APPENDIX F – GEOTECHNICAL OVERVIEW

Report of Geotechnical Overview

KY 86
Breckenridge and Hardin
Counties, Kentucky
Item No.4-8901.00
P-001-2017

Prepared by:
Stantec Consulting Services Inc.

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1.0 PROJECT DESCRIPTION

The Kentucky Transportation Cabinet (KYTC) is proposing to widen and reconstruct a portion of KY 86 in Breckinridge and Hardin Counties, Kentucky. The reconstruction will generally utilize the existing corridor. The corridor will begin near the US 60/KY 86 intersection (MP 15.96) near the community of Hensley and extend east and end at the intersection of KY 86/US 62 (MP 16.15) near Cecilia, Kentucky. The project corridor generally follows the existing alignment of KY 86 and is approximately 2000 feet 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 is 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):
    - R-011-1984
    - R-029-1987
    - R-012-2001
    - R-011-1984
    - S-017-1988
    - S-018-1988
    - S-065-1991
    - S-066-1991
- 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 Dripping Springs Escarpment and Mississippian Plateaus physiographic regions of Kentucky. Subsurface conditions are characteristic of Mississippian age bedrock. Also, there are oil and gas wells in the vicinity of the corridor.

Surface drainage is directed towards named and unnamed tributaries of Sinking Creek along the western portion of the alignment. The surface drainage along the remaining portion on the corridor is directed toward named and unnamed tributaries of Rough River.

3.2 STRATIGRAPHY

Available geologic mapping indicates that beginning half of the project corridor (near the Pole Bridge Fault), is underlain by the Big Clifty Sandstone and Beech Creek Limestone of the Golconda Formation, Reelsville Limestone, Sample Sandstone, Beaver Bend Limestone and Mooretown Formation. The Paoli Limestone and Ste. Genevieve Limestone primarily underlie the remaining portion of the alignment which is more prone to karst activity. Photograph 8 in Appendix B depicts a sinkhole area near the existing roadway alignment.

Structure contours presented on the various USGS geologic maps indicates that the bedrock to have a regional dip towards the west- southwest. The geologic mapping of the area is presented in Appendix B.

3.3 FAULTING IN THE AREA

Faults are depicted along/near the project. The Locust Hill Fault and the Cave Spring Fault intersects the project alignment near the beginning of the project ranging approximately one-half to 1.5 miles south east of the community of Hensley. The Mount Olive and Pole Bridge Faults are mapped approximately 2 miles southeast of the Breckenridge-Hardin County Line. Additional geotechnical information may be needed in these areas, however they are not expected to have a detrimental effect on the project. These areas are 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, sandstone 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 20 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 or D can be expected. The 2014 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; however, to determine the acceleration response spectrum and the site factors, a geotechnical exploration will be required.

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 86. 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 range from 1H:4V to 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 with rock cut slopes of 1H:2V being likely most common. Cuts in nondurable shales and shallow cuts in bedrock may be best handled on 2H:1V slopes. With the faults in the area, the cuts slopes can be affected not only by the fault itself but the orientation of the roadway alignment relative to the fault.

Typical cuts along the existing KY 86 alignment are shown in Photograph Numbers 1 and 2 on the geologic map presented in Appendix B. Photograph Number 2 shows a cut slope in an area of faulting. Based on visual observations, the bedding dips at an angle between 45 and 30 degrees.

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 sandstone and limestone. Foundation soils are likely to be plastic clays and sandy silty.

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.

Photograph Number 3 shown on the topographic mapping in Appendix A, shows a dip in the guardrail which may be a sign of slope instability.

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 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 system. Typical structures that are along the existing alignment are shown in Appendix A, Photograph Numbers 4, 7, 9, 10 and 11.

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. The coarse aggregate shall be underlain with Geotextile fabric. Ponds should be drained and any soft or saturated material should be removed and/or stabilized. For stabilization purposes, a sufficient thickness of non-erodible granular embankment should be placed over all soft / saturated foundation areas. 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.

Also, standing water was observed in low lying areas. Provisions for stabilizing such areas should be included as part of the project.

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

There are several oil and gas wells in the vicinity on the project corridor. Based on the geologic mapping, most of the holes were dry or did not show significant shows of oil or gas. Limited wells of commercial use should be expected. Recommendations are being provided in Section 5 to inventory the wells and verify what is active and what has been abandoned.

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 and retaining walls. It is anticipated that conventional spread footing and/or pile foundation systems can be utilized for these structures.

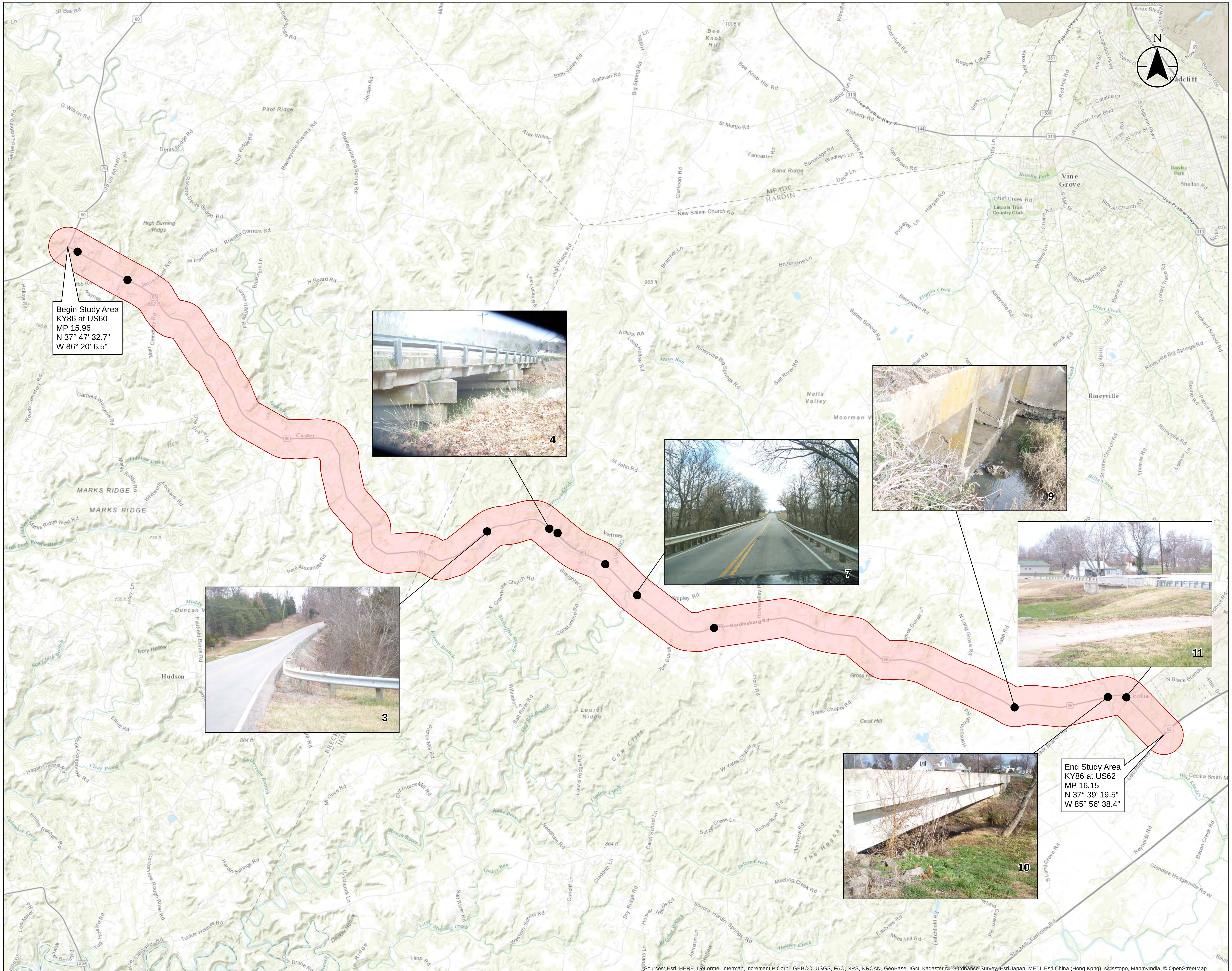
5.3. Because a portion of this project may be a widening project, information on pavement structure should be obtained to assist the team on pavement structure and California Bearing Ratio (CBR) information. It should be anticipated that chemically or mechanically stabilized roadbed will be required 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. Several oil and gas wells have been drilled near/along the proposed corridor. Many have reportedly been abandoned. The Design Team should inventory and survey active wells. Additional costs could be incurred if the selected alignment disturbs a well site.

5.6. 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



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Legend

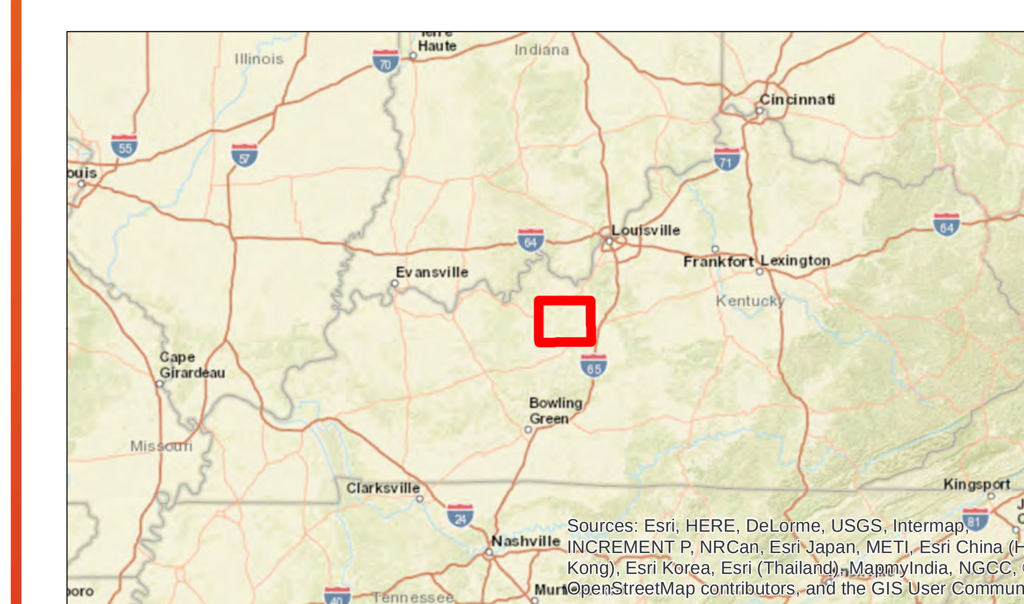
Study Area

0 9,000 18,000 Feet

1:60,000 (At original document size of 22x34)

Notes

1. Coordinate System: NAD 1983 StatePlane Kentucky FIPS 1600 Feet



Project Location

Hardin and Breckinridge County

178556010

Prepared by PJV on 2016-12-19

Technical Review by DB on 2016-12-19

Client/Project

KY-86 Scoping Study
Hardin and Breckinridge County
KYTC Item No. 4-8901.00

Figure No.

1

Title

KY-86 Scoping Study P-001-2017
Hardin and Breckinridge County

APPENIDX B
USGS GEOLOGIC MAP

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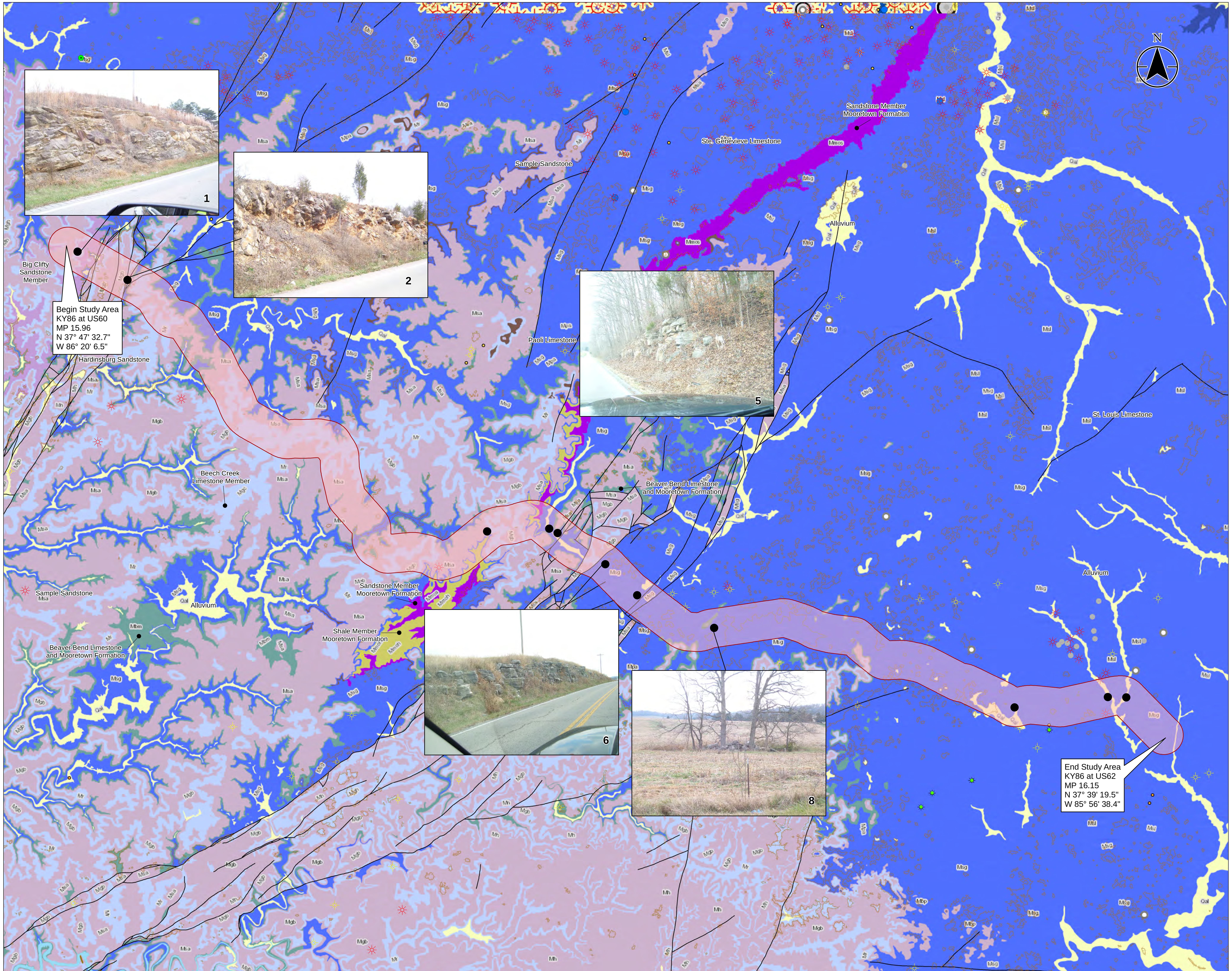
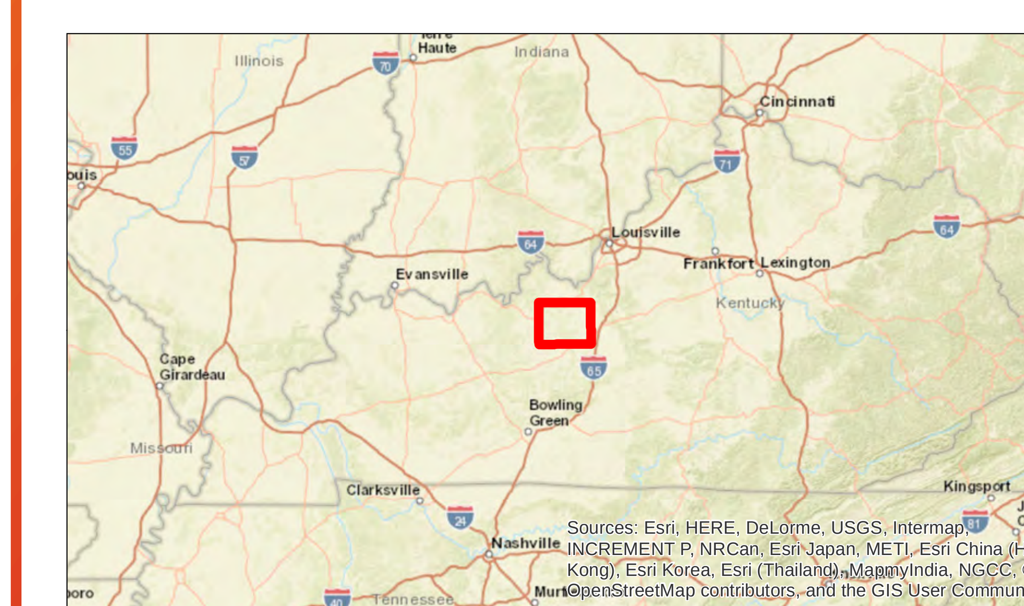


Legend

- Study Area
- Sinkholes
- Faults
- Gravel
- Gray Shale
- Limestone and Minor Shale
- Limestone and Shale
- Limestone, Fine-Grained
- Mixed Sediments
- Quartzose Sandstone
- Sandstone and Minor Shale
- Shale and Minor Dolomite
- Shale and Sandstone
- Coal Bed Methane Gas Well
- Dry and Abandoned Well
- Gas Well
- Location
- MSC
- Oil and Gas Well
- Oil Well
- Service or Secondary Recovery Well

0 9,000 18,000
Feet
1:60,000 (At original document size of 22x34)

Notes
1. Coordinate System: NAD 1983 StatePlane Kentucky FIPS 1600 Feet



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