APPENDIX E – GEOTECHNICAL OVERVIEW

M E M O R A N D U M **(P-002-2018) Consultant**

TO: **John Moore, PE**
Director
Division of Planning

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

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

DATE: **March 22, 2018**

Subject: **Anderson / Franklin Counties**
KY 151 Corridor Scoping Study
MARS No. 9351501P
Item No. 5-806.00
Preliminary Geotechnical Overview Report

The preliminary geotechnical overview report for the subject project has been completed by Stantec Consulting Services, Inc. This report was prepared as part of the KY 151 Corridor Scoping Study from US 127 in Anderson County to I-64 in Franklin County. This was performed under Statewide Planning Contract. The report will be made available on ProjectWise and the KYTC Geotechnical Database.

cc: **Division of Highway Design**
Division of Planning
TEBM for Project Development (District)
Stantec Consulting Services, Inc.

Report of Geotechnical Overview

KY 151
Anderson and Franklin Counties, Kentucky
Item No. 5-806.00
P-002-2018

Prepared by:
Stantec Consulting Services Inc.

March 21, 2018

Stantec Consulting Services Inc.
3052 Beaumont Centre Circle, Lexington KY 40513-1703

March 21, 2018
File: rpt_003_let_178556010

Attention: Mr. Michael Carpenter, PE
Kentucky Department of Highways
Division of Structural Design
Geotechnical Branch
1236 Wilkinson Boulevard
Frankfort, Kentucky 40601

Reference: Geotechnical Overview
KY 151
Anderson and Franklin Counties, Kentucky
P-002-2018

Dear Mr. Carpenter,

Enclosed is the geotechnical overview for the proposed Planning Study overview for the referenced project. The geotechnical overview is based upon research of available published data and preliminary data for the study area. The scope of work performed and results of the overview are presented in the accompanying report.

Regards,

STANTEC CONSULTING SERVICES INC.

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/rws

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1.0 PROJECT DESCRIPTION

The Kentucky Transportation Cabinet (KYTC) is proposing to widen and reconstruct a portion of KY 151 in Anderson and Franklin Counties, Kentucky. The corridor will begin near the US 127/KY 151 intersection near the community of Alton and extend northwest and end at the intersection of KY 151/I-64 near Frankfort, Kentucky. The project corridor generally follows the existing alignment of KY 151 along the northern portion of the study area and is approximately 0.5 mile wide. Near the intersection of KY 512 and KY 151 the corridor widens to approximately 2.75 miles wide. This project will improve safety by: addressing geometric deficiencies in the roadway, and by adjusting the alignment, improve sight distances and improve roadside design. This overview will be utilized to identify geotechnical considerations for the study area. The project location and corridor are presented on the drawing provided in Appendix A.

2.0 SCOPE OF WORK

The scope of work for this study consists of performing a geotechnical overview for the proposed corridor based upon research of available published data and Stantec's experience with highway design and construction within the region. General geotechnical and geologic characteristics of the study area have been identified and are discussed in this report. Stantec personnel, using a variety of sources, performed a literature search that included reviews of the following sources:

- Available topographic and geologic mapping of the project area published by the United States Geological Survey (USGS) and the Kentucky Geological Survey (KGS);
- The Geologic Map of Kentucky, published by the USGS and the KGS (1988);
- Kentucky Geologic Map Information Service http://kgs.uky.edu/kgsmap/kgsgeoserver/viewer.asp;
- KYTC Geotechnical Data, published by the KGS and KYTC, http://kgs.uky.edu/kgsmap/kytcLinks.asp;
- KYTC Projects Nearby (Identified by KYTC Report Number):

Report Number	County	Route	Item Number
R-017-1977	Anderson	US 127	07-0108.00
R-002-1978	Anderson	KY 151	07.0107.00
R-013-2004	Franklin	KY 151	05.0963.00
S-038-1978	Anderson	KY 151	07-0108.00
S-033-2004	Franklin	KY 151	05-0963.00
S-041-2007	Franklin	I-64	05-2035.40
S-101-2007	Franklin	I-64	05-2035.40
S-156-2007	Franklin	I-64	05-2035.40

- United States Department of Agriculture, Soil Conservation Service (SCS) Soil Survey Publications for affected counties;
- Physiographic Regions, published by KGS, http://kgs.uky.edu/kgsweb.

3.0 PHYSIOGRAPHIC AND STRATIGRAPHIC SETTING

3.1 TOPOGRAPHY AND DRAINAGE

The project corridor is located in the Outer Bluegrass and Inner Bluegrass physiographic regions of Kentucky. Subsurface conditions are characteristic of Ordovician age bedrock.

Surface drainage is directed towards named and unnamed tributaries of Benson Creek along the northern portion. The surface drainage along the remaining portion on the corridor is directed toward named and unnamed tributaries of Hammond Creek.

3.2 STRATIGRAPHY

Available geologic mapping indicates that the majority of the project corridor is underlain by the Clays Ferry Formation and Lexington Limestone. The Clays Ferry Formation underlies the bulk of the alignment from approximately KY 512 north. The remaining portion of the project is underlain by the Tanglewood Limestone Member. The geologic mapping of the area is presented in Appendix B.

3.3 FAULTING IN THE AREA

A fault is depicted near the project. The fault is located just outside the study area about 0.25 mile south of the intersection of US 127 and KY 151. The fault is not expected to have a detrimental effect on the project. This area is depicted on the geologic mapping in Appendix B.

3.4 SOILS AND UNCONSOLIDATED MATERIALS

Residual soils are the predominate soil type found within this area. Soil descriptions contained herein are based upon SCS soil surveys and on Stantec's knowledge of the study area. Soils within the area of the roadway have derived in-place from a weathering process of the parent shale, siltstone, and limestone rock formations. These soils consist of plastic clays and sandy silty clays.

Alluvial deposits consisting of tributary stream alluvium are mapped within the flood plain of the major drainage courses. These deposits consist of clays, sands and gravels with varying thicknesses up to approximately 15 feet.

3.5 REGIONAL SEISMICITY

Seismicity within the Commonwealth of Kentucky varies widely depending on location. The western portion of the state is dominated by the New Madrid and Wabash Valley source zones. In general, these zones are fairly active with many documented historical seismic events.

Central and eastern portions of the state experience less frequent earthquakes because the source zones are quite distant from these areas.

The seismic hazard at a bridge site shall be characterized by the acceleration response spectrum for the site and the site factors for the relevant site class. A comprehensive geotechnical investigation will be required to determine the site class. However, based on anticipated depths to bedrock at/near stream locations, Site Class B/C can be expected. The 2017 AASHTO LRFD Bridge Design specifications provide guidelines for selecting a seismic performance category and a soil profile type for bridge sites. This information establishes the elastic seismic response coefficient and spectrum for use in further structural design and analyses. Refer to Section 3.10.2 of the AASHTO guidelines for specifications. The corridor alignment will be likely affected by seismic activity from the New Madrid and Wabash Valley source zones and "local" seismic events.

4.0 GEOTECHNICAL CONSIDERATIONS

4.1 GENERAL

Based on the project corridor and Stantec's roadway experience, it is anticipated that the new alignment/reconstruction will generally follow the existing alignment of KY 151. Therefore, it is anticipated that this portion of the alignment will consist more of widening and not have many new cuts or fills required along the existing highway. For improved safety within portions where the existing roadway may be widened, it appears that several intersections and structures will need to be reworked/realigned along the reconstructed roadway. The revisions to the interchanges will include: providing necessary clear zones, addressing geometric deficiencies in the roadway and adjusting the alignment. As the interchanges are reworked, the Project Team should keep in mind the geotechnical considerations that are included in Section 4 as they pertain to existing utilities, cut slopes, embankments and widened structures.

4.2 CUT SLOPE CONSIDERATIONS

Cut slope configurations in rock are generally controlled by bedrock lithology, bedrock quality, results of Slake Durability Index (SDI) tests in shales and siltstones, and by the presence of any fractures and/or joints. In general, if joint/fracture angles are high (as measured from horizontal), steeper cut slopes can be constructed, and an acceptable level of stability can be maintained. If discontinuities exhibit low angles and steep cut slopes are utilized, large block failures may occur along the open cut face.

Slope configurations for rock cuts in durable or Type I non-durable rock generally be 1H:2V pre-split slopes on approximate 30-foot intervals of vertical height with 18 to 20-foot intermediate benches. These types of cuts could be anticipated within this alignment. Cuts in nondurable shales and shallow cuts in bedrock may be best handled on 2H:1V slopes. Slope configurations along the corridor will be dependent on many factors, including but not limited to, roadway grade, geology and bedrock durability which will be evaluated during a geotechnical exploration.

Typical cuts within the existing corridor are shown in photographs on the geologic map presented in Appendix B.

Slope configurations for soil cuts are generally constructed on a 2H:1V or flatter.

4.3 EMBANKMENT CONSIDERATIONS

The anticipated excavated rock materials should be suitable for use in project embankments. Select rock types for use as rock embankment, rock road bed, channel lining, etc., would be durable limestone. Foundation soils are likely to be plastic clays and silty sands.

Embankments constructed of durable rock materials generally exhibit adequate stability at 2H:1V slope configurations. However, flatter embankment slopes may be required for tall embankments constructed from nondurable shales or in areas where embankments are founded on alluvial materials. Alluvial soils can be expected along major drainage courses. The existing KY 151 alignment is located adjacent/near South Benson Creek north of the Anderson/Franklin county line. In areas such as this, granular embankment material and/or retaining walls may be necessary depending on the proposed alignment.

Low shear strengths and high settlement potentials are generally associated with alluvial deposits. Consolidation settlements and short-term embankment stability problems are common for roadway embankments in alluvial floodplains, and controlled embankment construction rates and/or flatter embankment side slopes and or partial rock embankment should be anticipated for these areas.

4.4 STRUCTURES

It is anticipated that mainline bridges will need to be widened and or replaced to meet horizontal clearances with the new highway. At this time, it is unknown as to whether the proposed roadway would require new and/or widened substructure elements. Based on Stantec's knowledge of the area, it can be anticipated that the majority of the bridges within the project corridor are likely supported by rock bearing foundation systems, which could be a spread footing or steel H-piles driven to bedrock. Culverts along the proposed alignment may be replaced or widened. It can be anticipated the culverts within the project corridor are likely supported by either a non-yielding or yielding foundation system depending upon the location along the proposed alignment. A detailed geotechnical investigation will be required to determine the foundation support systems. Typical structures that are along the existing alignment are shown in Appendix A.

4.5 SATURATED, SOFT OR UNSTABLE AREAS

Based on topographic mapping and literature reviewed, the alignment may be near ponds, drainage swales or stream channels. Any saturated, soft or unstable areas encountered within embankment foundation limits should be drained and stabilized utilizing non-erodible granular embankment or durable limestone from roadway excavation. The rock platform shall be underlain with Geotextile fabric. Ponds should be drained, and any soft or saturated material should be removed and/or stabilized. Additional rock may be required to stabilize soft soils and to maintain positive drainage. Based on observations, ponds exist within the project corridor. Depending on the project alignment, these ponds will require treatment if they are located within the construction limits.

4.6 COAL SEAMS/MINING

Based on the available geologic mapping, there are no coal seams mapped in the vicinity of the project alignment.

4.7 GAS AND OIL WELLS

Based on the available geologic mapping, there are no oil and gas wells in the vicinity on the project corridor.

4.8 WATER WELLS AND SPRINGS

Based on available information, a few water wells and springs are noted within/near the proposed study area. These locations should be inventoried and verify their locations. If impacted during construction, special construction will be required to close the wells, and spring boxes and/or granular material may be required in the vicinity of springs.

4.9 MUNICIPAL SOLID WASTE LANDFILL

The Benson Valley Area Landfill is an active landfill located on the west side of KY 151 and south of I-64. As part of the siting requirements for a solid waste landfill, the minimum buffer zone would be 250 feet from any property line. Any encroachment on the buffer zone could limit future expansion of the landfill. Obtaining additional right-of -way in this area could be difficult. Construction over and through existing landfilled areas would be costly when compared to other areas along the corridor.

As part of the landfill permitting process, groundwater monitoring wells are required at the facility. Results from the groundwater monitoring program should be evaluated for constituents which could affect construction in the vicinity of the landfill.

4.10 KARST CONDITIONS

The potential for karst conditions exist within the study area. The Tanglewood Limestone Member of the Lexington Limestone Formation exhibits the highest potential for karst conditions in the study 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 are noted on the mapping presented in Appendix C within and near the study area. 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 situation of open sinkholes.

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 lesson 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. Situation of sinkholes should be avoided, especially those to remain open after construction.

5.0 CONCLUSIONS

5.1. The purpose of this overview was to provide a general summary of the bedrock, soil and geomorphic features likely to be encountered within the proposed alignment; and to identify geotechnical features that may have an adverse impact on the project alignment.

5.2. Geotechnical drilling will be needed for replacement or widened culverts, bridges, retaining walls and roadway cuts and fills. It is anticipated that conventional spread footing and/or pile foundation systems can be utilized for these structures.

5.3. Because a portion of this project may be a widening project, information on pavement structure should be obtained to assist the team on pavement structure and California Bearing Ratio (CBR) information. It should be anticipated that chemically or mechanically stabilized roadbed will be required because CBR values are expected to be 6 or less.

5.4. Once alignment and sections are identified, then open faced logging of exposed cuts and/or drilling should be performed. Depending on the project alignment and grade, additional geotechnical information may be desired in the vicinity of the fault systems. Sampling of foundation soils should be performed for embankment situations of sufficient height to evaluate stability.

5.5 Any potential widening in the area of the existing landfill should stay within the existing right-of-way. This may require the use of retaining walls or steepened slopes. Construction within the landfill facility will increase the cost significantly.

5.6. Water wells, monitoring wells and springs exist along/near the proposed corridor. The design team should inventory and survey active wells and springs. In addition, results from groundwater monitoring program at the landfill site should be reviewed to assess any potential effects on construction.

5.7 The potential for karst conditions exists within the project study area. Sinkholes or solution cavities identified within the construction limits that are not accepting drainage should be filled and/or capped in accordance with Section 215 of the current edition of the Standard Specifications for Road and Bridge Construction.

Any sinkholes utilized for drainage purposes for the new roadway construction should incorporate adequate measures to minimize water infiltration into the subgrade and erosion control measures to minimize situation of open sinkholes. The Design Team should inventory the sinkholes and other karst features, such as caves, along the proposed alignment. The inventory should note whether or not the sinkhole accepts drainage.

5.8. The information presented in this overview should be reviewed in the general nature in which it was intended. A thorough geotechnical exploration of the proposed alignment and grade will be required to properly anticipate and plan for special requirements necessary for the design and construction of the proposed alignment.

APPENDIX A
USGS TOPOGRAPHIC MAP

Stantec

Legend

- Location of Photograph and Direction Taken
- Study Area

0 0.5 1 1.5 2 Miles

1:31,680 (At original document size of 22x34)

Notes

1. Coordinate System: NAD 1983 StatePlane Kentucky FIPS 1600 Feet
2. Basemap Sources: ESRI World Topographic Map and ESRI World Street Map

Project Location

Anderson and Franklin Counties, Kentucky

178565010

Prepared by WSW on 2018-03-09
Technical Review by JPA on 2018-03-09

Client/Project

KY-151 Scoping Study
Anderson and Franklin Counties

Figure No.

1

Title

KY-151 Scoping Study
Topographic Map

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APPENDIX B
USGS GEOLOGIC MAP

Stantec

Legend

- Location of Photograph and Direction Taken
- Spring
- Water Well
- Groundwater Well
- Coal Bed Methane Gas Well
- Dry and Abandoned Well
- Gas Well
- Location
- Oil and Gas Well
- Oil Well
- Service or Secondary Recovery Well
- Other Well
- Fault
- Study Area
- Sinkhole
- Alluvium (Qal)
- Artificial Fill (af)
- Brannon Mbr, Lexington Ls (Olb)
- Calloway Creek Ls (Occ)
- Clays Ferry Fm (Ocf)
- Drakes Fm (Od)
- High Level Fluvial Deposits (QTf)
- Lexington, lower part GRIR to CDVL (Ollr)
- Lexington, upper part excludes TLGD (Olu)
- Oregon and Camp Nelson Undif (Ooc)
- Tanglewood Ls Mbr, Lexington Ls (Olt)
- Tongue of the Tanglewood (Olt1; Olt2; Olt3; Olt4)
- Tyrone Ls, High Bridge Gp (Ot)

0 0.5 1 1.5 2 Miles

1:31,680 (At original document size of 22x34)

Notes

1. Coordinate System: NAD 1983 StatePlane Kentucky FIPS 1600 Feet
2. Basemap Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), Mapmyindia, © OpenStreetMap contributors, and the GIS User Community

Project Location

Anderson and Franklin Counties, Kentucky

178565010

Prepared by WSW on 2018-03-09
Technical Review by JPA on 2018-03-09

Client/Project

KY-151 Scoping Study
Anderson and Franklin Counties

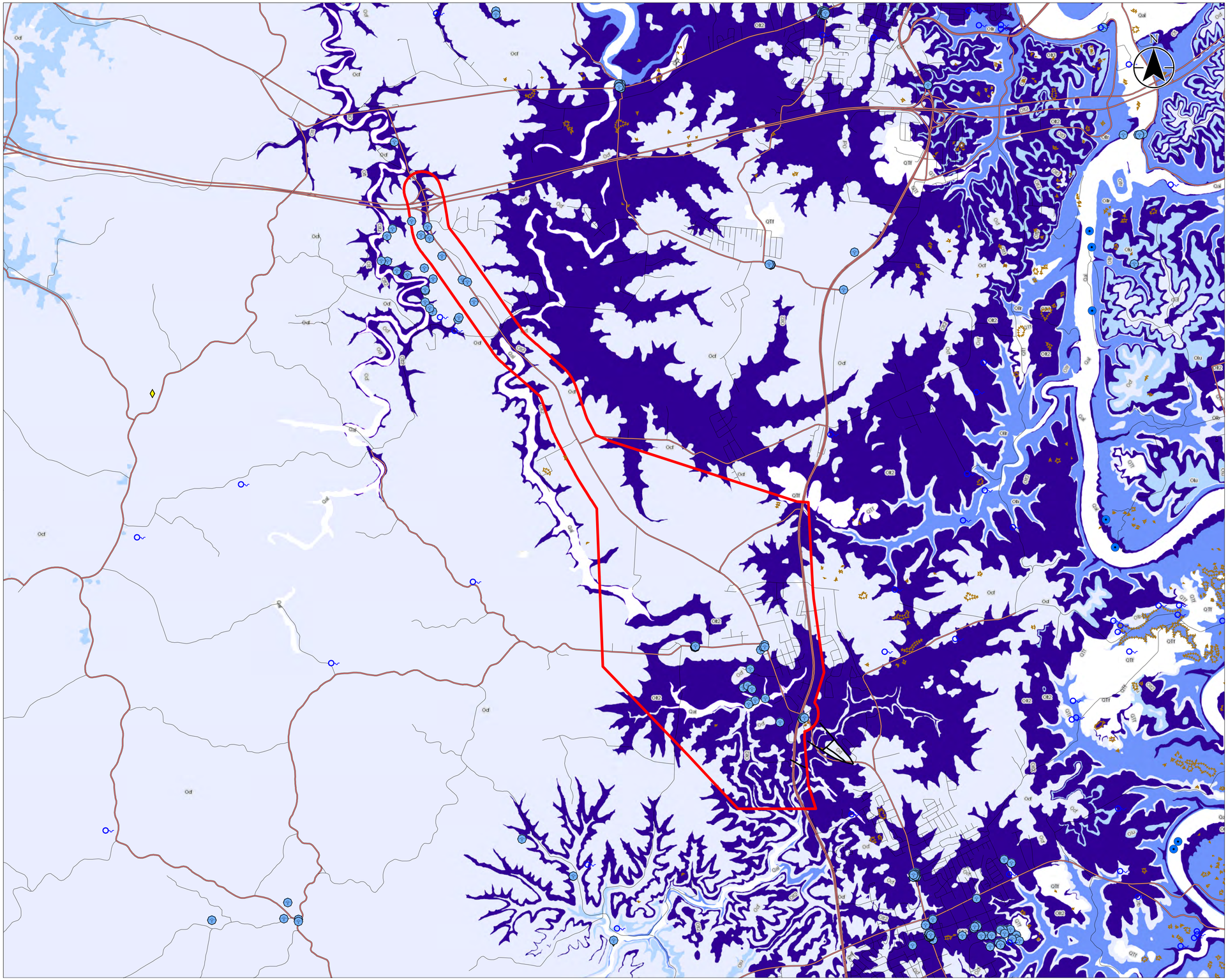
Figure No.

1

Title

KY-151 Scoping Study
Geologic Map

APPENDIX C
KARST POTENTIAL



Stantec

Legend

- Spring
- Water Well
- Groundwater Well
- Coal Bed Methane Gas Well
- Dry and Abandoned Well
- Gas Well
- Location
- Oil and Gas Well
- Oil Well
- Service or Secondary Recovery Well
- Other Well
- Fault
- Study Area
- Sinkhole

24K Karst Potential

- Very High
- High
- Medium
- Low
- non-karst

0 0.5 1 1.5 2 Miles

1:31,680 (At original document size of 22x34)

Notes

1. Coordinate System: NAD 1983 StatePlane Kentucky FIPS 1600 Feet
2. Basemap Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community
   Kentucky Geological Survey
3. Karst Potential: This layer contains polygons representing the 1:24,000-scale geologic formations, styled by karst potential. Karst potential was determined by KGS staff for each formation by a weighted matrix of lithologic characteristics detrmined for each unit: grain size, bedding thickness, %CaCO3, and % insoluble rock and minerals. The last (% insoluble rock and minerals) being weighted the most. Please note, this is unpublished and still a work in-progress. Polygons digitized from the 1:24,000 Geologic Map Series maps (original maps published by Kentucky Geological Survey - U.S. Geological Survey from 1960 to 1980).

Project Location

Anderson and Franklin Counties, Kentucky

178565010

Prepared by WSW on 2018-03-16
Technical Review by JPA on 2018-03-16

Client/Project

KY-151 Scoping Study
Anderson and Franklin Counties

Figure No.

1

Title

KY-151 Scoping Study
Geologic Map - Karst Potential

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