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

October 5, 2018
File: rpt_007_let_175665013
Revision 0

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

RE: Unstable Areas Demonstration
Bottom Ash Pond
EPA Final Coal Combustion Residuals (CCR) Rule
TVA Cumberland Fossil Plant
Cumberland City, Tennessee

1.0 PURPOSE

As described in 40 CFR § 257.64(a), an owner or operator of an existing CCR surface impoundment 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 Bottom Ash Pond at the TVA Cumberland Fossil Plant (CUF) 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 Bottom Ash Pond meets the requirements set forth in 40 CFR § 257.64(a).

3.0 QUALIFIED PROFESSIONAL ENGINEER CERTIFICATION

I, Stephen H. Bickel, 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 Cumberland Bottom Ash Pond meets the requirements specified in 40 CFR § 257.64(a).

Stantec

Re: **Unstable Areas Demonstration**
Bottom Ash Pond
EPA Final Coal Combustion Residuals (CCR) Rule
TVA Cumberland Fossil Plant
Cumberland City, Tennessee

SIGNATURE _______________ DATE 10/05/2018

ADDRESS: Stantec Consulting Services Inc.
10509 Timberwood Circle Suite 100
Louisville, Kentucky 40223

TELEPHONE: (502) 212-5075

ATTACHMENTS: Unstable Areas Demonstration

Unstable Areas Demonstration

Bottom Ash Pond
Cumberland Fossil Plant
Stewart County, Tennessee

Prepared for:
Tennessee Valley Authority
Chattanooga Tennessee

Prepared by:
Stantec Consulting Services Inc.
Lexington, Kentucky

October 5, 2018
Revision 0

Table of Contents

LIST OF FIGURES

LIST OF APPENDICES

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 Bottom Ash Pond regarding the requirements for the Unstable Areas Location Restriction as required by the EPA Final CCR Rule §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 lateral expansion of a CCR unit is required by October 17, 2018 to demonstrate that the unit is not located in an unstable area, or that generally accepted good engineering practices have been incorporated into the design of the CCR unit. These practices must promote the geotechnical integrity of the unit in such a manner that structural components of the CCR unit will not be disrupted.

The Bottom Ash Pond has been identified as a CCR surface impoundment on the Cumberland Fossil Plant site. As defined by §257.2 of the EPA Final CCR Rule, the Bottom Ash Pond is characterized as a "…diked area, which is designed to hold an accumulation of CCR and liquids, and the unit treats, stores, or disposes of CCR."

The following factors have been considered to determine whether the Bottom Ash Pond at the Cumberland Fossil Plant (CUF) 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).

2.0 UNIT DESCRIPTION

CUF is located on the south bank of the Cumberland River near river mile 103. The plant is approximately a half mile west of Cumberland City in Stewart County, Tennessee (see Appendix Map C for site vicinity to major roadways and rivers).

Figure 1. Site Vicinity Map

Referring to Figure 1, the Bottom Ash Pond is located at the northern junction of the Dry Ash Stack and the Gypsum Storage Area, southwest of the plant's fly ash silos and Powerhouse. Bottom ash is sluiced to the Bottom Ash Pond, reclaimed, and then spread and compacted on the Dry Ash Stack. Gypsum slurry is processed and dewatered either at the nearby plant or within two lined settling channels located on the top of the Gypsum Storage Area. Effluent from the lined settling channels is conveyed to the Bottom Ash Pond. Effluent from the Bottom Ash Pond is then conveyed to the Stilling Pond. Construction of the Bottom Ash Pond perimeter dike was originally constructed in 1969 and raised in 1979 to its current height and configuration. The dike is constructed of compacted clay. TVA has determined that the Bottom Ash Pond is a CCR Surface Impoundment and therefore subject to the CCR rule (Stantec Consulting Services Inc., 2016f).

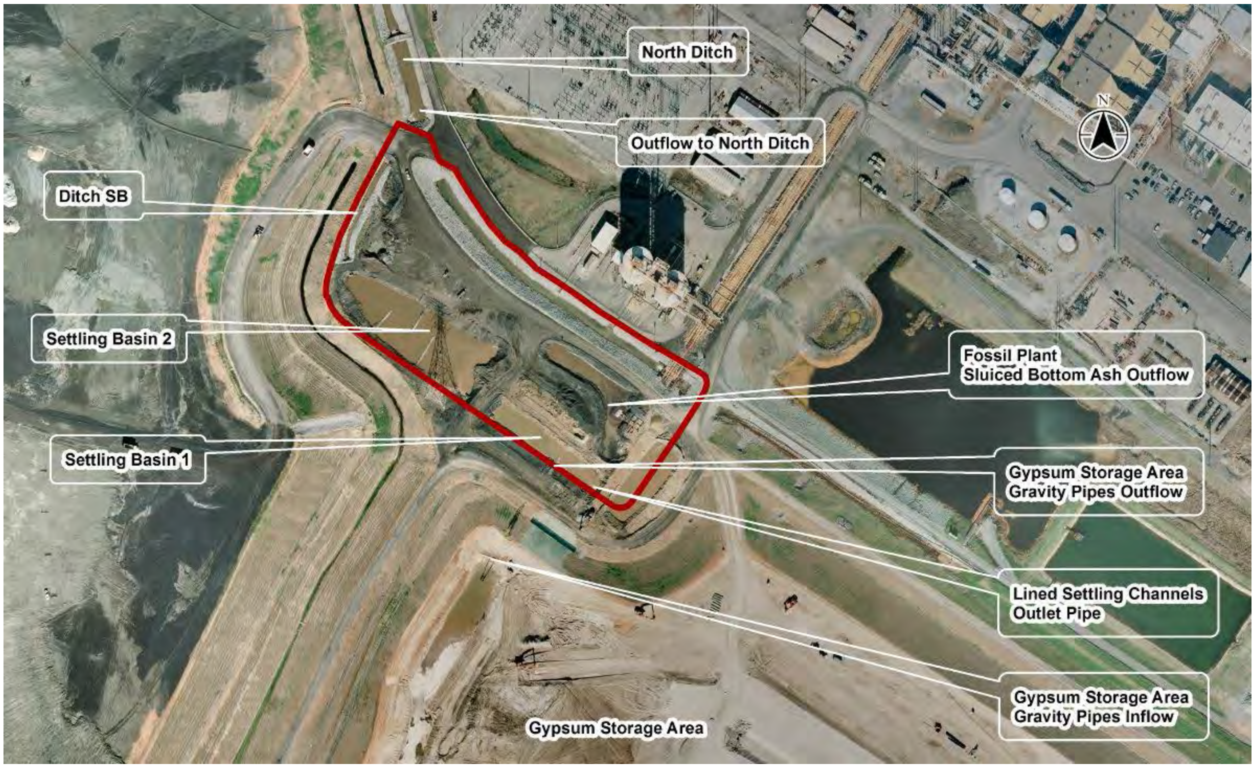


Figure 2. Bottom Ash Pond Unit Configuration

The Bottom Ash Pond is described as follows: It is comprised of two interconnected detention basins (Settling Basins 1 and 2) and a gravel-lined ditch (Ditch SB). The ditch conveys the flows from the Bottom Ash Pond and discharges into a perimeter gravel-lined ditch (North Ditch) (Stantec Consulting Services Inc., 2016d). The interior dike surface areas are typically compacted ash. The Bottom Ash Pond area is approximately 5.3 acres.

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 settling when determining whether the area is unstable.

Assessment of the soil conditions was completed by 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 within acceptable limits and would not cause 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 all available data on local soils information for a user-specified Area of Interest. Appendix A includes the Web Soil Survey completed for the CUF site. The soil survey (Web Soil Survey of Stewart County, Tennessee, United States Department of Agriculture (USDA), 2009) indicates that the soils surrounding CUF are Silt-Loams or Silty Clay-Loams of the Nolen, Sengtown, Bodine, Egam, Maury, Lindside, Melvinville, Byler and Wolftever Associations. These soils formed from the weathering of interbedded sedimentary rock and generally range from silt loam to clay loam in texture. (Stantec Consulting Services Inc., 2010a).

Soil Conditions (§257.64(b)(1))
October 5, 2018

Three Geotechnical Investigations have been conducted of the Bottom Ash Pond. These Investigations were conducted and reviewed for concurrence with the potential existence of soft soils and the published soil surveys. The perimeter dike foundation soils consist of alluvial clay and sand deposits that vary in thickness from approximately 20 to 70 feet (Stantec Consulting Services Inc., 2016f). The alluvial clay material was described as lean clay with a silty and or sandy gradation (Stantec Consulting Services Inc., 2010a). The soil was described as moist to wet, reddish brown to light gray in color. The alluvial clay has consistencies that generally range from soft to very stiff. The alluvial sands were mostly found to be beneath the clay layer and described as silty sand with gravel, gravel with clay, and silt and sand (Stantec Consulting Services Inc., 2016b).

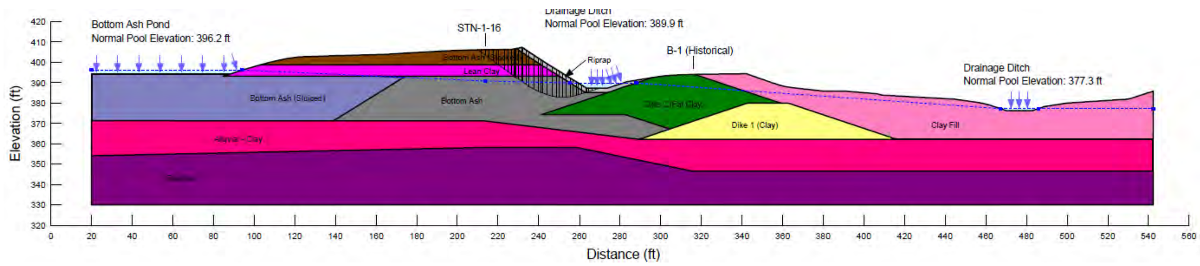


Figure 3. Typical Perimeter Dike Cross Section

As identified by the "Report of Geotechnical Exploration and Slope Stability Evaluation, Ash Pond, Cumberland Fossil Plant" (Stantec Consulting Services Inc., 2010a), and described within the History of Construction (Stantec Consulting Services Inc., 2016b), the perimeter dike is composed of three materials. The original perimeter dike, Dike 1, extends from approximate Elevation 350 to Elevation 380. The material has a textural description of lean clay and was described as moist to wet and red brown to gray brown in color. The soil consistency generally ranges from very soft to very stiff. Dike 2 was built with upstream construction methods to raise the original perimeter dike (Dike 1). Dike 2 was identified to have fat clay soils within the vicinity of the Bottom Ash Pond. The fat clay has textural descriptions of fat clay with gravel and was described as damp to wet and dark brown to reddish brown in color. The soil consistency generally ranges from firm to very stiff. A third dike was built upstream of the perimeter (Dike 3) with bottom ash and encompasses the Bottom Ash Unit. The bottom ash classifies as a silty sand with gravel or silty sand and was described as damp to wet and dark gray to black in color and coarse grained. The soil consistency generally ranges from very loose to very dense (Stantec Consulting Services Inc., 2016g).

Annual Site Inspections of the Bottom Ash Pond, conducted and documented regularly from 1996 to 2017, 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 and geotechnical exploration reports were reviewed for evidence of soft and compressible soils that may have been on site prior to the development of the Bottom Ash Pond. For the purposes of this report, soft and compressible soils are fat clays, elastic silts, organic silts and clays, or highly organic soils (peat). The information available from published soil surveys, borings, and the local soils described in Section 3.1 indicates the presence of soft or compressible soils within the Bottom Ash Pond foundation soils. The geotechnical explorations of the Bottom Ash Pond and subsequent analyses also show that the on-site dike soils did contain potions of soft or compressible soils at the interface of the foundation, located on the interior portions of the perimeter dike. These areas were small and in problem areas have been removed as a part of the improvements associated with the creation of the Bottom Ash Pond.

There is no record of structural instability of the Bottom Ash Pond perimeter dike. Annual site inspections report no signs of tension cracking, significant settlement, erosion, and/or deformations at the crest, slope, and toe of the perimeter dike (Stantec Consulting Services Inc., 2016b). Due to the original configuration of the site, the Bottom Ash Pond sits atop 30 feet of sluiced ash. As a part of the original construction of the Bottom Ash Pond dikes, soft or compressible soils of the original Ash Pond materials were removed directly below the dike foundations. Small settlements will occur in spots due to the placement of the Bottom Ash Pond over top of the original Ash Pond materials; however, because of the uniform loading method for which the Bottom Ash Pond was constructed, significant differential settlement is highly unlikely to occur and does not constitute a condition of an unstable area.

Based on the assessment of the soil conditions, the CCR Rule criteria listed above for soil conditions has 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 B 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 CUF site lies within a unique geologic feature that is known as the Wells Creek Structure. The structure is believed to be the result of a meteor impact event characterized by a roughly circular shaped depression with a diameter of nearly 2 miles, at its center containing uplifted, folded, and exposed Knox Dolomite and bedrock of the Stones River Group. The periphery of the circular structure is characterized by more recent sedimentary strata outcrops with concentric parallel bands that dip away from the basin center at higher elevations. Based on years of geologic field studies by other researchers, the rebound of impact shock waves caused upward thrusting forces within structure resulting in intensive brecciation and large-scale faulting in a radial and circular fault pattern. The bowl-shaped basin structure, with alluvium and residual overburden soils that are present today, is the result of weathering and erosion (Law Engineering, 1992a). The Wells Creek Crater Lithology Map, located in Appendix B, shows an aerial view of the CUF Plant with the top of rock lithology map transposed to show rock formations within the Wells Creek Structure. The Bottom Ash Pond is generally underlain by alluvial deposits and the Stone River Group formations.

The complex geology of the Wells Creek Structure has been extensively researched by multiple entities and mapped extensively by the USGS. Physiographic Regions of Tennessee Map indicates that CUF is generally located in the Western Highland Rim of Middle Tennessee. The geological map published by USGS indicates that the underlying bedrock of the region is chiefly Mississippian limestone, chert, shale, and sandstone with exposures of Devonian, Silurian, Ordovician, and Cambrian limestone, chert, and shale. In the northern part of the Western Highland Rim, caves and other karst features may be present (Stantec Consulting Services Inc., 2010a). The Generalized Geologic Map of Tennessee (Tennessee Department of Environment and Conservation (TDEC), 2009) indicates that the areas surrounding the project site are underlain by rock of Mississippian age. In the immediate vicinity of the project site, rock of Ordovician age predominates (Stantec Consulting Services Inc., 2010a).

According to the Geologic Map of the Cumberland City Quadrangle (USGS 1968, revised 1986), the complex site is predominantly underlain by bedrock belonging to the Mannie Shale, Fernvale Limestone, Hermitage, Carters, Lebanon, Ridley, Pierce and Murfreesboro Limestone Formations, in general order of descending lithology. Each of these formations is of Ordovician age and is comprised of limestones that may be described as thin to thick bedded, greenish-gray to gray, coarse to crystalline grained, argillaceous and hard. The Hermitage Formation also contains thin bedded to laminated gray sandy shale and the Mannie Shale Formation contains shale and limestone interbedded (Stantec Consulting Services Inc., 2010a).

Rock cores have not been collected directly beneath the Bottom Ash Pond unit; however, rock cores of the adjacent Dry Ash Stack and Gypsum Storage Area were collected during multiple geotechnical explorations of the CUF site, with the resulting bedrock core samples ranging from approximately 5 to 10 feet in length. The bedrock encountered in test borings typically is composed of slightly weathered, interbedded limestone and shale. The limestone is light gray, hard, and thick bedded. The shale is described to be light gray, calcareous, moderately hard and laminated. (Stantec Consulting Services Inc., 2010b).

Site inspections of the Bottom Ash Pond, conducted and documented regularly from 1996 to 2017, were reviewed to identify observations of potential deficiencies within the surface impoundment or along the perimeter dikes that indicate 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

The original topographic mapping for development of the Disposal Area 1 did not contain any contours, or mapped call-outs, that suggest sinks, sinkholes or springs were present beneath the area that would ultimately become the Bottom Ash Pond.

The digital elevations models (DEMs) show no indication of areas susceptible to mass movement within the vicinity of the surface impoundment. The nearest area having moderate to steep slopes is approximately ¼ of a mile northwest, and it is separated from the Unit by Wells Creek along with the Stilling Pond (including Retention Pond) and Dry Ash Stack.

A map of the lithologic units at the Wells Creek structure (United States Geological Survey (USGS), 1968) was transposed onto an aerial map of the CUF site (Appendix B). The regional existence of shallow sinkhole depressions has been noted in adjacent portions of the CUF facility as well as other suggestions of karstic activity such as losing ephemeral streams. Additionally, uplifted strata within the near vicinity of the ash ponds are regionally recognized for their susceptibility to karstic processes. As shown in Appendix B, the footprint of the Bottom Ash Pond is located over alluvial material and the Stones River Group formations. However, the risk of sinkhole formation within the site is believed to be relatively low due to the historic and unique geology of the site, topography, and the fact that there are no records of treatment for karstic conditions since the unit was constructed.

According to historical documentation relating to the systematic study of karst across the United States (United States Geological Survey, 1984) and as evidence in the EPA Seismic Assessment of the CUF Stilling Pond and Bottom Ash Pond, investigation into the existence of karst in this region indicates that the CUF site and surrounding area do not have a significant risk of sinkholes occurring (Geocomp, 2016b).

The Karst Potential Map included in Appendix B shows the location of sinkholes and areas to have mapped Karstic Potential. The closest reported sinkholes are 1.7 miles from the CUF site. No large natural springs have been observed at the site, but several small springs and seeps are present at various locations surrounding the CUF site. For the purposes of this report, spring size relates to the surface area of the spring orifice. In a regional groundwater study of CUF, Foust and Beard (1990) include off-site groundwater supplies and the locations of five springs surrounding the CUF site. One of these springs, Rye Spring, was routinely sampled until 2016 when the property owner no longer allowed sampling. As a part of the ongoing Environmental Investigation Plan, TVA will identify an alternate sampling location or work with TDEC and the property owner on accessing private property during the investigation. Rye Spring is located in a pasture approximately 0.5 km east of the ash pond on the Cass Rye property in a geologic formation identified as the Stones River group (Tennessee Valley Authority (TVA), 1998). Based on the information presented in the inspection reports and groundwater monitoring data of the Bottom Ash Pond, there have been no documented paleosinks, sinkholes, or other characteristic features of karstic formation.

The CUF site is located within a zone of Karstic Potential, characterized as having "fissures, tubes, and caves generally less than 1,000 feet long, and 50 feet or less vertical extent in gently dipping to flat-lying carbonate rock" (see Digital Engineering Aspects of Karst Map, located in Appendix B). The rock encountered in geotechnical explorations of the Bottom Ash Pond indicated that there was limestone encountered below the alluvial soils with rock core recovery quality ranging from fair to excellent. At the site, the limestones and dolomites that generally underlie the site indicated only a few cavities present in the rock near the soil rock interface after penetrating 10 feet or more of sound rock (Tennessee Valley Authority (TVA), 2011a). Although these conditions exist, the investigations indicate that these are not large enough to develop karstic conditions in which the site would become unstable.

Although these potential karstic conditions have been identified in the vicinity of the site, there is sufficient evidence to demonstrate that the Bottom Ash Pond is not located in an area of unstable karstic conditions. Topographical maps generated over time do not indicate the characteristics associated with unstable karstic formations. The CUF site history does not show any physical evidence of pre-treatment of karst. Since the site was constructed, there has been no evidence of water leaving the Bottom Ash Pond to indicate subsurface karstic conditions due to disposal activities. Furthermore, the site is set a top an ancient structure created by an immense force that impacted the earth an estimated 200 million years ago allowing for the passage of time to fill in areas of faults and fissures sealing up these seams and leaving a very stable foundation.

Based on this assessment of the geologic and geomorphologic features, the CCR Rule criteria listed above for geologic and geomorphologic features has 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 of the surface impoundment 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 Bottom Ash Pond, conducted and documented regularly from 1996 to 2017, were reviewed to identify observations of potential indications of human-induced events or forces that could have impaired the integrity of structural components, which are responsible for preventing the unpermitted release of CCR to the environment. TVA continues to comply with inspection requirements pursuant to the EPA Final CCR Rule and other regulatory requirements.

Historical geological surveys were reviewed to determine the historic land use of the site as it pertains to human-made features. The USGS in association with the USEPA digitized maps and datasets to meet the needs of the USGS National Water Quality Assessment (NAWQA) Program. The land use and land cover data from 1986 USGS indicates that the Bottom Ash Pond was in an area designated as "non-forested wetland" prior to the CUF site production.

The surface impoundment is being operated in accordance with approved quality control and operational procedures in the approved Operations and Maintenance Manual developed in accordance with the EPA Emergency Action Plan and is subject to periodic inspection by TDEC. The surface impoundment has been operating under the National Pollutant Discharge Elimination System (NPDES) Permit No. TN0005789 (Tennessee Valley Authority (TVA), 2011c).

There is no geotechnical instrumentation installed within the Bottom Ash Pond perimeter dike system (Stantec Consulting Services Inc., 2016b).

TVA inspects and maintains the Bottom Ash Pond in accordance with CCR Rule and other regulatory requirements. TVA performs inspections scheduled on specific intervals and with qualified personnel. The dikes are also visually inspected daily during operations by site personnel or designee.

Appendix C contains maps presenting the locations of permitted hazardous waste sites, water wells, nearby quarries, oil and gas wells and lines, and gas fields.

5.2 ASSESSMENT

The reviewed inspection reports contained no documentation of disposal activities that caused a structural component of the dike system to fail. Operations and inspection manuals were verified to include satisfactory measures to maintain precaution from human-induced events or forces that might impair structural components. In addition, the historic land use of the site does not indicate the site was pre-disposed to human activities that would indicate the Bottom Ash Pond was in an unstable area.

Local and on-site “human-made features or events” or activities both surface and subsurface were considered in the assessment of the stability of the CCR unit. Facilities within the vicinity of the CCR unit, such as active mining operation facilities, industrial wastes and well sites, and oil and gas fields, were reviewed for their potential to cause unstable conditions at the Bottom Ash Pond by their regular production activities. There were no records available for review of the site having been constructed on previous landfills or previously mined or quarried areas. An active clay quarry is located approximately 7.5 miles northwest of the site. There are no industrial wells or waste sites within 1 mile of the site. Based on the maps provided in the Appendix, the site is not located within oil or gas fields. There are no oil or gas wells, lines, or other related infrastructure within 1 mile of the site. It is not expected that human events related to these industries or their operations pose a negative impact to the structural components of the Bottom Ash Pond or that would cause the unit to become unstable.

Based on the assessment of the human-made features or events, the CCR Rule criteria listed above for human-made features or events have been met.

6.0 CONCLUSIONS

Based on the assessment given herein, the Bottom Ash Pond at CUF meets the requirements in §257.64 of the EPA Final CCR Rule for unstable areas.

7.0 REFERENCES

Geocomp. (2016a). EPA Seismic Assessment Supplemental Site Exploration, Cumberland Fossil Plant, Stilling Pond (including Retention Pond) and Bottom Ash Pond, Final Report, Volume 1 of 4. Prepared for Tennessee Valley Authority (TVA), October.

Geocomp. (2016b). Initial Seismic Safety Factor Assessment, Bottom Ash Pond, EPA Final Coal Combustion Residuals (CCR) Rule, TVA Cumberland Fossil Plant, Cumberland City, Tennessee. Prepared for Tennessee Valley Authority (TVA), October.

Law Engineering. (1992a). Report of Hydrogeologic Evaluation, Proposed Dry Fly Ash and Gypsum Disposal Facility Site, TVA Cumberland Fossil Plant, Cumberland City, Tennessee, July.

Law Engineering. (1992b). Report of Subsurface Exploration & Stability Analyses, Proposed Fly Ash/Scrubber Sludge Disposal Facility, TVA Cumberland Fossil Plant, Cumberland City, Tennessee. Prepared for Tennessee Valley Authority (TVA), January 27.

Stantec Consulting Services Inc. (2010a). Report of Geotechnical Exploration and Slope Stability Evaluation, Ash Pond, Cumberland Fossil Plant, Stewart County, Tennessee. Prepared for Tennessee Valley Authority, March.

Stantec Consulting Services Inc. (2010b). Report of Geotechnical Exploration, Dry Fly Ash Stack and Gypsum Disposal Complex, Cumberland Fossil Plant, Stewart County, Tennessee. Prepared for Tennessee Valley Authority (TVA), June.

Stantec Consulting Services Inc. (2016a). Closure and Post-Closure Plan, Bottom Ash Pond and Stilling Pond (Including Retention Pond), EPA Final Coal Combustion Residuals (CCR) Rule, TVA Cumberland Fossil Plant, Stewart County, Tennessee. Prepared for Tennessee Valley Authority (TVA), October.

Stantec Consulting Services Inc. (2016b). History of Construction, Bottom Ash Pond, EPA Final Coal Combustion Residuals (CCR) Rule, TVA Cumberland Fossil Plant, Cumberland City, Tennessee. Prepared for Tennessee Valley Authority (TVA), October.

Stantec Consulting Services Inc. (2016c). Initial Hazard Potential Classification Assessment, Bottom Ash Pond, EPA Final Coal Combustion Residuals (CCR) Rule, TVA Cumberland Fossil Plant, Cumberland City, Tennessee. Prepared by Tennessee Valley Authority (TVA), October.

Stantec Consulting Services Inc. (2016d). Initial Inflow Design Flood Control System Plan, Bottom Ash Pond, EPA Final Coal Combustion Residuals (CCR) Rule, TVA Cumberland Fossil Plant, Cumberland City, Tennessee. Prepared for Tennessee Valley Authority (TVA), October.

Stantec Consulting Services Inc. (2016e). Initial Safety Factor Assessment, Bottom Ash Pond, EPA Final Coal Combustion Residuals (CCR) Rule, TVA Cumberland Fossil Plant, Stewart County, Tennessee. Prepared for Tennessee Valley Authority (TVA), October.

Stantec Consulting Services Inc. (2016f). Initial Structural Stability Assessment, Bottom Ash Pond, EPA Final Coal Combustion Residuals (CCR) Rule, TVA Cumberland Fossil Plant, Cumberland City, Tennessee. Prepared for Tennessee Valley Authority (TVA), October.

Stantec Consulting Services Inc. (2016g). Report of Geotechnical Exploration, Cumberland Fossil Plant, Bottom Ash Pond, Stewart County, Tennessee. Prepared for Tennessee Valley Authority (TVA), October 12.

Tennessee Department of Environment and Conservation (TDEC). (2009). Generalized Geologic Map of Tennessee.

Tennessee Valley Authority (TVA). (1998). Cumberland Fossil Plant Groundwater Assessment, WR98-1-46-110. Prepared by Hank E. Julian and Andrew J. Danzig, August.

Tennessee Valley Authority (TVA). (2011a). Groundwater Quality Assessment Plan, Cumberland Fossil Plant, Dry Fly Ash and Gypsum Disposal Areas (IDL 81-102-0086). Prepared by J. Mark Bogga, P.G. December 12.

Tennessee Valley Authority (TVA). (2011b). Operations Support Document, Cumberland Fossil Plant, July.

Tennessee Valley Authority (TVA). (2011c). TVA Routine Handling Operations and Maintenance, Operations Support Document, Cumberland Fossil Plant. July.

Tennessee Valley Authority (TVA). (2015). Groundwater Assessment Monitoring Report, October 2015. Prepared by Jeff Norman, December 17.

Tennessee Valley Authority (TVA). (2016). Coal Combustion Products Inspection of CCP Storage Facilities, GCP&S-SPP-27.4.1, Rev. 003.

Tennessee Valley Authority (TVA). (2017). FY 2017 Intermediate Inspection of CCR Facilities, Cumberland Fossil Plant, Cumberland City, Stewart County, Tennessee, January 29.

United States Geological Survey (USGS). (1968). Geologic Map of Wells Creek Basin, Tennessee Division of Geology, Bulletin 68, Plate 2. Prepared by Herbert A. Tiedemann, Charles W. Wilson, Jr., and Richard G. Stearns.

United States Geological Survey. (1984). U.S. Geological Survey Open File Report 2004-1352: Digital Engineering Aspects of Karst Map: A GIS version of Davies, W.E., Simpson, J.H., Ohlmacher, G.C., Kirk, W.S., and Newton, E.G., 1984, Engineering Aspects of Karst; by Bret D. Tobin & David J. Weary. National Atlas of America.

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

Stewart County, Tennessee

Cumberland Fossil Plant

June 21, 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.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

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.

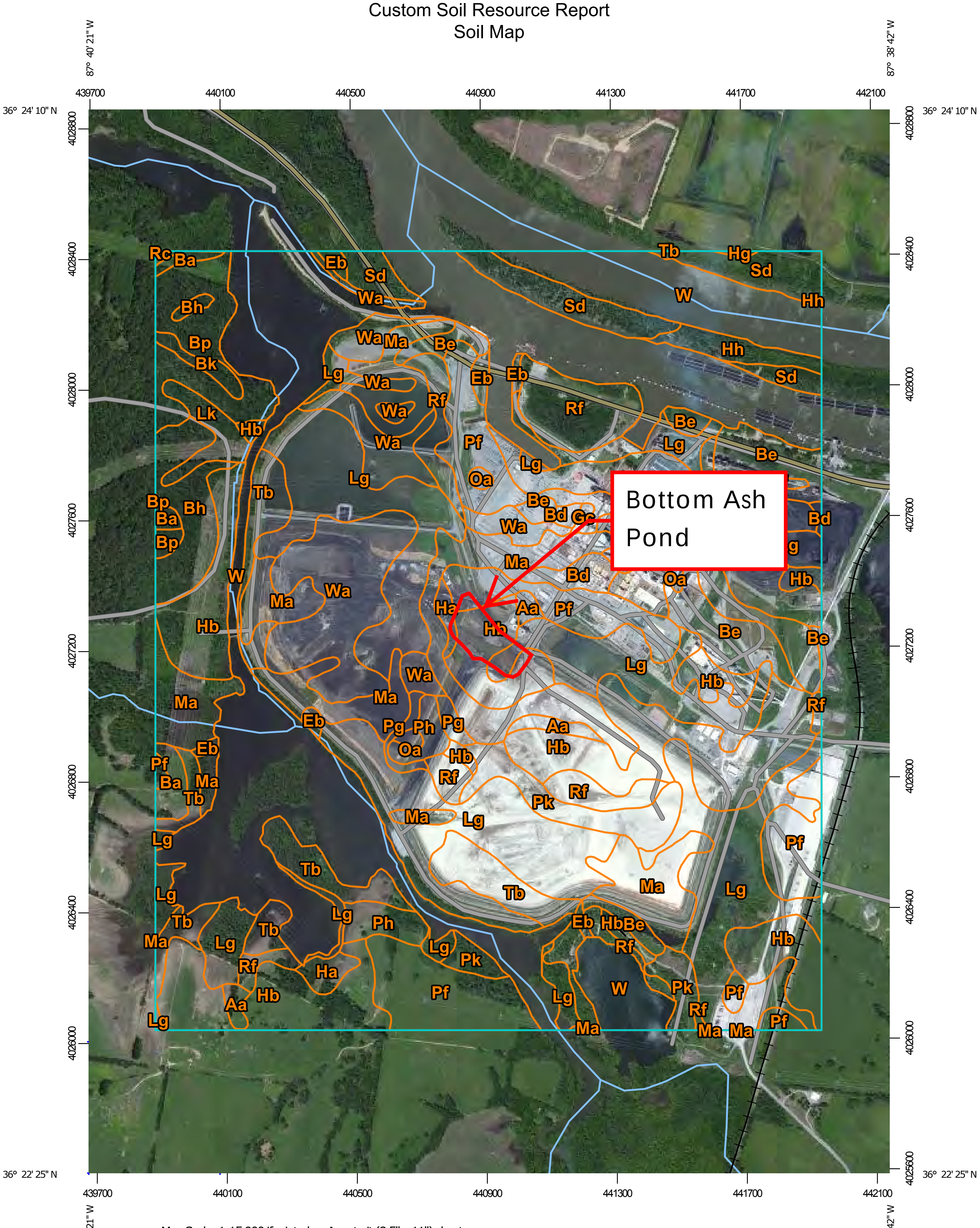
Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree 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.

Custom Soil Resource Report
Soil Map



Map Scale: 1:15,900 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0, 200, 400, 800, 1200

Feet: 0, 500, 1000, 2000, 3000

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 1:20,000.

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: Stewart County, Tennessee
Survey Area Data: Version 15, Sep 28, 2015

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

Date(s) aerial images were photographed: Mar 17, 2011—May 30, 2011

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

Stewart County, Tennessee (TN161)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
Aa	Nolin silt loam, occasionally ponded	6.0	0.5%
Ba	Sengtown gravelly silt loam, 5 to 12 percent slopes	31.9	2.6%
Bd	Sengtown gravelly silt loam, 12 to 20 percent slopes, severely eroded	6.8	0.6%
Be	Sengtown gravelly silt loam, 12 to 20 percent slopes	44.0	3.6%
Bh	Bodine gravelly silt loam, 12 to 20 percent slopes, eroded	19.8	1.6%
Bk	Bodine gravelly silt loam, 5 to 12 percent slopes, eroded	3.2	0.3%
Bp	Bodine gravelly silt loam, 20 to 60 percent slopes	26.9	2.2%
Eb	Egam silty clay loam, occasionally flooded	5.8	0.5%
Gc	Trace silt loam, 2 to 5 percent slopes	0.8	0.1%
Ha	Maury silty clay loam, 12 to 20 percent slopes, eroded	42.9	3.5%
Hb	Maury silty clay loam, 5 to 12 percent slopes, eroded	134.2	11.1%
Hg	Sequatchie fine sandy loam, 2 to 5 percent slopes	0.4	0.0%
Hh	Nolin silt loam, occasionally flooded	7.9	0.6%
Lg	Lindell silt loam, 0 to 2 percent slopes, occasionally flooded	207.5	17.1%
Lk	Lobelville silt loam, occasionally flooded	7.6	0.6%
Ma	Melvin silt loam, frequently flooded	96.5	8.0%
Oa	Newark silt loam, occasionally ponded	2.7	0.2%
Pf	Byler silt loam, 5 to 12 percent slopes, eroded	77.7	6.4%
Pg	Armour silt loam, 12 to 20 percent slopes	4.4	0.4%
Ph	Armour silt loam, 5 to 12 percent slopes	10.9	0.9%
Pk	Armour silt loam, 2 to 5 percent slopes, eroded	25.0	2.1%

Stewart County, Tennessee (TN161)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
Rc	Sengtown-Gullied land complex, 12 to 20 percent slopes	0.1	0.0%
Rf	Sengtown-Rock outcrop complex, 20 to 60 percent slopes	48.3	4.0%
Sd	Staser fine sandy loam, occasionally flooded	32.9	2.7%
Tb	Gumdale silt loam, rarely flooded	48.1	4.0%
W	Water	252.1	20.8%
Wa	Wolftever silt loam, 1 to 5 percent slopes, occasionally flooded	68.2	5.6%
Totals for Area of Interest		**1,212.5**	**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.

Stewart County, Tennessee

Aa—Nolin silt loam, occasionally ponded

Map Unit Setting

National map unit symbol: 2lg4f
Elevation: 310 to 680 feet
Mean annual precipitation: 38 to 50 inches
Mean annual air temperature: 48 to 57 degrees F
Frost-free period: 160 to 205 days
Farmland classification: All areas are prime farmland

Map Unit Composition

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

Description of Nolin

Setting

Landform: Flood plains
Landform position (three-dimensional): Tread
Parent material: Loamy alluvium derived from interbedded sedimentary rock

Typical profile

H1 - 0 to 8 inches: silt loam
H2 - 8 to 52 inches: silt loam
H3 - 52 to 65 inches: silt loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
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 36 to 72 inches
Frequency of flooding: Occasional
Frequency of ponding: None
Available water storage in profile: Very high (about 12.3 inches)

Interpretive groups

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

Ba—Sengtown gravelly silt loam, 5 to 12 percent slopes

Map Unit Setting

National map unit symbol: 2td2n
Elevation: 600 to 1,300 feet
Mean annual precipitation: 47 to 58 inches

Mean annual air temperature: 56 to 59 degrees F
Frost-free period: 190 to 230 days
Farmland classification: Not prime farmland

Map Unit Composition

Sengtown and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Sengtown

Setting

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

Typical profile

Ap - 0 to 8 inches: gravelly silt loam
E - 8 to 11 inches: gravelly silt loam
Bt - 11 to 79 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: 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
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Moderate (about 7.5 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B
Hydric soil rating: No

Minor Components

Mountview

Percent of map unit: 7 percent
Landform: Hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Minvale

Percent of map unit: 4 percent

Landform: Hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Waynesboro

Percent of map unit: 4 percent
Landform: Hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Bd—Sengtown gravelly silt loam, 12 to 20 percent slopes, severely eroded

Map Unit Setting

National map unit symbol: 2lg4l
Mean annual precipitation: 48 to 55 inches
Mean annual air temperature: 57 to 61 degrees F
Frost-free period: 185 to 205 days
Farmland classification: Not prime farmland

Map Unit Composition

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

Description of Sengtown

Setting

Landform: Hillslopes
Landform position (three-dimensional): Side slope
Parent material: Clayey residuum weathered from cherty limestone

Typical profile

H1 - 0 to 9 inches: cherty silty clay loam
H2 - 9 to 60 inches: cherty clay

Properties and qualities

Slope: 12 to 20 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
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 7.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B
Hydric soil rating: No

Be—Sengtown gravelly silt loam, 12 to 20 percent slopes

Map Unit Setting

National map unit symbol: 2qh76
Elevation: 600 to 1,300 feet
Mean annual precipitation: 47 to 58 inches
Mean annual air temperature: 56 to 59 degrees F
Frost-free period: 190 to 230 days
Farmland classification: Not prime farmland

Map Unit Composition

Sengtown and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Sengtown

Setting

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

Typical profile

Ap - 0 to 8 inches: gravelly silt loam
E - 8 to 11 inches: gravelly silt loam
Bt - 11 to 79 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
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Moderate (about 7.5 inches)

Interpretive groups

Land capability classification (irrigated): 4e

Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Hydric soil rating: No

Minor Components

Mountview

Percent of map unit: 7 percent
Landform: Hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Minvale

Percent of map unit: 4 percent
Landform: Hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Waynesboro

Percent of map unit: 4 percent
Landform: Hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Bh—Bodine gravelly silt loam, 12 to 20 percent slopes, eroded

Map Unit Setting

National map unit symbol: 2lg4q
Elevation: 700 to 1,300 feet
Mean annual precipitation: 48 to 54 inches
Mean annual air temperature: 57 to 61 degrees F
Frost-free period: 180 to 200 days
Farmland classification: Not prime farmland

Map Unit Composition

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

Description of Bodine

Setting

Landform: Hillslopes

Landform position (three-dimensional): Side slope
Parent material: Gravelly residuum weathered from cherty limestone

Typical profile

H1 - 0 to 8 inches: gravelly silt loam
H2 - 8 to 24 inches: gravelly silty clay loam
H3 - 24 to 72 inches: very gravelly silty clay loam

Properties and qualities

Slope: 12 to 20 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat excessively drained
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 4.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: A
Hydric soil rating: No

Bk—Bodine gravelly silt loam, 5 to 12 percent slopes, eroded

Map Unit Setting

National map unit symbol: 2lg4r
Elevation: 700 to 1,300 feet
Mean annual precipitation: 48 to 54 inches
Mean annual air temperature: 57 to 61 degrees F
Frost-free period: 180 to 200 days
Farmland classification: Not prime farmland

Map Unit Composition

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

Description of Bodine

Setting

Landform: Hillslopes
Landform position (three-dimensional): Side slope
Parent material: Gravelly residuum weathered from cherty limestone

Typical profile

H1 - 0 to 8 inches: gravelly silt loam
H2 - 8 to 24 inches: gravelly silty clay loam
H3 - 24 to 72 inches: very gravelly silty clay loam

Properties and qualities

Slope: 5 to 12 percent

Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat excessively drained
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 4.9 inches)

Interpretive groups

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

Bp—Bodine gravelly silt loam, 20 to 60 percent slopes

Map Unit Setting

National map unit symbol: 2lg4x
Elevation: 700 to 1,300 feet
Mean annual precipitation: 48 to 54 inches
Mean annual air temperature: 57 to 61 degrees F
Frost-free period: 180 to 200 days
Farmland classification: Not prime farmland

Map Unit Composition

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

Description of Bodine

Setting

Landform: Hillslopes
Landform position (three-dimensional): Side slope
Parent material: Gravelly residuum weathered from cherty limestone

Typical profile

H1 - 0 to 8 inches: gravelly silt loam
H2 - 8 to 24 inches: gravelly silty clay loam
H3 - 24 to 72 inches: very gravelly silty clay loam

Properties and qualities

Slope: 20 to 60 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat excessively drained
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 4.9 inches)

Interpretive groups

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

Eb—Egam silty clay loam, occasionally flooded

Map Unit Setting

National map unit symbol: 2lg5d
Elevation: 800 to 1,300 feet
Mean annual precipitation: 52 to 56 inches
Mean annual air temperature: 54 to 57 degrees F
Frost-free period: 170 to 190 days
Farmland classification: All areas are prime farmland

Map Unit Composition

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

Description of Egam

Setting

Landform: Flood plains
Landform position (three-dimensional): Tread
Parent material: Clayey alluvium

Typical profile

H1 - 0 to 22 inches: silty clay loam
H2 - 22 to 56 inches: silty clay
H3 - 56 to 75 inches: silty clay loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: About 36 to 48 inches
Frequency of flooding: Occasional
Frequency of ponding: None
Available water storage in profile: High (about 10.8 inches)

Interpretive groups

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

Gc—Trace silt loam, 2 to 5 percent slopes

Map Unit Setting

National map unit symbol: 2lg5m
Elevation: 430 to 600 feet
Mean annual precipitation: 49 to 58 inches
Mean annual air temperature: 45 to 72 degrees F
Frost-free period: 170 to 215 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Trace and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Trace

Setting

Landform: Stream terraces
Parent material: Fine-silty alluvium over gravelly alluvium

Typical profile

H1 - 0 to 8 inches: silt loam
H2 - 8 to 36 inches: silt loam
H3 - 36 to 41 inches: gravelly silt loam
H4 - 41 to 65 inches: extremely gravelly sandy loam

Properties and qualities

Slope: 2 to 5 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: Rare
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.3 inches)

Interpretive groups

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

Minor Components

Minor components

Percent of map unit: 20 percent
Hydric soil rating: No

Ha—Maury silty clay loam, 12 to 20 percent slopes, eroded

Map Unit Setting

National map unit symbol: 2lg5r
Mean annual precipitation: 48 to 55 inches
Mean annual air temperature: 57 to 61 degrees F
Frost-free period: 185 to 205 days
Farmland classification: Not prime farmland

Map Unit Composition

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

Description of Maury

Setting

Landform: Hillslopes
Landform position (three-dimensional): Side slope
Parent material: Loess over clayey residuum and/or alluvium derived from limestone

Typical profile

H1 - 0 to 16 inches: silty clay loam
H2 - 16 to 29 inches: silty clay loam
H3 - 29 to 42 inches: clay
H4 - 42 to 75 inches: clay

Properties and qualities

Slope: 12 to 20 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
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: High (about 11.2 inches)

Interpretive groups

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

Hb—Maury silty clay loam, 5 to 12 percent slopes, eroded

Map Unit Setting

National map unit symbol: 2lg5s
Mean annual precipitation: 48 to 55 inches
Mean annual air temperature: 57 to 61 degrees F
Frost-free period: 185 to 205 days
Farmland classification: Not prime farmland

Map Unit Composition

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

Description of Maury

Setting

Landform: Hillslopes
Landform position (three-dimensional): Side slope
Parent material: Loess over clayey residuum and/or alluvium derived from limestone

Typical profile

H1 - 0 to 16 inches: silty clay loam
H2 - 16 to 29 inches: silty clay loam
H3 - 29 to 42 inches: clay
H4 - 42 to 75 inches: clay

Properties and qualities

Slope: 5 to 12 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
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: High (about 11.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: A
Hydric soil rating: No

Hg—Sequatchie fine sandy loam, 2 to 5 percent slopes

Map Unit Setting

National map unit symbol: 2lg5y
Elevation: 600 to 1,500 feet
Mean annual precipitation: 47 to 55 inches
Mean annual air temperature: 57 to 61 degrees F
Frost-free period: 180 to 205 days
Farmland classification: All areas are prime farmland

Map Unit Composition

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

Description of Sequatchie

Setting

Landform: Stream terraces
Landform position (three-dimensional): Tread
Parent material: Loamy alluvium derived from interbedded sedimentary rock

Typical profile

H1 - 0 to 12 inches: fine sandy loam
H2 - 12 to 46 inches: loam
H3 - 46 to 72 inches: loam

Properties and qualities

Slope: 2 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
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: High (about 9.6 inches)

Interpretive groups

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

Hh—Nolin silt loam, occasionally flooded

Map Unit Setting

National map unit symbol: 2lg5z

Elevation: 310 to 680 feet
Mean annual precipitation: 38 to 50 inches
Mean annual air temperature: 48 to 57 degrees F
Frost-free period: 160 to 205 days
Farmland classification: All areas are prime farmland

Map Unit Composition

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

Description of Nolin

Setting

Landform: Flood plains
Landform position (three-dimensional): Tread
Parent material: Loamy alluvium derived from interbedded sedimentary rock

Typical profile

H1 - 0 to 8 inches: silt loam
H2 - 8 to 52 inches: silt loam
H3 - 52 to 65 inches: silt loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
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 36 to 72 inches
Frequency of flooding: Occasional
Frequency of ponding: None
Available water storage in profile: Very high (about 12.3 inches)

Interpretive groups

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

Lg—Lindell silt loam, 0 to 2 percent slopes, occasionally flooded

Map Unit Setting

National map unit symbol: 2td2y
Elevation: 500 to 850 feet
Mean annual precipitation: 48 to 58 inches
Mean annual air temperature: 57 to 61 degrees F
Frost-free period: 190 to 230 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Lindell and similar soils: 90 percent
Minor components: 10 percent

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

Description of Lindell

Setting

Landform: Flood plains
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Fine-loamy alluvium derived from limestone and siltstone

Typical profile

Ap - 0 to 7 inches: silt loam
Bw - 7 to 15 inches: silt loam
Bg - 15 to 52 inches: silt loam
Cg - 52 to 79 inches: silty clay loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Runoff class: Very 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: About 12 to 16 inches
Frequency of flooding: Occasional
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: High (about 11.2 inches)

Interpretive groups

Land capability classification (irrigated): 2w
Land capability classification (nonirrigated): 2w
Hydrologic Soil Group: B/D
Hydric soil rating: No

Minor Components

Arrington

Percent of map unit: 4 percent
Landform: Flood plains
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Norene

Percent of map unit: 4 percent
Landform: Flood plains
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: Yes

Armour

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

Lk—Lobelville silt loam, occasionally flooded

Map Unit Setting

National map unit symbol: 2lg68
Elevation: 400 to 900 feet
Mean annual precipitation: 48 to 55 inches
Mean annual air temperature: 57 to 61 degrees F
Frost-free period: 180 to 205 days
Farmland classification: All areas are prime farmland

Map Unit Composition

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

Description of Lobelville

Setting

Landform: Flood plains
Landform position (three-dimensional): Tread
Parent material: Loamy alluvium over gravelly alluvium

Typical profile

H1 - 0 to 9 inches: silt loam
H2 - 9 to 42 inches: gravelly silt loam
H3 - 42 to 65 inches: gravelly loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
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 18 to 30 inches
Frequency of flooding: Occasional
Frequency of ponding: None
Available water storage in profile: Moderate (about 6.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2w
Hydrologic Soil Group: C

Hydric soil rating: No

Ma—Melvin silt loam, frequently flooded

Map Unit Setting

National map unit symbol: 2lg6b
Elevation: 320 to 950 feet
Mean annual precipitation: 40 to 48 inches
Mean annual air temperature: 54 to 55 degrees F
Frost-free period: 165 to 205 days
Farmland classification: Not prime farmland

Map Unit Composition

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

Description of Melvin

Setting

Landform: Flood plains
Landform position (three-dimensional): Tread
Parent material: Loamy alluvium derived from interbedded sedimentary rock

Typical profile

H1 - 0 to 9 inches: silt loam
H2 - 9 to 30 inches: silt loam
H3 - 30 to 62 inches: silt loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Poorly drained
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 0 to 12 inches
Frequency of flooding: Frequent
Frequency of ponding: None
Available water storage in profile: Very high (about 12.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4w
Hydrologic Soil Group: B/D
Hydric soil rating: Yes

Oa—Newark silt loam, occasionally ponded

Map Unit Setting

National map unit symbol: 2lg6v
Mean annual precipitation: 48 to 55 inches
Mean annual air temperature: 57 to 61 degrees F
Frost-free period: 185 to 205 days
Farmland classification: Prime farmland if drained and either protected from flooding or not frequently flooded during the growing season

Map Unit Composition

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

Description of Newark

Setting

Landform: Flood plains
Landform position (three-dimensional): Tread
Parent material: Loamy alluvium derived from interbedded sedimentary rock

Typical profile

H1 - 0 to 9 inches: silt loam
H2 - 9 to 32 inches: silt loam
H3 - 32 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
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 6 to 18 inches
Frequency of flooding: Occasional
Frequency of ponding: None
Available water storage in profile: High (about 11.8 inches)

Interpretive groups

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

Pf—Byler silt loam, 5 to 12 percent slopes, eroded

Map Unit Setting

National map unit symbol: 2lg71

Elevation: 400 to 700 feet
Mean annual precipitation: 48 to 55 inches
Mean annual air temperature: 57 to 61 degrees F
Frost-free period: 190 to 205 days
Farmland classification: Not prime farmland

Map Unit Composition

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

Description of Byler

Setting

Landform: Stream terraces
Landform position (three-dimensional): Tread
Parent material: Loamy alluvium over clayey residuum weathered from limestone

Typical profile

H1 - 0 to 8 inches: silt loam
H2 - 8 to 25 inches: silty clay loam
H3 - 25 to 46 inches: silty clay loam
H4 - 46 to 65 inches: clay

Properties and qualities

Slope: 5 to 12 percent
Depth to restrictive feature: About 25 inches to fragipan
Natural drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 16 to 30 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 4.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C/D
Hydric soil rating: No

Pg—Armour silt loam, 12 to 20 percent slopes

Map Unit Setting

National map unit symbol: 2td30
Elevation: 500 to 850 feet
Mean annual precipitation: 48 to 58 inches
Mean annual air temperature: 57 to 61 degrees F
Frost-free period: 190 to 230 days
Farmland classification: Not prime farmland

Map Unit Composition

Armour and similar soils: 90 percent

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

Description of Armour

Setting

Landform: Stream terraces
Landform position (two-dimensional): Footslope, toeslope
Landform position (three-dimensional): Base slope, tread
Down-slope shape: Concave, convex
Across-slope shape: Linear, convex
Parent material: Silty alluvium over clayey residuum weathered from phosphatic limestone

Typical profile

A - 0 to 19 inches: silt loam
Bt - 19 to 58 inches: silty clay loam
BC - 58 to 79 inches: 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 (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: High (about 11.6 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Hydric soil rating: No

Minor Components

Dellrose

Percent of map unit: 6 percent
Landform: Hillsides
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Concave
Across-slope shape: Linear
Hydric soil rating: No

Mimosa

Percent of map unit: 4 percent
Landform: Escarpments
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Convex, concave
Across-slope shape: Convex, linear

Hydric soil rating: No

Ph—Armour silt loam, 5 to 12 percent slopes

Map Unit Setting

National map unit symbol: 2td32
Elevation: 500 to 850 feet
Mean annual precipitation: 48 to 58 inches
Mean annual air temperature: 57 to 61 degrees F
Frost-free period: 190 to 230 days
Farmland classification: Not prime farmland

Map Unit Composition

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

Description of Armour

Setting

Landform: Stream terraces
Landform position (two-dimensional): Footslope, toeslope
Landform position (three-dimensional): Base slope, tread
Down-slope shape: Concave, convex
Across-slope shape: Linear, convex
Parent material: Silty alluvium over clayey residuum weathered from phosphatic limestone

Typical profile

A - 0 to 19 inches: silt loam
Bt - 19 to 58 inches: silty clay loam
BC - 58 to 79 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: Medium
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
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: High (about 11.6 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B

Hydric soil rating: No

Minor Components

Dellrose

Percent of map unit: 4 percent
Landform: Hillsides
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Concave
Across-slope shape: Linear
Hydric soil rating: No

Byler

Percent of map unit: 4 percent
Landform: Stream terraces
Landform position (two-dimensional): Toeslope, footslope
Landform position (three-dimensional): Base slope, tread
Down-slope shape: Convex, concave
Across-slope shape: Convex, linear
Hydric soil rating: No

Mimosa

Percent of map unit: 2 percent
Landform: Escarpments
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Convex, concave
Across-slope shape: Convex, linear
Hydric soil rating: No

Pk—Armour silt loam, 2 to 5 percent slopes, eroded

Map Unit Setting

National map unit symbol: 2lg74
Elevation: 450 to 700 feet
Mean annual precipitation: 46 to 60 inches
Mean annual air temperature: 57 to 61 degrees F
Frost-free period: 190 to 200 days
Farmland classification: All areas are prime farmland

Map Unit Composition

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

Description of Armour

Setting

Landform: Stream terraces
Landform position (three-dimensional): Tread
Parent material: Loamy alluvium derived from interbedded sedimentary rock

Typical profile

H1 - 0 to 17 inches: silt loam
H2 - 17 to 48 inches: silty clay loam
H3 - 48 to 75 inches: silty clay loam

Properties and qualities

Slope: 2 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
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: High (about 11.1 inches)

Interpretive groups

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

Rc—Sengtown-Gullied land complex, 12 to 20 percent slopes

Map Unit Setting

National map unit symbol: 2lg79
Elevation: 600 to 1,300 feet
Mean annual precipitation: 48 to 55 inches
Mean annual air temperature: 57 to 61 degrees F
Frost-free period: 185 to 205 days
Farmland classification: Not prime farmland

Map Unit Composition

Sengtown and similar soils: 60 percent
Gullied land: 20 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Sengtown

Setting

Landform: Hillslopes
Landform position (three-dimensional): Side slope
Parent material: Clayey residuum weathered from cherty limestone

Typical profile

H1 - 0 to 11 inches: gravelly silt loam
H2 - 11 to 16 inches: gravelly silty clay loam
H3 - 16 to 73 inches: gravelly clay

Properties and qualities

Slope: 12 to 20 percent

Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
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 6.5 inches)

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

Description of Gullied Land

Setting
Landform: Stream terraces

Typical profile
- 0 to 60 inches: variable

Minor Components

Minor components
Percent of map unit: 20 percent
Hydric soil rating: No

Rf—Sengtown-Rock outcrop complex, 20 to 60 percent slopes

Map Unit Setting
National map unit symbol: 2lg7d
Elevation: 600 to 1,300 feet
Mean annual precipitation: 48 to 55 inches
Mean annual air temperature: 57 to 61 degrees F
Frost-free period: 185 to 205 days
Farmland classification: Not prime farmland

Map Unit Composition
Sengtown and similar soils: 60 percent
Rock outcrop: 20 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Sengtown

Setting
Landform: Hillslopes
Landform position (three-dimensional): Side slope

Parent material: Clayey residuum weathered from cherty limestone

Typical profile

H1 - 0 to 11 inches: gravelly silt loam
H2 - 11 to 16 inches: gravelly silty clay loam
H3 - 16 to 73 inches: gravelly clay

Properties and qualities

Slope: 20 to 60 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
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 6.5 inches)

Interpretive groups

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

Description of Rock Outcrop

Setting

Landform: Stream terraces

Typical profile

R - 0 to 10 inches: bedrock

Minor Components

Minor components

Percent of map unit: 20 percent
Hydric soil rating: No

Sd—Staser fine sandy loam, occasionally flooded

Map Unit Setting

National map unit symbol: 2lg7n
Mean annual precipitation: 48 to 55 inches
Mean annual air temperature: 57 to 61 degrees F
Frost-free period: 185 to 205 days
Farmland classification: All areas are prime farmland

Map Unit Composition

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

Description of Staser

Setting

Landform: Flood plains
Landform position (three-dimensional): Tread
Parent material: Loamy alluvium derived from interbedded sedimentary rock

Typical profile

H1 - 0 to 35 inches: fine sandy loam
H2 - 35 to 60 inches: loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
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 36 to 48 inches
Frequency of flooding: Occasional
Frequency of ponding: None
Available water storage in profile: High (about 9.9 inches)

Interpretive groups

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

Tb—Gumdale silt loam, rarely flooded

Map Unit Setting

National map unit symbol: 2lg7q
Elevation: 380 to 850 feet
Mean annual precipitation: 35 to 63 inches
Mean annual air temperature: 45 to 70 degrees F
Frost-free period: 183 to 232 days
Farmland classification: Not prime farmland

Map Unit Composition

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

Description of Gumdale

Setting

Landform: Stream terraces
Landform position (three-dimensional): Tread
Parent material: Loamy alluvium derived from limestone, sandstone, and shale

Typical profile

H1 - 0 to 10 inches: silt loam

H2 - 10 to 31 inches: clay loam
H3 - 31 to 40 inches: clay loam
H4 - 40 to 79 inches: clay loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: 18 to 36 inches to fragipan
Natural drainage class: Somewhat poorly drained
Runoff class: Very low
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: About 12 to 24 inches
Frequency of flooding: Rare
Frequency of ponding: None
Available water storage in profile: Low (about 5.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3w
Hydrologic Soil Group: C/D
Hydric soil rating: No

Minor Components

Minor components

Percent of map unit: 10 percent
Hydric soil rating: No

W—Water

Map Unit Composition

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

Wa—Wolftever silt loam, 1 to 5 percent slopes, occasionally flooded

Map Unit Setting

National map unit symbol: 2lg7t
Elevation: 350 to 1,000 feet
Mean annual precipitation: 48 to 55 inches
Mean annual air temperature: 57 to 61 degrees F
Frost-free period: 190 to 215 days
Farmland classification: All areas are prime farmland

Map Unit Composition

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

Description of Wolftever

Setting

Landform: Stream terraces
Landform position (three-dimensional): Tread
Parent material: Clayey alluvium derived from interbedded sedimentary rock

Typical profile

H1 - 0 to 7 inches: silt loam
H2 - 7 to 15 inches: silty clay loam
H3 - 15 to 53 inches: clay
H4 - 53 to 89 inches: silty clay loam

Properties and qualities

Slope: 2 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: About 18 to 30 inches
Frequency of flooding: Occasional
Frequency of ponding: None
Available water storage in profile: High (about 9.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C
Hydric soil rating: No

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

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–Stewart 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*
Aa—Nolin silt loam, occasionally ponded														
Nolin	100	B	0-8	Silt loam	CL, CL-ML	A-4, A-6	0- 0- 0	0- 0- 0	100-100-100	95-98-100	90-95-100	80-90-100	25-33-40	5-12-18
			8-52	Silt loam, silty clay loam	CL, CL-ML	A-4, A-6, A-7	0- 0- 0	0- 0- 0	100-100-100	95-98-100	85-93-100	75-88-100	25-36-46	5-14-23
			52-65	Loam, silt loam, gravelly loam	CL, CL-ML, GM, ML	A-4, A-6	0- 0- 0	0- 5- 10	50-75-100	50-75-100	40-68-95	35-65-95	15-23-30	NP-8-15

Engineering Properties–Stewart 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*
Ba—Sengtown gravelly silt loam, 5 to 12 percent slopes														
Sengtown	85	B	0-8	Gravelly silt loam	GC, CL	A-6	0- 0- 0	0- 0- 0	54-58-74	52-56-73	47-52-72	39-44-61	27-33-40	9-13-17
			8-11	Gravelly silt loam	CL, GC	A-6	0- 0- 0	0- 0- 0	52-65-73	52-65-73	50-64-73	44-56-67	27-30-36	12-13-18
			11-79	Gravelly clay, gravelly silty clay loam	CH, GC	A-7-6	0- 0- 0	0- 0- 0	49-67-75	49-67-75	38-62-73	32-55-64	42-56-62	24-36-40
Mountview	7	B/D	0-6	Silt loam	CL	A-6	0- 0- 0	0- 0- 0	100-100-100	95-96-100	89-96-100	83-89-97	27-34-41	9-13-17
			6-20	Silt loam, silty clay loam	CL	A-6, A-7	0- 0- 0	0- 0- 0	95-97-100	90-93-100	81-92-100	77-88-100	29-38-44	13-20-25
			20-79	Gravelly clay, gravelly silty clay loam, clay	CH, CL	A-7-6	0- 0- 0	0- 0- 15	80-95-100	51-69-100	43-66-100	35-54-88	43-52-63	24-32-40
Minvale	4	B	0-5	Gravelly silt loam	CL	A-6	0- 0- 0	5- 6- 7	77-84-85	58-75-78	53-73-78	50-69-78	26-34-42	9-15-21
			5-18	Gravelly silt loam	CL	A-6	0- 0- 0	0- 3- 4	73-80-83	52-70-75	47-69-75	44-64-74	22-30-38	7-13-19
			18-79	Gravelly silt loam, gravelly silty clay loam	CL	A-6	0- 0- 0	0- 3- 7	69-74-82	54-60-75	49-57-75	44-51-70	29-33-41	13-16-22
Waynesboro	4	B	0-8	Silt loam	CL, CL-ML	A-6	0- 0- 0	0- 0- 5	95-96-100	89-93-100	79-87-100	65-73-88	26-34-43	9-13-21
			8-27	Clay loam, loam	CL	A-6, A-7	0- 0- 0	0- 0- 4	90-95-100	76-91-100	65-83-97	50-66-78	32-38-44	15-20-24
			27-79	Clay loam, clay	CL, CH	A-7-6	0- 0- 0	0- 0- 1	95-95-100	85-90-100	73-84-100	59-69-84	42-50-57	24-30-36

Engineering Properties–Stewart 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*
Bd—Sengtown gravelly silt loam, 12 to 20 percent slopes, severely eroded														
Sengtown	100	B	0-9	Cherty silty clay loam	CL	A-6	0- 1- 2	0- 5- 10	60-73-85	55-65-75	55-65-75	55-65-75	30-35-40	15-19-22
			9-60	Cherty silty clay, cherty clay	CH, CL, GC, SC	A-7	0- 1- 2	0- 5- 10	55-73-90	45-65-85	45-65-85	45-63-80	40-50-60	20-28-35

Engineering Properties–Stewart 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*
Be—Sengtown gravelly silt loam, 12 to 20 percent slopes														
Sengtown	85	B	0-8	Gravelly silt loam	GC, CL	A-6	0- 0- 0	0- 0- 0	54-58-74	52-56-73	47-52-72	39-44-61	27-33-40	9-13-17
			8-11	Gravelly silt loam	CL, GC	A-6	0- 0- 0	0- 0- 0	52-65-73	52-65-73	50-64-73	44-56-67	27-30-36	12-13-18
			11-79	Gravelly silty clay loam, gravelly clay	CH, GC	A-7-6	0- 0- 0	0- 0- 0	49-67-75	49-67-75	38-62-73	32-55-64	42-56-62	24-36-40
Mountview	7	B/D	0-6	Silt loam	CL	A-6	0- 0- 0	0- 0- 0	100-100-100	95-96-100	89-96-100	83-89-97	27-34-41	9-13-17
			6-20	Silt loam, silty clay loam	CL	A-6, A-7	0- 0- 0	0- 0- 0	95-97-100	90-93-100	81-92-100	77-88-100	29-38-44	13-20-25
			20-79	Gravelly silty clay loam, clay, gravelly clay	CH, CL	A-7-6	0- 0- 0	0- 0- 15	80-95-100	51-69-100	43-66-100	35-54-88	43-52-63	24-32-40
Minvale	4	B	0-5	Gravelly silt loam	CL	A-6	0- 0- 0	5- 6- 7	77-84-85	58-75-78	53-73-78	50-69-78	26-34-42	9-15-21
			5-18	Gravelly silt loam	CL	A-6	0- 0- 0	0- 3- 4	73-80-83	52-70-75	47-69-75	44-64-74	22-30-38	7-13-19
			18-79	Gravelly silt loam, gravelly silty clay loam	CL	A-6	0- 0- 0	0- 3- 7	69-74-82	54-60-75	49-57-75	44-51-70	29-33-41	13-16-22
Waynesboro	4	B	0-8	Silt loam	CL, CL-ML	A-6	0- 0- 0	0- 0- 5	95-96-100	89-93-100	79-87-100	65-73-88	26-34-43	9-13-21
			8-27	Clay loam, loam	CL	A-6, A-7	0- 0- 0	0- 0- 4	90-95-100	76-91-100	65-83-97	50-66-78	32-38-44	15-20-24
			27-79	Clay loam, clay	CL, CH	A-7-6	0- 0- 0	0- 0- 1	95-95-100	85-90-100	73-84-100	59-69-84	42-50-57	24-30-36

Engineering Properties–Stewart 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*
Bh—Bodine gravelly silt loam, 12 to 20 percent slopes, eroded														
Bodine	100	A	0-8	Gravelly silt loam	CL-ML, GM, ML, SM	A-1-b, A-2, A-4	0- 0- 0	0- 5- 10	30-60-90	20-48-75	20-44-67	20-41-62	15-23-30	NP-4 -7
			8-24	Gravelly silt loam, gravelly silty clay loam	GC, GC-GM, SC, SC-SM	A-1, A-2, A-4, A-6	0- 0- 2	10-23-35	30-50-70	20-43-65	20-38-55	15-30-45	20-29-38	3-9 -15
			24-72	Very gravelly silty clay loam, gravelly clay loam, very gravelly silt loam	GC, GC, GM, SM	A-2	0- 1- 5	10-23-35	20-45-70	15-40-65	15-30-45	12-24-35	26-34-42	8-12-16
Bk—Bodine gravelly silt loam, 5 to 12 percent slopes, eroded														
Bodine	100	A	0-8	Gravelly silt loam	CL-ML, GM, ML, SM	A-1-b, A-2, A-4	0- 0- 0	0- 5- 10	30-60-90	20-48-75	20-44-67	20-41-62	15-23-30	NP-4 -7
			8-24	Gravelly silt loam, gravelly silty clay loam	GC, GC-GM, SC, SC-SM	A-1, A-2, A-4, A-6	0- 0- 0	10-23-35	30-50-70	20-43-65	20-38-55	15-30-45	20-29-38	3-9 -15
			24-72	Very gravelly silty clay loam, gravelly clay loam, very gravelly silt loam	GC, GC, GM, SM	A-2	0- 0- 0	10-23-35	20-45-70	15-40-65	15-30-45	12-24-35	26-34-42	8-12-16

Engineering Properties–Stewart 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*
Bp—Bodine gravelly silt loam, 20 to 60 percent slopes														
Bodine	100	A	0-8	Gravelly silt loam	CL-ML, GM, ML, SM	A-1-b, A-2, A-4	0- 0- 0	0- 5- 10	30-60-90	20-48-75	20-44-67	20-41-62	15-23-30	NP-4 -7
			8-24	Gravelly silt loam, gravelly silty clay loam	GC, GC-GM, SC, SC-SM	A-1, A-2, A-4, A-6	0- 0- 0	10-23-35	30-50-70	20-43-65	20-38-55	15-30-45	20-29-38	3-9 -15
			24-72	Very gravelly silty clay loam, gravelly clay loam, very gravelly silt loam	GC, GC, GM, SM	A-2	0- 0- 0	10-23-35	20-45-70	15-40-65	15-30-45	12-24-35	26-34-42	8-12-16
Eb—Egam silty clay loam, occasionally flooded														
Egam	100	C	0-22	Silty clay loam	CL, CL-ML, ML	A-4, A-6, A-7	0- 0- 0	0- 0- 0	95-98-100	95-98-100	85-93-100	75-85-95	21-33-45	4-12-20
			22-56	Silty clay, silty clay loam, clay	CH, CL, MH	A-6, A-7	0- 0- 0	0- 0- 0	95-98-100	95-98-100	90-95-100	85-90-95	38-49-60	15-23-30
			56-75	Silty clay loam, clay, clay loam	CH, CL, MH, ML	A-6, A-7, A-4	0- 0- 0	0- 0- 0	95-98-100	95-98-100	90-95-100	70-83-95	25-43-60	8-19-30

Engineering Properties–Stewart 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*
Gc—Trace silt loam, 2 to 5 percent slopes														
Trace	80	B	0-8	Silt loam	CL, CL-ML, ML	A-4	0- 0- 0	0- 0- 0	90-95-100	75-86-100	70-85-100	64-78-100	18-22-30	NP-7-10
			8-36	Silt loam, silty clay loam	CL, CL-ML	A-4, A-6	0- 0- 0	0- 0- 0	90-95-100	75-86-100	70-86-100	67-82-100	18-30-35	5-11-15
			36-41	Very gravelly loam, gravelly silt loam, very gravelly clay loam	CL, GC, GC-GM	A-1-b, A-2, A-4, A-6	0- 0- 0	0- 0- 3	41-78-79	18-57-79	16-56-79	15-53-79	15-26-35	4-9 -13
			41-65	Extremely gravelly sandy loam, extremely gravelly loam, extremely gravelly silt loam	GM, GP-GM, GW-GM	A-1	0- 0- 0	0- 3- 7	40-46-56	16-22-56	12-17-52	6- 9- 31	0-17 -25	NP-4 -5
Ha—Maury silty clay loam, 12 to 20 percent slopes, eroded														
Maury	100	A	0-16	Silty clay loam	CL	A-6, A-7	0- 0- 0	0- 0- 0	100-100-100	95-98-100	90-95-100	80-90-100	34-38-42	15-19-22
			16-29	Silty clay loam	CL, ML	A-4, A-6, A-7	0- 0- 0	0- 0- 0	95-98-100	95-98-100	85-93-100	80-90-100	30-40-50	8-17-26
			29-42	Silty clay loam, silty clay, clay	CH, CL, MH	A-6, A-7	0- 0- 0	0- 0- 0	95-98-100	90-95-100	85-93-100	80-90-100	35-48-60	15-23-30
			42-75	Silty clay, clay, silty clay loam	CH, CL, MH	A-6, A-7	0- 0- 0	0- 0- 0	90-95-100	90-95-100	85-93-100	75-88-100	35-50-65	15-25-35

Engineering Properties–Stewart 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*
Hb—Maury silty clay loam, 5 to 12 percent slopes, eroded														
Maury	100	A	0-16	Silty clay loam	CL	A-6, A-7	0- 0- 0	0- 0- 0	100-100-100	95-98-100	90-95-100	80-90-100	34-38-42	15-19-22
			16-29	Silty clay loam	CL, ML	A-4, A-6, A-7	0- 0- 0	0- 0- 0	95-98-100	95-98-100	85-93-100	80-90-100	30-40-50	8-17-26
			29-42	Silty clay loam, silty clay, clay	CH, CL, MH	A-6, A-7	0- 0- 0	0- 0- 0	95-98-100	90-95-100	85-93-100	80-90-100	35-48-60	15-23-30
			42-75	Silty clay, clay, silty clay loam	CH, CL, MH	A-6, A-7	0- 0- 0	0- 0- 0	90-95-100	90-95-100	85-93-100	75-88-100	35-50-65	15-25-35
Hg—Sequatchie fine sandy loam, 2 to 5 percent slopes														
Sequatchie	100	B	0-12	Fine sandy loam	CL, CL-ML, ML, SM	A-2, A-4	0- 0- 0	0- 0- 10	85-93-100	75-88-100	65-80-95	30-50-70	15-21-27	2-6 -10
			12-46	Clay loam, loam, silt loam	CL, CL-ML	A-4, A-6	0- 0- 0	0- 0- 10	85-93-100	75-88-100	65-80-95	55-70-85	20-26-32	5-10-15
			46-72	Sandy loam, loam, fine sandy loam	CL, CL-ML, ML, SM	A-2, A-4	0- 0- 0	0- 0- 15	75-88-100	65-83-100	45-65-85	25-45-65	15-20-25	2-6 -10
Hh—Nolin silt loam, occasionally flooded														
Nolin	100	B	0-8	Silt loam	CL, CL-ML	A-4, A-6	0- 0- 0	0- 0- 0	100-100-100	95-98-100	90-95-100	80-90-100	25-33-40	5-12-18
			8-52	Silt loam, silty clay loam	CL, CL-ML	A-4, A-6, A-7	0- 0- 0	0- 0- 0	100-100-100	95-98-100	85-93-100	75-88-100	25-36-46	5-14-23
			52-65	Loam, silt loam, gravelly loam	CL, CL-ML, GM, ML	A-4, A-6	0- 0- 0	0- 5- 10	50-75-100	50-75-100	40-68-95	35-65-95	15-23-30	NP-8-15

Engineering Properties–Stewart 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*
Lg—Lindell silt loam, 0 to 2 percent slopes, occasionally flooded														
Lindell	90	B/D	0-7	Silt loam, gravelly silt loam	CL	A-6	0- 0- 0	0- 0- 3	80-89-96	70-82-94	64-79-94	50-64-76	32-37-41	13-15-17
			7-15	Loam, silt loam	CL	A-6	0- 0- 0	0- 0- 3	81-94-100	71-91-100	66-87-100	51-70-81	30-34-36	13-16-17
			15-52	Silt loam, loam	CL	A-6	0- 0- 0	0- 0- 3	81-94-96	71-91-94	64-87-94	49-70-81	30-34-43	13-16-23
			52-79	Silt loam, silty clay loam, gravelly silt loam	CL	A-6	0- 0- 0	0- 1- 4	75-87-96	64-84-94	56-81-94	43-65-81	30-39-43	13-21-23
Arrington	4	B	0-26	Silt loam	CL	A-6	0- 0- 0	0- 0- 0	91-98-100	91-98-100	89-98-100	83-92-97	30-36-40	12-15-16
			26-50	Silty clay loam, silt loam	CL	A-6	0- 0- 0	0- 0- 0	91-98-100	91-98-100	88-98-100	81-92-100	29-34-44	12-15-23
			50-79	Silt loam, silty clay loam	CL	A-6	0- 0- 0	0- 0- 0	84-93-100	77-91-100	74-91-100	66-86-100	28-38-43	12-19-23
Norene	4	B/D	0-15	Silt loam	CL	A-4, A-6	0- 0- 0	0- 0- 0	95-100-100	91-100-100	84-99-100	76-93-100	27-35-41	10-14-18
			15-42	Silty clay loam, silt loam	CL	A-6, A-7	0- 0- 0	0- 0- 0	95-100-100	91-100-100	84-99-100	77-95-100	32-40-46	16-21-25

Engineering Properties–Stewart 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*
			42-79	Silty clay, clay, silty clay loam	CH, CL	A-7, A-7-6	0- 0- 0	0- 0- 0	94-100-100	91-100-100	84-99-100	78-95-100	44-51-54	25-30-32
Armour	2	B	0-19	Silt loam	CL	A-6	0- 0- 0	0- 0- 0	94-98-100	89-96-100	82-95-100	72-89-100	27-35-43	9-14-18
			19-58	Silty clay loam, silt loam, loam, clay loam	CL	A-6	0- 0- 0	0- 0- 0	95-98-100	87-96-100	80-96-100	72-91-100	31-40-45	15-21-25
			58-79	Silty clay loam, clay loam, clay, silty clay	CH	A-7-6	0- 0- 0	0- 0- 3	87-98-100	74-96-100	60-87-97	46-71-84	39-59-59	21-36-36
Lk—Lobelville silt loam, occasionally flooded														
Lobelville	100	C	0-9	Silt loam, gravelly silt loam	CL, CL-ML	A-6	0- 0- 0	0- 5- 7	82-82-100	81-81-100	73-76-100	61-64-86	27-35-40	9-14-18
			9-42	Gravelly silt loam, gravelly loam, gravelly silty clay loam	CL-ML, GC-GM, GM, ML	A-4, A-6	0- 0- 0	0- 3- 5	65-78-90	50-65-80	45-58-70	40-53-65	22-29-35	3-8 -12
			42-65	Gravelly silt loam, gravelly loam, gravelly sandy loam	CL-ML, GC-GM, GM, ML	A-1, A-2, A-4, A-6	0- 0- 0	0- 5- 10	50-65-80	25-48-70	20-45-70	15-40-65	23-29-35	3-8 -12
Ma—Melvin silt loam, frequently flooded														
Melvin	100	B/D	0-9	Silt loam	CL, CL-ML, ML	A-4	0- 0- 0	0- 0- 0	95-98-100	90-95-100	80-90-100	80-88-95	25-30-35	4-7 -10
			9-30	Silt loam, silty clay loam	CL, CL-ML	A-4, A-6	0- 0- 0	0- 0- 0	95-98-100	90-95-100	80-90-100	80-89-98	25-33-40	5-13-20
			30-62	Silt loam, silty clay loam, loam	CL, CL-ML	A-4, A-6	0- 0- 0	0- 0- 0	85-93-100	80-90-100	70-85-100	60-79-98	25-33-40	5-13-20

Engineering Properties–Stewart 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*
Oa—Newark silt loam, occasionally ponded														
Newark	100	B/D	0-9	Silt loam	CL, CL-ML, ML	A-4	0- 0- 0	0- 0- 0	95-98-100	90-95-100	80-90-100	55-75-95	15-24-32	NP-5-10
			9-32	Silt loam, silty clay loam	CL, CL-ML, ML	A-4, A-6, A-7	0- 0- 0	0- 0- 0	95-98-100	90-95-100	85-93-100	70-85-100	22-32-42	3-12-20
			32-60	Silt loam, silty clay loam	CL, CL-ML, ML	A-4, A-6, A-7	0- 0- 0	0- 2- 3	75-88-100	70-85-100	65-83-100	55-75-95	22-32-42	3-12-20
Pf—Byler silt loam, 5 to 12 percent slopes, eroded														
Byler	100	C/D	0-8	Silt loam	CL, CL-ML, ML	A-4	0- 0- 0	0- 0- 0	100-100-100	95-98-100	85-90-95	75-83-90	20-25-30	3-7 -10
			8-25	Silt loam, silty clay loam	CL, CL-ML, ML	A-4, A-6	0- 0- 0	0- 0- 0	100-100-100	95-98-100	85-93-100	85-90-95	20-30-40	3-9 -15
			25-46	Silty clay loam, silt loam, gravelly silty clay loam	CL, ML	A-4, A-6, A-7	0- 0- 0	0- 3- 5	80-90-100	75-88-100	70-85-100	60-78-95	30-38-45	8-14-20
			46-65	Clay, silty clay, gravelly clay	MH, ML	A-7	0- 0- 0	0- 5- 10	65-83-100	60-80-100	55-75-95	50-70-90	40-50-60	12-19-25

Engineering Properties–Stewart 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*
Pg—Armour silt loam, 12 to 20 percent slopes														
Armour	90	B	0-19	Silt loam	CL	A-6	0- 0- 0	0- 0- 0	94-98-100	89-96-100	82-95-100	72-89-100	27-35-43	9-14-18
			19-58	Silty clay loam, silt loam, loam, clay loam	CL	A-6	0- 0- 0	0- 0- 0	95-98-100	87-96-100	80-96-100	72-91-100	31-40-45	15-21-25
			58-79	Silty clay loam, clay loam, silty clay, clay	CH	A-7-6	0- 0- 0	0- 0- 3	87-98-100	74-96-100	60-87-97	46-71-84	39-59-59	21-36-36
Dellrose	6	B	0-8	Gravelly silt loam	CL	A-6	0- 0- 0	0- 0- 0	49-67-82	47-65-81	46-65-81	38-57-75	27-36-42	9-14-18
			8-16	Gravelly silt loam	CL	A-6	0- 0- 0	0- 0- 0	49-67-82	47-65-81	44-64-81	37-56-74	25-33-37	9-15-18
			16-54	Gravelly silt loam, gravelly silty clay loam	CL	A-6	0- 0- 0	0- 0- 0	51-68-83	49-67-82	44-64-82	39-58-77	29-38-44	13-20-25
			54-79	Silty clay, clay	CH	A-7-6	0- 0- 0	0- 0- 0	100-100-100	100-100-100	91-95-100	79-94-99	48-62-68	28-40-44
Mimosa	4	C	0-6	Silt loam	CL	A-6	0- 0- 0	0- 0- 0	60-82-100	59-81-100	54-78-100	47-68-90	30-38-41	12-17-19
			6-40	Clay, silty clay	CH	A-7-6	0- 0- 0	0- 0- 0	91-100-100	91-100-100	77-88-97	73-85-97	47-54-69	28-32-44
			40-50	Clay, silty clay	CH	A-7-6	0- 0- 0	0- 0- 0	91-100-100	91-100-100	84-98-100	79-95-100	49-65-73	29-41-46
			50-55	Clay	CH	A-7-6	0- 0- 0	0- 0- 0	91-100-100	91-100-100	82-98-100	73-93-100	57-69-81	35-44-53
			55-65	Bedrock	—	—	—	—	—	—	—	—	—	—

Engineering Properties–Stewart 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*
Ph—Armour silt loam, 5 to 12 percent slopes														
Armour	90	B	0-19	Silt loam	CL	A-6	0- 0- 0	0- 0- 0	94-98-100	89-96-100	82-95-100	72-89-100	27-35-43	9-14-18
			19-58	Silty clay loam, silt loam, loam, clay loam	CL	A-6	0- 0- 0	0- 0- 0	95-98-100	87-96-100	80-96-100	72-91-100	31-40-45	15-21-25
			58-79	Silty clay loam, clay loam, clay, silty clay	CH	A-7-6	0- 0- 0	0- 0- 3	87-98-100	74-96-100	60-87-97	46-71-84	39-59-59	21-36-36
Byler	4	C/D	0-3	Silt loam	CL	A-6	0- 0- 0	0- 0- 0	92-100-100	90-100-100	85-97-100	79-92-97	30-36-41	12-15-17
			3-25	Silt loam	CL	A-6	0- 0- 0	0- 0- 0	93-100-100	91-100-100	85-97-100	79-92-97	28-35-38	12-17-18
			25-46	Silty clay loam, silt loam	CL	A-6	0- 0- 0	0- 0- 0	93-100-100	92-100-100	85-97-100	77-92-99	27-38-42	12-21-24
			46-79	Clay	CH	A-7-6	0- 0- 0	0- 0- 0	84-100-100	78-100-100	71-96-100	57-80-86	52-62-67	32-40-44
Dellrose	4	B	0-8	Gravelly silt loam	CL	A-6	0- 0- 0	0- 0- 0	49-67-82	47-65-81	46-65-81	38-57-75	27-36-42	9-14-18
			8-16	Gravelly silt loam	CL	A-6	0- 0- 0	0- 0- 0	49-67-82	47-65-81	44-64-81	37-56-74	25-33-37	9-15-18
			16-54	Gravelly silt loam, gravelly silty clay loam	CL	A-6	0- 0- 0	0- 0- 0	51-68-83	49-67-82	44-64-82	39-58-77	29-38-44	13-20-25

Engineering Properties–Stewart 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*
			54-79	Silty clay, clay	CH	A-7-6	0- 0- 0	0- 0- 0	100-100-100	100-100-100	91-95-100	79-94-99	48-62-68	28-40-44
Mimosa	2	C	0-6	Silt loam	CL	A-6	0- 0- 0	0- 0- 0	60-82-100	59-81-100	54-78-100	47-68-90	30-38-41	12-17-19
			6-40	Silty clay, clay	CH	A-7-6	0- 0- 0	0- 0- 0	91-100-100	91-100-100	77-88-97	73-85-97	47-54-69	28-32-44
			40-50	Clay, silty clay	CH	A-7-6	0- 0- 0	0- 0- 0	91-100-100	91-100-100	84-98-100	79-95-100	49-65-73	29-41-46
			50-55	Clay	CH	A-7-6	0- 0- 0	0- 0- 0	91-100-100	91-100-100	82-98-100	73-93-100	57-69-81	35-44-53
			55-65	Bedrock	—	—	—	—	—	—	—	—	—	—
Pk—Armour silt loam, 2 to 5 percent slopes, eroded														
Armour	100	B	0-17	Silt loam	CL, CL-ML, ML	A-4	0- 0- 0	0- 0- 0	90-95-100	80-90-100	75-85-95	70-80-90	25-30-35	5-8 -10
			17-48	Silty clay loam, silt loam	CL	A-4, A-6	0- 0- 0	0- 0- 0	90-95-100	80-90-100	75-85-95	70-83-95	30-35-40	8-13-18
			48-75	Silty clay loam, silty clay, clay	ML, GC, GM, MH	A-4, A-6, A-7	0- 0- 0	0- 0- 3	60-88-100	50-85-95	45-68-90	40-63-85	35-44-53	9-16-23

Engineering Properties–Stewart 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*
Rc—Sengtown-Gullied land complex, 12 to 20 percent slopes														
Sengtown	60	B	0-11	Gravelly silt loam	CL, CL-ML, GM, ML	A-4	0- 1- 2	0- 3- 5	60-75-90	55-68-80	45-60-75	45-58-70	25-30-35	4-7 -10
			11-16	Gravelly silt loam, gravelly silty clay loam	CL, CL-ML, GC-GM	A-4, A-6	0- 1- 2	0- 3- 5	60-75-90	55-68-80	45-60-75	45-58-70	25-33-40	5-13-20
			16-73	Gravelly clay, gravelly silty clay	CH, CL, GC	A-7	0- 1- 2	0- 3- 5	50-70-90	40-58-75	40-55-70	40-55-70	45-58-70	20-30-40
Gullied land	20		0-60	Variable	—	—	0- 0- 0	—	—	—	—	—	—	—
Rf—Sengtown-Rock outcrop complex, 20 to 60 percent slopes														
Sengtown	60	B	0-11	Gravelly silt loam	CL, CL-ML, GM, ML	A-4	0- 1- 2	0- 3- 5	60-75-90	55-68-80	45-60-75	45-58-70	25-30-35	4-7 -10
			11-16	Gravelly silt loam, gravelly silty clay loam	CL, CL-ML, GC-GM	A-4, A-6	0- 1- 2	0- 3- 5	60-75-90	55-68-80	45-60-75	45-58-70	25-33-40	5-13-20
			16-73	Gravelly clay, gravelly silty clay	CH, CL, GC	A-7	0- 1- 2	0- 3- 5	50-70-90	40-58-75	40-55-70	40-55-70	45-58-70	20-30-40
Rock outcrop	20		0-10	Bedrock	—	—	—	—	—	—	—	—	—	—
Sd—Staser fine sandy loam, occasionally flooded														
Staser	100	B	0-35	Fine sandy loam	CL, CL-ML, ML	A-4, A-6	0- 0- 0	0- 0- 0	90-95-100	80-90-100	60-73-85	55-68-80	20-28-35	3-9 -15
			35-60	Silt loam, loam, fine sandy loam	CL, CL-ML, SC, SC-SM	A-2, A-4, A-6	0- 0- 0	0- 0- 5	45-88-100	40-85-100	35-58-80	30-53-75	20-28-35	5-10-15

Engineering Properties–Stewart 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*
Tb—Gumdale silt loam, rarely flooded														
Gumdale	90	C/D	0-10	Silt loam, loam	CL, CL-ML, ML	A-4	0- 0- 0	0- 0- 0	100-100-100	95-98-100	90-95-100	80-85-90	20-25-30	3-7 -10
			10-31	Silt loam, clay loam, loam	CL, CL-ML	A-4, A-6	0- 0- 0	0- 0- 0	100-100-100	95-98-100	90-95-100	80-88-95	25-30-35	7-11-15
			31-40	Loam, clay loam, sandy clay loam	CL	A-4, A-6	0- 0- 0	0- 1- 2	95-98-100	90-95-100	80-90-100	40-60-80	23-32-40	7-13-19
			40-79	Clay loam, sandy clay loam, loam	—	A-4, A-6	0- 0- 0	0- 0- 0	100-100-100	100-100-100	75-91-92	56-72-73	23-32-40	7-13-14
Wa—Wolftever silt loam, 1 to 5 percent slopes, occasionally flooded														
Wolftever	100	C	0-7	Silt loam	CL, CL-ML, ML	A-4, A-6	0- 0- 0	0- 0- 0	100-100-100	95-98-100	90-95-100	80-88-95	25-30-35	3-8 -12
			7-15	Silty clay, silty clay loam, silt loam	CL, ML	A-4, A-6	0- 0- 0	0- 0- 0	100-100-100	95-98-100	90-95-100	80-88-95	30-35-40	7-11-15
			15-53	Silty clay, silty clay loam, clay	MH, ML	A-7	0- 0- 0	0- 0- 0	100-100-100	95-98-100	90-95-100	75-85-95	41-48-55	11-16-20
			53-89	Loam, clay loam, silty clay loam	CL, CL-ML	A-4, A-6, A-7	0- 0- 0	0- 0- 0	100-100-100	95-98-100	90-95-100	51-71-90	25-35-45	5-13-20

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.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deep-water habitats of the United States. U.S. Fish and Wildlife Service FWS/OBS-79/31.

Federal Register. July 13, 1994. Changes in hydric soils of the United States.

Federal Register. September 18, 2002. Hydric soils of the United States.

Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.

National Research Council. 1995. Wetlands: Characteristics and boundaries.

Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_054262

Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service, U.S. Department of Agriculture Handbook 436. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053577

Soil Survey Staff. 2010. Keys to soil taxonomy. 11th edition. U.S. Department of Agriculture, Natural Resources Conservation Service. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053580

Tiner, R.W., Jr. 1985. Wetlands of Delaware. U.S. Fish and Wildlife Service and Delaware Department of Natural Resources and Environmental Control, Wetlands Section.

United States Army Corps of Engineers, Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Waterways Experiment Station Technical Report Y-87-1.

United States Department of Agriculture, Natural Resources Conservation Service. National forestry manual. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2_053374

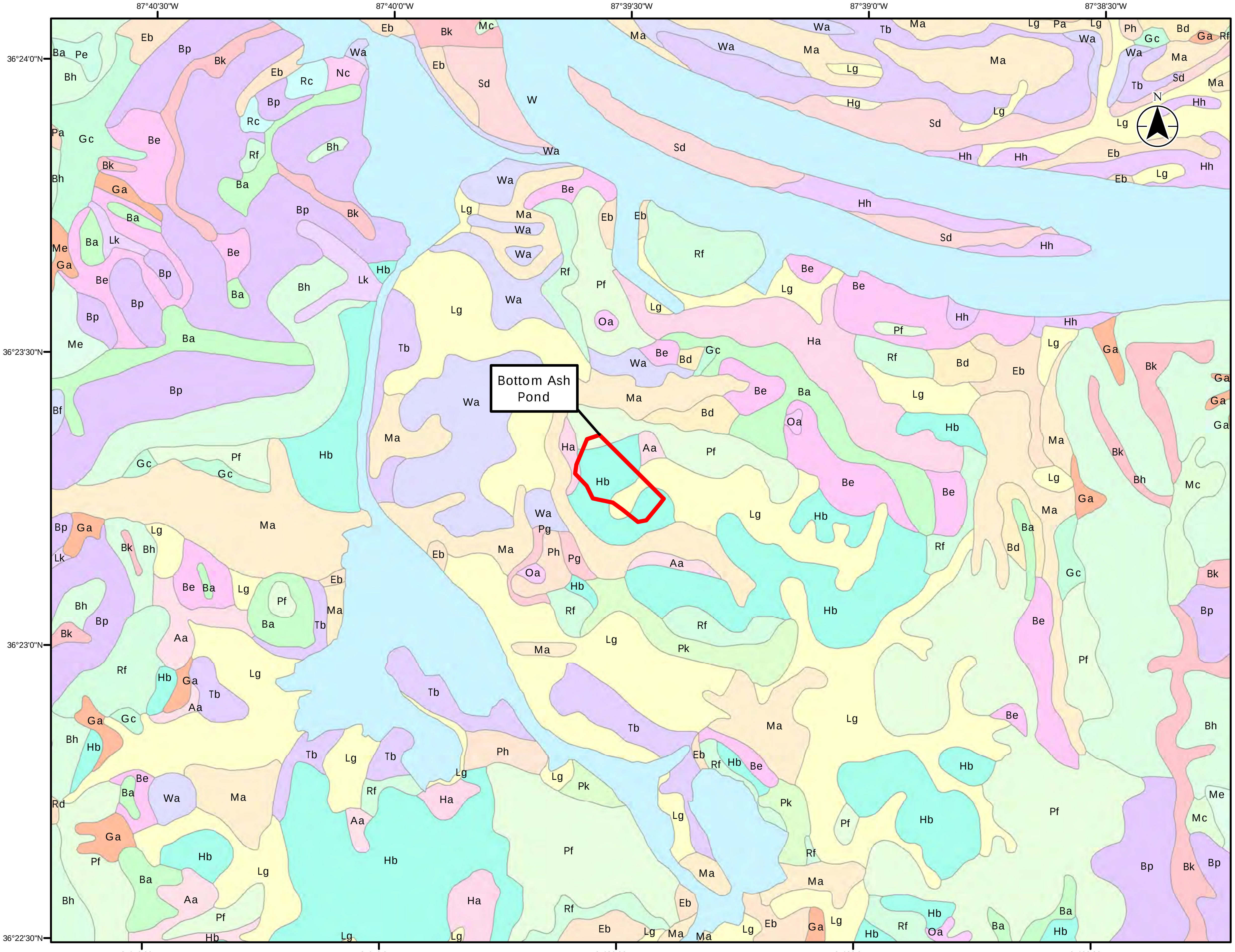
United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/rangepasture/?cid=stelprdb1043084

United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053624

United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf

APPENDIX B
GEOLOGIC OR GEOMORPHOLOGIC CONDITIONS



Geological Formation Map

Site
Cumberland Fossil Plant (CUF)
Bottom Ash Pond

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

Project Location
Stewart County,
Tennessee

Prepared by RRR on 2017-06-27

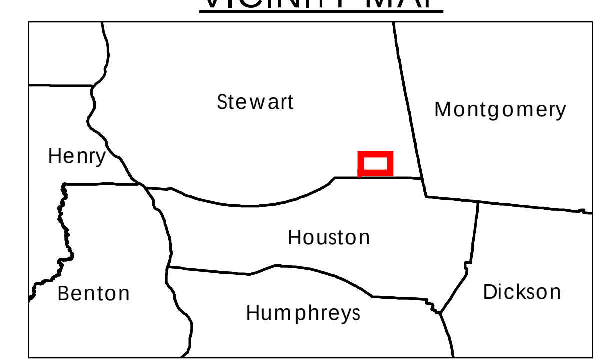
0 0.2 0.4 Miles

1:12,000 (At original document size of 11x17)

LEGEND

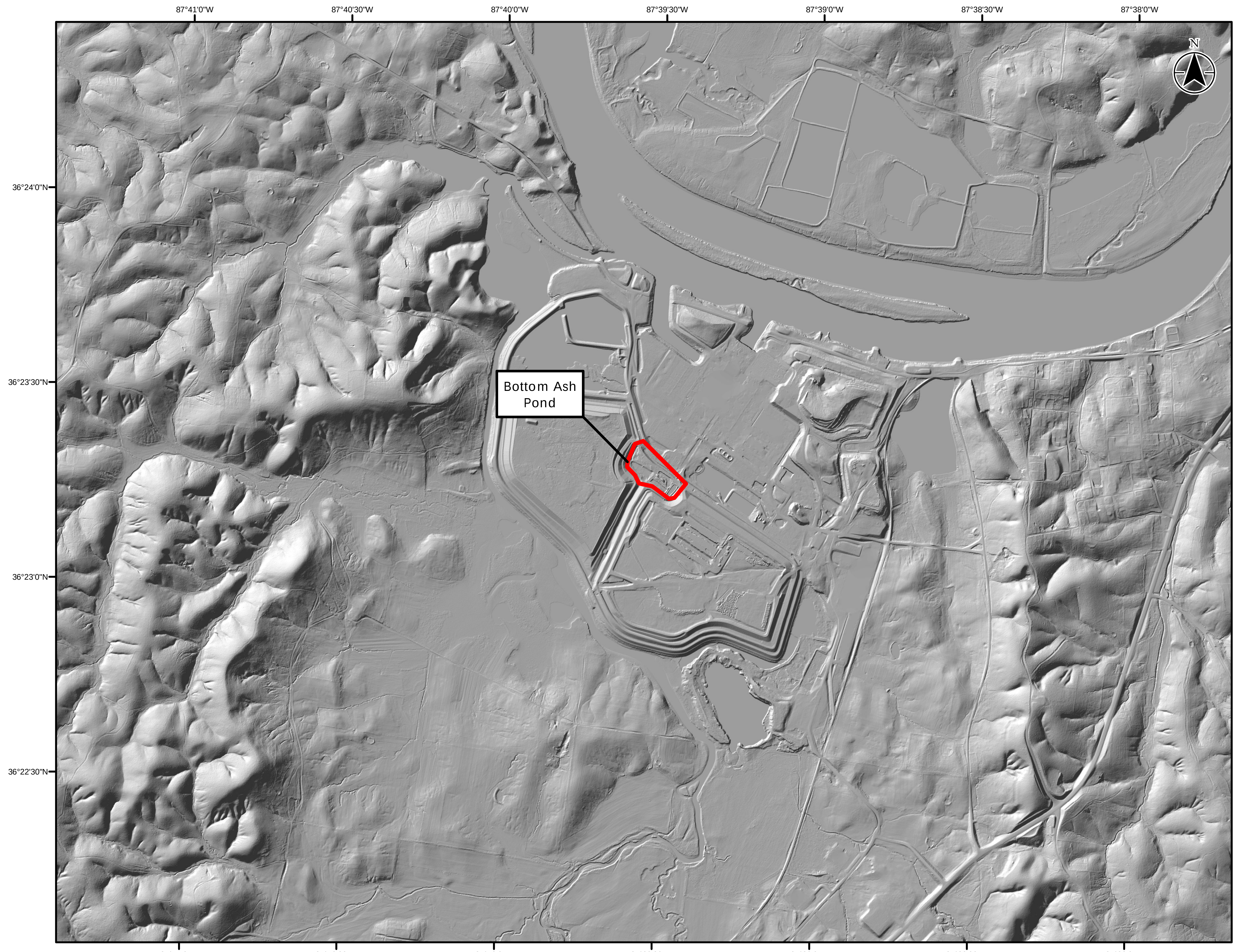
Bottom Ash Pond Unit Limits

VICINITY MAP



Notes
1. Coordinate System: NAD 1983 2011 StatePlane Tennessee FIPS 4100 Ft US.
2. Geological Formation data provided by National Resources. Conservation Service (NRCS) via Tennessee GIS.

Stantec



LIDAR Hillshade DEM Map

Site
Cumberland Fossil Plant (CUF)
Bottom Ash Pond

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

Project Location
Stewart County,
Tennessee

Prepared by RRR on 2017-06-27

0 0.3 0.6 Miles

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

LEGEND

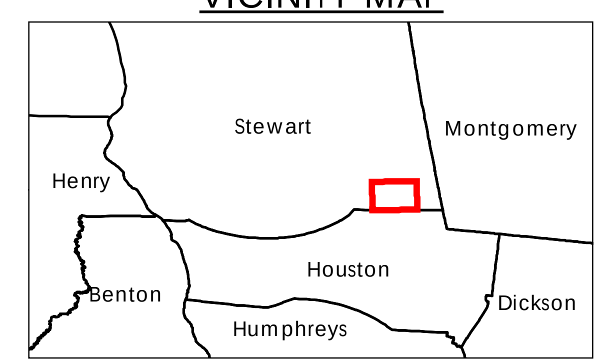
Bottom Ash Pond Unit Limits

Hillshade:

High : 254

Low : 0

VICINITY MAP



Notes
1. Coordinate System: NAD 1983 2011 StatePlane Tennessee FIPS 4100 Ft US.
2. Hillshade data was created using digital elevation data from Tennesee GIS and United States Geological Survey (USGS).

Stantec

Slope Raster Map

Site

Cumberland Fossil Plant (CUF)
Bottom Ash Pond

Client/Project

Tennessee Valley Authority (TVA)
Chattanooga, Tennessee

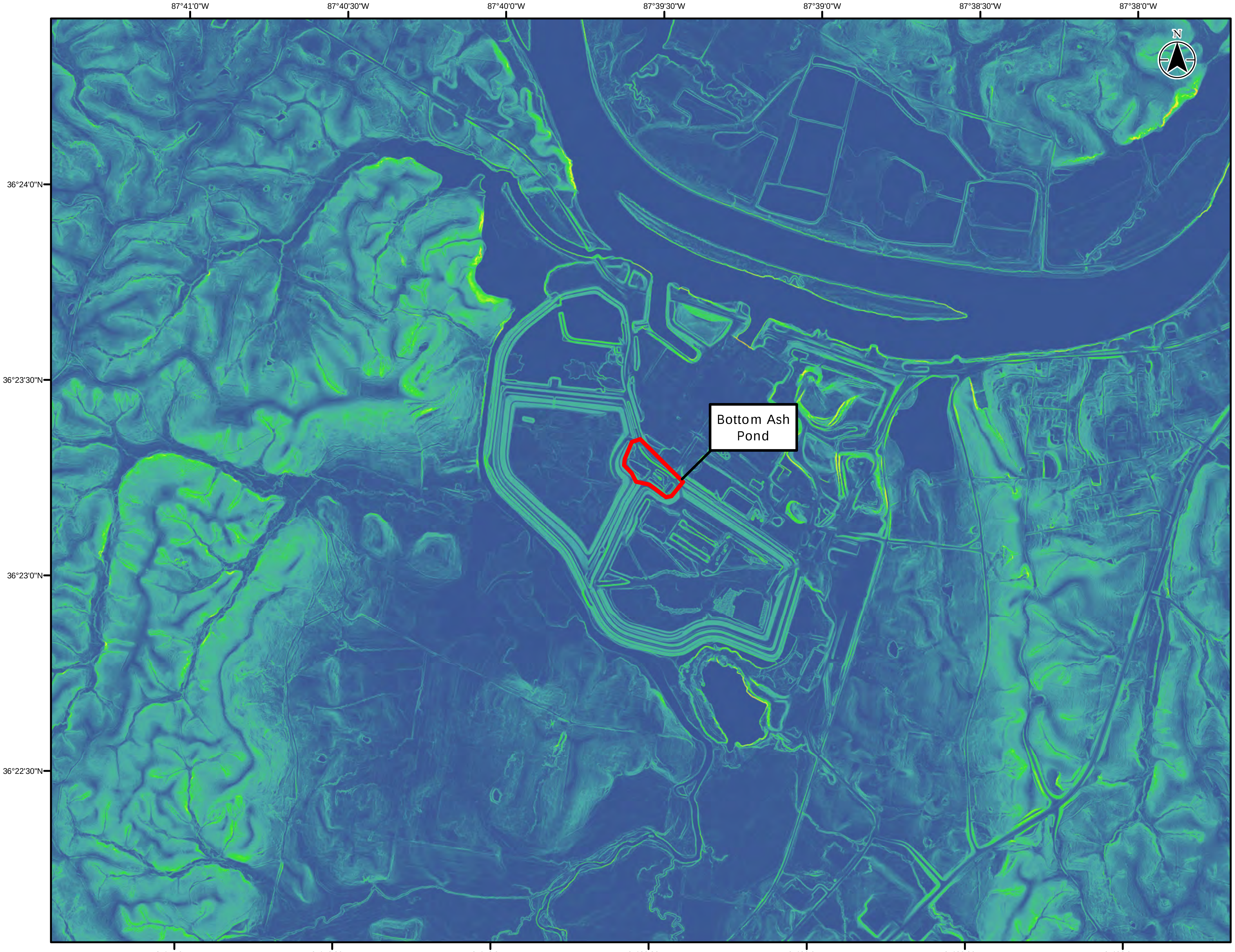
Project Location

Stewart County,
Tennessee

Prepared by RRR on 2017-06-27

0 0.3 0.6 Miles

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



LEGEND

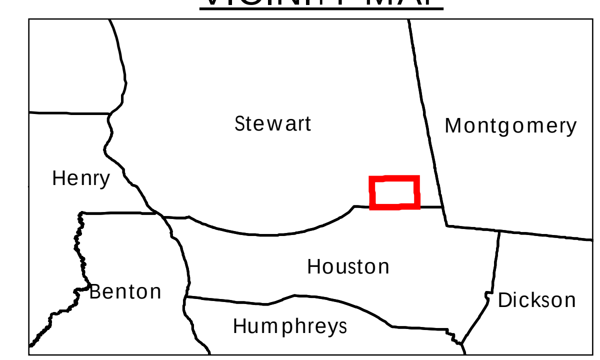
Bottom Ash Pond Unit Limits

Slope:

High : 80

Low : 0

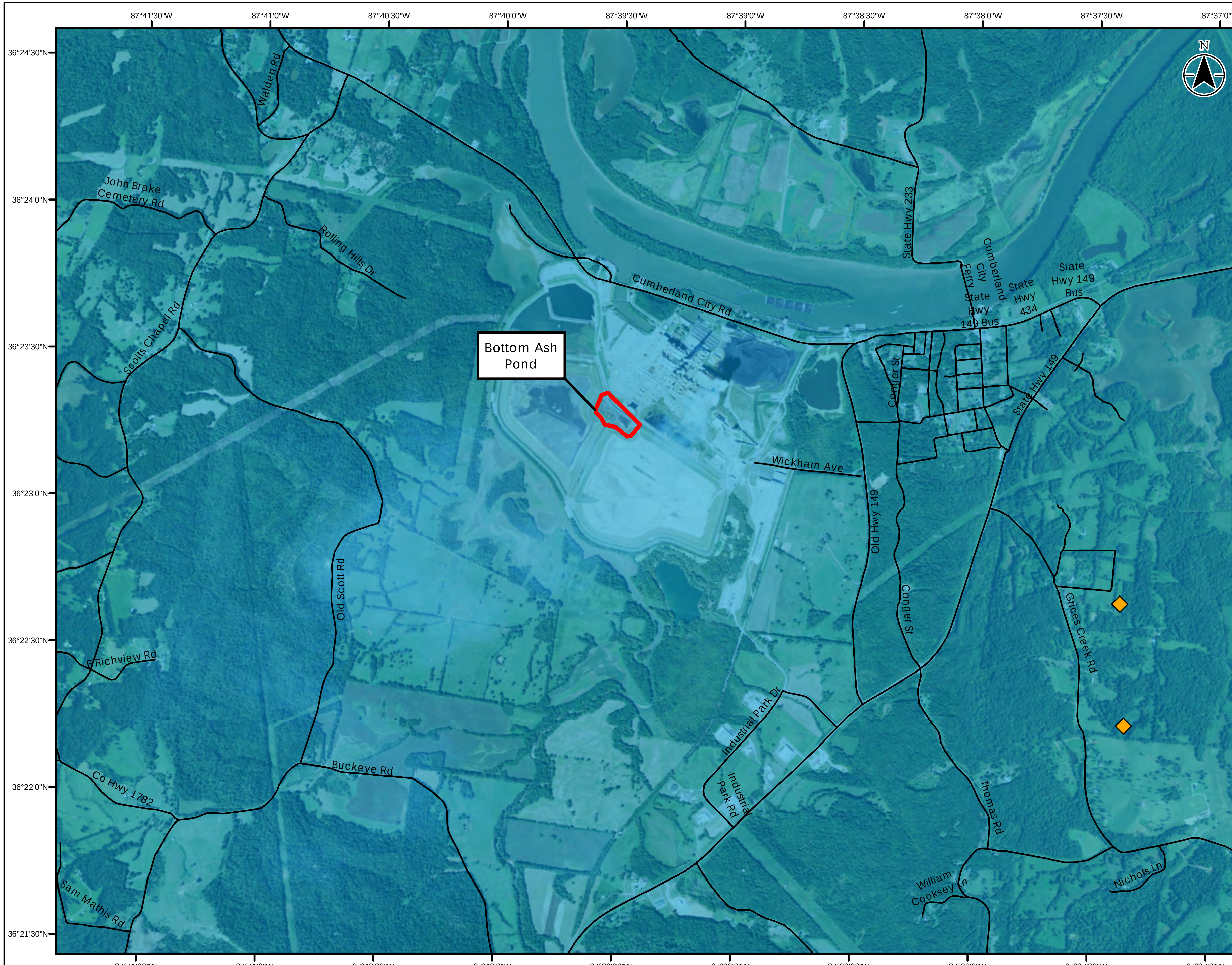
VICINITY MAP



Notes

1. Coordinate System: NAD 1983 2011 StatePlane Tennessee FIPS 4100 Ft US.
2. Slope data was created using Digital Elevation Data from Tennesse GIS and United States Geological Survey (USGS).

Stantec



Karst Potential Map

Site

Cumberland Fossil Plant (CUF)
Bottom Ash Pond

Client/Project

Tennessee Valley Authority (TVA)
Chattanooga, Tennessee

Project Location

Prepared by RRR on 2017-06-27

Stewart County,
Tennessee

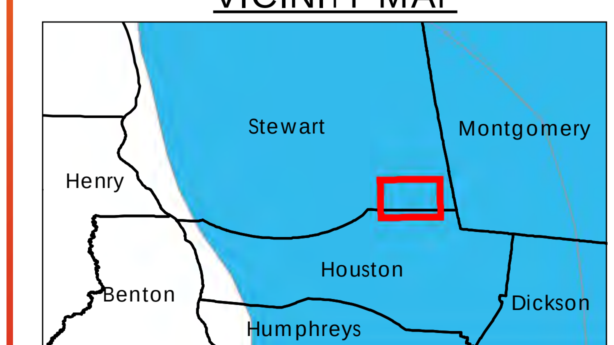
0 0.4 0.8 Miles

1:24,000 (At original document size of 11x17)

LEGEND

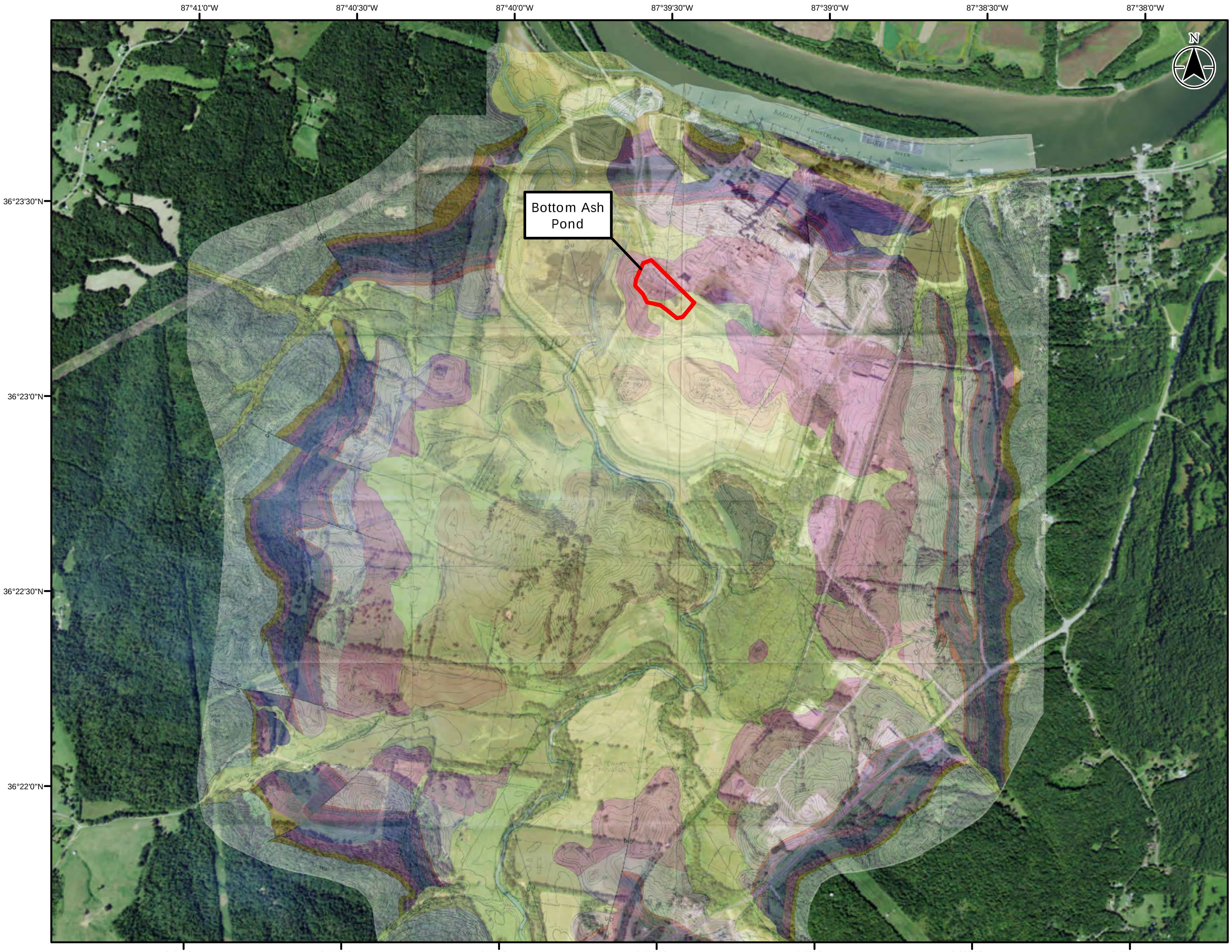
- Bottom Ash Pond Unit Limits
- Karstic Soil Conditions
- Reported Sinkholes
- Roads

VICINITY MAP



Notes
1. Coordinate System: NAD 1983 2011 StatePlane Tennessee FIPS 4100 Ft US.
2. Base Map features provided by ESRI.
3. Karst data provided by USGS Open-File Report 2004-1352.
4. Sinkhole data provided by Tennessee Landforms (tnlandforms.us).
5. Transporation data provided by United States Geological Survey (USGS)

Stantec



Wells Creek Crater Lithology

Site
Cumberland Fossil Plant (CUF)
Bottom Ash Pond

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

Project Location
Stewart County,
Tennessee

Prepared by RRR on 2017-06-27

0 0.3 0.6 Miles

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

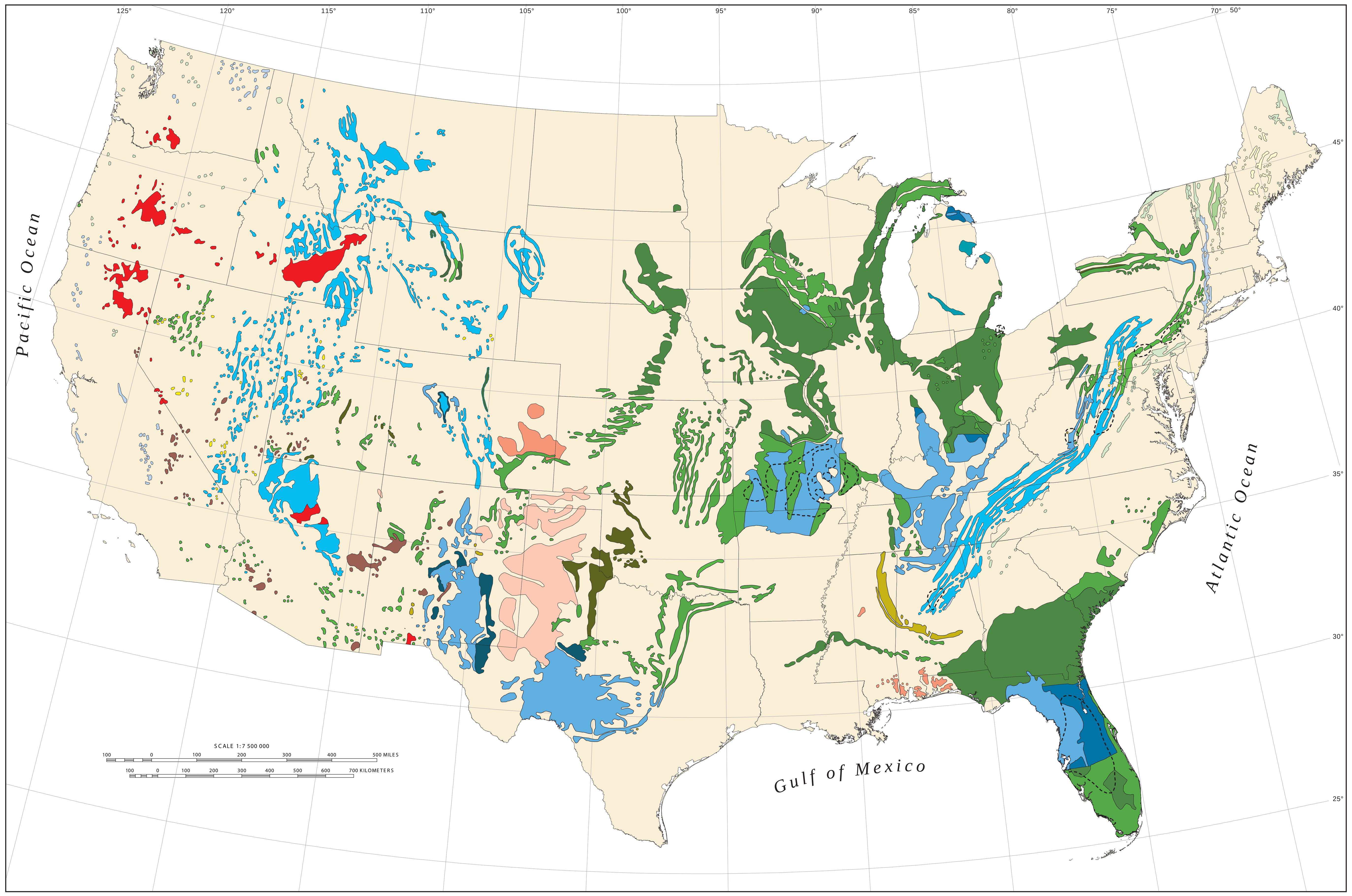
LEGEND

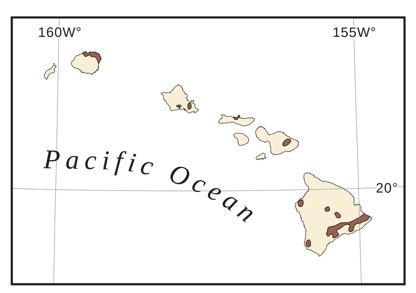
- Bottom Ash Pond Unit Limits
- Alluvial Deposits (Qal)
- Fort Payne Formation, New Providence Shale, and Chattanooga Shale (Mfp)
- Camden, Harriman, and Ross Formations (Dcr)
- Decatur Limestone (Sd)
- Brownsport Formation (Sbp)
- Dixon Formation (Sdx)
- Lego Limestone and Waldron Shale (Slw)
- Laurel Limestone (Sla)
- Osgood Formation (So)
- Brassfield Limestone (Sbr)
- Fernvale Limestone (Of)
- Hermitage Fromation (Oh)
- Stones River Group (Osr)
- Knox Dolomite (OCk)

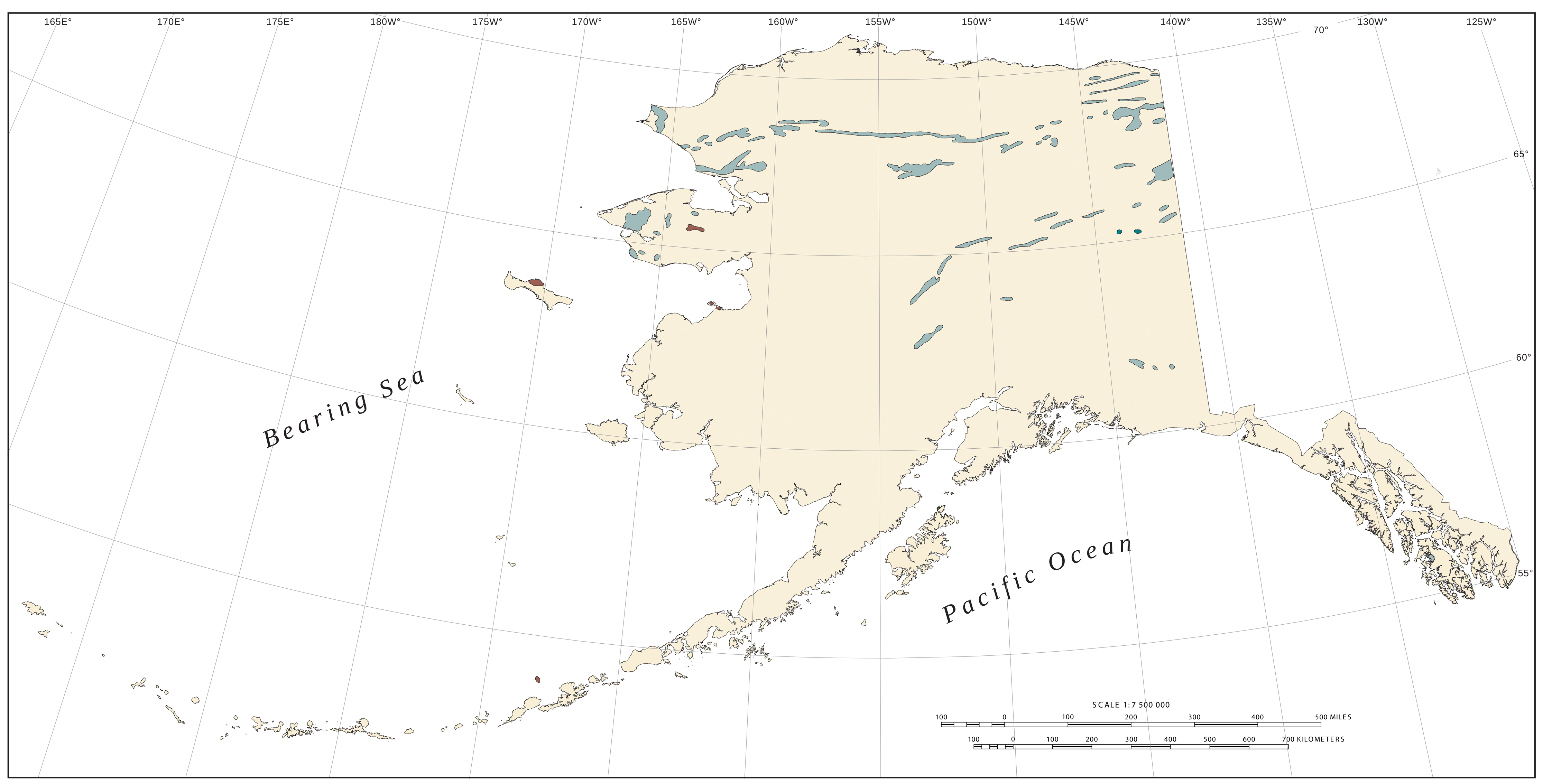
VICINITY MAP

Notes
1. Coordinate System: NAD 1983 2011 StatePlane Tennessee FIPS 4100 Ft US.
2. Base Map features provided by ESRI.
3. The Lithology Map was created by Herbert A. Teidemann, Charles W. Wilson, and Richard G. Stearns and was published in 1968

Stantec







Albers equal area projection
North American Datum 1983
standard parallels 25°N and 50°N
longitude of central meridian 96°W
latitude of projection origin 37°N

Digital Engineering Aspects of Karst Map : A GIS version of Davies, W.E., Simpson, J.H., Ohlmacher, G.C., Kirk, W.S., and Newton, E.G., 1984, Engineering aspects of karst: U.S. Geological Survey, National Atlas of the United States of America, scale 1:7,500,000

by Bret D. Tobin and David J. Weary

U.S. Geological Survey Open-File Report 2004-1352

FISSURES, TUBES, AND CAVES OVER 1,000 FT (300 M) LONG; 50 FT (15 M) TO OVER 250 FT (75 M) VERTICAL EXTENT

- In metamorphosed limestone, dolostone, and marble
- In moderately to steeply dipping beds of carbonate rock
- In gently dipping to flat-lying beds of carbonate rock
- In gently dipping to flat-lying beds of carbonate rock beneath an overburden of noncarbonate material 10 ft (3 m) to 200 ft (60 m) thick
- In moderately to steeply dipping beds of gypsum
- In gently dipping to flat-lying beds of gypsum

FISSURES, TUBES, AND CAVES GENERALLY LESS THAN 1,000 FT (300 M) LONG; 50 FT (15 M) OR LESS VERTICAL EXTENT

- In metamorphosed limestone, dolostone, and marble
- In crystalline, highly siliceous intensely folded cabonate rock
- In moderately to steeply dipping carbonate rock
- In gently dipping to flat-lying carbonate rock
- In gently dipping to flat-lying beds of carbonate rock beneath an overburden of noncarbonate material 10 ft (3 m) to 200 ft (60 m) thick
- In moderately to steeply dipping beds of gypsum
- In gently dipping to flat-lying beds of gypsum
- In gently dipping to flat-lying beds of gypsum beneath and overburden of nongypsiferous material 10 ft (3 m) to 200 ft (60 m) thick
- In carbonate zones in highly calcic granite (Alaska only)
- In moderately to steeply dipping beds of carbonate rock with a thin cover of glacial till and frost-derived residual soil (Alaska only)

FISSURES, TUBES, AND CAVES GENERALLY ABSENT; WHERE PRESENT IN SMALL ISOLATED AREAS, LESS THAN 50 FT (15 M) LONG; LESS THAN 10 FT (3 M) VERTICAL EXTENT

- In crystalline, highly siliceous intensely folded carbonate rock
- In moderately to steeply dipping beds of carbonate rock
- In gently dipping to flat-lying beds of carbonate rock

FEATURES ANALOGOUS TO KARST

- Fissures and voids present to a depth of 250 ft (75 m) or more in areas of subsidence from piping in thick unconsolidated material
- Fissures and voids present to a depth of 50 ft (15 m) in areas of subsidence from piping in thick, unconsolidated material
- Fissures, tubes, and tunnels present to a depth of 250 ft (75 m) or more in lava
- Fissures, tubes, and tunnels present to a depth of 50 ft (15 m) in lava

Areas in which extensive historical susidence has occurred

Introduction

This data set was converted from a printed map to a digital GIS coverage to provide users with a citable national-scale karst data set to use for graphic and demonstration purposes until new, improved data are developed. These data may be served on the internet or distributed freely with proper citation. Because it has been converted to GIS format, this data can be easily projected, displayed and queried for multiple uses in GIS. The karst polygons of the original map were scanned from the stable base negatives of the original, vectorized, edited, and then attributed with unit descriptions. All of these processes potentially introduce small errors and distortions to the geography. The original map was produced at a scale of 1:7,500,000; this coverage is not as accurate and should be used for broad scale purposes only. It is not intended for any site-specific studies.

The following text is taken verbatim from the original map, which was printed front and back on a single sheet.

ENGINEERING ASPECTS OF KARST

By
William E. Davies

Distinctive surficial and subterranean features developed by solution of carbonate and other rocks and characterized by closed depressions, sinking streams, and cavern openings are commonly referred to as karst. The term was used first to describe the region of Carso in northeastern Italy and northern Yugoslavia, where solution landscape was studied in the 19th century. Originally the term defined surface features derived by solution of carbonate rocks, but subsequent use has broadened the definition to include sulfates, halides, and other soluble rocks. The term has been expanded also to cover interrelated forms derived by solution on the surface in the subsurface. A further expansion of the concept of karst was the introduction of the term "pseudokarst" to designate karstlike terrain produced by processes other than the dissolution of rocks (Burger and Dubertret, 1975). When used in its broadest sense, the term encompasses many surface and subsurface conditions that give rise to problems in engineering geology. Most of these problems pertain to subterranean karst and pseudokarst features that affect foundations, tunnels, reservoir tightness, and diversion of surface drainage. Environmental aspects of karst lead to additional problems in engineering geology, especially in site selection. Subterranean openings may be the habitat of unique and, in some cases, endangered fauna. The openings are also conduits for water and refuse disposal from the surface or, in caves, for pollutants that can be carried for great distances. Many caves contain features of beauty and scientific interest that can be important esthetic factors in site selection for structures, transportation routes, and impoundments.

Although surface features of karst terrain (primarily sinkholes, solution valleys, and solution-sculptured rock ledges) are significant in engineering geology, they have not been included on this map because of the additional complexity that would occur in classification and portrayal.

The systematic study of karst in the United States started with W. M. Davis' (1930) theory on the origin of caves by deep-seated solution. Bretz (1942) obtained data, from studies in flat-lying carbonate rocks in the Midwestern States that supported Davis' theory. After World War II, studies of karst in the United States became widespread beginning with investigations in the Appalachian Mountains. Based on these studies, many of which were in areas of folded rock, older theories were modified with emphasis on maximum solution activity in a zone directly beneath a uniform water table (Davies, 1960). Since 1948, the exploration of caves and studies of landforms in carbonate terrains have produced a vast amount of data on karst. Reports of these explorations and studies have been primary sources in compiling this map on the subterranean aspects of engineering geology of karst and pseudokarst. In addition, published logs of borings were used. Much of the information on the Eastern United States, principally for the Appalachian Mountains and Plateau, is from field observations.

The small scale of the map and the limited data on openings, other than caves, in soluble rocks restrict the use of the map to the most general types of planning and as a guide to areas where subterranean karst and pseudokarst features occur. The map cannot be used either for specific site selection or as a substitute for field examination in planning and site development. Because cartographic license was taken to portray the features at the small scale of this map, enlargement can lead to gross errors in location of the data presented.

Subterranean openings in karst range in size from minute voids to large caverns. Most of the openings are formed by solution processes along fractures, joints, and bedding planes. Caves and related solution features are common in most carbonate and gypsum terrains in the United States, except in the area formerly covered by Pleistocene ice sheets (Davies and LeGrand, 1972). The southward advance of these ice sheets covered New England, New York, northeastern and northwestern Pennsylvania, most of the States bordering the Great Lakes, and much of the area north of the Missouri River. Karst features in the formerly glaciated area are covered by glacial drift, and most caves and fissure openings have been eroded away or filled. The caves and open fissures that remain generally have less than 1,000 ft (300 m) each of passages large enough to be traversed by humans.

South of the formerly glaciated area, caves, open joints, fissures, and other subterranean karst features are present in most soluble rocks. In general, both the number and size of solution features increase inversely with latitude. In addition, the number and size also vary according to the age and structure of the soluble rock in which solution features develop. Solution features in folded rocks are subordinate to those in nondeformed rocks; those in rocks older than Mississippian are subordinate to those in Mississippian and younger rocks. These are broad generalizations, and local exceptions exist. However, these generalizations can be used as a hasty estimate of karst conditions.

Most caves consist of a series of passages on one level. Some caves have multiple levels of passages that extend vertically as much as 300 ft (90 m). The levels are generally connected by shafts or large galleries. Most passages are less than 10 ft (3 m) high and less than 10 ft (3 m) wide. Maximum size of passages is about 100 ft (30 m) in height and width. In many caves, passages expand into galleries or rooms that are 30 to 200 ft (9 to 60 m) long and wide and up to 150 ft (45 m) high. The largest known solution opening in the United States is in Carlsbad Caverns, New Mexico, where a T-shaped room is 1,800 ft (550 m) long in one section, 1,100 ft (330 m) long in the other section, 255 ft (77 m) high, and up to 300 ft (90 m) wide.

Shafts are present in multiple-level caves and in some single-level caves. The deepest shafts are about 1,000 ft (300 m) deep, but in most caves they are less than 300 ft (90 m) deep. Most shafts are 30 ft (10 m) or less wide. In multiple-level caves, shafts connect levels; in other caves, the shafts are pits with no apparent connection at the base. Shafts are irregular in shape; some resemble funnels, and others are shaped like cylinders. Dome pits are cylindrical shafts that develop upward from a passage towards the surface of the Earth. Dome pits are up to 50 ft (15 m) wide and extend upward for as much as 150 ft (45 m). Their walls are uniform. Dome pits are capped by a cover of carbonate rocks 10 to 50 ft (3 to 15 m) thick. In many domes, the caps have collapsed and left vertical-sided open pits.

Virginia, West Virginia, Kentucky, Tennessee, Alabama, Missouri, Texas, and New Mexico contain hundreds of caves, each of which has over a mile of passages. At least one cavern system in each of these States has 10 to more than 100 mi (16 to 160 km) of passages. The largest known system is Flint Ridge-Mammoth Cave in Kentucky (Brucker, 1979), with over 200 mi (320 km) of passageways in an area of 362 mi (902 km).

Solution tubes with openings as much as 1 ft (0.3 m) wide and irregular alignment occupy portions of the carbonate bedrock. In some cases, the tubes connect with caves. However, the tubes generally lack the systematic patterns that are common in development of cavern passages. These tubes apparently predate cavern development. Although most tubes are seldom longer than a few hundred feet, they are interconnected and commonly act as conduits for subsurface drainage. During freezing weather, water from tubes can cause large buildups of ice where excavations intersect the tubes. At other times, the tubes lead to flooding of excavations and leaks in reservoirs and contribute to weakening of retaining walls.

Fissures (also referred to as open joints) up to 1 ft (0.3 m) wide result from limited solution along joints, fractures, and bedding planes. Fissures occur in various attitudes from vertical to gently inclined and generally are in repetitive geometrical patterns or sets. Fissures form systems that may extend for several thousand feet horizontally and over 300 ft (90 m) vertically. Some fissures or parts of fissures are filled with consolidated clay-silt and clay-gravel that seal them. The seals, however, are altered in contact with water and can be removed by running water. Fissures are commonly conduits for subterranean streams. In addition, they can cause serious engineering problems, such as reservoir leakage and instability of cuts, bridge abutments, piers, and dam foundations and abutments.

The depth to which solution openings occur depends on relief in an area, thickness of soluble rock, and geologic structure. The configuration and depth of the water table, in some cases, are controlling factors. Ground water in karst terrain generally is found in existing openings that extend tens to hundreds of feet below the water table. In the mountainous areas of the Western United States, the known vertical extent of solution openings is as much as 1,100 ft (330 m). In the Eastern United States, where relief is less, the vertical extent is generally less than 400 ft (120 m), with a maximum of 650 ft (200 m). Beneath many broad river valleys, solution features in carbonate rocks are present to a depth of about 100 ft (30 m) in both the Eastern and Western United States.

Surface subsidence (sinkhole development) occurs most commonly in areas where ground-water conditions are altered by excessive pumping or by diversion of surface drainage. Subsidence generally involves weathered bedrock and soil that bridge caverns, subterranean galleries, and dome pits. The collapse is caused by loss of support resulting from the reduction of hydrostatic pressure of ground water, by sapping, and by piping. Most subsidence forms shallow, steep-sided depressions up to 100 ft (30 m) wide and up to 20 ft (6 m) deep. However, in Florida and central Alabama, recent subsidence has resulted in nearly vertical sided sinkholes up to 425 ft (130 m) wide and 150 ft (45 m) deep.

Areas of local subsidence caused by mining operations and regional subsidence caused by withdrawal of ground water and petroleum in thick, unconsolidated sediments have not been included on the map of subterranean aspects of engineering geology of karst and pseudokarst because natural processes are involved only in a subordinate way in development of these phenomena. The problems of these types of subsidence are complex, and the areas involved are so extensive that they are best treated as subjects for another map.

In the New England States, solution terrain is confined to crystalline limestones and marbles mainly in northeastern Maine, western Vermont, and western Massachusetts. Solution features in these areas are primarily narrow fissures generally less than 200 ft (60 m) long and less than 30 ft (10 m) deep. A few small caves are known in western Vermont and in the Berkshire Mountains of western Massachusetts. In eastern Vermont and much of Maine, carbonate rocks high in silica and other impurities' are commonly, yet incorrectly, referred to as limestone. Solution features are generally absent in these rocks.

In the Appalachian Highlands, three major groups of carbonate rocks are in the karst regions. The Great Valley, in the eastern part of the Highlands, from southeastern New York to central Alabama, is a lowland up to 26 mi (42 km) wide eroded across dolomite, limestone, and shale of Cambrian and Ordovician age, Regionally, and to some extend reflecting differences in degree of karst development, the Great Valley is designated from north to south as the Kittatinny, Lehigh, Lebanon, Cumberland, Hagerstown, Shenandoah, and Tennessee Valleys. All types of solution features are present in the Great Valley, with small caves and fissures in southeastern New York and like features increasing in size and numbers southward. From central Virginia southward, large caves with over 1 mi (1.6 km) of passages in each are common, and fissures extend hundreds of feet in length and over 100 ft (30 m) in depth. The major geologic units involved in karst development in the Great Valley are the Elbrook (Cambrian), Conococheague (Cambrian-Ordovician), Beekmantown (Ordovician), and their equivalents. All are folded with steep dips, and overturning is common along the east half of the lowland. Faults are numerous and some major fault zones extend over 200 mi (320 km). Active subsidence is prevalent throughout the Great Valley and is a result primarily of alteration of the water table. Generally, the subsidence involves the opening of shallow fissures and shafts up to 10 ft (3 m) in diameter in farmland through removal of soil and thin rock cover over fissures, shallow cavern passages, and small dome pits. More extensive subsidence is in progress in the vicinity of Allentown and Harrisburg, Pennsylvania, where numerous subsidence depressions up to 100 ft (30 m) in diameter have developed. In Staunton, Virginia, active subsidence from collapse of rocks and soil covering shallow caves and fissures was recorded as early as 1911. Subsidence in the Staunton area resulted from large-scale piping of sinkhole soils by leakage from settling basins and from drawdown of the water table. In central Alabama, steep-sided, water-filled sinks, up to 425 ft (130 m) wide and 150 ft (45 m) deep, have formed recently by collapse of weathered limestone and thick soils covering limestone.

In the area west of the Great Valley, a sequence of limestones in the Upper Silurian (Tonoloway) and the Lower Devonian (Helderberg Group) forms subordinate ridges in southeastem New York, central Pennsylvania, eastern West Virginia, and western Virginia. The rock is folded, and dips are steep. Karst features include fissures extending several hundred feet vertically and caves with up to 1 mi (1.6 km) of large passageways. Subsidence is uncommon, but the fissures and caves have caused problems in foundations and abutments of dams, in cuts because of unstable wedges, and in tunnels that encounter earth fills in solution cavities.

Along the western edge of the Valley and Ridge province of the Appalachian Highlands, several large basinlike lowlands underlain by Cambrian and Ordovician carbonate rocks occur. The lowlands are eroded across large anticlines with steep dips on the flanks and moderate to steep plunges along the axes of the anticlines. In the Nittany and Kishacoquillas Valleys of Pennsylvania, and some smaller valleys designated as "coves," numerous caves occur, each with passageways 1,000 to 5,000 ft (300 to 1,5!)0 m) long The passages generally are 100 ft (30 m) or less below the surface. Many act as subterranean feeders that carry runoff from adjacent ridges to a few points of resurgence. The resurgent points are large springs with a daily flow of up to 1 million gallons or more (4 million or more). Fissures are present but seldom exceed 200 ft (60 m) in depth. Subsidence is not common, but deep cuts and excavations are subject to uncontrollable flooding if major subterranean conduits are encountered. In Germany Valley, West Virginia, solution features, primarily multiple-level caves and fissures, extend to depths of 350 ft (105 m) or more. Drainage of most of this valley is by way of one large spring. Subsidence from collapse of sinkholes is common, and potential for subsidence exists over numerous dome pits above caves.

The Appalachian Plateau's province and adjacent parts of the Interior Plains in West Virginia, Kentucky, Tennessee, northern Alabama, and southern Indiana contain the most intensely developed karst areas in the United States. The karstic carbonate rocks are Mississippian in age and include the Greenbrier limestone (West Virginia) and the Golconda, Ste. Genevieve. St. Louis, and Warsaw limestones and their equivalents elsewhere. Caves generally contain 3,000 ft (900 m) or more of passageways. Multiple-level caves are not common, but some large cave systems, such as Flint Ridge-Mammoth Cave in Kentucky and Organ Cave in West Virginia, have a multitude of complex passageways at various elevations that extend in aggregate from 30 to over 200 miles (48 to over 320 km). Dome pits, common in many caves, are areas of potential collapse. Many of the caves are large subterranean drainageways that receive streams flowing from adjacent highlands. Cuts and excavations intersecting these caves are subject to inundation from over 1 million cubic ft (40,000 m^3) of water stored in the subterranean reservoirs. Large sinkholes, up to 1 mi (1.6 km) wide and several hundred feet deep, are so numerous that the rims of many sinkholes intersect the rims of their neighbors. Suitable foundations for large structures are difficult to site. Deep cuts, mines, tunnels, and excavations commonly encounter deeply weathered rock and large volumes of weak soil filling cavern passages and fissures. Seasonal flooding is common from snow melt and from heavy rainfall that exceeds the infiltration capacity of sinkholes and the capacity of subterranean channels to carry the runoff. Subsidence in most of the area is not extensive except above the dome pits and along karst valleys in southern Indiana and in the Mammoth Cave plateau in Kentucky.

In the Southeastern United States, karst is extensive on the Coastal Plain in southern Alabama, Georgia, and Florida. The limestones in the karst area are primarily the Ocala Limestone and Jackson Formation of Eocene age and their equivalents. In the Dougherty Plain of southeastern Alabama and southern Georgia, the limestone has been weathered deeply, and in the southern part of the plain the limestone is covered by a residuum of sandy clay. In the northern part of the plain, only small areas of the limestone remain within the residuum. Subsidence occurs as broad, slowly developing, shallow sinkholes in the residuum. In Florida, subsidence is more extensive. In the northern half of the State, the limestone is covered by younger sand deposits that are locally over 100 ft (30 m) thick. In Polk County, subsidence has resulted in vertical-sided sinkholes up to 150 ft (45 m) deep and 425 ft (130 m) wide. The subsidence has engulfed several houses and resulted in large property losses to homeowners. The subsidence is related to alteration of ground-water levels in caverns and to collapse of the weathered carbonate rock that supports the surface deposits.

In the Southeastern United States, karst is extensive on the Coastal Plain in southern Alabama, Georgia, and Florida. The limestones in the karst area are primarily the Ocala Limestone and Jackson Formation of Eocene age and their equivalents. In the Dougherty Plain of southeastern Alabama and southern Georgia, the limestone has been weathered deeply, and in the southern part of the plain the limestone is covered by a residuum of sandy clay. In the northern part of the plain, only small areas of the limestone remain within the residuum. Subsidence occurs as broad, slowly developing, shallow sinkholes in the residuum. In Florida, subsidence is more extensive. In the northern half of the State, the limestone is covered by younger sand deposits that are locally over 100 ft (30 m) thick. In Polk County, subsidence has resulted in vertical-sided sinkholes up to 150 ft (45 m) deep and 425 ft (130 m) wide. The subsidence has engulfed several houses and resulted in large property losses to homeowners. The subsidence is related to alteration of ground-water levels in caverns and to collapse of the weathered carbonate rock that supports the surface deposits.

Cretaceous carbonate rocks of the Selma Group are extensive in central and western Alabama and northeastern Mississippi. These rocks show little alteration by solution, and open fissures, open joints, and caves are generally not present.

The Silurian limestones and dolomites (Niagaran) of northwestern Ohio and adjacent Indiana are buried beneath glacial drift. Only in northwestern Ohio, where the glacial deposits are less than 20 ft (6 m) thick, are there karst features large enough to cause problems in engineering geology. Caves, each generally with less than 1,000 ft (300 m) of passages, are present but not numerous. Fissures less than 100 ft (30 m) wide extend for hundreds of feet. Small areas of subsidence have been attributed to alteration of the water table by pumping processes in quarries several miles from the site of subsidence. Because of the flat terrain, excavations and cuts seldom are deep enough to encounter major karst features. In the vicinity of Sandusky, Ohio, and on some of the nearby islands in Lake Erie, beds of calcium sulfate expand and change because of weathering and may cause local problems in heaving.

Broad anticlines with gentle dips bring Ordovician limestones and dolomite to the surface in southwestern Ohio and north-central Kentucky. Small caves and numerous joint-controlled fissures occur. Subsidence is not common or extensive, but the fissures and caves that result contain a large volume of water that may flood excavations. Ordovician and Silurian carbonate rocks also are brought to the surface in a broad anticline in central Tennessee around Nashville. Karst conditions are similar to those in north-central Kentucky.

In the Lower Peninsula of Michigan, carbonate rocks are extensive but are buried deeply beneath glacial deposits. Silurian limestones along Lake Huron between Alpena and the Straits of Mackinac contain several large sinkholes up to 1 mi (1.6 km) long and 200 ft (60 m) deep. The sinkholes are interconnected by an extensive fissure system. Normally, the sinkholes are filled with water, but, over time, plugs in the fissure system fail and the lakes drain through the subterranean openings. Subsidence generally does not occur in the Lower Peninsula.

Ordovician limestones cover the south half of the Upper Peninsula of Michigan and extend through eastern and southern Wisconsin, eastern Iowa, and parts of southeastern Minnesota. Karstic features are poorly developed and consist of simple caves, each with less than 1,000 ft (300 m) of passageways and less than 50 ft (15 m) of vertical extent. Fissures developed along joint lines are in about the same size range as the caves. In the vicinity of Dubuque, Iowa, and extending into adjacent Wisconsin and Illinois, fissures several hundred feet long and more than 300 ft (90 m) deep have been encountered in lead-zinc mines. The fissures possibly are relict from older buried karst. Subsidence from karst features is rare, although subsidence over mines is extensive.

The Ozark Plateaus province and adjacent plains in Missouri and northern Arkansas have extensive karst areas. The Ozarks are a large regional structural dome with steep dips along the southern flank. The dome brings Cambrian and Ordovician limestones and dolomites to the surface. North and west of the dome are plains underlain by Mississippian carbonate rocks (Warsaw, St Louis, Ste. Genevieve, and equivalents). Within the Ozarks, caves, each with passages 1,000 ft (300 m) or more long, are common. The passages in most caves extend to a depth of less than 100 ft (30 m). Pits, formed by collapse into cavern shafts and dome pits, are common, and, in southern Missouri, active subsidence is extensive. Most of the pits are water filled. Fissures over 1,000 ft (300 m) long and more than 300 ft (90 m) deep are present in much of the area. Similar fissures are numerous in the lead-zinc mining region in southwestern Missouri and adjacent Oklahoma and Arkansas. Throughout the Ozarks, the caves and fissures give rise to serious problems in foundations and abutments of dams and with reservoir tightness, stability of bridge piers, and stability of cut slopes. The presence of large quantities of subterranean water is a problem in deep foundations.

The Niobrara Formation (Upper Cretaceous) and its equivalents are the most widespread carbonate rocks in western Kansas, eastern Nebraska, and southeastern South Dakota. The Niobrara is generally covered by more than 50 ft (15 m) of younger sediments. Small fissures, less than 1,000 ft (300 m) long and up to 100 ft (30 m) deep, are present, but they are not common and are generally irregularly spaced with 1,000 ft (300 m) or more of solid rock between fissures.

Salt beds in south-central and southwestern Kansas form karst areas. Fissures are extensive, with openings more than 1,000 ft (300 m) long and over 300 ft (90 m) deep. Throughout the saline rock, recent subsidence has resulted from natural causes, as well as from alteration of the water table by solution mining and open pit mining.

In western South Dakota and adjacent parts of Wyoming and Montana, Paleozoic and Cretaceous carbonate rocks, arched steeply upwards, encircle the structural dome that forms the Black Hills. Caves and open fissures are common in the Paleozoic carbonate rocks. A few caves contain many miles of passages but most of the cave passages and fissures in the Black Hills area only extend up to 3,000 ft (900 m) in length and are generally less than 150 ft (45 m) in depth. Closely spaced solution joints also are prevalent.

In western Oklahoma and in the eastern part of the Texas Panhandle, extensive areas of karstic gypsum occur. Small open fissures up to 50 ft (15 m) deep and 1,000 ft (300 m) long are present. Passages in caves in gypsum are generally of similar length and depth.

The Edwards Limestone (Cretaceous) in west-central Texas forms an extensive plateau. Large caves and fissures are present to a depth of 600 ft (180 m), and both fissure systems and passages of single caves commonly extend for more than 1 mi (1.6 km). Both the caves and fissures contain large quantities of water in their deeper parts.

Permian carbonate rocks in central and southern New Mexico contain numerous well-developed karst features. Caves are generally very large and contain miles of passages with a vertical extent of 1,000 ft (300 m) or more. Fissures are of similar size and are interconnected, forming networks that extend for several miles. Closely spaced open joints, enlarged by solution, and numerous small, near-surface solution tubes cause extensive trouble in reservoir tightness throughout this karst area.

In northern and central Arizona, the Kaibab Limestone (Lower Permian) and its equivalents are karstic. North of the Grand Canyon, subterranean openings are primarily widely spaced fissures up to 1,000 ft (300 m) long and 250 ft (75 m) or more deep. South of the Grand Canyon, the fissures are more closely spaced and a few shallow caves are present. East of Flagstaff, there is an area of open fissures. These fissures are over 300 ft (90 m) deep, up to 1,000 ft (300 m) long, and up to 3 ft (1 m) wide. They cut the Coconino Sandstone, as well as the Kaibab Limestone (Colton, 1938).

The Madison Limestone (Mississippian) lies under karst areas in western Montana and adjacent parts of Idaho and Wyoming. Passages in a single cave are commonly up to 2 mi (3.2 km) long. Open fissures up to 1,000 ft (300 m) long and shallow, open joint systems are also common. Fissures and cavern passages extend as much as 1,000 ft (300 m) deep. Large quantities of water are present in the lower parts of the fissures and in some of the deeper cavern passages. Relict karst features developed during times of disconformity at the end of the Mississippian are common in the Madison Limestone. Most of the relict features are solution tubes, caves, and small fissures that have been filled with younger deposits that are now lithified. Because of differences in materials, residual openings, and secondary solution, these features can give rise to foundation problems and leakage.

Karst features in Alaska are not well known. Most of these features are shallow, swalelike depressions developed in a thin cover of residual soil and glacial till that lies over intensely folded limestone. A few cave openings are in limestone bluffs, but most cave entrances are hidden by a cover of spalled rock fragments. Streams crossing limestone terrains commonly disappear into the soil mantle and resurge at contact with insoluble rocks bordering the limestone. No subsidence features have been reported in Alaska.

Pseudokarst conditions in the United States develop in areas of thick, unconsolidated sediments and are primary features in basalt lava. In addition, in Mississippi and Alabama. numerous subsidence features occur in unconsolidated silt, sand and gravel of the Coastal Plain; these subsidence features are analogous to karst features. The subsidence occurs as numerous shallow depressions that are generally less than 50 ft (15 m) deep and up to 1 mi (1.6 km) or more wide. The depressions occur in Miocene and Pliocene sediments 800 to 1,000 ft (240 to 300 m) or more thick. Oligocene carbonate rocks are present beneath these sediments. The origin of the depressions is not understood The depressions appear to be associated with poorly drained areas such as flat lowlands and elevated, dissected, higher erosion surfaces. The depressions apparently are confined to flat surfaces and are not present on slopes that bound the flat surfaces. Excavations in the depressions probably would encounter weak and unstable soil and would be subject to flooding.

The High Plains of western Texas and adjacent States contain numerous depressions, some of which are as much as 3 mi (4.8 km) long and up to 1 mi (1.6 km) wide. They vary from "buffalo wallows," 3 to 10 ft (1 to 3 m) deep, to steep-sided features as much as 250 ft (75 m) deep. The depressions are aligned along a series of major joints and apparently formed by piping and removal of fine-grained material along joint planes at depths greater than 250 ft (75 m). Deep excavations in the depressions encounter weak, unstable soils and are subject to flooding from ground water during occasional periods of high rainfall.

Pseudokarst features in late Cenozoic basalt lava fields are extensive in some regions of the west. The largest regions with this type of pseudokarst are in the Snake River area of Idaho, in part of the Columbia Basalt Plateau in Washington and Oregon, and in the lava fields of northeastern California. Smaller areas are in New Mexico, Arizona, Utah, Nevada, southern California and on the Seward Peninsula in Alaska. The pseudokarst features include lava tubes, fissures, open sinkholes, and caves formed by extrusion of the still-liquid portion of the lava. Subsurface solution of the bedrock and subsequent collapse are not involved in the formation of these features. Lava tubes, in the form of tunnels, are up to 20 ft (6 m) in diameter, and some extend for several miles. Fissures are common but seldom extend for more than 1,000 ft (300 m). The fissures and lava tubes, in contrast to solution features, are not in geometrical sets but are generally parallel and extend in the direction of the flow of the lava. Fissures and lava tubes are generally near-surface features, but some are as much as 250 ft (75 m) deep. "Sinkholes" in lava generally lack the symmetry of those developed in solution terrain. The lava sinks are commonly less than 100 ft (30 m) wide, but a few large sinks, notably in the Snake River area of Idaho, are as much as 1 mi (1.6 km) or more wide. Most of the lava sinks are irregular in shape and generally are shallow features (less than 30 ft (10 m) deep), although some are 150 ft (45 m) or more deep. Many of the sinks have near-vertical sides or overhangs. Lava pseudokarst features present problems in foundations, abutments, and reservoir tightness. In addition, the tubes and related permeable lava often contain large quantities of water that may lead to flooding and slope-stability problems in cuts and excavations.

Acknowledgments and gratitude are extended to Allen W. Hatheway, Cambridge, Massachusetts, for information and guidance on pseudokarst in lava, to the thousands of members of the National Speleological Society whose papers on caves and karst areas they explored are the basic sources used in compilation of this map, and to members of the U.S. Geological Survey and various State Geological Surveys for information they contributed and for technical review and advice on this map and text.

REFERENCES CITED

Bretz, J. H., 1942, Vadose and phreatic features of limestone caverns. Journal of Geology, v 50, no. 6, pt2 , p. 675-811.

Brucker, Roger, 1979, New Kentucky Junction. Proctor-Mammoth Link Puts System over 200 miles, National Speleological Society News, v 37, no. 10. October, p. 231-236.

Burger, A., and Dubertret, L., 1975, Hydrogeology of Karstic terrain: Paris, International Association of Hydrogeologists, p. 159.

Colton, S., 1938, Exploration of limestone solution cracks: Museum of Northern Arizona, Museum Notes, v. 10, no. 10, p. 29-30.

Davies, W. E.. 1960, Origin of caves in folded limestone (Appalachian Mountains) *in* Moore, G W., ed.. Origin of limestone caves; a symposium with discussion: National Speleological Society, Bulletin, v. 22, pt. 1, p. 5-18.

Davies, W E., and LeGrand, H. E., 1972, Karst of the United States; *in* Herak, M. and Stringfield, V. T.. eds., Karst; important karst regions of the northern hemisphere. New York Elsevier Publishing Co., p. 467-505.

Davis, W. M.. 1930, Origin of limestone caverns: Geological Society of America Bulletin, v. 41, no.3, p, 475-628.

The following publications have not been cited in the text but are works that cover the subject of karst in great detail.

Ford, T. D., and Cullingford, C. H, D., eds., 1976, The science of speleology: London, Academic Press, 593 p.

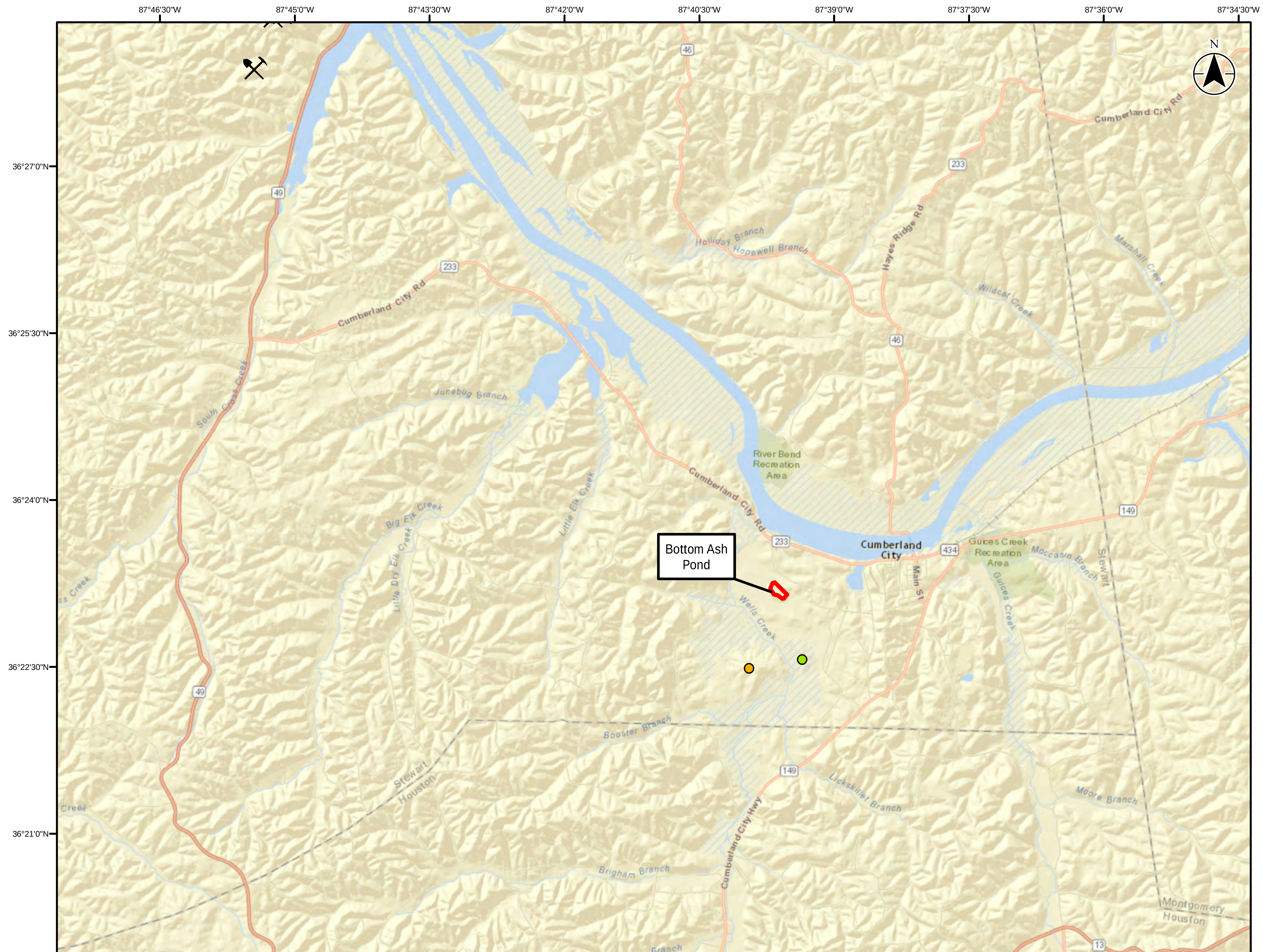
Jakucs, Laszlo, 1977, Morphogenetics of karst regions: New York, Halstead Press, 284 p.

Jennings, J. N.. 1971, Karst: Cambridge, M.I.T. Press, 252 p.

Sweeting, M M.. 1972, Karst landforms: London, MacMillan, 362 p.

Sweeting, M. M.. ed.. 1981, Karst geomorphology: Benchmark Papers in Geology, v. 59, Stroudsburg, Hutchinson Ross Publishing, 427 p.

APPENDIX C
HUMAN-MADE FEATURES OR EVENTS



Human-Made Features Map

Site

Cumberland Fossil Plant (CUF)
Bottom Ash Pond

Client/Project

Tennessee Valley Authority (TVA)
Chattanooga, Tennessee

Project Location

Stewart County,
Tennessee

Prepared by RRR on 2017-06-27

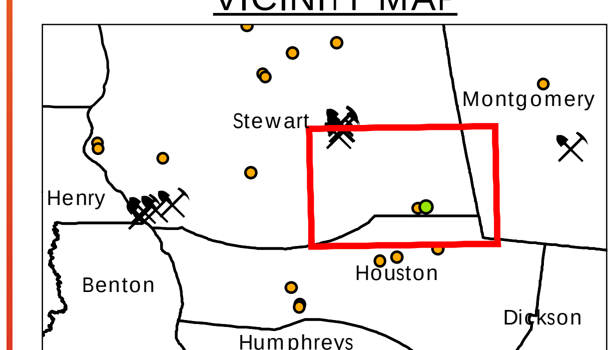
0 1 2 Miles

1:64,000 (At original document size of 11x17)

LEGEND

- Bottom Ash Pond Unit Limits
- Oil and Gas Wells
- Historical Mines
- Mines/ Active Quarries

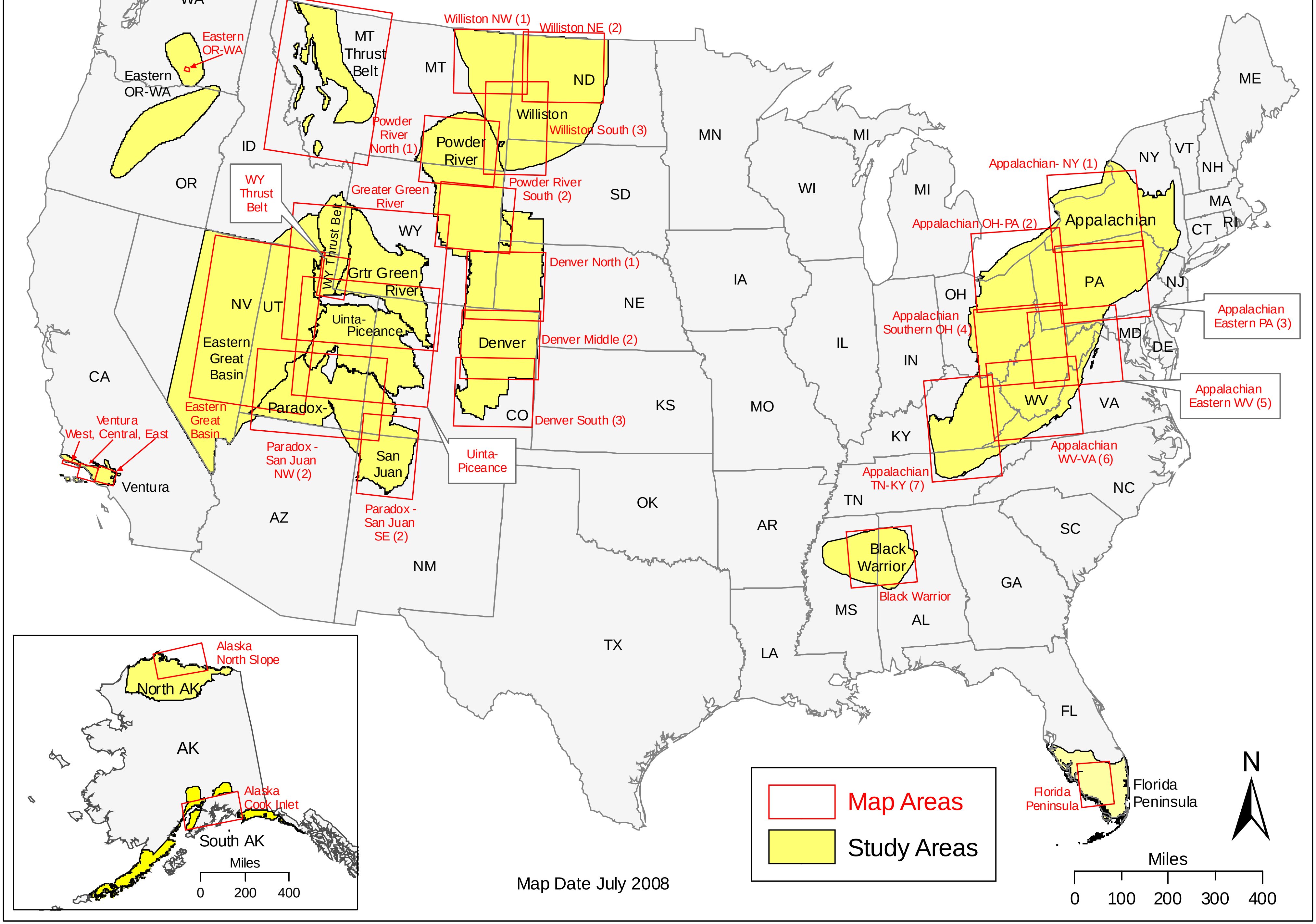
VICINITY MAP



Notes
1. Coordinate System: NAD 1983 2011 StatePlane Tennessee FIPS 4100 Ft US.
2. Base Map features provided by ESRI.
3. Oil and gas well data provided by Tennesse Department of Environment and Conservation.
4. Mine data provided by Tennesse Home Town Locator.

Stantec

Detailed Oil and Gas Field Maps



Map Date July 2008