 700 1,400

(IN FEET)

DRAWN BY: C. WYATT	DATE: 09/09/2019
REVISED BY: J. KIRTZ	DATE: 12/29/2019
CHECKED BY: A. ALBERT	DATE: 12/29/2019
APPROVED BY: A. ALBERT	DATE: 12/29/2019
PROJECT MANAGER: A. ALBERT	

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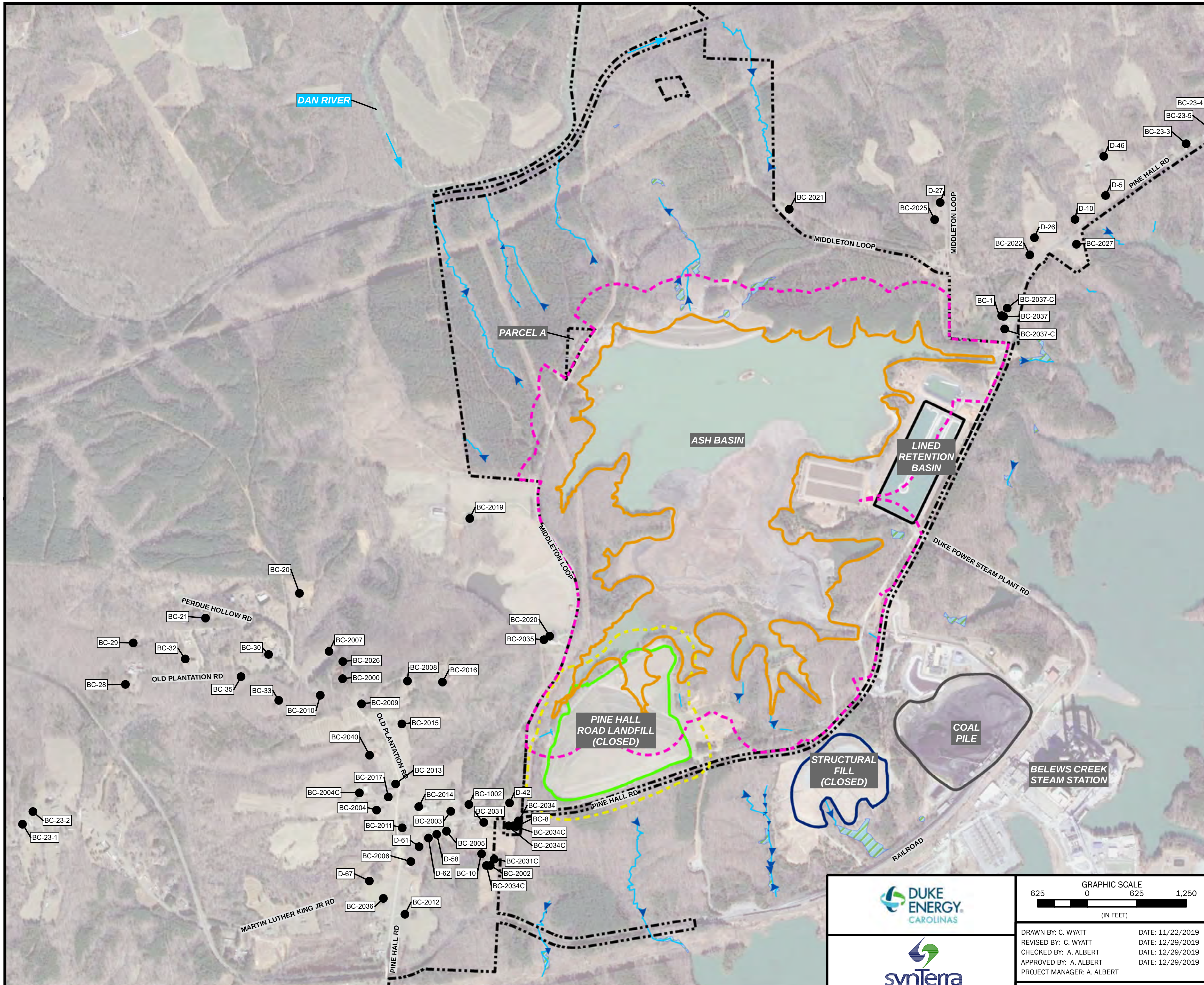
FIGURE 5-6
MAP OF SURFACE WATERS
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA



LEGEND

- WATER SUPPLY WELL
- ASH BASIN WASTE BOUNDARY
- LANDFILL BOUNDARY (CLOSED)
- STRUCTURAL FILL BOUNDARY (CLOSED)
- ASH BASIN COMPLIANCE BOUNDARY
- LANDFILL COMPLIANCE BOUNDARY
- LINED RETENTION BASIN
- COAL PILE STORAGE AREA
- DUKE ENERGY CAROLINAS PROPERTY LINE
- STREAM (AMEC NRTR)
- WETLAND (AMEC NRTR)

NOTES:

1. INFORMATION PROVIDED IN *BELEWS CREEK HB 630 PROVISION OF PERMANENT WATER SUPPLY COMPLETION DOCUMENTATION,* DUKE ENERGY, AUGUST 31, 2018 (APPENDIX D).

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 NOT TO BE USED FOR JURISDICTIONAL DETERMINATION PURPOSES. THE WETLANDS AND STREAMS BOUNDARIES WERE OBTAINED FROM AMEC FOSTER WHEELER ENVIRONMENTAL & INFRASTRUCTURE, INC. NATURAL RESOURCE TECHNICAL REPORT FOR BELEWS CREEK STEAM STATION DATED JULY 2, 2015.

3. ALL BOUNDARIES ARE APPROXIMATE.

4. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.

5. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON JUNE 11, 2019. AERIAL WAS COLLECTED ON FEBRUARY 3, 2019.

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

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REVISED BY: C. WYATT	DATE: 12/29/2019
CHECKED BY: A. ALBERT	DATE: 12/29/2019
APPROVED BY: A. ALBERT	DATE: 12/29/2019
PROJECT MANAGER: A. ALBERT	

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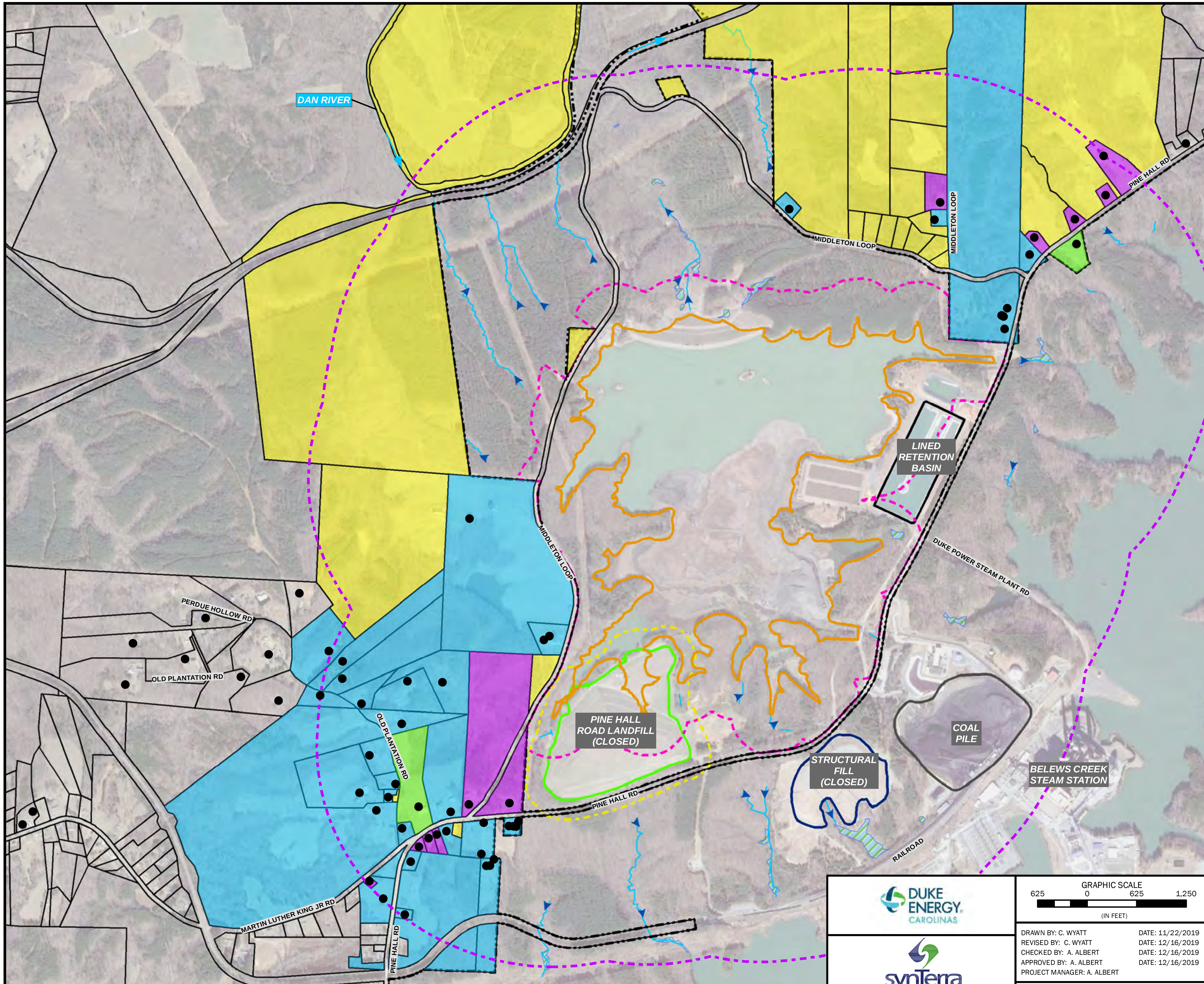
FIGURE 5-7a
WATER SUPPLY WELL SAMPLE LOCATIONS
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA



LEGEND

- WATER TREATMENT SYSTEM
- OPT OUT OR NON-RESPONSIVE
- LOCATIONS DEEMED NOT ELIGIBLE PER HOUSE BILL 630 (BUSINESS/CHURCH/SCHOOL) BUT VOLUNTARILY SUPPLIED PERMANENT WATER SOLUTION
- VACANT PARCELS WITHIN HALF-MILE RADIUS
- WATER SUPPLY WELL
- 0.5-MILE RADIUS FROM ASH BASIN COMPLIANCE BOUNDARY
- ASH BASIN WASTE BOUNDARY
- LANDFILL BOUNDARY (CLOSED)
- STRUCTURAL FILL BOUNDARY (CLOSED)
- ASH BASIN COMPLIANCE BOUNDARY
- LANDFILL COMPLIANCE BOUNDARY
- LINED RETENTION BASIN
- COAL PILE STORAGE
- DUKE ENERGY CAROLINAS PROPERTY LINE
- STREAM (AMEC NRTR)
- WETLAND (AMEC NRTR)

NOTES:

1. INFORMATION PROVIDED IN *BELEWS CREEK HB 630 PROVISION OF PERMANENT WATER SUPPLY COMPLETION DOCUMENTATION,* DUKE ENERGY, AUGUST 31, 2018 (APPENDIX D).

2. NON-DUKE PARCEL BOUNDARIES PROVIDED BY NC ONEMAP, DATED 2018. http://data.nconemap.gov/downloads/vector/parcels.

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 NOT TO BE USED FOR JURISDICTIONAL DETERMINATION PURPOSES. THE WETLANDS AND STREAMS BOUNDARIES WERE OBTAINED FROM AMEC FOSTER WHEELER ENVIRONMENTAL & INFRASTRUCTURE, INC. NATURAL RESOURCE TECHNICAL REPORT FOR BELEWS CREEK STEAM STATION DATED JULY 2, 2015.

4. ALL BOUNDARIES ARE APPROXIMATE.

5. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.

6. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON JUNE 11, 2019. AERIAL WAS COLLECTED ON FEBRUARY 3, 2019.

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

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REVISED BY: C. WYATT	DATE: 12/16/2019
CHECKED BY: A. ALBERT	DATE: 12/16/2019
APPROVED BY: A. ALBERT	DATE: 12/16/2019
PROJECT MANAGER: A. ALBERT	

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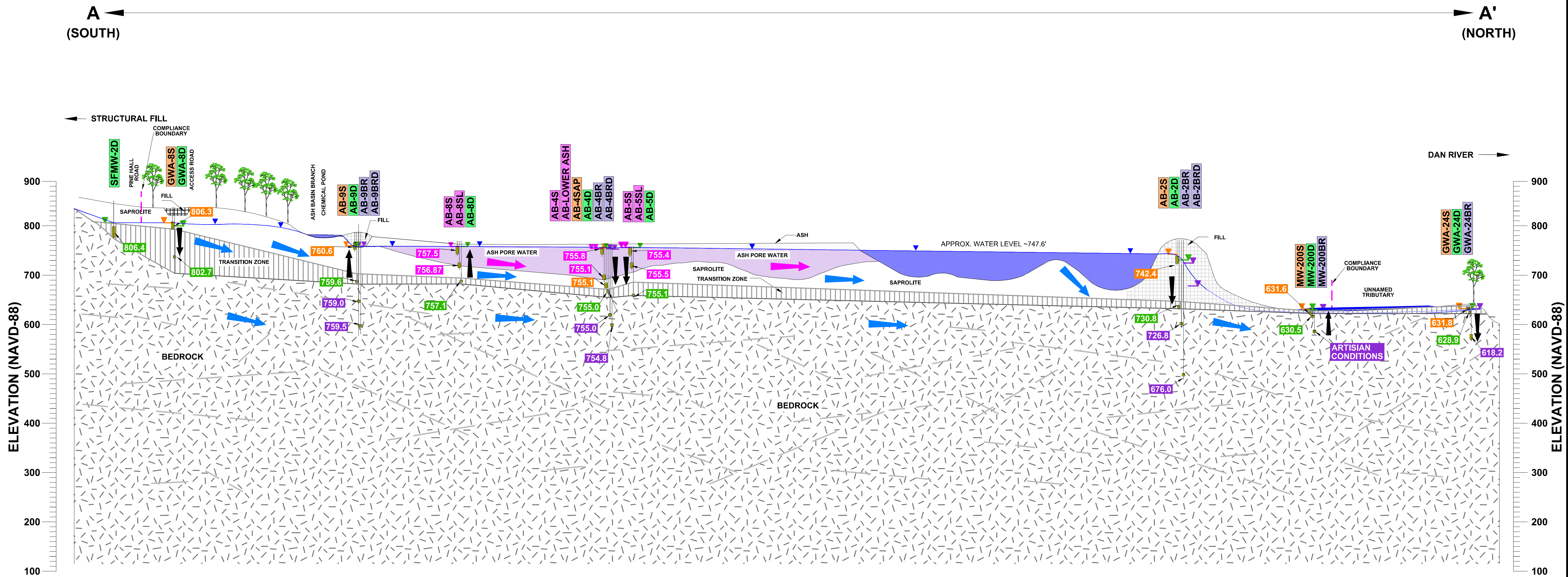
FIGURE 5-7b
HB 630 PROVISION OF PERMANENT WATER SUPPLY COMPLETION MAP
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA

Figure 6-1

Fly Ash and Bottom Ash Interbedded Depiction

Included in Section 6 text



LEGEND

- AB-9S — WELL IN SHALLOW/SAPROLITE ZONE
- AB-9D — WELL IN DEEP/TRANSITION ZONE
- AB-9BR — WELL IN COMPETENT BEDROCK
- AB-4S — WELL IN ASH PORE WATER
- GENERALIZED WATER TABLE
- BEDROCK FRACTURE ORIENTATION
- GENERALIZED GROUNDWATER FLOW DIRECTION
- GENERALIZED ASH PORE WATER FLOW DIRECTION
- GENERALIZED VERTICAL HYDRAULIC GRADIENT
- ASH
- ASH PORE WATER
- FILL
- SAPROLITE
- WEATHERED ROCK
- BEDROCK
- ASH PORE WATER FLOW LAYER WATER LEVEL ELEVATION
- SHALLOW/SAPROLITE FLOW ZONE GROUNDWATER LEVEL ELEVATION
- DEEP/TRANSITION ZONE FLOW ZONE GROUNDWATER LEVEL ELEVATION
- BEDROCK FLOW ZONE GROUNDWATER LEVEL ELEVATION
- 754.8 — WATER LEVEL ELEVATION (NAVD 88) (LABEL COLORING BY FLOW ZONE)
- WELL SCREEN
- COMPLIANCE BOUNDARY

NOTES:

1. WATER ELEVATIONS REPRESENT THE MANUAL WATER LEVELS COLLECTED FOR APRIL 8, 2019 FOR EACH WELL. NOTE ELEVATIONS WITHIN EACH CLUSTER ARE MEASURED IN THE SAME DAY. ASH BASIN WATER ELEVATION IS RECORDED FROM APRIL 8, 2019. REFERENCED TO NORTH AMERICAN VERTICAL DATUM 1988.
2. FRACTURES DEPICTED ON THIS CROSS SECTION REPRESENT 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 DEPTHS AND LENGTHS OF FRACTURES VERSUS DEPTH ARE CONCEPTUAL ONLY.

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

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0 125 250 500
HORIZONTAL SCALE: 1" = 500'
VERTICAL SCALE: 1" = 200'
5X VERTICAL EXAGGERATION

DRAWN BY: C. BRUCE	DATE: 08/01/2019
REVISED BY: C. BRUCE	DATE: 11/15/2019
CHECKED BY: A. ALBERT	DATE: 11/15/2019
APPROVED BY: A. ALBERT	DATE: 11/15/2019
PROJECT MANAGER: A. ALBERT	DATE: 08/01/2019

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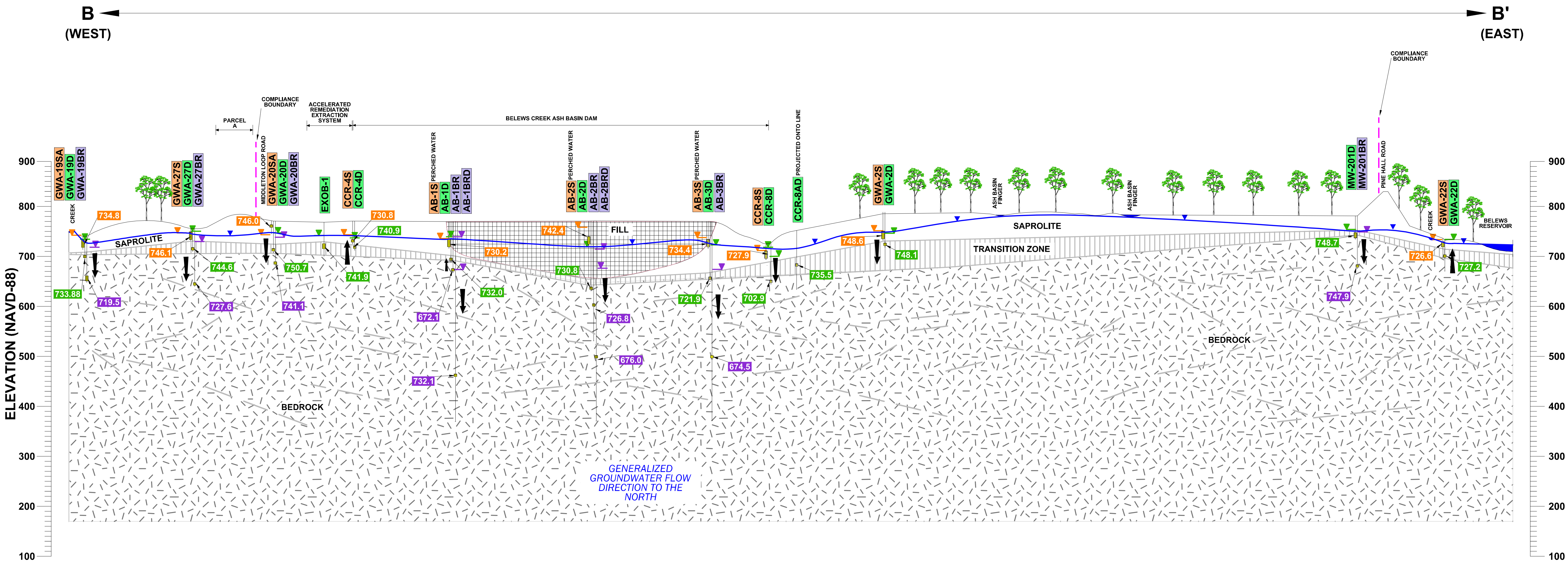
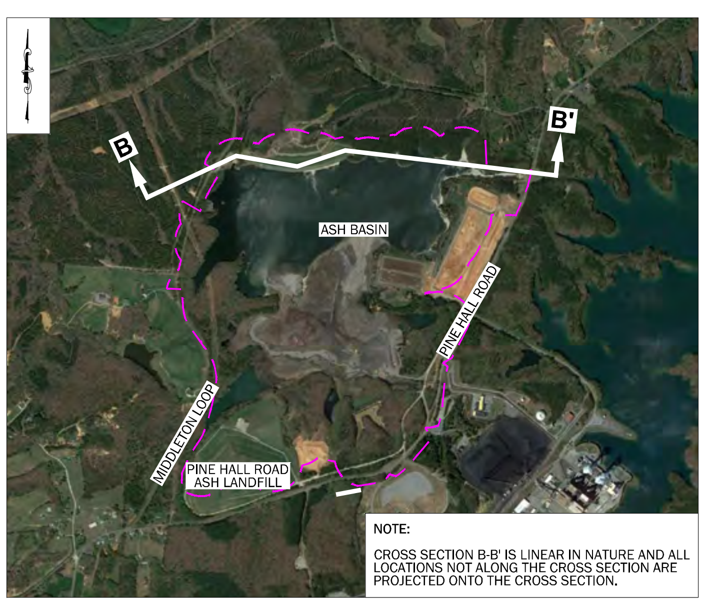
FIGURE 6-2
GENERAL CROSS SECTION A-A'
ASH BASIN
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA



LEGEND

AB-9S	WELL IN SHALLOW/SAPROLITE ZONE
AB-9D	WELL IN DEEP/TRANSITION ZONE
AB-9BR	WELL IN COMPETENT BEDROCK
AB-4S	WELL IN ASH PORE WATER
	GENERALIZED WATER TABLE
	BEDROCK FRACTURE ORIENTATION
	GENERALIZED VERTICAL HYDRAULIC GRADIENT
	ASH
	ASH PORE WATER
	FILL
	SAPROLITE
	WEATHERED ROCK
	BEDROCK
	COMPLIANCE BOUNDARY
	ASH PORE WATER FLOW LAYER WATER LEVEL ELEVATION
	SHALLOW/SAPROLITE FLOW ZONE GROUNDWATER LEVEL ELEVATION
	DEEP/TRANSITION ZONE FLOW ZONE GROUNDWATER LEVEL ELEVATION
	BEDROCK FLOW ZONE GROUNDWATER LEVEL ELEVATION
674.5	WATER LEVEL ELEVATION (NAVD 88) (LABEL COLORING BY FLOW ZONE)
	WELL SCREEN



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

NOTES:

1. WATER ELEVATIONS REPRESENT THE MANUAL WATER LEVELS COLLECTED FOR APRIL 8, 2019 FOR EACH WELL. NOTE ELEVATIONS WITHIN EACH CLUSTER ARE MEASURED IN THE SAME DAY. ASH BASIN POND ELEVATION IS RECORDED FROM APRIL 8, 2019. REFERENCED TO NORTH AMERICAN VERTICAL DATUM 1988.
2. FRACTURES DEPICTED ON THIS CROSS SECTION REPRESENT 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 DEPTHS AND LENGTHS OF FRACTURES VERSUS DEPTH ARE CONCEPTUAL ONLY.

DUKE ENERGY CAROLINAS

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0 125 250 500
HORIZONTAL SCALE: 1" = 500'
VERTICAL SCALE: 1" = 200'
5X VERTICAL EXAGGERATION

DRAWN BY: C. BRUCE	DATE: 08/01/2019
REVISED BY: C. BRUCE	DATE: 11/15/2019
CHECKED BY: A. ALBERT	DATE: 11/15/2019
APPROVED BY: A. ALBERT	DATE: 11/15/2019
PROJECT MANAGER: A. ALBERT	DATE: 08/01/2019

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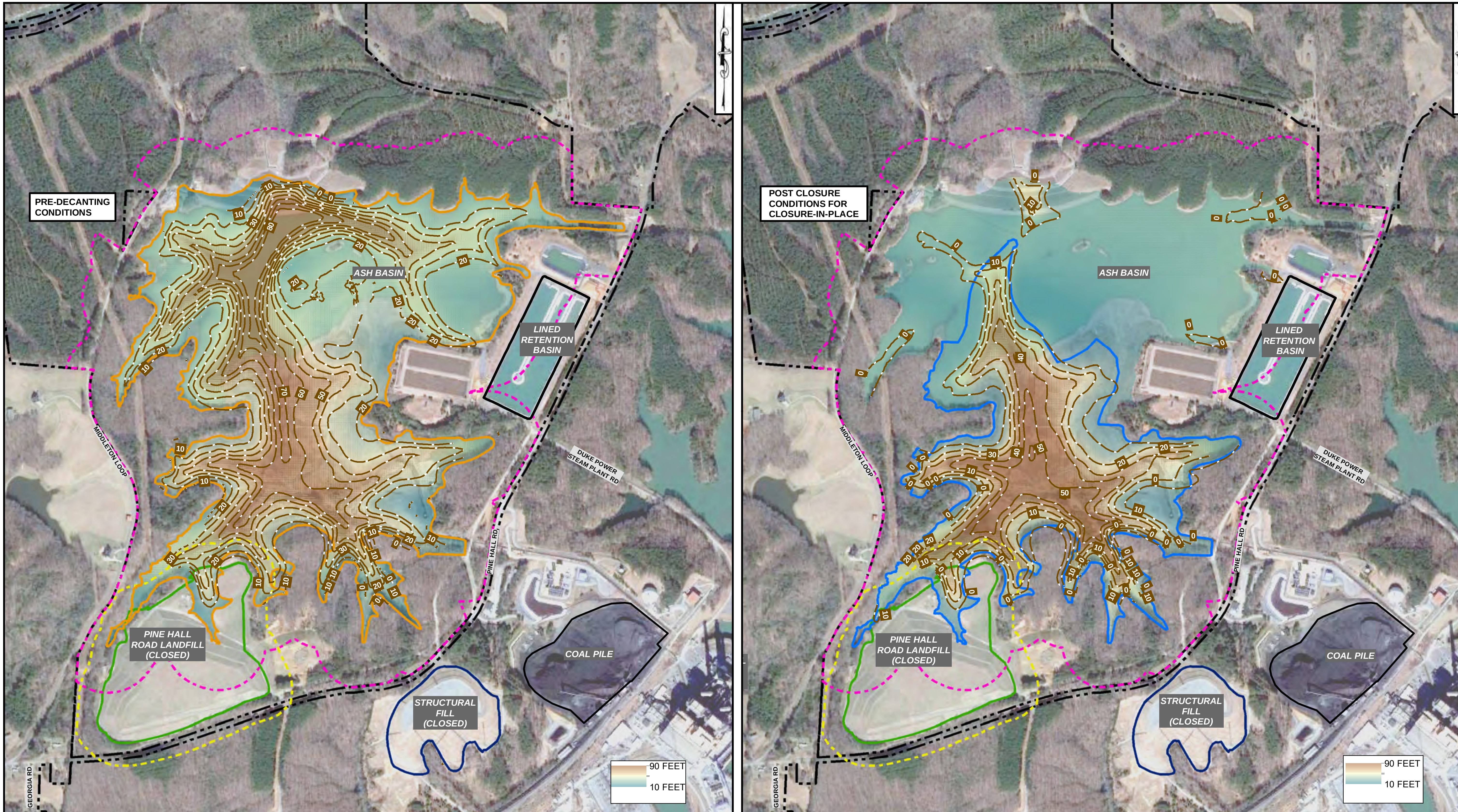
FIGURE 6-3
GENERAL CROSS SECTION B-B'
ASH BASIN
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA



LEGEND

- APPROXIMATE SATURATED ASH THICKNESS ISOPACH
- LINED RETENTION BASIN
- COAL PILE BOUNDARY
- ASH BASIN WASTE BOUNDARY
- ASH BASIN COMPLIANCE BOUNDARY
- PROPOSED HYBRID LANDFILL WASTE EXTENT
- LANDFILL BOUNDARY
- STRUCTURAL FILL BOUNDARY
- LANDFILL COMPLIANCE BOUNDARY
- DUKE ENERGY CAROLINAS PROPERTY LINE

NOTES:

1. ASH THICKNESS ISOPACH SURFACES FROM FLOW AND TRANSPORT MODELS (FALTA AND OTHERS, 2019).

2. SATURATED ASH THICKNESS FOR CLOSURE-IN-PLACE IS BASED ON CLOSURE MODEL RESULTS WITH UNDERDRAINS.

3. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.

4. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO FEBRUARY 2019.

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

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GRAPHIC SCALE

500 0 500 1,000

(IN FEET)

DRAWN BY: C. WYATT DATE: 06/07/2019
REVISED BY: A. ROBINSON DATE: 12/04/2019
CHECKED BY: A. ALBERT DATE: 12/04/2019
APPROVED BY: C. EADY DATE: 12/04/2019
PROJECT MANAGER: A. ALBERT

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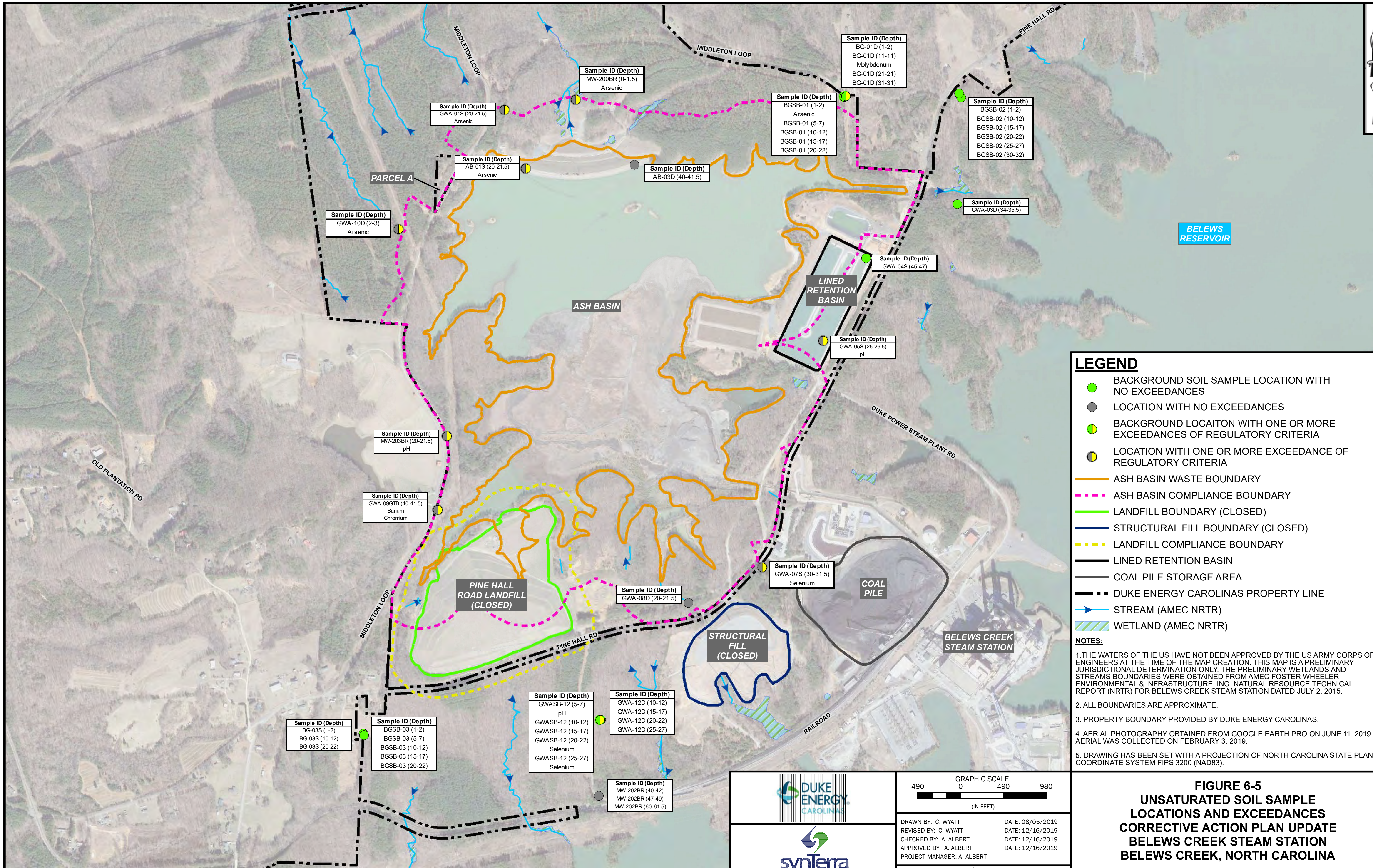
FIGURE 6-4
SATURATED ASH THICKNESS MAP FOR PRE-DECANTING AND POST-CLOSURE CONDITIONS
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION



LEGEND

- BACKGROUND SOIL SAMPLE LOCATION WITH NO EXCEEDANCES
- LOCATION WITH NO EXCEEDANCES
- BACKGROUND LOCAITON WITH ONE OR MORE EXCEEDANCES OF REGULATORY CRITERIA
- LOCATION WITH ONE OR MORE EXCEEDANCE OF REGULATORY CRITERIA
- ASH BASIN WASTE BOUNDARY
- ASH BASIN COMPLIANCE BOUNDARY
- LANDFILL BOUNDARY (CLOSED)
- STRUCTURAL FILL BOUNDARY (CLOSED)
- LANDFILL COMPLIANCE BOUNDARY
- LINED RETENTION BASIN
- COAL PILE STORAGE AREA
- DUKE ENERGY CAROLINAS PROPERTY LINE
- STREAM (AMEC NRTR)
- WETLAND (AMEC NRTR)

NOTES:

1.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 BELEWS CREEK STEAM STATION DATED JULY 2, 2015.

2. ALL BOUNDARIES ARE APPROXIMATE.

3. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.

4. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON JUNE 11, 2019. AERIAL WAS COLLECTED ON FEBRUARY 3, 2019.

5. 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
490 0 490 980
(IN FEET)

DRAWN BY: C. WYATT DATE: 08/05/2019
REVISED BY: C. WYATT DATE: 12/16/2019
CHECKED BY: A. ALBERT DATE: 12/16/2019
APPROVED BY: A. ALBERT DATE: 12/16/2019
PROJECT MANAGER: A. ALBERT

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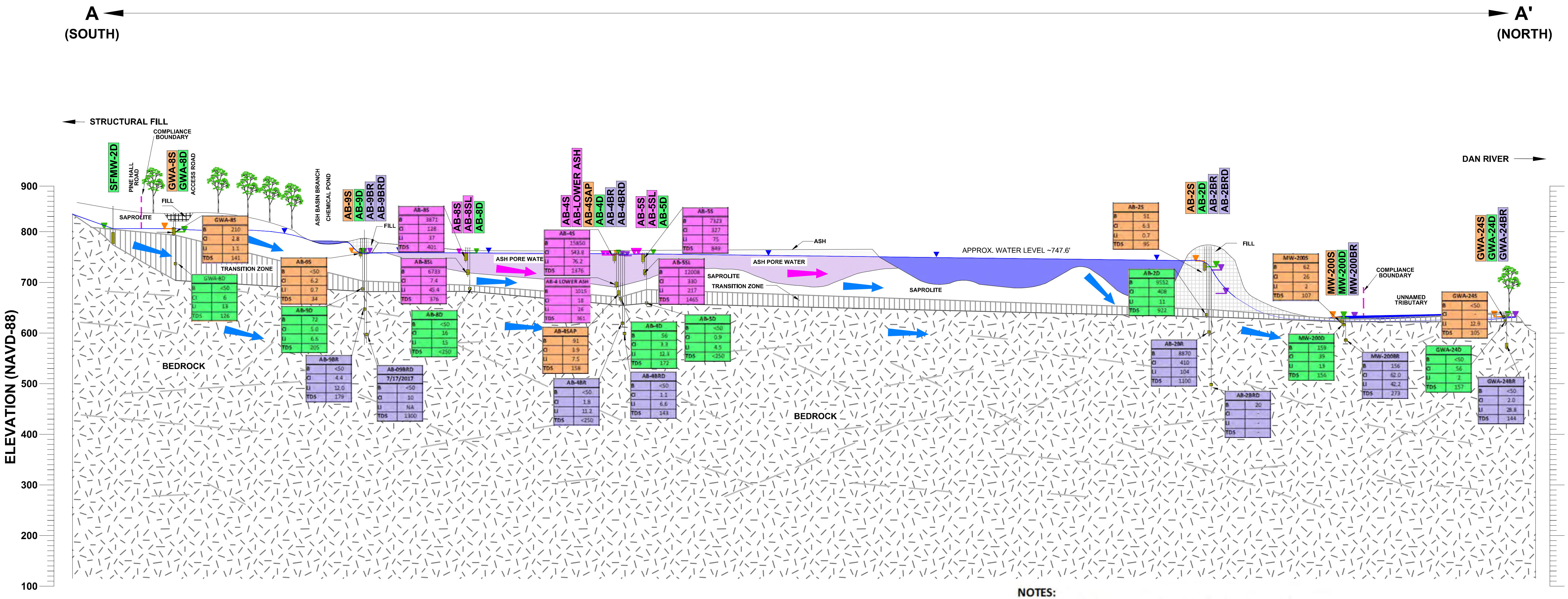
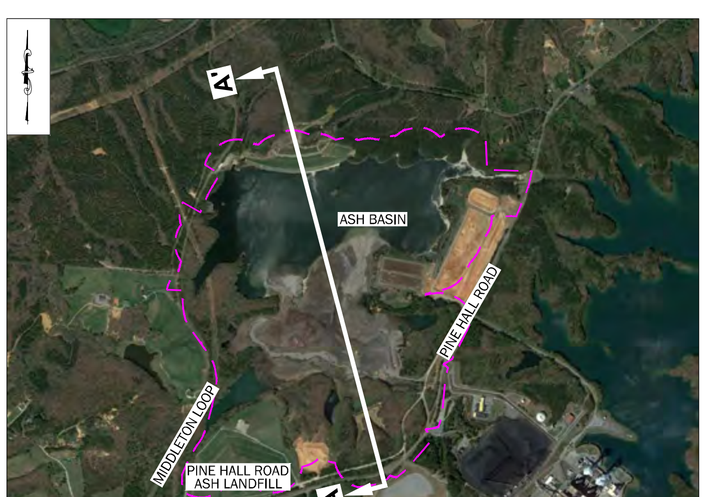
FIGURE 6-5
UNSATURATED SOIL SAMPLE LOCATIONS AND EXCEEDANCES
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA



LEGEND

AB-9S	WELL IN SHALLOW/SAPROLITE ZONE
AB-9D	WELL IN DEEP/TRANSITION ZONE
AB-9BR	WELL IN COMPETENT BEDROCK
AB-4S	WELL IN ASH PORE WATER
	GENERALIZED WATER TABLE
	BEDROCK FRACTURE ORIENTATION
	GENERALIZED GROUNDWATER FLOW DIRECTION
	GENERALIZED ASH PORE WATER FLOW DIRECTION
	ASH
	ASH PORE WATER
	FILL
	SAPROLITE
	WEATHERED ROCK
	BEDROCK
	ASH PORE WATER FLOW LAYER WATER LEVEL ELEVATION
	SHALLOW/SAPROLITE FLOW ZONE GROUNDWATER LEVEL ELEVATION
	DEEP/TRANSITION ZONE FLOW ZONE GROUNDWATER LEVEL ELEVATION
	BEDROCK FLOW ZONE GROUNDWATER LEVEL ELEVATION
AB-4BRD: B <50; Cl 1.1; Li 6.6; TDS 143	MEAN BORON (B) CONCENTRATION (µg/L) MEAN CHLORIDE (Cl) CONCENTRATION (mg/L) LITHIUM (Li) CONCENTRATION (µg/L) MEAN TOTAL DISSOLVED SOLIDS (TDS) CONCENTRATION (mg/L)
	WELL SCREEN
	COMPLIANCE BOUNDARY



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

NOTES:

1. ALL CONCENTRATIONS SHOWN ARE STATISTICAL MEAN OR GEOMEAN CALCUALTED BASED ON CENTRAL TENDANCY OF DATASET USING DATA RANGING FROM JANUARY 2018 TO APRIL 2019.
2. Boron (B) AND LITHIUM (Li) CONCENTRATIONS ARE IN MICROGRAMS PER LITER (µg/L)
3. Chloride (Cl) AND TOTAL DISSOLVED SOLIDS (TDS) CONCENTRATIONS ARE IN MILLIGRAMS PER LITER (mg/L)
4. NO MEAN ANALYSIS FOR BEDROCK WELLS (AB-2BRD AND AB-3BRD) FOR CONSTITUENTS; CHLORIDE, LITHIUM AND TOTAL DISSOLVED SOLIDS
5. SFMW-2D IS PART OF THE SOLID WASTE STRUCTURAL FILL MONITORING NETWORK. THIS UNIT IS NOT CONTIGUOUS WITH THE ASH BASIN HYDRAULIC SYSTEM AND IS PART OF A SEPARATE ONGOING SITES ASSESSMENT.

- NO DATA AVAILABLE

ANALYTICAL PARAMETER	B	Cl	Li	TDS
REPORTING UNITS	µg/L	mg/L	µg/L	mg/L
15A NCAC 02L STANDARD	700	250	NE	500
BACKGROUND THRESHOLD VALUE (SHALLOW FLOW ZONE)[1]	50	19	2	93
BACKGROUND THRESHOLD VALUE (DEEP FLOW ZONE)[1]	50	19	95	134
BACKGROUND THRESHOLD VALUE (BEDROCK FLOW ZONE)[1]	50	3	30	181

[1]BACKGROUND THRESHOLD VALUES WERE CALCULATED USING DATA FROM BACKGROUND GROUNDWATER SAMPLES COLLECTED MAY 2015 TO DECEMBER 2018 AS SUBMITTED IN JUNE 2019.

DUKE ENERGY CAROLINAS

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0 125 250 500
HORIZONTAL SCALE: 1" = 500'
VERTICAL SCALE: 1" = 200'
5X VERTICAL EXAGGERATION

DRAWN BY: C. BRUCE	DATE: 08/01/2019
REVISED BY: C. BRUCE	DATE: 11/15/2019
CHECKED BY: A. ALBERT	DATE: 11/15/2019
APPROVED BY: A. ALBERT	DATE: 11/15/2019
PROJECT MANAGER: A. ALBERT	DATE: 08/01/2019

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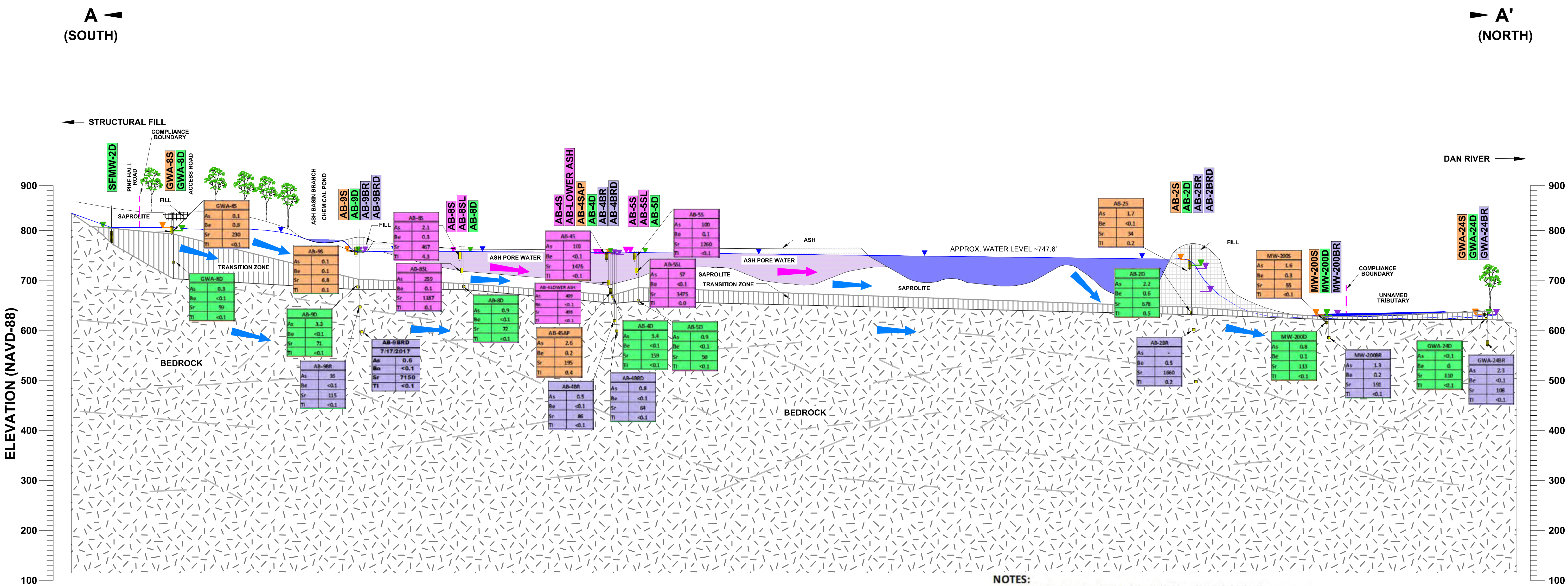
FIGURE 6-6a
GENERAL CROSS SECTION A-A'
ASH BASIN - CONSERVATIVE GROUP
MEAN OF BORON, CHLORIDE, LITHIUM AND TOTAL DISSOLVED SOLIDS
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA



LEGEND

AB-9S WELL IN SHALLOW/SAPROLITE ZONE

AB-9D WELL IN DEEP/TRANSITION ZONE

AB-9BR WELL IN COMPETENT BEDROCK

AB-4S WELL IN ASH PORE WATER

GENERALIZED WATER TABLE

BEDROCK FRACTURE ORIENTATION

GENERALIZED GROUNDWATER FLOW DIRECTION

GENERALIZED ASH PORE WATER FLOW DIRECTION

ASH

ASH PORE WATER

FILL

SAPROLITE

WEATHERED ROCK

BEDROCK

ASH PORE WATER FLOW LAYER WATER LEVEL ELEVATION

SHALLOW/SAPROLITE FLOW ZONE GROUNDWATER LEVEL ELEVATION

DEEP/TRANSITION ZONE FLOW ZONE GROUNDWATER LEVEL ELEVATION

BEDROCK FLOW ZONE GROUNDWATER LEVEL ELEVATION

AB-4BRD	
As	0.8
Be	<0.1
Sr	64
Tl	<0.1

MEAN ARSENIC (As) CONCENTRATION (µg/L)
MEAN BERYLLIUM (Be) CONCENTRATION (µg/L)
MEAN STRONTIUM (Sr) CONCENTRATION (µg/L)
MEAN THALLIUM (Tl) CONCENTRATION (µg/L)

WELL SCREEN

COMPLIANCE BOUNDARY

NOTES:

1. ALL CONCENTRATIONS SHOWN ARE STATISTICAL MEAN OR GEOMEAN CALCUALTED BASED ON CENTRAL TENDANCY OF DATASET USING DATA RANGING FROM JANUARY 2018 TO APRIL 2019.
2. ALL CONCENTRATIONS ARE IN MICROGRAMS PER LITER (µg/L)
3. NO MEAN ANALYSIS FOR WELLS AB-2BRD AND GWA-24S FOR CONSTITUENTS; ARSENIC (As), BERYLLIUM (Be), STRONTIUM (Sr) AND THALLIUM (Tl)
4. SFMW-2D IS PART OF THE SOLID WASTE STRUCTURAL FILL MONITORING NETWORK. THIS UNIT IS NOT CONTIGUOUS WITH THE ASH BASIN HYDRAULIC SYSTEM AND IS PART OF A SEPARATE ONGOING SITES ASSESSMENT.

- NO DATA AVAILABLE

ANALYTICAL PARAMETER	As	Be	Sr	Tl
REPORTING UNITS	µg/L	µg/L	µg/L	µg/L
15A NCAC 02L STANDARD	10	4*	NE	0.2*
BACKGROUND THRESHOLD VALUE (SHALLOW FLOW ZONE)[1]	1	0.3	46	0.2
BACKGROUND THRESHOLD VALUE (DEEP FLOW ZONE)[1]	1	0.1	73	0.2
BACKGROUND THRESHOLD VALUE (BEDROCK FLOW ZONE)[1]	2	0.2	99	0.1

* - 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 MAY 2015 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

DUKE ENERGY CAROLINAS

synTerra

0 125 250 500
HORIZONTAL SCALE: 1" = 500'
VERTICAL SCALE: 1" = 200'
5X VERTICAL EXAGGERATION

DRAWN BY: C. BRUCE	DATE: 08/01/2019
REVISED BY: C. BRUCE	DATE: 11/15/2019
CHECKED BY: A. ALBERT	DATE: 11/15/2019
APPROVED BY: A. ALBERT	DATE: 11/15/2019
PROJECT MANAGER: A. ALBERT	DATE: 08/01/2019

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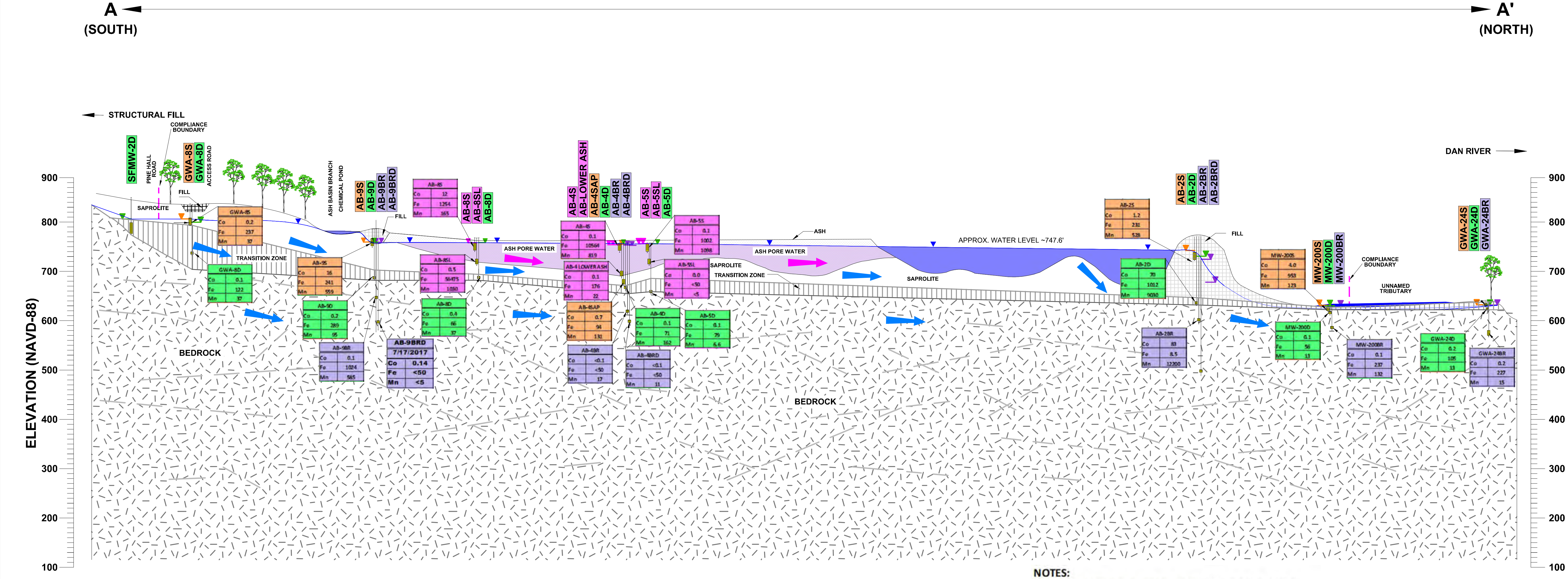
FIGURE 6-6b
GENERAL CROSS SECTION A-A'
ASH BASIN - NON-CONSERVATIVE GROUP
MEAN OF ARSENIC, BERYLLIUM, STRONTIUM AND THALLIUM
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA

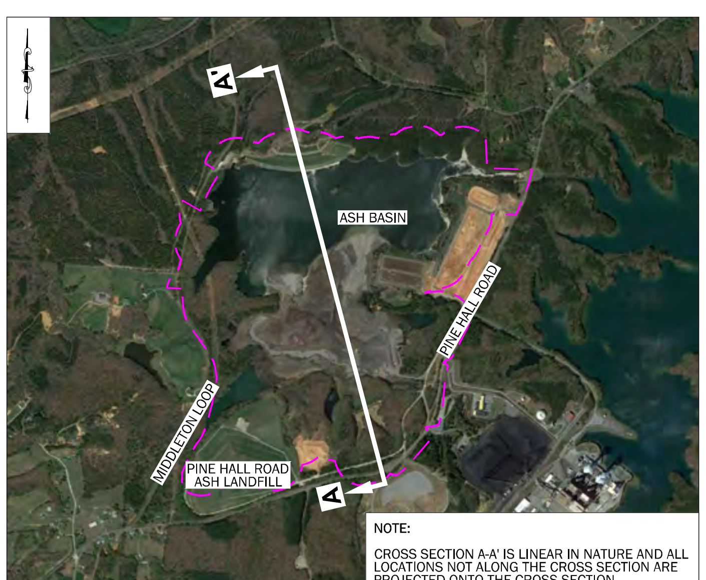


LEGEND

AB-9S WELL IN SHALLOW/SAPROLITE ZONE
AB-9D WELL IN DEEP/TRANSITION ZONE
AB-9BR WELL IN COMPETENT BEDROCK
AB-4S WELL IN ASH PORE WATER
GENERALIZED WATER TABLE
BEDROCK FRACTURE ORIENTATION
GENERALIZED GROUNDWATER FLOW DIRECTION
GENERALIZED ASH PORE WATER FLOW DIRECTION
ASH
ASH PORE WATER
FILL
SAPROLITE
WEATHERED ROCK
BEDROCK
ASH PORE WATER FLOW LAYER WATER LEVEL ELEVATION
SHALLOW/SAPROLITE FLOW ZONE GROUNDWATER LEVEL ELEVATION
DEEP/TRANSITION ZONE FLOW ZONE GROUNDWATER LEVEL ELEVATION
BEDROCK FLOW ZONE GROUNDWATER LEVEL ELEVATION

AB-4BRD	
Co	<0.1
Fe	<50
Mn	11

MEAN COBALT (Co) CONCENTRATION (μg/L)
MEAN IRON (Fe) CONCENTRATION (μg/L)
MEAN MANGANESE (Mn) CONCENTRATION (μg/L)
WELL SCREEN
COMPLIANCE BOUNDARY



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

NOTES:

1. ALL CONCENTRATIONS SHOWN ARE STATISTICAL MEAN OR GEOMEAN CALCUALTED BASED ON CENTRAL TENDANCY OF DATASET USING DATA RANGING FROM JANUARY 2018 TO APRIL 2019.
2. ALL CONCENTRATIONS ARE IN MICROGRAMS PER LITER (mg/L)
3. NO MEAN ANALYSIS FOR BEDROCK WELLS AB-2BRD AND GWA-24S FOR CONSTITUENTS; COBALT (Co), IRON (Fe) AND MAMGAMESE (Mn)
4. SFMW-2D IS PART OF THE SOLID WASTE STRUCTURAL FILL MONITORING NETWORK. THIS UNIT IS NOT CONTIGUOUS WITH THE ASH BASIN HYDRAULIC SYSTEM AND IS PART OF A SEPARATE ONGOING SITES ASSESSMENT.

- 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]	0.6	1600	40
BACKGROUND THRESHOLD VALUE (DEEP FLOW ZONE)[1]	2	226	57
BACKGROUND THRESHOLD VALUE (BEDROCK FLOW ZONE)[1]	0.8	341	64

* - 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 MAY 2015 TO DECEMBER 2018 AS SUBMITTED IN JUNE 2019.

DUKE ENERGY CAROLINAS

synTerra

0 125 250 500
HORIZONTAL SCALE: 1" = 500'
VERTICAL SCALE: 1" = 200'
5X VERTICAL EXAGGERATION

DRAWN BY: C. BRUCE	DATE: 08/01/2019
REVISED BY: C. BRUCE	DATE: 11/15/2019
CHECKED BY: A. ALBERT	DATE: 11/15/2019
APPROVED BY: A. ALBERT	DATE: 11/15/2019
PROJECT MANAGER: A. ALBERT	DATE: 08/01/2019

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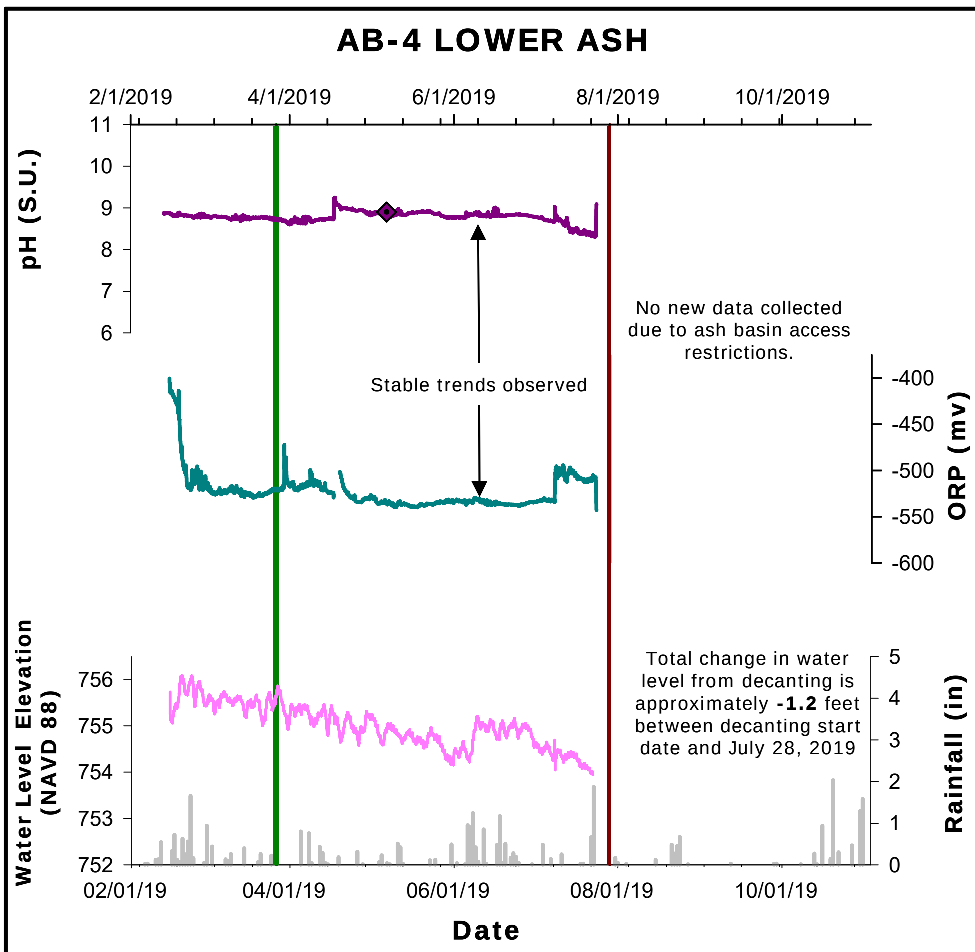
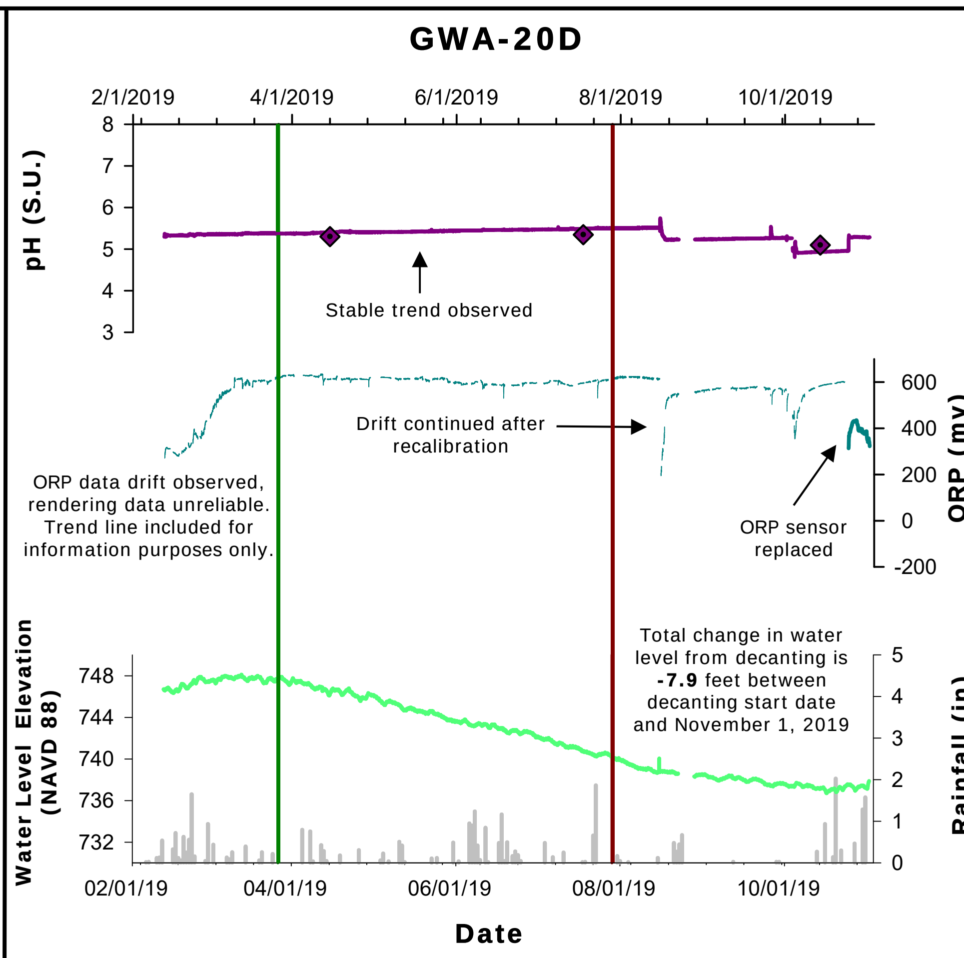
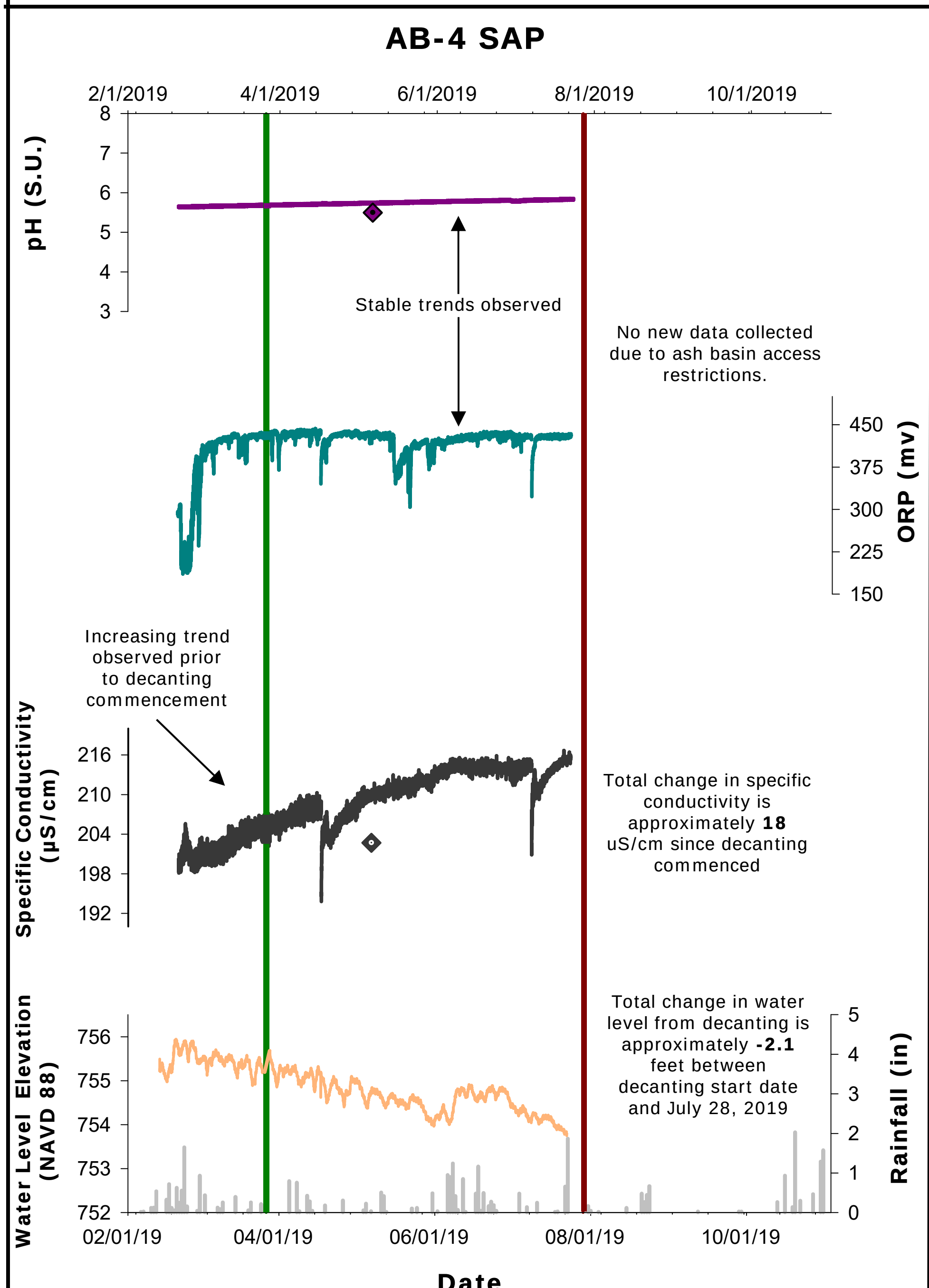
FIGURE 6-6c
GENERAL CROSS SECTION A-A'
ASH BASIN - VARIABLE GROUP
MEAN OF COBALT, IRON AND MANGANESE
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA



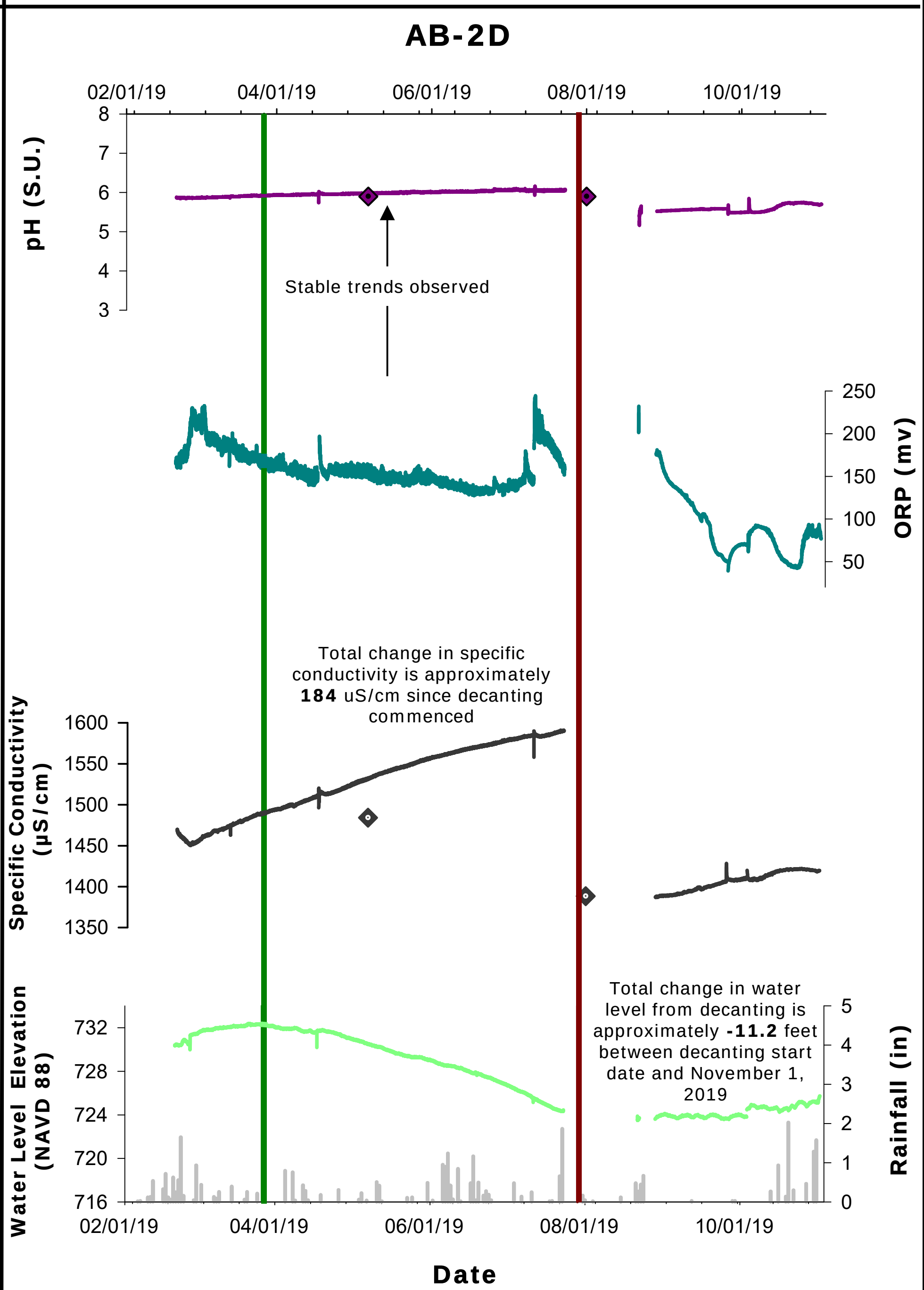
AB-4 LOWER ASH: Ash pore water well located central to the ash basin delta. See Figure 6-9 for monitoring location.



GWA-20D: Deep flow zone well located downgradient and northwest of the ash basin. See Figure 6-9 for monitoring location.



AB-4SAP: Shallow flow zone monitoring well located within the footprint of the ash basin, below ash pore water well AB-4 LOWER ASH. See Figure 6-9 for monitoring location.



AB-2D: Deep flow zone well located downgradient of the ash basin, below the ash basin dam. See Figure 6-9 for monitoring location.

LEGEND

- pH (S.U.)
- Oxidation Reduction Potential (ORP)(mV)
- ORP data included for information purposes
- Specific Conductivity (µS/cm)
- Decanting Start (03/27/2019)
- Decanting Suspended (07/29/2019)
- Daily Total Rainfall (inches)
- Calibrated Field Parameter Measurements (pH and specific conductivity)

Notes:

Specific conductivity is monitored at AB-4SAP and AB-2D only.

NAVD 88 – North American Vertical Datum

in – inches

µS/cm – micro Siemens per centimeter

mv – millivolts

SU – standard unit

DUKE ENERGY. CAROLINAS

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DRAWN BY: D. AVARD	DATE: 11/20/2019
REVISED BY: M. ROZIER	DATE: 12/03/2019
CHECKED BY: A. ALBERT	DATE: 12/03/2019
APPROVED BY: A. ALBERT	DATE: 12/03/2019
PROJECT MANAGER: A. ALBERT	

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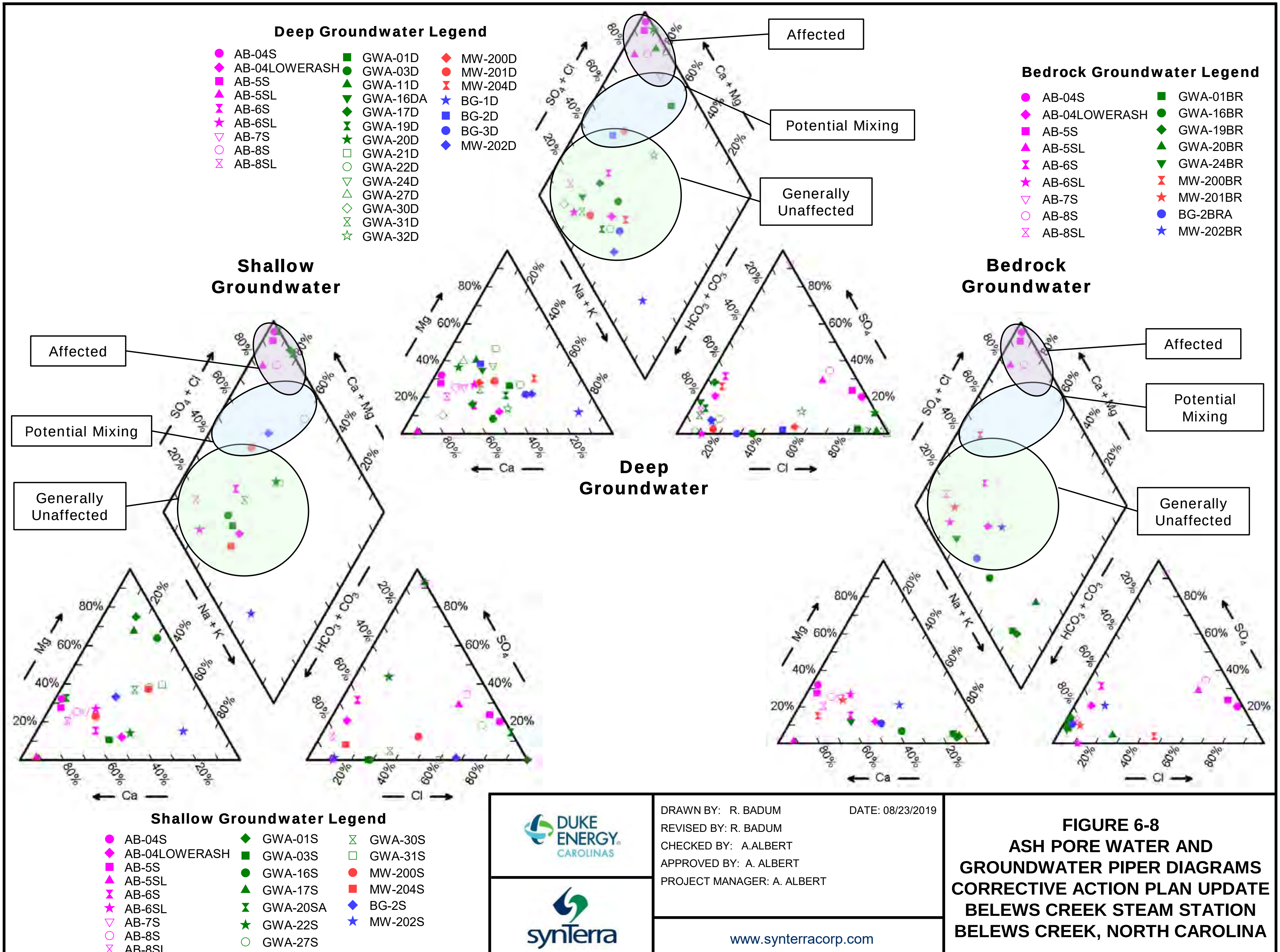
FIGURE 6-7
GEOCHEMICAL WATER QUALITY PLOTS
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NC



DUKE ENERGY CAROLINAS

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REVISED BY: R. BADUM
CHECKED BY: A.ALBERT
APPROVED BY: A. ALBERT
PROJECT MANAGER: A. ALBERT

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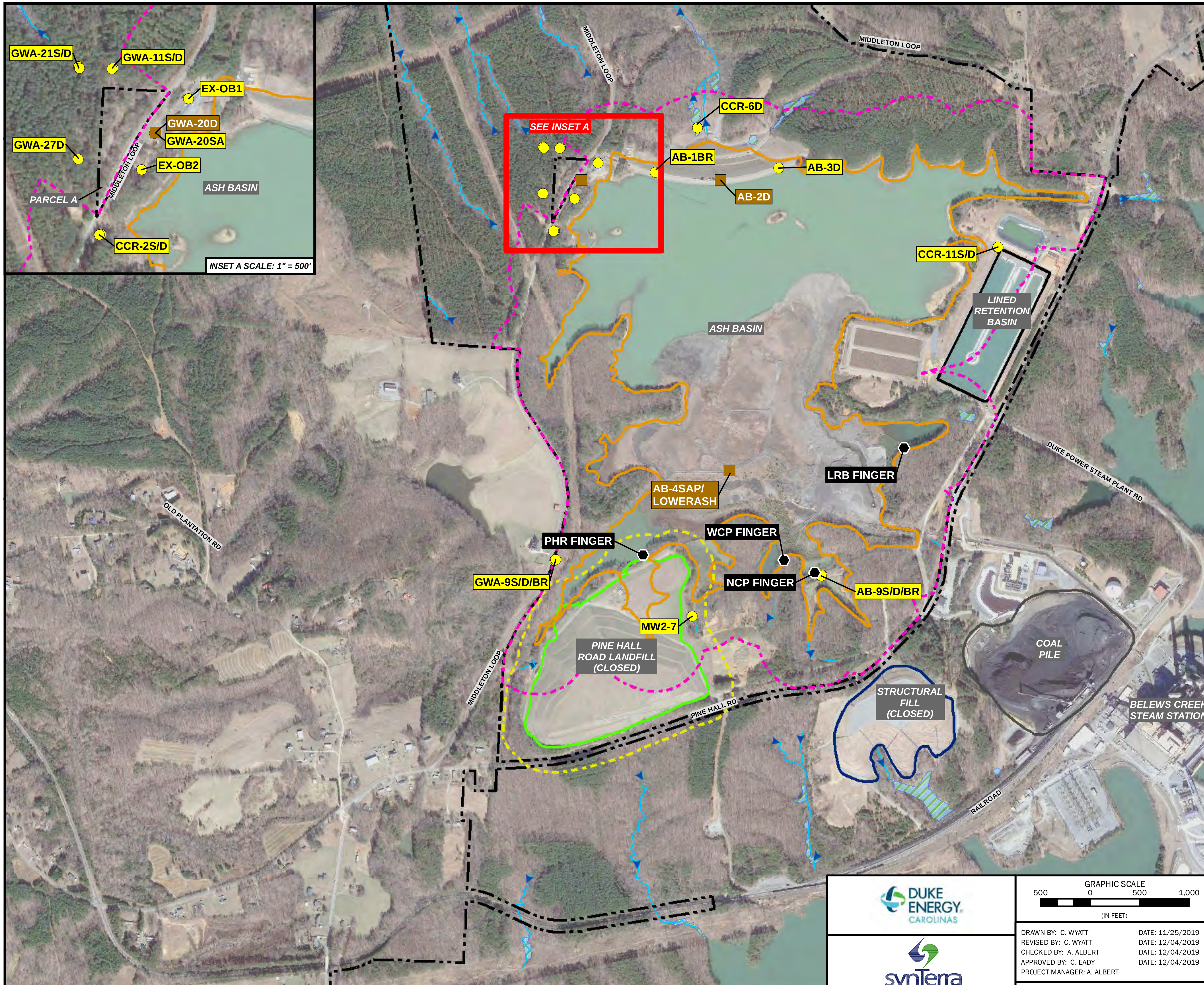
FIGURE 6-8
ASH PORE WATER AND GROUNDWATER PIPER DIAGRAMS
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA



LEGEND

- ⬢ PROPOSED TRANSDUCER LOCATION FOR ASH BASIN FINGER PONDED WATER LEVEL MONITORING
- ● TRANSDUCER LOCATION FOR ASH BASIN GROUNDWATER LEVEL MONITORING
- ■ GEOCHEMICAL SONDE LOCATION FOR ASH BASIN GROUNDWATER LEVEL AND WATER QUALITY MONITORING
- ASH BASIN WASTE BOUNDARY
- ASH BASIN COMPLIANCE BOUNDARY
- LANDFILL BOUNDARY (CLOSED)
- STRUCTURAL FILL BOUNDARY (CLOSED)
- LANDFILL COMPLIANCE BOUNDARY
- LINED RETENTION BASIN
- COAL PILE STORAGE AREA
- DUKE ENERGY CAROLINAS PROPERTY LINE
- STREAM (AMEC NRTR)
- WETLAND (AMEC NRTR)

NOTES:

1. PHR - PINE HALL ROAD
2. WCP - WEST OF CHEMICAL POND
3. NCP - NORTH OF CHEMICAL POND
4. LRB - LINED RETENTION BASIN
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 NOT TO BE USED FOR JURISDICTIONAL DETERMINATION PURPOSES. THE WETLANDS AND STREAMS BOUNDARIES WERE OBTAINED FROM AMEC FOSTER WHEELER ENVIRONMENTAL & INFRASTRUCTURE, INC. NATURAL RESOURCE TECHNICAL REPORT FOR BELEWS CREEK STEAM STATION DATED JULY 2, 2015.
6. ALL BOUNDARIES ARE APPROXIMATE.
7. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.
8. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON JUNE 11, 2019. AERIAL WAS COLLECTED ON FEBRUARY 3, 2019.
9. DRAWING HAS BEEN SET WITH A PROJECTION OF NORTH CAROLINA STATE PLANE COORDINATE SYSTEM FIPS 3200 (NAD83).

GRAPHIC SCALE
500 0 500 1,000
(IN FEET)

DRAWN BY: C. WYATT DATE: 11/25/2019
REVISED BY: C. WYATT DATE: 12/04/2019
CHECKED BY: A. ALBERT DATE: 12/04/2019
APPROVED BY: C. EADY DATE: 12/04/2019
PROJECT MANAGER: A. ALBERT

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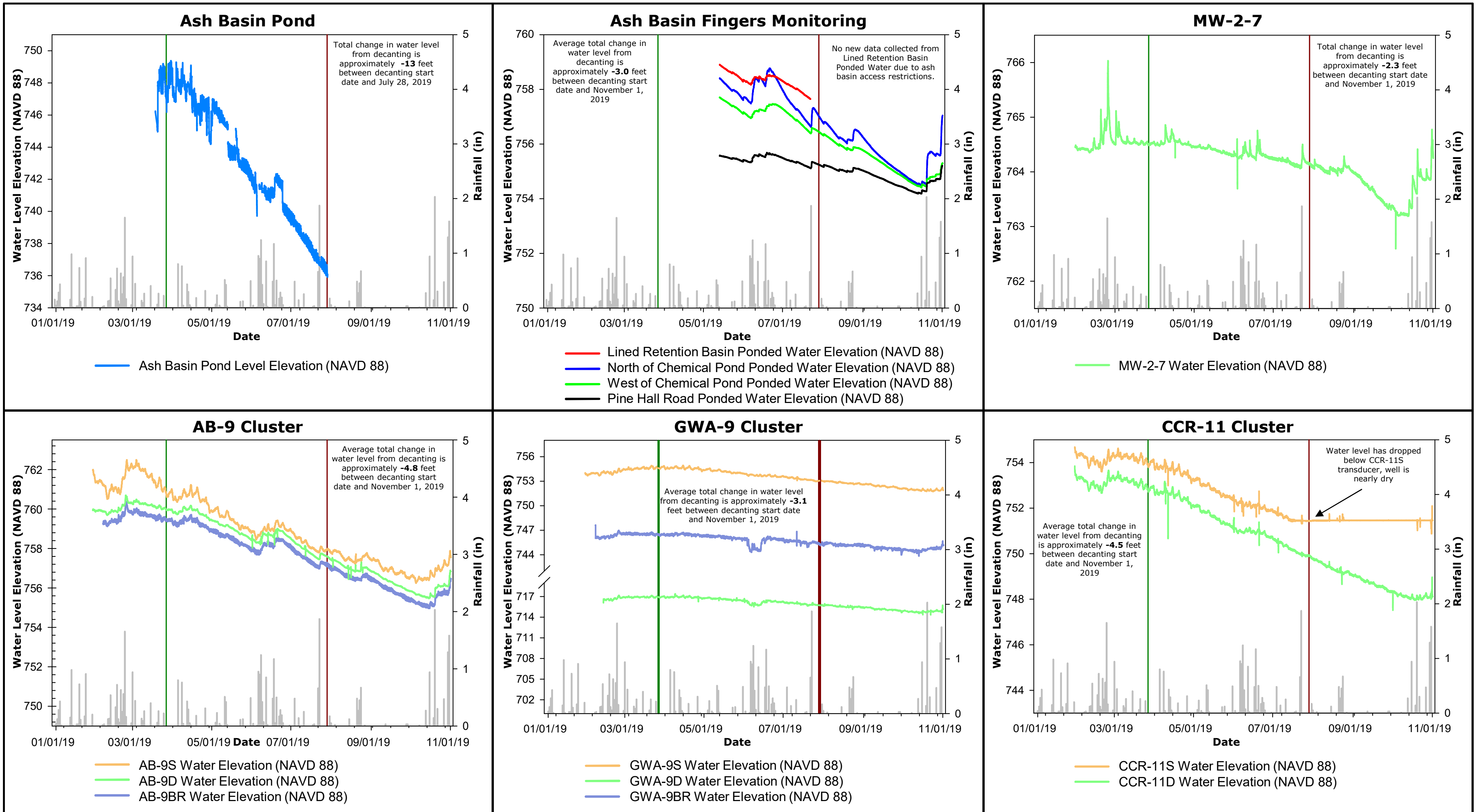
FIGURE 6-9
SITE LAYOUT
DECANTING MONITORING NETWORK
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA



LEGEND

- Decanting Start (03/27/2019)
- Decanting Suspended (07/29/2019)
- Daily Total Rainfall (inches)

- Ash Pore Water
- Shallow Flow Groundwater Zone
- Deep Flow Groundwater Zone
- Bedrock Flow Groundwater Zone

Notes:
NAVD 88 – North American Vertical Datum 1988
in – inches

DUKE ENERGY. CAROLINAS

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REVISED BY: M. ROZIER	DATE: 12/03/2019
CHECKED BY: A. ALBERT	DATE: 12/03/2019
APPROVED BY: A. ALBERT	DATE: 12/03/2019
PROJECT MANAGER: A. ALBERT	

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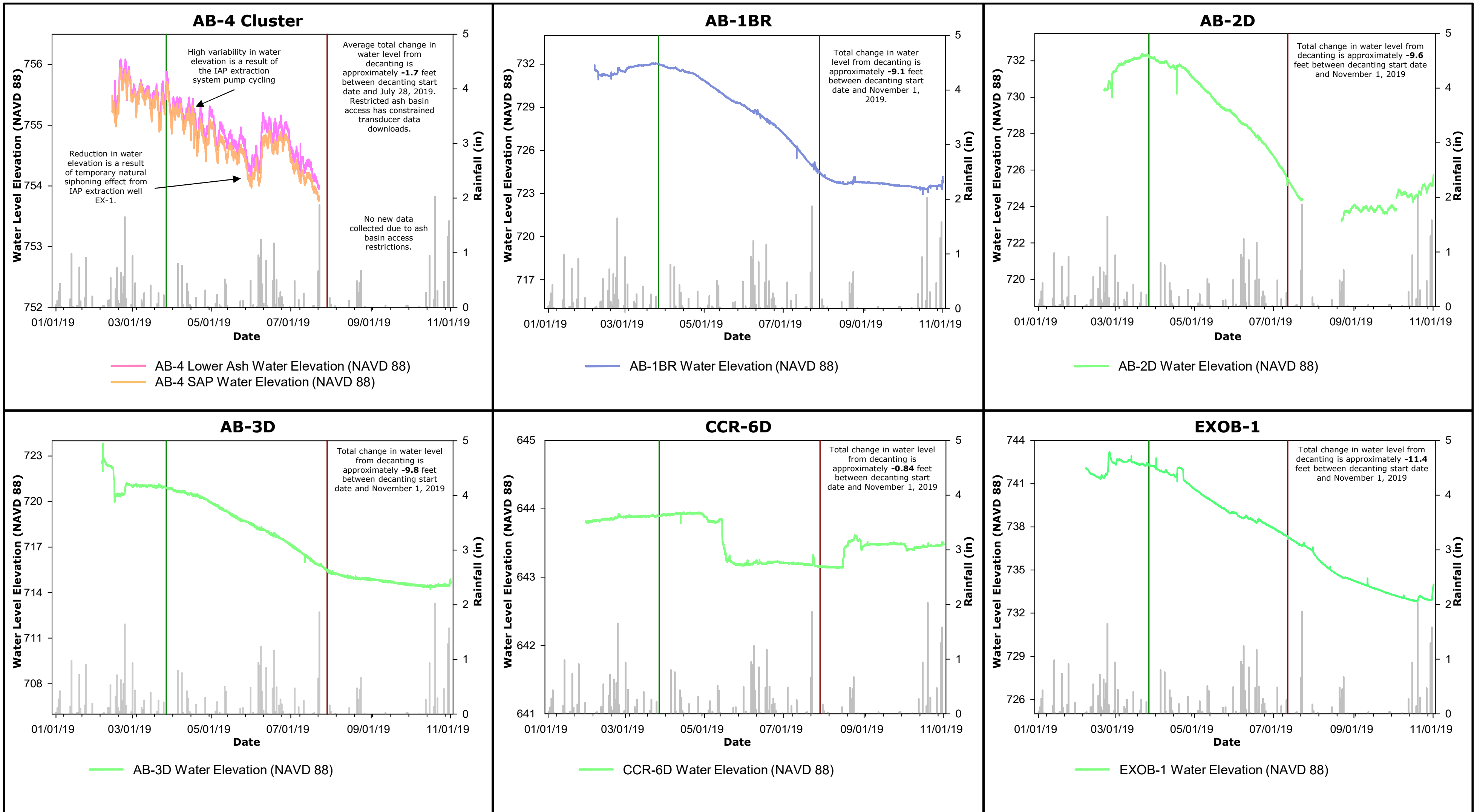
FIGURE 6-10a
HYDROGRAPHS – ASH BASIN AND SOUTH, EAST, AND WEST OF ASH BASIN
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NC



LEGEND

- Decanting Start (03/27/2019)
- Decanting Suspended (07/29/2019)
- Daily Total Rainfall (inches)

- Ash Pore Water
- Shallow Flow Groundwater Zone
- Deep Flow Groundwater Zone
- Bedrock Flow Groundwater Zone

Notes:
NAVD 88 – North American Vertical Datum 1988
in – inches

DUKE ENERGY. CAROLINAS

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REVISED BY: M. ROZIER	DATE: 12/03/2019
CHECKED BY: A. ALBERT	DATE: 12/03/2019
APPROVED BY: A. ALBERT	DATE: 12/03/2019
PROJECT MANAGER: A. ALBERT	

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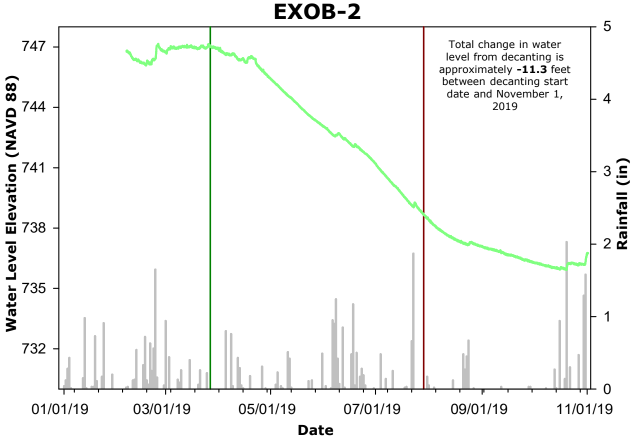
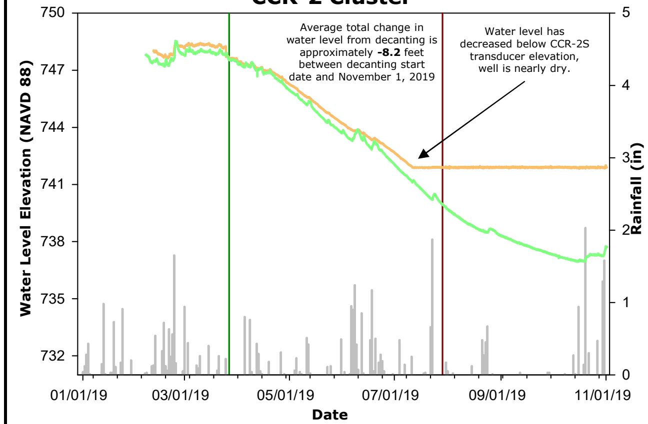
FIGURE 6-10b
HYDROGRAPHS – WITHIN ASH BASIN AND NORTH OF ASH BASIN
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NC

EXOB-2



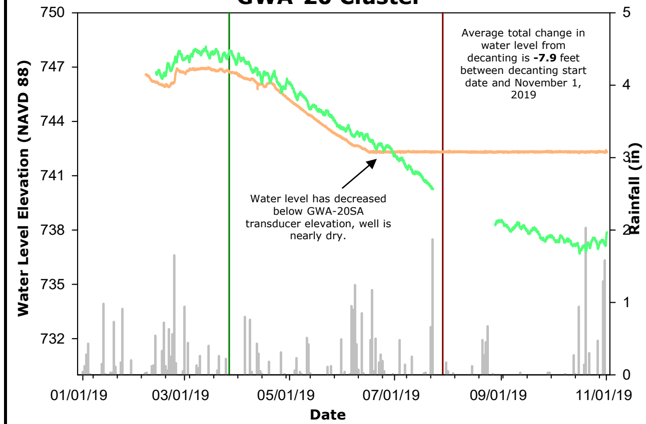
EXOB-2 Water Elevation (NAVD 88)

CCR-2 Cluster



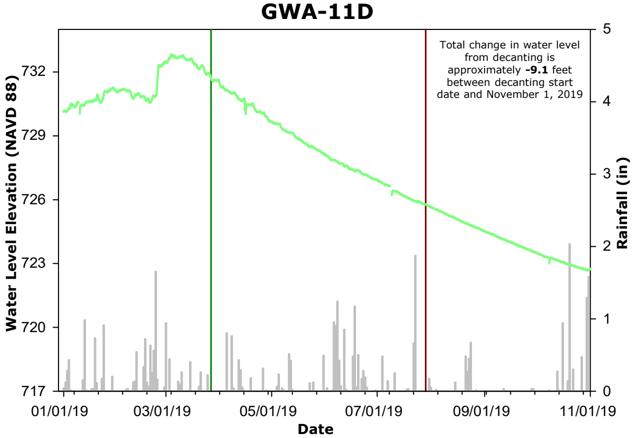
CCR-2S Water Elevation (NAVD 88)
CCR-2D Water Elevation (NAVD 88)

GWA-20 Cluster



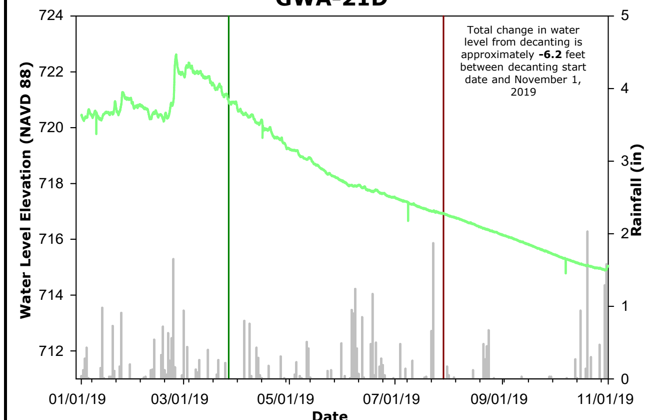
GWA-20SA Water Elevation (NAVD 88)
GWA-20D Water Elevation (NAVD 88)

GWA-11D



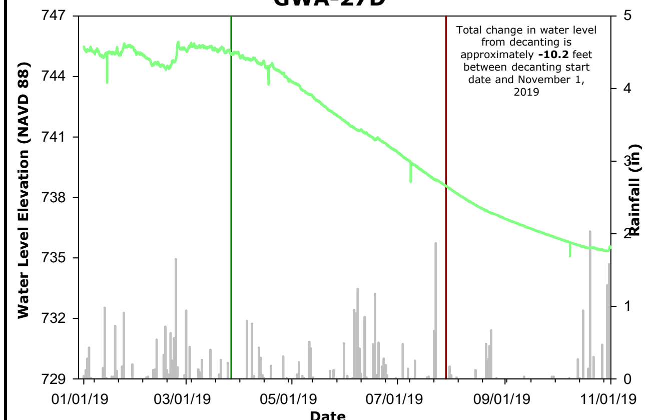
GWA-11D Water Elevation (NAVD 88)

GWA-21D



GWA-21D Water Elevation (NAVD 88)

GWA-27D



GWA-27D Water Elevation (NAVD 88)

LEGEND

Decanting Start (03/27/2019)
Decanting Suspended (07/29/2019)
Daily Total Rainfall (inches)

Shallow Groundwater Flow Zone
Deep Flow Groundwater Zone

Notes:
NAVD 88 – North American Vertical Datum 1988
in – inches

DUKE ENERGY. CAROLINAS

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DRAWN BY: D. AVARD	DATE: 11/10/2019
REVISED BY: M. ROZIER	DATE: 12/03/2019
CHECKED BY: A. ALBERT	DATE: 12/03/2019
APPROVED BY: A. ALBERT	DATE: 12/03/2019
PROJECT MANAGER: A. ALBERT	

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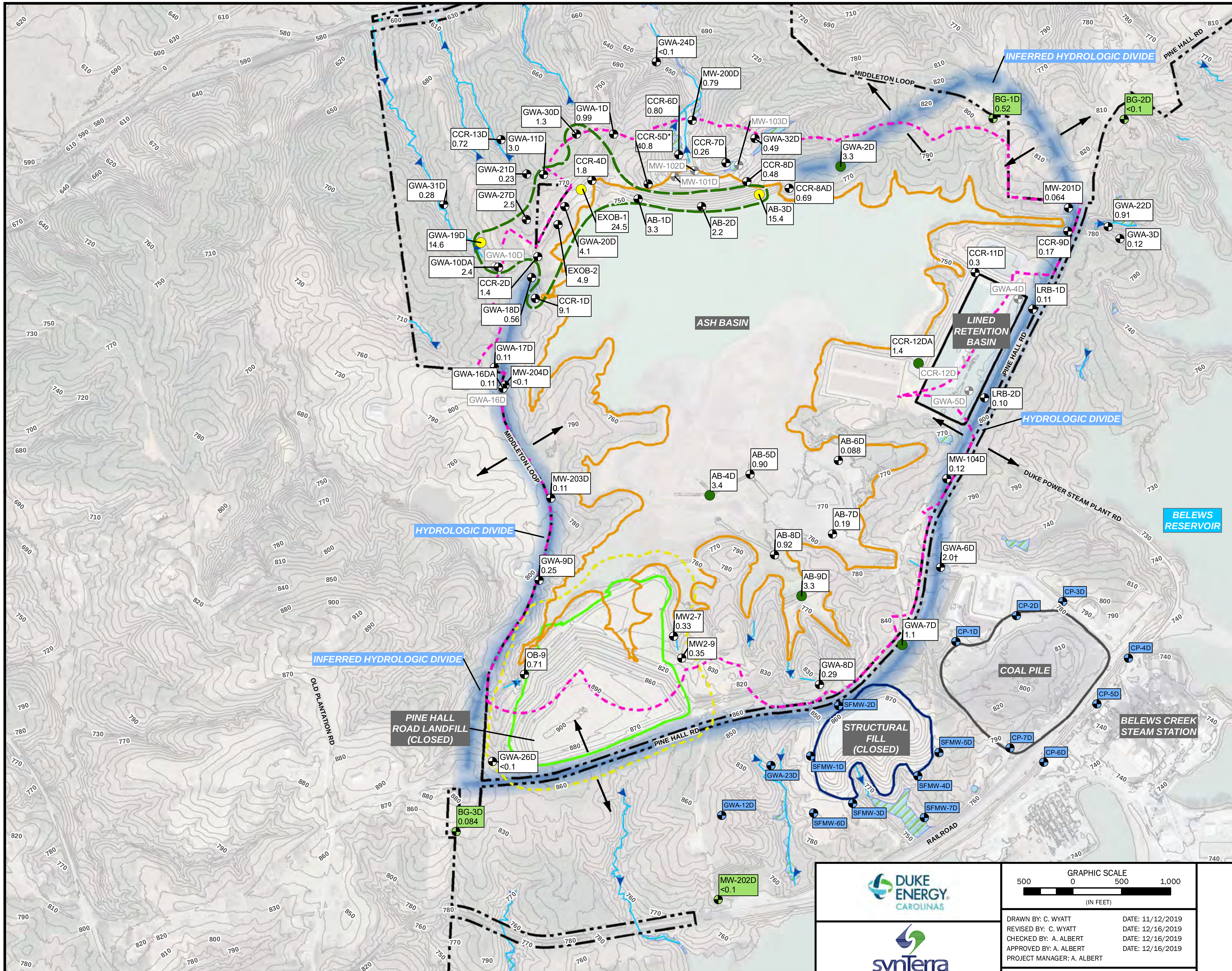
FIGURE 6-10c
HYDROGRAPHS – NORTHWEST OF ASH BASIN
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NC



LEGEND

- ASSESSMENT MONITORING WELL
- BACKGROUND MONITORING WELL
- WELL ABANDONED
- STRUCTURAL FILL AND COAL PILE MONITORING WELL
- ISOLATED EXCEEDANCE OF NC 02L
- ISOLATED EXCEEDANCE OF BACKGROUND
- INFERRED BACKGROUND CONTOUR
- ASH BASIN WASTE BOUNDARY
- ASH BASIN COMPLIANCE BOUNDARY
- LANDFILL BOUNDARY (CLOSED)
- STRUCTURAL FILL BOUNDARY (CLOSED)
- LANDFILL COMPLIANCE BOUNDARY
- LINED RETENTION BASIN
- COAL PILE STORAGE AREA
- DUKE ENERGY CAROLINAS PROPERTY LINE
- TOPOGRAPHIC CONTOUR (10' INTERVAL)
- GROUNDWATER FLOW DIRECTION
- STREAM (AMEC NRTR)
- WETLAND (AMEC NRTR)
- APPROXIMATE HYDROLOGIC DIVIDE

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 ARSENIC IS 10 µg/L

3. THE BACKGROUND VALUE FOR ARSENIC IS 2 µg/L (AS SUBMITTED JUNE 2019).

4. HYDROLOGIC DIVIDE IDENTIFIED IN CSA UPDATE (SYNTERRA, 2017) AND UPDATED GROUNDWATER FLOW AND TRANSPORT MODELING REPORT (FALTA AND OTHERS, 2019).

5. THE WATERS OF THE U.S. 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 BELEWS CREEK STEAM STATION DATED JULY 2, 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. COAL PILE AND STRUCTRUAL FILL ASSESSMENT ARE ONGOING AND ARE THEREFORE NOT ADDRESSED IN THE CORRECTIVE ACTION PLAN UPDATE.

8. ALL BOUNDARIES ARE APPROXIMATE.

9. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.

10. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON JUNE 11, 2019. AERIAL WAS COLLECTED ON FEBRUARY 3, 2019.

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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GRAPHIC SCALE
500 0 500 1,000
(IN FEET)

DRAWN BY: C. WYATT DATE: 11/12/2019
REVISED BY: C. WYATT DATE: 12/16/2019
CHECKED BY: A. ALBERT DATE: 12/16/2019
APPROVED BY: A. ALBERT DATE: 12/16/2019
PROJECT MANAGER: A. ALBERT

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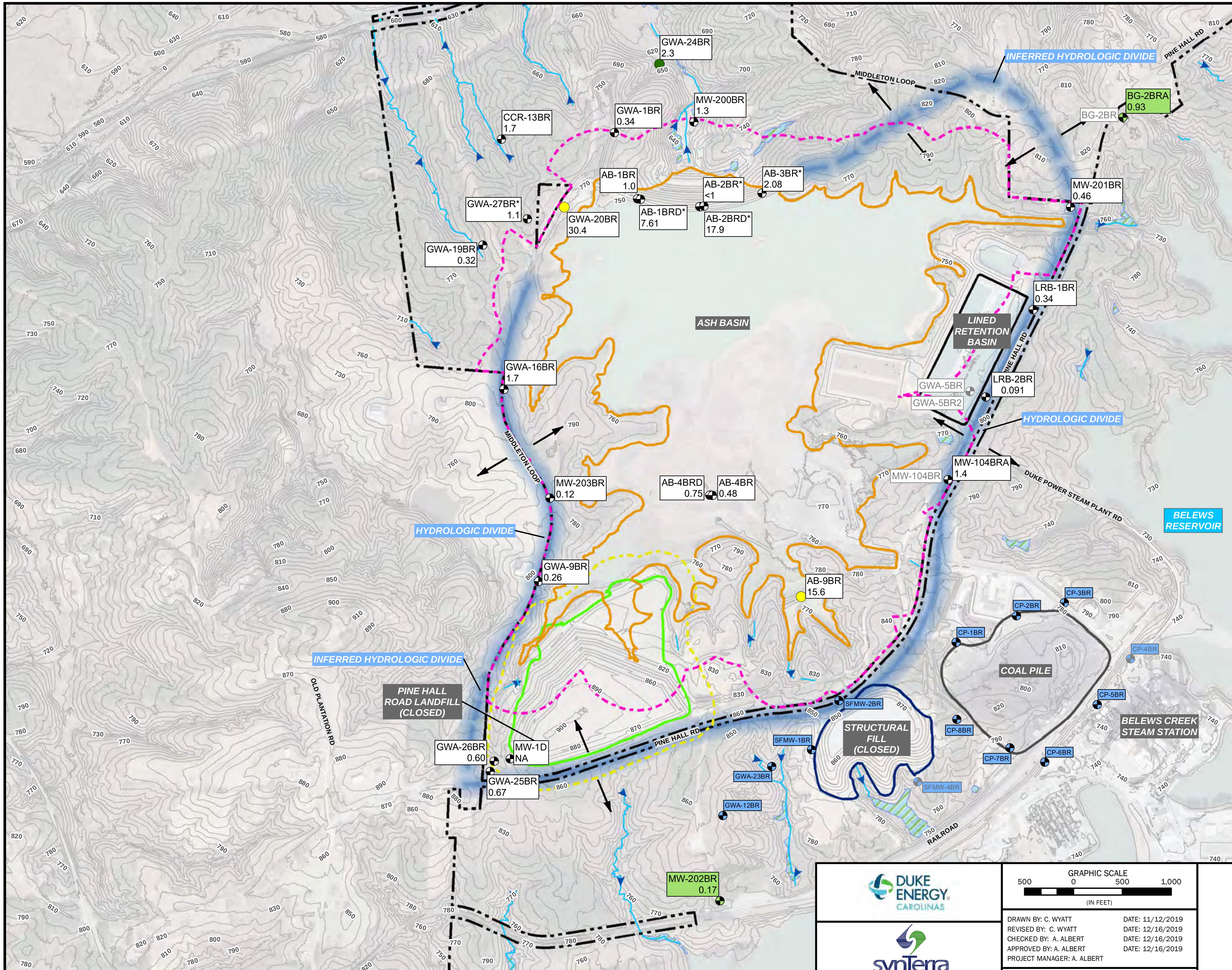
FIGURE 6-11a
ISOCONCENTRATION MAP
ARSENIC IN DEEP FLOW ZONE
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA



LEGEND

- ASSESSMENT MONITORING WELL
- BACKGROUND MONITORING WELL
- WELL ABANDONED
- STRUCTURAL FILL AND COAL PILE MONITORING WELL
- ISOLATED EXCEEDANCE OF NC 02L
- ISOLATED EXCEEDANCE OF BACKGROUND
- ASH BASIN WASTE BOUNDARY
- ASH BASIN COMPLIANCE BOUNDARY
- LANDFILL BOUNDARY (CLOSED)
- STRUCTURAL FILL BOUNDARY (CLOSED)
- LANDFILL COMPLIANCE BOUNDARY
- LINED RETENTION BASIN
- COAL PILE STORAGE AREA
- DUKE ENERGY CAROLINAS PROPERTY LINE
- TOPOGRAPHIC CONTOUR (10' INTERVAL)
- GROUNDWATER FLOW DIRECTION
- STREAM (AMEC NRTR)
- WETLAND (AMEC NRTR)
- APPROXIMATE HYDROLOGIC DIVIDE

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 ARSENIC IS 10 µg/L

3. THE BACKGROUND VALUE FOR ARSENIC IS 2 µg/L (AS SUBMITTED JUNE 2019).

4. * - CONSTITUENT CONCENTRATION SHOWN IS THE MOST RECENT VALID SAMPLE AVAILABLE BETWEEN JANUARY 2018 AND APRIL 2019.

5. HYDROLOGIC DIVIDE IDENTIFIED IN CSA UPDATE (SYNTERRA, 2017) AND UPDATED GROUNDWATER FLOW AND TRANSPORT MODELING REPORT (FALTA AND OTHERS, 2019).

6. THE WATERS OF THE U.S. 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 BELEWS CREEK STEAM STATION DATED JULY 2, 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. COAL PILE AND STRUCTRUAL FILL ASSESSMENT ARE ONGOING AND ARE THEREFORE NOT ADDRESSED IN THE CORRECTIVE ACTION PLAN UPDATE.

9. ALL BOUNDARIES ARE APPROXIMATE.

10. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.

11. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON JUNE 11, 2019. AERIAL WAS COLLECTED ON FEBRUARY 3, 2019.

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

DUKE ENERGY CAROLINAS

synTerra

GRAPHIC SCALE
500 0 500 1,000
(IN FEET)

DRAWN BY: C. WYATT	DATE: 11/12/2019
REVISED BY: C. WYATT	DATE: 12/16/2019
CHECKED BY: A. ALBERT	DATE: 12/16/2019
APPROVED BY: A. ALBERT	DATE: 12/16/2019
PROJECT MANAGER: A. ALBERT	

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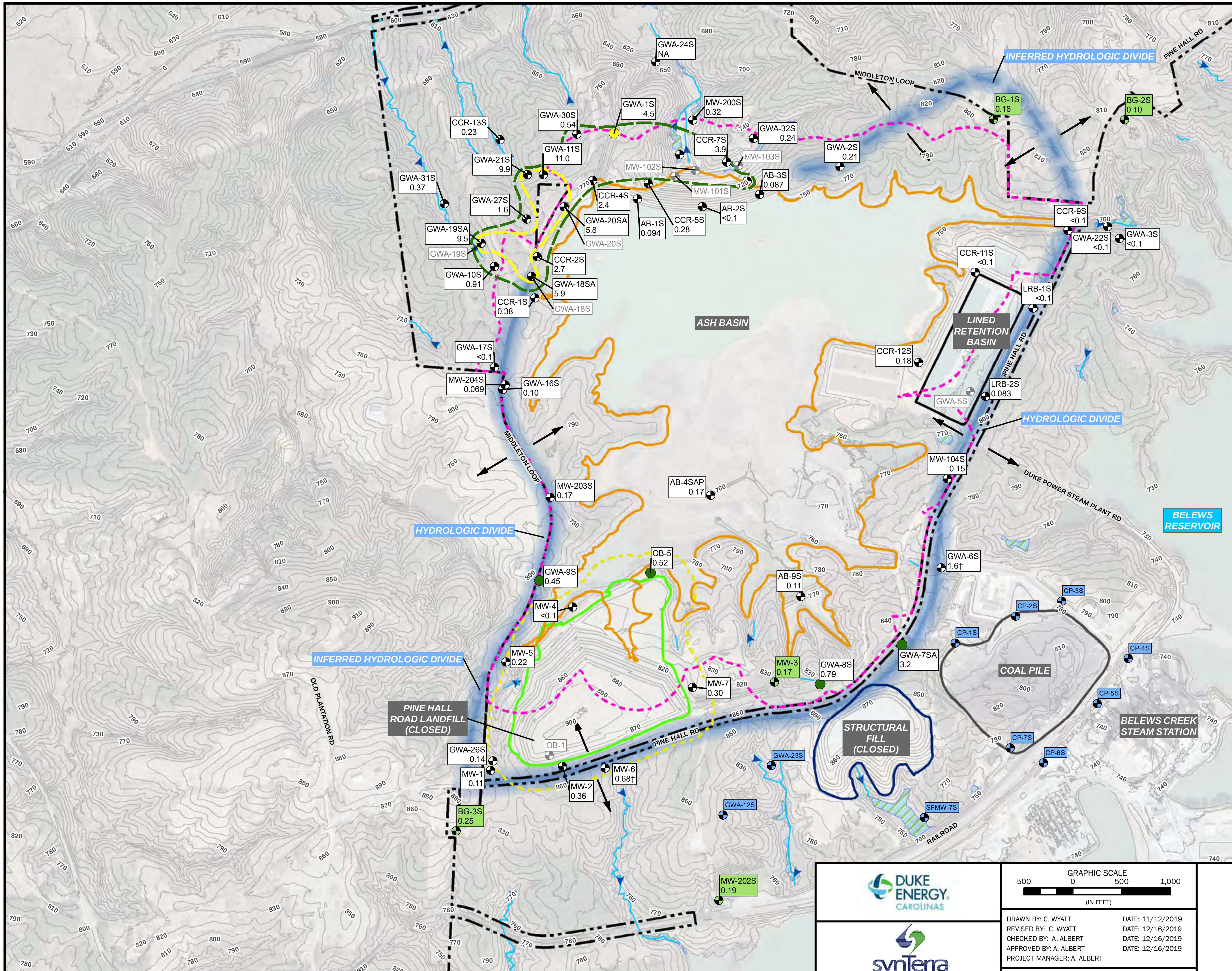
FIGURE 6-11b
ISOCONCENTRATION MAP
ARSENIC IN BEDROCK FLOW ZONE
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA



LEGEND

- ASSESSMENT MONITORING WELL
- BACKGROUND MONITORING WELL
- WELL ABANDONED
- STRUCTURAL FILL AND COAL PILE MONITORING WELL
- ISOLATED EXCEEDANCE OF IMAC
- ISOLATED EXCEEDANCE OF BACKGROUND
- INFERRED IMAC VALUE CONTOUR
- INFERRED BACKGROUND CONTOUR
- ASH BASIN WASTE BOUNDARY
- ASH BASIN COMPLIANCE BOUNDARY
- LANDFILL BOUNDARY (CLOSED)
- STRUCTURAL FILL BOUNDARY (CLOSED)
- LANDFILL COMPLIANCE BOUNDARY
- LINED RETENTION BASIN
- COAL PILE STORAGE AREA
- DUKE ENERGY CAROLINAS PROPERTY LINE
- TOPOGRAPHIC CONTOUR (10' INTERVAL)
- GROUNDWATER FLOW DIRECTION
- STREAM (AMEC NRTR)
- WETLAND (AMEC NRTR)
- APPROXIMATE HYDROLOGIC DIVIDE

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 BERYLLIUM IS 4 µg/L.

3. THE BACKGROUND VALUE FOR BERYLLIUM IS 0.4 ug/L (AS SUBMITTED JUNE 2019).

4. HYDROLOGIC DIVIDE IDENTIFIED IN CSA UPDATE (SYNTERRA, 2017) AND UPDATED GROUNDWATER FLOW AND TRANSPORT MODELING REPORT (FALTA AND OTHERS, 2019).

5. THE WATERS OF THE U.S. 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 BELEWS CREEK STEAM STATION DATED JULY 2, 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. COAL PILE AND STRUCTRUAL FILL ASSESSMENT ARE ONGOING AND ARE THEREFORE NOT ADDRESSED IN THE CORRECTIVE ACTION PLAN UPDATE.

8. ALL BOUNDARIES ARE APPROXIMATE.

9. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.

10. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON JUNE 11, 2019. AERIAL WAS COLLECTED ON FEBRUARY 3, 2019.

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

DUKE ENERGY CAROLINAS

synTerra

GRAPHIC SCALE
500 0 500 1,000
(IN FEET)

DRAWN BY: C. WYATT	DATE: 11/12/2019
REVISED BY: C. WYATT	DATE: 12/16/2019
CHECKED BY: A. ALBERT	DATE: 12/16/2019
APPROVED BY: A. ALBERT	DATE: 12/16/2019
PROJECT MANAGER: A. ALBERT	

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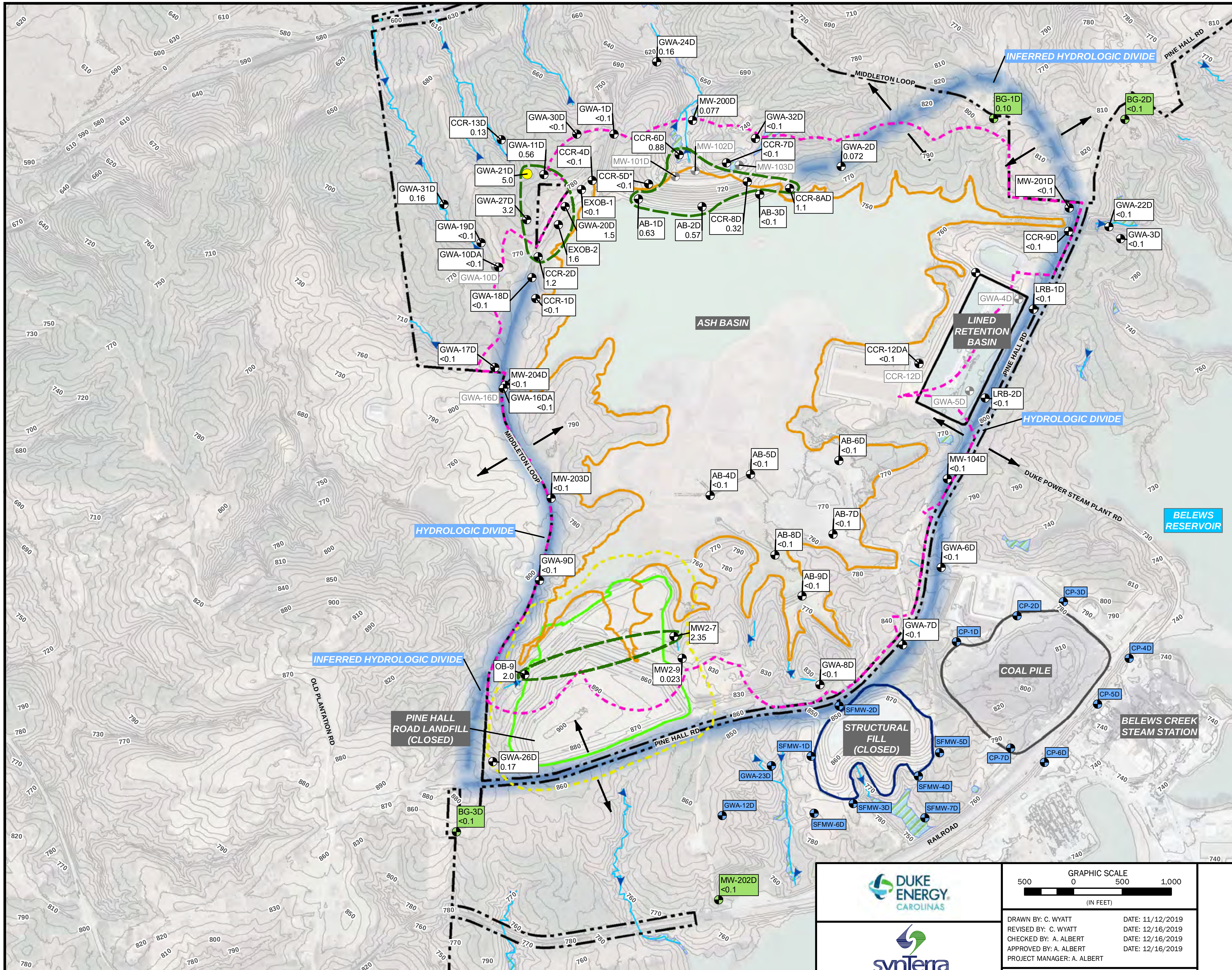
FIGURE 6-12a
ISOCONCENTRATION MAP
BERYLLIUM IN SHALLOW FLOW ZONE
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA



LEGEND

- ASSESSMENT MONITORING WELL
- BACKGROUND MONITORING WELL
- WELL ABANDONED
- STRUCTURAL FILL AND COAL PILE MONITORING WELL
- ISOLATED EXCEEDANCE OF IMAC
- INFERRED BACKGROUND CONTOUR
- ASH BASIN WASTE BOUNDARY
- ASH BASIN COMPLIANCE BOUNDARY
- LANDFILL BOUNDARY (CLOSED)
- STRUCTURAL FILL BOUNDARY (CLOSED)
- LANDFILL COMPLIANCE BOUNDARY
- LINED RETENTION BASIN
- COAL PILE STORAGE AREA
- DUKE ENERGY CAROLINAS PROPERTY LINE
- TOPOGRAPHIC CONTOUR (10' INTERVAL)
- GROUNDWATER FLOW DIRECTION
- STREAM (AMEC NRTR)
- WETLAND (AMEC NRTR)
- APPROXIMATE HYDROLOGIC DIVIDE

NOTES:

1. DATA INCLUDED IN THIS FIGURE ARE THE GEOMEAN FOR WELLS FROM WHICH FOUR OR MORE VALID SAMPLES WERE OBTAINED BETWEEN JANUARY 2018 THROUGH APRIL 2019. FOR WELLS FROM WHICH FOUR OR MORE VALID SAMPLES WERE NOT OBTAINED BETWEEN JANUARY 2018 THROUGH APRIL 2019, THE MOST RECENT VALID DATA ARE INCLUDED (REFERENCE TABLE 6-5).

2. THE IMAC FOR BERYLLIUM IS 4 μg/L.

3. THE BACKGROUND VALUE FOR BERYLLIUM IS 0.2 μg/L.

4. NA - NO DATA AVAILABLE.

5. CCR-5D* - INSUFFCIENT NUMBER OF SAMPLE EVENTS (≥4 SAMPLE EVENTS) TO CALCULATE MEAN OF DATASET OR WELL EXHIBITS HIGH pH INDICATIVE OF GROUT CONTAMINATION. NO CENTRAL TENDENCY MEAN ANALYSIS COMPLETED FOR COI, THEREFORE DATA FROM WELL REPRESENTS MOST RECENT AVAILABLE DATA FROM 2019 PROVIDED FOR INFORMATIONAL PURPOSES ONLY.(APPENDIX C, TABLE 1)

6. HYDROLOGIC DIVIDE INDENTIFIED IN CSA UPDATE (SYNTERRA, 2017) AND FLOW AND TRANSPORT REPORT REFERENCE.

7. 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 NOT TO BE USED FOR JURISDICTIONAL DETERMINATION PURPOSES. THE WETLANDS AND STREAMS BOUNDARIES WERE OBTAINED FROM AMEC FOSTER WHEELER ENVIRONMENTAL & INFRASTRUCTURE, INC. NATURAL RESOURCE TECHNICAL REPORT FOR BELEWS CREEK STEAM STATION DATED JULY 2, 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.COAL PILE AND STRUCTURAL FILL ASSESSMENTS ONGOING AND ARE THEREFORE NOT ADDRESSED IN THE CORRECTIVE ACTION PLAN UPDATE

10. ALL BOUNDARIES ARE APPROXIMATE.

11. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.

12. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON JUNE 11, 2019. AERIAL WAS COLLECTED ON FEBRUARY 3, 2019.

13. 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
500 0 500 1,000
(IN FEET)

DRAWN BY: C. WYATT DATE: 11/12/2019
REVISED BY: C. WYATT DATE: 12/16/2019
CHECKED BY: A. ALBERT DATE: 12/16/2019
APPROVED BY: A. ALBERT DATE: 12/16/2019
PROJECT MANAGER: A. ALBERT

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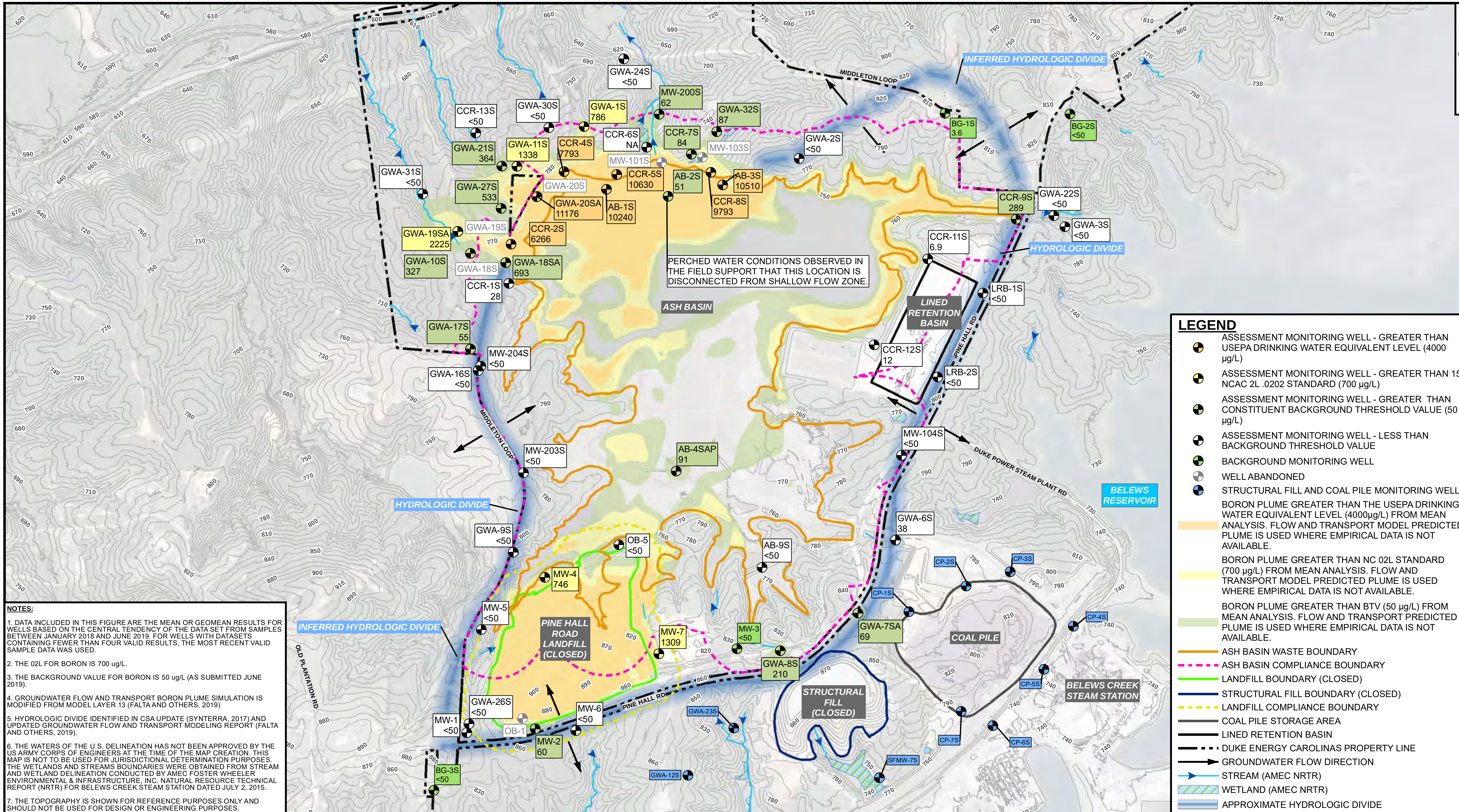
FIGURE 6-12b
ISOCONCENTRATION MAP
BERYLLIUM IN DEEP FLOW ZONE
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA



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 ug/L.

3. THE BACKGROUND VALUE FOR BORON IS 50 ug/L (AS SUBMITTED JUNE 2019).

4. GROUNDWATER FLOW AND TRANSPORT BORON PLUME SIMULATION IS MODIFIED FROM MODEL LAYER 13 (FALTA AND OTHERS, 2019)

5. HYDROLOGIC DIVIDE IDENTIFIED IN CSA UPDATE (SYNTERRA, 2017) AND UPDATED GROUNDWATER FLOW AND TRANSPORT MODELING REPORT (FALTA AND OTHERS, 2019).

6. THE WATERS OF THE U.S. 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 BELEWS CREEK STEAM STATION DATED JULY 2, 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. COAL PILE AND STRUCTRUAL FILL ASSESSMENT ARE ONGOING AND ARE THEREFORE NOT ADDRESSED IN THE CORRECTIVE ACTION PLAN UPDATE.

9. ALL BOUNDARIES ARE APPROXIMATE.

10. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.

11. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON JUNE 11, 2019. AERIAL WAS COLLECTED ON FEBRUARY 3, 2019.

12. 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. DAVIS	DATE: 05/09/2019
REVISED BY: C. WYATT	DATE: 12/23/2019
CHECKED BY: A. ALBERT	DATE: 12/23/2019
APPROVED BY: A. ALBERT	DATE: 12/23/2019
PROJECT MANAGER: A. ALBERT	

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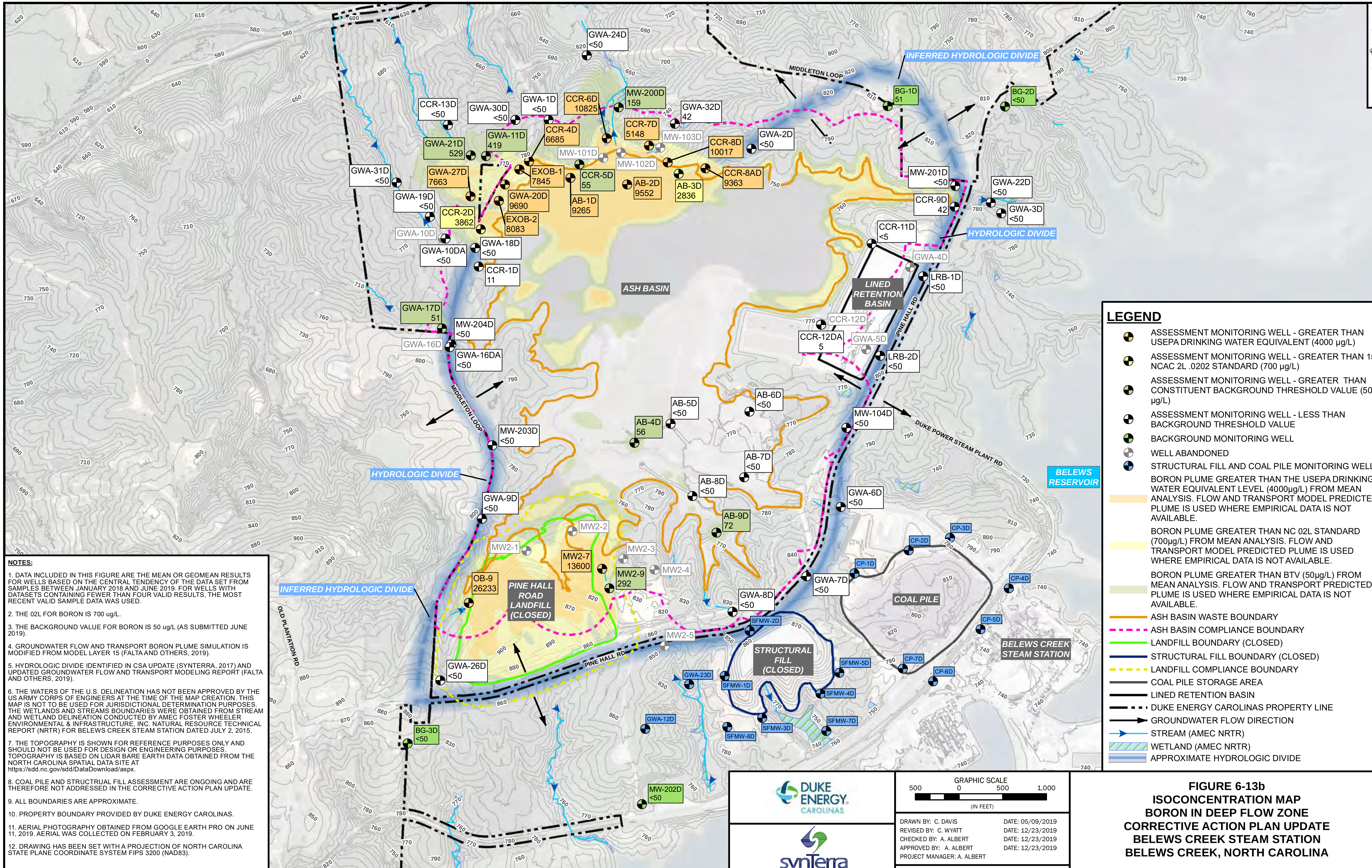
FIGURE 6-13a
ISOCONCENTRATION MAP
BORON IN SHALLOW FLOW ZONE
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA



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 ug/L.

3. THE BACKGROUND VALUE FOR BORON IS 50 ug/L (AS SUBMITTED JUNE 2019).

4. GROUNDWATER FLOW AND TRANSPORT BORON PLUME SIMULATION IS MODIFIED FROM MODEL LAYER 15 (FALTA AND OTHERS, 2019).

5. HYDROLOGIC DIVIDE IDENTIFIED IN CSA UPDATE (SYNTERRA, 2017) AND UPDATED GROUNDWATER FLOW AND TRANSPORT MODELING REPORT (FALTA AND OTHERS, 2019).

6. THE WATERS OF THE U.S. 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 BELEWS CREEK STEAM STATION DATED JULY 2, 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. COAL PILE AND STRUCTURAL FILL ASSESSMENT ARE ONGOING AND ARE THEREFORE NOT ADDRESSED IN THE CORRECTIVE ACTION PLAN UPDATE.

9. ALL BOUNDARIES ARE APPROXIMATE.

10. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.

11. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON JUNE 11, 2019. AERIAL WAS COLLECTED ON FEBRUARY 3, 2019.

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

LEGEND

- ASSESSMENT MONITORING WELL - GREATER THAN USEPA DRINKING WATER EQUIVALENT (4000 µg/L)
- ASSESSMENT MONITORING WELL - GREATER THAN 15A NCAC 2L .0202 STANDARD (700 µg/L)
- ASSESSMENT MONITORING WELL - GREATER THAN CONSTITUENT BACKGROUND THRESHOLD VALUE (50 µg/L)
- ASSESSMENT MONITORING WELL - LESS THAN BACKGROUND THRESHOLD VALUE
- BACKGROUND MONITORING WELL
- WELL ABANDONED
- STRUCTURAL FILL AND COAL PILE MONITORING WELL
- BORON PLUME GREATER THAN THE USEPA DRINKING WATER EQUIVALENT LEVEL (4000µg/L) FROM MEAN ANALYSIS. FLOW AND TRANSPORT MODEL PREDICTED PLUME IS USED WHERE EMPIRICAL DATA IS NOT AVAILABLE.
- BORON PLUME GREATER THAN NC 02L STANDARD (700µg/L) FROM MEAN ANALYSIS. FLOW AND TRANSPORT MODEL PREDICTED PLUME IS USED WHERE EMPIRICAL DATA IS NOT AVAILABLE.
- BORON PLUME GREATER THAN BTV (50µg/L) FROM MEAN ANALYSIS. FLOW AND TRANSPORT PREDICTED PLUME IS USED WHERE EMPIRICAL DATA IS NOT AVAILABLE.
- ASH BASIN WASTE BOUNDARY
- ASH BASIN COMPLIANCE BOUNDARY
- LANDFILL BOUNDARY (CLOSED)
- STRUCTURAL FILL BOUNDARY (CLOSED)
- LANDFILL COMPLIANCE BOUNDARY
- COAL PILE STORAGE AREA
- LINED RETENTION BASIN
- DUKE ENERGY CAROLINAS PROPERTY LINE
- GROUNDWATER FLOW DIRECTION
- STREAM (AMEC NRTR)
- WETLAND (AMEC NRTR)
- APPROXIMATE HYDROLOGIC DIVIDE

DUKE ENERGY CAROLINAS

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GRAPHIC SCALE
500 0 500 1,000
(IN FEET)

DRAWN BY: C. DAVIS	DATE: 05/09/2019
REVISED BY: C. WYATT	DATE: 12/23/2019
CHECKED BY: A. ALBERT	DATE: 12/23/2019
APPROVED BY: A. ALBERT	DATE: 12/23/2019
PROJECT MANAGER: A. ALBERT	

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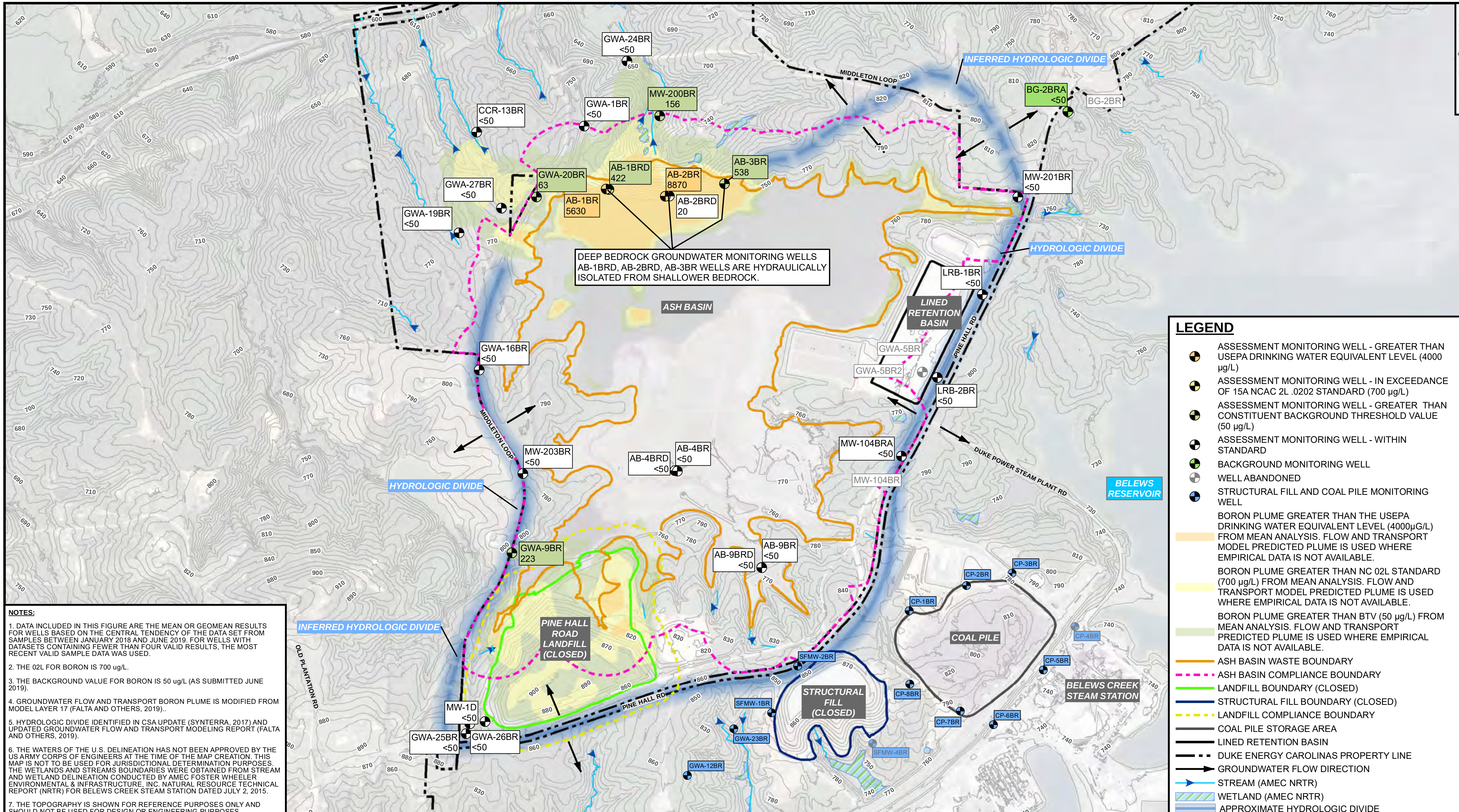
FIGURE 6-13b
ISOCONCENTRATION MAP
BORON IN DEEP FLOW ZONE
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA



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 ug/L.
3. THE BACKGROUND VALUE FOR BORON IS 50 ug/L (AS SUBMITTED JUNE 2019).
4. GROUNDWATER FLOW AND TRANSPORT BORON PLUME IS MODIFIED FROM MODEL LAYER 17 (FALTA AND OTHERS, 2019).
5. HYDROLOGIC DIVIDE IDENTIFIED IN CSA UPDATE (SYNTERRA, 2017) AND UPDATED GROUNDWATER FLOW AND TRANSPORT MODELING REPORT (FALTA AND OTHERS, 2019).
6. THE WATERS OF THE U.S. 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 BELEWS CREEK STEAM STATION DATED JULY 2, 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. COAL PILE AND STRUCTRUAL FILL ASSESSMENT ARE ONGOING AND ARE THEREFORE NOT ADDRESSED IN THE CORRECTIVE ACTION PLAN UPDATE.
9. ALL BOUNDARIES ARE APPROXIMATE.
10. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.
11. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON JUNE 11, 2019. AERIAL WAS COLLECTED ON FEBRUARY 3, 2019.
12. DRAWING HAS BEEN SET WITH A PROJECTION OF NORTH CAROLINA STATE PLANE COORDINATE SYSTEM FIPS 3200 (NAD83).

LEGEND

- ASSESSMENT MONITORING WELL - GREATER THAN USEPA DRINKING WATER EQUIVALENT LEVEL (4000 µg/L)
- ASSESSMENT MONITORING WELL - IN EXCEEDANCE OF 15A NCAC 2L .0202 STANDARD (700 µg/L)
- ASSESSMENT MONITORING WELL - GREATER THAN CONSTITUENT BACKGROUND THRESHOLD VALUE (50 µg/L)
- ASSESSMENT MONITORING WELL - WITHIN STANDARD
- BACKGROUND MONITORING WELL
- WELL ABANDONED
- STRUCTURAL FILL AND COAL PILE MONITORING WELL
- BORON PLUME GREATER THAN THE USEPA DRINKING WATER EQUIVALENT LEVEL (4000µG/L) FROM MEAN ANALYSIS. FLOW AND TRANSPORT MODEL PREDICTED PLUME IS USED WHERE EMPIRICAL DATA IS NOT AVAILABLE.
- 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.
- ASH BASIN WASTE BOUNDARY
- ASH BASIN COMPLIANCE BOUNDARY
- LANDFILL BOUNDARY (CLOSED)
- STRUCTURAL FILL BOUNDARY (CLOSED)
- LANDFILL COMPLIANCE BOUNDARY
- COAL PILE STORAGE AREA
- LINED RETENTION BASIN
- DUKE ENERGY CAROLINAS PROPERTY LINE
- GROUNDWATER FLOW DIRECTION
- STREAM (AMEC NRTR)
- WETLAND (AMEC NRTR)
- APPROXIMATE HYDROLOGIC DIVIDE

DUKE ENERGY CAROLINAS

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GRAPHIC SCALE
500 0 500 1,000
(IN FEET)

DRAWN BY: C. DAVIS	DATE: 05/09/2019
REVISED BY: C. WYATT	DATE: 12/23/2019
CHECKED BY: A. ALBERT	DATE: 12/23/2019
APPROVED BY: A. ALBERT	DATE: 12/23/2019
PROJECT MANAGER: A. ALBERT	

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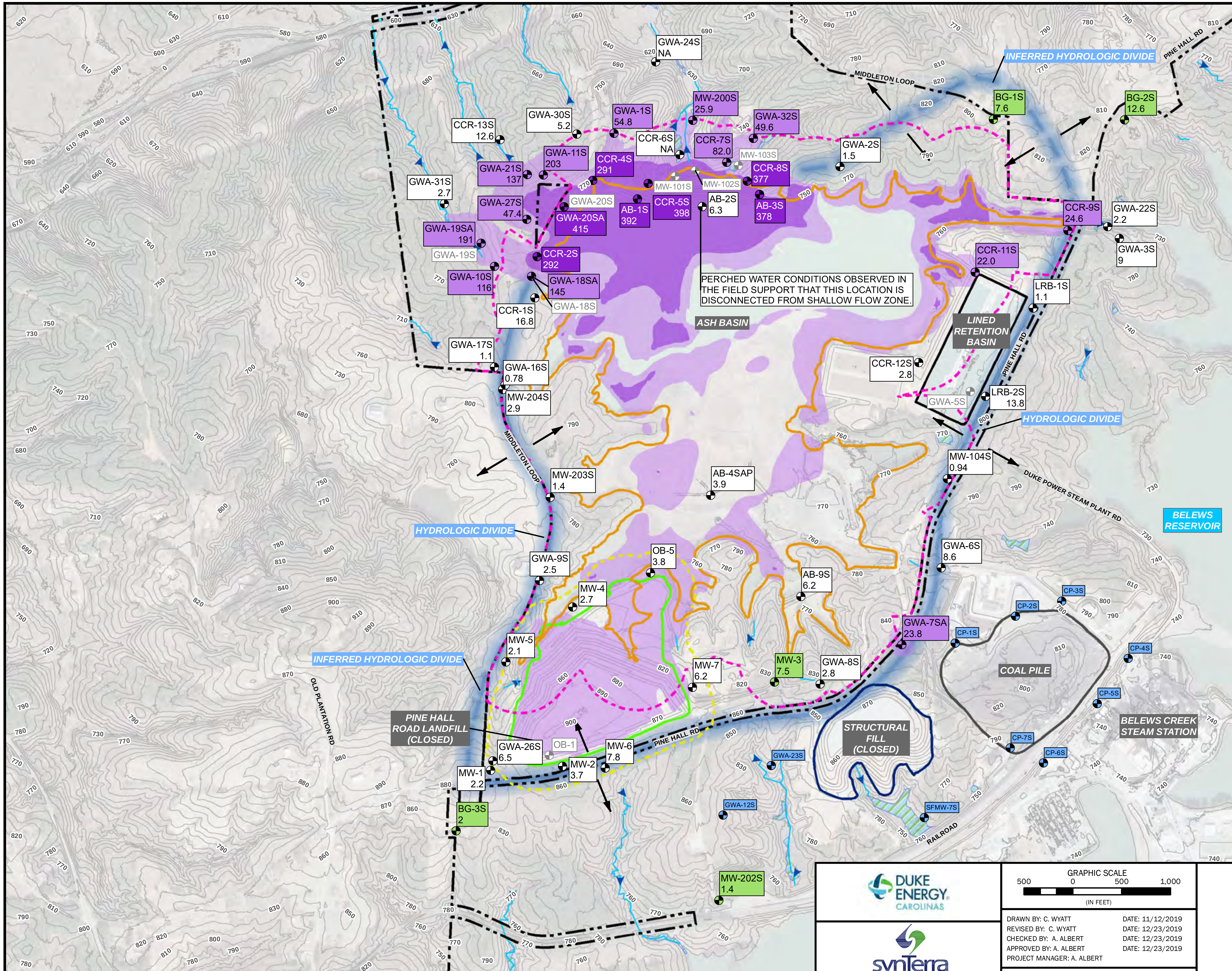
FIGURE 6-13c
ISOCONCENTRATION MAP
BORON BEDROCK FLOW ZONE
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA



LEGEND

- ASSESSMENT MONITORING WELL - GREATER THAN NC 02L STANDARD (250mg/L)
- ASSESSMENT MONITORING WELL - GREATER THAN BACKGROUND THRESHOLD VALUE (19mg/L)
- ASSESSMENT MONITORING WELL - LESS THAN BACKGROUND THRESHOLD VALUE
- BACKGROUND MONITORING WELL
- WELL ABANDONED
- STRUCTURAL FILL AND COAL PILE MONITORING WELL
- CHLORIDE PLUME GREATER THAN NC 02L STANDARD (250mg/L) FROM MEAN ANALYSIS. FLOW AND TRANSPORT MODEL PREDICTED PLUME IS USED WHERE EMPIRICAL DATA IS NOT AVAILABLE.
- CHLORIDE PLUME GREATER THAN BTV (19mg/L) FROM MEAN ANALYSIS. FLOW AND TRANSPORT MODEL PREDICTED PLUME IS USED WHERE EMPIRICAL DATA IS NOT AVAILABLE.
- ASH BASIN WASTE BOUNDARY
- ASH BASIN COMPLIANCE BOUNDARY
- LANDFILL BOUNDARY (CLOSED)
- STRUCTURAL FILL BOUNDARY (CLOSED)
- LANDFILL COMPLIANCE BOUNDARY
- LINED RETENTION BASIN
- COAL PILE STORAGE AREA
- DUKE ENERGY CAROLINAS PROPERTY LINE
- TOPOGRAPHIC CONTOUR (10' INTERVAL)
- GROUNDWATER FLOW DIRECTION
- STREAM (AMEC NRTR)
- WETLAND (AMEC NRTR)
- APPROXIMATE HYDROLOGIC DIVIDE

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 CHLORIDE IS 250 mg/L.
3. THE BACKGROUND VALUE FOR CHLORIDE IS 19 mg/L (AS SUBMITTED JUNE 2019).
4. GROUNDWATER FLOW AND TRANSPORT CHLORIDE PLUME SIMULATION IS MODIFIED FROM MODEL LAYER 13 (FALTA AND OTHERS, 2019).
5. HYDROLOGIC DIVIDE IDENTIFIED IN CSA UPDATE (SYNTERRA, 2017) AND UPDATED GROUNDWATER FLOW AND TRANSPORT MODELING REPORT (FALTA AND OTHERS, 2019).
6. THE WATERS OF THE U.S. 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 BELEWS CREEK STEAM STATION DATED JULY 2, 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. COAL PILE AND STRUCTRUAL FILL ASSESSMENT ARE ONGOING AND ARE THEREFORE NOT ADDRESSED IN THE CORRECTIVE ACTION PLAN UPDATE.
9. ALL BOUNDARIES ARE APPROXIMATE.
10. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.
11. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON JUNE 11, 2019. AERIAL WAS COLLECTED ON FEBRUARY 3, 2019.
12. DRAWING HAS BEEN SET WITH A PROJECTION OF NORTH CAROLINA STATE PLANE COORDINATE SYSTEM FIPS 3200 (NAD83).

DUKE ENERGY CAROLINAS

synTerra

GRAPHIC SCALE
500 0 500 1,000
(IN FEET)

DRAWN BY: C. WYATT DATE: 11/12/2019
REVISED BY: C. WYATT DATE: 12/23/2019
CHECKED BY: A. ALBERT DATE: 12/23/2019
APPROVED BY: A. ALBERT DATE: 12/23/2019
PROJECT MANAGER: A. ALBERT

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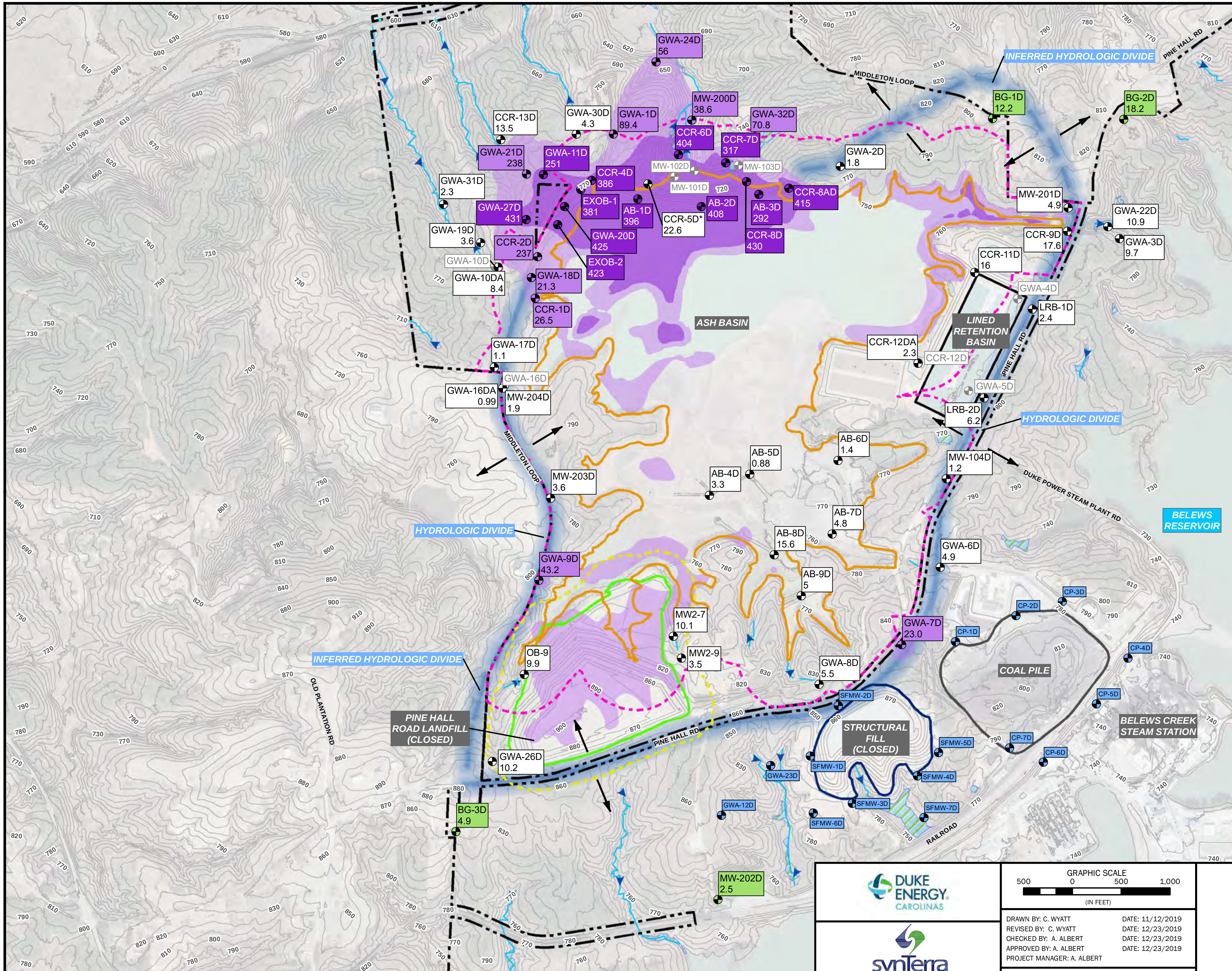
FIGURE 6-14a
ISOCONCENTRATION MAP
CHLORIDE IN SHALLOW FLOW ZONE
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA



LEGEND

- ASSESSMENT MONITORING WELL - GREATER THAN NC 02L STANDARD (250mg/L)
- ASSESSMENT MONITORING WELL - GREATER THAN BACKGROUND THRESHOLD VALUE (19mg/L)
- ASSESSMENT MONITORING WELL - LESS THAN BACKGROUND THRESHOLD VALUE
- BACKGROUND MONITORING WELL
- WELL ABANDONED
- STRUCTURAL FILL AND COAL PILE MONITORING WELL
- CHLORIDE PLUME GREATER THAN NC 02L STANDARD (250mg/L) FROM MEAN ANALYSIS. FLOW AND TRANSPORT MODEL PREDICTED PLUME IS USED WHERE EMPIRICAL DATA IS NOT AVAILABLE.
- CHLORIDE PLUME GREATER THAN BTV (19mg/L) FROM MEAN ANALYSIS. FLOW AND TRANSPORT MODEL PREDICTED PLUME IS USED WHERE EMPIRICAL DATA IS NOT AVAILABLE.
- ASH BASIN WASTE BOUNDARY
- ASH BASIN COMPLIANCE BOUNDARY
- LANDFILL BOUNDARY (CLOSED)
- STRUCTURAL FILL BOUNDARY (CLOSED)
- LANDFILL COMPLIANCE BOUNDARY
- LINED RETENTION BASIN
- COAL PILE STORAGE AREA
- DUKE ENERGY CAROLINAS PROPERTY LINE
- TOPOGRAPHIC CONTOUR (10' INTERVAL)
- GROUNDWATER FLOW DIRECTION
- STREAM (AMEC NRTR)
- WETLAND (AMEC NRTR)
- APPROXIMATE HYDROLOGIC DIVIDE

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 CHLORIDE IS 250 mg/L.
3. THE BACKGROUND VALUE FOR CHLORIDE IS 19 mg/L (AS SUBMITTED JUNE 2019).
4. * - CONSTITUENT CONCENTRATION SHOWN IS THE MOST RECENT VALID SAMPLE AVAILABLE BETWEEN JANUARY 2018 AND APRIL 2019.
5. GROUNDWATER FLOW AND TRANSPORT CHLORIDE PLUME SIMULATION IS MODIFIED FROM MODEL LAYER 15 (FALTA AND OTHERS, 2019).
6. HYDROLOGIC DIVIDE IDENTIFIED IN CSA UPDATE (SYNTERRA, 2017) AND UPDATED GROUNDWATER FLOW AND TRANSPORT MODELING REPORT (FALTA AND OTHERS, 2019).
7. THE WATERS OF THE U.S. 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 BELEWS CREEK STEAM STATION DATED JULY 2, 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. COAL PILE AND STRUCTRUAL FILL ASSESSMENT ARE ONGOING AND ARE THEREFORE NOT ADDRESSED IN THE CORRECTIVE ACTION PLAN UPDATE.
10. ALL BOUNDARIES ARE APPROXIMATE.
11. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.
12. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON JUNE 11, 2019. AERIAL WAS COLLECTED ON FEBRUARY 3, 2019.
13. DRAWING HAS BEEN SET WITH A PROJECTION OF NORTH CAROLINA STATE PLANE COORDINATE SYSTEM FIPS 3200 (NAD83).

DUKE ENERGY CAROLINAS

synTerra

GRAPHIC SCALE
500 0 500 1,000
(IN FEET)

DRAWN BY: C. WYATT	DATE: 11/12/2019
REVISED BY: C. WYATT	DATE: 12/23/2019
CHECKED BY: A. ALBERT	DATE: 12/23/2019
APPROVED BY: A. ALBERT	DATE: 12/23/2019
PROJECT MANAGER: A. ALBERT	

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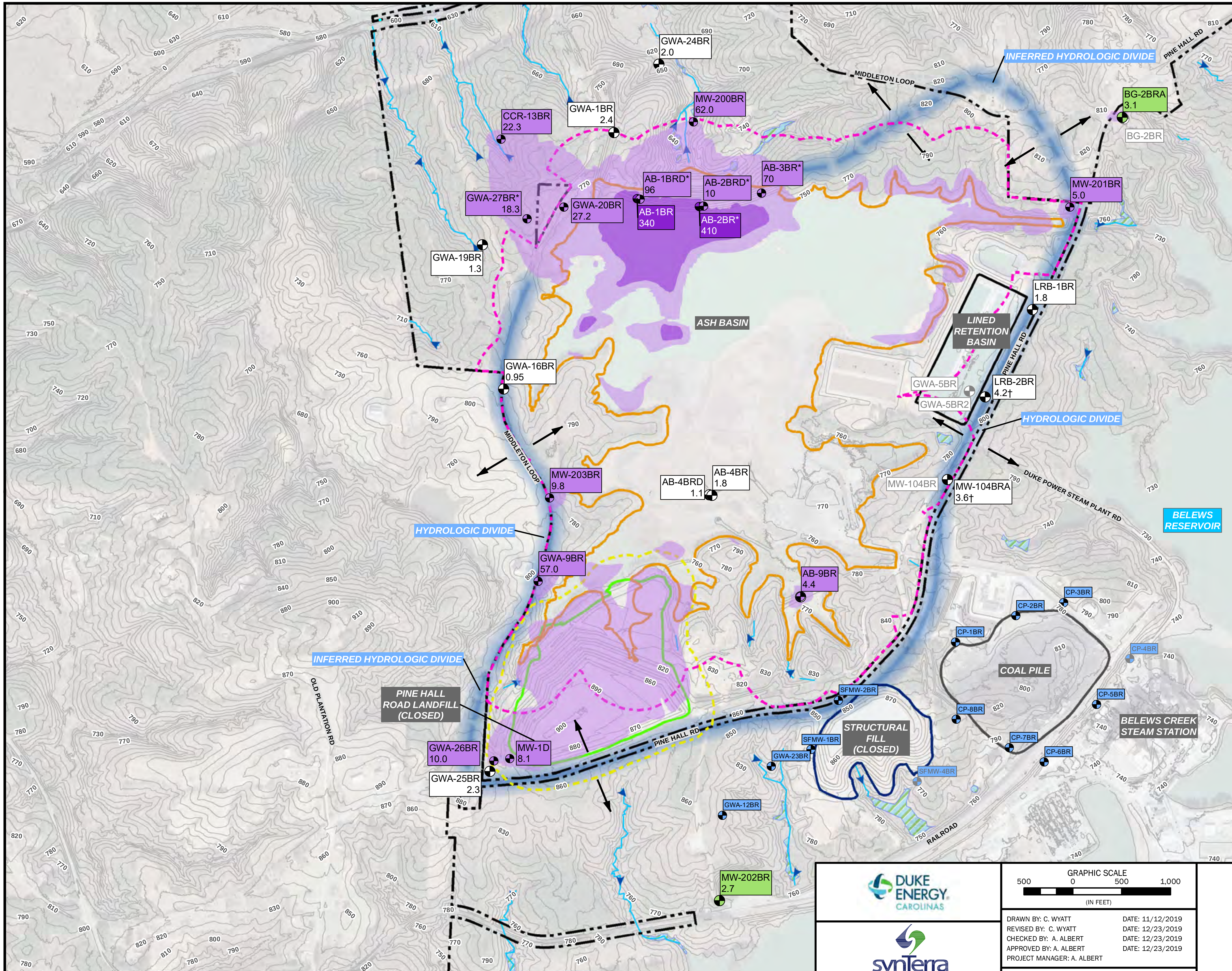
FIGURE 6-14b
ISOCONCENTRATION MAP
CHLORIDE IN DEEP FLOW ZONE
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA



LEGEND

- ASSESSMENT MONITORING WELL - GREATER THAN NC 02L STANDARD (250mg/L)
- ASSESSMENT MONITORING WELL - GREATER THAN BACKGROUND THRESHOLD VALUE (3mg/L)
- ASSESSMENT MONITORING WELL - LESS THAN BACKGROUND THRESHOLD VALUE
- BACKGROUND MONITORING WELL
- WELL ABANDONED
- STRUCTURAL FILL AND COAL PILE MONITORING WELL
- CHLORIDE PLUME GREATER THAN NC 02L STANDARD (250mg/L) FROM MEAN ANALYSIS. FLOW AND TRANSPORT MODEL PREDICTED PLUME IS USED WHERE EMPIRICAL DATA IS NOT AVAILABLE.
- CHLORIDE PLUME GREATER THAN BTV (3mg/L) FROM MEAN ANALYSIS. FLOW AND TRANSPORT MODEL PREDICTED PLUME IS USED WHERE EMPIRICAL DATA IS NOT AVAILABLE.
- ASH BASIN WASTE BOUNDARY
- ASH BASIN COMPLIANCE BOUNDARY
- LANDFILL BOUNDARY (CLOSED)
- STRUCTURAL FILL BOUNDARY (CLOSED)
- LANDFILL COMPLIANCE BOUNDARY
- LINED RETENTION BASIN
- COAL PILE STORAGE AREA
- DUKE ENERGY CAROLINAS PROPERTY LINE
- TOPOGRAPHIC CONTOUR (10' INTERVAL)
- GROUNDWATER FLOW DIRECTION
- STREAM (AMEC NRTR)
- WETLAND (AMEC NRTR)
- APPROXIMATE HYDROLOGIC DIVIDE

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 CHLORIDE IS 250 mg/L.

3. THE BACKGROUND VALUE FOR CHLORIDE IS 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 AREA BASED ON MODELED SITE HYDRAULIC CHARACTERISTICS AND ARE NOT CONTOURED. DOES NOT SUGGEST IMPACT FROM SOURCE AREA.

5. * - CONSTITUENT CONCENTRATION SHOWN IS THE MOST RECENT VALID SAMPLE AVAILABLE BETWEEN JANUARY 2018 AND APRIL 2019.

6. GROUNDWATER FLOW AND TRANSPORT CHLORIDE PLUME SIMULATION IS MODIFIED FROM MODEL LAYER 17 (FALTA AND OTHERS, 2019.

7. HYDROLOGIC DIVIDE IDENTIFIED IN CSA UPDATE (SYNTERRA, 2017) AND UPDATED GROUNDWATER FLOW AND TRANSPORT MODELING REPORT (FALTA AND OTHERS, 2019).

8. THE WATERS OF THE U.S. 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 BELEWS CREEK STEAM STATION DATED JULY 2, 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. COAL PILE AND STRUCTRUAL FILL ASSESSMENT ARE ONGOING AND ARE THEREFORE NOT ADDRESSED IN THE CORRECTIVE ACTION PLAN UPDATE.

11. ALL BOUNDARIES ARE APPROXIMATE.

12. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.

13. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON JUNE 11, 2019. AERIAL WAS COLLECTED ON FEBRUARY 3, 2019.

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

DUKE ENERGY CAROLINAS

synTerra

GRAPHIC SCALE
500 0 500 1,000
(IN FEET)

DRAWN BY: C. WYATT DATE: 11/12/2019
REVISED BY: C. WYATT DATE: 12/23/2019
CHECKED BY: A. ALBERT DATE: 12/23/2019
APPROVED BY: A. ALBERT DATE: 12/23/2019
PROJECT MANAGER: A. ALBERT

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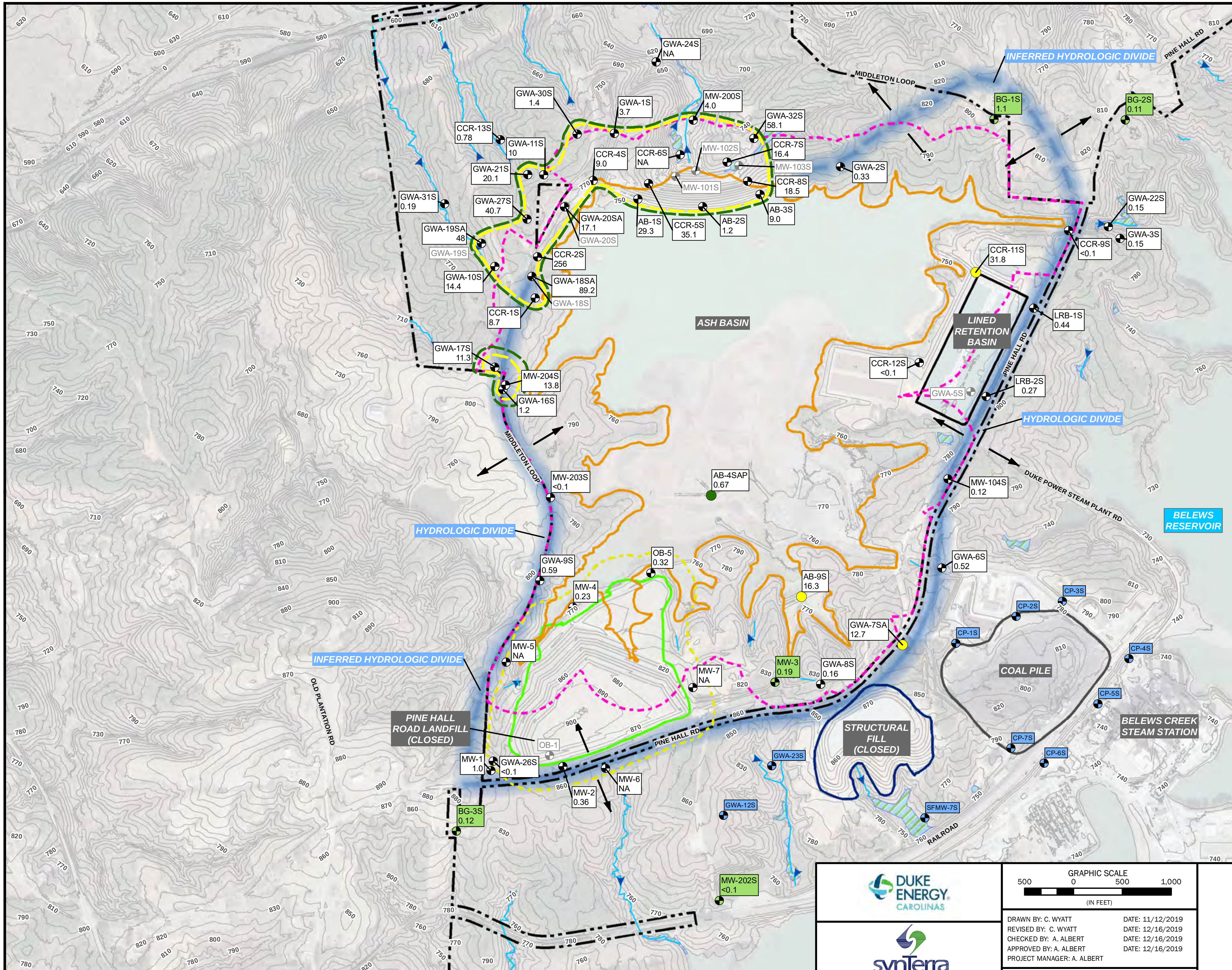
FIGURE 6-14c
ISOCONCENTRATION MAP
CHLORIDE IN BEDROCK FLOW ZONE
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA



LEGEND

- ASSESSMENT MONITORING WELL
- BACKGROUND MONITORING WELL
- WELL ABANDONED
- STRUCTURAL FILL AND COAL PILE MONITORING WELL
- ISOLATED EXCEEDANCE OF IMAC
- ISOLATED EXCEEDANCE OF BACKGROUND
- INFERRED IMAC VALUE CONTOUR
- INFERRED BACKGROUND CONTOUR
- ASH BASIN WASTE BOUNDARY
- ASH BASIN COMPLIANCE BOUNDARY
- LANDFILL BOUNDARY (CLOSED)
- STRUCTURAL FILL BOUNDARY (CLOSED)
- LANDFILL COMPLIANCE BOUNDARY
- LINED RETENTION BASIN
- COAL PILE STORAGE AREA
- DUKE ENERGY CAROLINAS PROPERTY LINE
- TOPOGRAPHIC CONTOUR (10' INTERVAL)
- GROUNDWATER FLOW DIRECTION
- STREAM (AMEC NRTR)
- WETLAND (AMEC NRTR)
- APPROXIMATE HYDROLOGIC DIVIDE

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 IMAC FOR COBALT IS 1μg/L.

3. THE BACKGROUND VALUE FOR COBALT IS 0.6μg/L (AS SUBMITTED JUNE 2019).

4. † - CONCENTRATIONS WITHIN REASONABLE RANGE OF BACKGROUND DATA SET AND/OR NOT REPRESENTATIVE OF PLUME MIGRATION FROM SOURCE AREA BASED ON MODELED SITE HYDRAULIC CHARACTERISTICS AND ARE NOT CONTOURED. DOES NOT SUGGEST IMPACT FROM SOURCE AREA.

5. HYDROLOGIC DIVIDE IDENTIFIED IN CSA UPDATE (SYNTERRA, 2017) AND UPDATED GROUNDWATER FLOW AND TRANSPORT MODELING REPORT (FALTA AND OTHERS, 2019).

6. THE WATERS OF THE U.S. 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 BELEWS CREEK STEAM STATION DATED JULY 2, 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. COAL PILE AND STRUCTRUAL FILL ASSESSMENT ARE ONGOING AND ARE THEREFORE NOT ADDRESSED IN THE CORRECTIVE ACTION PLAN UPDATE.

9. ALL BOUNDARIES ARE APPROXIMATE.

10. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.

11. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON JUNE 11, 2019. AERIAL WAS COLLECTED ON FEBRUARY 3, 2019.

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

DUKE ENERGY CAROLINAS

synTerra

GRAPHIC SCALE
500 0 500 1,000
(IN FEET)

DRAWN BY: C. WYATT	DATE: 11/12/2019
REVISED BY: C. WYATT	DATE: 12/16/2019
CHECKED BY: A. ALBERT	DATE: 12/16/2019
APPROVED BY: A. ALBERT	DATE: 12/16/2019
PROJECT MANAGER: A. ALBERT	

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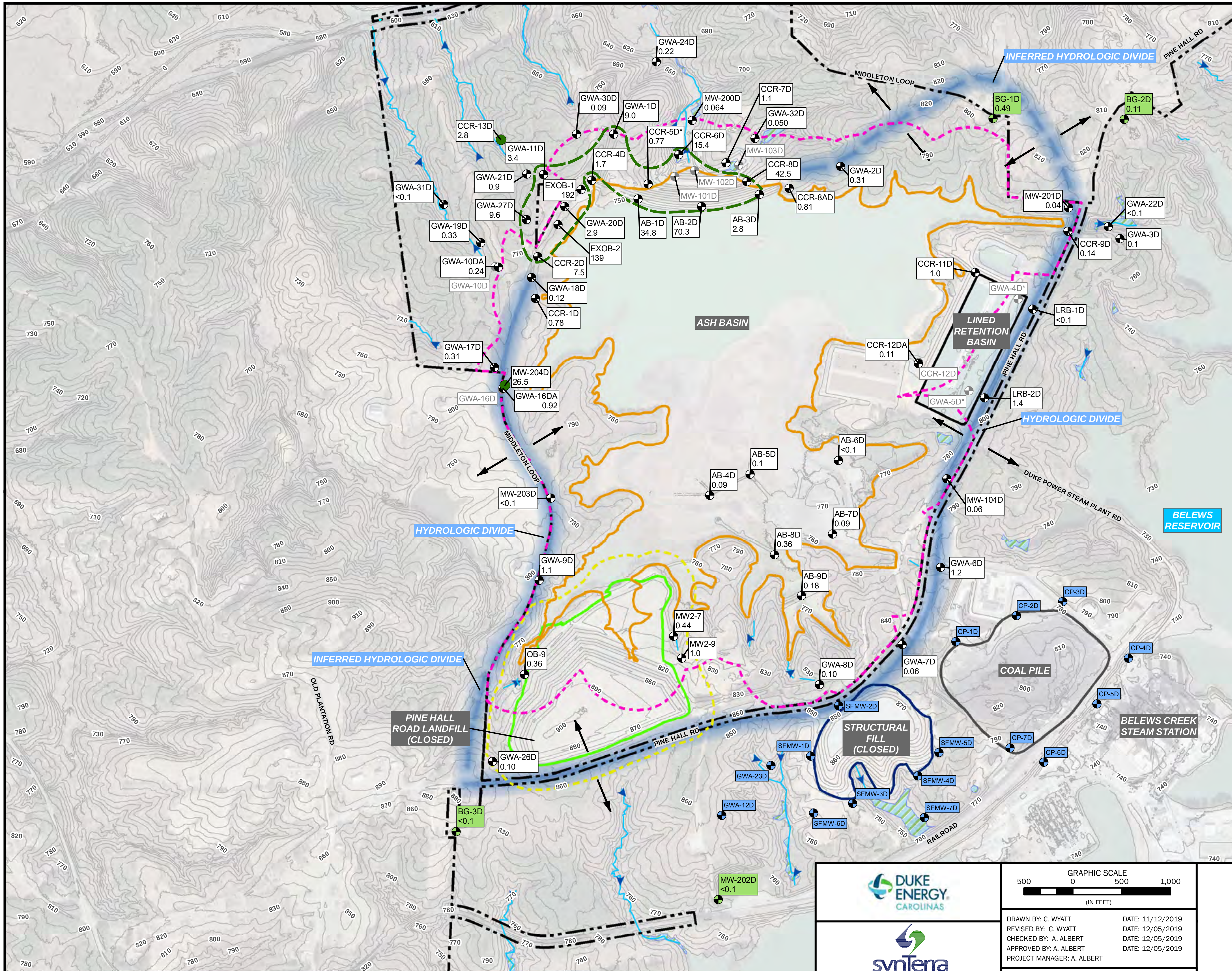
FIGURE 6-15a
ISOCONCENTRATION MAP
COBALT IN SHALLOW FLOW ZONE
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA



LEGEND

- ASSESSMENT MONITORING WELL
- BACKGROUND MONITORING WELL
- WELL ABANDONED
- STRUCTURAL FILL AND COAL PILE MONITORING WELL
- ISOLATED EXCEEDANCE OF BACKGROUND
- INFERRED BACKGROUND CONTOUR
- ASH BASIN WASTE BOUNDARY
- ASH BASIN COMPLIANCE BOUNDARY
- LANDFILL BOUNDARY (CLOSED)
- STRUCTURAL FILL BOUNDARY (CLOSED)
- LANDFILL COMPLIANCE BOUNDARY
- LINED RETENTION BASIN
- COAL PILE STORAGE AREA
- DUKE ENERGY CAROLINAS PROPERTY LINE
- TOPOGRAPHIC CONTOUR (10' INTERVAL)
- GROUNDWATER FLOW DIRECTION
- STREAM (AMEC NRTR)
- WETLAND (AMEC NRTR)
- APPROXIMATE HYDROLOGIC DIVIDE

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 IMAC FOR COBALT IS 1μg/L.

3. THE BACKGROUND VALUE FOR COBALT IS 2μg/L (AS SUBMITTED JUNE 2019).

4. * - CONSTITUENT CONCENTRATION SHOWN IS THE MOST RECENT VALID SAMPLE AVAILABLE BETWEEN JANUARY 2018 AND APRIL 2019.

5. HYDROLOGIC DIVIDE IDENTIFIED IN CSA UPDATE (SYNTERRA, 2017) AND UPDATED GROUNDWATER FLOW AND TRANSPORT MODELING REPORT (FALTA AND OTHERS, 2019).

6. THE WATERS OF THE U.S. 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 BELEWS CREEK STEAM STATION DATED JULY 2, 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. COAL PILE AND STRUCTRUAL FILL ASSESSMENT ARE ONGOING AND ARE THEREFORE NOT ADDRESSED IN THE CORRECTIVE ACTION PLAN UPDATE.

9. ALL BOUNDARIES ARE APPROXIMATE.

10. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.

11. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON JUNE 11, 2019. AERIAL WAS COLLECTED ON FEBRUARY 3, 2019.

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

DUKE ENERGY CAROLINAS

synTerra

GRAPHIC SCALE
500 0 500 1,000
(IN FEET)

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REVISED BY: C. WYATT	DATE: 12/05/2019
CHECKED BY: A. ALBERT	DATE: 12/05/2019
APPROVED BY: A. ALBERT	DATE: 12/05/2019
PROJECT MANAGER: A. ALBERT	

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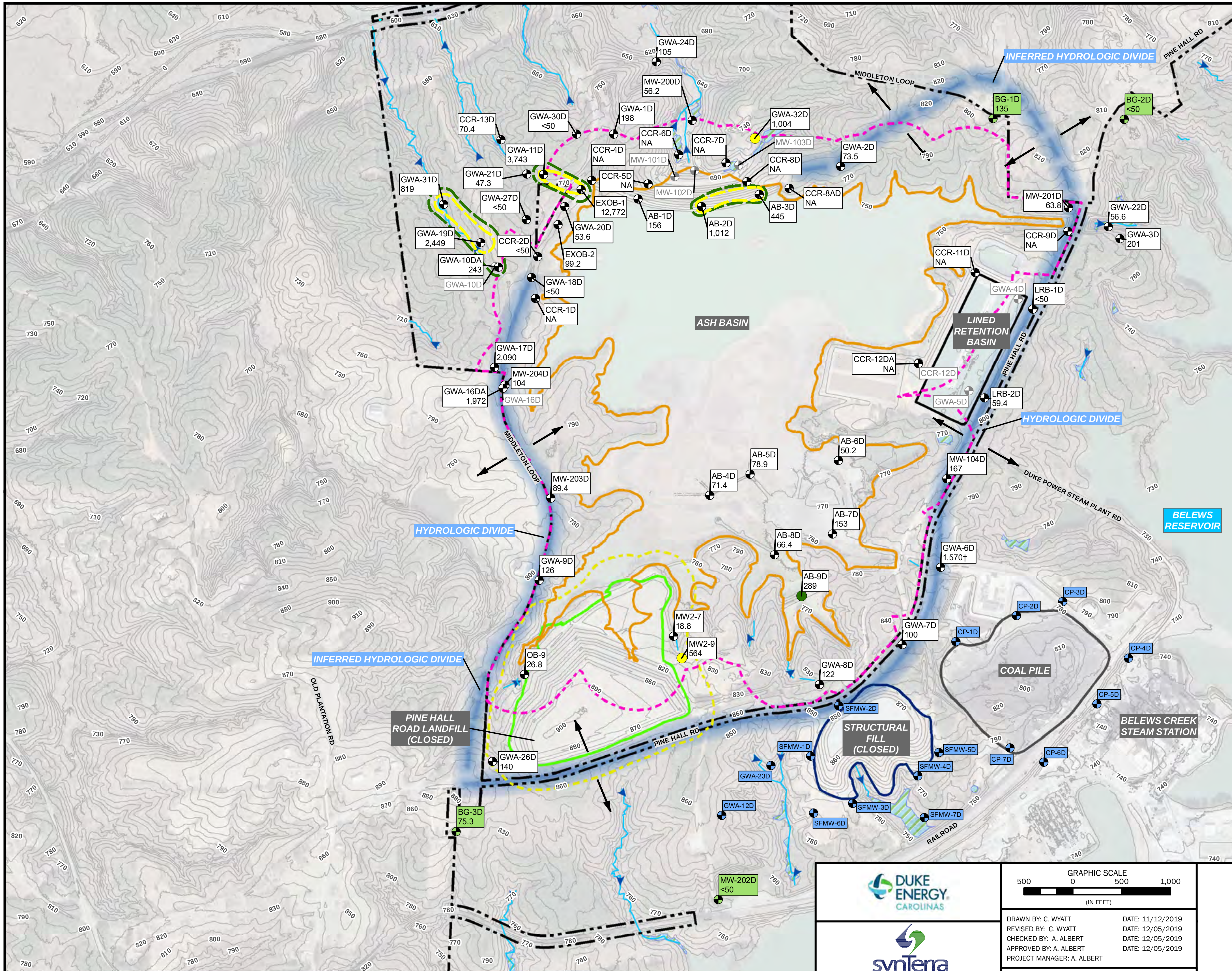
FIGURE 6-15b
ISOCONCENTRATION MAP
COBALT IN DEEP FLOW ZONE
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA



LEGEND

- ASSESSMENT MONITORING WELL
- BACKGROUND MONITORING WELL
- WELL ABANDONED
- STRUCTURAL FILL AND COAL PILE MONITORING WELL
- ISOLATED EXCEEDANCE OF NC 02L
- ISOLATED EXCEEDANCE OF BACKGROUND
- INFERRED NC 02L STANDARD CONTOUR
- INFERRED BACKGROUND CONTOUR
- ASH BASIN WASTE BOUNDARY
- ASH BASIN COMPLIANCE BOUNDARY
- LANDFILL BOUNDARY (CLOSED)
- STRUCTURAL FILL BOUNDARY (CLOSED)
- LANDFILL COMPLIANCE BOUNDARY
- LINED RETENTION BASIN
- COAL PILE STORAGE AREA
- DUKE ENERGY CAROLINAS PROPERTY LINE
- TOPOGRAPHIC CONTOUR (10' INTERVAL)
- GROUNDWATER FLOW DIRECTION
- STREAM (AMEC NRTR)
- WETLAND (AMEC NRTR)
- APPROXIMATE HYDROLOGIC DIVIDE

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 240 µg/L (AS SUBMITTED JUNE 2019).

4. † - CONCENTRATIONS WITHIN REASONABLE RANGE OF BACKGROUND DATA SET AND/OR NOT REPRESENTATIVE OF PLUME MIGRATION FROM SOURCE AREA BASED ON MODELED SITE HYDRAULIC CHARACTERISTICS AND ARE NOT CONTOURED. DOES NOT SUGGEST IMPACT FROM SOURCE AREA.

5. HYDROLOGIC DIVIDE IDENTIFIED IN CSA UPDATE (SYNTERRA, 2017) AND UPDATED GROUNDWATER FLOW AND TRANSPORT MODELING REPORT (FALTA AND OTHERS, 2019).

6. THE WATERS OF THE U.S. 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 BELEWS CREEK STEAM STATION DATED JULY 2, 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. COAL PILE AND STRUCTRUAL FILL ASSESSMENT ARE ONGOING AND ARE THEREFORE NOT ADDRESSED IN THE CORRECTIVE ACTION PLAN UPDATE.

9. ALL BOUNDARIES ARE APPROXIMATE.

10. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.

11. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON JUNE 11, 2019. AERIAL WAS COLLECTED ON FEBRUARY 3, 2019.

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

DUKE ENERGY CAROLINAS

synTerra

GRAPHIC SCALE
500 0 500 1,000
(IN FEET)

DRAWN BY: C. WYATT	DATE: 11/12/2019
REVISED BY: C. WYATT	DATE: 12/05/2019
CHECKED BY: A. ALBERT	DATE: 12/05/2019
APPROVED BY: A. ALBERT	DATE: 12/05/2019
PROJECT MANAGER: A. ALBERT	

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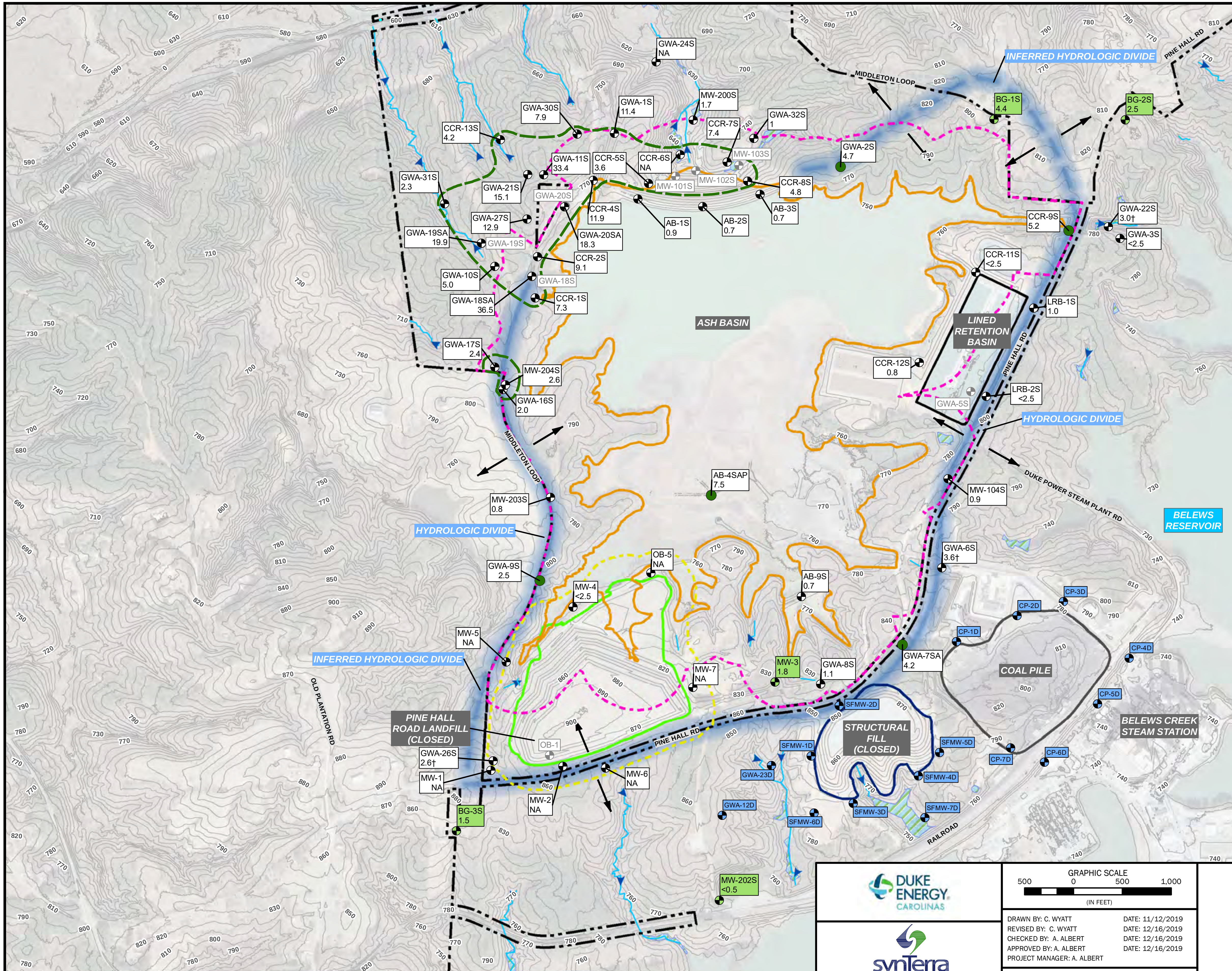
FIGURE 6-16
ISOCONCENTRATION MAP
IRON IN DEEP FLOW ZONE
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA



LEGEND

- ASSESSMENT MONITORING WELL
- BACKGROUND MONITORING WELL
- WELL ABANDONED
- STRUCTURAL FILL AND COAL PILE MONITORING WELL
- ISOLATED EXCEEDANCE OF BACKGROUND
- INFERRED BACKGROUND CONTOUR
- ASH BASIN WASTE BOUNDARY
- ASH BASIN COMPLIANCE BOUNDARY
- LANDFILL BOUNDARY (CLOSED)
- STRUCTURAL FILL BOUNDARY (CLOSED)
- LANDFILL COMPLIANCE BOUNDARY
- LINED RETENTION BASIN
- COAL PILE STORAGE AREA
- DUKE ENERGY CAROLINAS PROPERTY LINE
- TOPOGRAPHIC CONTOUR (10' INTERVAL)
- GROUNDWATER FLOW DIRECTION
- STREAM (AMEC NRTR)
- WETLAND (AMEC NRTR)
- APPROXIMATE HYDROLOGIC DIVIDE

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 LITHIUM IS NE.

3. THE BACKGROUND VALUE FOR LITHIUM IS 2 ug/L (AS SUBMITTED JUNE 2019).

4. † - CONCENTRATIONS WITHIN REASONABLE RANGE OF BACKGROUND DATA SET AND/OR NOT REPRESENTATIVE OF PLUME MIGRATION FROM SOURCE AREA BASED ON MODELED SITE HYDRAULIC CHARACTERISTICS AND ARE NOT CONTOURED. DOES NOT SUGGEST IMPACT FROM SOURCE AREA.

5. HYDROLOGIC DIVIDE IDENTIFIED IN CSA UPDATE (SYNTERRA, 2017) AND UPDATED GROUNDWATER FLOW AND TRANSPORT MODELING REPORT (FALTA AND OTHERS, 2019).

6. THE WATERS OF THE U.S. 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 BELEWS CREEK STEAM STATION DATED JULY 2, 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. COAL PILE AND STRUCTRUAL FILL ASSESSMENT ARE ONGOING AND ARE THEREFORE NOT ADDRESSED IN THE CORRECTIVE ACTION PLAN UPDATE.

9. ALL BOUNDARIES ARE APPROXIMATE.

10. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.

11. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON JUNE 11, 2019. AERIAL WAS COLLECTED ON FEBRUARY 3, 2019.

12. DRAWING HAS BEEN SET WITH A PROJECTION OF NORTH CAROLINA STATE

DUKE ENERGY CAROLINAS

synTerra

GRAPHIC SCALE
500 0 500 1,000
(IN FEET)

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REVISED BY: C. WYATT	DATE: 12/16/2019
CHECKED BY: A. ALBERT	DATE: 12/16/2019
APPROVED BY: A. ALBERT	DATE: 12/16/2019
PROJECT MANAGER: A. ALBERT	

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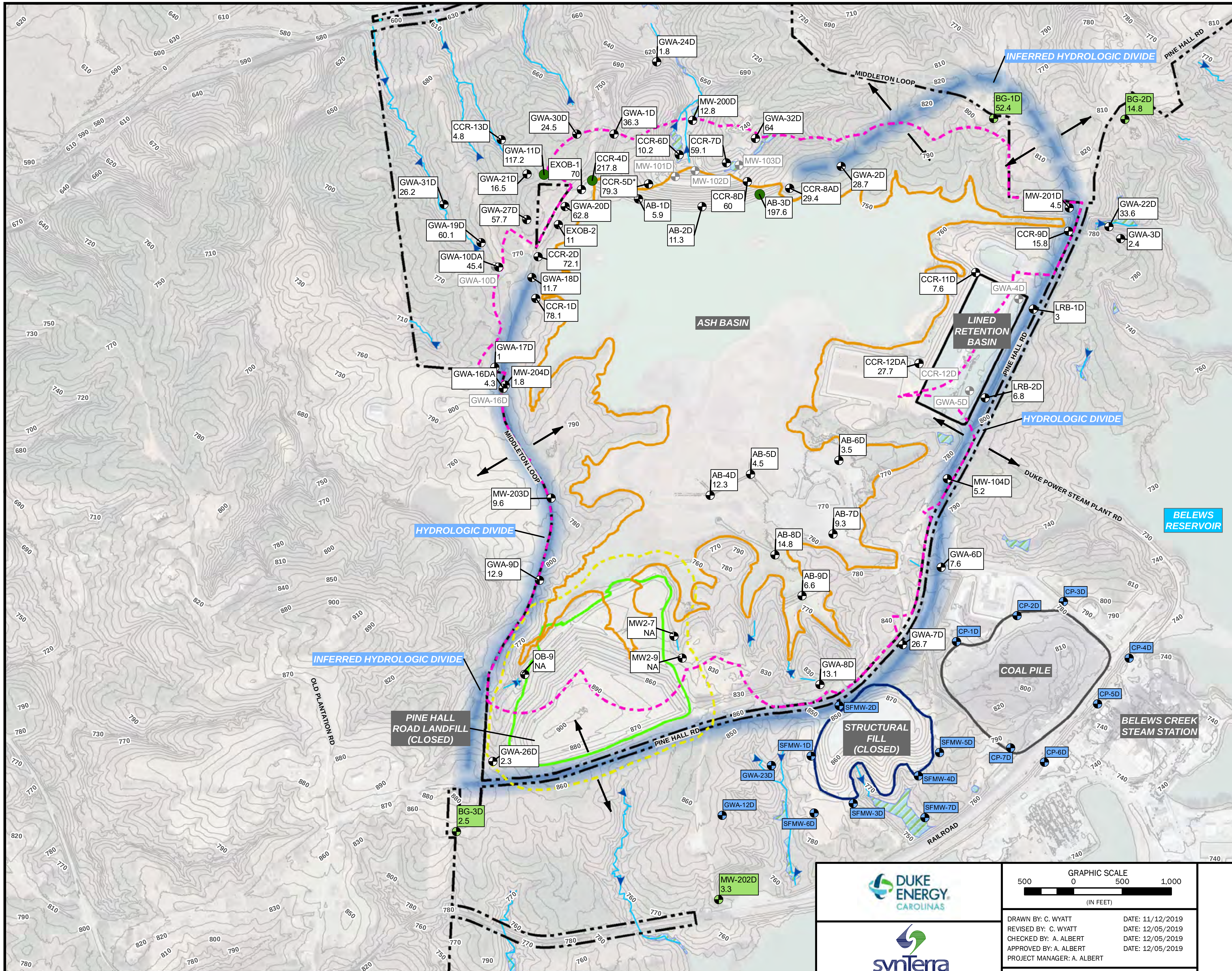
FIGURE 6-17a
ISOCONCENTRATION MAP
LITHIUM IN SHALLOW FLOW ZONE
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA



LEGEND

- ASSESSMENT MONITORING WELL
- BACKGROUND MONITORING WELL
- WELL ABANDONED
- STRUCTURAL FILL AND COAL PILE MONITORING WELL
- ISOLATED EXCEEDANCE OF BACKGROUND
- INFERRED BACKGROUND CONTOUR
- ASH BASIN WASTE BOUNDARY
- ASH BASIN COMPLIANCE BOUNDARY
- LANDFILL BOUNDARY (CLOSED)
- STRUCTURAL FILL BOUNDARY (CLOSED)
- LANDFILL COMPLIANCE BOUNDARY
- LINED RETENTION BASIN
- COAL PILE STORAGE AREA
- DUKE ENERGY CAROLINAS PROPERTY LINE
- TOPOGRAPHIC CONTOUR (10' INTERVAL)
- GROUNDWATER FLOW DIRECTION
- STREAM (AMEC NRTR)
- WETLAND (AMEC NRTR)
- APPROXIMATE HYDROLOGIC DIVIDE

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 LITHIUM IS NE

3. THE BACKGROUND VALUE FOR LITHIUM IS 95 µg/L (AS SUBMITTED JUNE 2019).

4. * - CONSTITUENT CONCENTRATION SHOWN IS THE MOST RECENT VALID SAMPLE AVAILABLE BETWEEN JANUARY 2018 AND APRIL 2019.

5. HYDROLOGIC DIVIDE IDENTIFIED IN CSA UPDATE (SYNTERRA, 2017) AND UPDATED GROUNDWATER FLOW AND TRANSPORT MODELING REPORT (FALTA AND OTHERS, 2019).

6. THE WATERS OF THE U.S. 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 BELEWS CREEK STEAM STATION DATED JULY 2, 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. COAL PILE AND STRUCTRUAL FILL ASSESSMENT ARE ONGOING AND ARE THEREFORE NOT ADDRESSED IN THE CORRECTIVE ACTION PLAN UPDATE.

9. ALL BOUNDARIES ARE APPROXIMATE.

10. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.

11. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON JUNE 11, 2019. AERIAL WAS COLLECTED ON FEBRUARY 3, 2019.

12. 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
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CHECKED BY: A. ALBERT DATE: 12/05/2019
APPROVED BY: A. ALBERT DATE: 12/05/2019
PROJECT MANAGER: A. ALBERT

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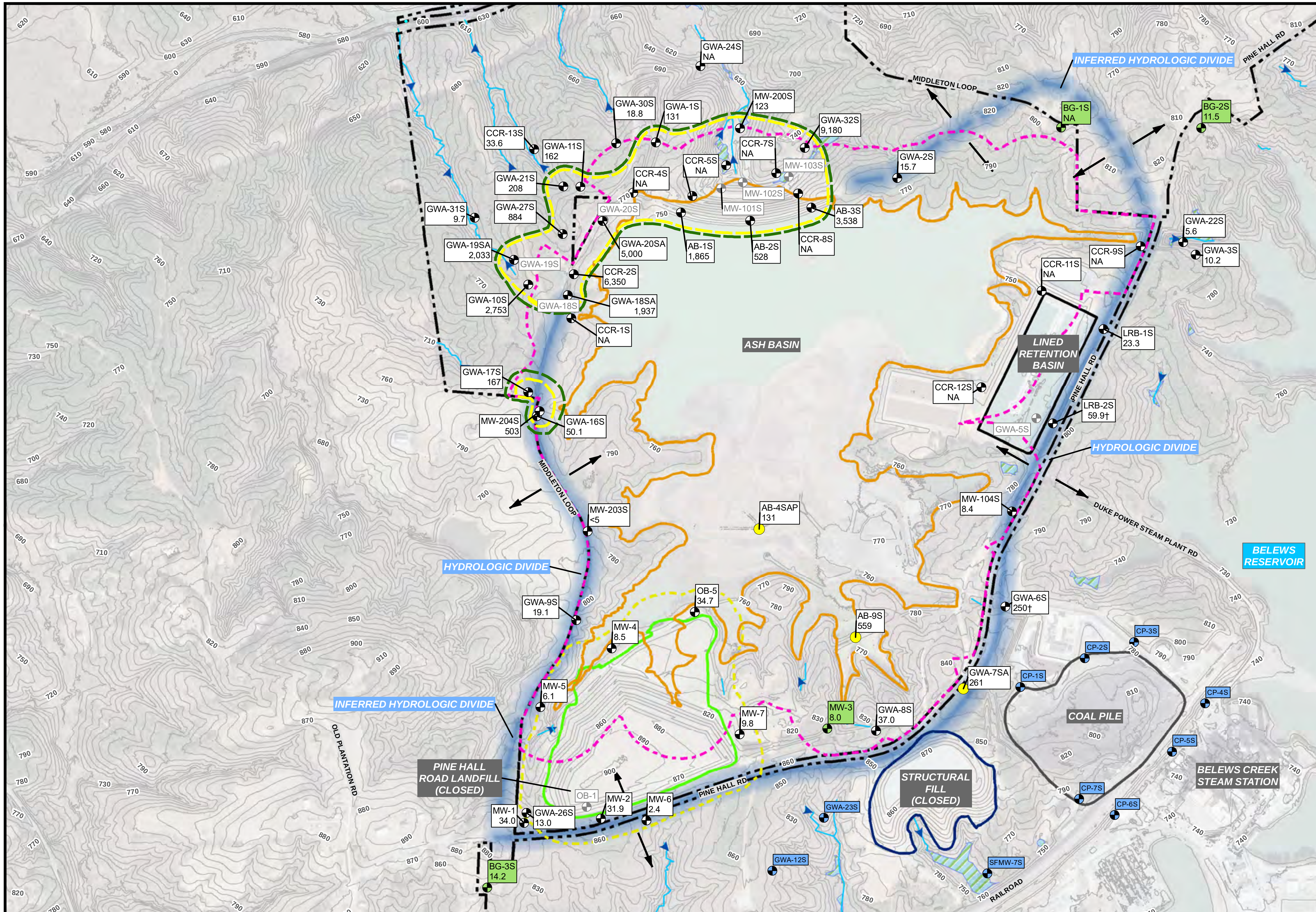
FIGURE 6-17b
ISOCONCENTRATION MAP
LITHIUM IN DEEP FLOW ZONE
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA



LEGEND

- ASSESSMENT MONITORING WELL
- BACKGROUND MONITORING WELL
- WELL ABANDONED
- STRUCTURAL FILL AND COAL PILE MONITORING WELL
- ISOLATED EXCEEDANCE OF NC 02L
- INFERRED NC 02L STANDARD CONTOUR
- INFERRED BACKGROUND CONTOUR
- ASH BASIN WASTE BOUNDARY
- ASH BASIN COMPLIANCE BOUNDARY
- LANDFILL BOUNDARY (CLOSED)
- STRUCTURAL FILL BOUNDARY (CLOSED)
- LANDFILL COMPLIANCE BOUNDARY
- LINED RETENTION BASIN
- COAL PILE STORAGE AREA
- DUKE ENERGY CAROLINAS PROPERTY LINE
- TOPOGRAPHIC CONTOUR (10' INTERVAL)
- GROUNDWATER FLOW DIRECTION
- STREAM (AMEC NRTR)
- WETLAND (AMEC NRTR)
- APPROXIMATE HYDROLOGIC DIVIDE

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 ug/L

3.THE BACKGROUND VALUE FOR MANGANESE IS 40 ug/L (AS SUBMITTED JUNE 2019).

4.† - CONCENTRATIONS WITHIN REASONABLE RANGE OF BACKGROUND DATA SET AND/OR NOT REPRESENTATIVE OF PLUME MIGRATION FROM SOURCE AREA BASED ON MODELED SITE HYDRAULIC CHARACTERISTICS AND ARE NOT CONTOURED. DOES NOT SUGGEST IMPACT FROM SOURCE AREA.

5.HYDROLOGIC DIVIDE IDENTIFIED IN CSA UPDATE (SYNTERRA, 2017) AND UPDATED GROUNDWATER FLOW AND TRANSPORT MODELING REPORT (FALTA AND OTHERS, 2019).

6.THE WATERS OF THE U.S. 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 BELEWS CREEK STEAM STATION DATED JULY 2, 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.COAL PILE AND STRUCTRUAL FILL ASSESSMENT ARE ONGOING AND ARE THEREFORE NOT ADDRESSED IN THE CORRECTIVE ACTION PLAN UPDATE.

9.ALL BOUNDARIES ARE APPROXIMATE.

10.PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.

11.AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON JUNE 11, 2019. AERIAL WAS COLLECTED ON FEBRUARY 3, 2019.

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

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GRAPHIC SCALE
500 0 500 1,000
(IN FEET)

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REVISED BY: C. WYATT DATE: 12/13/2019
CHECKED BY: A. ALBERT DATE: 12/13/2019
APPROVED BY: A. ALBERT DATE: 12/13/2019
PROJECT MANAGER: A. ALBERT

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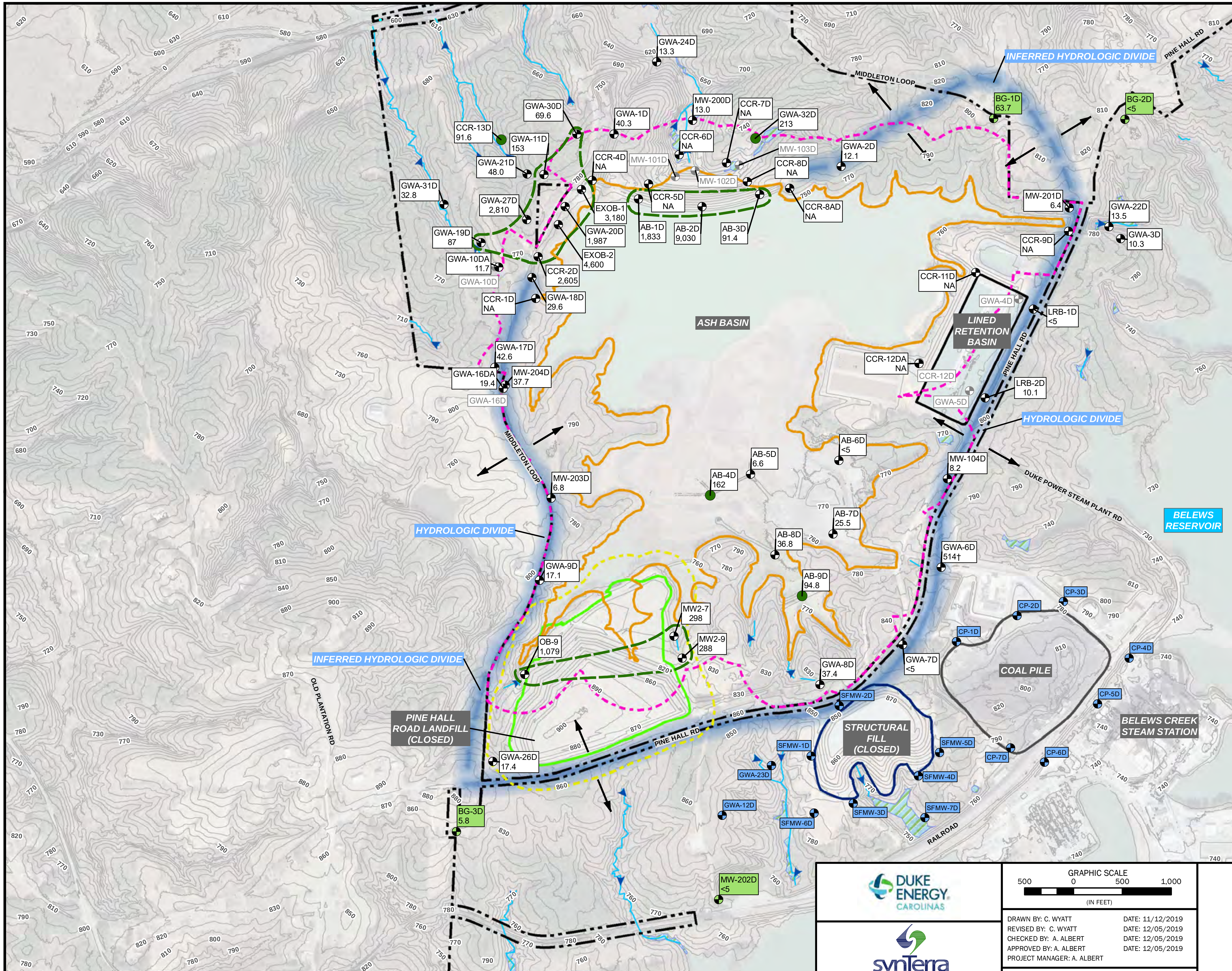
FIGURE 6-18a
ISOCONCENTRATION MAP
MANGANESE IN SHALLOW FLOW ZONE
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA



LEGEND

- ASSESSMENT MONITORING WELL
- BACKGROUND MONITORING WELL
- WELL ABANDONED
- STRUCTURAL FILL AND COAL PILE MONITORING WELL
- ISOLATED EXCEEDANCE OF BACKGROUND
- INFERRED BACKGROUND CONTOUR
- ASH BASIN WASTE BOUNDARY
- ASH BASIN COMPLIANCE BOUNDARY
- LANDFILL BOUNDARY (CLOSED)
- STRUCTURAL FILL BOUNDARY (CLOSED)
- LANDFILL COMPLIANCE BOUNDARY
- LINED RETENTION BASIN
- COAL PILE STORAGE AREA
- DUKE ENERGY CAROLINAS PROPERTY LINE
- TOPOGRAPHIC CONTOUR (10' INTERVAL)
- GROUNDWATER FLOW DIRECTION
- STREAM (AMEC NRTR)
- WETLAND (AMEC NRTR)
- APPROXIMATE HYDROLOGIC DIVIDE

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 ug/L

3. THE BACKGROUND VALUE FOR MANGANESE IS 57 µg/L (AS SUBMITTED JUNE 2019).

4. † - CONCENTRATIONS WITHIN REASONABLE RANGE OF BACKGROUND DATA SET AND/OR NOT REPRESENTATIVE OF PLUME MIGRATION FROM SOURCE AREA BASED ON MODELED SITE HYDRAULIC CHARACTERISTICS AND ARE NOT CONTOURED. DOES NOT SUGGEST IMPACT FROM SOURCE AREA.

5. HYDROLOGIC DIVIDE IDENTIFIED IN CSA UPDATE (SYNTERRA, 2017) AND UPDATED GROUNDWATER FLOW AND TRANSPORT MODELING REPORT (FALTA AND OTHERS, 2019).

6. THE WATERS OF THE U.S. 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 BELEWS CREEK STEAM STATION DATED JULY 2, 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. COAL PILE AND STRUCTRUAL FILL ASSESSMENT ARE ONGOING AND ARE THEREFORE NOT ADDRESSED IN THE CORRECTIVE ACTION PLAN UPDATE.

9. ALL BOUNDARIES ARE APPROXIMATE.

10. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.

11. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON JUNE 11, 2019. AERIAL WAS COLLECTED ON FEBRUARY 3, 2019.

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

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APPROVED BY: A. ALBERT DATE: 12/05/2019
PROJECT MANAGER: A. ALBERT

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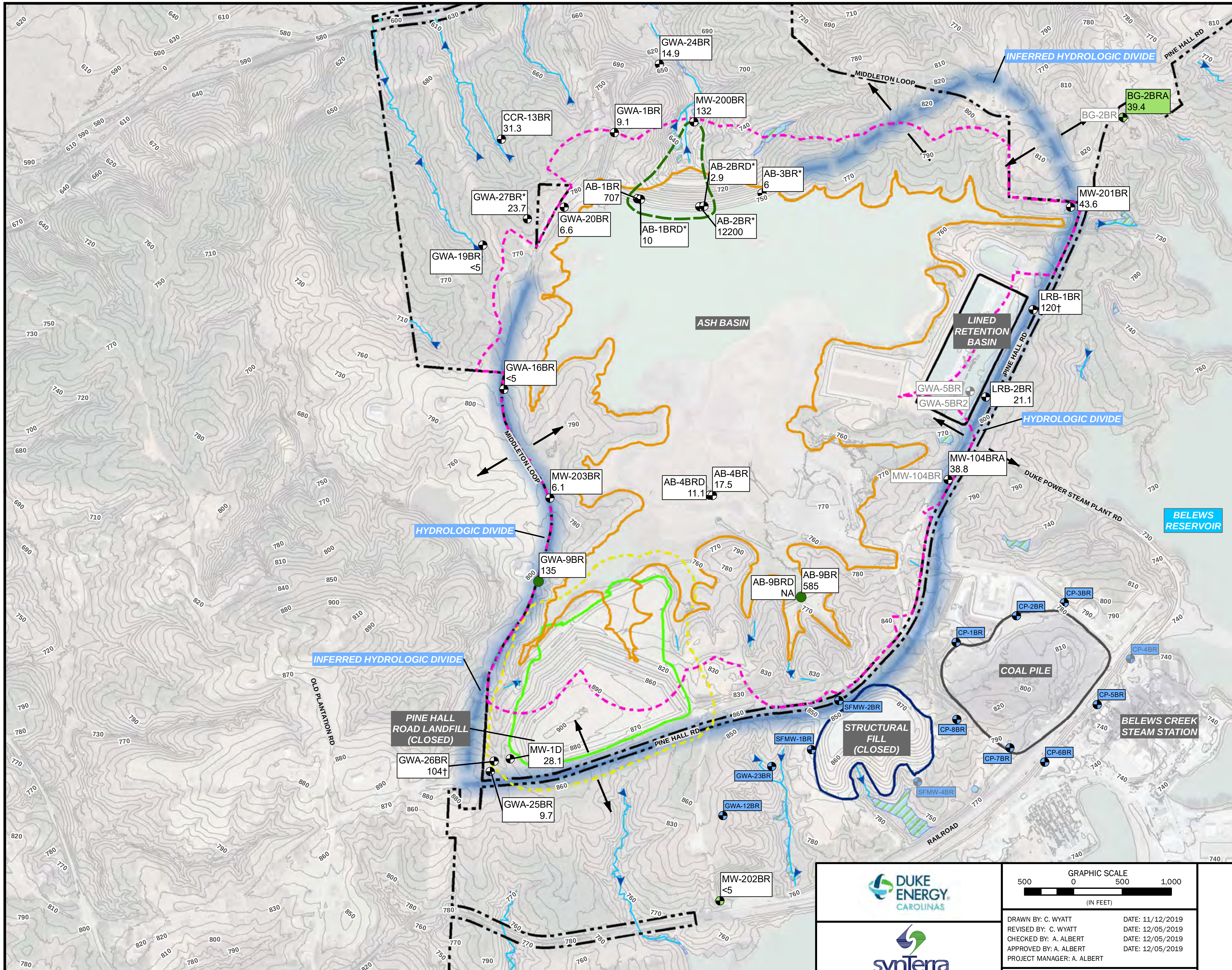
FIGURE 6-18b
ISOCONCENTRATION MAP
MANGANESE IN DEEP FLOW ZONE
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA



LEGEND

- ASSESSMENT MONITORING WELL
- BACKGROUND MONITORING WELL
- WELL ABANDONED
- STRUCTURAL FILL AND COAL PILE MONITORING WELL
- ISOLATED EXCEEDANCE OF BACKGROUND
- INFERRED BACKGROUND CONTOUR
- ASH BASIN WASTE BOUNDARY
- ASH BASIN COMPLIANCE BOUNDARY
- LANDFILL BOUNDARY (CLOSED)
- STRUCTURAL FILL BOUNDARY (CLOSED)
- LANDFILL COMPLIANCE BOUNDARY
- LINED RETENTION BASIN
- COAL PILE STORAGE AREA
- DUKE ENERGY CAROLINAS PROPERTY LINE
- TOPOGRAPHIC CONTOUR (10' INTERVAL)
- GROUNDWATER FLOW DIRECTION
- STREAM (AMEC NRTR)
- WETLAND (AMEC NRTR)
- APPROXIMATE HYDROLOGIC DIVIDE

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 64 µg/L (AS SUBMITTED JUNE 2019).

4. † - CONCENTRATIONS WITHIN REASONABLE RANGE OF BACKGROUND DATA SET AND/OR NOT REPRESENTATIVE OF PLUME MIGRATION FROM SOURCE AREA BASED ON MODELED SITE HYDRAULIC CHARACTERISTICS AND ARE NOT CONTOURED. DOES NOT SUGGEST IMPACT FROM SOURCE AREA.

5. * - CONSTITUENT CONCENTRATION SHOWN IS THE MOST RECENT VALID SAMPLE AVAILABLE BETWEEN JANUARY 2018 AND APRIL 2019.

6. HYDROLOGIC DIVIDE IDENTIFIED IN CSA UPDATE (SYNTERRA, 2017) AND UPDATED GROUNDWATER FLOW AND TRANSPORT MODELING REPORT (FALTA AND OTHERS, 2019).

7. THE WATERS OF THE U.S. 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 BELEWS CREEK STEAM STATION DATED JULY 2, 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. COAL PILE AND STRUCTRUAL FILL ASSESSMENT ARE ONGOING AND ARE THEREFORE NOT ADDRESSED IN THE CORRECTIVE ACTION PLAN UPDATE.

10. ALL BOUNDARIES ARE APPROXIMATE.

11. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.

12. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON JUNE 11, 2019. AERIAL WAS COLLECTED ON FEBRUARY 3, 2019.

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

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500 0 500 1,000
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APPROVED BY: A. ALBERT	DATE: 12/05/2019
PROJECT MANAGER: A. ALBERT	

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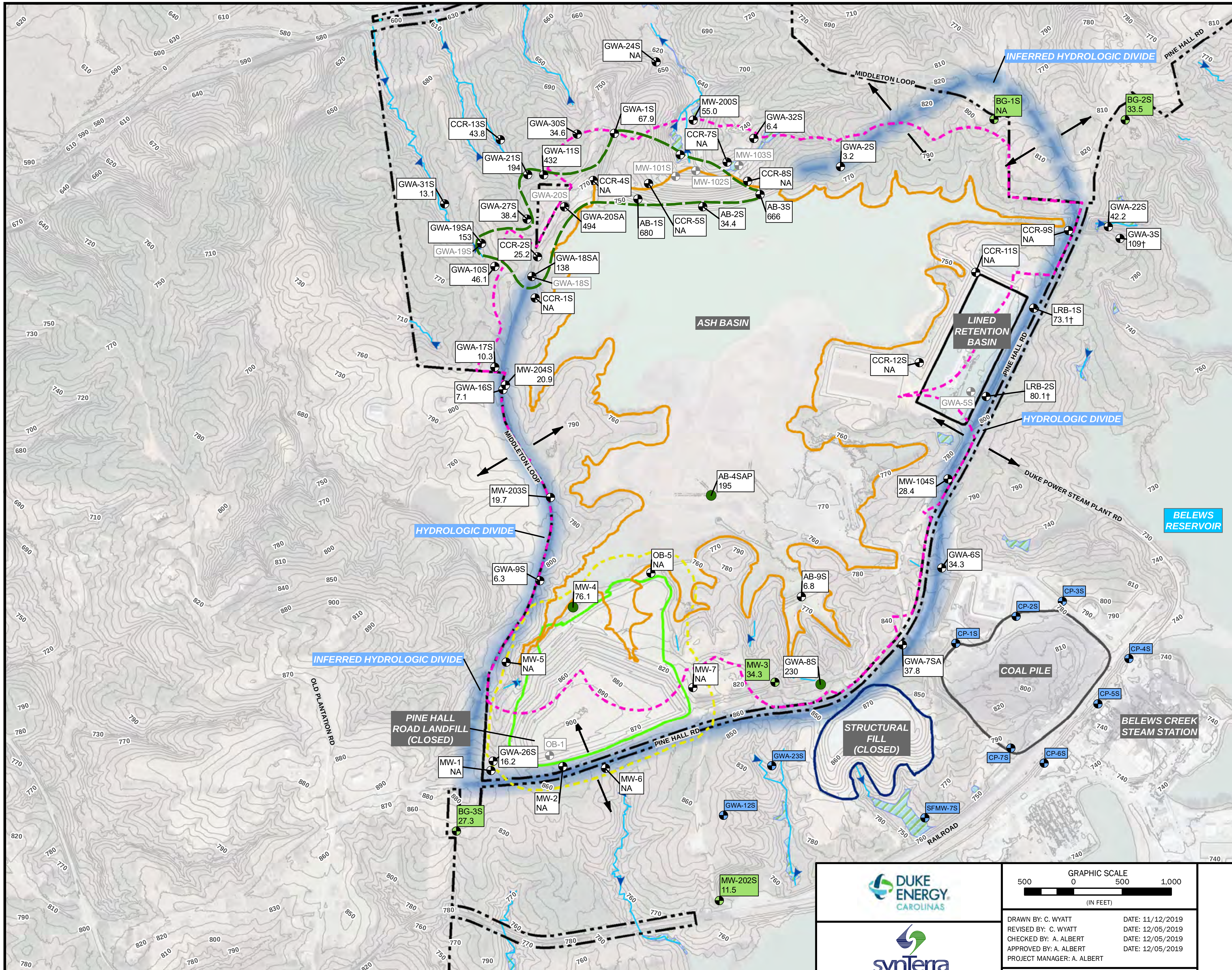
FIGURE 6-18c
ISOCONCENTRATION MAP
MANGANESE IN BEDROCK FLOW ZONE
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA



LEGEND

- ASSESSMENT MONITORING WELL
- BACKGROUND MONITORING WELL
- WELL ABANDONED
- STRUCTURAL FILL AND COAL PILE MONITORING WELL
- ISOLATED EXCEEDANCE OF BACKGROUND
- INFERRED BACKGROUND CONTOUR
- ASH BASIN WASTE BOUNDARY
- ASH BASIN COMPLIANCE BOUNDARY
- LANDFILL BOUNDARY (CLOSED)
- STRUCTURAL FILL BOUNDARY (CLOSED)
- LANDFILL COMPLIANCE BOUNDARY
- LINED RETENTION BASIN
- COAL PILE STORAGE AREA
- DUKE ENERGY CAROLINAS PROPERTY LINE
- TOPOGRAPHIC CONTOUR (10' INTERVAL)
- GROUNDWATER FLOW DIRECTION
- STREAM (AMEC NRTR)
- WETLAND (AMEC NRTR)
- APPROXIMATE HYDROLOGIC DIVIDE

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 57 ug/L (AS SUBMITTED JUNE 2019).

4. † - CONCENTRATIONS WITHIN REASONABLE RANGE OF BACKGROUND DATA SET AND/OR NOT REPRESENTATIVE OF PLUME MIGRATION FROM SOURCE AREA BASED ON MODELED SITE HYDRAULIC CHARACTERISTICS AND ARE NOT CONTOURED. DOES NOT SUGGEST IMPACT FROM SOURCE AREA.

5. HYDROLOGIC DIVIDE IDENTIFIED IN CSA UPDATE (SYNTERRA, 2017) AND UPDATED GROUNDWATER FLOW AND TRANSPORT MODELING REPORT (FALTA AND OTHERS, 2019).

6. THE WATERS OF THE U.S. 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 BELEWS CREEK STEAM STATION DATED JULY 2, 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. COAL PILE AND STRUCTRUAL FILL ASSESSMENT ARE ONGOING AND ARE THEREFORE NOT ADDRESSED IN THE CORRECTIVE ACTION PLAN UPDATE.

9. ALL BOUNDARIES ARE APPROXIMATE.

10. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.

11. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON JUNE 11, 2019. AERIAL WAS COLLECTED ON FEBRUARY 3, 2019.

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

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CHECKED BY: A. ALBERT DATE: 12/05/2019
APPROVED BY: A. ALBERT DATE: 12/05/2019
PROJECT MANAGER: A. ALBERT

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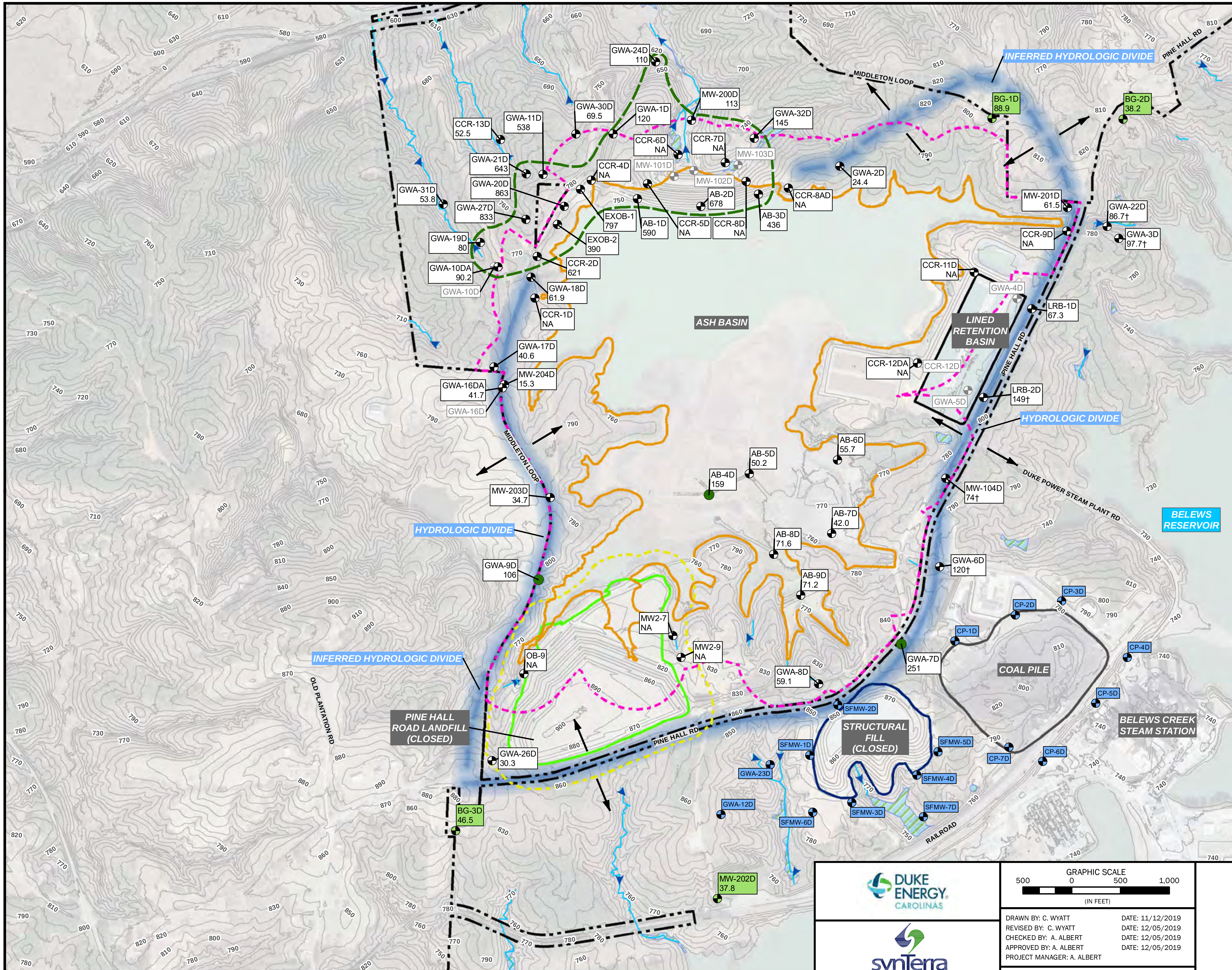
FIGURE 6-19a
ISOCONCENTRATION MAP
STRONTIUM IN SHALLOW FLOW ZONE
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA



LEGEND

- ASSESSMENT MONITORING WELL
- BACKGROUND MONITORING WELL
- WELL ABANDONED
- STRUCTURAL FILL AND COAL PILE MONITORING WELL
- ISOLATED EXCEEDANCE OF BACKGROUND
- INFERRED BACKGROUND CONTOUR
- ASH BASIN WASTE BOUNDARY
- ASH BASIN COMPLIANCE BOUNDARY
- LANDFILL BOUNDARY (CLOSED)
- STRUCTURAL FILL BOUNDARY (CLOSED)
- LANDFILL COMPLIANCE BOUNDARY
- LINED RETENTION BASIN
- COAL PILE STORAGE AREA
- DUKE ENERGY CAROLINAS PROPERTY LINE
- TOPOGRAPHIC CONTOUR (10' INTERVAL)
- GROUNDWATER FLOW DIRECTION
- STREAM (AMEC NRTR)
- WETLAND (AMEC NRTR)
- APPROXIMATE HYDROLOGIC DIVIDE

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 73 µg/L (AS SUBMITTED JUNE 2019).

4. † - CONCENTRATIONS WITHIN REASONABLE RANGE OF BACKGROUND DATA SET AND/OR NOT REPRESENTATIVE OF PLUME MIGRATION FROM SOURCE AREA BASED ON MODELED SITE HYDRAULIC CHARACTERISTICS AND ARE NOT CONTOURED. DOES NOT SUGGEST IMPACT FROM SOURCE AREA.

5. HYDROLOGIC DIVIDE IDENTIFIED IN CSA UPDATE (SYNTERRA, 2017) AND UPDATED GROUNDWATER FLOW AND TRANSPORT MODELING REPORT (FALTA AND OTHERS, 2019).

6. THE WATERS OF THE U.S. 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 BELEWS CREEK STEAM STATION DATED JULY 2, 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. COAL PILE AND STRUCTRUAL FILL ASSESSMENT ARE ONGOING AND ARE THEREFORE NOT ADDRESSED IN THE CORRECTIVE ACTION PLAN UPDATE.

9. ALL BOUNDARIES ARE APPROXIMATE.

10. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.

11. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON JUNE 11, 2019. AERIAL WAS COLLECTED ON FEBRUARY 3, 2019.

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

DUKE ENERGY CAROLINAS

synTerra

GRAPHIC SCALE
500 0 500 1,000
(IN FEET)

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REVISED BY: C. WYATT	DATE: 12/05/2019
CHECKED BY: A. ALBERT	DATE: 12/05/2019
APPROVED BY: A. ALBERT	DATE: 12/05/2019
PROJECT MANAGER: A. ALBERT	

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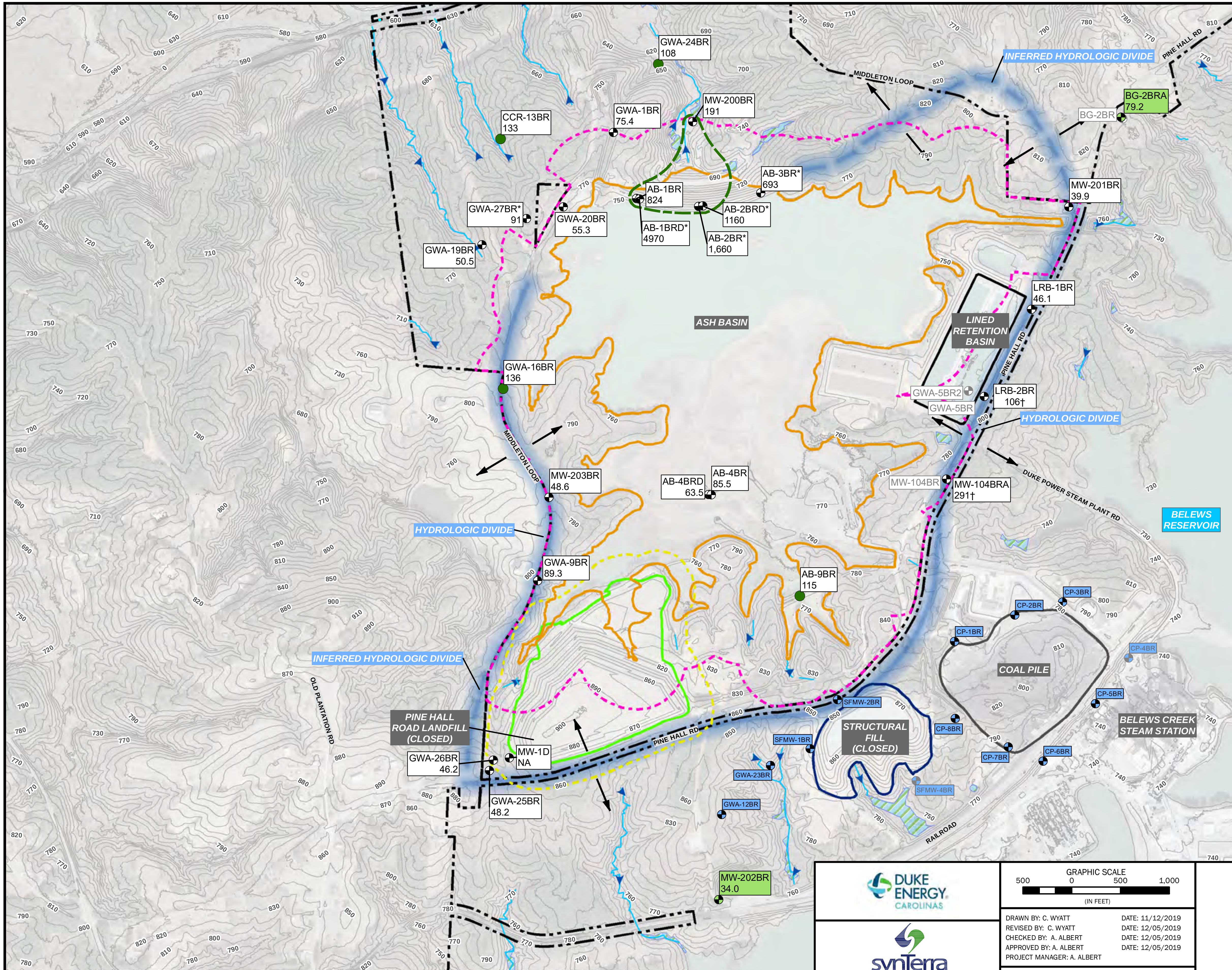
FIGURE 6-19b
ISOCONCENTRATION MAP
STRONTIUM IN DEEP FLOW ZONE
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA



LEGEND

- ASSESSMENT MONITORING WELL
- BACKGROUND MONITORING WELL
- WELL ABANDONED
- STRUCTURAL FILL AND COAL PILE MONITORING WELL
- ISOLATED EXCEEDANCE OF BACKGROUND
- INFERRED BACKGROUND CONTOUR
- ASH BASIN WASTE BOUNDARY
- ASH BASIN COMPLIANCE BOUNDARY
- LANDFILL BOUNDARY (CLOSED)
- STRUCTURAL FILL BOUNDARY (CLOSED)
- LANDFILL COMPLIANCE BOUNDARY
- LINED RETENTION BASIN
- COAL PILE STORAGE AREA
- DUKE ENERGY CAROLINAS PROPERTY LINE
- TOPOGRAPHIC CONTOUR (10' INTERVAL)
- GROUNDWATER FLOW DIRECTION
- STREAM (AMEC NRTR)
- WETLAND (AMEC NRTR)
- APPROXIMATE HYDROLOGIC DIVIDE

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 100 μg/L (AS SUBMITTED JUNE 2019).

4. † - CONCENTRATIONS WITHIN REASONABLE RANGE OF BACKGROUND DATA SET AND/OR NOT REPRESENTATIVE OF PLUME MIGRATION FROM SOURCE AREA BASED ON MODELED SITE HYDRAULIC CHARACTERISTICS AND ARE NOT CONTOURED. DOES NOT SUGGEST IMPACT FROM SOURCE AREA.

5. * - CONSTITUENT CONCENTRATION SHOWN IS THE MOST RECENT VALID SAMPLE AVAILABLE BETWEEN JANUARY 2018 AND APRIL 2019.

6. HYDROLOGIC DIVIDE IDENTIFIED IN CSA UPDATE (SYNTERRA, 2017) AND UPDATED GROUNDWATER FLOW AND TRANSPORT MODELING REPORT (FALTA AND OTHERS, 2019).

7. THE WATERS OF THE U.S. 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 BELEWS CREEK STEAM STATION DATED JULY 2, 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. COAL PILE AND STRUCTRUAL FILL ASSESSMENT ARE ONGOING AND ARE THEREFORE NOT ADDRESSED IN THE CORRECTIVE ACTION PLAN UPDATE.

10. ALL BOUNDARIES ARE APPROXIMATE.

11. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.

12. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON JUNE 11, 2019. AERIAL WAS COLLECTED ON FEBRUARY 3, 2019.

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

DUKE ENERGY CAROLINAS

synTerra

GRAPHIC SCALE
500 0 500 1,000
(IN FEET)

DRAWN BY: C. WYATT DATE: 11/12/2019
REVISED BY: C. WYATT DATE: 12/05/2019
CHECKED BY: A. ALBERT DATE: 12/05/2019
APPROVED BY: A. ALBERT DATE: 12/05/2019
PROJECT MANAGER: A. ALBERT

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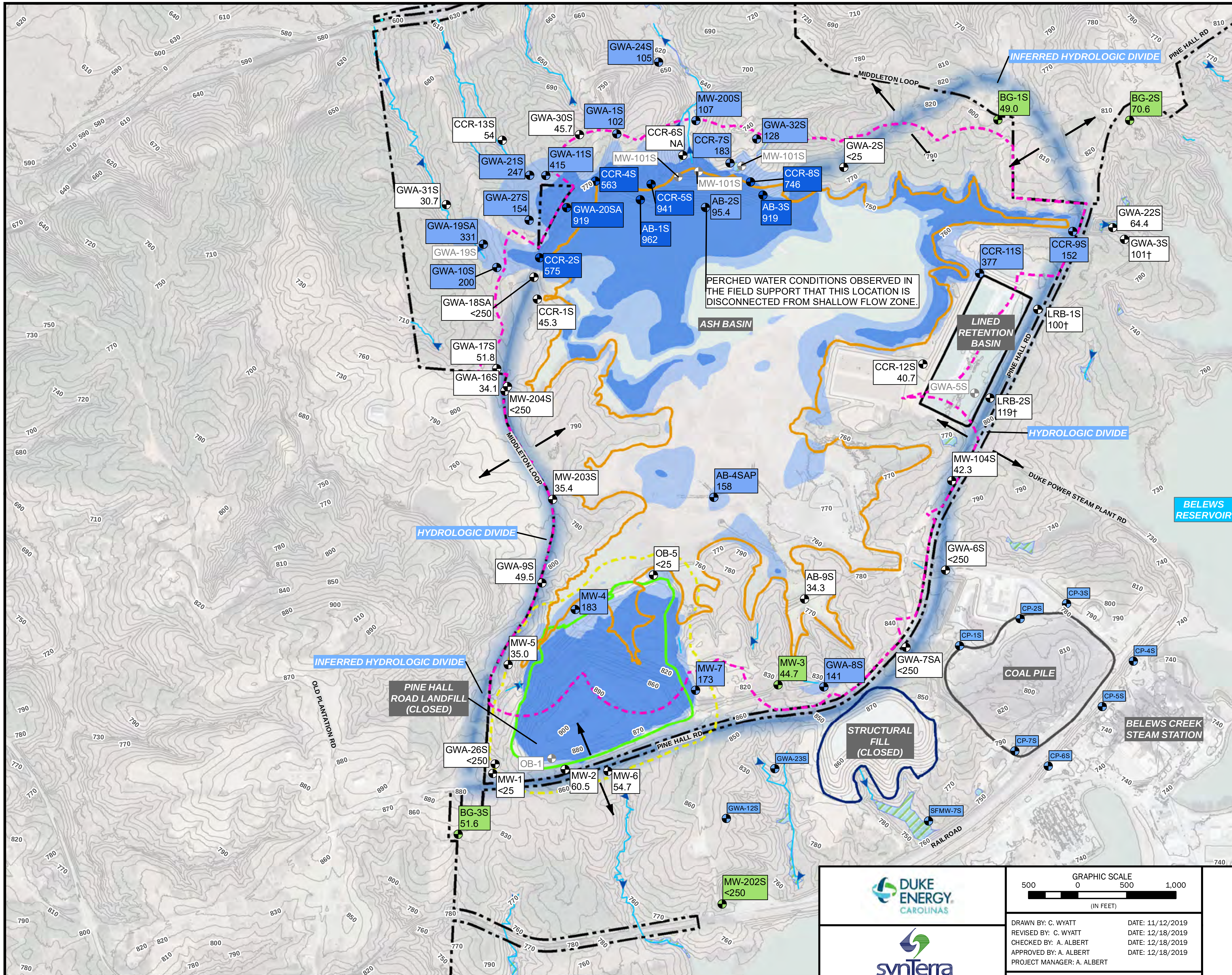
FIGURE 6-19c
ISOCONCENTRATION MAP
STRONTIUM IN BEDROCK FLOW ZONE
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA



LEGEND

- ASSESSMENT MONITORING WELL - GREATER THAN NC 02L STANDARD (500mg/L)
- ASSESSMENT MONITORING WELL - GREATER THAN BACKGROUND THRESHOLD VALUE (93mg/L)
- ASSESSMENT MONITORING WELL - LESS THAN BACKGROUND THRESHOLD VALUE
- BACKGROUND MONITORING WELL
- WELL ABANDONED
- STRUCTURAL FILL AND COAL PILE MONITORING WELL
- TDS PLUME GREATER THAN NC 02L STANDARD (500mg/L) FROM MEAN ANALYSIS. FLOW AND TRANSPORT MODEL PREDICTED PLUME IS USED WHERE EMPIRICAL DATA IS NOT AVAILABLE.
- TDS PLUME GREATER THAN BTV (93mg/L) FROM MEAN ANALYSIS. FLOW AND TRANSPORT MODEL PREDICTED PLUME IS USED WHERE EMPIRICAL DATA IS NOT AVAILABLE.
- ASH BASIN WASTE BOUNDARY
- ASH BASIN COMPLIANCE BOUNDARY
- LANDFILL BOUNDARY (CLOSED)
- STRUCTURAL FILL BOUNDARY (CLOSED)
- LANDFILL COMPLIANCE BOUNDARY
- LINED RETENTION BASIN
- COAL PILE STORAGE AREA
- DUKE ENERGY CAROLINAS PROPERTY LINE
- TOPOGRAPHIC CONTOUR (10' INTERVAL)
- GROUNDWATER FLOW DIRECTION
- STREAM (AMEC NRTR)
- WETLAND (AMEC NRTR)
- APPROXIMATE HYDROLOGIC DIVIDE

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 TOTAL DISSOLVED SOLIDS IS 500 mg/L.
3. THE BACKGROUND VALUE FOR TOTAL DISSOLVED SOLIDS IS 93 mg/L (AS SUBMITTED JUNE 2019).
4. † - CONCENTRATIONS WITHIN REASONABLE RANGE OF BACKGROUND DATA SET AND/OR NOT REPRESENTATIVE OF PLUME MIGRATION FROM SOURCE AREA BASED ON MODELED SITE HYDRAULIC CHARACTERISTICS AND ARE NOT CONTOURED. DOES NOT SUGGEST IMPACT FROM SOURCE AREA.
5. GROUNDWATER FLOW AND TRANSPORT TDS PLUME SIMULATION IS MODIFIED FROM MODEL LAYER 13 (FALTA AND OTHERS, 2019).
6. HYDROLOGIC DIVIDE IDENTIFIED IN CSA UPDATE (SYNTERRA, 2017) AND UPDATED GROUNDWATER FLOW AND TRANSPORT MODELING REPORT (FALTA AND OTHERS, 2019).
7. THE WATERS OF THE U.S. 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 BELEWS CREEK STEAM STATION DATED JULY 2, 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. COAL PILE AND STRUCTRUAL FILL ASSESSMENT ARE ONGOING AND ARE THEREFORE NOT ADDRESSED IN THE CORRECTIVE ACTION PLAN UPDATE.
10. ALL BOUNDARIES ARE APPROXIMATE.
11. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.
12. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON JUNE 11, 2019. AERIAL WAS COLLECTED ON FEBRUARY 3, 2019.
13. DRAWING HAS BEEN SET WITH A PROJECTION OF NORTH CAROLINA STATE PLANE COORDINATE SYSTEM FIPS 3200 (NAD83).

DUKE ENERGY CAROLINAS

synTerra

GRAPHIC SCALE
500 0 500 1,000
(IN FEET)

DRAWN BY: C. WYATT	DATE: 11/12/2019
REVISED BY: C. WYATT	DATE: 12/18/2019
CHECKED BY: A. ALBERT	DATE: 12/18/2019
APPROVED BY: A. ALBERT	DATE: 12/18/2019
PROJECT MANAGER: A. ALBERT	

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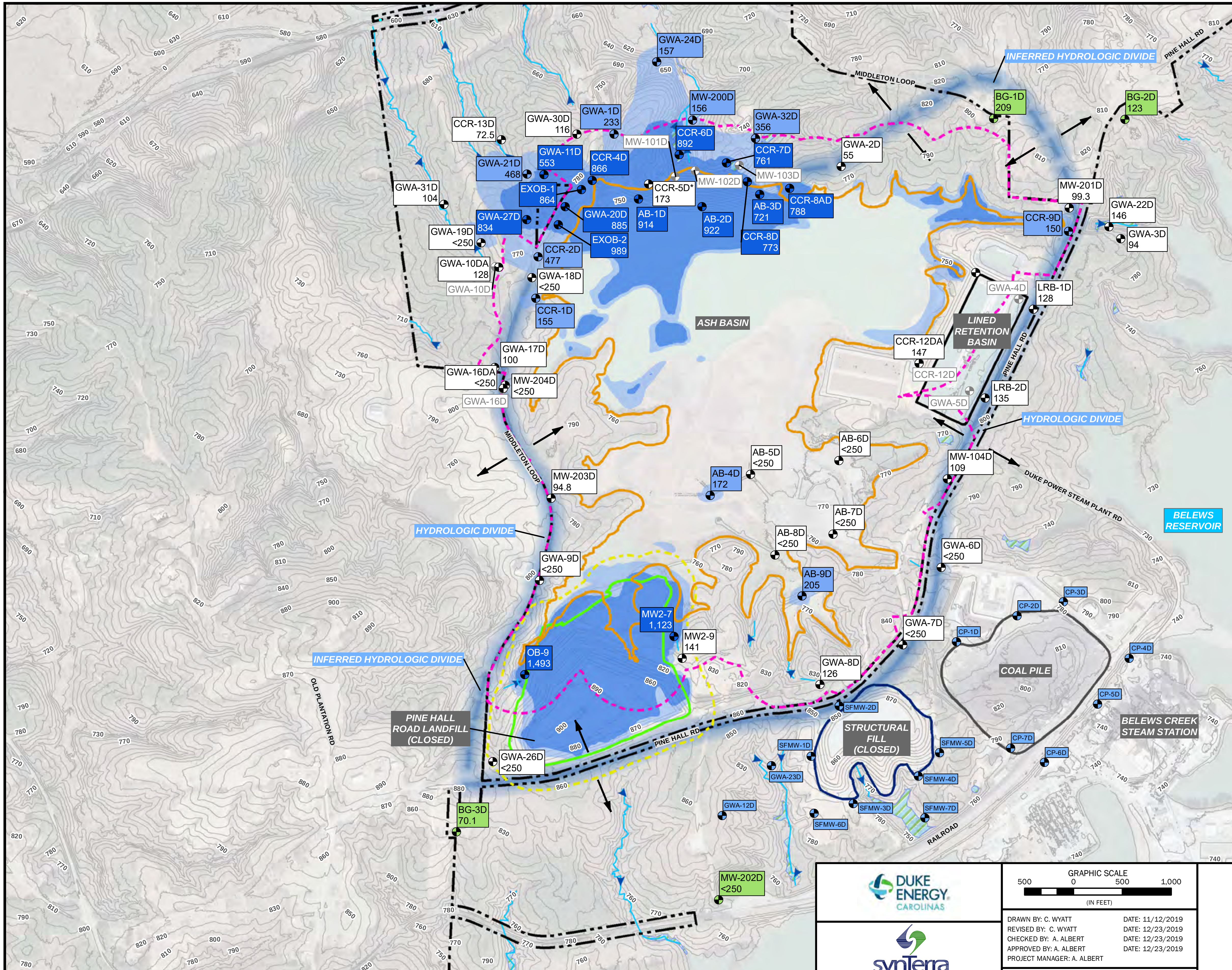
FIGURE 6-20a
ISOCONCENTRATION MAP
TOTAL DISSOLVED SOLIDS
IN SHALLOW FLOW ZONE
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA



LEGEND

- ASSESSMENT MONITORING WELL - GREATER THAN NC 02L STANDARD (500mg/L)
- ASSESSMENT MONITORING WELL - GREATER THAN BACKGROUND THRESHOLD VALUE (148mg/L)
- ASSESSMENT MONITORING WELL - LESS THAN BACKGROUND THRESHOLD VALUE
- BACKGROUND MONITORING WELL
- WELL ABANDONED
- STRUCTURAL FILL AND COAL PILE MONITORING WELL
- TDS PLUME GREATER THAN NC 02L STANDARD (500mg/L) FROM MEAN ANALYSIS. FLOW AND TRANSPORT MODEL PREDICTED PLUME IS USED WHERE EMPIRICAL DATA IS NOT AVAILABLE.
- TDS PLUME GREATER THAN BTV (148mg/L) FROM MEAN ANALYSIS. FLOW AND TRANSPORT MODEL PREDICTED PLUME IS USED WHERE EMPIRICAL DATA IS NOT AVAILABLE.
- ASH BASIN WASTE BOUNDARY
- ASH BASIN COMPLIANCE BOUNDARY
- LANDFILL BOUNDARY (CLOSED)
- STRUCTURAL FILL BOUNDARY (CLOSED)
- LANDFILL COMPLIANCE BOUNDARY
- LINED RETENTION BASIN
- COAL PILE STORAGE AREA
- DUKE ENERGY CAROLINAS PROPERTY LINE
- TOPOGRAPHIC CONTOUR (10' INTERVAL)
- GROUNDWATER FLOW DIRECTION
- STREAM (AMEC NRTR)
- WETLAND (AMEC NRTR)
- APPROXIMATE HYDROLOGIC DIVIDE

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 TOTAL DISSOLVED SOLIDS IS 500 mg/L.
3. THE BACKGROUND VALUE FOR TOTAL DISSOLVED SOLIDS IS 148 mg/L (AS SUBMITTED JUNE 2019).
4. * - CONSTITUENT CONCENTRATION SHOWN IS THE MOST RECENT VALID SAMPLE AVAILABLE BETWEEN JANUARY 2018 AND APRIL 2019.
5. GROUNDWATER FLOW AND TRANSPORT TDS PLUME SIMULATION IS MODIFIED FROM MODEL LAYER 15 (FALTA AND OTHERS, 2019).
6. HYDROLOGIC DIVIDE IDENTIFIED IN CSA UPDATE (SYNTERRA, 2017) AND UPDATED GROUNDWATER FLOW AND TRANSPORT MODELING REPORT (FALTA AND OTHERS, 2019).
7. THE WATERS OF THE U.S. 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 BELEWS CREEK STEAM STATION DATED JULY 2, 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. COAL PILE AND STRUCTRUAL FILL ASSESSMENT ARE ONGOING AND ARE THEREFORE NOT ADDRESSED IN THE CORRECTIVE ACTION PLAN UPDATE.
10. ALL BOUNDARIES ARE APPROXIMATE.
11. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.
12. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON JUNE 11, 2019. AERIAL WAS COLLECTED ON FEBRUARY 3, 2019.
13. DRAWING HAS BEEN SET WITH A PROJECTION OF NORTH CAROLINA STATE PLANE COORDINATE SYSTEM FIPS 3200 (NAD83).

DUKE ENERGY CAROLINAS

synTerra

GRAPHIC SCALE
500 0 500 1,000
(IN FEET)

DRAWN BY: C. WYATT DATE: 11/12/2019
REVISED BY: C. WYATT DATE: 12/23/2019
CHECKED BY: A. ALBERT DATE: 12/23/2019
APPROVED BY: A. ALBERT DATE: 12/23/2019
PROJECT MANAGER: A. ALBERT

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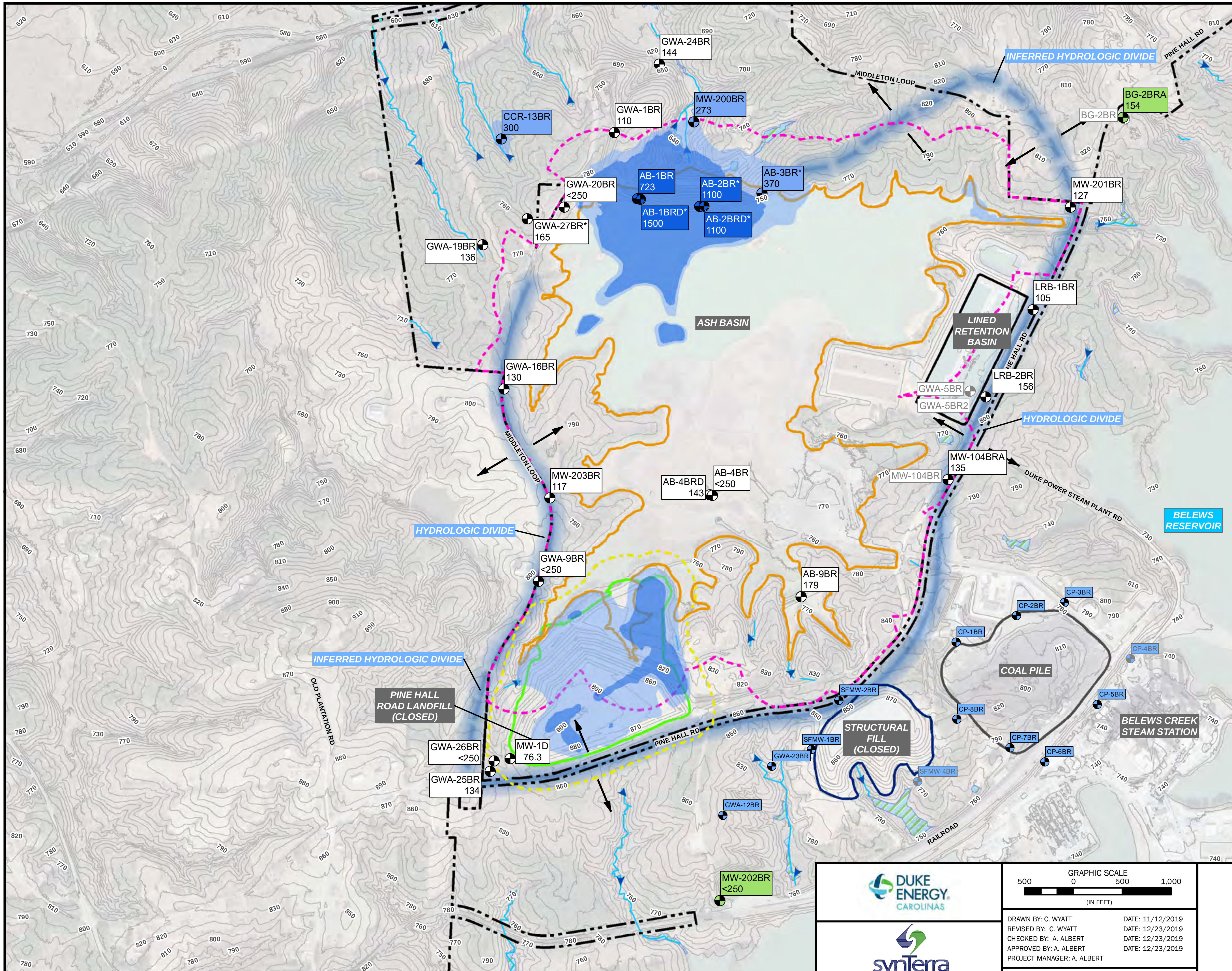
FIGURE 6-20b
ISOCONCENTRATION MAP
TOTAL DISSOLVED SOLIDS
IN DEEP FLOW ZONE
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA



LEGEND

- ASSESSMENT MONITORING WELL - GREATER THAN NC 02L STANDARD (500mg/L)
- ASSESSMENT MONITORING WELL - GREATER THAN BACKGROUND THRESHOLD VALUE (181mg/L)
- ASSESSMENT MONITORING WELL - LESS THAN BACKGROUND THRESHOLD VALUE
- BACKGROUND MONITORING WELL
- WELL ABANDONED
- STRUCTURAL FILL AND COAL PILE MONITORING WELL
- TDS PLUME GREATER THAN NC 02L STANDARD (500mg/L) FROM MEAN ANALYSIS. FLOW AND TRANSPORT MODEL PREDICTED PLUME IS USED WHERE EMPIRICAL DATA IS NOT AVAILABLE.
- TDS PLUME GREATER THAN BTV (181mg/L) FROM MEAN ANALYSIS. FLOW AND TRANSPORT MODEL PREDICTED PLUME IS USED WHERE EMPIRICAL DATA IS NOT AVAILABLE.
- ASH BASIN WASTE BOUNDARY
- ASH BASIN COMPLIANCE BOUNDARY
- LANDFILL BOUNDARY (CLOSED)
- STRUCTURAL FILL BOUNDARY (CLOSED)
- LANDFILL COMPLIANCE BOUNDARY
- LINED RETENTION BASIN
- COAL PILE STORAGE AREA
- DUKE ENERGY CAROLINAS BELEWS CREEK PLANT SITE BOUNDARY
- TOPOGRAPHIC CONTOUR (10' INTERVAL)
- GROUNDWATER FLOW DIRECTION
- STREAM (AMEC NRTR)
- WETLAND (AMEC NRTR)
- APPROXIMATE HYDROLOGIC DIVIDE

NOTES:

1. DATA INCLUDED IN THIS FIGURE ARE THE GEOMEAN FOR WELLS FROM WHICH FOUR OR MORE VALID SAMPLES WERE OBTAINED BETWEEN JANUARY 2018 THROUGH APRIL 2019. FOR WELLS FROM WHICH FOUR OR MORE VALID SAMPLES WERE NOT OBTAINED BETWEEN JANUARY 2018 THROUGH APRIL 2019, THE MOST RECENT VALID DATA ARE INCLUDED (REFERENCE TABLE 6-5).

2. THE 02L FOR TDS IS 500mg/L.

3. THE BACKGROUND VALUE FOR TDS IS 181mg/L.

4. BACKGROUND CONCENTRATIONS GREATER THAN CURRENT SITE SPECIFIC BTV BUT WITHIN THE BACKGROUND CONCENTRATION RANGE FOR SIMILAR PIEDMONT GEOLOGIC SETTINGS ARE NOT CONTOURED. DUE TO GROUNDWATER FLOW DIRECTION AND OTHER CONSTITUENT MIGRATION PATTERNS, CONCENTRATION DOES NOT SUGGEST IMPACT FROM THE ASH BASIN.

5. * - INSUFFCIENT NUMBER OF SAMPLE EVENTS (≥4 SAMPLE EVENTS) TO CALCULATE MEAN OF DATASET OR WELL EXHIBITS HIGH pH INDICATIVE OF GROUT CONTAMINATION. NO CENTRAL TENDENCY MEAN ANALYSIS COMPLETED FOR COI, THEREFORE DATA FROM WELL REPRESENTS MOST RECENT AVAILABLE DATA FROM 2019 PROVIDED FOR INFORMATIONAL PURPOSES ONLY.(APPENDIX C, TABLE 1)

6. GROUNDWATER FLOW AND TRANSPORT TDS PLUME SIMULATION IS MODIFIED FROM MODEL LAYER 13 (FALTA AND OTHERS, 2019).

7. HYDROLOGIC DIVIDE INDENTIFIED IN CSA UPDATE (SYNTERRA, 2017) AND FLOW AND TRANSPORT REPORT REFERENCE.

8. 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 NOT TO BE USED FOR JURISDICTIONAL DETERMINATION PURPOSES. THE WETLANDS AND STREAMS BOUNDARIES WERE OBTAINED FROM AMEC FOSTER WHEELER ENVIRONMENTAL & INFRASTRUCTURE, INC. NATURAL RESOURCE TECHNICAL REPORT FOR BELEWS CREEK STEAM STATION DATED JULY 2, 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. COAL PILE AND STRUCTURAL FILL ASSESSMENTS ONGOING AND ARE THEREFORE NOT ADDRESSED IN THE CORRECTIVE ACTION PLAN UPDATE

11. ALL BOUNDARIES ARE APPROXIMATE.

12. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.

13. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON JUNE 11, 2019. AERIAL WAS COLLECTED ON FEBRUARY 3, 2019.

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

DUKE ENERGY CAROLINAS

synTerra

GRAPHIC SCALE
500 0 500 1,000
(IN FEET)

DRAWN BY: C. WYATT	DATE: 11/12/2019
REVISED BY: C. WYATT	DATE: 12/23/2019
CHECKED BY: A. ALBERT	DATE: 12/23/2019
APPROVED BY: A. ALBERT	DATE: 12/23/2019
PROJECT MANAGER: A. ALBERT	

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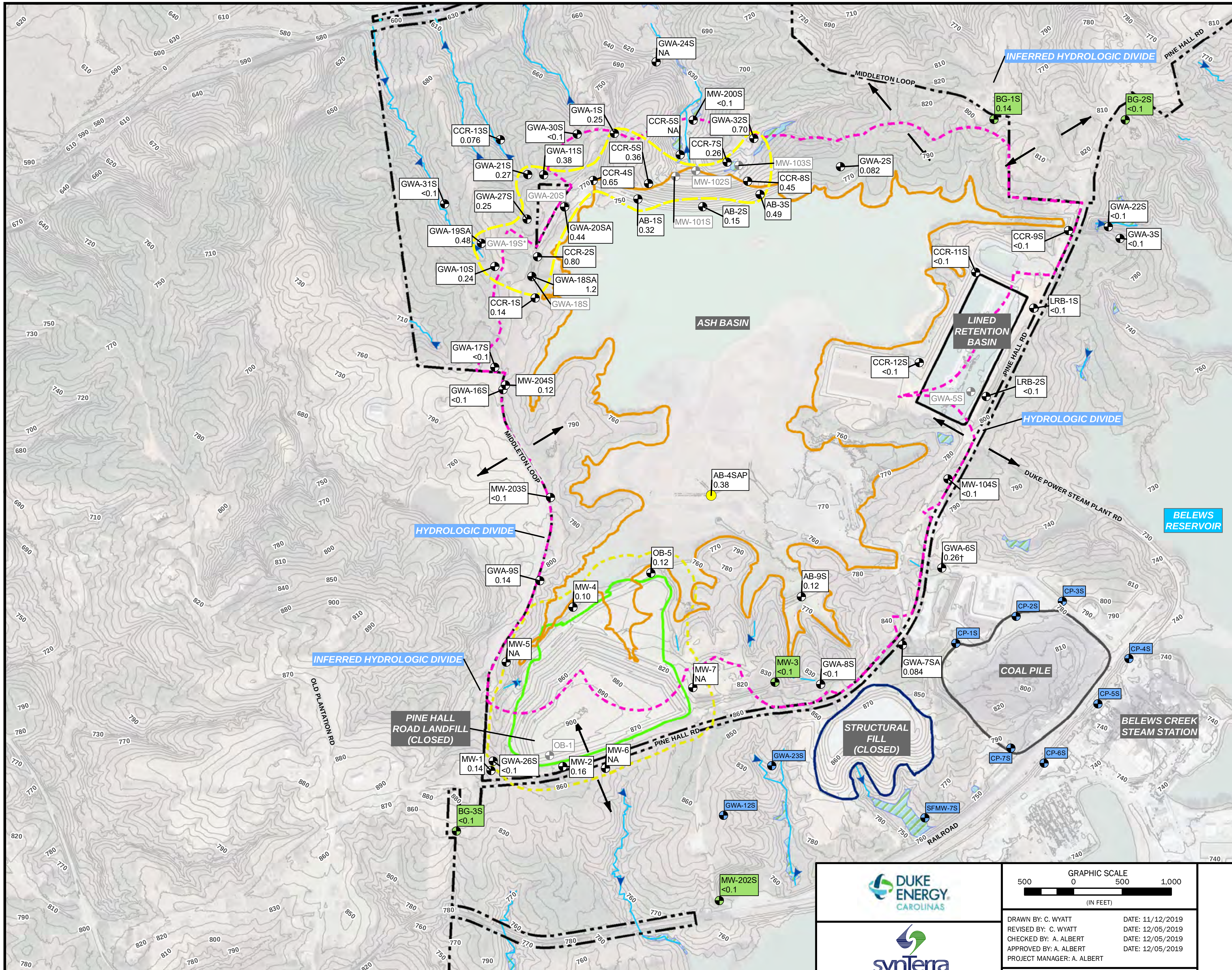
FIGURE 6-20c
ISOCONCENTRATION MAP
TOTAL DISSOLVED SOLIDS
IN BEDROCK FLOW ZONE
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA



LEGEND

- ASSESSMENT MONITORING WELL
- BACKGROUND MONITORING WELL
- WELL ABANDONED
- STRUCTURAL FILL AND COAL PILE MONITORING WELL
- ISOLATED EXCEEDANCE OF IMAC
- INFERRED IMAC VALUE CONTOUR
- ASH BASIN WASTE BOUNDARY
- ASH BASIN COMPLIANCE BOUNDARY
- LANDFILL BOUNDARY (CLOSED)
- STRUCTURAL FILL BOUNDARY (CLOSED)
- LANDFILL COMPLIANCE BOUNDARY
- LINED RETENTION BASIN
- COAL PILE STORAGE AREA
- DUKE ENERGY CAROLINAS PROPERTY LINE
- TOPOGRAPHIC CONTOUR (10' INTERVAL)
- GROUNDWATER FLOW DIRECTION
- STREAM (AMEC NRTR)
- WETLAND (AMEC NRTR)
- APPROXIMATE HYDROLOGIC DIVIDE

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 IMAC FOR THALLIUM IS 0.2µg/L.

3. THE BACKGROUND VALUE FOR THALLIUM IS 0.2µg/L.

4. † - CONCENTRATIONS WITHIN REASONABLE RANGE OF BACKGROUND DATA SET AND/OR NOT REPRESENTATIVE OF PLUME MIGRATION FROM SOURCE AREA BASED ON MODELED SITE HYDRAULIC CHARACTERISTICS AND ARE NOT CONTOURED. DOES NOT SUGGEST IMPACT FROM SOURCE AREA.

5. HYDROLOGIC DIVIDE IDENTIFIED IN CSA UPDATE (SYNTERRA, 2017) AND UPDATED GROUNDWATER FLOW AND TRANSPORT MODELING REPORT (FALTA AND OTHERS, 2019).

6. THE WATERS OF THE U.S. 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 BELEWS CREEK STEAM STATION DATED JULY 2, 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. COAL PILE AND STRUCTRUAL FILL ASSESSMENT ARE ONGOING AND ARE THEREFORE NOT ADDRESSED IN THE CORRECTIVE ACTION PLAN UPDATE.

9. ALL BOUNDARIES ARE APPROXIMATE.

10. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.

11. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON JUNE 11, 2019. AERIAL WAS COLLECTED ON FEBRUARY 3, 2019.

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

DUKE ENERGY CAROLINAS

synTerra

GRAPHIC SCALE
500 0 500 1,000
(IN FEET)

DRAWN BY: C. WYATT DATE: 11/12/2019
REVISED BY: C. WYATT DATE: 12/05/2019
CHECKED BY: A. ALBERT DATE: 12/05/2019
APPROVED BY: A. ALBERT DATE: 12/05/2019
PROJECT MANAGER: A. ALBERT

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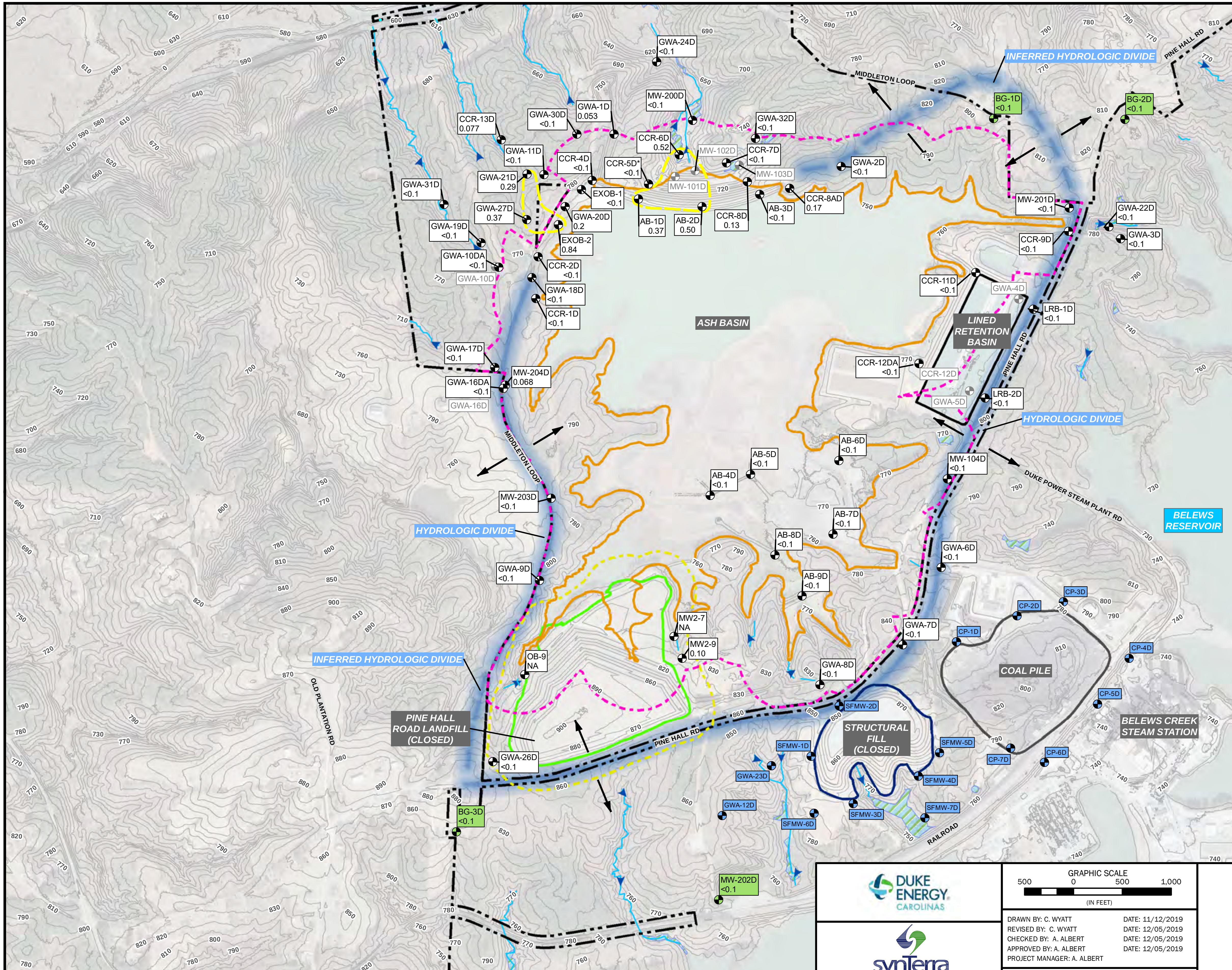
FIGURE 6-21a
ISOCONCENTRATION MAP
THALLIUM IN SHALLOW FLOW ZONE
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA



LEGEND

- ASSESSMENT MONITORING WELL
- BACKGROUND MONITORING WELL
- WELL ABANDONED
- STRUCTURAL FILL AND COAL PILE MONITORING WELL
- INFERRED IMAC VALUE CONTOUR
- ASH BASIN WASTE BOUNDARY
- ASH BASIN COMPLIANCE BOUNDARY
- LANDFILL BOUNDARY (CLOSED)
- STRUCTURAL FILL BOUNDARY (CLOSED)
- LANDFILL COMPLIANCE BOUNDARY
- LINED RETENTION BASIN
- COAL PILE STORAGE AREA
- DUKE ENERGY CAROLINAS PROPERTY LINE
- TOPOGRAPHIC CONTOUR (10' INTERVAL)
- GROUNDWATER FLOW DIRECTION
- STREAM (AMEC NRTR)
- WETLAND (AMEC NRTR)
- APPROXIMATE HYDROLOGIC DIVIDE

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 IMAC FOR THALLIUM IS 0.2 ug/L.

3. THE BACKGROUND VALUE FOR THALLIUM IS 0.2 µg/L (AS SUBMITTED JUNE 2019).

4. * - CONSTITUENT CONCENTRATION SHOWN IS THE MOST RECENT VALID SAMPLE AVAILABLE BETWEEN JANUARY 2018 AND APRIL 2019.

5. HYDROLOGIC DIVIDE IDENTIFIED IN CSA UPDATE (SYNTERRA, 2017) AND UPDATED GROUNDWATER FLOW AND TRANSPORT MODELING REPORT (FALTA AND OTHERS, 2019).

6. THE WATERS OF THE U.S. 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 BELEWS CREEK STEAM STATION DATED JULY 2, 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. COAL PILE AND STRUCTRUAL FILL ASSESSMENT ARE ONGOING AND ARE THEREFORE NOT ADDRESSED IN THE CORRECTIVE ACTION PLAN UPDATE.

9. ALL BOUNDARIES ARE APPROXIMATE.

10. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.

11. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON JUNE 11, 2019. AERIAL WAS COLLECTED ON FEBRUARY 3, 2019.

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

GRAPHIC SCALE
500 0 500 1,000
(IN FEET)

DRAWN BY: C. WYATT DATE: 11/12/2019
REVISED BY: C. WYATT DATE: 12/05/2019
CHECKED BY: A. ALBERT DATE: 12/05/2019
APPROVED BY: A. ALBERT DATE: 12/05/2019
PROJECT MANAGER: A. ALBERT

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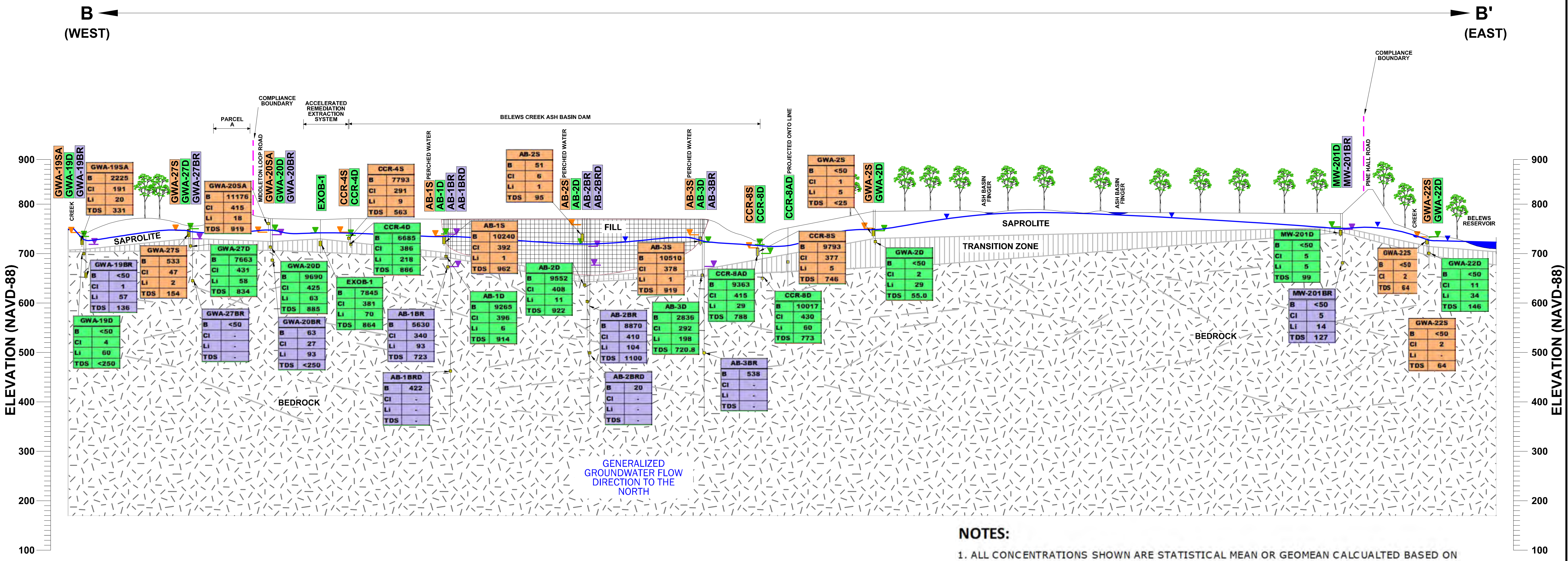
FIGURE 6-21b
ISOCONCENTRATION MAP
THALLIUM IN DEEP FLOW ZONE
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA



NOTES:

1. ALL CONCENTRATIONS SHOWN ARE STATISTICAL MEAN OR GEOMEAN CALCUALTED BASED ON CENTRAL TENDANCY OF DATASET USING DATA RANGING FROM JANUARY 2018 TO APRIL 2019.
2. BORON (B) AND LITHIUM (Li) CONCENTRATIONS ARE IN MICROGRAMS PER LITER (µg/L)
3. CHLORIDE (Cl) AND TOTAL DISSOLVED SOLIDS (TDS) CONCENTRATIONS ARE IN MILLIGRAMS PER LITER (mg/L)
4. NO MEAN ANALYSIS FOR BEDROCK WELLS (GWA-27BR, AB-1BRD, AB-2BRD AND AB-3BRD) FOR CONSTITUENTS; CHLORIDE AND TOTAL DISSOLVED SOLIDS

- NO DATA AVAILABLE

ANALYTICAL PARAMETER	B	Cl	Li	TDS
REPORTING UNITS	µg/L	mg/L	µg/L	mg/L
15A NCAC 02L STANDARD	700	250	NE	500
BACKGROUND THRESHOLD VALUE (SHALLOW FLOW ZONE)[1]	50	19	2	93
BACKGROUND THRESHOLD VALUE (DEEP FLOW ZONE)[1]	50	19	95	134
BACKGROUND THRESHOLD VALUE (BEDROCK FLOW ZONE)[1]	50	3	30	181

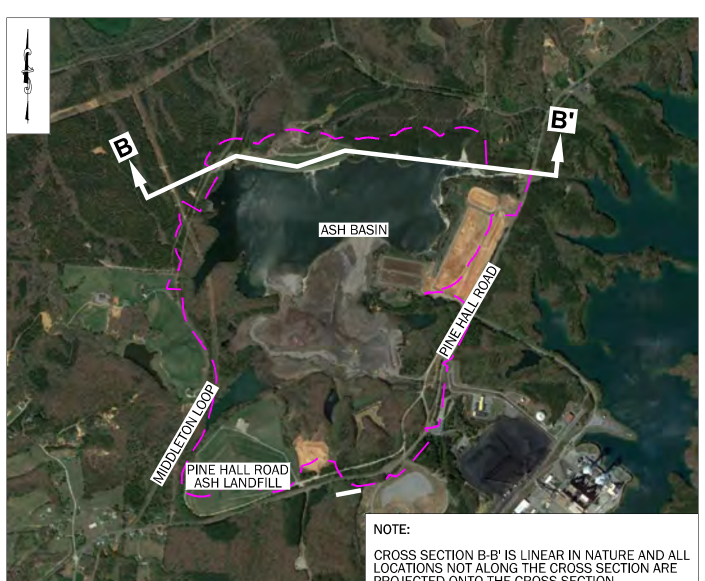
[1]BACKGROUND THRESHOLD VALUES WERE CALCULATED USING DATA FROM BACKGROUND GROUNDWATER SAMPLES COLLECTED MAY 2015 TO DECEMBER 2018 AS SUBMITTED IN JUNE 2019.

LEGEND

- AB-9S WELL IN SHALLOW/SAPROLITE ZONE
- AB-9D WELL IN DEEP/TRANSITION ZONE
- AB-9BR WELL IN COMPETENT BEDROCK
- AB-4S WELL IN ASH PORE WATER
- GENERALIZED WATER TABLE
- BEDROCK FRACTURE ORIENTATION
- FILL
- SAPROLITE
- WEATHERED ROCK
- BEDROCK
- WELL SCREEN
- COMPLIANCE BOUNDARY
- ASH PORE WATER FLOW LAYER WATER LEVEL ELEVATION
- SHALLOW/SAPROLITE FLOW ZONE GROUNDWATER LEVEL ELEVATION
- DEEP/TRANSITION ZONE FLOW ZONE GROUNDWATER LEVEL ELEVATION
- BEDROCK FLOW ZONE GROUNDWATER LEVEL ELEVATION

MW-201BR	
B	<50
Cl	5
TDS	127

MEAN BORON (B) CONCENTRATION (µg/L)
MEAN CHLORIDE (Cl) CONCENTRATION (mg/L)
MEAN TOTAL DISSOLVED SOLIDS (TDS) CONCENTRATION (mg/L)



CROSS SECTION LOCATION

DUKE ENERGY CAROLINAS

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0 125 250 500
HORIZONTAL SCALE: 1" = 500'
VERTICAL SCALE: 1" = 200'
5X VERTICAL EXAGGERATION

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APPROVED BY: A. ALBERT	DATE: 11/15/2019
PROJECT MANAGER: A. ALBERT	DATE: 08/01/2019

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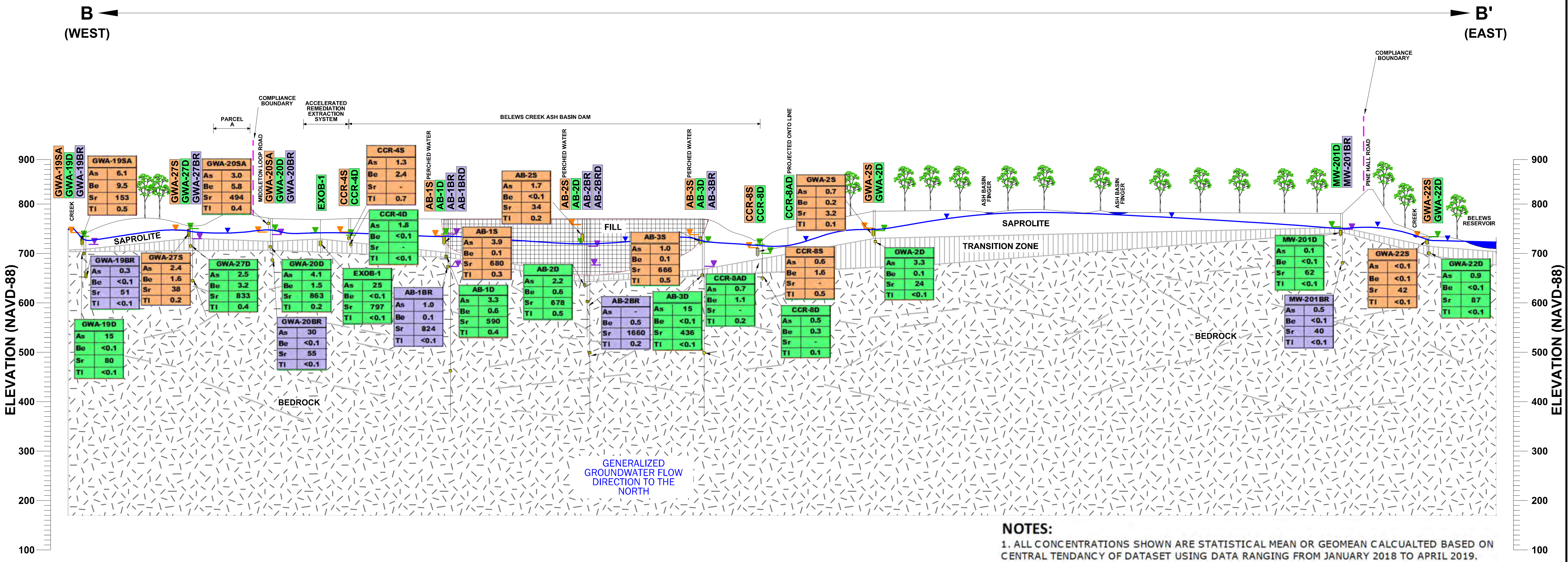
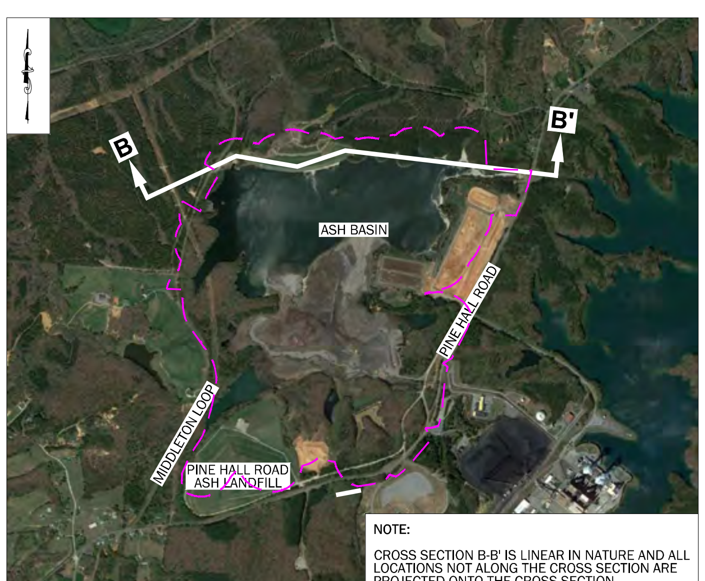
FIGURE 6-22a
GENERAL CROSS SECTION B-B'
ASH BASIN - CONSERVATIVE GROUP
MEAN OF BORON, CHLORIDE, LITHIUM AND TOTAL DISSOLVED SOLIDS
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA





CROSS SECTION LOCATION

LEGEND

- AB-9S — WELL IN SHALLOW/SAPROLITE ZONE
- AB-9D — WELL IN DEEP/TRANSITION ZONE
- AB-9BR — WELL IN COMPETENT BEDROCK
- AB-4S — WELL IN ASH PORE WATER
- GENERALIZED WATER TABLE
- BEDROCK FRACTURE ORIENTATION
- FILL
- SAPROLITE
- WEATHERED ROCK
- BEDROCK
- WELL SCREEN
- COMPLIANCE BOUNDARY
- ASH PORE WATER FLOW LAYER WATER LEVEL ELEVATION
- SHALLOW/SAPROLITE FLOW ZONE GROUNDWATER LEVEL ELEVATION
- DEEP/TRANSITION ZONE FLOW ZONE GROUNDWATER LEVEL ELEVATION
- BEDROCK FLOW ZONE GROUNDWATER LEVEL ELEVATION

CCR-8D		
As	0.5	MEAN ARSENIC (As) CONCENTRATION (µg/L)
Be	0.3	MEAN BERYLLIUM (Be) CONCENTRATION (µg/L)
Sr	-	MEAN STRONTIUM (Sr) CONCENTRATION (µg/L)
Tl	0.1	MEAN THALLIUM (Tl) CONCENTRATION (µg/L)

NOTES:

1. ALL CONCENTRATIONS SHOWN ARE STATISTICAL MEAN OR GEOMEAN CALCUALTED BASED ON CENTRAL TENDANCY OF DATASET USING DATA RANGING FROM JANUARY 2018 TO APRIL 2019.
2. ALL CONCENTRATIONS ARE IN MICROGRAMS PER LITER (µg/L)
3. NO MEAN ANALYSIS FOR BEDROCK WELLS (GWA-27BR, AB-1BRD, AB-2BRD AND AB-3BRD) FOR CONSTITUENTS; ARESNIC (As), BERYLLIUM (Be), STRONTIUM (Sr) AND THALLIUM (Tl)

- NO DATA AVAILABLE

ANALYTICAL PARAMETER	As	Be	Sr	Tl
REPORTING UNITS	µg/L	µg/L	µg/L	µg/L
15A NCAC 02L STANDARD	10	4*	NE	0.2*
BACKGROUND THRESHOLD VALUE (SHALLOW FLOW ZONE)[1]	1	0.3	46	0.2
BACKGROUND THRESHOLD VALUE (DEEP FLOW ZONE)[1]	1	0.1	73	0.2
BACKGROUND THRESHOLD VALUE (BEDROCK FLOW ZONE)[1]	2	0.2	99	0.1

* - 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 MAY 2015 TO DECEMBER 2018 AS SUBMITTED IN JUNE 2019.

DUKE ENERGY CAROLINAS

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0 125 250 500

HORIZONTAL SCALE: 1" = 500'
VERTICAL SCALE: 1" = 200'
5X VERTICAL EXAGGERATION

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APPROVED BY: A. ALBERT	DATE: 11/15/2019
PROJECT MANAGER: A. ALBERT	DATE: 08/01/2019

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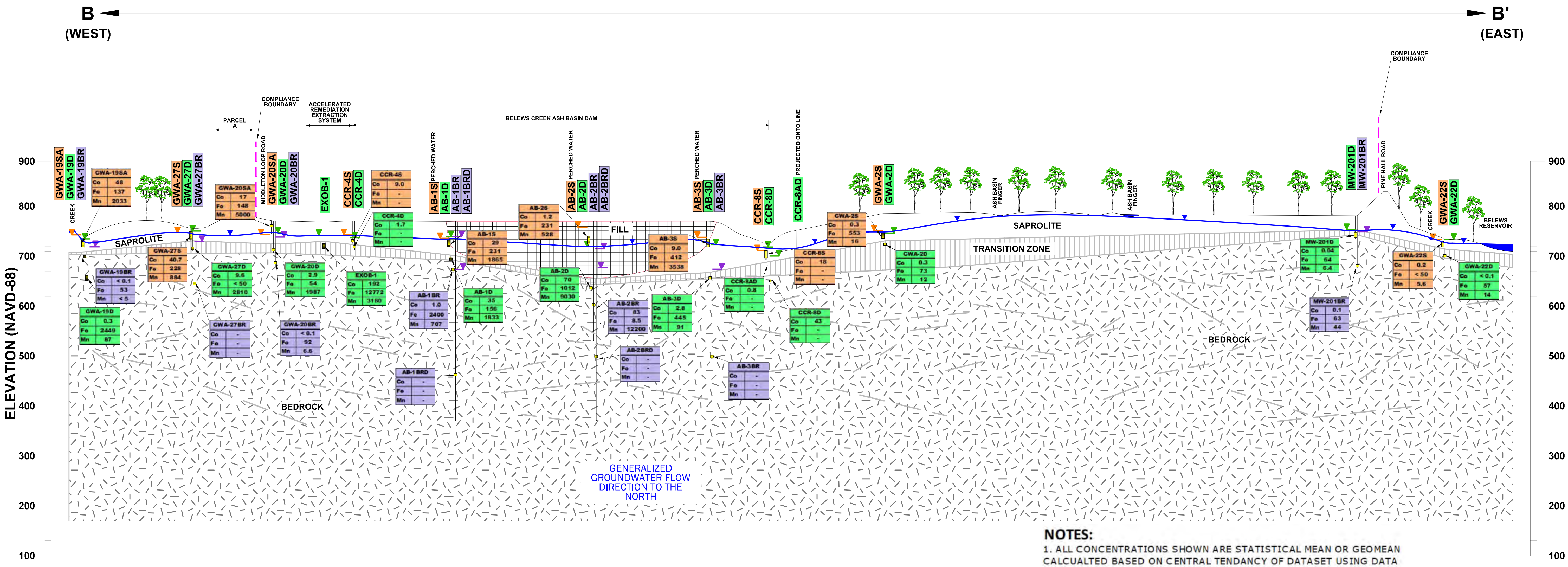
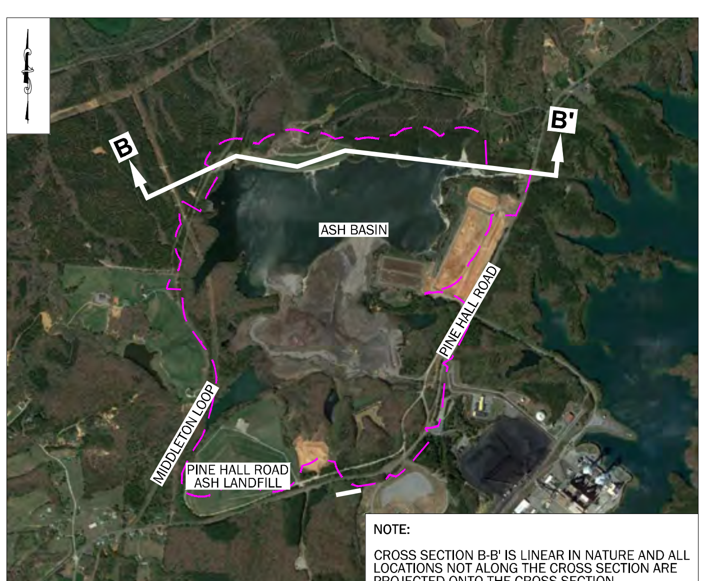
FIGURE 6-22b
GENERAL CROSS SECTION B-B'
ASH BASIN - NON-CONSERVATIVE GROUP
MEAN OF ARSENIC, BERYLLIUM, STRONTIUM AND THALLIUM EXISTING CONDITIONS
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA





CROSS SECTION LOCATION

LEGEND

- AB-9S — WELL IN SHALLOW/SAPROLITE ZONE
- AB-9D — WELL IN DEEP/TRANSITION ZONE
- AB-9BR — WELL IN COMPETENT BEDROCK
- AB-4S — WELL IN ASH PORE WATER
- GENERALIZED WATER TABLE
- BEDROCK FRACTURE ORIENTATION
- FILL
- SAPROLITE
- WEATHERED ROCK
- BEDROCK
- WELL SCREEN
- COMPLIANCE BOUNDARY
- ASH PORE WATER FLOW LAYER WATER LEVEL ELEVATION
- SHALLOW/SAPROLITE FLOW ZONE GROUNDWATER LEVEL ELEVATION
- DEEP/TRANSITION ZONE FLOW ZONE GROUNDWATER LEVEL ELEVATION
- BEDROCK FLOW ZONE GROUNDWATER LEVEL ELEVATION
- AB-2BR (Co 83, Fe 8.5, Mn 12200) — MEAN COBALT (Co) CONCENTRATION (µg/L), MEAN IRON (Fe) CONCENTRATION (µg/L), MEAN MANGANESE (Mn) CONCENTRATION (µg/L)

NOTES:

1. ALL CONCENTRATIONS SHOWN ARE STATISTICAL MEAN OR GEOMEAN CALCUALTED BASED ON CENTRAL TENDANCY OF DATASET USING DATA

2. ALL CONCENTRATIONS ARE IN MICROGRAMS PER LITER (mg/L)

3. NO MEAN ANALYSIS FOR BEDROCK WELLS (GWA-27BR, AB-1BRD, AB-2BRD AND AB-3BRD) FOR CONSTITUENTS; COBALT (Co), IRON (Fe) AND MANGANESE (Mn)

- 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]	0.6	1600	40
BACKGROUND THRESHOLD VALUE (DEEP FLOW ZONE)[1]	2	226	57
BACKGROUND THRESHOLD VALUE (BEDROCK FLOW ZONE)[1]	0.8	341	64

* - 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 MAY 2015 TO DECEMBER 2018 AS SUBMITTED IN JUNE 2019.

DUKE ENERGY CAROLINAS

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0 125 250 500

HORIZONTAL SCALE: 1" = 500'
VERTICAL SCALE: 1" = 200'
5X VERTICAL EXAGGERATION

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APPROVED BY: A. ALBERT	DATE: 11/15/2019
PROJECT MANAGER: A. ALBERT	DATE: 08/01/2019

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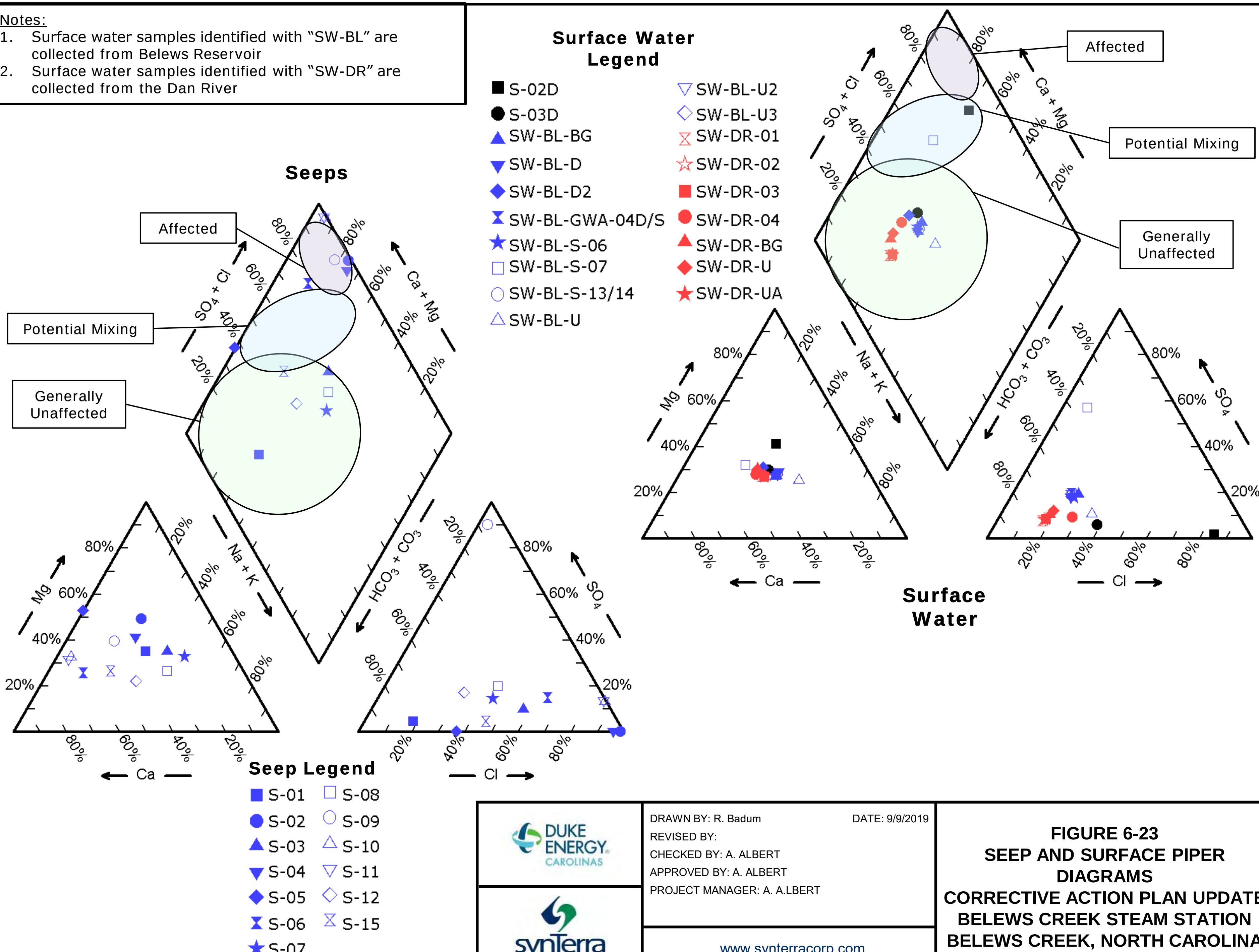
FIGURE 6-22c
GENERAL CROSS SECTION B-B'
ASH BASIN - VARIABLE GROUP
MEAN OF COBALT, IRON AND MANGANESE EXISTING CONDITIONS
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA

Notes:
1. Surface water samples identified with "SW-BL" are collected from Belews Reservoir
2. Surface water samples identified with "SW-DR" are collected from the Dan River

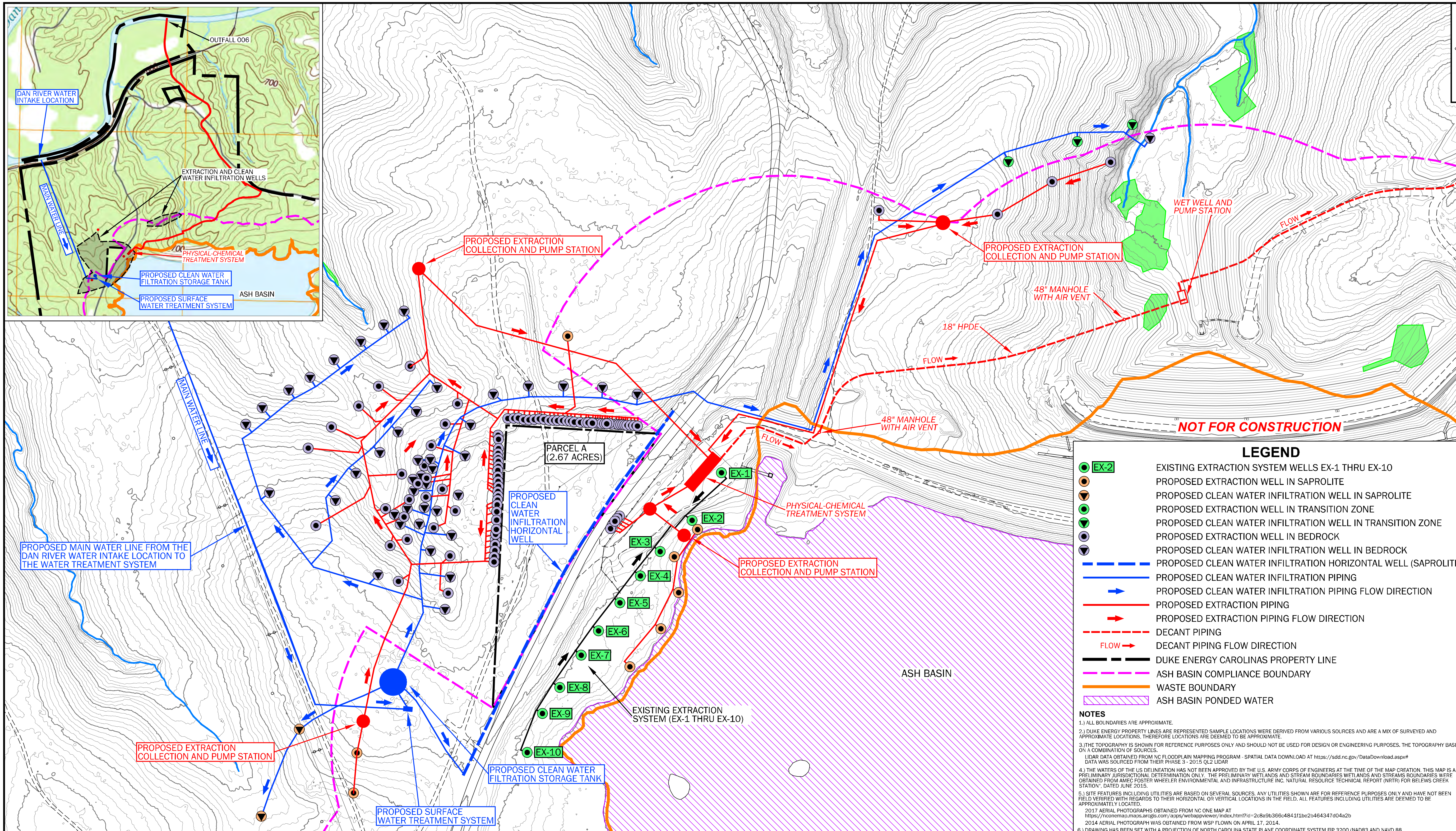


DUKE ENERGY CAROLINAS / synTerra	DRAWN BY: R. Badum DATE: 9/9/2019 REVISED BY: CHECKED BY: A. ALBERT APPROVED BY: A. ALBERT PROJECT MANAGER: A. A.LBERT www.synterracorp.com	**FIGURE 6-23** **SEEP AND SURFACE PIPER DIAGRAMS** **CORRECTIVE ACTION PLAN UPDATE** **BELEWS CREEK STEAM STATION** **BELEWS CREEK, NORTH CAROLINA**

Figure 6-24

Pourbaix Diagram for Iron-Water System

Included in Section 6 text



LEGEND

- EX-2 — EXISTING EXTRACTION SYSTEM WELLS EX-1 THRU EX-10
- PROPOSED EXTRACTION WELL IN SAPROLITE
- PROPOSED CLEAN WATER INFILTRATION WELL IN SAPROLITE
- PROPOSED EXTRACTION WELL IN TRANSITION ZONE
- PROPOSED CLEAN WATER INFILTRATION WELL IN TRANSITION ZONE
- PROPOSED EXTRACTION WELL IN BEDROCK
- PROPOSED CLEAN WATER INFILTRATION WELL IN BEDROCK
- PROPOSED CLEAN WATER INFILTRATION HORIZONTAL WELL (SAPROLITE)
- PROPOSED CLEAN WATER INFILTRATION PIPING
- PROPOSED CLEAN WATER INFILTRATION PIPING FLOW DIRECTION
- PROPOSED EXTRACTION PIPING
- PROPOSED EXTRACTION PIPING FLOW DIRECTION
- DECANT PIPING
- FLOW — DECANT PIPING FLOW DIRECTION
- DUKE ENERGY CAROLINAS PROPERTY LINE
- ASH BASIN COMPLIANCE BOUNDARY
- WASTE BOUNDARY
- ASH BASIN PONDED WATER

NOTES

1.) ALL BOUNDARIES ARE APPROXIMATE.

2.) DUKE ENERGY PROPERTY LINES ARE REPRESENTED SAMPLE LOCATIONS WERE DERIVED FROM VARIOUS SOURCES AND ARE A MIX OF SURVEYED AND APPROXIMATE LOCATIONS. THEREFORE LOCATIONS ARE DEEMED TO BE APPROXIMATE.

3.)THE TOPOGRAPHY IS SHOWN FOR REFERENCE PURPOSES ONLY AND SHOULD NOT BE USED FOR DESIGN OR ENGINEERING PURPOSES. THE TOPOGRAPHY BASED ON A COMBINATION OF SOURCES.

LIDAR DATA OBTAINED FROM NC FLOODPLAIN MAPPING PROGRAM - SPATIAL DATA DOWNLOAD AT https://sdd.nc.gov/DataDownload.aspx# DATA WAS SOURCED FROM THEIR PHASE 3 - 2015 QL2 LIDAR

4.) THE WATERS OF THE US DELINEATION HAS NOT BEEN APPROVED BY THE U.S. ARMY CORPS OF ENGINEERS AT THE TIME OF THE MAP CREATION. THIS MAP IS A PRELIMINARY JURISDICTIONAL DETERMINATION ONLY. THE PRELIMINARY WETLANDS AND STREAM BOUNDARIES WETLANDS AND STREAMS BOUNDARIES WERE OBTAINED FROM AMEC FOSTER WHEELER ENVIRONMENTAL AND INFRASTRUCTURE INC. NATURAL RESOURCE TECHNICAL REPORT (NRTR) FOR BELEWS CREEK STATION", DATED JUNE 2015.

5.) SITE FEATURES INCLUDING UTILITIES ARE BASED ON SEVERAL SOURCES. ANY UTILITIES SHOWN ARE FOR REFERENCE PURPOSES ONLY AND HAVE NOT BEEN FIELD VERIFIED WITH REGARDS TO THEIR HORIZONTAL OR VERTICAL LOCATIONS IN THE FIELD. ALL FEATURES INCLUDING UTILITIES ARE DEEMED TO BE APPROXIMATELY LOCATED.

2017 AERIAL PHOTOGRAPHS OBTAINED FROM NC ONE MAP AT https://nconemap.maps.arcgis.com/apps/webappviewer/index.html?id=2c8a9b366c4841f1be2b464347d04a2b

2014 AERIAL PHOTOGRAPH WAS OBTAINED FROM WSP FLOWN ON APRIL 17, 2014.

6.) DRAWING HAS BEEN SET WITH A PROJECTION OF NORTH CAROLINA STATE PLANE COORDINATE SYSTEM FIP 3200 (NAD83 AND NAVD 88.

DUKE ENERGY CAROLINAS

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GRAPHIC SCALE
200 0 100 200
IN FEET

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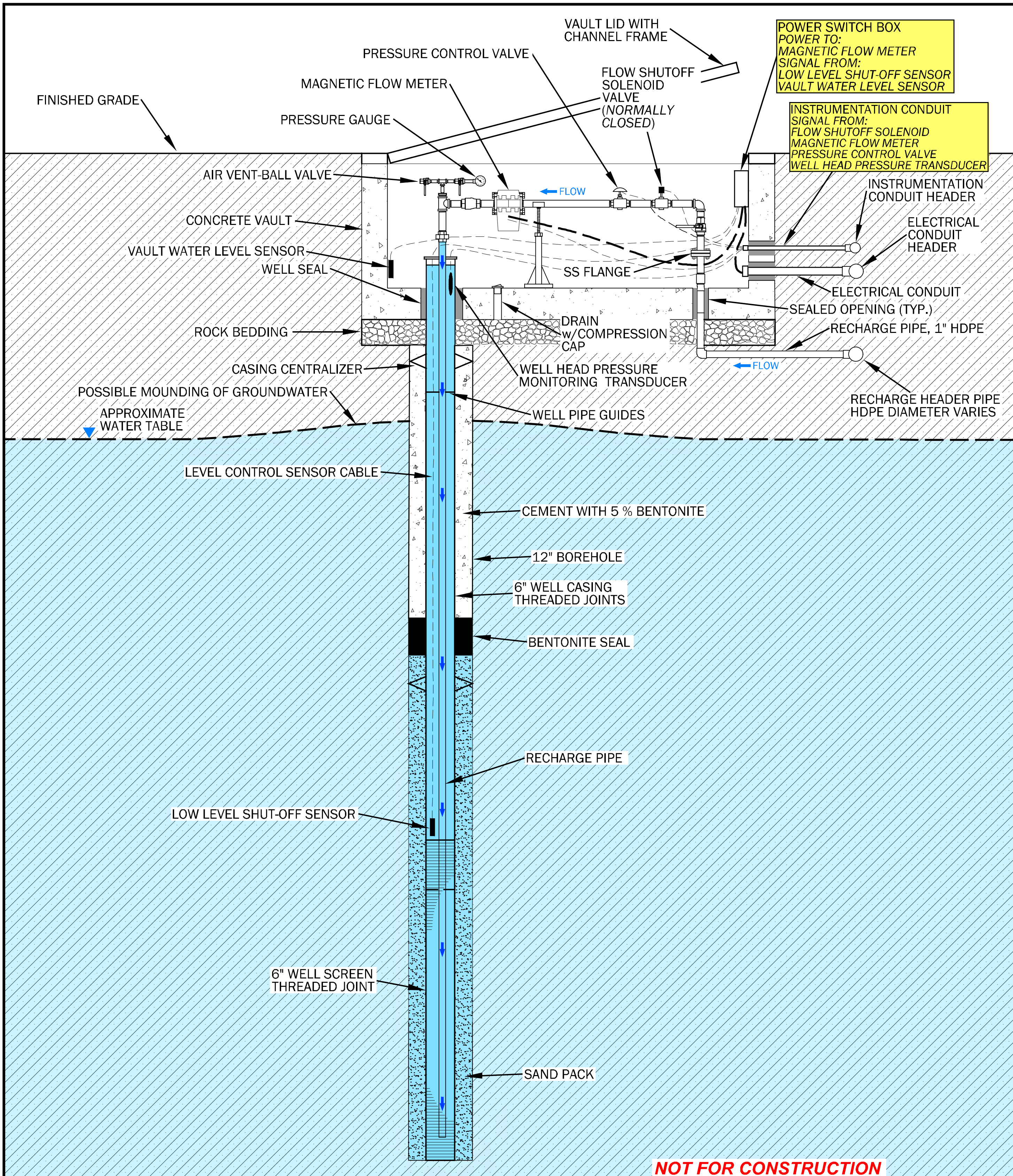
FIGURE 6-25a
REMEDIAL ALTERNATIVE 3
WELL SYSTEM LAYOUT
GROUNDWATER REMEDIATION BY EXTRACTION WITH CLEAN WATER INFILTRATION AND TREATMENT
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA



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PROJECT MANAGER: A. ALBERT

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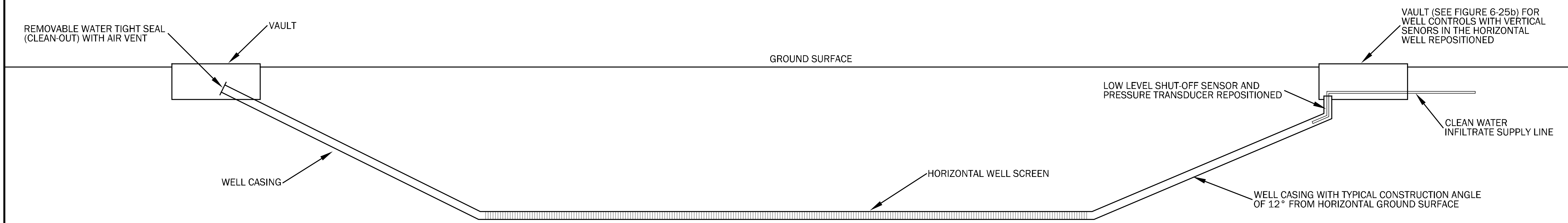
FIGURE 6-25b
REMEDIAL ALTERNATIVE 3
CONCEPTUAL VERTICAL CLEAN WATER INFILTRATION WELL SCHEMATIC
REMEDIATION BY EXTRACTION COMBINED WITH CLEAN WATER INFILTRATION AND TREATMENT
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA



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GENERALLY BASED ON INFORMATION FROM ELLINGTON, DTD

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PROJECT MANAGER: A. ALBERT	

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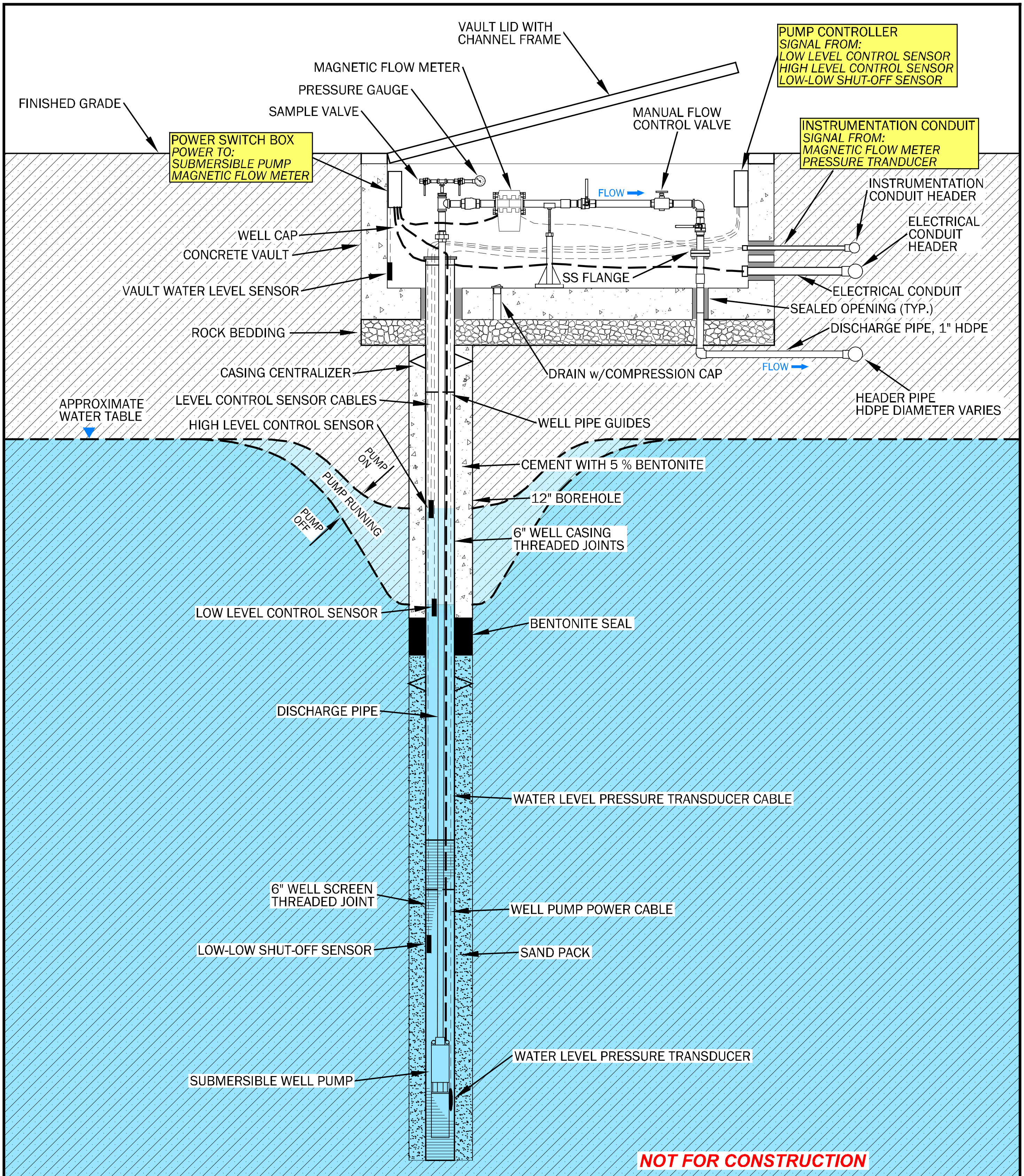
FIGURE 6-25c
REMEDIAL ALTERNATIVE 3
CONCEPTUAL HORIZONTAL WELL
REMEDIATION BY EXTRACTION COMBINED WITH CLEAN WATER INFILTRATION AND TREATMENT
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA



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APPROVED BY: J. CLEMMER DATE: 12/9/2019
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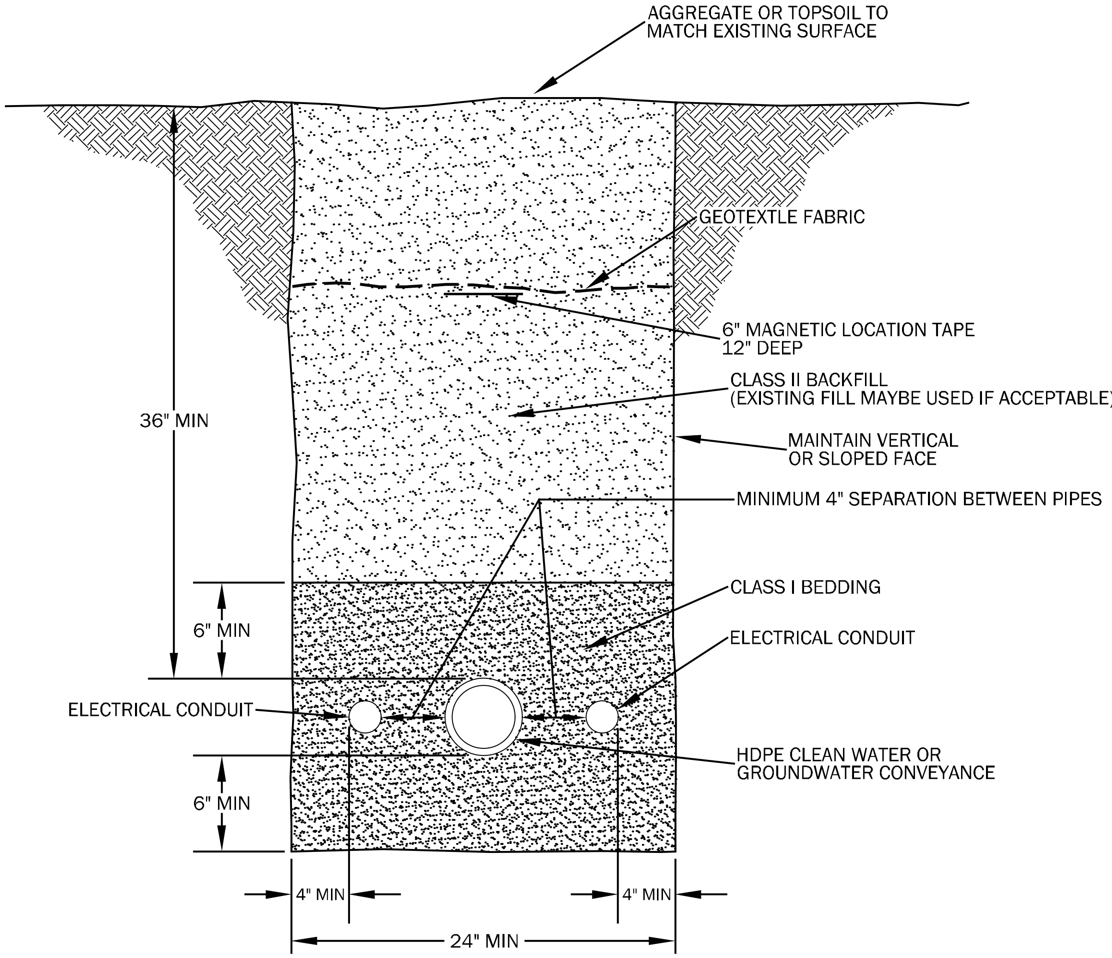
FIGURE 6-25d
REMEDIAL ALTERNATIVE 3
CONCEPTUAL EXTRACTION WELL SCHEMATIC
REMEDIATION BY EXTRACTION COMBINED WITH CLEAN WATER INFILTRATION AND TREATMENT
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA



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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PROJECT MANAGER: A. ALBERT

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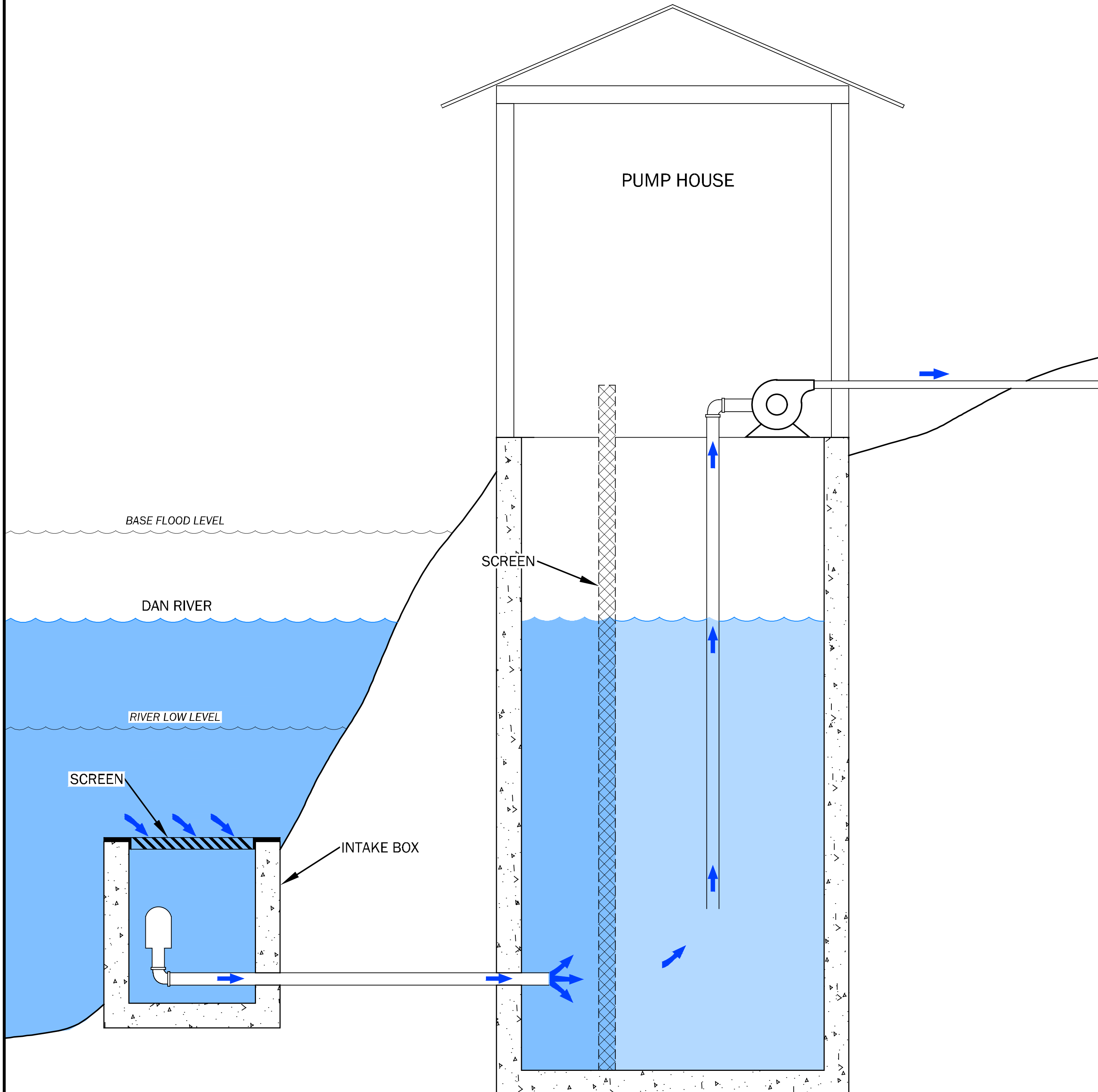
FIGURE 6-25e
REMEDIAL ALTERNATIVE 3
CONCEPTUAL TRENCH DETAIL
REMEDIATION BY EXTRACTION COMBINED WITH CLEAN WATER INFILTRATION AND TREATMENT
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA



NOT FOR CONSTRUCTION

DUKE ENERGY CAROLINAS	NOT TO SCALE	FIGURE 6-25f REMEDIAL ALTERNATIVE 3 DAN RIVER WATER INTAKE SCHEMATIC REMEDIATION BY EXTRACTION COMBINED WITH CLEAN WATER INFILTRATION AND TREATMENT CORRECTIVE ACTION PLAN UPDATE BELEWS CREEK STEAM STATION BELEWS CREEK, NORTH CAROLINA
synTerra	DRAWN BY: J. CHASTAIN DATE: 12/9/2019 REVISED BY: DATE: - CHECKED BY: J. CLEMMER DATE: 12/9/2019 APPROVED BY: J. CLEMMER DATE: 12/9/2019 PROJECT MANAGER: A. ALBERT	
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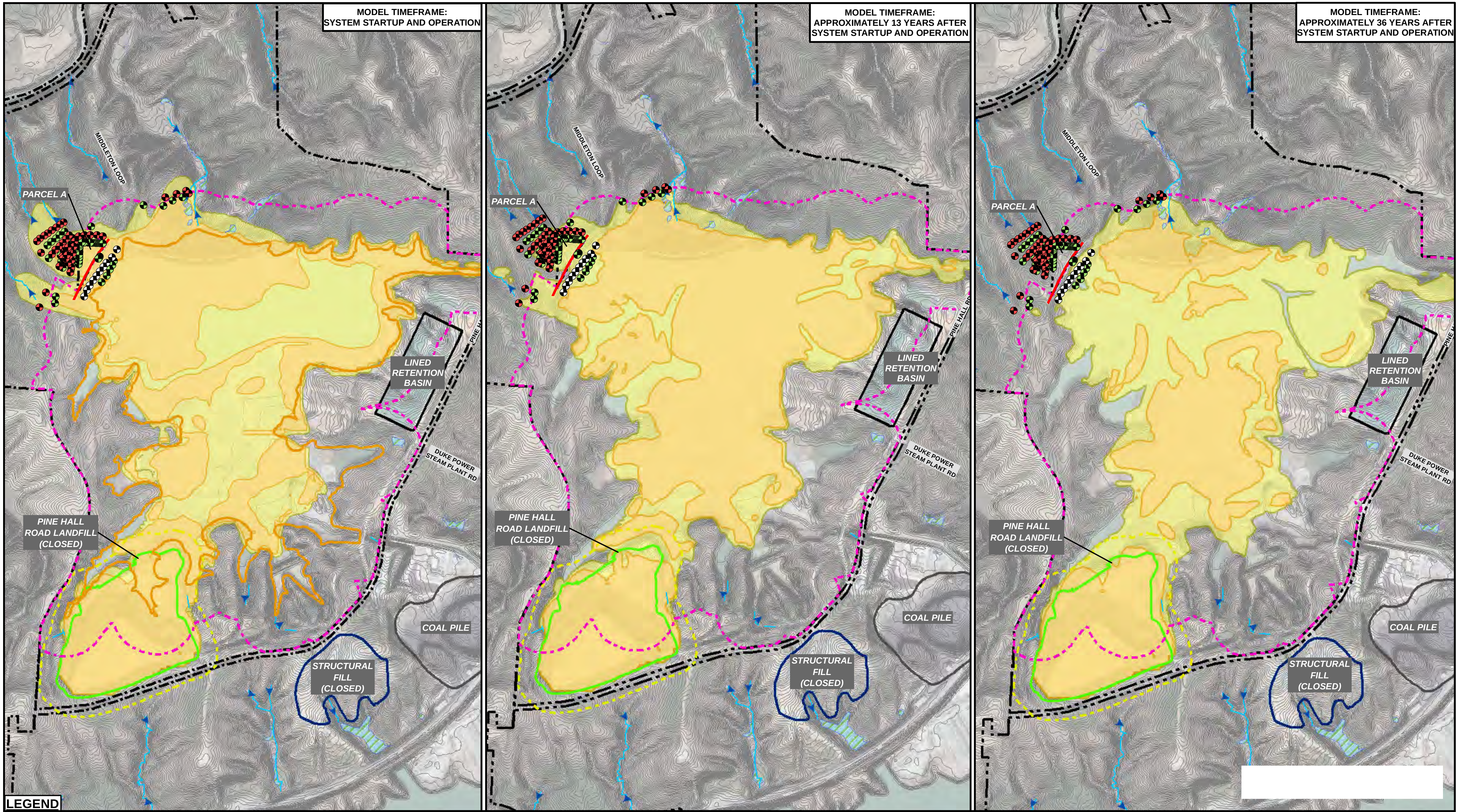

LEGEND

- BORON CONCENTRATION RANGE (>4,000 µg/L)
- BORON CONCENTRATION RANGE (700 - 4,000 µg/L)
- EXISTING EXTRACTION WELL
- PROPOSED EXTRACTION WELL
- PROPOSED CLEAN WATER INFILTRATION WELL
- PROPOSED INFILTRATION HORIZONTAL WELL
- ASH BASIN WASTE BOUNDARY
- ASH BASIN COMPLIANCE BOUNDARY
- LANDFILL COMPLIANCE BOUNDARY
- LANDFILL BOUNDARY (CLOSED)
- STRUCTURAL FILL BOUNDARY (CLOSED)
- DUKE ENERGY CAROLINAS BELEWS CREEK PLANT SITE BOUNDARY
- LINED RETENTION BASIN
- COAL PILE STORAGE AREA
- STREAM (AMEC NRTR)
- WETLAND (AMEC NRTR)

NOTES:

NO WASTE BOUNDARY SHOWN FOR MODEL TIMEFRAMES 12 AND 36 YEARS AFTER SYSTEM STARTUP AND OPERATION DUE TO COMPLETION OF ASH BASIN CLOSURE. FUTURE WASTE BOUNDARY WILL BE DETERMINED BY THE SELECTED CLOSURE OPTION.

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 NOT TO BE USED FOR JURISDICTIONAL DETERMINATION PURPOSES. THE WETLANDS AND STREAMS BOUNDARIES WERE OBTAINED FROM AMEC FOSTER WHEELER ENVIRONMENTAL & INFRASTRUCTURE, INC. NATURAL RESOURCE TECHNICAL REPORT FOR BELEWS CREEK STEAM STATION DATED JULY 2, 2015.

ALL BOUNDARIES ARE APPROXIMATE.

PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.

AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON JUNE 11, 2019. AERIAL WAS COLLECTED ON FEBRUARY 3, 2019.

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
600 0 600 1,200
(IN FEET)

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APPROVED BY: A. ALBERT DATE: 11/25/2019
PROJECT MANAGER: A. ALBERT

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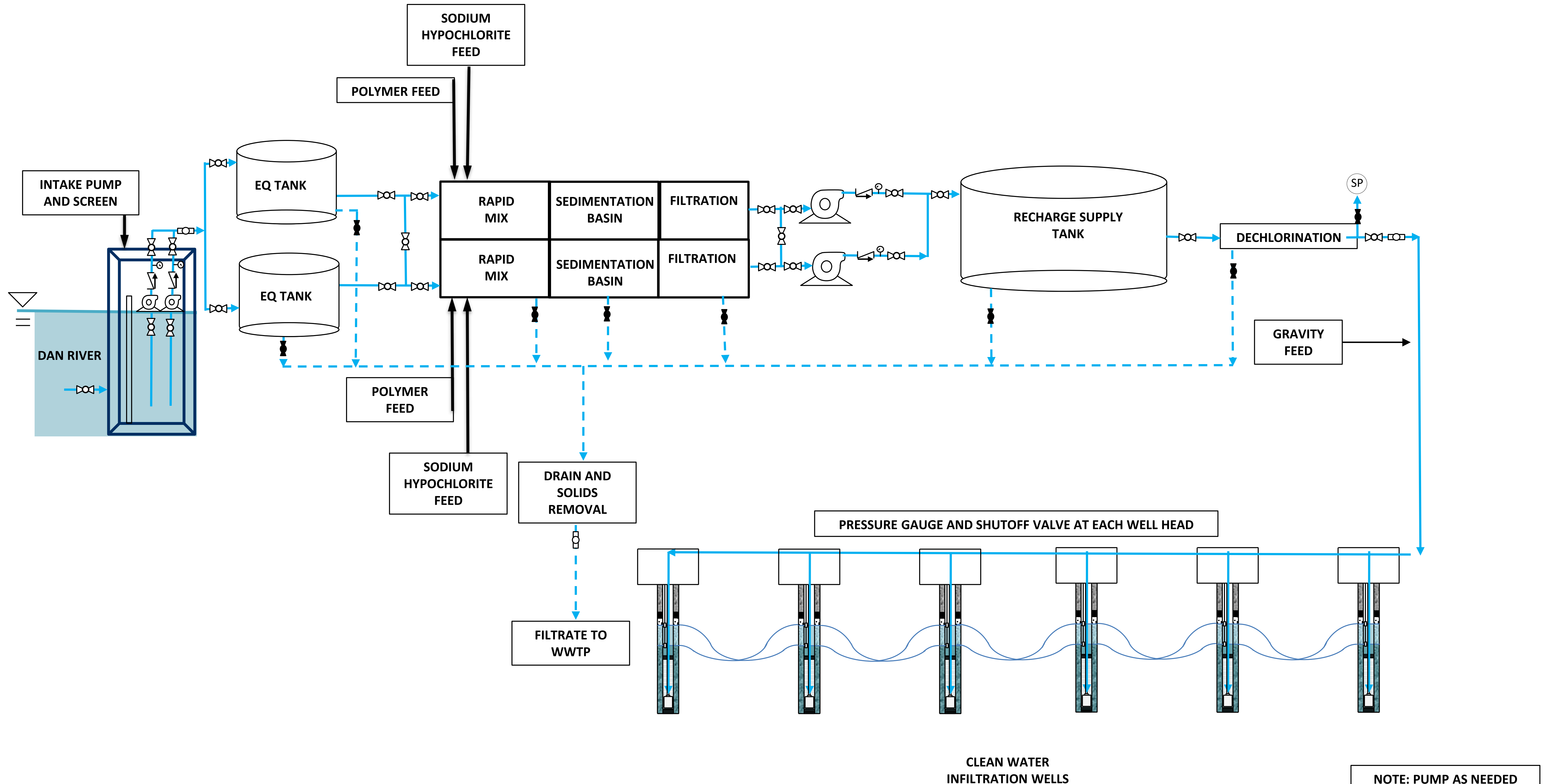
FIGURE 6-25g
REMEDIAL ALTERNATIVE 3
GROUNDWATER REMEDIATION
BY CLEAN WATER INFILTRATION AND EXTRACTION TERM
SIMULATED BORON CONCENTRATIONS IN ALL FLOW ZONES
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA



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

DRAWN BY: T. COLTON DATE: 11/17/2019
REVISED BY: B. GREEN
CHECKED BY: A. ALBERT
APPROVED BY: A. ALBERT
PROJECT MANAGER: A. ALBERT

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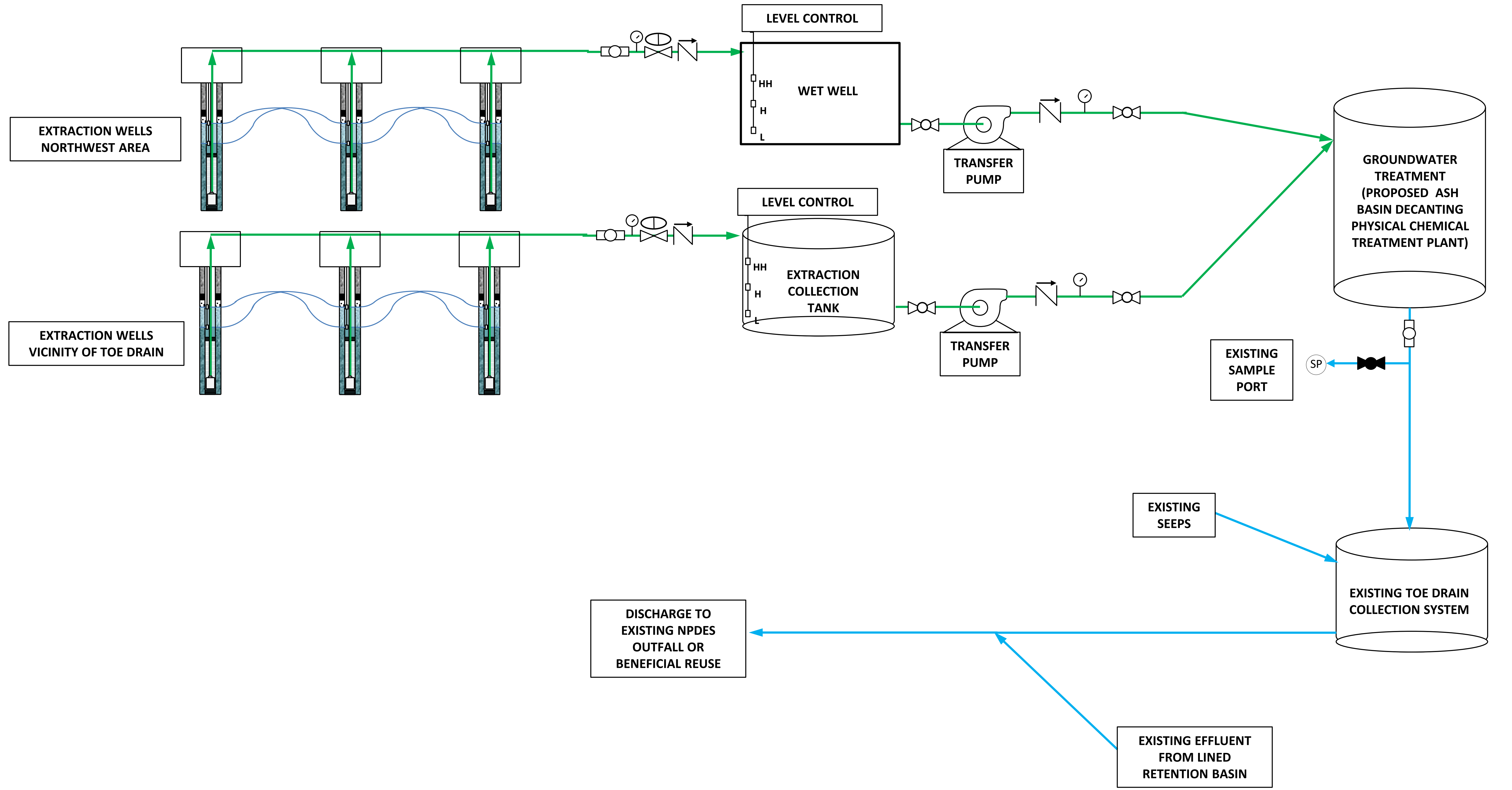
FIGURE 6-26
CONCEPTUAL PROCESS FLOW DIAGRAM
CLEAN WATER INFILTRATION SYSTEM
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA



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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PROJECT MANAGER: A. ALBERT

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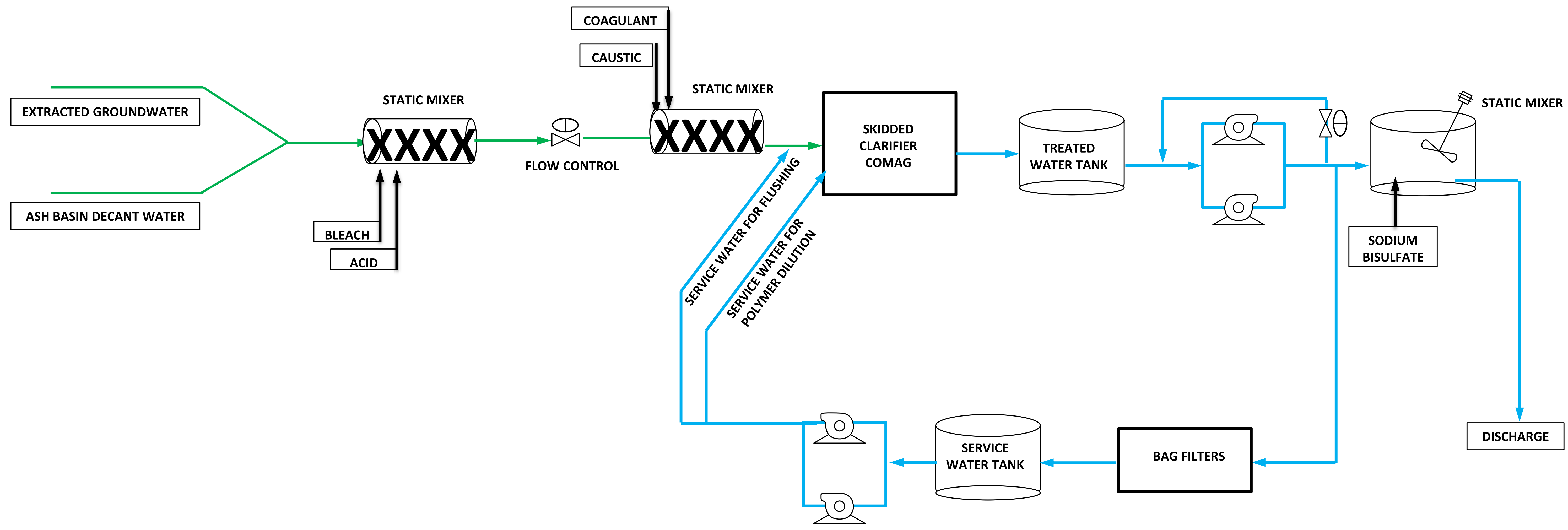
FIGURE 6-27
CONCEPTUAL PROCESS FLOW DIAGRAM
GROUNDWATER EXTRACTON SYSTEM
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA



NOTE: TREATMENT SYSTEM PROCESS FLOW BASED ON DESIGN BY EVOQUA

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

DRAWN BY: T. COLTON DATE: 11/17/2019
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APPROVED BY: A. ALBERT
PROJECT MANAGER: A. ALBERT

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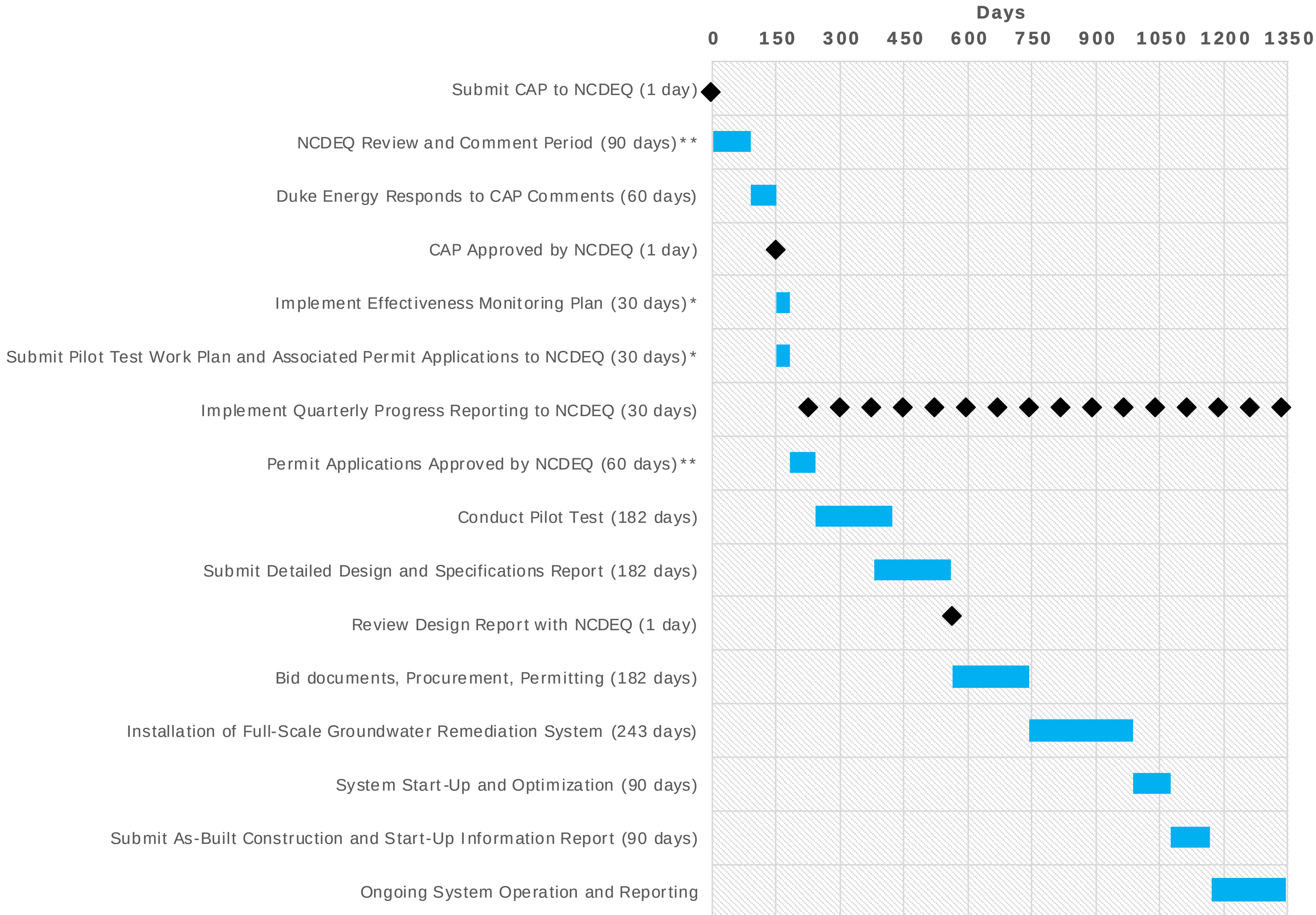
FIGURE 6-28
CONCEPTUAL PROCESS FLOW DIAGRAM
GROUNDWATER TREATMENT SYSTEM
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA



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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DRAWN BY: R. ISHAM DATE: 12/5/2019
REVISED BY:
CHECKED BY: S. WOOD
APPROVED BY:
PROJECT MANAGER: A. ALBERT

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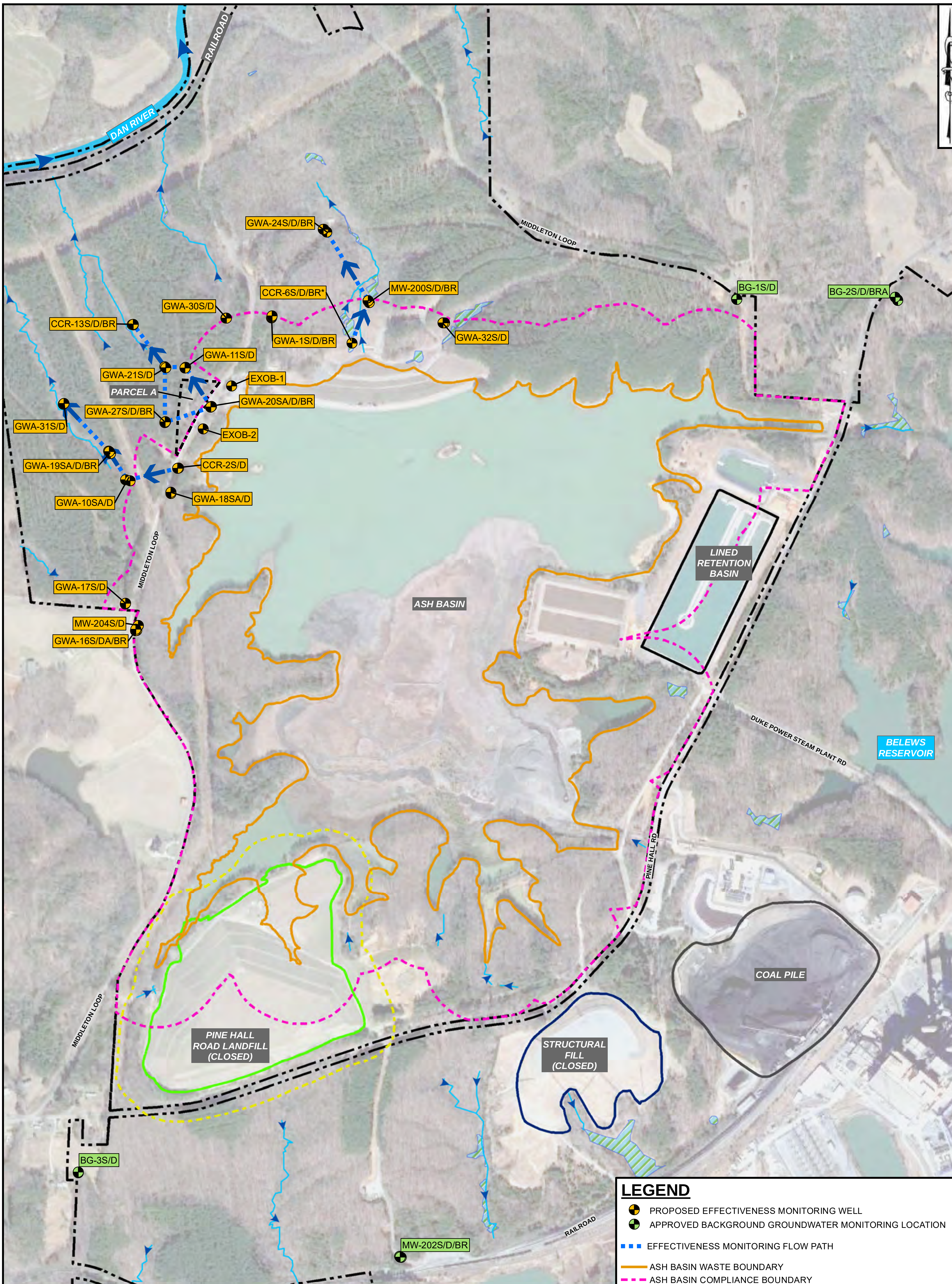
FIGURE 6-29
CAP IMPLEMENTATION GANTT CHART
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA



LEGEND

- PROPOSED EFFECTIVENESS MONITORING WELL
- APPROVED BACKGROUND GROUNDWATER MONITORING LOCATION
- EFFECTIVENESS MONITORING FLOW PATH
- ASH BASIN WASTE BOUNDARY
- ASH BASIN COMPLIANCE BOUNDARY
- PINE HALL ROAD LANDFILL BOUNDARY (CLOSED)
- STRUCTURAL FILL BOUNDARY (CLOSED)
- LANDFILL COMPLIANCE BOUNDARY
- COAL PILE STORAGE AREA
- LINED RETENTION BASIN
- DUKE ENERGY CAROLINAS PROPERTY LINE
- STREAM (AMEC NRTR 2015)
- WETLANDS (AMEC NRTR 2015)

NOTES:

1. * - PROPOSED NEW WELL FOR EFFECTIVENESS MONITORING

2. FLOW PATH MONITORING LOCATIONS INCLUDE:
1) WASTE BOUNDARY WELLS,
2) 250' FROM WASTE BOUNDARY WELLS,
3) 500' CAMA COMPLIANCE BOUNDARY WELLS,
4) WELLS NO LESS THAN 1 YEAR TRAVEL TIME UPGRADIENT OF RECEPTOR AND NO GREATER THAN THE DISTANCE GROUNDWATER IS EXPECTED TO TRAVEL IN FIVE YEARS

3. IF THE WASTE BOUNDARY AND COMPLIANCE BOUNDARY ARE LOCATED SUFFICIENTLY CLOSE TO EVALUATE COI TRENDS OVER TIME, THE 250' INTERVAL LOCATION WOULD NOT BE MONITORED.

4. FLOW PATH GROUNDWATER WELLS WOULD HAVE GEOCHEMICAL SONDES INSTALLED FOR TELEMETRY MONITORING.

5. **BG-1S/D, BG-2S/D/BRA,BG-3S/D,MW-200S/D/BR** APPROVED BACKGROUND GROUNDWATER MONITORING LOCATION.

6. 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 NOT TO BE USED FOR JURISDICTIONAL DETERMINATION PURPOSES. THE WETLANDS AND STREAMS BOUNDARIES WERE OBTAINED FROM AMEC FOSTER WHEELER ENVIRONMENTAL & INFRASTRUCTURE, INC. NATURAL RESOURCE TECHNICAL REPORT FOR BELEWS CREEK STEAM STATION DATED JULY 2, 2015.

7. ALL BOUNDARIES ARE APPROXIMATE.

8. PROPERTY BOUNDARY PROVIDED BY DUKE ENERGY CAROLINAS.

9. AERIAL PHOTOGRAPHY OBTAINED FROM GOOGLE EARTH PRO ON JUNE 11, 2019. AERIAL WAS COLLECTED ON FEBRUARY 3, 2019.

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

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GRAPHIC SCALE
400 0 400 800
(IN FEET)

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REVISED BY: C. WYATT DATE: 12/19/2019
CHECKED BY: A. ALBERT DATE: 12/19/2019
APPROVED BY: A. ALBERT DATE: 12/19/2019
PROJECT MANAGER: A. ALBERT

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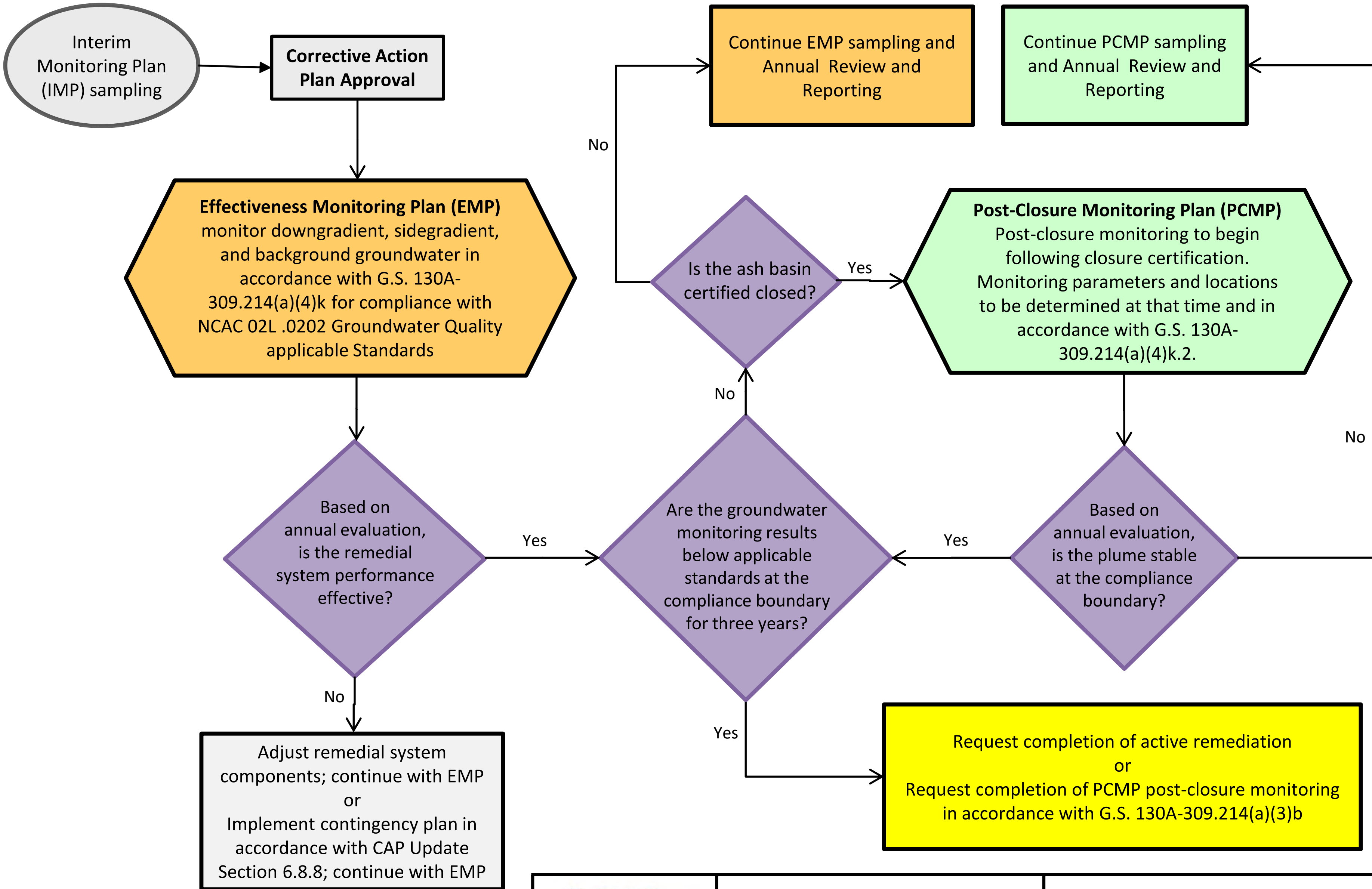
FIGURE 6-30
EFFECTIVENESS MONITORING WELL NETWORK AND FLOW PATHS
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA



Notes:

NCAC - North Carolina Administrative Code

02L - NCAC Title 15A, Subchapter 02L. Groundwater Classification and Standards

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DRAWN BY: T. PLATING DATE: 10/112019
REVISED BY: K SHECK DATE: 10/16/2019
CHECKED BY: A. ALBERT DATE: 12/16/2019
APPROVED BY: A. ALBERT DATE: 12/18/2019
PROJECT MANAGER: A. ALBERT

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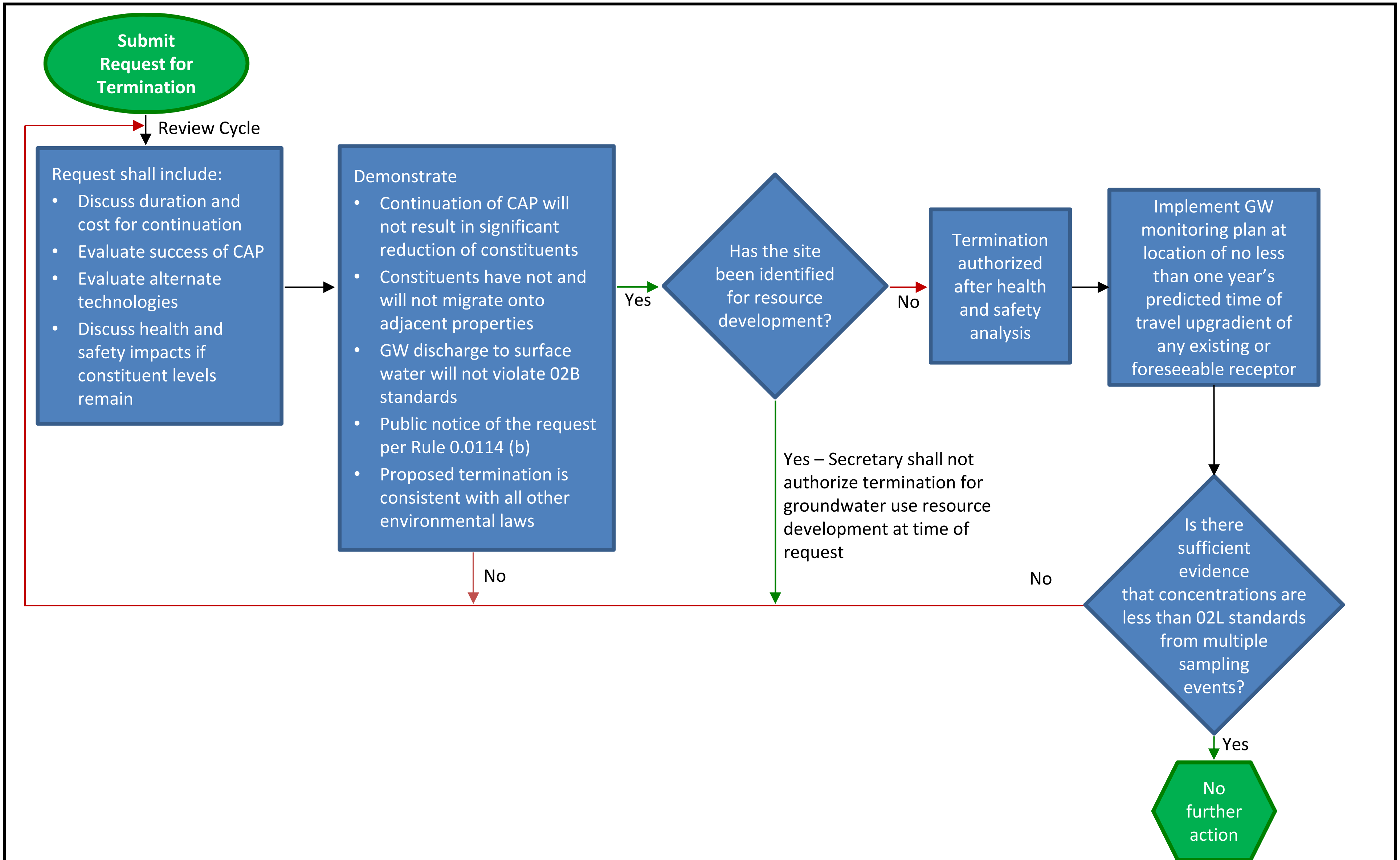
FIGURE 6-31
EFFECTIVENESS MONITORING PLAN WORK FLOW AND OPTIMIZATION FLOW DIAGRAM
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA



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DRAWN BY: K. SHECK DATE: 07/12/2019
REVISED BY: A. ALBERT DATE: 07/12/2019
CHECKED BY: T. PLATING DATE: 07/12/2019
APPROVED BY: A. ALBERT DATE: 12/05/2019
PROJECT MANAGER: A. ALBERT

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FIGURE 6-32
TERMINATION OF GROUNDWATER REMEDIATION FLOW DIAGRAM
CORRECTIVE ACTION PLAN UPDATE
BELEWS CREEK STEAM STATION
BELEWS CREEK, NORTH CAROLINA