M E M O R A N D U M **(P-004-2018) Consultant**

TO: **Amanda Spencer, PE**
Director, Division of Planning

FROM: **Michael Carpenter, PE**
Geotechnical Branch Manager
Division of Structural Design

BY: **Erik Scott, PE**
Geotechnical Branch

DATE: **July 31, 2018**

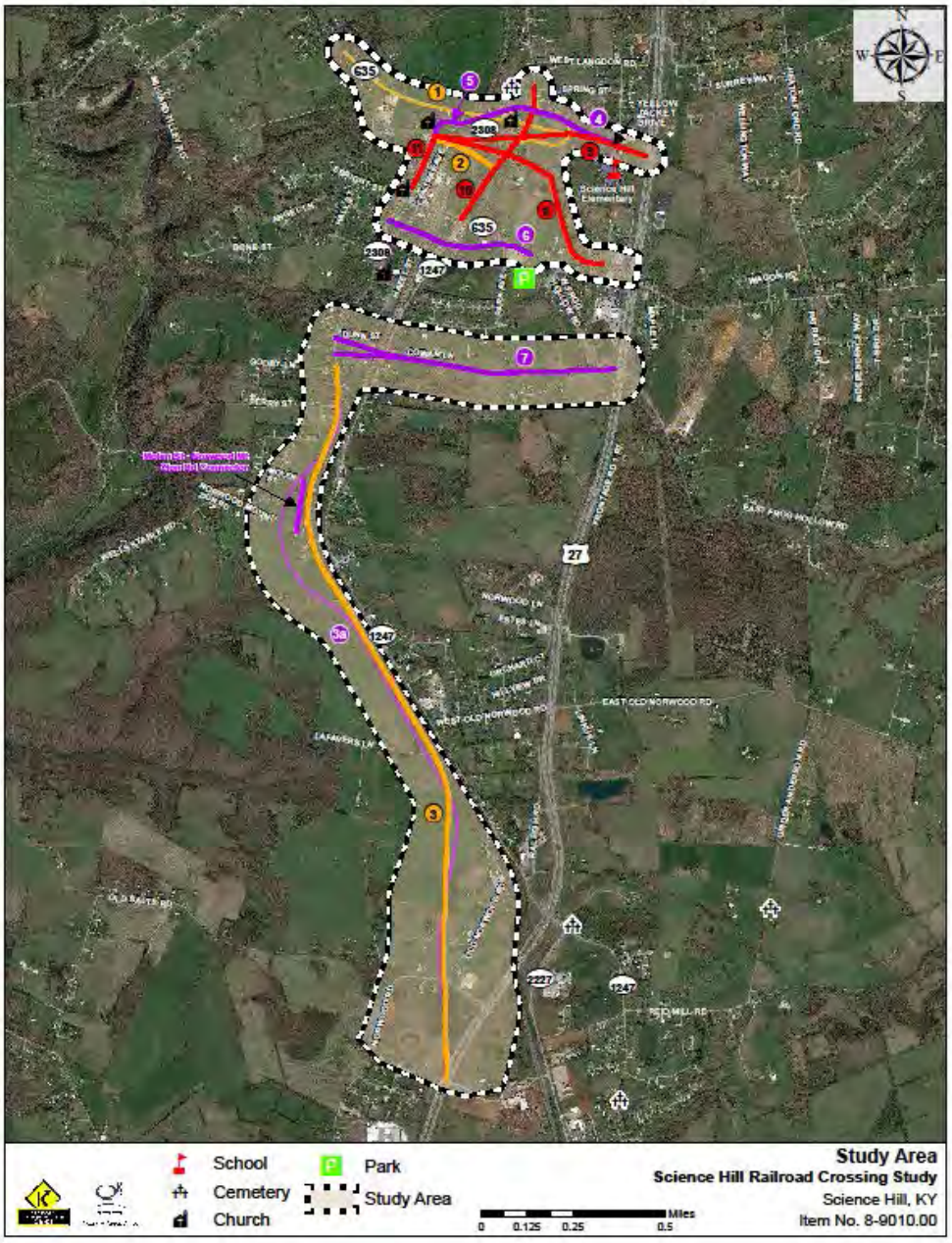
Subject: **Pulaski County**
Item No. 8-9010.00
Science Hill Railroad Crossing Study:
Preliminary Geotechnical Overview

The preliminary geotechnical overview report for the subject project has been completed by American Engineers, Inc. This report was prepared as part of the scoping study for a new grade-separated railroad crossing in Science Hill, KY. The study is being performed by QK4, Inc. under Statewide Planning Contract. The report has been forwarded to the Design Consultant and will also be made available on ProjectWise.

If you have any questions or need additional information, please contact the Geotechnical Branch at 502-564-2374.

cc: **Division of Highway Design, Project Management Coordinator**
TEBM for Project Development (District)
Division of Planning
American Engineers, Inc.
QK4, Inc.

Attachment



GEOTECHNICAL OVERVIEW REPORT P-004-2018

SCIENCE HILL RAILROAD CROSSING

Pulaski County, KY

June 2018

DESIGNING YOUR FUTURE, TODAY.

AEI
AMERICAN
ENGINEERS, INC.

June 14, 2018

Ms. Annette Coffey, PE
Senior Transportation Engineer
Qk4, Inc.
Engineering Planning
2225 Lawrenceburg Road
Building B, 1st Floor
Frankfort, KY 40601

Re: Geotechnical Overview Report
Science Hill Railroad Crossing Study
Pulaski County, Kentucky
AEI Project No. 218-102
Item No. 8-9010.00

Dear Ms. Coffey:

American Engineers, Inc. Field Services Center is pleased to submit this geotechnical overview that details the results of our site and mapping reconnaissance for the above referenced site.

The attached report describes the site conditions and near-surface geology and also details potential design recommendations for the proposed project. The Appendices to the report contains maps of surficial geology as well as karst potential.

We appreciate the opportunity to be of service to you on this project and hope to provide further support on this and other projects in the future. Please contact us if you have any questions regarding this report.

Respectfully,
AMERICAN ENGINEERS, INC.

Brad High, PG, PMP
Geotechnical Engineer

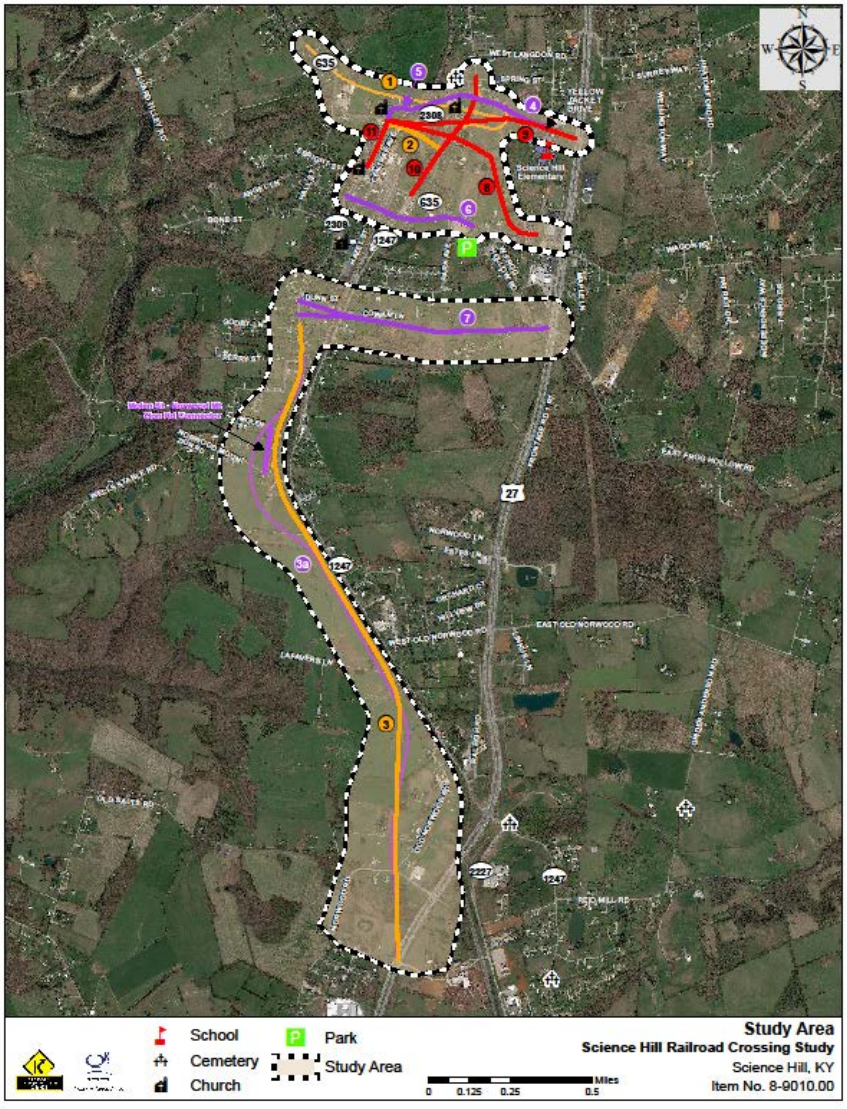
Dennis Mitchell, PE, PMP
Director of Geotechnical Services

Geotechnical Overview

Science Hill Railroad Crossing Study

Science Hill, Kentucky

Item No. 8-9010.00



Geotechnical Overview
Science Hill Railroad Crossing Study
Science Hill, Kentucky
Item No. 8-9010.00

1. Project Description

The Geotechnical Overview includes two separate areas in and near Science Hill, KY. The first area begins south of Science Hill near the intersection of Norwood Road and US 27 and runs relatively parallel with KY 1247 and the railway to an area near Cowan Lane. This section then trends east to the intersection of Frog Hollow Road and US 27. The southern section is mostly rural with a few commercial properties and residential areas. The northern study area encompasses Central Avenue and KY 635 from the south and west and trends to the east to US 27 both north and south of Science Hill Elementary. The north end of this study area ends near the intersection of Spring Street and KY 1247 near the Science Hill Cemetery. The northern section is more highly developed and includes many businesses, residences, churches, city streets and various support facilities. Approximate coordinates for the northern section of the study area are 37.180424, -84.632199; approximate coordinates for the southern section of the study area are 37.142051, -84.634723.

The study area is dissected by several small streams and creeks, roadways, existing roadway structures, a railway and at least one cemetery. This geotechnical overview is a part of a larger scoping study to define alternative railroad crossings to improve traffic flow and accessibility. Currently 11 preliminary alternatives are indicated.

This geotechnical overview was conducted in relative accordance with the Scope of Work for Geotechnical Overviews for Planning Studies provided by KYTC Planning Division, as well as Section 801 of the Kentucky Transportation Cabinet Geotechnical Manual. The study was conducted during March and April 2018

and included field reconnaissance and geologic research of available geologic and topographic quadrangle maps, soil survey of Pulaski County, Kentucky, as well as online resources available from the Kentucky Geological Survey and the United States Geological Survey. Past reports from geotechnical investigations of portions of the existing roadways and structures in the area were also reviewed in preparation of the overview.

2. Site Geology

United States Geological Survey (USGS) 7.5-minute geologic quadrangle maps were reviewed (*Geologic Map of the Science Hill Quadrangle, South-Central Kentucky, KGS, 1973 and Geologic Map of the Bobtown Quadrangle, Pulaski County, Kentucky, KGS, 1973)* as well as online geologic mapping http://kgs.uky.edu/kgsmap/kgsgeoserver/viewer.asp for the study area. Available geologic mapping indicates the study area is underlain primarily by Mississippian-aged bedrock, in descending order of lithology, the Ste. Genevieve Limestone Member of the Monteagle Limestone Formation, the St. Louis Limestone Formation, Salem and Warsaw Formations and various members of the Borden Formation.

Mapping describes the Ste. Genevieve Limestone Member as primarily limestone, medium to light gray in color, commonly oolitic and silty, thin to thick bedded and in part crossbedded. Chert occurs in nodules, thin beds and as chert breccia. A few thin clay shale beds are also present in the Ste. Genevieve Limestone Member within the region.

Mapping describes the St. Louis Limestone Formation as being comprised of limestone, claystone and siltstone. The majority of the study area is indicated to be underlain by the St. Louis Limestone Formation. The limestone of the formation is commonly light olive-gray to medium dark gray in color, micrograined to fine grained in texture, medium bedded, argillaceous and fossiliferous. Residual soils weathered from the St. Louis Limestone Formation are commonly reddish-brown clays with abundant chert fragments.

The Salem and Warsaw Formations are undifferentiated on available geologic mapping in the area. The formations are mostly comprised of limestone with lesser instances of sandstone, siltstone and shale. The limestone is commonly medium gray in color, fine to coarse grained, medium to thick bedded and cherty. The sandstone is typically quartzose, reddish brown, fine to coarse grained, thin to medium bedded and locally calcareous. Karst features such as caves, springs and karst widows are often encountered near the contact between the Salem and Warsaw Formations and the St. Louis Limestone Formation. In general, the Salem and Warsaw Formations are less karst and more resistant to weathering than overlying formations. Sinkhole dropouts are more commonly encountered within formations overlying the Salem and Warsaw Formations. Groundwater can also be anticipated at the top of chert beds and shale zones in formations predominantly comprised of limestone.

The Borden Formation is comprised of four separate Members; the Muldraugh Member, Halls Gap Member, Nancy Member and the New Providence Shale Member. The Borden Formation will generally be encountered within the study area at the lowest site elevations near streams. The Members of the Borden Formation are comprised primarily of siltstone, shale, limestone and chert.

Karst potential mapping provided by the Kentucky Geologic Survey indicates that the study area exhibits very high karst potential in areas underlain by the St. Louis Limestone and Ste. Genevieve Limestone Formations and medium karst potential in areas underlain by the Salem and Warsaw Formations. The majority of the study area is underlain by these three formations. Areas underlain by the Borden Formation are indicated as non-karst to low karst potential. A few surface depressions and springs were observed during the field reconnaissance within the study areas, are proximate to the areas and are noted in the attached photographs. It should also be noted that past development in an area can mask the presence of karst features.

Regional dip of the area was reviewed based on structure contours drawn on the base of the St. Louis Limestone Formation on geologic mapping. Regional dip of the study areas was determined to trend toward the southeast ranging from nearly flat to as steep as about 20 to 30 feet per mile, or about 0.4 to 0.6 percent. Geotechnical reports reviewed indicate that the residual soils within the potential new corridors typically classify as moderate to high plasticity clay soils with USCS Classifications of CH and CL, with lesser instances of CL-ML, SC or ML. Geotechnical reports also indicate depths to bedrock will likely vary widely, similar to most areas underlain by soluble bedrock. Published mapping indicated at least one abandoned quarry to lie within the Bobtown quadrangle, however none were noted proximate to the study area during field reconnaissance.

3. Topography and Drainage

The study areas lie within the western Pennyrile or Mississippian Plateau physiographic region of Kentucky. Topographic relief throughout the project area ranges from a high of approximately 1180 feet in the western section of the southern study area to a low of approximately 1020 feet west of Science Hill near proposed alignment Number 1 in the northern study area. Generally, the topography of this area is described as a karst landscape, characterized by red clay soils, numerous sinkholes and depressions, gently rolling to rolling hills and small streams and creeks. The limestone bedrock in this area is highly soluble and prone to dissolution resulting in the development of sinkholes, caves, springs and other karst features. A spring was observed along West Norwood-Mt Zion Road (Lat/Long, 37.166728, -84.646837). No KY mapped sinkholes were observed on the available mapping, however in locations the typical bowl-shaped topography commonly associated with karst terrain was observed. Additionally, there were small detention ponds which could have been created by sinkhole infills (Lat/Long, 37.155047, -84.636637). Photographs of the above described features are included at the end of this report.

Surface runoff in the area is typically intercepted by surface depressions and sinkholes or small intermittent streams. The western portions of the study area

will tend to drain toward Big Clifty Creek while eastern portions of the study area may drain toward Pitman Creek to the east. In general, low-lying areas in karst terrain or sinkhole plains such as the study area, will tend to exhibit soft, silty and wet soils. These areas will also be more prone to sinkhole collapse during and following construction of any new roadway or structures.

Underground drainage is a function of surface and groundwater flows that are controlled by the nature of these rocks and the associated surface features. Slopes generally control the runoff from precipitation and stream drainage, with ridgelines forming drainage boundaries. Underground water in most watersheds and drainage basins tend to follow the lay of the land. Yet, in areas containing soluble limestone or karst regions, the underground drainage may differ from the boundary of its surface watershed; flowing through caves, cracks or faults in the rocks beneath surface ridges. This phenomenon is typically referred to as misbehaved karst drainage (Kentucky Division of Water).

4. Geotechnical Considerations

- Subgrade soils which lie within the study area are anticipated to have a design CBR value ranging from 2 to 3 based on review of previous roadway reports in the area. Chemical treatment, such as lime stabilization may be required to effectively stabilize road subgrades. In areas where rock is encountered during roadway excavations, it should be considered for use as a more affordable yet effective subgrade alternative.

- Wet areas could require stabilization for embankment construction. Likewise, subgrade soils under existing pavements could be very wet and might require stabilization if pavements are removed due to grade changes, etc. An addendum to past roadway reports in the area recommended granular embankment wrapped in Type IV Geotextile Fabric to stabilize low-lying areas prior to embankment construction for other roadways in the area.

- Any open sinkholes or solution cavities identified within the construction limits that are not utilized for drainage purposes should be filled and/ or capped in accordance with Section 215 of the current edition of the Standard Specifications for Road and Bridge Construction.

- Sinkholes were noted within the study area both during field reconnaissance and from review of geologic mapping. Any sinkholes utilized for drainage purposes for new roadway construction should incorporate adequate measures to minimize water infiltration into the subgrade and erosion control measures to minimize siltation of open sinkholes and adhere to KYTC Drainage policy.

- High plasticity clays may be encountered within the study area. High plasticity clays tend to shrink and swell with corresponding changes in moisture content. These areas will best be delineated after a thorough geotechnical investigation and subsequent lab testing. Treatment methods will vary dependent upon lateral and vertical extent of any high plasticity clays. Chemical treatment of subgrade soils such as lime or cement is one method to minimize the shrink/ swell potential of expansive clays.

- Any new sizable structures or widening of existing structures required for the project are likely to be designed for nonyielding foundations utilizing H-Piles or drilled shafts. Culverts may require either a yielding or nonyielding foundation based on similar projects in the area. Yielding foundations may require stabilization if soft soils are encountered as indicated in previous structure reports for the area. Specific site investigations will be required for any new structures or additions to existing structures once locations are known.

- Adequate drainage will be of primary concern with any new design or new construction in the area to minimize environmental impacts by surface runoff into the underlying karst network. Proper management of surface water will also lessen the occurrence of sinkhole dropouts during construction. Mitigation of surface runoff should be performed by silt checks, silt traps, sediment basins and lined ditches where appropriate. Siltation of sinkholes should be avoided, especially those to remain open after construction.

- Roadway embankments and cut slopes will likely be required for construction of any new roadway or widening or realignment of existing roadways. Based on prior experience with residual soils weathered from the geologic formations beneath the study area, embankments constructed at 2H:1V or flatter will likely provide an acceptable factor of safety for embankments less than 30 feet in height. Cut and fill heights for 2H:1V slopes will be less at structures due to a higher required safety factor of 1.6. Roadway embankments over approximately 30 feet may require flattening to as much as 3H:1V. Soil cuts in the residual soils can be problematic due to softening of the clays upon exposure in the cuts.

Soil cuts deeper than 15 to 20 feet may require slopes flatter than 2H:1V for slope stability. Based on review of the KYTC Geotechnical Manual, typical cut slope configurations for massive limestone of ½H:1V will likely be used. During design of cut slopes in bedrock, the presence of joints, fractures, solution features and crossbedding should be taken into consideration. **There is an existing slope failure near the intersection of US 27 and Norwood Road Connector**. If this destination is widened it may be necessary to repair this slope failure. Due to overgrowth it is impossible to accurately classify the failure type but we believe it is a shallow rotational failure.

- No active oil or gas wells were identified in the study area through review of online mapping of the study area, however it is possible that some exist and are not indicated on available mapping. Any oil or gas wells identified prior to or during construction should be closed in accordance with Section 708 of the current edition of the Standard Specifications for Road and Bridge Construction. Locations were derived from the oil and gas well database on the Kentucky Geological Survey database online.

- Several domestic water wells and monitoring wells were indicated to lie near and within the study area upon review of online mapping. Any water wells, cisterns, manholes or catch basins not incorporated into any new design and identified prior to or during construction should be closed in accordance with Section 708 of the current edition of the Standard Specifications for Road and Bridge Construction.

- A list of previously completed Geotechnical Investigations proximate to the study area is included below. These reports were reviewed in consideration of generation of this report. These reports can be accessed through the KYTC Geotechnical Report Database.

List of Projects & Reports

Project ID	Project Type	Route	Project Description
R-061-2001	Roadway	US 27	US 27 Widening (Somerset-Stanford Rd) Sta. 999+74.29 to 1249+40.00
S-055-1985	Culvert	KY 635	KY 635-Mt. Zion Road Culvert at Station 20+10
S-028-2004	Bridge	KY 1247	KY 1247 over Somerset Northern Bypass (I-66)
S-164-2002	Bridge	US 27	US 27 over Norfolk Southern Railroad
S-165-2002	Culvert	US 27	US 27 Box Culvert Extension @ Sta. 1238+89
R-001-2002	Roadway	US 27	US 27 Widening from KY 452 to the Lincoln County Line Station 703+50 to 937+00

List of Projects & Reports (Continued)

S-047-2004	Culvert	US 27	US 27 Widening and Reconstruction Culvert at Mainline Sta. 452+48 Single 10'x7' RCBC Outlet Extension
R-013-2002	Roadway	US 27	US 27 Widening from Norwood Road to KY 452 Station 408+00 to 638+50
RA-005-2007	Roadway Addendum	US 27	US 27 Widening Geotechnical Engineering Roadway Addendum

5. Summary

A summary of the geotechnical report for US 27 (R-013-2002) and the Roadway Addendum (RA-005-2007) are as follows. Soil cut slopes ranged from 2H:1V to 3H:1V. All embankments were constructed at 2H:1V, however this embankment geometry may be too steep, note the embankment failure observed during the field review. Local ponds were drained and soft/saturated material was removed prior to stabilizing the areas with stone and placing engineered fill. There were ponds noted in the field which may require similar effort to stabilize and fill. Non-durable shale was encountered and cannot be placed in the subgrade. This material was placed in accordance to Section 206 of the current Kentucky Department of Highways Standard Specifications for Road and Bridge Construction. Sinkholes were noted in the report and were recommended to be filled or capped in accordance to Section 215 of the current Edition of the Kentucky Department of Highways Standard Specifications for Road and Bridge Construction. The project was designed for a soil subgrade utilizing a CBR value of 2. Lime modification was suggested as a soil stabilization method.

Karst terrain in the study area will be likely be the most detrimental factor to any new construction in the area. The Ste. Genevieve Limestone Member of the Monteagle Limestone, the St. Louis Limestone and the Salem and Warsaw Limestones Formations are typically the uppermost bedded formations which underlie each of the proposed study areas. Each of these formations exhibit significant potential for karst impacts

during construction, as indicated on karst potential mapping. A karst potential map of the study area is included at the conclusion of this report. Soft, silty soils also may be encountered in low lying areas, especially in surface depressions.

Much of the study area, especially the northern section is highly developed which can mask the existence of karst features such as sinkholes and surface depressions. At the time of the field review, much of the southern area was covered in row crops as well as partially wooded which made it difficult to identify individual sinkholes. While any new construction within the study area will not likely be at any greater risk to ground subsidence or other impact from karst than existing roadways and structures which lie within the study area, a site specific geotechnical investigation will provide critical information with regard to karst potential, problematic soils and other pertinent information for design.

There is an existing slope failure near the intersection of US 27 and Norwood Road Connector. If this roadway is widened it may be necessary to repair this slope failure. Due to overgrowth, it is impossible to accurately classify the failure type but we believe it is a shallow rotational failure.

An existing railroad travels parallel to SR 1247 on the western side of the roadway. In some places the railroad embankment toe and the edge of pavement are as close as 50 feet. Above ground utility lines travel on the other side of SR 1247 making it difficult to widen this section of roadway.

Table 2: Summary of Photographs

Photograph Number	Latitude	Longitude
1	37.145451	-84.633239
2	37.145451	-84.633239

3	37.1416130	-84.636811
4	37.1416130	-84.636811
5	37.155047	-84.636637
6	37.155047	-84.636637
7	37.155047	-84.636637
8	37.169756	-84.627731
9	37.179218	-84.625745
10	37.166728	-84.646837
11	37.166680	-84.639278
12	37.143121	-84.634188
13	37.143121	-84.634188

Site Photographs

Photograph 1 (Slope Failure)

Photograph 2 (Slope Failure)

Photograph 3 (Spring)

Photograph 4 (Spring)

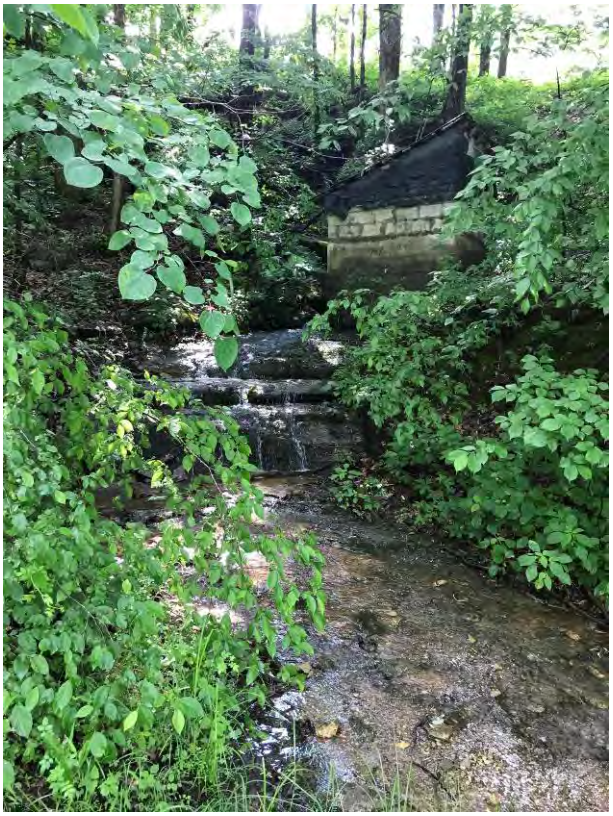
Photograph 5 (Karst Topography)

Photograph 6 (Karst Pond)

Photograph 7 (Karst Pond)

Photograph 8 (Karst Topography)

Photograph 9 (Karst Topography)



Photograph 10 (Spring)

Photograph 11 (Railroad)

Photograph 12 (Existing Terrain)

Photograph 13 (Existing Terrain)

COUNTY OF	ITEM NO.	SHEET NO.
PULASKI	8-9010.00	

Molen St. - Ironwood Dr. Zion Rd Connector

LEGEND

Msl	St. Louis Limestone (Upper Mississippian-Upper Mississippian)	Mmg	Ste. Genevieve Limestone Member, Monteagle Limestone (Upper Mississippian-Upper Mississippian)		
Mmk	Kidder Limestone Member, Monteagle Limestone (Upper Mississippian-Upper Mississippian)	Mbh	Borden Formation (Lower Mississippian-Lower Mississippian)	Msw	Salem and Warsaw Limestones (Upper Mississippian-Upper Mississippian)
Qal	Alluvium (Quaternary-Quaternary)	Mbm	Muldraugh Member, Borden Formation (Lower Mississippian-Lower Mississippian)		

SCALE: 1" = 1000' HORIZONTAL
1" = 1000' VERTICAL

SCIENCE HILL OVERVIEW
GEOLOGIC MAP

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DATE PLOTTED: March 27, 2018
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COUNTY OF	ITEM NO.	SHEET NO.
PULASKI	8-9010.00	

Mojen St - Norwood Mt Zion Rd Connector

NORWOOD RD

WEST LANGDON RD

MSW

MSN

MMO

1 2 3 3a 4 5 6 7 8 9 10 11

LEGEND

KARST POTENTIAL

- VERY HIGH
- HIGH

SCALE: 1" = 500' HORIZONTAL
1" = 500' VERTICAL

SCIENCE HILL OVERVIEW
KARST POTENTIAL MAP

FILE NAME: T:\GEOTECH SUPPORT\KYTC\218-XXX SCIENCE HILL OVERVIEW\REPORT DRAWINGS\SCINCE HILL OV KARST.DGN
USER: jchildress
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COUNTY OF	ITEM NO.	SHEET NO.
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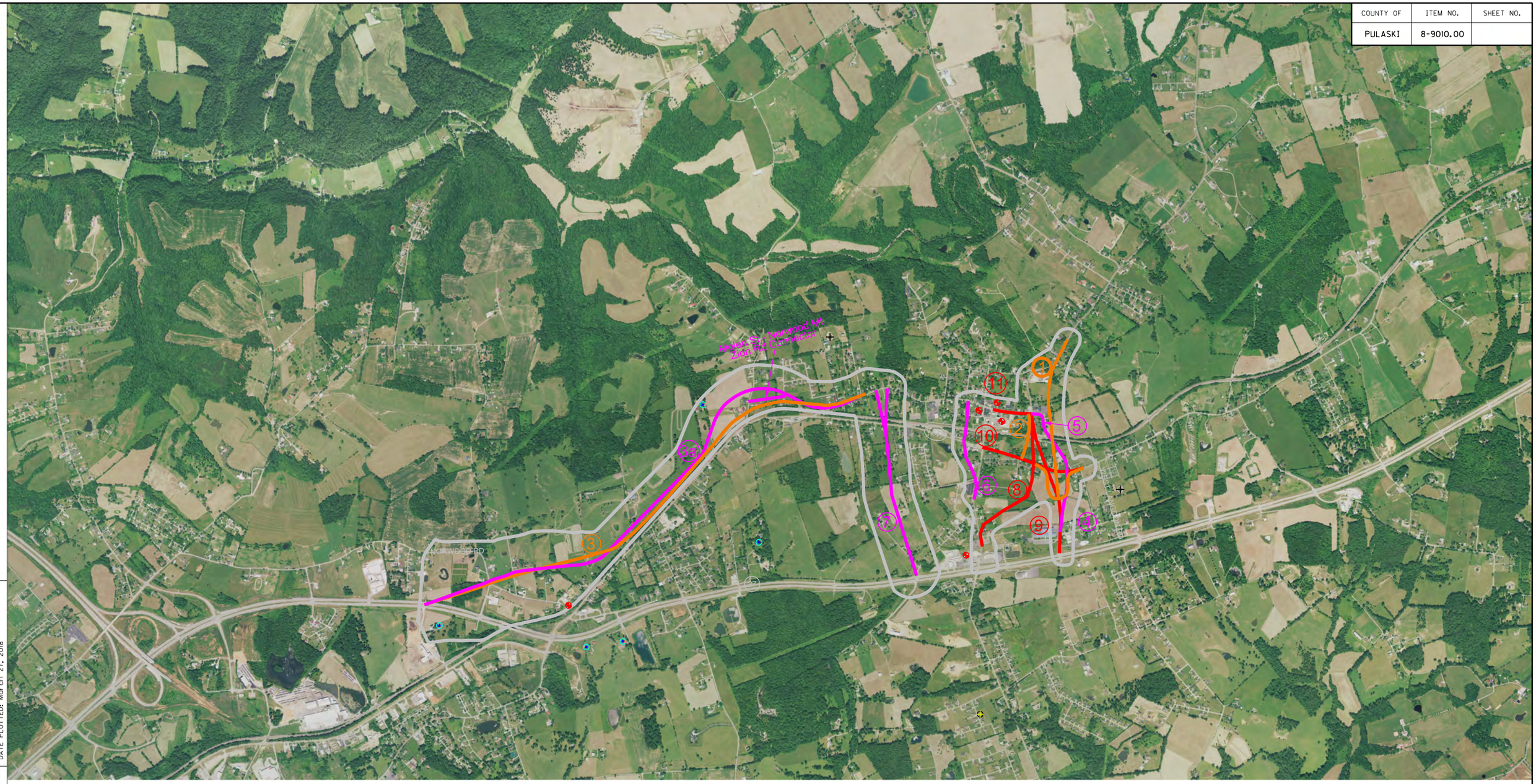

LEGEND

WATER WELLS & SPRINGS

- DOMESTIC
- MONITORING
- \+ OTHER

OIL & GAS

- DRY AND ABANDONED WELL

SCALE: 1" = 1000' HORIZONTAL
1" = 1000' VERTICAL

SCIENCE HILL OVERVIEW
WELL LOCATION MAP

FILE NAME: T:\GEOTECH SUPPORT\KTC\218-XXX SCIENCE HILL OVERVIEW\REPORT DRAWINGS\SCINCE HILL OV WELLS.DGN
USER: jchildress
DATE PLOTTED: March 27, 2018
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