Stantec Consulting Services Inc.
3052 Beaumont Circle, Lexington KY 40513

October 10, 2018
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Revision 0

Tennessee Valley Authority (TVA)
1101 Market Street
Chattanooga, Tennessee 37402

RE: Unstable Areas Demonstration
Dry Fly Ash Stack Lateral Expansion
EPA Final Coal Combustion Residuals (CCR) Rule
TVA Bull Run Fossil Plant
Clinton, Tennessee

1.0 PURPOSE

As described in 40 CFR § 257.64(a), an owner or operator of an existing CCR landfill is required to demonstrate that the unit is not located in unstable areas unless the unit meets certain requirements. This letter documents Stantec's certification that the Dry Fly Ash Stack Lateral Expansion at the TVA Bull Run Fossil Plant (BRF) complies with the location restrictions for unstable areas in the EPA Final CCR Rule at 40 CFR § 257.64(a).

2.0 SUMMARY OF FINDINGS

The attached demonstration documents that the Dry Fly Ash Stack Lateral Expansion meets the requirements set forth 40 CFR § 257.64(a).

3.0 QUALIFIED PROFESSIONAL ENGINEER CERTIFICATION

I, Hugo Aparicio, being a Professional Engineer in good standing in the State of Tennessee, do hereby certify, to the best of my knowledge, information, and belief:

1. that the information contained in this certification is prepared in accordance with the accepted practice of engineering;

2. that the information contained herein is accurate as of the date of my signature below; and

3. that the TVA Bull Run Dry Fly Ash Stack Lateral Expansion meets the requirements specified in 40 CFR § 257.64(a).

Re: **Unstable Areas Demonstration**
Dry Fly Ash Stack Lateral Expansion
EPA Final Coal Combustion Residuals (CCR) Rule
TVA Bull Run Fossil Plant
Clinton, Tennessee

SIGNATURE ______________________ DATE 10/10/2018

ADDRESS: Stantec Consulting Services Inc.
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Lexington, Kentucky 40513-1703

TELEPHONE: (859) 422-3000

ATTACHMENTS: Unstable Areas Demonstration

Unstable Areas

Bull Run Fossil Plant
Dry Fly Ash Stack Lateral Expansion
Clinton, Tennessee

Prepared for:
Tennessee Valley Authority
Chattanooga Tennessee

Prepared by:
Stantec Consulting Services Inc.
Lexington, Kentucky

October 10, 2018
Revision 0

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1.0 PROJECT BACKGROUND

On April 17, 2015, EPA published the "Disposal of Coal Combustion Residuals (CCR) from Electric Utilities" final rule in the Federal Register. The Tennessee Valley Authority (TVA) contracted Stantec Consulting Services Inc. (Stantec) to evaluate the Dry Fly Ash Stack Lateral Expansion at the Bull Run Fossil Plant (BRF) regarding the requirements for the Unstable Areas Location Restriction as required by the EPA Final CCR Rule, 40 C.F.R. § 257.64.

As required by §257.64 of the EPA Final CCR Rule, an owner or operator of an existing or new CCR landfill, existing or new CCR surface impoundment, or any lateral expansion of a CCR unit is required by October 17, 2018, to demonstrate that the unit is not located in an unstable area unless the owner or operator demonstrates that generally accepted good engineering practices have been incorporated into the design of the CCR unit to promote the geotechnical integrity of the unit in such a manner that structural components of the CCR unit will not be disrupted.

The Dry Fly Ash Stack Lateral Expansion has been identified as a CCR landfill on the BRF site. As defined by §257.53 of the EPA Final CCR Rule, the Dry Fly Ash Stack Lateral Expansion is characterized as, "…an area of land or an excavation that receives CCR and which is not a surface impoundment, an underground injection well, a salt dome formation, a salt bed formation, an underground or surface coal mine, or a cave."

The following factors have been considered to determine whether the Dry Fly Ash Stack Lateral Expansion located at BRF is located in an unstable area:

- On-site or local soil conditions that may result in significant differential settling;
- On-site or local geologic or geomorphologic features; and
- On-site or local human-made features or events (both surface and subsurface).

2.0 UNIT DESCRIPTION

BRF is a coal-fired, electric-generating plant located in Anderson County, Tennessee. The plant is situated on the east bank of Clinch River north of Bull Run Creek near river mile 48, approximately 10 miles west of Knoxville. More specifically, the site is approximately 4 miles east of Oak Ridge, Tennessee and five miles south of Clinton, Tennessee off Edgemoor Road.

Figure 1. Site Vicinity Map

Unit Description
October 10, 2018

The Dry Fly Ash Stack (DFAS) Lateral Expansion area is located to the northeast of the main plant and coal yard and is comprised of multiple phased landfills built concurrently. The DFAS Phase I and II areas were permitted together as a Class II Landfill and went into operation in 1983 (permit No. IDL 01-103-0080). Construction of the Phase I area cap was completed in 1992. The Phase II area stacking began in 1989, overlapping the Phase I area, and is currently inactive (Tennessee Valley Authority (TVA), 2006).

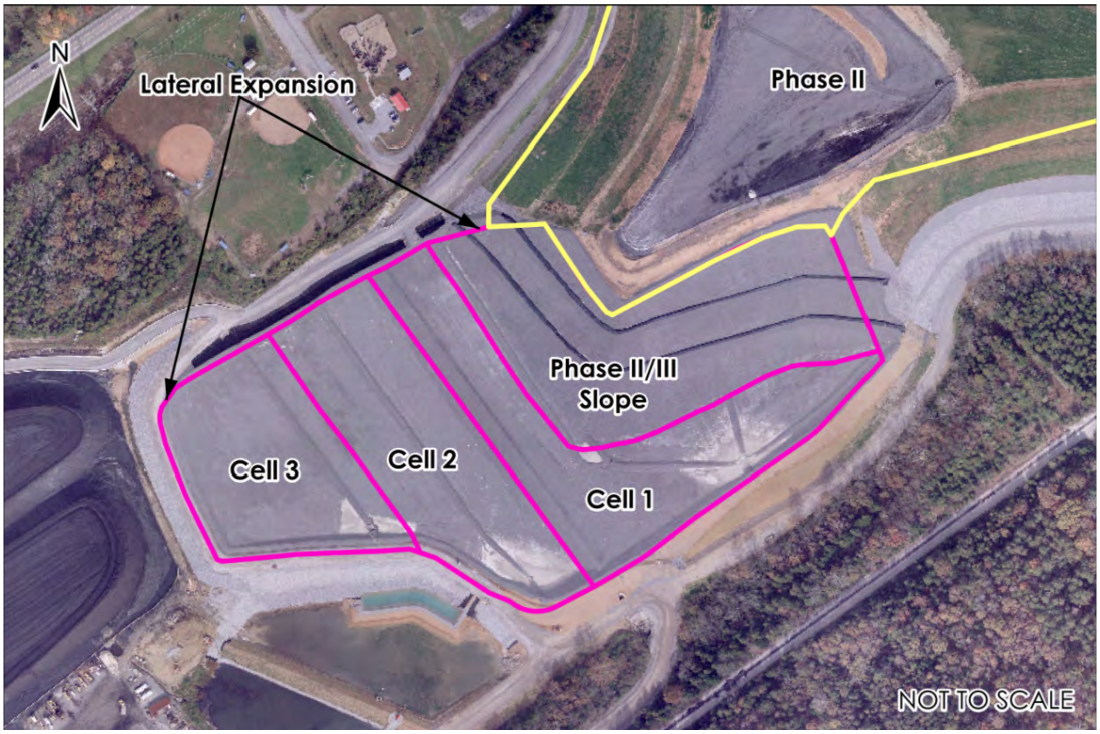

Figure 2. Dry Fly Ash Stack Unit Configuration

The placement of ash within the DFAS Lateral Expansion began in 2015 as a part of Phase III, which classifies it as the only active landfill at the BRF site per the CCR Rule.

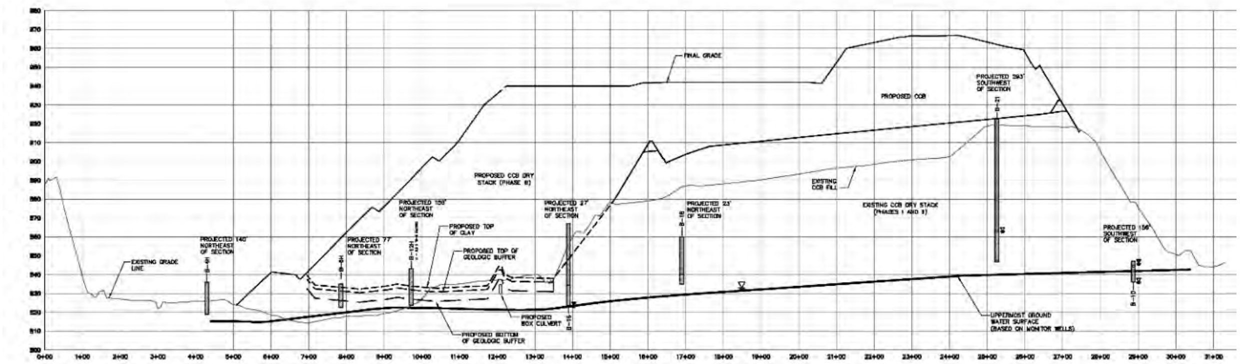

Figure 3. Typical Cross Section

The footprint of the DFAS Lateral Expansion provides approximately 15 additional acres and partially overlaps the southernmost portion of Phase II (Stantec Consulting Services Inc., 2015a). The DFAS Lateral Expansion is permitted to reach elevation 940 feet. A liner system was constructed for the expansion foundation, consisting of a clay geologic buffer, geomembrane liner, geocomposite layer and a capillary break layer (Stantec Consulting Services Inc., 2016).

3.0 SOIL CONDITIONS (§257.64(B)(1))

Per §257.64(b)(1), the unstable areas demonstration must consider on-site or local soil conditions that may result in significant differential settlement when determining whether the area is unstable.

Assessment of the soil conditions was completed considering the following criteria related to the CCR Rule:

- Review inspection reports of the CCR unit for any documented deformations in the soils or movement of structural components indicating possible differential settlement of foundation soils.
- Review published soil surveys that indicate on-site or local presence of soft or compressible soil formation(s).
- Review documentation (including but not limited to geotechnical data reports, construction drawings, and field notes) containing information that may indicate the foundation materials are soft or compressible.
- Review results of existing analyses to confirm that settlement of the unit would be negligible (within acceptable limits) and would not cause a release of CCR into the environment.

3.1 BACKGROUND

This section describes the reports, investigations, and records that were reviewed as a part of the determination as it pertains to this portion of the CCR Rule.

The U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS) maintains an online web soil survey tool that provides available data on local soils information for a user-specified Area of Interest. Appendix A includes the Web Soil Survey completed for the BRF site.

According to available geologic data, the site is located within the Great Valley of East Tennessee, a part of the Valley and Ridge Province of the Appalachian Highlands (Stantec Consulting Services Inc., 2011b). Generally, the DFAS Lateral Expansion is underlain by residual soils and man-made fill overlying the Chickamauga formation. The residuum primarily consists of silty clay with fragments of chert, limestone and shale, which was derived from the weathering of the Chickamauga formation (Tennessee Valley Authority (TVA), 2006). The bedrock formation at the site is characterized as a heterogeneous assemblage of limestones, shaley limestones, calcareous shales, and calcareous siltstones of Middle Ordovician age approximately 1,800 feet in thickness (Stantec Consulting Services Inc., 2011b).

Geotechnical explorations of the DFAS Lateral Expansion were reviewed to determine the presence of soft or compressible foundation soils. The soil fill reportedly consisted of brown clays with chert and black manganese nodules. The soil fill exhibited a soft to hard consistency based on SPT resistance values (N-values) ranging between 2 to over 50 blows per foot. The underlying residuum reportedly consisted of orange brown, yellow brown, brown, and tan clays with chert. The residuum exhibited a very soft to hard consistency based on N-values in the range of 1 to over 50 blows per foot. The Hydrogeologic Report (Young & Beard 1989) stated that past grading activities involved cutting and filling of foundation soils, most likely to level the site for construction. The combined thickness of foundation fill and residuum reportedly varies from 2 to 32 feet with an average of 14 feet (Stantec Consulting Services Inc., 2011b).

For the current configuration of the DFAS Lateral Expansion, existing settlement analyses were not identified. Therefore, this demonstration includes a settlement analysis in Appendix B. The analysis calculates the potential settlement due to the future build-out of the permitted Lateral Expansion and discusses possible consequences on the leachate collection system and the bottom liner.

Site inspections of the DFAS Lateral Expansion have been conducted and documented in 2016 and 2017. These inspections were reviewed to identify observations of potential signs of deformations in the soil or movement of structural components, which would indicate differential settlement of the foundation soils. TVA continues to comply with inspection requirements pursuant to the EPA Final CCR Rule and other regulatory requirements.

3.2 ASSESSMENT

Historic soil reports from the USGS and geotechnical exploration reports described in the previous section were reviewed for evidence of soft and compressible soils that may have been on site prior to the development of the DFAS Lateral Expansion. For the purposes of this report, soft and compressible soils are fat clays, elastic silts, organic silts and clays, or highly organic soils (peat). These soil types have Unified Soil Classifications of CH, MH, OH, and PT. The information available from published soil surveys, borings, and the local soils described in Section 3.1 indicates that the soft or compressible soils are present in foundation soils particularly where the lateral expansion overlays the Phase II stack.

The settlement analysis in Appendix B evaluates consolidation of the fill (geologic buffer) and residuum beneath the bottom liner of the Lateral Expansion, as a result of stacking ash to the permitted geometry. Potential effects on the leachate collection system, with respect to post-settlement pipe slopes, are considered. The significance of a concrete box culvert, installed beneath the geologic buffer layer, is considered with respect to potential differential settlement and damage to the overlying liner.

According to this analysis, the post-settlement slopes of the leachate collection system pipes will remain positive, promoting flow in the direction that the design intended. The post-settlement slope of the box culvert will also maintain positive drainage for the stream it conveys. The box culvert has been structurally designed to withstand the proposed loads, and the potential for differential settlement along the culvert alignment is not expected to damage the liner.

UNSTABLE AREAS - BRF DRY FLY ASH STACK LATERAL EXPANSION

Soil Conditions (§257.64(b)(1))
October 10, 2018

There were no indications of deficiencies in the soil slopes or movement of structural components of the DFAS Lateral Expansion according to post-construction inspection records (Tennessee Valley Authority (TVA), 2017).

Based on this assessment of the soil conditions, the CCR Rule-related criteria listed above for soil conditions have been met.

4.0 GEOLOGIC OR GEOMORPHOLOGIC FEATURES (§257.64(B)(2))

Per §257.64(b)(2), the unstable areas demonstration must consider on-site or local geologic or geomorphologic features when determining whether the area is unstable.

Assessment of the geologic or geomorphologic features was completed considering the following criteria related to the CCR Rule:

- Review of published geologic maps that indicate on-site or local geomorphologic features such as:
  - Karst potential;
  - Known sinkhole outlines;
  - Known spring locations; and,
  - Known landslide locations.
- Review of inspection reports of the CCR unit for any documented characteristic features of karstic formation (e.g. sinkholes, vertical shafts, sinking streams, caves, seeps, large springs, or blind valleys).
- Review documentation (including but not limited to geotechnical data reports, construction drawings, and field notes) containing information regarding the on-site or local geology and geomorphology.
- Review of 5-foot and 10-meter Digital Elevation Models (DEMs) derived from 10-meter LiDAR data obtained by the United States Geological Survey (USGS) to identify areas susceptible to mass movement.

4.1 BACKGROUND

This section describes the reports, investigations and records that were reviewed as a part of the determination as it pertains to this portion of the CCR Rule. Appendix C contains a map presenting the geology of the area, a map displaying nearby sinkholes, landslide locations, and springs, and two maps showing 5-foot and 10-meter DEMs that show topography highlighting areas of shallow and steep slopes.

The geologic map of the Clinton Quadrangle, Tennessee published by the Division of Geology, Tennessee (1964) indicates the site is located within the Appalachian Valley and Ridge Province of the Appalachian Highlands. The DFAS Lateral Expansion is situated in what is known as Raccoon Valley that is bordered by Bull Run Ridge to the south and by the Chestnut Ridge to the north. The topography and geology within the vicinity of the plant are typical of the Valley and Ridge

Physiographic Province, characterized by parallel ridges trending northeast to southwest and underlain by more erosion resistant siltstones, sandstones, and dolomites, and valleys underlain by the less erosion resistant shales and limestones. The area has been subjected to several tectonic events that have caused folding, fracturing and faulting of the bedrock throughout the region. A succession of thrust faults within the area has resulted in several bedrock units being present beneath the DFAS Lateral Expansion footprint (Stantec Consulting Services Inc., 2011b).

A Hydrogeologic Evaluation of the proposed horizontal and vertical expansion of the Phase I and II Dry Ash Stacks was conducted by TVA in 2006 to assess the suitability of the Lateral Expansion site with respect to applicable standards of the Tennessee Department of Environment and Conservation (TDEC) Rule 1200-1-7-04. The Chickamauga lithologic units within the DFAS Lateral Expansion appear to lay primarily upon units Och-c and Och-d, and to a lesser extent Och-b and Och-e (Swingle, 1964). Swingle describes Och-c as gray limestone, fine- to coarse-grained, thin- to thick-bedded having total thickness of 300 feet. Och-d consists of gray shaley limestone, fine- to coarse-grained, thin- to thick-bedded having a thickness of 300 feet. Unit Och-b is described as calcareous shale approximately 160 feet in thickness, while Och-e consists of some 400 feet of gray fine- to coarse-grained limestone, thin- to thick-bedded. Bedrock encountered in recent shallow core drilling in and around the proposed disposal area is generally consistent with descriptions of units Och-c through Och-e. Core holes penetrating the upper 10 to 20 feet of rock typically encountered either gray shaley limestone beds or intervals of thin interbedded gray limestone and shale (Tennessee Valley Authority (TVA), 2006).

Rock cores were collected during multiple geotechnical explorations at the DFAS Lateral Expansion site, with the resulting bedrock core samples ranging from approximately 10 to 20.5 feet in length. The bedrock encountered in the test borings typically was composed of gray shaley limestone, occasionally interbedded with maroon to greenish-gray shale. The recovered bedrock was observed to be hard in the limestone and medium hard in the shale. The core recovery ratio for the various core runs ranged from about 57 to 100 percent with an average of about 88 percent. The rock quality designation (RQD) values for the various rock core runs ranged from 4 to 99 percent with an average of about 60 percent (Mactec Engineering and Consulting, Inc., 2006) (Stantec Consulting Services Inc., 2011b).

Site inspections of the DFAS Lateral Expansion have been conducted and documented regularly from 2016 to 2017. These inspections were reviewed to identify observations of potential deficiencies that indicated characteristic features of karstic formations. TVA continues to comply with inspection requirements pursuant to the EPA Final CCR Rule and other regulatory requirements.

4.2 ASSESSMENT

Based on the information presented in the inspection reports of the CCR landfill unit, there have been no documented sinkholes or other characteristic features of karstic formation. As cited within the Hydrogeologic Evaluation of Expanded Dry Fly Ash Disposal Area, "The potential for future sinkhole-related subsidence at the site appears low given the lack of significant karstification of the limestone bedrock. Coring in and around the proposed disposal site indicates the presence of open cavities having dimensions of two feet or less in 33% of coreholes. Limited cavity development is consistent with the prevalence of shaley limestone beds and the absence of observed sinkholes in pre-plant surface topography." (Tennessee Valley Authority (TVA), 2006)

Upon review of the Mactec test boring logs, the rock quality of the DFAS Lateral Expansion was assigned a mostly Fair to Excellent RQD designation. The lower values of recovery and poor RQD value are located in the area of the stilling pond. The shaley limestone was described as shaley hard to hard (Mactec Engineering and Consulting, Inc., 2006). According to the Hydrogeologic Report, no adverse geologic conditions are indicated for the DFAS Lateral Expansion. Karstification of limestone beneath the site has been limited due to the predominance of relatively thin shaley limestone strata. Shallow bedrock coring in and around the disposal site indicated open cavities of 2 feet or less which is consistent with the absence of observed sinkhole features in the pre-plant topography. In addition to the Hydrogeologic Evaluation, the Karst Potential Map included in Appendix C, shows that the DFAS Lateral Expansion is in a non-karst area, with no karst related characteristic (sinkholes, enclosed depressions, springs, etc.) occurrences on the site (Tennessee Valley Authority (TVA), 2006).

The digital elevations models (DEMs) show no indication of areas susceptible to mass movement within the vicinity of the lateral expansion site. The nearest area having moderate to steep slopes is approximately 0.3 miles southeast of the site.

Based on the information presented in the inspection reports of the DFAS Lateral Expansion, there have been no documented characteristic features of karstic formation. Accordingly, the CCR Rule-related criteria listed above for geologic and geomorphologic features have been met.

5.0 HUMAN-MADE FEATURES OR EVENTS (§257.64(B)(3))

Per §257.64(b)(3), the unstable areas demonstration must consider on-site or local human-made features or events when determining whether the area is unstable.

Assessment of the human-made features or events was completed considering the following criteria related to the CCR Rule:

- Review inspection reports of the CCR unit for any documented indications of tension cracking, settlement, depressions, or deformation of the unit's structural components (embankments, spillways, outlets, liners, leachate collection systems, or final covers).
- Review of routine operations and inspections at the landfill to maintain precaution from human-induced events or forces that might impair the integrity of some or all the structural components responsible for preventing unpermitted release of CCR into the environment.
- Review instrumentation installed to monitor the CCR unit to ensure readings are maintained within documented tolerances.
- Review of maps and other resources to confirm that the CCR unit is not located:
  - On previously mined or quarried areas;
  - On areas that have undergone excessive drawdown of groundwater; or,
  - On an old landfill.

5.1 BACKGROUND

This section describes the reports, investigations, and records that were reviewed as a part of the determination as it pertains to this portion of the CCR Rule.

Site inspections of the DFAS Lateral Expansion have been conducted and documented regularly from 2016 to 2017. These inspections were reviewed to identify observations of potential indications of human-induced events or forces that could have impaired the integrity of any structural components, which are responsible for preventing the release of CCR to the environment. TVA continues to comply with inspection requirements pursuant to the EPA Final CCR Rule and other regulatory requirements.

A box culvert was constructed to route an unnamed tributary below the DFAS Lateral Expansion. The box culvert was considered as part of the settlement analysis presented in Section 3.0 and Appendix B.

Additionally, there are 2 wells within the limits of the DFAS Lateral Expansion that are currently monitored. These were developed in accordance with the Tennessee Division of Solid Waste Management Regulations (TDSWM) Rule 1200-1-7 that established maximum containment levels (MCL) for significant increases occurring in any monitored analyte (P&CC Engineering, 2015). There is no other instrumentation actively monitored in the DFAS Lateral Expansion Area.

Appendix D contains maps presenting the locations of water wells, nearby quarries, oil and gas wells and lines, and gas fields.

5.2 ASSESSMENT

There are no industrial wells or waste sites within 10 miles of the site. An active clay quarry is located approximately 5 miles northeast of the site. Based on the maps provided in Appendix D, the site is not located within oil or gas fields. There are no oil or gas wells, lines, or other related infrastructure within 10 miles of the site. There are no records of the site being located on previous landfills, previously mined or quarried areas. It is not expected that human events related to these industries or their operations pose negative impact to the structural components of the DFAS Lateral Expansion.

The landfill is being operated in accordance with approved quality control and operational procedures in the approved TDSWM permit and is subject to periodic inspection by the Tennessee Department of Environment and Conservation (TDEC). The landfill has been operating under TDSWM Permit Number 01-0080.

The inspection reports of the landfill structure document no reports of impaired structural components. Operations and inspection manuals include satisfactory measures to maintain precaution from human-induced events or forces that might impair structural components (P&CC Engineering, 2015). TVA continues to comply with inspection requirements pursuant to the EPA Final CCR Rule and other regulatory requirements.

Refer to Section 3.2 for discussion of the box culvert constructed below the DFAS Lateral Expansion. Based on this assessment of the human-made features or events, the CCR Rule-related criteria listed above for human-made features or events have been met.

6.0 CONCLUSIONS

The following factors were reviewed to determine whether the Dry Fly Ash Stack Lateral Expansion at the BRF site is in an unstable area:

- On-site or local soil conditions that may result in significant differential settling;
- On-site or local geologic or geomorphic features; and
- On-site or local human-made features or events (both surface and subsurface).

Based on the assessment given herein, the CCR Rule-related criteria defined by §257.64(b) parts (1)-(3) have been met for the Dry Fly Ash Stack Lateral Expansion.

7.0 REFERENCES

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APPENDIX A
SOIL CONDITIONS

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for

Anderson County, Tennessee

Bull Run Fossil Plant

June 28, 2017

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

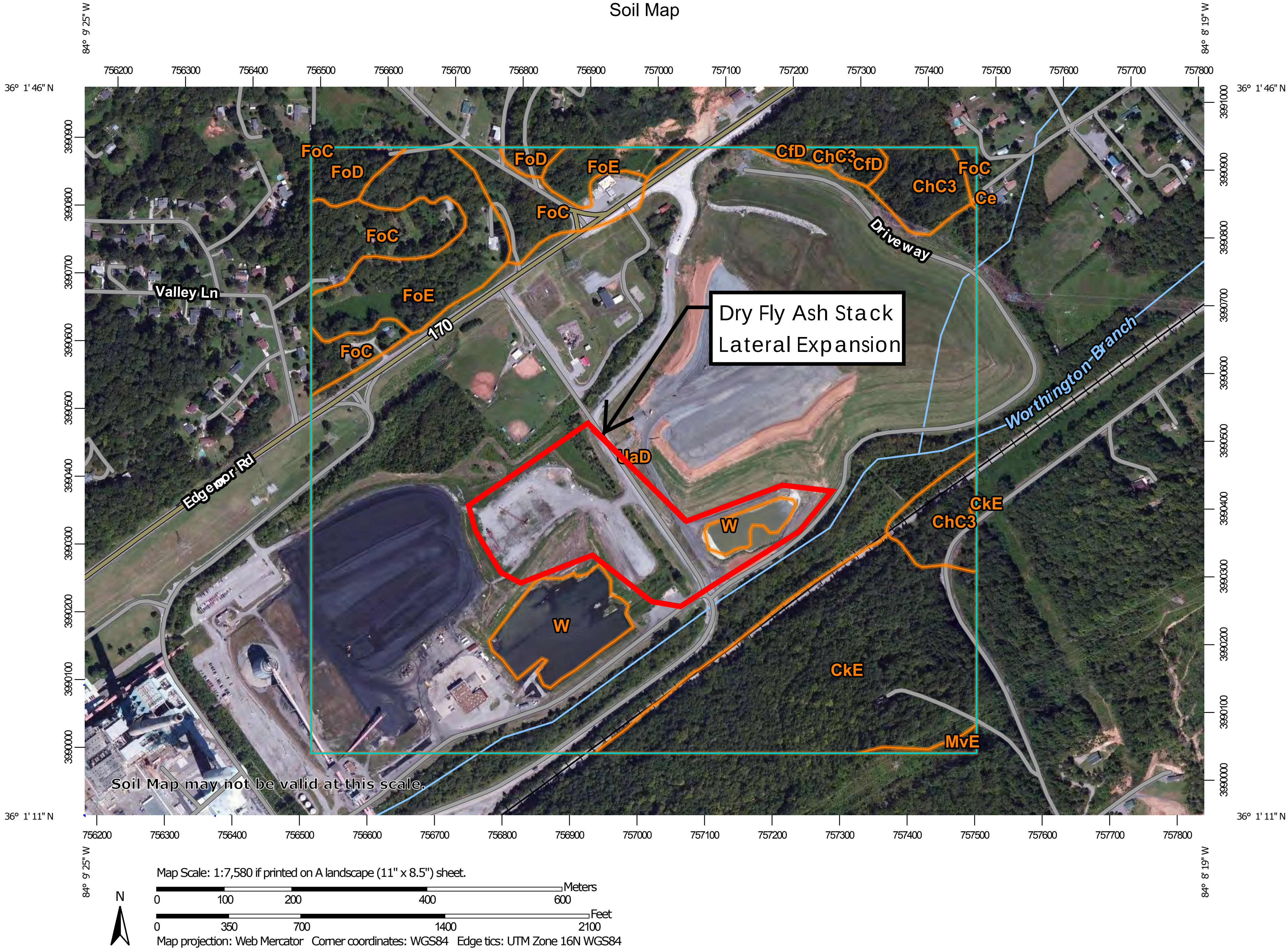
Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Soil Map



Map Scale: 1:7,580 if printed on A landscape (11" x 8.5") sheet.

Meters: 0, 100, 200, 400, 600

Feet: 0, 350, 700, 1400, 2100

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 16N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Anderson County, Tennessee
Survey Area Data: Version 9, Sep 21, 2015

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Apr 17, 2010—Sep 13, 2010

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Anderson County, Tennessee (TN001)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
Ce	Chenneby silt loam, frequently flooded	0.0	0.0%
CfD	Colbert-Lyerly-Rock outcrop complex, 5 to 20 percent slopes	1.1	0.5%
ChC3	Collegedale clay, 5 to 12 percent slopes, severely eroded	7.4	3.4%
CkE	Collegedale-Rock outcrop complex, 20 to 35 percent slopes	26.9	12.3%
FoC	Fullerton-Pailo complex, 5 to 12 percent slopes	12.1	5.5%
FoD	Fullerton-Pailo complex, 12 to 20 percent slopes	2.7	1.2%
FoE	Fullerton-Pailo complex, 20 to 35 percent slopes	12.2	5.6%
MvE	Montevallo channery silt loam, 20 to 35 percent slopes	0.5	0.2%
UaD	Udorthents, 0 to 25 percent slopes	148.7	68.1%
W	Water	6.9	3.2%
Totals for Area of Interest		**218.4**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Anderson County, Tennessee

Ce—Chenneby silt loam, frequently flooded

Map Unit Setting

National map unit symbol: 21byh
Elevation: 500 to 2,130 feet
Mean annual precipitation: 41 to 62 inches
Mean annual air temperature: 55 to 58 degrees F
Frost-free period: 178 to 236 days
Farmland classification: Prime farmland if protected from flooding or not frequently flooded during the growing season

Map Unit Composition

Chenneby and similar soils: 95 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Chenneby

Setting

Landform: Flood plains
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Concave
Parent material: Fine-silty alluvium derived from sedimentary rock

Typical profile

A - 0 to 8 inches: silt loam
Bw - 8 to 13 inches: silt loam
Bg - 13 to 40 inches: silt loam
Cg - 40 to 60 inches: silt loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat poorly drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: About 12 to 30 inches
Frequency of flooding: Frequent
Frequency of ponding: None
Available water storage in profile: High (about 10.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2w
Hydrologic Soil Group: B/D
Hydric soil rating: No

Minor Components

Bloomingdale

Percent of map unit: 5 percent
Landform: Flood plains

Landform position (three-dimensional): Dip
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

CfD—Colbert-Lyerly-Rock outcrop complex, 5 to 20 percent slopes

Map Unit Setting

National map unit symbol: 21c13
Elevation: 500 to 2,130 feet
Mean annual precipitation: 41 to 63 inches
Mean annual air temperature: 55 to 58 degrees F
Frost-free period: 178 to 236 days
Farmland classification: Not prime farmland

Map Unit Composition

Colbert and similar soils: 39 percent
Lyerly and similar soils: 30 percent
Rock outcrop: 23 percent
Minor components: 8 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Colbert

Setting

Landform: Ridges
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear, convex
Parent material: Clayey residuum weathered from argillaceous limestone

Typical profile

Ap - 0 to 9 inches: silt loam
Bt - 9 to 58 inches: clay
R - 58 to 62 inches: bedrock

Properties and qualities

Slope: 5 to 20 percent
Depth to restrictive feature: 40 to 60 inches to lithic bedrock
Natural drainage class: Moderately well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: About 24 to 42 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: D
Hydric soil rating: No

Description of Lyerly

Setting

Landform: Ridges
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Clayey residuum weathered from argillaceous limestone

Typical profile

A - 0 to 5 inches: silt loam
BE - 5 to 10 inches: silty clay loam
Btss - 10 to 38 inches: clay
R - 38 to 42 inches: bedrock

Properties and qualities

Slope: 5 to 20 percent
Depth to restrictive feature: 20 to 40 inches to lithic bedrock
Natural drainage class: Well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 in/hr)
Depth to water table: About 24 to 42 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 5.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: D
Hydric soil rating: No

Description of Rock Outcrop

Setting

Landform: Rock pediments

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Hydric soil rating: No

Minor Components

Gladeville

Percent of map unit: 8 percent
Landform: Ridges
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Concave
Hydric soil rating: No

ChC3—Collegedale clay, 5 to 12 percent slopes, severely eroded

Map Unit Setting

National map unit symbol: 21bz1
Elevation: 500 to 2,130 feet
Mean annual precipitation: 41 to 62 inches
Mean annual air temperature: 55 to 58 degrees F
Frost-free period: 178 to 236 days
Farmland classification: Not prime farmland

Map Unit Composition

Collegedale and similar soils: 95 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Collegedale

Setting

Landform: Ridges
Landform position (three-dimensional): Interfluve
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Clayey residuum weathered from limestone and shale

Typical profile

Bt1 - 0 to 7 inches: clay
Bt2 - 7 to 80 inches: clay

Properties and qualities

Slope: 5 to 12 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: C
Hydric soil rating: No

Minor Components

Colbert

Percent of map unit: 5 percent
Landform: Ridges
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear, convex
Hydric soil rating: No

CkE—Collegedale-Rock outcrop complex, 20 to 35 percent slopes

Map Unit Setting

National map unit symbol: 21bz4
Elevation: 500 to 2,130 feet
Mean annual precipitation: 41 to 62 inches
Mean annual air temperature: 55 to 58 degrees F
Frost-free period: 178 to 236 days
Farmland classification: Not prime farmland

Map Unit Composition

Collegedale and similar soils: 80 percent
Rock outcrop: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Collegedale

Setting

Landform: Ridges
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Side slope
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Clayey residuum weathered from limestone and shale

Typical profile

Ap - 0 to 5 inches: silt loam
Bt1 - 5 to 35 inches: clay
Bt2 - 35 to 80 inches: clay

Properties and qualities

Slope: 20 to 35 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None

Frequency of ponding: None
Available water storage in profile: Moderate (about 8.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: C
Hydric soil rating: No

Description of Rock Outcrop

Setting

Landform: Rock pediments

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Hydric soil rating: No

FoC—Fullerton-Pailo complex, 5 to 12 percent slopes

Map Unit Setting

National map unit symbol: 21bzl
Elevation: 500 to 2,130 feet
Mean annual precipitation: 41 to 62 inches
Mean annual air temperature: 55 to 58 degrees F
Frost-free period: 178 to 236 days
Farmland classification: Not prime farmland

Map Unit Composition

Fullerton and similar soils: 65 percent
Pailo and similar soils: 26 percent
Minor components: 9 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Fullerton

Setting

Landform: Ridges
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Creep deposits derived from cherty limestone over clayey residuum weathered from cherty limestone

Typical profile

A - 0 to 2 inches: gravelly silt loam
E - 2 to 15 inches: gravelly silt loam
Bt1 - 15 to 19 inches: gravelly silty clay loam
Bt2 - 19 to 60 inches: gravelly clay

Bt3 - 60 to 90 inches: gravelly clay

Properties and qualities

Slope: 5 to 12 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B
Ecological site: Thermic Cherty Dolomite Upland Oak-Hickory Forest (F128XY001TN)
Hydric soil rating: No

Description of Pailo

Setting

Landform: Ridges
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Skeletal loamy residuum weathered from cherty limestone

Typical profile

A - 0 to 15 inches: gravelly silt loam
Bt1 - 15 to 40 inches: very gravelly silty clay loam
2Bt2 - 40 to 80 inches: gravelly clay

Properties and qualities

Slope: 5 to 12 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3s
Hydrologic Soil Group: B
Ecological site: Thermic Cherty Dolomite Upland Oak-Hickory Forest (F128XY001TN)
Hydric soil rating: No

Minor Components

Minvale

Percent of map unit: 9 percent
Landform: Ridges
Landform position (two-dimensional): Backslope
Down-slope shape: Concave
Across-slope shape: Linear
Ecological site: Thermic Cherty Dolomite Upland Oak-Hickory Forest (F128XY001TN)
Hydric soil rating: No

FoD—Fullerton-Pailo complex, 12 to 20 percent slopes

Map Unit Setting

National map unit symbol: 21bzm
Elevation: 500 to 2,130 feet
Mean annual precipitation: 41 to 62 inches
Mean annual air temperature: 54 to 58 degrees F
Frost-free period: 178 to 236 days
Farmland classification: Not prime farmland

Map Unit Composition

Fullerton and similar soils: 58 percent
Pailo and similar soils: 33 percent
Minor components: 9 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Fullerton

Setting

Landform: Ridges
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Creep deposits derived from cherty limestone over clayey residuum weathered from cherty limestone

Typical profile

A - 0 to 2 inches: gravelly silt loam
E - 2 to 15 inches: gravelly silt loam
Bt1 - 15 to 19 inches: gravelly silty clay loam
Bt2 - 19 to 60 inches: gravelly clay
Bt3 - 60 to 90 inches: gravelly clay

Properties and qualities

Slope: 12 to 20 percent
Depth to restrictive feature: More than 80 inches

Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Ecological site: Thermic Cherty Dolomite Upland Oak-Hickory Forest (F128XY001TN)
Hydric soil rating: No

Description of Pailo

Setting

Landform: Ridges
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Skeletal loamy residuum weathered from cherty limestone

Typical profile

A - 0 to 15 inches: gravelly silt loam
Bt1 - 15 to 40 inches: very gravelly silty clay loam
2Bt2 - 40 to 80 inches: gravelly clay

Properties and qualities

Slope: 12 to 20 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4s
Hydrologic Soil Group: B
Ecological site: Thermic Cherty Dolomite Upland Oak-Hickory Forest (F128XY001TN)
Hydric soil rating: No

Minor Components

Minvale

Percent of map unit: 9 percent
Landform: Ridges

Landform position (two-dimensional): Backslope
Down-slope shape: Concave
Across-slope shape: Linear
Ecological site: Thermic Cherty Dolomite Upland Oak-Hickory Forest (F128XY001TN)
Hydric soil rating: No

FoE—Fullerton-Pailo complex, 20 to 35 percent slopes

Map Unit Setting

National map unit symbol: 21bzn
Elevation: 500 to 2,130 feet
Mean annual precipitation: 41 to 62 inches
Mean annual air temperature: 55 to 58 degrees F
Frost-free period: 178 to 236 days
Farmland classification: Not prime farmland

Map Unit Composition

Fullerton and similar soils: 58 percent
Pailo and similar soils: 33 percent
Minor components: 9 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Fullerton

Setting

Landform: Ridges
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Creep deposits derived from cherty limestone over clayey residuum weathered from cherty limestone

Typical profile

A - 0 to 2 inches: gravelly silt loam
E - 2 to 15 inches: gravelly silt loam
Bt1 - 15 to 19 inches: gravelly silty clay loam
Bt2 - 19 to 60 inches: gravelly clay
Bt3 - 60 to 90 inches: gravelly clay

Properties and qualities

Slope: 20 to 35 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches

Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B
Ecological site: Thermic Cherty Dolomite Upland Oak-Hickory Forest (F128XY001TN)
Hydric soil rating: No

Description of Pailo

Setting

Landform: Ridges
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Skeletal loamy residuum weathered from cherty limestone

Typical profile

A - 0 to 15 inches: gravelly silt loam
Bt1 - 15 to 40 inches: very gravelly silty clay loam
2Bt2 - 40 to 80 inches: gravelly clay

Properties and qualities

Slope: 20 to 35 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: B
Ecological site: Thermic Cherty Dolomite Upland Oak-Hickory Forest (F128XY001TN)
Hydric soil rating: No

Minor Components

Minvale

Percent of map unit: 9 percent
Landform: Ridges
Landform position (two-dimensional): Backslope
Down-slope shape: Concave
Across-slope shape: Linear
Ecological site: Thermic Cherty Dolomite Upland Oak-Hickory Forest (F128XY001TN)

Hydric soil rating: No

MvE—Montevallo channery silt loam, 20 to 35 percent slopes

Map Unit Setting

National map unit symbol: 2t3gt
Elevation: 670 to 2,740 feet
Mean annual precipitation: 42 to 57 inches
Mean annual air temperature: 53 to 58 degrees F
Frost-free period: 150 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Montevallo and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Montevallo

Setting

Landform: Ridges
Landform position (two-dimensional): Shoulder, backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Channery residuum weathered from shale and siltstone

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
A - 1 to 2 inches: channery silt loam
Bw - 2 to 18 inches: very channery silt loam
Cr - 18 to 40 inches: bedrock

Properties and qualities

Slope: 20 to 35 percent
Depth to restrictive feature: 10 to 20 inches to paralithic bedrock
Natural drainage class: Well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 1.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: D
Hydric soil rating: No

Minor Components

Armuchee

Percent of map unit: 3 percent
Landform: Ridges
Landform position (two-dimensional): Shoulder, backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Linear
Hydric soil rating: No

Townley

Percent of map unit: 3 percent
Landform: Ridges
Landform position (two-dimensional): Shoulder, backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Loyston

Percent of map unit: 2 percent
Landform: Ridges
Landform position (two-dimensional): Shoulder, backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Salacoa

Percent of map unit: 2 percent
Landform: Ridges
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Linear
Hydric soil rating: No

UaD—Udorthents, 0 to 25 percent slopes

Map Unit Setting

National map unit symbol: 2tg8d
Elevation: 500 to 2,130 feet
Mean annual precipitation: 41 to 62 inches
Mean annual air temperature: 55 to 58 degrees F
Frost-free period: 178 to 236 days
Farmland classification: Not prime farmland

Map Unit Composition

Udorthents and similar soils: 100 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Udorthents

Setting

Parent material: Fine-loamy human-transported material derived from sedimentary rock and/or clayey human-transported material derived from sedimentary rock and/or skeletal loamy human-transported material derived from sedimentary rock

Properties and qualities

Slope: 0 to 25 percent
Depth to restrictive feature: More than 80 inches
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None

W—Water

Map Unit Setting

National map unit symbol: 2qyn6
Elevation: 740 to 2,130 feet
Mean annual precipitation: 40 to 54 inches
Mean annual air temperature: 48 to 69 degrees F
Frost-free period: 190 to 200 days
Farmland classification: Not prime farmland

Map Unit Composition

Water: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Soil Information for All Uses

Soil Reports

The Soil Reports section includes various formatted tabular and narrative reports (tables) containing data for each selected soil map unit and each component of each unit. No aggregation of data has occurred as is done in reports in the Soil Properties and Qualities and Suitabilities and Limitations sections.

The reports contain soil interpretive information as well as basic soil properties and qualities. A description of each report (table) is included.

Soil Physical Properties

This folder contains a collection of tabular reports that present soil physical properties. The reports (tables) include all selected map units and components for each map unit. Soil physical properties are measured or inferred from direct observations in the field or laboratory. Examples of soil physical properties include percent clay, organic matter, saturated hydraulic conductivity, available water capacity, and bulk density.

Engineering Properties (Bull Run Fossil Plant)

This table gives the engineering classifications and the range of engineering properties for the layers of each soil in the survey area.

Hydrologic soil group is a group of soils having similar runoff potential under similar storm and cover conditions. The criteria for determining Hydrologic soil group is found in the National Engineering Handbook, Chapter 7 issued May 2007(http://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=17757.wba). Listing HSGs by soil map unit component and not by soil series is a new concept for the engineers. Past engineering references contained lists of HSGs by soil series. Soil series are continually being defined and redefined, and the list of soil series names changes so frequently as to make the task of maintaining a single national list virtually impossible. Therefore, the criteria is now used to calculate the HSG using the component soil properties and no such national series lists will be maintained. All such references are obsolete and their use should be discontinued. Soil properties that influence runoff potential are those that influence the minimum rate of infiltration for a bare soil after prolonged wetting and when not frozen. These properties are depth to a seasonal high water table, saturated hydraulic conductivity after prolonged wetting, and depth to a layer with a very slow water transmission rate. Changes in soil properties caused by land management or climate changes also cause the hydrologic soil group to change. The influence of ground cover is treated independently. There are four hydrologic soil groups, A, B, C, and D, and three dual groups, A/D, B/D, and C/D. In the dual groups, the first letter is for drained areas and the second letter is for undrained areas.

The four hydrologic soil groups are described in the following paragraphs:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Depth to the upper and lower boundaries of each layer is indicated.

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is 15 percent or more, an appropriate modifier is added, for example, "gravelly."

Classification of the soils is determined according to the Unified soil classification system (ASTM, 2005) and the system adopted by the American Association of State Highway and Transportation Officials (AASHTO, 2004).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to particle-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of particle-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest.

Percentage of rock fragments larger than 10 inches in diameter and 3 to 10 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage. Three values are provided to identify the expected Low (L), Representative Value (R), and High (H).

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field. Three values are provided to identify the expected Low (L), Representative Value (R), and High (H).

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination. Three values are provided to identify the expected Low (L), Representative Value (R), and High (H).

References:

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

Absence of an entry indicates that the data were not estimated. The asterisk '*' denotes the representative texture; other possible textures follow the dash. The criteria for determining the hydrologic soil group for individual soil components is found in the National Engineering Handbook, Chapter 7 issued May 2007(http://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=17757.wba). Three values are provided to identify the expected Low (L), Representative Value (R), and High (H).

Engineering Properties–Anderson County, Tennessee

Map unit symbol and soil name	Pct. of map unit	Hydrologic group	Depth	USDA texture	Classification		Pct Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
					Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
			In				*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*
Ce—Chenneby silt loam, frequently flooded														
Chenneby	95	B/D	0-8	Silt loam	CL-ML, ML, CL	A-6	0- 0- 0	0- 0- 0	100-100-100	100-100-100	92-99-100	85-92-100	23-33-43	7-13-18
			8-13	Silty clay loam, silt loam	CL	A-4, A-7, A-6	0- 0- 0	0- 0- 0	100-100-100	100-100-100	88-100-100	84-96-100	22-33-44	7-16-25
			13-40	Silty clay loam, silt loam, loam	CL	A-4, A-7, A-6	0- 0- 0	0- 2- 3	94-96-100	90-94-100	79-93-100	75-90-100	22-33-44	7-16-25
			40-60	Loam, silt loam, silty clay loam, clay loam	CL	A-4, A-7, A-6	0- 0- 0	0- 2- 3	94-96-100	90-94-100	83-93-100	77-86-100	22-28-44	7-12-25

Engineering Properties–Anderson County, Tennessee														
Map unit symbol and soil name	Pct. of map unit	Hydrologic group	Depth	USDA texture	Classification		Pct Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
					Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
			In				*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*
CfD—Colbert-Lyerly-Rock outcrop complex, 5 to 20 percent slopes														
Colbert	39	D	0-9	Silt loam	CL-ML, ML, CL	A-6	0- 0- 0	0- 0- 0	100-100-100	100-100-100	76-97-98	64-85-86	17-37-41	2-18-19
			9-58	Silty clay, clay	CH	A-7, A-7-6	0- 0- 0	0- 0- 0	100-100-100	100-100-100	88-97-100	81-90-100	58-67-78	36-43-51
			58-62	Bedrock	—	—	—	—	—	—	—	—	—	—
Lyerly	30	D	0-5	Silt loam	CL-ML, CL	A-6, A-4	0- 0- 0	0- 0- 8	83-100-100	83-100-100	62-95-97	51-82-84	19-38-42	2-17-19
			5-10	Silty clay loam	CL, CH	A-6, A-7, A-7-6	0- 0- 0	0- 0- 8	84-100-100	83-100-100	77-99-100	69-89-96	39-46-53	19-24-29
			10-38	Clay, silty clay	CH	A-7-6	0- 0- 0	0- 0- 7	84-100-100	84-100-100	67-97-100	62-92-99	58-74-82	36-49-55
			38-42	Bedrock	—	—	—	—	—	—	—	—	—	—
ChC3—Collegedale clay, 5 to 12 percent slopes, severely eroded														
Collegedale	95	C	0-7	Clay	CH	A-7, A-7-6	0- 0- 0	0- 1- 1	95-96-100	84-91-100	65-84-100	56-74-91	45-60-70	25-36-43
			7-80	Clay, silty clay	CH	A-7-6	0- 0- 0	0- 1- 1	95-97-100	85-92-100	65-88-100	56-79-91	43-62-67	25-40-44

Engineering Properties–Anderson County, Tennessee														
Map unit symbol and soil name	Pct. of map unit	Hydrologic group	Depth	USDA texture	Classification		Pct Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
					Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
			In				*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*
CkE—Collegedale-Rock outcrop complex, 20 to 35 percent slopes														
Collegedale	80	C	0-5	Silt loam	CL, CL-ML, ML	A-6	0- 0- 0	0- 0- 5	89-100-100	80-100-100	61-97-98	51-85-86	17-37-41	2-18-19
			5-35	Silty clay, clay	CH, CL	A-7, A-7-6	0- 0- 0	0- 0- 4	90-100-100	81-100-100	68-99-100	65-96-100	48-62-67	28-40-44
			35-80	Silty clay, clay	CH, CL	A-7, A-7-6	0- 0- 0	0- 0- 3	90-92-100	80-83-100	64-82-100	62-80-98	48-64-67	28-42-44

Engineering Properties–Anderson County, Tennessee														
Map unit symbol and soil name	Pct. of map unit	Hydrologic group	Depth	USDA texture	Classification		Pct Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
					Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
			In				*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*
FoC—Fullerton-Pailo complex, 5 to 12 percent slopes														
Fullerton	65	B	0-2	Gravelly silt loam, very gravelly loam, silt loam	GC-GM, SC-SM, CL, GC	A-2, A-6, A-2-4	0- 0- 0	1- 3- 12	72-92-93	31-77-84	26-70-84	22-63-79	21-29-40	6-11-18
			2-15	Gravelly silt loam, silty clay loam, very gravelly loam	GC, SC-SM, SC, CL	A-4, A-2-4, A-6, A-7-6, A-2, A-7	0- 0- 0	1- 3- 18	65-90-93	37-77-84	31-71-84	25-63-81	21-31-45	6-13-24
			15-19	Gravelly silty clay loam, gravelly silty clay, very gravelly clay	SC, CL, CH	A-2-6, A-2, A-7-6	0- 0- 0	1- 3- 18	64-84-87	38-71-77	33-67-77	28-62-77	35-43-66	18-24-43
			19-60	Gravelly clay, gravelly silty clay, very gravelly clay	CH, SC, CL	A-7-6, A-2-7, A-2	0- 0- 0	1- 4- 19	63-80-86	36-63-75	31-61-75	28-58-75	46-69-75	28-47-51

Engineering Properties–Anderson County, Tennessee														
Map unit symbol and soil name	Pct. of map unit	Hydrologic group	Depth	USDA texture	Classification		Pct Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
					Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
			In				*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*
			60-90	Very gravelly clay, gravelly clay, gravelly silty clay	SC, CH, CL	A-2, A-2-7, A-7-6	0- 0- 0	1-12- 15	68-79-86	31-66-75	27-64-75	23-61-75	46-73-75	28-50-51
Pailo	26	B	0-15	Gravelly silt loam	CL, GC, GC-GM, SC-SM	A-4	0- 0- 0	0- 0- 1	72-74-77	52-56-62	46-52-62	38-44-52	26-33-40	9-14-18
			15-40	Very gravelly silty clay loam, very gravelly loam, very gravelly silt loam, very gravelly clay loam	SC	A-6, A-2-6	0- 0- 0	0- 0- 2	67-69-72	28-30-49	24-29-49	22-27-49	27-38-48	12-21-28
			40-80	Gravelly silty clay, very gravelly silty clay, gravelly clay, very gravelly clay, clay	CH	A-2, A-7, A-7-6	0- 0- 0	0- 0- 15	71-97-98	33-85-91	26-81-91	23-73-91	46-61-74	28-39-51

Engineering Properties–Anderson County, Tennessee														
Map unit symbol and soil name	Pct. of map unit	Hydrologic group	Depth	USDA texture	Classification		Pct Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
					Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
			In				*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*
FoD—Fullerton-Pailo complex, 12 to 20 percent slopes														
Fullerton	58	B	0-2	Gravelly silt loam, very gravelly loam, silt loam	GC-GM, SC-SM, CL, GC	A-2, A-6, A-2-4	0- 0- 0	1- 3- 12	72-92-93	31-77-84	26-70-84	22-63-79	21-29-40	6-11-18
			2-15	Gravelly silt loam, silty clay loam, very gravelly loam	GC, SC-SM, SC, CL	A-4, A-2-4, A-6, A-7-6, A-2, A-7	0- 0- 0	1- 3- 18	65-90-93	37-77-84	31-71-84	25-63-81	21-31-45	6-13-24
			15-19	Gravelly silty clay loam, gravelly silty clay, very gravelly clay	SC, CL, CH	A-2-6, A-2, A-7-6	0- 0- 0	1- 3- 18	64-84-87	38-71-77	33-67-77	28-62-77	35-43-66	18-24-43
			19-60	Gravelly clay, gravelly silty clay, very gravelly clay	CH, SC, CL	A-7-6, A-2-7, A-2	0- 0- 0	1- 4- 19	63-80-86	36-63-75	31-61-75	28-58-75	46-69-75	28-47-51

Engineering Properties–Anderson County, Tennessee														
Map unit symbol and soil name	Pct. of map unit	Hydrologic group	Depth	USDA texture	Classification		Pct Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
					Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
			In				*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*
			60-90	Very gravelly clay, gravelly clay, gravelly silty clay	SC, CH, CL	A-2, A-2-7, A-7-6	0- 0- 0	1-12- 15	68-79-86	31-66-75	27-64-75	23-61-75	46-73-75	28-50-51
Pailo	33	B	0-15	Gravelly silt loam	CL, GC, GC-GM, SC-SM	A-4	0- 0- 0	0- 0- 1	72-74-77	52-56-62	46-52-62	38-44-52	26-33-40	9-14-18
			15-40	Very gravelly silty clay loam, very gravelly loam, very gravelly silt loam, very gravelly clay loam	SC	A-6, A-2-6	0- 0- 0	0- 0- 2	67-69-72	28-30-49	24-29-49	22-27-49	27-38-48	12-21-28
			40-80	Gravelly silty clay, very gravelly silty clay, gravelly clay, very gravelly clay, clay	CH	A-2, A-7, A-7-6	0- 0- 0	0- 0- 15	71-97-98	33-85-91	26-81-91	23-73-91	46-61-74	28-39-51

Engineering Properties–Anderson County, Tennessee														
Map unit symbol and soil name	Pct. of map unit	Hydrologic group	Depth	USDA texture	Classification		Pct Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
					Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
			In				*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*
FoE—Fullerton-Pailo complex, 20 to 35 percent slopes														
Fullerton	58	B	0-2	Gravelly silt loam, very gravelly loam, silt loam	GC-GM, SC-SM, CL, GC	A-2, A-6, A-2-4	0- 0- 0	1- 3- 20	70-92-93	43-77-84	36-70-84	30-63-79	21-29-40	6-11-18
			2-15	Gravelly silt loam, silty clay loam, very gravelly loam	GC, SC-SM, SC, CL	A-4, A-2-4, A-6, A-7-6, A-2, A-7	0- 0- 0	1- 3- 18	65-90-93	37-77-84	31-71-84	25-63-81	21-31-45	6-13-24
			15-19	Gravelly silty clay loam, gravelly silty clay, very gravelly clay	SC, CL, CH	A-2-6, A-2, A-7-6	0- 0- 0	1- 3- 18	64-84-87	38-71-77	33-67-77	28-62-77	35-43-66	18-24-43
			19-60	Gravelly clay, gravelly silty clay, very gravelly clay	CH, SC, CL	A-7-6, A-2-7, A-2	0- 0- 0	1- 4- 19	63-80-86	36-63-75	31-61-75	28-58-75	46-69-75	28-47-51

Engineering Properties–Anderson County, Tennessee														
Map unit symbol and soil name	Pct. of map unit	Hydrologic group	Depth	USDA texture	Classification		Pct Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
					Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
			In				*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*
			60-90	Very gravelly clay, gravelly clay, gravelly silty clay	SC, CH, CL	A-2, A-2-7, A-7-6	0- 0- 0	1-12- 15	68-79-86	31-66-75	27-64-75	23-61-75	46-73-75	28-50-51
Pailo	33	B	0-15	Gravelly silt loam	CL, GC, GC-GM, SC-SM	A-4	0- 0- 0	0- 0- 1	72-74-77	52-56-62	46-52-62	38-44-52	26-33-40	9-14-18
			15-40	Very gravelly silty clay loam, very gravelly loam, very gravelly silt loam, very gravelly clay loam	SC	A-6, A-2-6	0- 0- 0	0- 0- 2	67-69-72	28-30-49	24-29-49	22-27-49	27-38-48	12-21-28
			40-80	Gravelly silty clay, very gravelly silty clay, gravelly clay, very gravelly clay, clay	CH	A-2, A-7, A-7-6	0- 0- 0	0- 0- 15	71-97-98	33-85-91	26-81-91	23-73-91	46-61-74	28-39-51
MvE—Montevallo channery silt loam, 20 to 35 percent slopes														
Montevallo	90	D	0-1	Slightly decomposed plant material	PT	A-8	0- 0- 0	0- 0- 0	—	—	—	—	—	—
			1-2	Channery silt loam	CL, CL-ML, SC, SC-SM	A-4, A-6	0- 0- 0	12-22-24	68-71-86	67-71-85	58-66-85	46-54-76	19-29-40	3-11-18
			2-18	Very channery silt loam, extremely channery clay loam, very channery silty clay loam, extremely channery loam	GC, GC-GM, SC, SC-SM	A-2, A-4, A-6	0- 0- 6	25-36-45	19-44-67	18-42-66	15-41-66	12-36-66	25-34-43	9-17-24
			18-40	Bedrock	—	—	—	—	—	—	—	—	—	—

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APPENDIX B
SETTLEMENT ANALYSIS

Tennessee Valley Authority Bull Run Fossil Plant Clinton, Anderson County, Tennessee	**Dry Fly Ash Stack, Lateral Expansion, Settlement Analysis**
Calculation Package N/A	
Stantec	**Exhibit Settlement Analysis**

Purpose:

- Calculate the potential settlement due to future build-out of the Lateral Expansion
- Discuss possible consequences on the leachate collection system and the bottom liner.

Methods:

- One-dimensional consolidation analysis.

Results:

- The post-settlement slopes of the leachate collection system pipes will remain positive, promoting flow in the direction that the design intended.
- The post-settlement slope of the box culvert will also maintain positive drainage for the stream it contains.
- The box culvert has been structurally designed to withstand the proposed loads, and the potential for differential settlement along the culvert alignment is not expected to damage the liner.

Calculation Performed by: Stantec Consulting Services Inc., March 13, 2018	
Prepared by: Enrique Farfan, PhD, PE	*Reviewed by: Jeffrey S. Dingrando, PE, PG*
Revisions: N/A	

TVA BULL RUN DRY FLY ASH STACK

LATERAL EXPANSION

SETTLEMENT ANALYSIS

1. SCOPE

Calculate the potential settlement due to the future build-out of the permitted Lateral Expansion and discuss possible consequences on the leachate collection system and the bottom liner.

2. GEOMETRY

The geometry of the proposed Lateral Expansion is presented in Figure 1. The top of the proposed stack reaches elevation 940 feet. The footprint of the new stack is irregular and connects with the existing Phases 1 and 2 Dry Fly Ash Stack (DFAS).

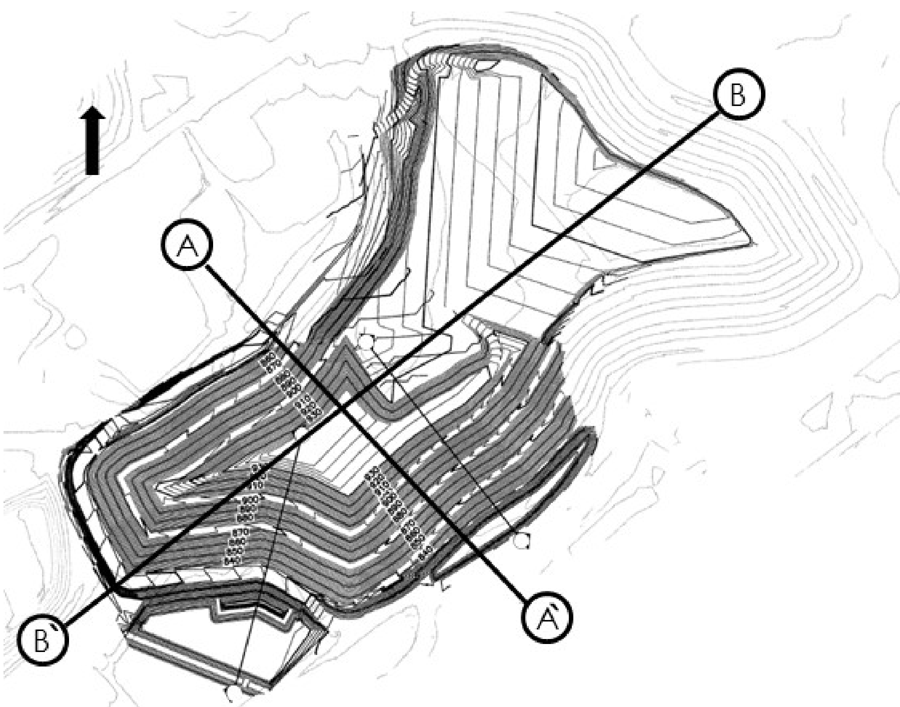


Figure 1. Proposed Ash Stack Geometry (N.T.S) (CEC, 2012a)

The maximum height of the proposed ash stack is approximately 90 feet above the geologic buffer (i.e., base of the liner). Figure 2 shows cross sections A-A' and B-B'.

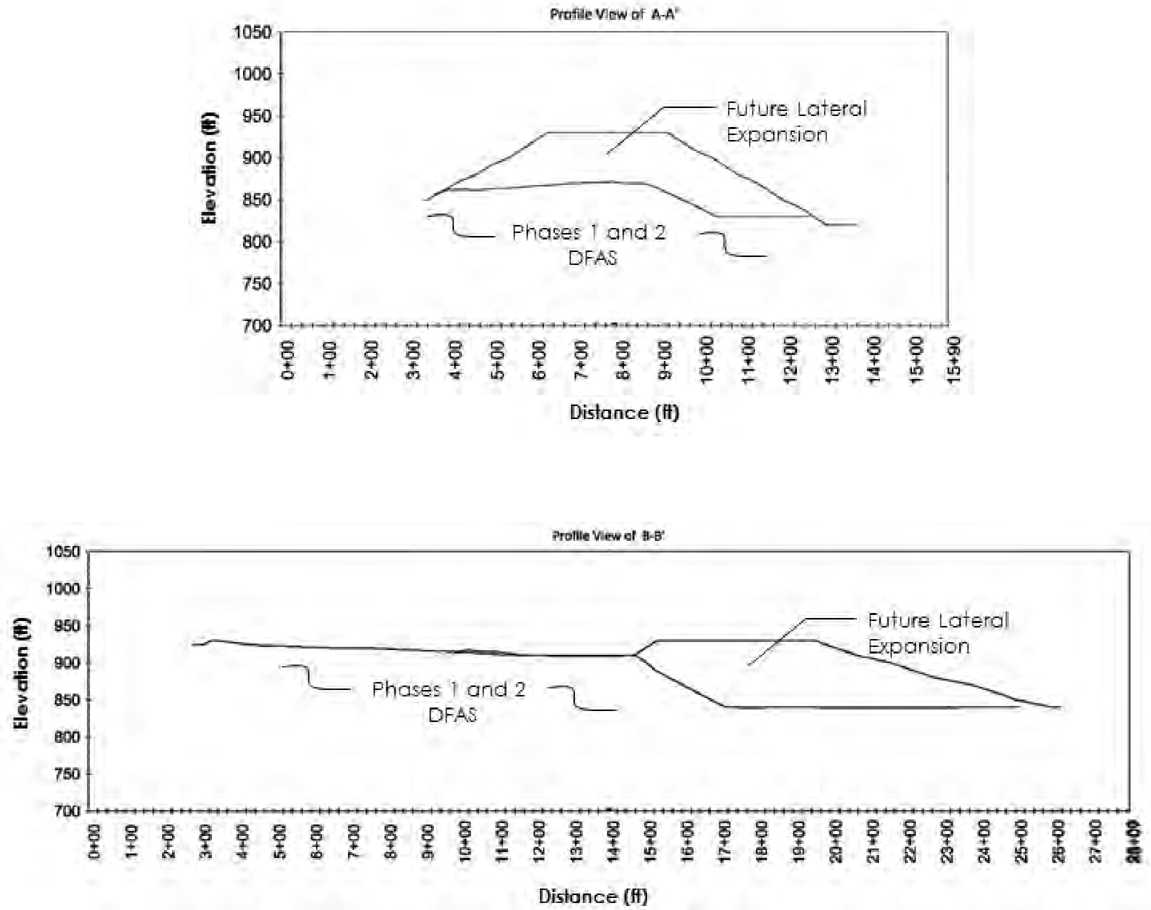


Figure 2. Cross Sections A-A' and B-B'

3. COMPRESSIBLE SOILS

The proposed ash stack will sit on a liner/leachate collection system, that overlies a geologic buffer, that overlies a residual clay layer. The geologic buffer and the residuum (clay) thicknesses vary beneath the ash stack footprint based on the pre-construction topography and the site geology. Several borings within the Lateral Expansion footprint were selected as references for the settlement analysis of the geologic buffer soil and the residual clay. The selected borings are located along Section A-A', under the portion of the Lateral Expansion with the highest permitted elevation, which also corresponds to the area with the thickest zone of stacked ash.

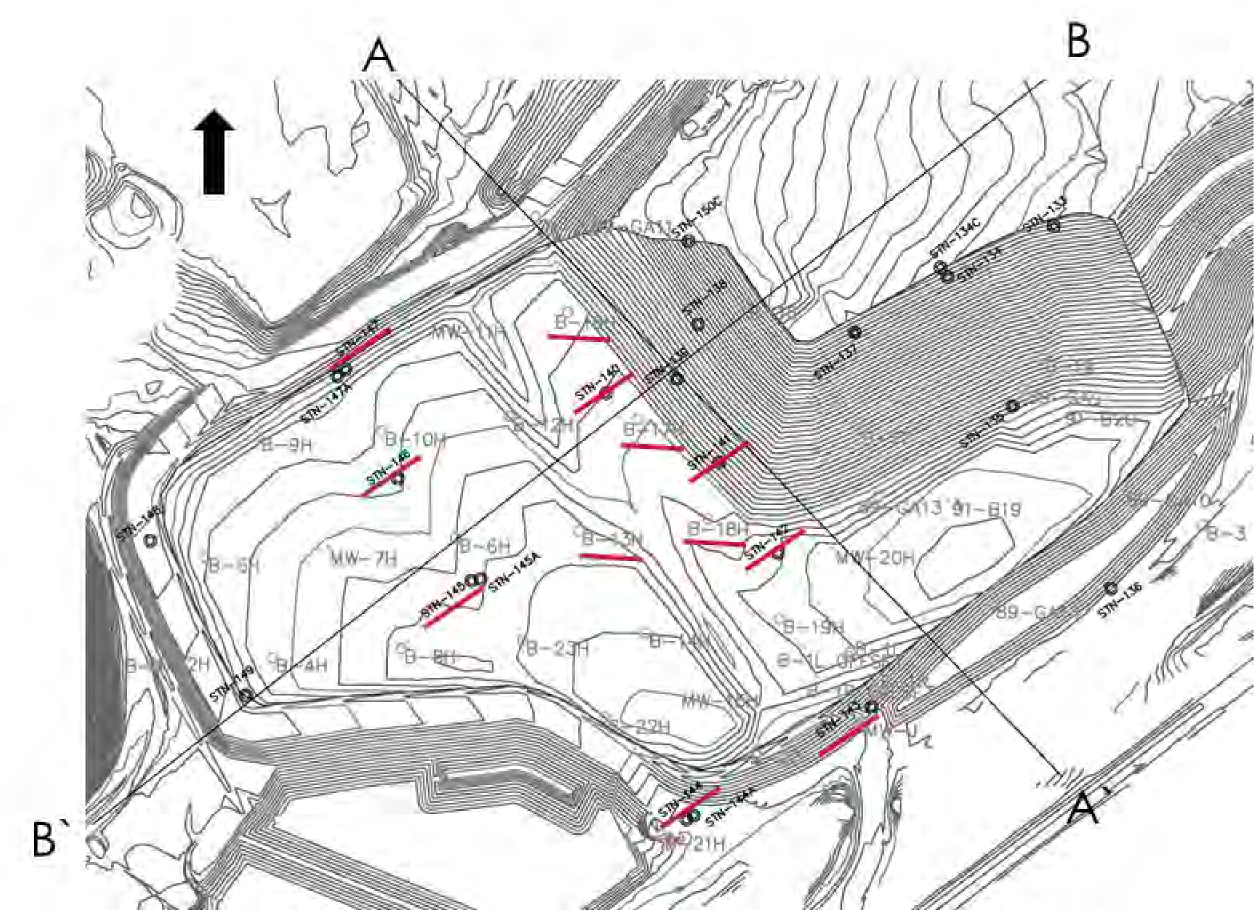


Figure 3. Boring Location, showing as-built bottom of geologic buffer grading (N.T.S.) (Stantec 2011)

Table below summarizes the thickness of the residuum and geologic buffer (i.e., fill) layers from the information contained in the boring logs (Stantec 2011; MACTEC 2006). The subgrade elevations from Figure 3 were considered to calculate the fill and the residuum thickness. Borings developed by Stantec are considered as primary source while other borings were used to corroborate the information.

Table 1. Compressible layer thickness on selected borings

Boring	**STN-140**	**STN-141**	**STN-142**	**STN-143**
Fill (ft)	0.1	0	0.1	0
Residuum (ft)	14.2	15	7.5	11.8
Total (ft)	14.3	15	7.6	11.8

Boring	STN-147	STN-146	STN-145	STN-144
Fill (ft)	15.7	5.7	14.2	0
Residuum (ft)	2.2	16.3	2.1	16.3
Total (ft)	17.9	22	16.3	16.3

Boring	B-16H	B-17H	B-18H	B-13H
Fill (ft)	-2.9 (cut)	0.8	6.4	2
Residuum (ft)	9	9.7	15	18
Total (ft)	6.1	10.5	21.4	20

For this analysis, the fill layer and the residuum layer are combined into a single layer, because the soil types and densities are similar and should exhibit similar settlement characteristics. The thickness of the compressible layer varies between 6 feet to 20 feet. Based on the boring information, a uniform, 15-foot thick compressible layer was assumed for the settlement analysis under the proposed ash stack. Although the actual soil thickness varies across the footprint, this simplification is suitable for the analysis.

4. SOIL PROPERTIES

The compressibility characteristics for the compressible layer underlaying the ash stack was obtained from existing consolidation tests (MACTEC, 2006) of undisturbed samples of fill and residuum. A summary of the soil properties is presented below.

Table 2. Soil Properties Summary

Boring	Depth (ft)	USCS	C_c	C_r	e_o	w (%)	γ_d (pcf)	p'_o (ksf)
B-8R	19-20.4	Sandy Silty Clay (Residuum)	0.3	0.02	0.88	33.4	88.4	4.68
B-11A	4.5-6.5	Sandy Silty Clay (Fill)	0.24	0.02	1.191	35.7	78.3	4.49
B-14HA	18-20	Sandy Silty Clay (Residuum)	0.22	0.02	0.973	33.3	87.2	9.44
B-14L	28.5-30.5	Sandy Silty Clay (Residuum)	0.38	0.04	1.095	40.2	81	6.28

C_c = compression index, slope, C_r = swell index, e_o = initial void ratio, w = moisture content, γ_d = dry unit weight, p'_o = preconsolidation pressure.

For this analysis, the following parameters are assumed: γ_t = 122 pcf, C_c = 0.3, C_r =0.03, e_o = 0.88, and p'_o = 4.5 ksf.

The selected parameters were compared against typical values based on common correlations between compression index (C_c) and the liquid limit (LL) of the clay (Das 2010). The table below shows the calculated C_c from LL and Plasticity Index (PI).

Table 3. Soil Data (MACTEC 2006, Stantec 2011)

Boring	Depth (ft)	LL (%)	PL (%)	PI (%)	USCS	$C_c \approx 0.009$ (LL-10)	$C_c \approx$ PI/74 (G_s ~2.7)	$C_r \approx (0.1\ C_c)$
B-12H	9-11	64	27	37	CH	0.5	0.5	0.05
STN-136	13.5-18	41	17	24	CL	0.3	0.3	0.03
STN-132	16.5-19.5	52	20	32	CH	0.4	0.4	0.04
STN-117	61-30	48	20	28	CL	0.3	0.4	0.03
STN-144A	5-6.5	48	20	28	GC	0.3	0.4	0.03
STN-144A	6.5-12.5	51	19	32	CH	0.4	0.4	0.04
STN-146	9.5-14	62	22	40	CH	0.5	0.5	0.05
STN-148	3-9.4	53	22	31	CH	0.4	0.4	0.04

The compressibility parameters derived from the Atterberg limits generally agree with the selected values assumed to represent the compressible layer.

To calculate the increase in effective stresses within the compressible layer (due to ash stacking), a unit weight of 110 pounds per cubic feet (Stantec 2011) is assumed for the stacked ash.

5. GROUNDWATER TABLE

Groundwater table is assumed to be below the compressible layer based on information provided in previous stability analysis for the proposed Lateral Expansion (CEC 2012b).

6. SETTLEMENT CALCULATION

In the following section the calculations of the maximum settlement are presented.

a. Initial stress at layer midpoint

Compressible layer thickness: 15 feet

Total unit weight: 122 pcf

$$\sigma_0 = 122pcf * (\frac{15ft}{2}) = 915\ psf$$

b. Stress increase due to ash stack

Due to the thickness of the compressible layer in relation to the ash stack, it is assumed that the stress distribution can be calculated using the solution for the vertical stress below a rectangular loaded area.

The stress under the center of a rectangular loaded area is:

$\Delta\sigma_z = q\ I_8$ (Das, 2010)

Where I_8 = 0.997. (Das, 2010)

Therefore, the increase in the vertical stress is:

q = 110 pcf (90 ft) = 9900 psf

$$\Delta\sigma_z = 9900\ psf\ (0.997) = 9870\ psf$$

c. Total settlement

The total settlement is calculated using the equation based on one-dimensional consolidation (Das, 2010):

$$\Delta H = \frac{H}{1+eo}\left(C_r \log\frac{p'_o}{\sigma'_o} + C_c \log\frac{\sigma'_o + \Delta\sigma_z}{p'_o}\right)$$

$$\Delta H = \frac{15\ ft}{1+0.88}\left(0.03 \log\frac{4500\ psf}{915\ psf} + 0.3 \log\frac{915psf + 9870psf}{4500\ psf}\right)$$

$\Delta H = 1.07$ ft = 12.8 in

7. IMPACTS DUE TO SETTLEMENT

Assuming the maximum settlement of 13 inches occurs at the area where the maximum thickness of the ash stack is located, and the settlement linearly reduces to zero at the perimeter of the ash stack footprint, the potential effects on the leachate collection system are discussed below.

Figure 4 depicts the alignment of the box culvert and the leachate collection system pipes under the area of maximum settlement. The area of maximum settlement was defined based on the area with the highest elevation of the ash stack, which also corresponds to the area with the thickest ash layer.

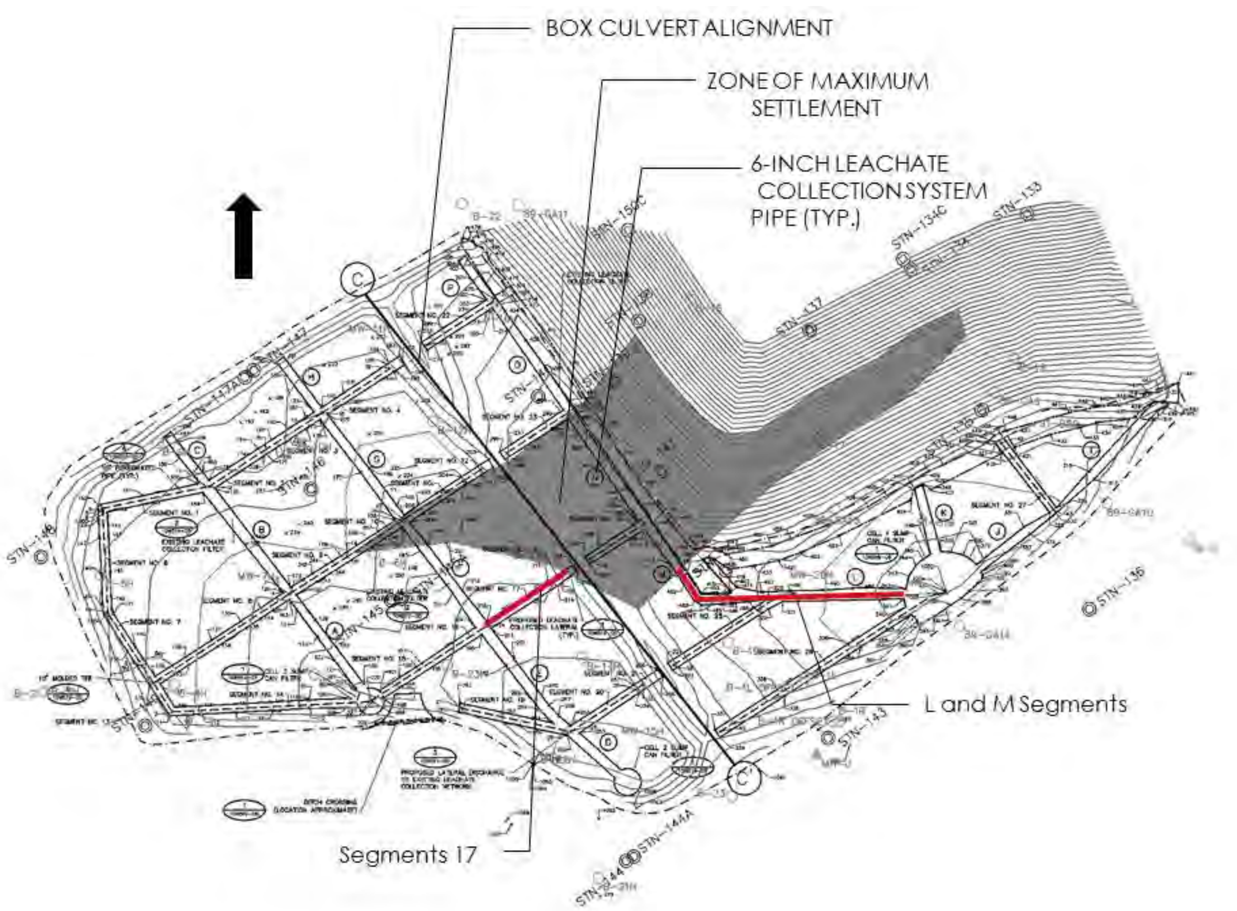


Figure 4. Box Culvert Alignment and zone of maximum stacked ash thickness.

8. BOX CULVERT

A concrete box culvert was installed beneath the geologic buffer layer, to route an unnamed tributary stream under the Lateral Expansion footprint. The box culvert was designed to have a 1.7% slope (CEC 2011), draining from north to south (see Section C-C'). The settlement due to the proposed ash stack will reduce the slope of the box culvert to a slope of 1.4%, considering a maximum settlement of 13 inches in the middle and zero settlement at the perimeter. Figure 5 depicts the approximate settlement profile for the box culvert alignment.

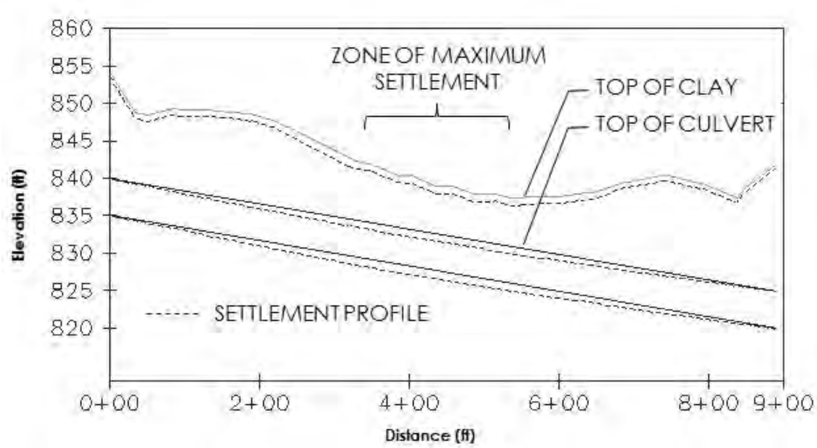


Figure 5. Approximate settlement profile for the box culvert (Section C-C')

With respect to potential settlement due to collapse of the box culvert, structural calculations for the precast concrete culvert shows that it was designed for a vertical load equivalent to 110 feet of ash (Tindall Corporation, 2012). The permitted geometry has a maximum of 90-feet of stacked ash; therefore, the culvert design is more than sufficient to resist collapse.

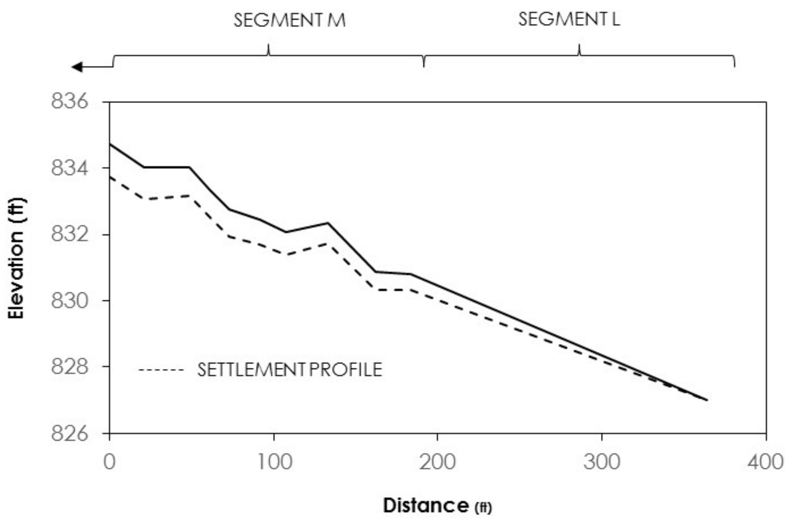
The design drawings (TVA Drawing No. 10W299-17R0, in particular) and the Construction Quality Assurance (CQA) Certification Report (CEC 2014) does document several construction measures that should reduce the potential for differential settlement. According to the design drawings, the existing topsoil was stripped and subgrade soils were to be proof rolled prior to placing structural fill. Compacted crushed stone was placed to provide a foundation for the culvert. On-site construction observation and field density testing were performed on the crushed stone. Compacted crushed stone was also placed along the sides of the box culvert, up to the top of the culvert. Next, compacted clayey soil for the geologic buffer (5 feet thick) was placed over the entire unit footprint, including over top of the culvert. The bottom liner and leachate collection system were then constructed. The subgrade soils are unlikely to settle significantly, because they are relatively thin and they were proof rolled ahead of installing the culvert. The placement of the overlying geologic buffer layer across the entire unit footprint also reduces the potential for abrupt differential settlement along the culvert alignment.

9. LEACHATE COLLECTION SYSTEM

Two of the flattest segments of the leachate collection system are analyzed to determine the possible adverse effects (i.e., reduction in positive slope) of the pipes due to settlement, as a result of loading of the proposed ash stack.

Segment "M" and "L"

The average as-built slope for Section M and Section L is about 2.1% (Stantec 2015). After ash stacking and the resulting settlement, this pipe slope will be reduced to about 1.9%.



Segment 17

According to the as-built pipe segment point location table (Stantec, 2015), Segment 17 has an average as-built slope of about 0.9%. The table below summarizes the information for this segment.

Table 4. Segment 17 as-built data

Segment No.	Crown In			Crown Out				
	Northing	Easting	Elevation (ft)	Northing	Easting	Elevation (ft)	Pipe length (ft)	Slope (%)
17	599118.55	2547535.14	832.72	599052.82	2547434.2	831.61	120.45	0.92

The calculated settlement at the upstream invert is 13 inches and the settlement at the downstream invert is approximately 9 inches (interpolated settlement, see below calculation). The new slope for segment 17 after the settlement occurs is about 0.6%.

The settlement at the invert out of segment 17 was calculated using the following relationship:

$$\frac{365\ ft - 120.45ft}{365\ ft}\ 1.083\ ft * 12\frac{inch}{ft} = 9\ inch$$

Where 365-ft is the distance between the invert in location and the perimeter of the ash stack.

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10. CONCLUSION

According to this analysis, the post-settlement slopes of the leachate collection system pipes will remain positive, promoting flow in the direction that the design intended. The post-settlement slope of the box culvert will also maintain positive drainage for the stream it conveys. The box culvert has been structurally designed to withstand the proposed loads, and the potential for differential settlement along the culvert alignment is not expected to damage the liner.

11. REFERENCES

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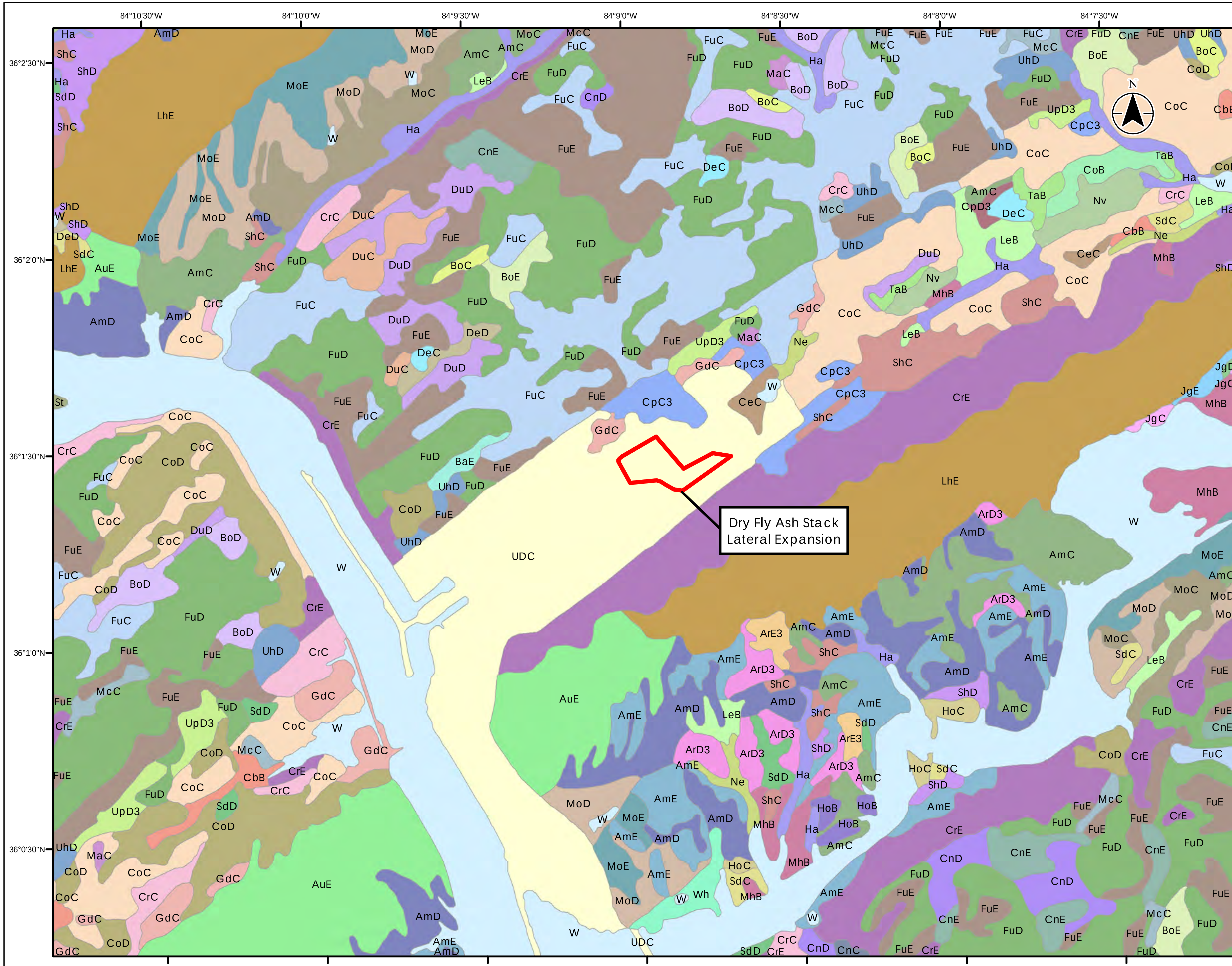
APPENDIX C
GEOLOGIC OR GEOMORPHOLOGIC CONDITIONS



Geological Formation Map

Site

Bull Run Fossil Plant (BRF)
Dry Fly Run Stack Lateral Expansion

Client/Project

Tennessee Valley Authority (TVA)
Chattanooga, Tennesse

Project Location

Anderson County,
Tennessee

Prepared by RRR on 2017-06-07

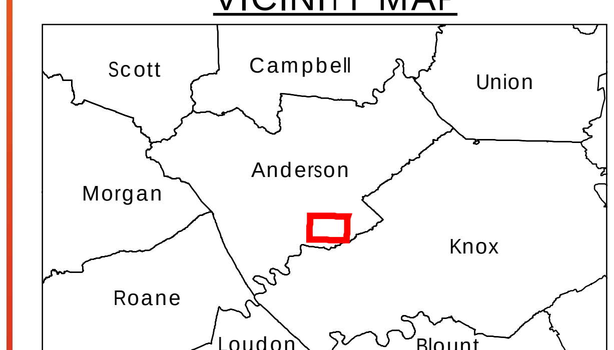
0 0.2 0.4 Miles

1:18,000 (At original document size of 11x17)

LEGEND

CCR Landfill Unit Limits

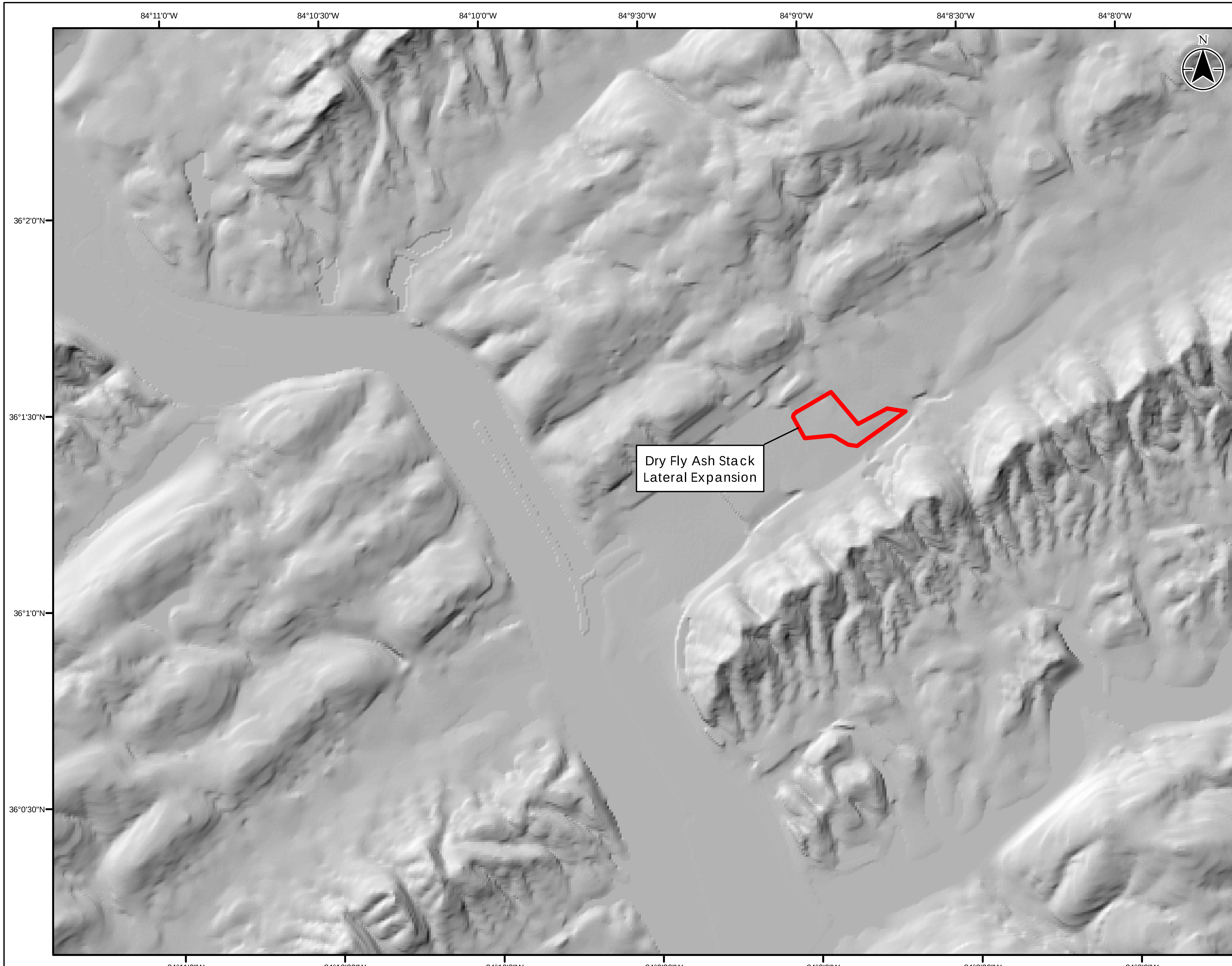
VICINITY MAP



Notes

1. Coordinate System: NAD 1927 UTM Zone 16N
2. Base features provided by ESRI
3. Geological Formation data provided by U.S. Department of Agriculture, Natural Resources Conservation Service

Stantec



LiDAR Hillshade DEM Map

Site
Bull Run Fossil Plant (BRF)
Dry Fly Run Stack Lateral Expansion

Client/Project
Tennessee Valley Authority (TVA)
Chattanooga, Tennesse

Project Location
Anderson County,
Tennessee

Prepared by RRR on 2017-06-07

0 0.2 0.4 Miles

1:18,000 (At original document size of 11x17)

LEGEND

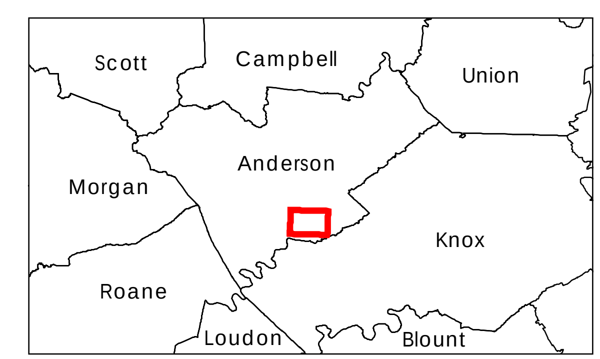
CCR Landfill Unit Limits

Hillshade:

High : 254

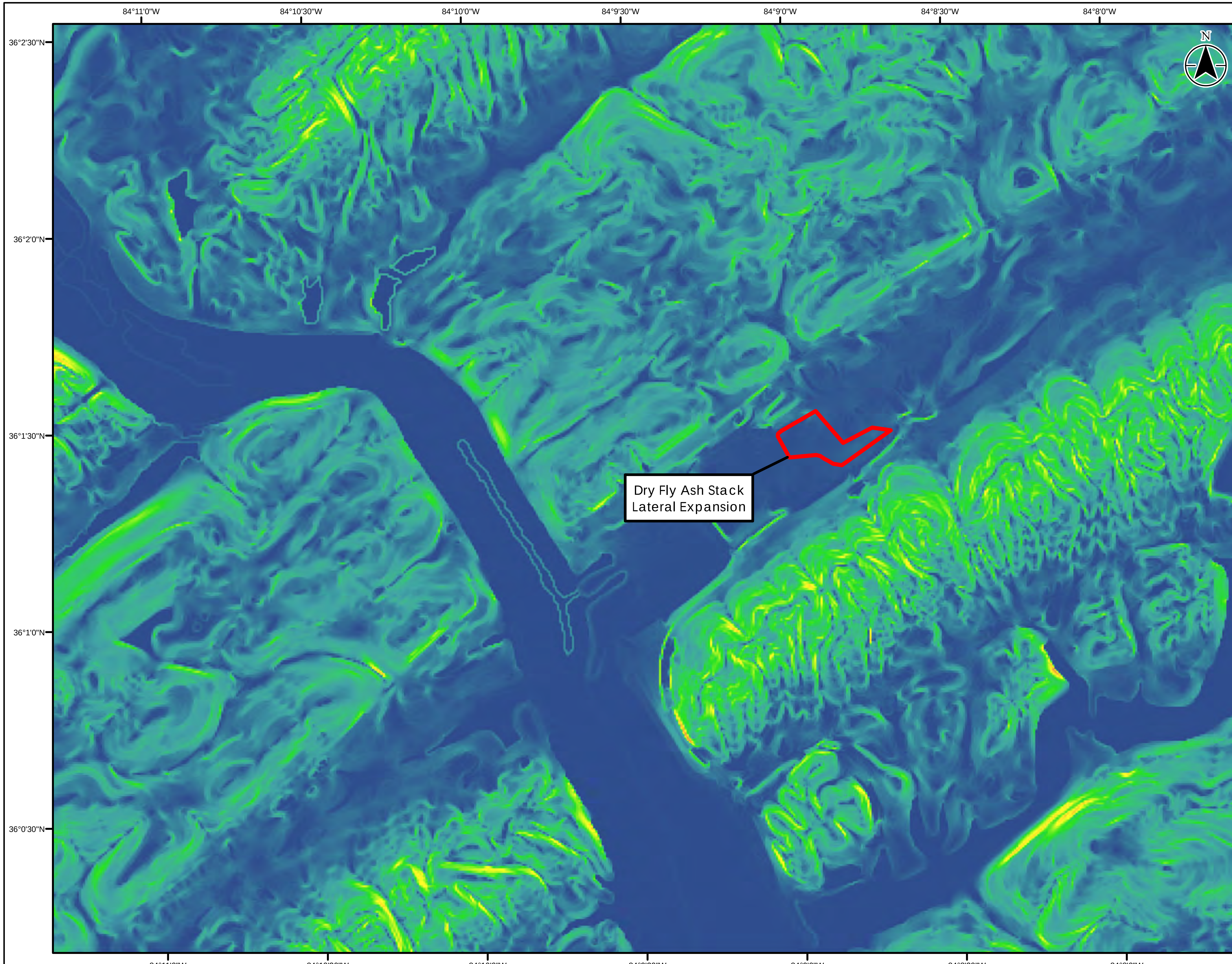
Low : 0

VICINITY MAP



Notes
1. Coordinate System: NAD 1927 UTM Zone 16N
2. Base features provided by ESRI
3. Hillshade Created Using 10m Digital Elevation Model from USGS

Stantec



Slope Raster Map

Site

Bull Run Fossil Plant (BRF)
Dry Fly Run Stack Lateral Expansion

Client/Project

Tennessee Valley Authority (TVA)
Chattanooga, Tennessee

Project Location

Anderson County,
Tennessee

Prepared by RRR on 2017-06-13

0 0.2 0.4 Miles

1:18,000 (At original document size of 11x17)

LEGEND

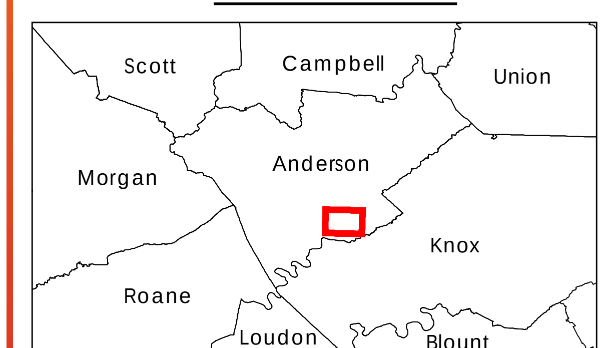
CCR Landfill Unit Limits

Slope:

High : 65

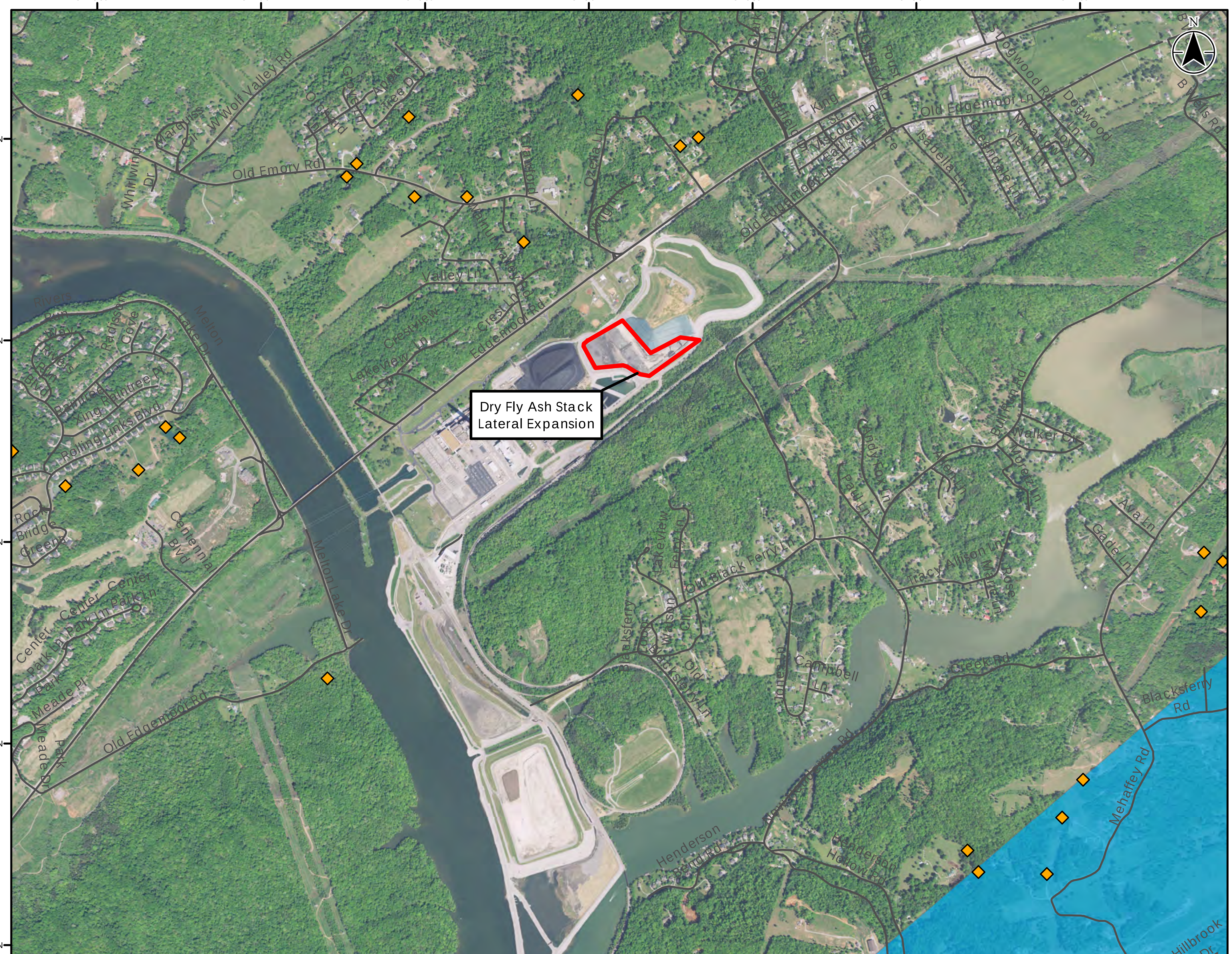
Low : 0

VICINITY MAP



Notes
1. Coordinate System: NAD 1927 UTM Zone 16N
2. Base features provided by ESRI
3. Slope Created Using 10m Digital Elevation Model from USGS

Stantec



Karst Potential Map

Site

Bull Run Fossil Plant (BRF)
Dry Fly Run Stack Lateral Expansion

Client/Project

Tennessee Valley Authority (TVA)
Chattanooga, Tennessee

Project Location

Anderson County,
Tennessee

Prepared by RRR on 2017-06-13

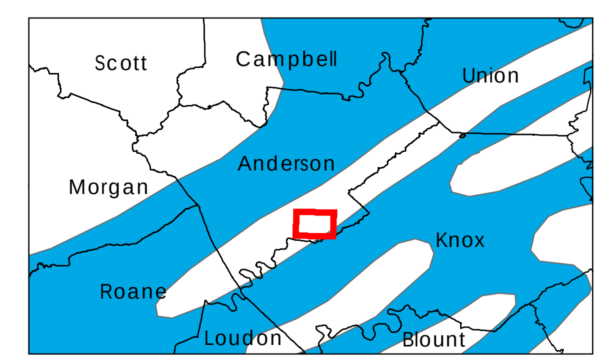
0 0.2 0.4 Miles

1:18,000 (At original document size of 11x17)

LEGEND

- CCR Landfill Unit Limits
- Reported Sinkholes
- Karstic Soil Conditions
- Roads

VICINITY MAP



Notes

1. Coordinate System: NAD 1927 UTM Zone 16N
2. Base features provided by ESRI
3. Karst data provided by USGS Open-File Report 2004-1352
4. Sinkhole information provided by Tennessee Landforms (tnlandforms.us)
5. Transportation data is availble from USGS

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APPENDIX D
HUMAN-MADE FEATURES OR EVENTS

Human-Made Features Map

Site
Bull Run Fossil Plant (BRF)
Dry Fly Run Stack Lateral Expansion

Client/Project
Tennessee Valley Authority (TVA)
Chattanooga, Tennessee

Project Location
Anderson County,
Tennessee

Prepared by RRR on 2017-06-07

0 0.75 1.5 Miles

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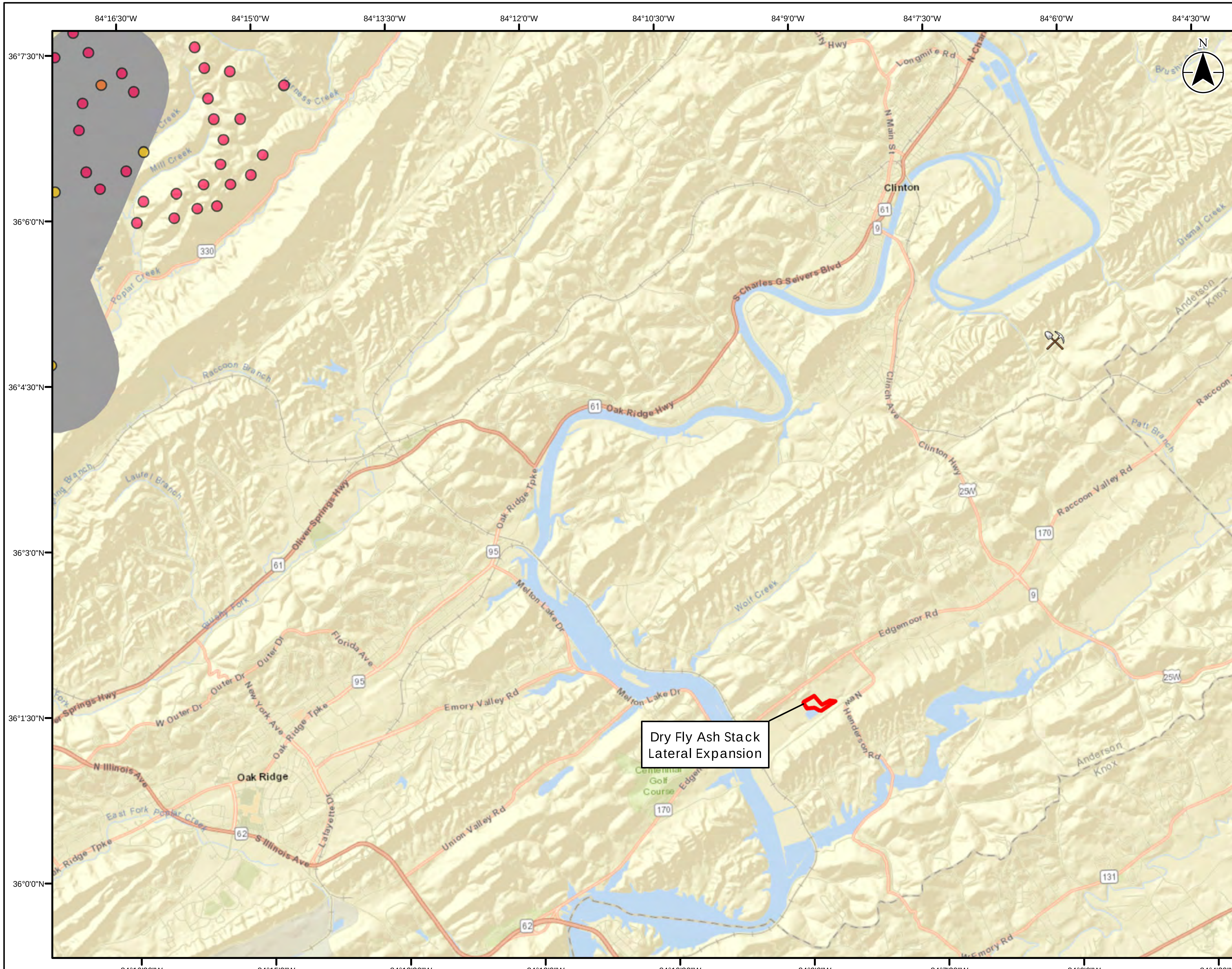
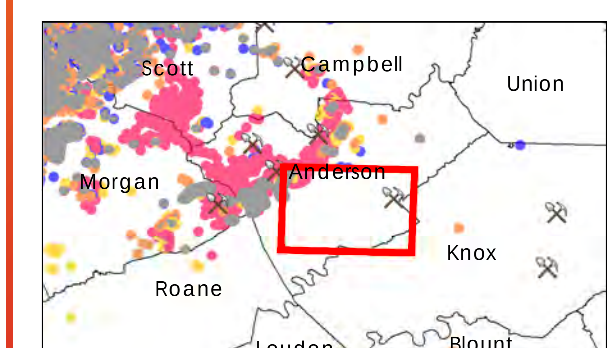


LEGEND

- CCR Landfill Unit Limits
- Oil and Gas Fields
- Gas Wells
- Unspecified Wells
- NCG - Domestic Use
- Oil Wells
- Oil And Gas Wells
- Active Quarries

VICINITY MAP



Notes

1. Coordinate System: NAD 1927 UTM Zone 16N
2. Base features provided by ESRI
3. Well data provided by TN Department of Environment and Conservation
4. Oil and Gas Field data provided by U.S. Energy Information Administration
5. Active Quarry data provided by U.S. Department of Homeland Security

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