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REPORT ON

EVALUATION OF WATER SUPPLY WELLS IN THE VICINITY OF DUKE ENERGY COAL ASH BASINS IN NORTH CAROLINA

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List of Acronyms

2L Standards	North Carolina Groundwater Quality Standards as specified in Title 15A NCAC.0202L
BTV	Background Threshold Value
CAMA	North Carolina Coal Ash Management Act of 2014
CAP	Corrective Action Plan
CC	Confidence Coefficient
CCR	Coal Combustion Residuals
CSA	Comprehensive Site Assessment
EDF	Empirical Distribution Function
GOF	Goodness-Of-Fit
HDR	HDR, Inc.
IID	Independent, Identically Distributed
IQR	Interquartile Range
IMAC	Interim Maximum Allowable Concentrations
IQR	Interquartile Range
KM	Kaplan-Meier
µg/L	Micrograms per Liter
MCL	Maximum Contaminant Level
MDL	Method Detection Limit
NCAC	North Carolina Administrative Code
NCDEQ	North Carolina Department of Environmental Quality
ND	Non-Detect
NCDHHS	North Carolina Department of Health and Human Services
Q-Q Plot	Normal Quantile-Quantile Plot
ROS	Robust Regression on Order Statistics
RSL	Risk-Based Screening Level
SCM	Site Conceptual Model
SMCL	Secondary Maximum Contaminant Level
S-W	Shapiro-Wilk
TDS	Total Dissolved Solids
UPL95	95% Upper Prediction Limit
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
UTL95-95	Upper Tolerance Limit with 95% confidence and 95% coverage

1. Introduction

This document was prepared to supplement previous work completed by Duke Energy to meet the requirements of the North Carolina Coal Ash Management Act of 2014 (CAMA, 2014) for its coal-fueled generating stations. Duke Energy owns and operates, or has operated 14 coal-fueled electric generating facilities in the state of North Carolina. Figure 1 shows the locations of the Duke coal-fueled fleet in North Carolina.

1.1 CURRENT CAMA STATUS

The CAMA is primarily administered by the North Carolina Department of Environmental Quality (NCDEQ). The CAMA requires the NCDEQ to, as soon as practicable, but no later than January 31, 2016, prioritize for the purpose of closure and remediation coal combustion residuals (CCR) surface impoundments, including active and retired sites, based on these sites' risks to public health, safety, and welfare, the environment, and natural resources.

On 31 January 2016, NCDEQ released draft proposed risk classifications for Duke Energy's coal ash impoundments in North Carolina in the document "Coal Combustion Residual Impoundment Risk Classifications, January 2016" (NCDEQ, 2016). Four of the facilities were ranked High risk, per the CAMA. Four facilities (or portions thereof) were ranked Intermediate risk based on the position of ash impoundments in the 100-year flood level (see below for the exception to this basis). Six facilities (or portions thereof) were ranked Low to Intermediate risk, and three facilities (or portions thereof) were ranked Low risk.

The Low to Intermediate risk classification is not specified in the CAMA; for those facilities with this "interim" classification, a final Low risk or Intermediate risk classification will need to be made at the end of the public review process. The following facilities have draft NCDEQ Low to Intermediate classifications:

- Allen Steam Station (Allen)
- Belews Creek Steam Station (Belews Creek)
- Buck Steam Station (Buck)
- Cliffside Steam Station (Cliffside) – [one ash basin; two ash basins are classified as Low risk]
- Marshall Steam Station (Marshall)
- Roxboro Steam Electric Plant (Roxboro) – [one ash basin; another ash basin is classified as Low risk, and one former impoundment area is classified as Intermediate risk as it was identified after the site investigation was completed]

The primary basis for the Low to Intermediate risk classification was stated by NCDEQ as the current "uncertainty related to site conditions that may relate to potential impacts to up-gradient and side-gradient well users." The most cited information needs in the document included incomplete background concentration determination, and incomplete capture zone modeling for the water supply wells in the vicinity of each facility.

In addition to the six facilities listed above, this report also includes an evaluation of:

- Mayo Steam Electric Plant (Mayo)

Mayo is classified as Low risk; by including it in this report, all Low to Intermediate risk and all Low risk ash basins are evaluated using the approach identified below.

1.2 APPROACH TO EVALUATION OF WATER SUPPLY WELLS

There is not a single metric that can be used to identify if a well has been impacted by a release from a coal ash management unit. This is due in large part to the fact that all of the constituents that are present in coal ash and that could be released to groundwater are naturally occurring. The challenge is to understand these background conditions, and in that context evaluate whether there has been an impact from a release of constituents from coal ash.

Based on our understanding of the behavior of constituents that can be released from coal ash into groundwater, the U.S. Environmental Protection Agency (USEPA) has identified those constituents that are considered together to be indicators of a potential release from coal ash; these are identified as the Appendix III constituents in the *Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities* (CCR Rule; USEPA, 2015a). Of these, boron and sulfate are the most common constituents used to evaluate the potential for an impact in groundwater. These constituents move with groundwater flow unlike other constituents whose movement is impeded by chemical or physical interactions with soil and weathered rock.

Constituent concentrations alone are not sufficient to identify whether impact has occurred. There must also be a transport pathway from the coal ash management unit of interest to the specific well or wells of interest. For an exposure pathway to be complete, the following conditions must exist (as defined by USEPA (1989)):

1) A source and mechanism of chemical release to the environment;
2) An environmental transport medium (e.g., water);
3) A point of potential contact with the receiving medium by a receptor; and
4) A receptor exposure route at the contact point (e.g., ingestion).

Thus, to understand if a particular well or wells have been impacted by a release from a coal ash management unit, the following are needed:

- An evaluation of the magnitude of concentrations of the constituents in the well;
- An evaluation of those detected constituents in relation to background concentrations in groundwater;

- Consideration of the information available on the potential for there to be a complete transport pathway between a coal ash management unit and a well; and
- An evaluation of the potential correlation between the co-presence and concentration of constituents considered to be indicators of a release from a coal ash management unit.

The purpose of this document is to provide the NCDEQ with additional information needed to develop a final risk classification for the Duke Energy ash basins under the CAMA requirements. A technical weight of evidence approach has been used to evaluate the available data for these facilities to determine whether or not the local water supply wells sampled by NCDEQ in the vicinity of these facilities may be impacted by a release from an ash basin or coal ash management area. This report provides technical evaluations for each of the seven facilities in four important assessment areas:

1) An evaluation of the data collected by NCDEQ for local private and public water supply wells, and "reconnaissance" or background water supply wells, with respect to groundwater standards and screening levels, and evaluation of background water supply well data collected by Duke Energy with respect to the same screening levels;
2) Additional statistical analysis of regional background groundwater data (NCDEQ and Duke Energy data), and facility-specific background groundwater data;
3) A more comprehensive evaluation of groundwater flow with respect to local water supply wells, including a water supply well capture zone analysis (where appropriate); and
4) A detailed comparison of facility-specific coal ash groundwater chemistry, background groundwater chemistry (both regional and facility-specific), and local water supply well chemistry.

1.3 REPORT ORGANIZATION

This report provides an overview of the four-part evaluation process used for each of the seven (7) facilities. This report is divided into eight sections:

- Section 2 describes the sources of data used in the evaluation.
- Section 3 describes the methods used to conduct the standards-based and risk-based screening of the water supply well data.
- Section 4 provides the methods used to conduct the statistical evaluation of the background groundwater data and the development of the background threshold values.
- Section 5 provides an overview of the groundwater flow evaluation.
- Section 6 describes the methods used to conduct the groundwater chemistry analysis.
- Section 7 summarizes the results for the facilities evaluated.
- Section 8 provides the references used.

The appendices provide the details of the evaluation for each of the facilities:

A. Allen
B. Belews Creek
C. Buck
D. Cliffside
E. Marshall
F. Mayo
G. Roxboro

2. Sources of Data

Data used in this analysis include:

1) Local water supply well data collected by NCDEQ in the vicinity of the seven Duke Energy facilities.
2) "Reconnaissance" or background water supply well data collected by NCDEQ in the environs of the Duke Energy Allen, Buck, and Marshall facilities.
3) Background water supply well data collected by Duke Energy in the environs, within 2 to 10 miles, of each of the seven facilities.
4) On-site monitoring well data collected by Duke Energy and their site investigation lead contractors, HDR, Inc. (HDR), and Synterra Corporation (Synterra).

Each of these is discussed below.

2.1 NCDEQ WATER SUPPLY WELL DATA

The CAMA (2014) requires that "all drinking water supply well within one-half mile down-gradient from the established compliance boundary of the impoundment" be identified (§130A-309.209. (c)). At the request of NCDEQ, a receptor survey was conducted by Duke Energy at each facility for the purpose of identifying drinking water wells within a 0.5-mile (2,640-foot) radius of each facility's ash basin(s) compliance boundary. Using this information, NCDEQ offered to sample water supply wells within a 1,000 foot radius, and subsequently within a 1,500 radius of the ash basin(s)' compliance boundary, referred to here as the "local" area. Table 1 provides a summary by facility of the number of wells sampled by NCDEQ and the number of sample results. (See Section 2.6 below for how the data were summarized for this analysis.)

The NCDEQ provides a "Water Well Testing Information" webpage here: http://deq.nc.gov/news/hot-topics/coal-ash-nc/well-water-testing-information

The NCDEQ publicly available local water supply well data are posted here:
https://ncdenr.s3.amazonaws.com/s3fs-public/document-library/Full%20Well%20Water%20Testing%20Results%20For%20Posting%208.20.pdf

NCDEQ provided Duke Energy with an Excel version of the most recent data, dated 2016-03-08. These data were used in this analysis. The local water supply well data were evaluated by facility in each of the appendices to this report.

2.2 NCDEQ RECONNAISSANCE OR BACKGROUND WATER SUPPLY WELL DATA

In what it describes as a reconnaissance study, NCDEQ collected 24 water samples from 24 water supply well locations in the vicinity of three of the Duke Energy facilities: Allen (seven [7] locations), Buck (seven [7] locations), and Marshall (ten [10] locations), as shown on Table 1.

NCDEQ provides the following description: "The study provides a limited evaluation of the distribution of metals and other parameters that may be naturally occurring in the groundwater, and provides data for staff to develop a better understanding of background concentrations of metals and other parameters in areas that are not hydraulically connected to groundwater beneath Duke Energy's coal-fired power plant facilities."

The NCDEQ background water supply well data are publicly available at: http://deq.nc.gov/news/hot-topics/coal-ash-nc/coal-ash-news (note, as of this writing, some of the links are not functional).
In October 2015, NCDEQ provided Duke Energy with Excel versions of 16 of the 24 analytical results posted on the website. The Excel versions were used in this evaluation and supplemented with the missing results that are available in PDF on the website.

2.3 DUKE ENERGY BACKGROUND WATER SUPPLY WELL DATA

Duke Energy developed a background water supply well dataset by offering to sample private drinking water wells for facility employees, contractors, and others associated with Duke Energy, if their well was located generally between 2 miles and 10 miles of each facility.

Table 1 shows the number of background water supply wells/samples from those wells.

2.4 PER-FACILITY MONITORING WELL DATA

Monitoring well data are available for each of the seven facilities included in this analysis. The data include samples from ash porewater wells, and groundwater monitoring wells screened at various depths in upgradient (background), downgradient, and lateral or side gradient locations. The specifics of each dataset are provided in the Appendices.

The background monitoring well data are referred to as the "facility-specific background monitoring well data" or "facility-specific background data."

2.5 REGIONAL BACKGROUND WATER SUPPLY WELL DATA

The background water supply well data collected by NCDEQ and Duke Energy are referred to for each facility as "regional background water supply well data" or "regional background data" to distinguish these data from the "facility-specific background monitoring well data."

After statistical evaluation, as described in Section 4 and in each of the appendices, confirmed that it was appropriate, the NCDEQ background water supply well data and the Duke Energy background water supply well data were combined into one dataset each for Allen, Buck, and Marshall, as indicated on Table 1.

2.6 DATA MANAGEMENT

The data for this analysis were managed in an EQuIS database. Where there were multiple results for a single well in the NCDEQ-sampled local water supply well dataset, a representative value was identified to be used in the evaluation, which is defined as the maximum of the detected values if the analytical results are detected values. If the analytical results are all not detected, the lowest reporting limit is defined as the representative value.

3. Water Supply Well Evaluation

Analytical data for the local and regional background water supply wells for each of the facilities were compared to screening levels and standards, as described below.

3.1 SCREENING LEVELS

The screening levels used in this evaluation are provided on Table 2. They are from both State and Federal (USEPA) sources, as follows:

- **2L Standards:** NCAC. 2013. 15A NCAC 02L.0202. Groundwater Standard (2L), Classifications and Water Quality Standards Applicable to Groundwaters of North Carolina. North Carolina Administrative Code. April 1, 2013. These values include Interim Maximum Allowable Concentrations (IMAC). Available at: http://portal.ncdenr.org/c/document_library/get_file?uuid=1aa3fa13-2c0f-45b7-ae96-5427fb1d25b4&groupId=38364
- **Federal Drinking Water Standards:** Maximum Contaminant Levels (MCLs) and Secondary Maximum Contaminant Levels (SMCLs). USEPA. 2012. 2012 Edition of the Drinking Water Standards and Health Advisories. Spring 2012. Available at: http://water.epa.gov/drink/contaminants/index.cfm. Note that the MCLs are enforceable standards for public drinking water supplies, and that the SMCLs are not enforceable standards.
- **NCDHHS Screening Levels:** NCDHHS. 2015. DHHS Screening Levels. Division of Public Health, Epidemiology Section, Occupational and Environmental Epidemiology Branch. North Carolina Department of Health and Human Services. April 24, 2015. Available at: http://portal.ncdenr.org/c/document_library/get_file?p_l_id=1169848&folderId=24814087&name=DLFE-112704.PDF. Note that these screening levels have been developed for water supply well sampling near coal ash facilities, and do not apply to other areas of the state, or to drinking water supplies.
- **USEPA Risk-Based Screening Levels (RSLs)**: USEPA. 2015b. USEPA Risk-Based Screening Levels. November 2015. Available at: http://www2.epa.gov/risk/risk-based-screening-table-generic-tables. The RSLs are purely risk-based levels, derived using standard default exposure parameters that do not take into consideration treatment technologies or regulatory issues.

3.2 SCREENING LEVELS FOR VANADIUM AND HEXAVALENT CHROMIUM

The analysis provided in this report and its appendices uses the currently available IMAC for vanadium (0.3 micrograms per liter [µg/L]) and NCDHHS screening level for hexavalent chromium (0.07 µg/L). These are the values used by the NCDHHS to issue “Do Not Drink” letters to the majority of water supply well owners, both local to each facility and regionally for those background water supply wells sampled by NCDEQ. However, NCDEQ announced that it has changed those values and has rescinded many of the “Do Not Drink” letters sent to residents due to the change. Because the updated values have not been published, they have not been incorporated into the analysis in this report. However, to account for the change, the discussion of the results for each facility does not focus on these two constituents.

3.3 SCREENING METHODOLOGY

The analytical results for each well for all three water supply well data sets described in Section 2 are compared to each of these four types of screening levels.

SOURCES OF DATA	SCREENING LEVELS
1) NCDEQ Water Supply Well Data	1) 2L Standards (including IMACs)
2) NCDEQ Reconnaissance or Background Well Data	2) Federal Drinking Water Standards
3) Duke Energy Background Water Supply Well Data	3) DHHS Screening Levels
	4) USEPA Risk-Based Screening Levels (RSLs)

The screening comparisons are presented by facility in each of the appendices to this report. Each of the screening tables provides the analytical data by well location and by constituent. Each row presents the analytical data from one well sample. The constituents have been organized in columns left to right based on the constituents required for groundwater monitoring under the federal CCR Rule (USEPA, 2015a) (see Section 3.4, below). Thus, Appendix III (Detection Monitoring) constituents are listed first, followed by Appendix IV (Assessment Monitoring) constituents, followed by all others. In the “All Others” category, vanadium has been listed first – the remaining constituents are presented by alphabetical order.

The four sets of screening levels are listed at the top of each table in the appendices. There are four screening tables for each set of water supply well data for each facility; each of the tables provides the results of screening using one set of screening levels. For example:

- The first table presents the results of the comparison to 2L groundwater standards/IMAC;
- The second table presents the results of the comparison to federal MCLs/SMCLs;
- The third table presents the results of the comparison to NCDHHS screening levels; and
- The fourth and last table presents the results of the comparison to USEPA RSLs.

Yellow highlighting is used to indicate results that are above the applicable screening level; gray highlighting is used to indicate that the detection limit for a non-detect result is above the applicable screening level.

3.4 CCR RULE CONSTITUENTS

The constituents identified for Detection Monitoring and Assessment Monitoring under the CCR Rule were identified by USEPA as part of the six-year long rule-making process that culminated in the 2015 Final Rule (USEPA, 2015a).

The constituents included on the NCDEQ private well sampling analyte list that are also identified for detection monitoring in the CCR Rule are: boron, calcium, chloride, pH, sulfate, and total dissolved solids (TDS). These are constituents that are considered to be indicators of potential releases from a coal ash management unit. The presence of these constituents in groundwater is not enough to conclude that there has been a release from a coal ash management unit; it is the magnitude of the concentrations, the potential correlations between the constituent concentrations, and importantly the information on the hydrogeology of an area that are used to make such a determination.

The constituents identified by USEPA in Appendix IV for Assessment Monitoring are those that USEPA has identified as constituents most likely to be present in groundwater at levels that may present a risk to human health or the environment if there has been a release from a coal ash management unit. The Appendix IV constituents included in the NCDEQ private well sampling are:

Antimony
Arsenic
Barium
Beryllium
Cadmium
Chromium
Cobalt
Lead
Mercury
Molybdenum
Selenium
Thallium

The Appendix IV constituents were identified by USEPA using a very conservative national risk assessment evaluating potential impacts of ash management units on groundwater (USEPA, 2015c). This is not to say that all of these constituents would be present at concentrations above screening levels in all locations if there has been a release from an ash management unit – only that there is the potential for release of these constituents that could result in concentrations in groundwater above screening levels. This potential is the basis for the development of the Appendix IV list. The USEPA risk assessment considered many other constituents, as shown in the table from the Executive Summary of the risk assessment:

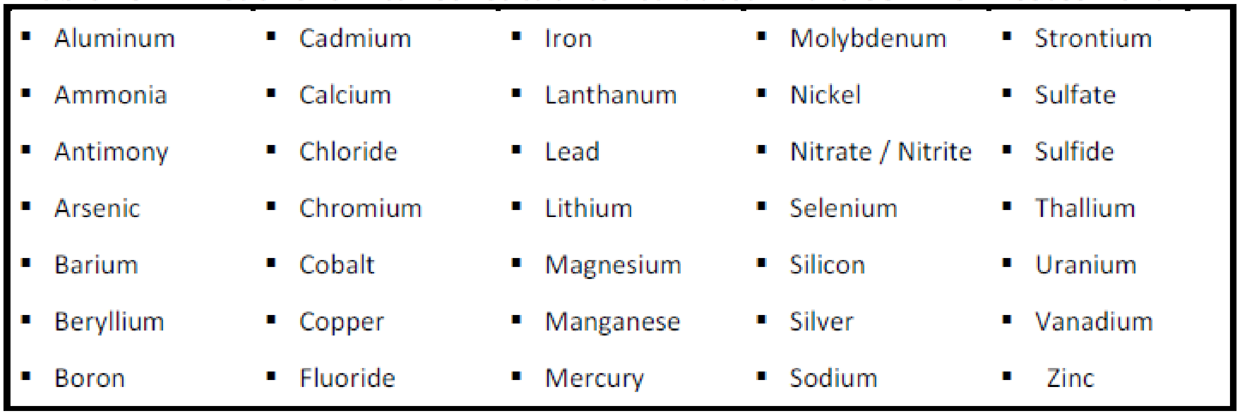

Table ES-1. List of Chemical Constituents Evaluated in the CCR Risk Assessment

- Aluminum
- Ammonia
- Antimony
- Arsenic
- Barium
- Beryllium
- Boron
- Cadmium
- Calcium
- Chloride
- Chromium
- Cobalt
- Copper
- Fluoride
- Iron
- Lanthanum
- Lead
- Lithium
- Magnesium
- Manganese
- Mercury
- Molybdenum
- Nickel
- Nitrate / Nitrite
- Selenium
- Silicon
- Silver
- Sodium
- Strontium
- Sulfate
- Sulfide
- Thallium
- Uranium
- Vanadium
- Zinc

Most notably, vanadium was evaluated quantitatively but was not included in Appendix IV based on the national risk assessment results.

4. STATISTICAL EVALUATION OF BACKGROUND

It is important to note that all of these constituents are naturally present in our environment, as shown by work conducted by the U.S. Geological Survey (USGS, 2014), and they are also naturally occurring in groundwater (USGS, 2011).

Applicable statistical analysis method(s) were chosen to perform background statistical evaluations of selected constituents for each facility. The ultimate purpose of the statistical evaluations conducted for each facility in each appendix to this report is to develop a Background Threshold Value (BTV) for a subset of constituents for each facility. The subset of constituents was defined first by whether “Do Not Drink” letters were issued for those constituents, and second by the needs of the groundwater chemistry evaluation, which is the fourth component of this evaluation.

This statistical plan refers to the USEPA “Unified Guide” (USEPA, 2009) for additional details of the methods that have been chosen for estimating BTVs. An overview of the process is provided here. The BTV value for each dataset is estimated for selected constituents at each facility by using a stepwise approach outlined below.

1) Initial evaluation of background input data sources.
2) Raw data evaluation by descriptive statistics, histograms, outlier tests, and trend tests.
3) Testing of statistical assumptions of the input data by checking for independent, identically distributed (IID) measurements and goodness-of-fit (GOF) distribution tests.
4) Selection of an appropriate parametric or non-parametric analysis method to estimate constituents BTVs.
5) Summarizing the statistical analysis results and drawing conclusions.

4.1 BACKGROUND DATASETS

Two or three background groundwater datasets are available for each facility.

- As described in Section 2.2, NCDEQ collected 24 water samples from 24 regional background water supply well locations in the vicinity of three of the Duke Energy facilities: Allen (seven [7] locations), Buck (seven [7] locations), and Marshall (ten [10] locations).
- As described in Section 2.3, Duke Energy developed a regional background water supply well data set for each of its facilities by offering to sample private drinking water wells for facility employees, contractors, and others associated with Duke Energy, if their well was located generally between 2 miles and 10 miles of each facility.
- As described in Section 2.4, monitoring well data for upgradient/background locations are available for each of the seven facilities included in this analysis.

4.2 INITIAL STATISTICAL EVALUATION

For three facilities, two regional background water supply well datasets are available (Allen, Buck, and Marshall). For all of the facilities, there are multiple sets of data for the facility specific monitoring wells are available. Before combining data within each of these groups, an initial statistical evaluation was performed to check the homogeneity of variance assumption for the multiple groups of wells using Levin's test. The test examines if the differences in sample variances occurred because of random sampling. This evaluation is conducted to identify any significant variations between the groups to determine the need for excluding the data.

Note that the original focus of the background evaluation was on vanadium and hexavalent chromium, as these were the two constituents for which the majority of the "Do Not Drink" letters were issued. This statistical analysis was begun prior to the lifting of the "Do Not Drink" letters, however, the use of these two constituents for the purpose of determining whether the datasets can be combined is appropriate. Data sources were tested for statistical variations as described in the following sections.

4.2.1 Regional Water Supply Well Data

The regional background groundwater data for Allen, Buck, and Marshall regional wells include the data provided by both NCDEQ and Duke Energy. The background groundwater data for remaining facilities' regional background water supply wells included only the data provided by Duke Energy. The data provided by NCDEQ and Duke Energy were collected in similar environs of the Allen, Buck, and Marshall facilities. However, before combining the two data sources, the NCDEQ and Duke Energy data were tested for homogeneity of variance assumption using Levine's test. If the variances are concluded to be homogenous by Levine's test then the two datasets were combined. If not, the NCDEQ dataset would be omitted from further analysis (because the NCDEQ regional background water supply well dataset is smaller than the corresponding Duke Energy dataset); however this was not the case.

4.2.2 Facility Monitoring Well Data

The background groundwater data for each facility consists of data from facility-specific background monitoring wells screened in different subsurface groundwater formations. Before combining the facility-specific background monitoring wells into one dataset as one group, the test for homogeneity of variance assumption was tested using Levine's test. If the variances are concluded to be homogenous by Levine's test then the datasets were combined. If not, the datasets were omitted from further analysis.

4.3 RAW DATA EVALUATION

The next step is to compute and tabulate the descriptive statistics for each facility dataset for each selected constituent. The most common descriptive statistics are: number of observations, number of detects, percentage of non-detects (ND), minimum ND concentration, maximum ND concentration, mean concentration, median concentration (50th percentile), 95th percentile, variance, standard deviation, and coefficient of variation. Although statistics computed using discrete data sets of small sizes (e.g., < 8) are generally not used to make decisions, facility-specific knowledge and limited statistical evaluation, can be used to evaluate such datasets.

Next, visual plots such as histograms and probability plots are developed to examine the data closely and visually determine if there are extreme outliers in the dataset. If extreme outliers are visually identified, then outlier tests using Rosner's and Dixon's outlier tests were performed to confirm the outliers at a 5% significant level. The presence of outliers in the computation of the various decision statistics can lead to incorrect conclusions. The decision to include or not include outliers in statistical computations is decided by the project team based on constituent and facility-specific knowledge. In some cases, decision statistics are computed with and without the outliers to evaluate the influence of outliers on the decision making statistics. If the presence of an outlier is confirmed, and if there is enough evidence to remove the outlier, then the outlier is removed from further statistical analysis. Where applicable, time series plots were also developed for each constituent for each facility by using all wells in the same plot or as single well plots to examine any temporal trend.

4.4 TESTING OF STATISTICAL ASSUMPTION

After performing the initial statistical evaluation and removing the potential outliers, two critical statistical assumptions are tested for: independent, identically distributed (IID) measurements, and test for normality.

In general, the groundwater monitoring program is designed to have IID measurements for statistical analysis, which is generally satisfied in designing and carrying out the monitoring program. The groundwater samples are not statistically independent when analyzed as aliquots or splits from a single physical sample. Therefore, split sample data were removed from the dataset. In case of a duplicate sample, the maximum detected value or minimum ND value is selected. For a small fraction of non-detects in a sample (10-15% or less) censored at a single reporting limit, simple substitution methods can be utilized by substituting each non-detection with an imputed value of the method detection limit (MDL). However, more complicated situations arise when there is a combination of multiple MDLs (detected values intermingled with different non-detection levels), or the proportion of non-detections is larger. For complicated situations, strategies such as Kaplan-Meier (KM), Cohen's Method, Robust Regression on Order Statistics (ROS), and Parametric Regression on Order Statistics are utilized. The substitution will depend on the data distribution and site conditions.

For the normality assumption, the data is first tested for normal distribution with histograms, probability plots and GOF tests statistics for each constituent for each dataset for each facility. If the data appeared to be skewed, then the data are transformed to test for log-normal and Gamma distributions. The GOF statistics tests are generated using the USEPA ProUCL software (USEPA, 2013), which tests for normal, lognormal, and gamma distributions to establish the appropriate distribution. The GOF test statistics for normal and lognormal distributions is based on Normal Quantile-Quantile (Q-Q) plot and Shapiro-Wilk (S-W) Tests. The GOF test statistics for a gamma distribution are based upon the Empirical Distribution Function (EDF). The two EDF tests incorporated in ProUCL are the K-S test and the A-D test. If the Q-Q plot and the values of the GOF test statistics suggest the data follow a certain distribution, then parametric methods are utilized to estimate the BTV value. If the normality assumption is not met, then the data are considered as distribution free, and non-parametric statistical methods are used to estimate BTV values.

A common difficulty in checking for normality among groundwater measurements is the frequent presence of non-detect values, known in statistical terms as left-censored (positively skewed) measurements. The magnitude of these sample concentrations is unknown and they fall somewhere between zero and the detection or reporting limit. Many positively skewed data sets follow a lognormal as well as a gamma distribution. It is well-known that for moderately skewed to highly skewed data sets, the use of a lognormal distribution tends to yield inflated and unrealistically large values of the decision statistics especially when the sample size is small (e.g., <20-30). It is observed that the use of a gamma distribution tends to yield reliable and stable results to a practical merit. If the GOF statics are inconclusive then non-parametric methods are utilized.

4.5 BTV ESTIMATE

In this step, an appropriate parametric or non-parametric test method to estimate BTVs was selected based on conclusions from the above sections. When selecting parametric methods or non-parametric methods, it is implicitly assumed that the background data set used to estimate BTV's represent unimpacted single statistical population that are free from outliers. However, since outliers are inevitable in most environmental data (high percent of NDs), when present, outliers were treated on a facility-specific basis using all existing knowledge about the facility, groundwater conditions and reference areas under investigation as discussed in the previous section. The BTV's for the constituents were estimated using ProUCL by using one of the following methods.

- Parametric or non-parametric 95% Upper Prediction Limits (UPL95)
- Parametric or non-parametric Upper Tolerance Limits with 95% confidence and 95% coverage (UTL95-95)

A prediction interval is the interval (based upon background data) within which a newly and independently obtained (future observation) site observation (e.g., onsite, downgradient well) of the predicted variable (e.g., boron) falls with a given probability (or Confidence Coefficient (CC)). A UPL95 represents that statistic such that an independently collected new/future observation from the population will be less than or equal to the UPL95 with a CC of 0.95. It is noted that the use of a UPL95 to compare many observations may result in a higher number of false positives; that is the use of a UPL95 to compare many observations just by chance tends to incorrectly classify observations coming from the background population as coming from the impacted site locations.

A tolerance limit is a confidence limit on a percentile of the population rather than a confidence limit on the mean. A UTL95-95 represents that statistic such that 95% observations (current and future) from the target population will be less than or equal to the UTL95-95 with a CC of 0.95. A UTL95-95 represents a 95% UCL of the 95th percentile of the data distribution. A UTL95-95 is designed to simultaneously provide coverage for 95% of all potential observations (current and future) from the background population with a CC of 0.95. A UTL95-95 can be used when many (unknown) current or future onsite observations need to be compared with a BTV. For moderately to highly skewed data sets (high percentage of NDs), upper limits using KM estimates in gamma upper concentration limit and UTL equations provide better results, if the detected observations in the left-censored data set follow a gamma distribution.

The nonparametric upper limits (e.g., UTLs, UPLs) are computed by the higher order statistics such as the largest, the second largest, the third largest, and so on of the background data. The order of the statistic used to compute a nonparametric upper limit depends on the sample size, coverage probability, and the desired CC. In practice, non-parametric upper limits do not provide the desired coverage to the population parameter (upper threshold) unless the sample size is large.

4.6 FACILITY-SPECIFIC APPLICATION

In each appendix to this report, these statistical methods were used to develop a regional background groundwater BTV for specific constituents using the NCDEQ and/or the Duke Energy water supply well data, and a facility-specific background groundwater BTV for the same constituents using the facility upgradient/background monitoring well data. The results are provided in each appendix, and the detailed statistical evaluations are provided as attachments to each appendix.

5. Groundwater Flow Evaluation

The groundwater flow evaluations were conducted for this report by the companies that have been the lead investigators on each site for Duke Energy under the CAMA program:

- HDR, Inc. (HDR) is the lead investigator for Allen, Belews Creek, Buck, Cliffside, and Marshall.
- SynTerra Corporation (SynTerra) is the lead investigator for Mayo and Roxboro.

The sections on groundwater flow provided in each appendix succinctly summarize the wealth of information collected during the CAMA program on the hydrogeology of each site, information that has been included in the following reports:

- Comprehensive Site Assessment (CSA);
- Corrective Action Plan, Part 1 (CAP-1); and
- Corrective Action Plan, Part 2 (CAP-2).

While the purpose of the CAMA program groundwater investigation is to evaluate the impact the ash basins and other ash management areas on groundwater at and downgradient of these units, these data have been used in this report to evaluate groundwater flow with respect to the location of the water supply wells within the vicinity of each facility, which are upgradient and in some cases side gradient.

A detailed site conceptual model (SCM) is presented for each facility. The generalized SCM is a slope-aquifer system typical of the Piedmont Province where a surface drainage basin is contained within one or more adjacent topographic divides, located along ridge tops serving as the upper hydraulic boundaries and with a stream, river, or lake serving as the lower hydraulic boundary. Detailed plan views and cross-sections are used to localize the area of groundwater impact at the facility, as defined by the locations where boron, the leading coal ash indicator, is present above the 2L standard.

It should be noted that all of the groundwater investigations at each of the facilities have been conducted under the conditions where the local water supply wells have been active and in normal operation. Thus the water level measurements and the interpretations of groundwater flow reflect the combined impact this active pumping condition may have on groundwater flow.

A groundwater model has been developed for each site, and where the model has been sufficiently developed, reverse particle tracking has been used in a well capture zone analysis to delineate well capture zones for the active water supply wells near each of these facilities: Belews Creek, Cliffside, Marshall, Mayo, and Roxboro. These models have simulated active pumping and were conducted to simulate a time frame of water supply well usage starting with the first date that the ash basin(s) were in operation.

Details on these evaluations are provided in the appendices.

6. Groundwater Characteristics Evaluation

The objective of the groundwater characteristics evaluation is to understand, from the groundwater chemistry perspective, whether the CCR-impacted groundwater at each facility has resulted in the water quality exceedances reported in the local water supply wells. The following provides a summary of the methods applied to the groundwater characteristics evaluation for each of the facilities.

6.1 EVALUATION APPROACH

The evaluation consists of the following two key steps:

- Identify site-specific CCR-related signature constituents that can effectively serve as indicators to evaluate the extent of the CCR-impacted groundwater.
- Compare the absolute and relative abundance of major common constituents and signature constituents among various well groups to determine whether CCR-impacted groundwater at the site has resulted in the water quality exceedances found in the local water supply wells.

The approach taken to address these two steps follows:

- Screen the geochemical and transport behaviors of typical CCR-related constituents to establish candidate constituents for further evaluation.
- Assess the presence and magnitude of candidate constituents in the groundwater beneath the site as a result of a release from the ash basin system by comparing the concentration magnitude of these constituents in the four major well groups below:
    - Ash basin porewater monitoring wells;
    - Other facility monitoring wells, including wells screened in the shallow flow layer (shallow wells), wells screened in the transition zones (deep wells), and bedrock wells;
    - Local water supply wells (data from NCDEQ); and
    - Regional background wells (data from NCDEQ and/or from Duke Energy).

  Note that the wells in a major group may be further divided into multiple subgroups in order to evaluate the spatial trends of the groundwater data; for example, the facility bedrock wells may be further divided into two subgroups based on the groundwater flow direction in the bedrock unit: (a) facility bedrock wells that are likely to be within the area of CCR-impacted groundwater, and (b) facility bedrock wells that are likely to be outside of this area.
- Identify useful reduction-oxidation (redox) sensitive constituents that can also serve as an indicator or a signature for CCR-impacted groundwater by comparing the concentration magnitude of dissolved oxygen, iron, and manganese, among various well groups.
- Select effective constituents that can differentiate the site-related impacts and background conditions to serve as signature constituents to assess the potential relationship between the facility CCR-impacted groundwater and the local water supply wells.

- Compare the relative abundance patterns of major cations and anions in groundwater among various well groups to assess the data clustering pattern and correlation among various well groups.
- Apply the site-specific geochemical principles and the knowledge of the groundwater flow field, which have been developed and documented in the CSA and CAP reports and summarized for each facility in this report, to coherently interpret the groundwater data trends and to verify or reject the connection between the CCR-impacted groundwater and the water quality exceedances found in the local water supply wells.

6.2 CCR-RELATED CONSTITUENTS SCREENING FOR SIGNATURE DEVELOPMENT

The first step for the identification of the CCR-impacted signature constituents is to identify the constituents that have the following characteristics:

- They are recalcitrant to degradation and transformation under site-specific conditions.
- They are very soluble and subject to little sorption.
- During the transport process, the constituents of interest are not likely subject to a mechanism that can increase or decrease their concentrations.
- Their concentrations or values are substantially different from the background concentrations or values.

6.3 DATA ANALYSIS METHODS

Three types of data visualization techniques were used to evaluate the data for the constituents identified as useful or key indicator constituents. Each facility-specific appendix identifies how these tools are used to evaluate the site-specific data.

6.3.1 Box Plot

The comparisons of the concentration magnitude among different well groups for various potential indicators were made using the box plots produced by the ProUCL software (USEPA, 2013). An example box plot (also commonly known as a “box and whiskers plot”) is shown in Panel (a) of Figure 2, which defines the various components of the box plot. The location of the upper whisker is the lesser of 1.5 times the interquartile range (IQR) above the 75 percentile or the maximum value; the location of the lower whisker is the greater of 1.5 times the IQR below the 25 percentile or the minimum value. The analyses include both detected and non-detected values.

6.3.2 Correlation Plot

The constituents found to be signature indicators of CCR-impacted groundwater can be used to generate correlation plots to further evaluate the relationships among various data groups. To create a correlation plot, different data groups can be plotted using different symbols with the concentrations of one constituent on the x-axis and the concentrations of the other constituent on the y-axis. The clustering patterns or trends will illustrate the correlations among data groups.

6.3.3 Piper Plot

Piper plots have been frequently used to assess the relative abundance of general cations (sodium, potassium, magnesium, calcium) and anions (chloride, sulfate, bicarbonate and carbonate) in groundwater and to differentiate different water sources in hydrogeology (Domenico and Schwartz, 1998). Groundwater resulting from different water sources or in different geologic units may exhibit distinct clustering patterns on a piper plot. Because calcium and sulfate are common coal ash constituents, it is expected that CCR-impacted groundwater may show a different clustering pattern than the background groundwater or the groundwater that has not been impacted by CCR.

An example figure is shown in Panel (b) of Figure 2, which compares the general water chemistry among the porewater in an ash basin, surface water in the ash basins, and groundwater in the bedrock wells for an example site. The piper plot consists of three subplots: a cation composition trilinear plot in the lower left corner, an anion composition trilinear plot in the lower right corner, and a diamond plot in between. The red lines on each subplot show how to read the meanings of a data point in a subplot. For example, in the cation subplot, the data point of AB-4S shows about 37 percent of the total cation charges from sodium and potassium, approximately 40 percent from calcium, and about 26 percent from magnesium. In the anion subplot, the data point of SW-AB1 shows about 37 percent of the total anion charges from sulfate, approximately 25 percent from chloride and nitrate related anions (NO2$^-$ and NO3$^-$), and 38 percent from carbonate (CO3^{2-}) plus bicarbonate (HCO3$^-$) anions. In the diamond subplot, the data point of AB-7BRU shows about 68 percent of the total anion charges from chloride, nitrate related anions, and sulfate, and approximately 48 percent of the total cation charges from calcium and magnesium.

The piper plots for this evaluation were generated using the GW_Chart program developed by the USGS (Winston, 2000).

6.4 DATA SYNTHESIS

The groundwater characterization uses the results of these analyses in concert with the groundwater flow information and the background statistics to determine if the local water supply wells may be impacted by a release of constituents from the ash basins and coal ash management facilities at each location.

7. Summary of Results

The NCDEQ classified six of the Duke Energy ash basins as Low to Intermediate risk. The primary basis for this classification was stated as the current “uncertainty related to site conditions that may relate to potential impacts to up-gradient and side-gradient well users.” When finalizing the classifications, a decision must be made by NCDEQ to classify these ash basins as Low or as Intermediate risk. The NCDEQ cited a lack of information as the basis for the Low to Intermediate classification. The most cited information needs in the document included incomplete background concentration determination, and incomplete capture zone modeling for the water supply wells in the vicinity of each facility.

Duke Energy commissioned Haley & Aldrich, Inc. (Haley & Aldrich) to conduct a detailed evaluation of available facility data for the sites classified Low to Intermediate. The purpose of the study was to evaluate whether or not the ash basins and other coal ash management areas at each facility may impact off-site local water supply wells.

The results of an initial evaluation of the local water supply well data collected by NCDEQ in the vicinity of each of the Duke Energy facilities was conducted by Haley & Aldrich, and was presented to the NCDEQ in December 2015 (Haley & Aldrich, 2015). This report supplements and expands on that initial evaluation, and provides technical evaluations in four important assessment areas: 1) an evaluation of the private and public water supply well data collected by the NCDEQ with respect to groundwater standards and screening levels; 2) additional statistical analysis of regional background groundwater data, and facility-specific background groundwater data; 3) a more comprehensive evaluation of groundwater flow with respect to local water supply wells, including a water supply well capture zone analysis; and 4) a detailed comparison of facility-specific coal ash groundwater chemistry, background groundwater chemistry (both regional and facility-specific), and water supply well chemistry. This report addresses the following facilities: Allen, Belews Creek, Buck, Cliffside, Marshall, Roxboro, and Mayo. The draft NCDEQ classification for Mayo is Low, but has been included in this report so that it addresses all sites with draft classifications of Low to Intermediate, and Low.

7.1 AVAILABLE DATA

The data used in the analysis came from several sources. The local water supply well data were provided directly to Duke Energy by the NCDEQ in March 2016. These data included results for the water supply wells sampled within 1,500 feet of the ash basin(s) compliance boundary for each facility. In October 2015, NCDEA provided “reconnaissance” or background water supply well data collected in the vicinity of the Allen, Buck, and Marshall facilities. Regional background water supply well data are also available from Duke Energy for samples collected within a 2- to 10-mile radius of each facility. Groundwater monitoring well data for each facility were also used in the analysis.

Table 1 provides a summary of the sample count used in this analysis for the local water supply wells and the regional background water supply wells.

Water supply wells constructed in the Piedmont province of North Carolina are predominantly deep bedrock wells. Typically in the Piedmont, private water supply wells are assumed to be open boreholes installed within the upper 100 feet of bedrock; however, most are generally less than 250 feet deep with yields of 10 to 20 gallons per minute (Daniel and Dahlen, 2002). Therefore, the facility-specific data for bedrock and deep wells were the focus of the comparative analysis of local water supply wells and facility-specific information.

7.2 RISK-BASED SCREENING EVALUATION

Local water supply well data and the background data from both NCDEQ and Duke were compared to the following (Table 2):

- North Carolina Statute 15A NCAC 02L.0202 (2L Standard) groundwater standards, and IMACs;
- Federal Safe Drinking Water Act MCLs and SMCLs;
- NCDHHS screening levels; and
- USEPA RSLs.

The detailed screening tables for each of the seven facilities are provided in the appendices, by facility.

Table 3 provides a statistical data summary and Table 4 provides a summary of the screening results for all of the local water supply well data available for all of the Duke Energy facilities in North Carolina. Tables 5 and 6 provide the same information, respectively, for the NCDEQ-sampled regional background wells. Tables 7 and 8 provide the same information, respectively, for the Duke Energy-sampled regional background wells.

The analysis provided in this report uses the currently available IMAC for vanadium (0.3 µg/L) and NCDHHS screening level for hexavalent chromium (0.07 µg/L); however, NCDEQ announced that it has changed those values and has rescinded many of the “Do Not Drink” letters sent to residents due to the change. Because the updated values have not been published, they have not been incorporated into the analysis in this report. However, to account for the change, the discussion of the results for each facility does not focus on these two constituents.

The concentrations of boron and the other potential coal ash indicators were low and generally not above screening levels in the local water supply wells sampled by NCDEQ, nor in the regional background wells. The exception to this is pH. pH was below the drinking water standard range in approximately half of the NCDEQ-sampled water supply wells, both local and regional background. These results are not unexpected, based on a study published by the USGS (Chapman, et al., 2013) and additional North Carolina specific studies (Briel, 1997) showing that groundwater pH in the state is commonly below the MCL range of 6.5 to 8.5.

Table 9 provides background groundwater data available from the literature for the constituents included in this evaluation.

When looking at the local water supply well data, it is clear that there are very few results above regulatory levels or risk-based screening levels (with the earlier caveat about the lifting of the “Do Not Drink” letters for hexavalent chromium and vanadium). The water supply well sampling conducted by

NCDEQ within the 0.5-mile radius of Duke Energy ash basins included over 14,200 chemical analyses of samples from 347 wells. Only 1.38% of the results were above an MCL; the vast majority of these were due to pH readings outside the federal drinking water range, and these values are generally consistent with background in North Carolina, as noted above. When pH is not considered, only 0.16% of the results are above an MCL. Only 1.15% of the individual results are above a secondary federal drinking water standard (aluminum, iron, and manganese); these SMCLs are based on aesthetics and most of the results are below USEPA's risk-based screening levels.

7.3 BACKGROUND EVALUATION

The constituents present in coal ash and, therefore, in the groundwater impacted by coal ash, are naturally occurring in our environment. Therefore, it is important to consider the water supply well data in the context of background concentrations of the detected constituents. The background water supply well data collected by Duke Energy and by the NCDEQ (where available) for each facility are referred to as "regional" background to distinguish it from the "facility-specific" background groundwater data collected from monitoring wells located in upgradient locations at each facility. A detailed statistical analysis of regional background groundwater data and facility-specific background groundwater data was conducted to develop "background threshold values" or point descriptors of background for specific constituents to compare to the data for the NCDEQ-sampled local water supply wells. The comparison indicates that constituent concentrations in the water supply wells are generally consistent with both regional and facility-specific background concentrations (including vanadium and hexavalent chromium).

Table 10 provides a summary of the regional and facility-specific BTVs for bedrock groundwater, calculated for each of the seven facilities included in this analysis. The results are generally similar between the two datasets for each facility, and across facilities, and represent regional and local natural variability in groundwater.

7.4 GROUNDWATER FLOW EVALUATION

A comprehensive evaluation of groundwater flow was conducted with specific emphasis on evaluating flow directions with respect to the locations of the ash basin(s) and other coal ash management areas and the local water supply wells at each facility. The results for all facilities demonstrate that groundwater flow at each site is predominantly in directions away from areas where water supply wells are located and towards the local groundwater discharge features, whether they be a river or lake. In all cases the detailed groundwater models support these flow directions.

The water supply well capture zone analyses conducted for each facility (where appropriate) using reverse particle tracking also indicates that groundwater utilized by water supply wells near the coal ash impoundments is not impacted by the coal ash sources.

7.5 GROUNDWATER CHARACTERISTICS EVALUATION

These conclusions about groundwater flow and the lack of impact on the local water supply wells are confirmed by the detailed characterization of groundwater chemistry at each facility. Data for facility-specific groundwater, regional background groundwater, and local water supply well water were included in the evaluations. The analyses included evaluation of CCR indicators, redox conditions, and correlation evaluations. The results of the chemical correlation analyses indicate that, based on the differences in clustering patterns of constituents from the ash basin porewater wells and the local water supply wells, the source water for the local water supply wells is not CCR-impacted groundwater.

The graphical results from these seven facility evaluations allow for easy comparison of the ash porewater well results between facilities, and easy comparison of the local water supply well results between facilities. The correlations between the ash indicators boron and sulfate, and between the major groundwater ions (calcium, magnesium, chloride, sulfate, etc.) for the ash porewater wells are strikingly similar between facilities. These same comparisons are also strikingly similar between all of the facilities' local water supply wells. Moreover, the patterns between the two groups of data, ash porewater wells and local water supply wells, are distinctly different in the correlation plots. This comparison between facilities further supports the conclusion that CCR-impacted groundwater is not impacting the local water supply wells.

7.6 CONCLUSIONS

Therefore, the evaluations performed for all 7 of these facilities support a Low risk classification under CAMA:

- Allen Steam Station
- Belews Creek Steam Station
- Buck Steam Station
- Cliffside Steam Station
- Marshall Steam Station
- Mayo Steam Electric Plant
- Roxboro Steam Electric Plant

These results confirm the Low risk classification proposed by NCDEQ for Mayo, and the specific ash basins at Cliffside and Roxboro.

8. References

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Table 1
Summary of NCDEQ and Duke Energy Water Supply Well and Background Well Samples and Well Counts
Water Supply Well Evaluation
Duke Energy
April 2016

Station	Number of NCDEQ Private Wells (a)	NCDEQ (b) Background	Duke Energy (c) Background	Combined Background
Allen	124	7	16	23
Belews Creek	34	0	11	11
Buck	89	7	17	24
Cliffside	22	0	9	9
Marshall	39	10	29	39
Mayo	3	0	14	14
Roxboro	15	0	26	26

Notes:

DEQ - Department of Environmental Quality.
NC - North Carolina.

(a) - NCDEQ Water Supply Well data. Data from NCDEQ document submittal from March 15, 2016.
(b) - NCDEQ Background data. Accessed December 14, 2015.
http://portal.ncdenr.org/c/document_library/get_file?uuid=1b4291cf-958f-4b7e-a272-fb7ab608a158&groupId=14
(c) - Duke Energy Background data. Duke employee private well survey within 2-10 miles from identified facility.

Table 2
Summary of Screening Values
Water Supply Well Evaluation
Duke Energy
April 2016

	Constituents	**Units**	**15A NCAC 02L .0202 Groundwater Standard (a)**	**Federal MCL/ SMCL (b)**	**DHHS Screening Level (c)**	**Tap Water RSL 2015 (d)**
Appendix III (e)	Boron	ug/L	700	NS	700	4000
	Calcium	ug/L	NS	NS	NS	NS
	Chloride	mg/L	250	*250	250	NS
	pH	su	6.5-8.5	6.5 - 8.5	NS	NS
	Sulfate	mg/L	250	*250	250	NS
	Total Dissolved Solids	mg/L	500	*500	NS	NS
Appendix IV (f)	Antimony	ug/L	1	6	1	7.8
	Arsenic	ug/L	10	10	10	0.052
	Barium	ug/L	700	2000	700	3800
	Beryllium	ug/L	^4	4	4	25
	Cadmium	ug/L	2	5	2	9.2
	Chromium	ug/L	10	100	10	22000
	Cobalt	ug/L	^1	NS	1	6
	Lead	ug/L	15	15	15	15
	Mercury	ug/L	1	2	1	5.7
	Molybdenum	ug/L	NS	NS	18	100
	Selenium	ug/L	20	50	20	100
	Thallium	ug/L	0.2	2	0.2	0.2
Constituents Not Identified in the CCR Rule	Aluminum	ug/L	NS	*50 to 200	3500	20000
	Copper	mg/L	1	1.3	1	0.8
	Hexavalent Chromium	ug/L	NS	NS	0.07	44 (g)
	Iron	ug/L	300	*300	2500	14000
	Magnesium	ug/L	NS	NS	NS	NS
	Manganese	ug/L	50	*50	200	430
	Nickel	ug/L	100	NS	100	390
	Potassium	ug/L	NS	NS	NS	NS
	Sodium	ug/L	NS	NS	20000	NS
	Strontium	ug/L	NS	NS	2100	12000
	Vanadium	ug/L	^0.3	NS	0.3	86
	Zinc	mg/L	1	*5	1	6
	Alkalinity	mg/L	NS	NS	NS	NS
	Bicarbonate	mg/L	NS	NS	NS	NS
	Carbonate	mg/L	NS	NS	NS	NS
	Total Suspended Solids	mg/L	NS	NS	NS	NS
	Turbidity	NTU	NS	NS	NS	NS
	Temperature	°C	NS	NS	NS	NS
	Specific Conductance	umhos/cm	NS	NS	NS	NS
	Dissolved Oxygen	mg/L	NS	NS	NS	NS
	Oxidation Reduction Potential	mV	NS	NS	NS	NS

Table 2
Summary of Screening Values
Water Supply Well Evaluation
Duke Energy
April 2016

Notes:

^ - Denotes IMAC value.
* - Denotes SMCL value.
°C - Degrees Celsius.
CCR - Coal Combustion Residual.
DEQ - Department of Environmental Quality.
DHHS - Department of Health and Human Services.
HI - Hazard Index.
IMAC - Interim Maximum Allowable Concentration.
MCL - Maximum Contaminant Level.
mg/L - milligrams/liter.
mV - millivolts.
NA - Not Available.
NC - North Carolina.
NS - No standard Available.
NTU - Nephelometric Turbidity Units.
RSL - Risk Based Screening Level.
SMCL - Secondary Maximum Contaminant Level.
su - Standard units.
USEPA - United States Environmental Protection Agency.
ug/L - micrograms/liter.
umhos/cm - micromhos/centimeter.
USGS - United States Geological Survey.

(a) - Classifications and Water Quality Standards Applicable to Groundwaters of North Carolina. North Carolina Administrative Code. April 1, 2013. http://portal.ncdenr.org/web/wq/ps/csu/gwstandards

(b) - USEPA 2012 Edition of the Drinking Water Standards and Health Advisories. Spring 2012. http://www.epa.gov/sites/production/files/2015-09/documents/dwstandards2012.pdf.

(c) - DHHS Screening Levels. Department of Health and Human Services, Division of Public Health, Epidemiology Section, Occupational and Environmental Epidemiology Branch. http://portal.ncdenr.org/c/document_library/get_file?p_l_id=1169848&folderId=24814087&name=DLFE-112704.pdf

(d) - USEPA Risk Based Screening Levels (November 2015). Values for tapwater. HI = 1. http://www.epa.gov/risk/risk-based-screening-table-generic-tables

(e) - The CCR Rule lists these constituents as Constituents for Detection Monitoring (Appendix III). http://www.gpo.gov/fdsys/pkg/FR-2015-04-17/pdf/2015-00257.pdf

(f) - The CCR Rule lists these constituents as Constituents for Assessment Monitoring (Appendix IV).

(g) - Alternative screening level calculated for hexavalent chromium using RSL calculator (http://epa-prgs.ornl.gov/cgi-bin/chemicals/csl_search) and current dose-response data from the USEPA's Integrated Risk Information System. Available at: http://www.epa.gov/IRIS/. The RSL for hexavalent chromium is not a drinking water standard, and the basis of the draft oral cancer toxicity value used in the calculation of the RSL has been questioned by USEPA's Science Advisory Board; therefore, RSL for Chromium (IV) is based on the noncancer values developed by USEPA.

Table 3
Statistical Summary of NCDEQ-Sampled Water Supply Well (d) Data
Water Supply Well Evaluation
Duke Energy
April 2016

Constituents	Units	Frequency of Detection (a)	Frequency of Detection Percent	Range of Detected Concentrations	Mean Detect	10th Percentile	25th Percentile	50th Percentile	75th Percentile	90th Percentile
Constituents Listed in Appendix III (Detection Monitoring) of the CCR Rule (b)										
Boron	ug/L	97 / 368	26%	5 - 690	50.57	5	5	5	12.45	50
Calcium	ug/L	366 / 368	99%	1,340 - 246,000	18,465	4,964	7,208	12,200	20,925	31,940
Chloride	mg/L	363 / 368	99%	0.92 - 335	10.13	1.57	2.3	4.29	8.4	19.03
pH	su	368 / 368	100%	2.13 - 9.4	6.553	5.87	6.2	6.5	6.9	7.409
Sulfate	mg/L	239 / 368	65%	0.15 - 711	20.17	2	2	2.5	6.575	18.85
Total Dissolved Solids	mg/L	364 / 367	99%	25 - 2040	139.1	59	81	109	147.5	201.6
Constituents Listed in Appendix IV (Assessment Monitoring) of the CCR Rule (c)										
Antimony	ug/L	37 / 368	10%	0.031 - 1.87	0.243	0.4	0.5	0.5	0.5	0.832
Arsenic	ug/L	77 / 368	21%	0.1 - 108	4.06	0.5	0.5	0.5	0.5	2.06
Barium	ug/L	362 / 368	98%	0.46 - 400	39	5.5	11.9	25.15	47.7	79.9
Beryllium	ug/L	17 / 368	5%	0.04 - 0.78	0.24	0.2	0.2	0.2	0.2	0.4
Cadmium	ug/L	32 / 368	9%	0.063 - 1.4	0.247	0.08	0.08	0.08	0.08	0.159
Chromium	ug/L	245 / 368	67%	0.176 - 22.1	2.499	0.5	0.515	1.105	2.6	5
Cobalt	ug/L	67 / 368	18%	0.03 - 12	1.301	0.227	0.5	0.5	0.5	1
Lead	ug/L	318 / 368	86%	0.073 - 75.5	1.991	0.1	0.23	0.52	1.4	3.128
Mercury	ug/L	25 / 368	7%	0.017 - 0.12	0.0484	0.0594	0.2	0.2	0.2	0.2
Molybdenum	ug/L	144 / 368	39%	0.064 - 20.2	1.991	0.387	0.5	0.5	1.1	4.23
Selenium	ug/L	39 / 368	11%	0.164 - 3.4	1.049	0.5	0.5	0.5	0.5	1.73
Thallium	ug/L	13 / 368	4%	0.057 - 0.24	0.117	0.1	0.1	0.1	0.1	0.2
Constituents Not Identified in the CCR Rule										
Vanadium	ug/L	270 / 368	73%	0.197 - 26.5	6.572	1	1	4	8.2	12
Aluminum	ug/L	129 / 368	35%	2.2 - 5,000	195.2	10	10	10	25.18	109.3
Copper	mg/L	328 / 368	89%	0.00019 - 29	0.181	0.0011	0.0027	0.00764	0.0231	0.0709
Iron	ug/L	171 / 368	46%	14.5 - 18,200	869.9	50	50	50	188.3	1016
Hexavalent Chromium	ug/L	265 / 365	73%	0.033 - 22.3	1.659	0.03	0.081	0.62	1.9	4.72
Magnesium	ug/L	366 / 368	99%	372 - 61,200	4,655	1,300	2,123	3,455	5,193	7,141
Manganese	ug/L	304 / 368	83%	0.49 - 1010	34.49	0.5	0.84	2.77	14.7	47.78
Nickel	ug/L	168 / 368	46%	0.18 - 15	1.55	0.5	0.5	0.5	1.2	3.26
Potassium	ug/L	367 / 368	100%	96.1 - 21,200	2187	953.8	1,300	1,800	2,405	3,500
Sodium	ug/L	368 / 368	100%	570 - 370,000	11,388	4,207	5,578	7,435	9,643	16,430
Strontium	ug/L	365 / 368	99%	9.7 - 3,400	140.9	38.03	60	98.6	168.3	263.6
Zinc	mg/L	317 / 368	86%	0.00212 - 5.26	0.135	0.005	0.00975	0.025	0.0662	0.238
Alkalinity	mg/L	359 / 366	98%	1.4 - 376	54.01	16.05	28.5	42.4	61.95	89.8
Bicarbonate	mg/L	345 / 356	97%	1.23 - 317	52.73	13.35	26.9	41.85	61.18	89.75
Carbonate	mg/L	2 / 354	1%	6 - 42.6	24.3	1	5	5	5	5
Total Suspended Solids	mg/L	59 / 367	16%	0.4 - 363	16.7	1	2.5	2.5	2.5	5
Turbidity	NTU	104 / 367	28%	0.15 - 210	11.16	1	1	1	1	3.68
Temperature	°C	366 / 366	100%	7.4 - 28.3	18.01	15.6	16.8	17.8	19.1	21
Specific Conductance	umhos/cm	367 / 367	100%	4.5 - 1,770	174.3	64	92.2	134.5	197.3	280.8
Dissolved Oxygen	mg/L	367 / 367	100%	0.01 - 13	5.532	1.258	4.005	5.91	7.4	8.3
Oxidation Reduction Potential	mV	328 / 328	100%	1 - 774.7	211.5	112.9	166.8	203.2	246.5	300.4
Total Number of Analyses:		**14,274**								

Table 3
Statistical Summary of NCDEQ-Sampled Water Supply Well (d) Data
Water Supply Well Evaluation
Duke Energy
April 2016

Notes:

°C - Degrees Celsius.	CCR - Coal Combustion Residual.
mg/L - milligrams/liter.	DEQ - Department of Environmental Quality.
mV - millivolts.	NC - North Carolina.
NTU - Nephelometric Turbidity Units.	
su - standard units.	
ug/L - micrograms/liter.	
umhos/cm - micromhos/centimeter.	

(a) - Frequency of Detection: number of detects / total number of results.
(b) - The CCR Rule (FR80(74):21302-21501; April 17, 2015) lists these constituents as Constituents for Detection Monitoring (Appendix III).
http://www.gpo.gov/fdsys/pkg/FR-2015-04-17/pdf/2015-00257.pdf
(c) - The CCR Rule lists these constituents as Constituents for Assessment Monitoring (Appendix IV).
(d) - NCDEQ Water Supply Well data. Data from NCDEQ document submittal from March 15, 2016.

Table 4
Summary of NCDEQ-Sampled Water Supply Well (h) Data Screening
Water Supply Well Evaluation
Duke Energy
April 2016

Constituents	Units	Frequency of Detection (g)	Frequency of Detection Percent	Range of Detected Concentrations	Frequency Detected Above:				Frequency of Reporting Limits Above:				Frequency of Detects Below All Screening Levels
					2L (a)	DHHS (b)	MCL (c)	RSL (d)	2L (a)	DHHS (b)	MCL (c)	RSL (d)	
Constituents Listed in Appendix III (Detection Monitoring) of the CCR Rule (e)													
Boron	ug/L	97 / 368	26%	5 - 690	0	0	--	0	0	0	--	0	97
Calcium	ug/L	366 / 368	99%	1,340 - 246,000	--	--	--	--	--	--	--	--	--
Chloride	mg/L	363 / 368	99%	0.92 - 335	1	1	1	--	0	0	0	--	362
pH	su	368 / 368	100%	2.13 - 9.4	173	--	173	--	0	--	0	--	195
Sulfate	mg/L	239 / 368	65%	0.15 - 711	5	5	5	--	0	0	0	--	234
Total Dissolved Solids	mg/L	364 / 367	99%	25 - 2040	7	--	7	--	0	--	0	--	357
Constituents Listed in Appendix IV (Assessment Monitoring) of the CCR Rule (f)													
Antimony	ug/L	37 / 368	10%	0.031 - 1.87	2	2	0	0	8	8	0	0	35
Arsenic	ug/L	77 / 368	21%	0.1 - 108	7	7	7	77	0	0	0	290	0
Barium	ug/L	362 / 368	98%	0.46 - 400	0	0	0	0	0	0	0	0	362
Beryllium	ug/L	17 / 368	5%	0.04 - 0.78	0	0	0	0	0	0	0	0	17
Cadmium	ug/L	32 / 368	9%	0.063 - 1.4	0	0	0	0	0	0	0	0	32
Chromium	ug/L	245 / 368	67%	0.176 - 22.1	8	8	0	0	4	4	0	0	237
Cobalt	ug/L	67 / 368	18%	0.03 - 12	27	27	--	2	9	9	--	2	40
Lead	ug/L	318 / 368	86%	0.073 - 75.5	6	6	6	6	0	0	0	0	312
Mercury	ug/L	25 / 368	7%	0.017 - 0.12	0	0	0	0	0	0	0	0	25
Molybdenum	ug/L	144 / 368	39%	0.064 - 20.2	--	1	--	0	--	1	--	0	143
Selenium	ug/L	39 / 368	11%	0.164 - 3.4	0	0	0	0	0	0	0	0	39
Thallium	ug/L	13 / 368	4%	0.057 - 0.24	1	1	0	1	28	28	0	28	12
Constituents Not Identified in the CCR Rule													
Vanadium	ug/L	270 / 368	73%	0.197 - 26.5	263	263	--	0	86	86	--	0	7
Aluminum	ug/L	129 / 368	35%	2.2 - 5,000	--	1	57	0	--	0	3	0	72
Copper	mg/L	328 / 368	89%	0.00019 - 29	4	4	3	4	0	0	0	0	324
Iron	ug/L	171 / 368	46%	14.5 - 18,200	67	17	67	1	1	0	1	0	104
Hexavalent Chromium	ug/L	265 / 365	73%	0.033 - 22.3	--	243	--	0	--	35	--	0	22
Magnesium	ug/L	366 / 368	99%	372 - 61,200	--	--	--	--	--	--	--	--	--
Manganese	ug/L	304 / 368	83%	0.49 - 1010	33	14	33	5	0	0	0	0	271
Nickel	ug/L	168 / 368	46%	0.18 - 15	0	0	--	0	0	0	--	0	168
Potassium	ug/L	367 / 368	100%	96.1 - 21,200	--	--	--	--	--	--	--	--	--
Sodium	ug/L	368 / 368	100%	570 - 370,000	--	28	--	--	--	0	--	--	340
Strontium	ug/L	365 / 368	99%	9.7 - 3,400	--	1	--	0	--	0	--	0	364
Zinc	mg/L	317 / 368	86%	0.00212 - 5.26	10	10	1	0	0	0	0	0	307
Alkalinity	mg/L	359 / 366	98%	1.4 - 376	--	--	--	--	--	--	--	--	--
Bicarbonate	mg/L	345 / 356	97%	1.23 - 317	--	--	--	--	--	--	--	--	--
Carbonate	mg/L	2 / 354	1%	6 - 42.6	--	--	--	--	--	--	--	--	--
Total Suspended Solids	mg/L	59 / 367	16%	0.4 - 363	--	--	--	--	--	--	--	--	--
Turbidity	NTU	104 / 367	28%	0.15 - 210	--	--	--	--	--	--	--	--	--
Temperature	°C	366 / 366	100%	7.4 - 28.3	--	--	--	--	--	--	--	--	--
Specific Conductance	umhos/cm	367 / 367	100%	4.5 - 1,770	--	--	--	--	--	--	--	--	--
Dissolved Oxygen	mg/L	367 / 367	100%	0.01 - 13	--	--	--	--	--	--	--	--	--
Oxidation Reduction Potential	mV	328 / 328	100%	1 - 774.7	--	--	--	--	--	--	--	--	--
Total Number of Analyses:		**14,274**	**Total Number of Exceedances:**		**614**	**639**	**360**	**96**	**136**	**171**	**4**	**320**	**4,478**

Table 4
Summary of NCDEQ-Sampled Water Supply Well (h) Data Screening
Water Supply Well Evaluation
Duke Energy
April 2016

Notes:

°C - Degrees Celsius.
mg/L - milligrams/liter.
mV - millivolts.
NTU - Nephelometric Turbidity Units.
su - standard units.
ug/L - micrograms/liter.
umhos/cm - micromhos/centimeter.

CCR - Coal Combustion Residual.
DEQ - Department of Environmental Quality.
DHHS - Department of Health and Human Services.
HI - Hazard Index.
IMAC - Interim Maximum Allowable Concentration.
MCL - Maximum Contaminant Level.
NC - North Carolina.

RSL - Risk Based Screening Level.
SMCL - Secondary Maximum Contaminant Level.
USEPA - United States Environmental Protection Agency.
-- - No Standard Available.

(a) - Classifications and Water Quality Standards Applicable to Groundwaters of North Carolina. North Carolina Administrative Code. April 1, 2013
http://portal.ncdenr.org/web/wq/ps/csu/gwstandards
(b) - DHHS Screening Levels. Department of Health and Human Services, Division of Public Health, Epidemiology Section, Occupational and Environmenta
Epidemiology Branch. http://portal.ncdenr.org/c/document_library/get_file?p_l_id=1169848&folderId=24814087&name=DLFE-112704.pdf
(c) - USEPA 2012 Edition of the Drinking Water Standards and Health Advisories. Spring 2012.
http://water.epa.gov/drink/contaminants/index.cfm
(d) - USEPA Risk Based Screening Levels (November 2015). Values for tap water. HI = 1.
http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm
(e) - The CCR Rule (FR80(74):21302-21501; April 17, 2015) lists these constituents as Constituents for Detection Monitoring (Appendix III)
http://www.gpo.gov/fdsys/pkg/FR-2015-04-17/pdf/2015-00257.pdf
(f) - The CCR Rule lists these constituents as Constituents for Assessment Monitoring (Appendix IV).
(g) - Frequency of Detection: number of detects / total number of results.
(h) - NCDEQ Water Supply Well data. Data from NCDEQ document submittal from March 15, 2016.

Table 5
Statistical Summary of NCDEQ-Sampled Background Water Supply Well Data
Water Supply Well Evaluation
Duke Energy
April 2016

Constituents	Units	Frequency of Detection (a)	Frequency of Detection Percent	Range of Detected Concentrations	Mean Detect	10th Percentile	25th Percentile	Median	75th Percentile	90th Percentile
Constituents Listed in Appendix III (Detection Monitoring) of the CCR Rule (b)										
Boron	ug/L	6 / 24	25%	5.3 - 135	30.08	5	5	5	5.075	11.41
Calcium	ug/L	24 / 24	100%	1,680 - 74,200	24,238	8,227	10,700	17,900	31,400	55,880
Chloride	mg/L	24 / 24	100%	1.6 - 38	6.667	1.73	1.975	4.1	7.675	12.11
pH	su	24 / 24	100%	5.15 - 7.85	6.532	6.033	6.215	6.545	6.878	7.169
Sulfate	mg/L	17 / 24	71%	2.1 - 186	22.52	2	2	4.55	13.73	30.36
Total Dissolved Solids	mg/L	23 / 24	96%	51 - 373	153.7	79.9	87.25	109	166.5	336.6
Constituents Listed in Appendix IV (Assessment Monitoring) of the CCR Rule (c)										
Antimony	ug/L	0 / 24	0%	NA	NA	0.5	0.5	0.5	0.5	0.5
Arsenic	ug/L	2 / 24	8%	4.4 - 4.4	2.62	0.5	0.5	0.5	0.5	0.5
Barium	ug/L	24 / 24	100%	0.89 - 77.3	26.05	5.36	12.63	22.35	33.48	58.11
Beryllium	ug/L	0 / 24	0%	NA	NA	0.2	0.2	0.2	0.2	0.2
Cadmium	ug/L	0 / 24	0%	NA	NA	0.08	0.08	0.08	0.08	0.08
Chromium	ug/L	18 / 24	75%	0.51 - 5	1.37	0.5	0.508	0.805	1.45	1.9
Cobalt	ug/L	0 / 24	0%	NA	NA	0.5	0.5	0.5	0.5	0.5
Lead	ug/L	18 / 24	75%	0.12 - 3.2	0.603	0.1	0.115	0.24	0.58	0.888
Mercury	ug/L	0 / 24	0%	NA	NA	0.2	0.2	0.2	0.2	0.2
Molybdenum	ug/L	6 / 24	25%	0.58 - 4.9	2.523	0.5	0.5	0.5	0.52	2.66
Selenium	ug/L	2 / 24	8%	0.52 - 0.72	0.62	0.5	0.5	0.5	0.5	0.5
Thallium	ug/L	0 / 24	0%	NA	NA	0.1	0.1	0.1	0.1	0.1
Constituents Not Identified in the CCR Rule										
Vanadium	ug/L	19 / 24	79%	1 - 23.7	5.784	1	1.15	2.85	5.3	11.38
Aluminum	ug/L	5 / 24	21%	12.1 - 213	85.72	10	10	10	10	60.55
Copper	mg/L	21 / 24	88%	0.001 - 0.0161	0.00537	0.001	0.00185	0.0028	0.00758	0.011
Iron	ug/L	6 / 24	25%	57.5 - 1,340	335.6	50	50	50	51.88	164
Hexavalent Chromium	ug/L	12 / 24	50%	0.14 - 4.5	1.187	0.247	0.6	0.6	0.918	1.5
Magnesium	ug/L	24 / 24	100%	808 - 28,800	7172	2,109	2,858	5,165	8,238	14,550
Manganese	ug/L	16 / 24	67%	0.5 - 271	25.03	0.5	0.5	0.785	8.9	22.5
Nickel	ug/L	6 / 24	25%	0.53 - 1.8	1.038	0.5	0.5	0.5	0.508	0.97
Potassium	ug/L	24 / 24	100%	265 - 3,450	1906	1,010	1,253	1,880	2,428	3,203
Sodium	ug/L	24 / 24	100%	4,610 - 29,900	10,375	6,491	6,785	8,300	9,603	19,920
Strontium	ug/L	24 / 24	100%	12.2 - 1150	238.6	78.03	98.4	147.5	214.8	516.8
Zinc	mg/L	17 / 24	71%	0.0051 - 0.147	0.0209	0.005	0.005	0.00735	0.0137	0.0281
Alkalinity	mg/L	24 / 24	100%	7.4 - 226	79.86	34.19	48.03	66.1	90	166.2
Bicarbonate	mg/L	23 / 24	96%	7.4 - 226	81.04	25.03	46.63	66.1	90	166.2
Carbonate	mg/L	0 / 24	0%	NA	NA	5	5	5	5	5
Total Suspended Solids	mg/L	4 / 24	17%	4.2 - 20.6	10.38	2.5	2.5	2.5	2.5	5.07
Turbidity	NTU	4 / 24	17%	2 - 10.6	4.675	1	1	1	1	2.63
Temperature	°C	24 / 24	NA	15.25 17.68	16.59	16.01	16.37	16.51	16.86	17.18
Specific Conductance	umhos/cm	24 / 24	NA	0.053 0.9	0.26	0.0912	0.116	0.188	0.295	0.563
Dissolved Oxygen	mg/L	24 / 24	NA	0.32 9.86	3.291	0.604	1.553	3.025	4.335	5.488
Oxidation Reduction Potential	mV	24 / 24	NA	-63 241	134.6	46	110.5	146.5	177	198.3
Total Number of Analyses:		**936**								

Table 5
Statistical Summary of NCDEQ-Sampled Background Water Supply Well Data
Water Supply Well Evaluation
Duke Energy
April 2016

Notes:
°C - Degrees Celsius.
mg/L - milligrams/liter.
mV - millivolts.
NTU - Nephelometric Turbidity Units.
su - standard units.
ug/L - micrograms/liter.
umhos/cm - micromhos/centimeter.
CCR - Coal Combustion Residual.
DENR - Department of Environment and Natural Resources.
DEQ - Department of Environmental Quality.
NC - North Carolina.

(a) - Frequency of Detection: number of detects / total number of results.
(b) - The CCR Rule (FR80(74):21302-21501; April 17, 2015) lists these constituents as Constituents for Detection Monitoring (Appendix III).
http://www.gpo.gov/fdsys/pkg/FR-2015-04-17/pdf/2015-00257.pdf
(c) - The CCR Rule lists these constituents as Constituents for Assessment Monitoring (Appendix IV).

Table 6
Summary of NCDEQ-Sampled Background Water Supply Well Data Screening
Water Supply Well Evaluation
Duke Energy
April 2016

Constituents	Units	Frequency of Detection (g)	Frequency of Detection Percent	Range of Detected Concentrations	Frequency Detected Above:				Frequency of Reporting Limits Above:				Frequency of Detects Below All Screening Levels
					2L (a)	DHHS (b)	MCL (c)	RSL (d)	2L (a)	DHHS (b)	MCL (c)	RSL (d)	
Constituents Listed in Appendix III (Detection Monitoring) of the CCR Rule (e)													
Boron	ug/L	6 / 24	25%	5.3 - 135	0	0	--	0	0	0	--	0	6
Calcium	ug/L	24 / 24	100%	1,680 - 74,200	--	--	--	--	-	--	--	--	--
Chloride	mg/L	24 / 24	100%	1.6 - 38	0	0	0	--	0	0	0	--	24
pH	su	24 / 24	100%	5.15 - 7.85	12	--	12	--	--	--	--	--	--
Sulfate	mg/L	17 / 24	71%	2.1 - 186	0	0	0	--	0	0	0	--	17
Total Dissolved Solids	mg/L	23 / 24	96%	51 - 373	0	--	0	--	0	--	0	--	23
Constituents Listed in Appendix IV (Assessment Monitoring) of the CCR Rule (f)													
Antimony	ug/L	0 / 24	0%	NA	0	0	0	0	0	0	0	0	0
Arsenic	ug/L	2 / 24	8%	4.4 - 4.4	0	0	0	2	0	0	0	22	0
Barium	ug/L	24 / 24	100%	0.89 - 77.3	0	0	0	0	0	0	0	0	24
Beryllium	ug/L	0 / 24	0%	NA	0	0	0	0	0	0	0	0	0
Cadmium	ug/L	0 / 24	0%	NA	0	0	0	0	0	0	0	0	0
Chromium	ug/L	18 / 24	75%	0.51 - 5	0	0	0	0	0	0	0	0	18
Cobalt	ug/L	0 / 24	0%	NA	0	0	--	0	0	0	--	0	0
Lead	ug/L	18 / 24	75%	0.12 - 3.2	0	0	0	0	0	0	0	0	18
Mercury	ug/L	0 / 24	0%	NA	0	0	0	0	0	0	0	0	0
Molybdenum	ug/L	6 / 24	25%	0.58 - 4.9	--	0	--	0	--	0	--	0	6
Selenium	ug/L	2 / 24	8%	0.52 - 0.72	0	0	0	0	0	0	0	0	2
Thallium	ug/L	0 / 24	0%	NA	0	0	0	0	0	0	0	0	0
Constituents Not Identified in the CCR Rule													
Vanadium	ug/L	19 / 24	79%	1 - 23.7	19	19	--	0	5	5	--	0	0
Aluminum	ug/L	5 / 24	21%	12.1 - 213	--	0	3	0	--	0	0	0	2
Copper	mg/L	21 / 24	88%	0.001 - 0.0161	0	0	0	0	0	0	0	0	21
Iron	ug/L	6 / 24	25%	57.5 - 1,340	1	0	1	0	0	0	0	0	5
Hexavalent Chromium	ug/L	12 / 24	50%	0.14 - 4.5	--	12	--	0	--	11	--	0	0
Magnesium	ug/L	24 / 24	100%	808 - 28,800	--	--	--	--	--	--	--	--	--
Manganese	ug/L	16 / 24	67%	0.5 - 271	0	1	0	0	0	0	0	0	15
Nickel	ug/L	6 / 24	25%	0.53 - 1.8	0	0	--	0	0	0	--	0	6
Potassium	ug/L	24 / 24	100%	265 - 3,450	--	--	--	--	--	--	--	--	--
Sodium	ug/L	24 / 24	100%	4,610 - 29,900	--	3	--	--	--	0	--	--	21
Strontium	ug/L	24 / 24	100%	12.2 - 1150	--	0	--	0	--	0	--	0	24
Zinc	mg/L	17 / 24	71%	0.0051 - 0.147	0	0	0	0	0	0	0	0	17
Alkalinity	mg/L	24 / 24	100%	7.4 - 226	--	--	--	--	--	--	--	--	--
Bicarbonate	mg/L	23 / 24	96%	7.4 - 226	--	--	--	--	--	--	--	--	--
Carbonate	mg/L	0 / 24	0%	NA	--	--	--	--	--	--	--	--	--
Total Suspended Solids	mg/L	4 / 24	17%	4.2 - 20.6	--	--	--	--	--	--	--	--	--
Turbidity	NTU	4 / 24	17%	2 - 10.6	--	--	--	--	--	--	--	--	--
Temperature	°C	24 / 24	NA	15.25 - 17.68	--	--	--	--	--	--	--	--	--
Specific Conductance	umhos/cm	24 / 24	NA	0.053 - 0.9	--	--	--	--	--	--	--	--	--
Dissolved Oxygen	mg/L	24 / 24	NA	0.32 - 9.86	--	--	--	--	--	--	--	--	--
Oxidation Reduction Potential	mV	24 / 24	NA	-63 - 241	--	--	--	--	--	--	--	--	--
Total Number of Analyses:		**936**	**Total Number of Exceedances:**		**32**	**35**	**16**	**2**	**5**	**16**	**0**	**22**	**249**

Table 6
Summary of NCDEQ-Sampled Background Water Supply Well Data Screening
Water Supply Well Evaluation
Duke Energy
April 2016

Notes:

°C - Degrees Celsius.
mg/L - milligrams/liter.
mV - millivolts.
NTU - Nephelometric Turbidity Units.
su - standard units.
ug/L - micrograms/liter.
umhos/cm - micromhos/centimeter.

CCR - Coal Combustion Residual.
DENR - Department of Environment and Natural Resources.
DEQ - Department of Environmental Quality.
DHHS - Department of Health and Human Services.
HI - Hazard Index.
IMAC - Interim Maximum Allowable Concentration.

MCL - Maximum Contaminant Level.
NC - North Carolina.
RSL - Risk Based Screening Level.
SMCL - Secondary Maximum Contaminant Level.
USEPA - United States Environmental Protection Agency.
-- - No Standard Available.

(a) - Classifications and Water Quality Standards Applicable to Groundwaters of North Carolina. North Carolina Administrative Code. April 1, 2013.
http://portal.ncdenr.org/web/wq/ps/csu/gwstandards
(b) - DHHS Screening Levels. Department of Health and Human Services, Division of Public Health, Epidemiology Section, Occupational and Environmental Epidemiology Branch. http://portal.ncdenr.org/c/document_library/get_file?p_l_id=1169848&folderId=24814087&name=DLFE-112704.pdf
(c) - USEPA 2012 Edition of the Drinking Water Standards and Health Advisories. Spring 2012.
http://water.epa.gov/drink/contaminants/index.cfm
(d) - USEPA Risk Based Screening Levels (November 2015). Values for tap water. HI = 1.
http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm
(e) - The CCR Rule (FR80(74):21302-21501; April 17, 2015) lists these constituents as Constituents for Detection Monitoring (Appendix III).
http://www.gpo.gov/fdsys/pkg/FR-2015-04-17/pdf/2015-00257.pdf
(f) - The CCR Rule lists these constituents as Constituents for Assessment Monitoring (Appendix IV).
(g) - Frequency of Detection: number of detects / total number of results.

Table 7
Statistical Summary of Duke Energy-Sampled Background Water Supply Well Data
Water Supply Well Evaluation
Duke Energy
April 2016

Constituents	Units	Frequency of Detection (a)	Frequency of Detection Percent	Range of Detected Concentrations	Mean Detect	10th Percentile	25th Percentile	50th Percentile	75th Percentile	90th Percentile
Constituents Listed in Appendix III (Detection Monitoring) of the CCR Rule (b)										
Boron	ug/L	39 / 198	20%	5.1 - 928	96.69	5	5.6	50	50	50
Calcium	ug/L	198 / 198	100%	14 - 195,000	22,946	3,273	7,485	13,750	29,975	53,360
Chloride	mg/L	66 / 66	100%	0.62 - 290	24.39	1.6	2.9	6.3	12.5	31.5
pH	su	65 / 65	100%	4.54 - 11.7	7.245	6.508	6.9	7.31	7.73	8.06
Sulfate	mg/L	63 / 66	95%	0.26 - 170	11.17	0.43	1.325	5.2	12.75	19.5
Total Dissolved Solids	mg/L	50 / 50	100%	42 - 760	198.4	65.5	96.25	140	200	439
Constituents Listed in Appendix IV (Assessment Monitoring) of the CCR Rule (c)										
Antimony	ug/L	100 / 198	51%	0.5 - 1.5	0.976	0.551	0.94	1	1.035	1.15
Arsenic	ug/L	27 / 198	14%	0.52 - 14.1	2.65	0.5	0.5	1	1	1.003
Barium	ug/L	176 / 198	89%	0.47 - 486	47.89	5	6.2	20	57.5	116.9
Beryllium	ug/L	7 / 198	4%	0.2 - 0.5	0.349	0.2	0.2	1	1	1
Cadmium	ug/L	8 / 198	4%	0.01 - 1.17	0.284	0.08	0.08	1	1	1
Chromium	ug/L	32 / 198	16%	0.5 - 157	11.28	0.5	0.5	5	5	5
Cobalt	ug/L	21 / 198	11%	0.58 - 25.9	3.47	0.5	0.5	1	1	1
Lead	ug/L	113 / 198	57%	0.12 - 73.2	3.009	0.2	0.643	1	1.303	3.09
Mercury	ug/L	1 / 198	1%	0.27 - 0.27	0.27	0.05	0.05	0.05	0.2	0.2
Molybdenum	ug/L	49 / 198	25%	0.52 - 10.8	2.438	0.5	0.5	1	1	1.891
Selenium	ug/L	10 / 198	5%	0.59 - 1.7	1.188	0.5	0.5	1	1	1
Thallium	ug/L	3 / 198	2%	0.18 - 0.554	0.363	0.1	0.1	0.2	0.2	0.2
Constituents Not Identified in the CCR Rule										
Vanadium	ug/L	107 / 198	54%	0.318 - 112	6.035	0.3	0.471	1	2.638	8.782
Aluminum	ug/L	98 / 198	49%	5 - 32,200	725.6	5	6	10	21.75	79.02
Copper	mg/L	131 / 198	66%	0.0011 - 0.992	0.0445	0.00227	0.005	0.005	0.0214	0.0619
Iron	ug/L	131 / 198	66%	10 - 45,000	1,410	10	18.25	50	300.8	2,059
Hexavalent Chromium	ug/L	72 / 128	56%	0.033 - 73.5	1.656	0.03	0.03	0.115	0.6	1.29
Magnesium	ug/L	197 / 198	99%	14.2 - 46,300	5,244	800.6	1,868	3,520	5,928	11,880
Manganese	ug/L	130 / 198	66%	0.56 - 4,820	124.9	2.37	5	7	34.53	103.7
Nickel	ug/L	39 / 198	20%	0.53 - 380	14.02	0.5	0.575	5	5	5
Potassium	ug/L	198 / 198	100%	123 - 32,700	2,344	535.5	1,113	1,720	2,518	3,912
Sodium	ug/L	198 / 198	100%	763 - 200,000	15,777	4,377	5,960	8,460	11,775	21,450
Strontium	ug/L	193 / 194	99%	0.88 - 2,210	175.2	26.39	55.35	107	190	354.8
Zinc	ug/L	155 / 198	78%	5 - 2,990	143.7	5	6	16.35	61.65	233.9
Alkalinity	mg/L	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bicarbonate	mg/L	NA	NA	NA	NA	NA	NA	NA	NA	NA
Carbonate	mg/L	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Suspended Solids	mg/L	8 / 72	11%	5 - 970	135.3	5	5	5	5	5
Turbidity	NTU	NA	NA	NA	NA	NA	NA	NA	NA	NA
Temperature	°C	NA	NA	NA	NA	NA	NA	NA	NA	NA
Specific Conductance	umhos/cm	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved Oxygen	mg/L	NA	NA	NA	NA	NA	NA	NA	NA	NA
Oxidation Reduction Potential	mV	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Number of Analyses:		**5,393**								

Table 7
Statistical Summary of Duke Energy-Sampled Background Water Supply Well Data
Water Supply Well Evaluation
Duke Energy
April 2016

Notes:

°C - Degrees Celsius.
mg/L - milligrams/liter.
mV - millivolts.
NTU - Nephelometric Turbidity Units.
su - standard units.
ug/L - micrograms/liter.
umhos/cm - micromhos/centimeter.

BTV - Background Threshold Value.
CCR - Coal Combustion Residual.
DENR - Department of Environment and Natural Resources.
DEQ - Department of Environmental Quality.
DHHS - Department of Health and Human Services.
HI - Hazard Index.
IMAC - Interim Maximum Allowable Concentration.

KM - Kaplan-Meier
MCL - Maximum Contaminant Level.
NC - North Carolina.
RSL - Risk Based Screening Level.
SMCL - Secondary Maximum Contaminant Level.
USEPA - United States Environmental Protection Agency.
USL - Upper Simultaneous Limit
WH - Wilson Hilferty.

(a) - Frequency of Detection: number of detects / total number of results.
(b) - The CCR Rule (FR80(74):21302-21501; April 17, 2015) lists these constituents as Constituents for Detection Monitoring (Appendix III).
http://www.gpo.gov/fdsys/pkg/FR-2015-04-17/pdf/2015-00257.pdf
(c) - The CCR Rule lists these constituents as Constituents for Assessment Monitoring (Appendix IV).

Table 8
Summary of Duke Energy-Sampled Background Water Supply Well Data Screening
Water Supply Well Evaluation
Duke Energy
April 2016

Constituents	**Units**	**Frequency of Detection (g)**	**Frequency of Detection Percent**	**Range of Detected Concentrations**	**Frequency Detected Above:**				**Frequency of Reporting Limits Above:**				**Frequency of Detects Below All Screening Levels**
					2L (a)	**DHHS (b)**	**MCL (c)**	**RSL (d)**	**2L (a)**	**DHHS (b)**	**MCL (c)**	**RSL (d)**	
Constituents Listed in Appendix III (Detection Monitoring) of the CCR Rule (e													
Boron	ug/L	39 / 198	20%	5.1 - 928	1	1	--	0	0	0	--	0	38
Calcium	ug/L	198 / 198	100%	14 - 195,000	--	--	--	--	--	--	--	--	--
Chloride	mg/L	66 / 66	100%	0.62 - 290	2	2	2	--	0	0	0	--	64
pH	su	65 / 65	100%	4.54 - 11.7	7	--	7	--	0	--	0	--	58
Sulfate	mg/L	63 / 66	95%	0.26 - 170	0	0	0	--	0	0	0	--	63
Total Dissolved Solids	mg/L	50 / 50	100%	42 - 760	5	--	5	--	0	--	0	--	45
Constituents Listed in Appendix IV (Assessment Monitoring) of the CCR Rule (f													
Antimony	ug/L	100 / 198	51%	0.5 - 1.5	51	51	0	0	0	0	0	0	49
Arsenic	ug/L	27 / 198	14%	0.52 - 14.1	1	1	1	27	0	0	0	171	0
Barium	ug/L	176 / 198	89%	0.47 - 486	0	0	0	0	0	0	0	0	176
Beryllium	ug/L	7 / 198	4%	0.2 - 0.5	0	0	0	0	0	0	0	0	7
Cadmium	ug/L	8 / 198	4%	0.01 - 1.17	0	0	0	0	0	0	0	0	8
Chromium	ug/L	32 / 198	16%	0.5 - 157	3	3	2	0	0	0	0	0	29
Cobalt	ug/L	21 / 198	11%	0.58 - 25.9	15	15	--	2	0	0	--	0	6
Lead	ug/L	113 / 198	57%	0.12 - 73.2	5	5	5	5	0	0	0	0	108
Mercury	ug/L	1 / 198	1%	0.27 - 0.27	0	0	0	0	0	0	0	0	1
Molybdenum	ug/L	49 / 198	25%	0.52 - 10.8	--	0	--	0	--	0	--	0	49
Selenium	ug/L	10 / 198	5%	0.59 - 1.7	0	0	0	0	0	0	0	0	10
Thallium	ug/L	3 / 198	2%	0.18 - 0.554	2	2	0	2	0	0	0	0	1
Constituents Not Identified in the CCR Rule													
Vanadium	ug/L	107 / 198	54%	0.318 - 112	107	107	--	1	52	52	--	0	0
Aluminum	ug/L	98 / 198	49%	5 - 32,200	--	3	31	2	--	0	0	0	67
Copper	mg/L	131 / 198	66%	0.0011 - 0.992	0	0	0	1	0	0	0	0	130
Iron	ug/L	131 / 198	66%	10 - 45,000	50	16	50	2	0	0	0	0	81
Hexavalent Chromium	ug/L	72 / 128	56%	0.033 - 73.5	--	61	--	1	--	13	--	0	11
Magnesium	ug/L	197 / 198	99%	14.2 - 46,300	--	--	--	--	--	--	--	--	--
Manganese	ug/L	130 / 198	66%	0.56 - 4,820	40	13	40	7	0	0	0	0	90
Nickel	ug/L	39 / 198	20%	0.53 - 380	1	1	--	0	0	0	--	0	38
Potassium	ug/L	198 / 198	100%	123 - 32,700	--	--	--	--	--	--	--	--	--
Sodium	ug/L	198 / 198	100%	763 - 200,000	--	24	--	--	--	0	--	--	174
Strontium	ug/L	193 / 194	99%	0.88 - 2,210	--	1	--	0	--	0	--	0	192
Zinc	ug/L	155 / 198	78%	5 - 2,990	5	5	0	0	0	0	0	0	150
Alkalinity	mg/L	NA	NA	NA	--	--	--	--	--	--	--	--	--
Bicarbonate	mg/L	NA	NA	NA	--	--	--	--	--	--	--	--	--
Carbonate	mg/L	NA	NA	NA	--	--	--	--	--	--	--	--	--
Total Suspended Solids	mg/L	8 / 72	11%	5 - 970	--	--	--	--	--	--	--	--	--
Turbidity	NTU	NA	NA	NA	--	--	--	--	--	--	--	--	--
Temperature	°C	NA	NA	NA	--	--	--	--	--	--	--	--	--
Specific Conductance	umhos/cm	NA	NA	NA	--	--	--	--	--	--	--	--	--
Dissolved Oxygen	mg/L	NA	NA	NA	--	--	--	--	--	--	--	--	--
Oxidation Reduction Potential	mV	NA	NA	NA	--	--	--	--	--	--	--	--	--
Total Number of Analyses:		**5,393**	**Total Number of Exceedances:**		**295**	**311**	**143**	**50**	**52**	**65**	**0**	**171**	**1,645**

Table 8
Summary of Duke Energy-Sampled Background Water Supply Well Data Screening
Water Supply Well Evaluation
Duke Energy
April 2016

Notes:

°C - Degrees Celsius.
mg/L - milligrams/liter.
mV - millivolts.
NTU - Nephelometric Turbidity Units.
su - standard units.
ug/L - micrograms/liter.
umhos/cm - micromhos/centimeter.

BTV - Background Threshold Value.
CCR - Coal Combustion Residual.
DENR - Department of Environment and Natural Resources.
DEQ - Department of Environmental Quality.
DHHS - Department of Health and Human Services.
HI - Hazard Index.
IMAC - Interim Maximum Allowable Concentration.

KM - Kaplan-Meier.
MCL - Maximum Contaminant Level.
NC - North Carolina.
RSL - Risk Based Screening Level.
SMCL - Secondary Maximum Contaminant Level.
USEPA - United State-- - No Standard Available.
-- - No Standard Available.

(a) - Classifications and Water Quality Standards Applicable to Groundwaters of North Carolina. North Carolina Administrative Code. April 1, 2013.
http://portal.ncdenr.org/web/wq/ps/csu/gwstandards
(b) - DHHS Screening Levels. Department of Health and Human Services, Division of Public Health, Epidemiology Section, Occupational and Environmenta
Epidemiology Branch. http://portal.ncdenr.org/c/document_library/get_file?p_l_id=1169848&folderId=24814087&name=DLFE-112704.pd
(c) - USEPA 2012 Edition of the Drinking Water Standards and Health Advisories. Spring 2012.
http://water.epa.gov/drink/contaminants/index.cfm
(d) - USEPA Risk Based Screening Levels (November 2015). Values for tap water. HI = 1.
http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm
(e) - The CCR Rule (FR80(74):21302-21501; April 17, 2015) lists these constituents as Constituents for Detection Monitoring (Appendix III).
http://www.gpo.gov/fdsys/pkg/FR-2015-04-17/pdf/2015-00257.pdf
(f) - The CCR Rule lists these constituents as Constituents for Assessment Monitoring (Appendix IV)
(g) - Frequency of Detection: number of detects / total number of results

Table 9
Summary of Available Background Data for Groundwater
Water Supply Well Evaluation
Duke Energy
April 2016

			USGS						North Carolina Private Wells	
	Constituents	**Units**	**USGS (c) 1992-2003 10th Percentile**	**USGS (c) 1992-2003 25th Percentile**	**USGS (c) 1992-2003 Median**	**USGS (c) 1992-2003 75th Percentile**	**USGS (c) 1992-2003 90th Percentile**	**USGS (c) 1992-2003 Maximum**	**NC Private Well Water Range of County Averages 1998-2010 (d)**	**NC Private Well Water Range of County Averages 2010 (d)**
Appendix III (a)	Boron	ug/L	8.5	17	35	82	220	3400	NA	NA
	Calcium	ug/L	NA	NA	NA	NA	NA	NA	NA	NA
	Chloride	mg/L	NA	NA	NA	NA	NA	NA	NA	NA
	pH	su	NA	NA	NA	NA	NA	NA	5.36 - 8.32	5.02 - 8.36
	Sulfate	mg/L	NA	NA	NA	NA	NA	NA	NA	NA
	Total Dissolved Solids	mg/L	NA	NA	NA	NA	NA	NA	NA	NA
Appendix IV (b)	Antimony	ug/L	< 1	< 1	< 1	< 1	< 1	6.3	NA	NA
	Arsenic	ug/L	0.079	0.23	0.79	3.0	7.4	550	0.83 - 10	2.44 - 13.06
	Barium	ug/L	9.0	24	54	120	220	5100	50.00 - 1,607.60	50.00 - 3,351.22
	Beryllium	ug/L	< 1	< 1	< 1	< 1	< 1	18	NA	NA
	Cadmium	ug/L	< 1	< 1	< 1	< 1	< 1	16	0.50 - 5.00	0.49 - 5.00
	Chromium	ug/L	0.41	0.68	1.2	3.0	5.2	150	4.88 - 713.60	0.49 - 100.00
	Cobalt	ug/L	0.026	0.063	0.17	0.48	1.1	680	NA	NA
	Lead	ug/L	0.005	0.018	0.070	0.27	1.0	480	2.5 - 104.83	2.44 - 105.39
	Mercury	ug/L	NA	NA	NA	NA	NA	NA	0.25 - 2.00	0.25 - 2.0
	Molybdenum	ug/L	0.13	0.32	1.0	3.3	8.0	4700	NA	NA
	Selenium	ug/L	0.04	0.12	0.34	1.0	3.0	94	2.38 - 100.00	2.44 - 100.00
	Thallium	ug/L	< 1	< 1	< 1	< 1	< 1	< 1	NA	NA
Constituents Not Identified in the CCR Rule	Vanadium	ug/L	0.11	0.295	1.4	11	27	190	NA	NA
	Aluminum	ug/L	0.43	0.98	3.0	4.9	11	1100	NA	NA
	Copper	mg/L	0.00020	0.00047	0.0010	0.0030	0.0085	2.0	0.025 - 9.62092	0.025 - 81.74479
	Iron	ug/L	0.095	0.81	7.9	93	1500	81000	228.24 - 125,698.66	50.00 - 1,100,356.35
	Hexavalent Chromium	ug/L	NA	NA	NA	NA	NA	NA	NA	NA
	Magnesium	ug/L	NA	NA	NA	NA	NA	NA	50.00 - 40,031.32	50.00 - 137,878.48
	Manganese	ug/L	0.14	0.85	7.0	84	360	28000	19.51 - 209.54	15.00 - 281.71
	Nickel	ug/L	0.15	0.35	1.1	2.5	4.9	670	NA	NA
	Potassium	ug/L	NA	NA	NA	NA	NA	NA	NA	NA
	Sodium	ug/L	NA	NA	NA	NA	NA	NA	4,500 - 102,484	1 - 20,000
	Strontium	ug/L	46	100	270	680	1700	44000	NA	NA
	Zinc	mg/L	0.00043	0.0016	0.0048	0.018	0.069	3.3	0.03182 - 10.00	0.025 - 10.00
	Alkalinity	mg/L	NA	NA	NA	NA	NA	NA	NA	NA
	Bicarbonate	mg/L	NA	NA	NA	NA	NA	NA	NA	NA
	Carbonate	mg/L	NA	NA	NA	NA	NA	NA	NA	NA
	Total Suspended Solids	mg/L	NA	NA	NA	NA	NA	NA	NA	NA
	Turbidity	NTU	NA	NA	NA	NA	NA	NA	NA	NA
	Temperature	°C	NA	NA	NA	NA	NA	NA	NA	NA
	Specific Conductance	umhos/cm	NA	NA	NA	NA	NA	NA	NA	NA
	Dissolved Oxygen	mg/L	NA	NA	NA	NA	NA	NA	NA	NA
	Oxidation Reduction Potential	mV	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

°C - Degrees Celsius.
mg/L - milligrams/liter.
mV - millivolts.
NTU - Nephelometric Turbidity Units.
su - Standard units.
ug/L - micrograms/liter.
umhos/cm - micromhos/centimeter.

CCR - Coal Combustion Residual.
DEQ - Department of Environmental Quality.
DHHS - Department of Health and Human Services.
HI - Hazard Index.
NA - Not Available.
NC - North Carolina.
USGS - United States Geological Survey.

(a) - The CCR Rule lists these constituents as Constituents for Detection Monitoring (Appendix III).
http://www.gpo.gov/fdsys/pkg/FR-2015-04-17/pdf/2015-00257.pdf
(b) - The CCR Rule lists these constituents as Constituents for Assessment Monitoring (Appendix IV).
(c) - Trace Elements and Radon in Groundwater Across the United States, 1992–2003. USGS, 2011. Scientific Investigations Report 2011–5059.
http://water.usgs.gov/nawqa/trace/pubs/sir2011-5059/
(d) - North Carolina Public Health – Epidemiology - Well Water & Health - Maps by Contaminant Name
http://epi.publichealth.nc.gov/oee/wellwater/by_contaminant.html

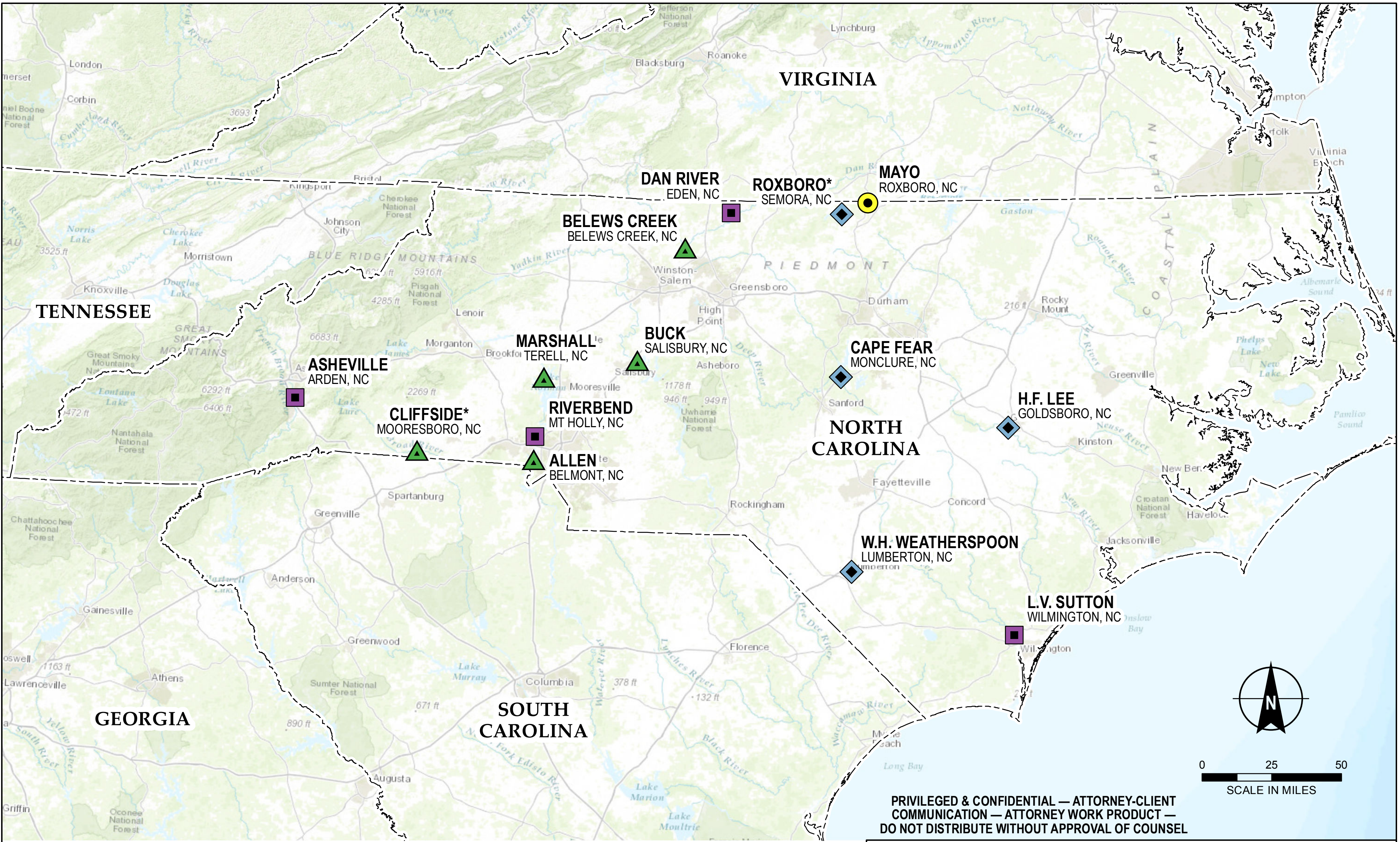
Table 10
Comparison of Background Threshold Values
Water Supply Well Evaluation
Duke Energy
April 2016

Constituent	**Units**	**Allen**		**Belews Creek**		**Buck**		**Cliffside**		**Marshall**		**Mayo**		**Roxboro**	
		Regional BTVs	**Facility-Specific BTVs**	**Regional BTVs**	**Facility-Specific BTVs**	**Regional BTVs**	**Facility-Specific BTVs**	**Regional BTVs**	**Facility-Specific BTVs**	**Regional BTVs**	**Facility-Specific BTVs**	**Regional BTVs**	**Facility-Specific BTVs**	**Regional BTVs**	**Facility-Specific BTVs**
Barium	ug/L	103.1	99	126.8	16.98	56.09	87	112.9	36	208.3	890	83.03	132.9	126.8	349
Boron	ug/L	10.12	30	50	37	6	54.02	50	59.7	67.25	29	12.6	65	9	50
Chloride	ug/L	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	130000
Chromium	ug/L	NA	NA	NA	NA	NA	NA	NA	NA	5.253	10.61	NA	NA	NA	NA
Cobalt	ug/L	1	1.913	0.6	1.167	1	0.395	4.751	4.74	1.33	4.48	1	1.08	3.6	14.41
Hexavalent Chromium	ug/L	4.539	34.3	2.2	0.766	2.554	0.761	0.27	1.517	3.304	11	1.646	13.6	0.65	4.401
Iron	ug/L	260.9	2334	610.9	1022	334	257.8	12836	3801	3920	1000	537.6	3780	6862	5368
Lead	ug/L	1.462	3.271	29.57	1.15	2.617	0.167	NA	NA	4.022	0.28	4.078	4.694	16.4	0.11
Manganese	ug/L	NA	NA	NA	NA	66.4	5.799	173.2	134.1	NA	NA	NA	NA	952.1	1220
Nickel	ug/L	7.416	14.8	3	4.838	2.678	1.566	7	13.2	3.681	9	2.512	2.073	380	17.9
Sodium	ug/L	NA	NA	NA	NA	21695	80400	NA	NA	NA	NA	NA	NA	NA	NA
Sulfate	mg/L	NA	NA	NA	NA	33.46	105000	NA	NA	NA	NA	NA	NA	NA	NA
Thallium	ug/L	0.2	0.346	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Vanadium	ug/L	20.27	24.3	3.606	9	16.77	167	6.337	19.77	14.7	23.8	11.22	11.4	7.351	19.26
Zinc	mg/L	NA	NA	NA	NA	0.491	26	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

BTV - Background Threshold Value.
mg/L - milligrams/liter.
NA - Not available/Not applicable.
ug/L - micrograms/liter.

See Appendices for additional BTV information.



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DRAFT ASH BASIN RISK CLASSIFICATION

- ■ HIGH
- ◆ INTERMEDIATE
- ▲ LOW TO INTERMEDIATE
- ● LOW

NOTES

1. * DENOTES FACILITY HAS MORE THAN ONE CLASSIFICATION:
ROXBORO: INTERMEDIATE, LOW TO INTERMEDIATE, AND LOW
CLIFFSIDE: LOW TO INTERMEDIATE, AND LOW

2. SOURCE: NCDEQ. COAL COMBUSTION RESIDUAL IMPOUNDMENT RISK CLASSIFICATIONS. JANUARY 2016. AVAILABLE AT:
https://ncdenr.s3.amazonaws.com/s3fs-public/document-library/
1.29.16_Coal Combustion Residual Impoundment Classifications.pdf

3. BASE MAP SOURCE: ESRI

HALEY ALDRICH

WATER SUPPLY WELL EVALUATION
DUKE ENERGY

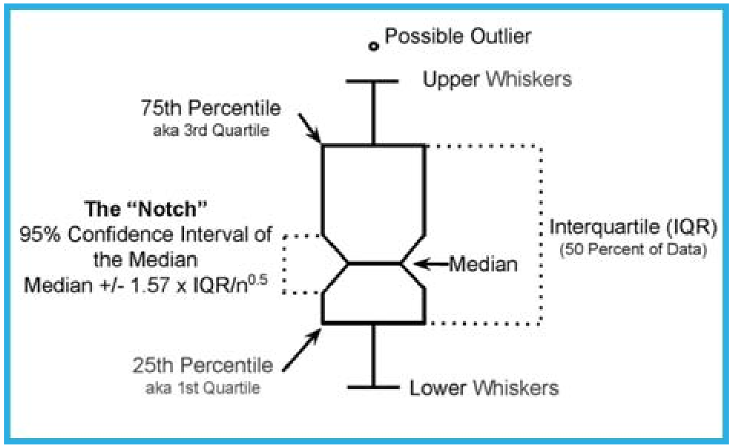
NORTH CAROLINA DEPARTMENT OF ENVIRONMENTAL QUALITY: DRAFT ASH BASIN RISK CLASSIFICATION

APRIL 2016

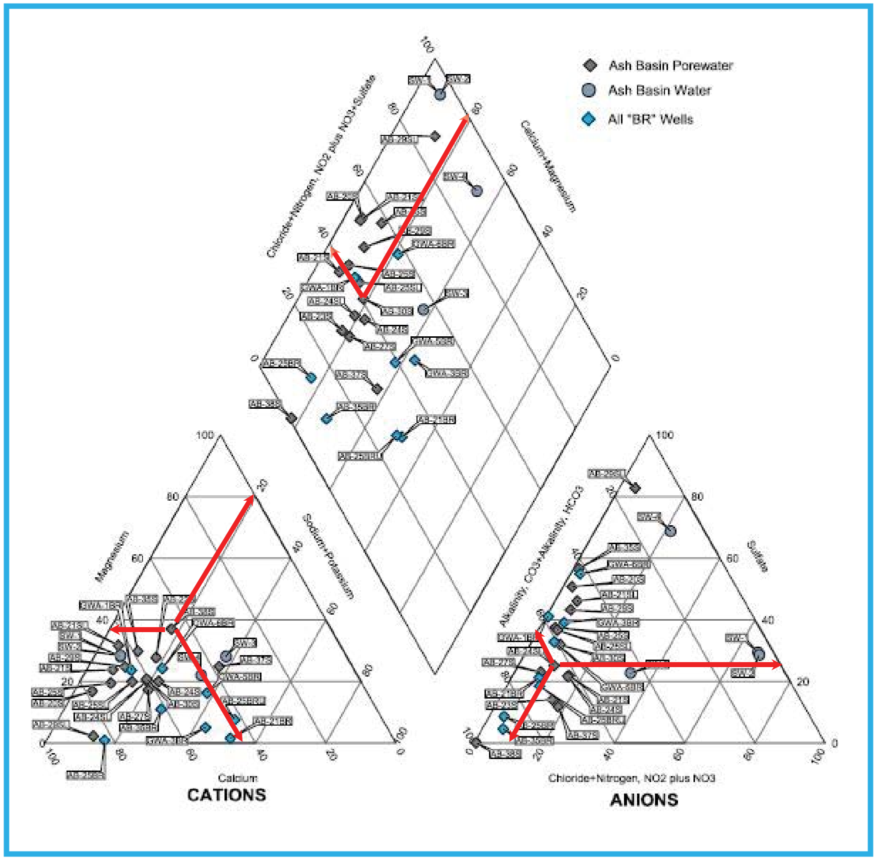
FIGURE 1

GIS FILE PATH: \\bos\common\43239_DukeEnergy\Global\GIS\Maps\2016_04\43239_000_0000_RISK_CLASSIFICATION.mxd — USER: craumann — LAST SAVED: 4/14/2016 2:21:39 PM

Panel (a): Example Box Plot



Panel (b): Example Piper Plot



NOTES

1. BOX PLOT EXPLANATION DIAGRAM ADOPTED FROM HTTP://SITES.GOOGLE.COM/SITE/DAVIDSSTATISTICS/HOME/NOTCHED-BOX-PLOTS.

2. PIPER PLOT ADOPTED FROM CSA REPORT FOR ALLEN STEAM STATION BY HDR.

HALEY
ALDRICH

WATER SUPPLY WELL EVALUATION
DUKE ENERGY

EXAMPLE BOX PLOT
AND PIPER PLOT

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FIGURE 2