REPORT OF GEOTECHNICAL OVERVIEW

KY 32 ALTERNATIVES STUDY - FROM KY 504 IN ELLIOTVILLE TO KY 7 NEAR SANDY HOOK IN ROWAN AND ELLIOTT COUNTIES

KYTC ITEM NO. 9-192.00

ENGINEERS
PLANNERS
ECONOMISTS

WilburSmith
ASSOCIATES

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KYTC ITEM NO. 9-192.00

Prepared for:

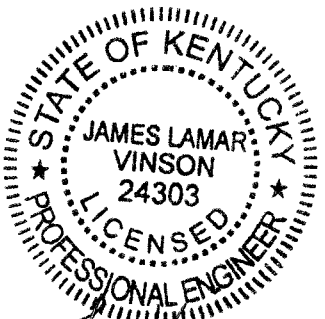
KENTUCKY TRANSPORTATION CABINET
DIVISION OF PLANNING

Prepared by:

WILBUR SMITH ASSOCIATES

WSA Project No. 102534

September 12, 2008



James L. Vinson, PE
Geotechnical Engineer

C. Eric Burke, PE
Vice President

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1.0 INTRODUCTION

The existing 13.7-mile segment of Kentucky Highway 32 (KY 32) between KY 504 near Elliotville, Kentucky and KY 7 near Sandy Hook, Kentucky is currently being studied by Wilbur Smith Associates (WSA) to allow evaluation of alternative alignments. The study limits for the KY 32 corridor are shown on the Study Area drawing in Appendix A. The approximately 11-mile long study area also encompasses segments of several other state routes, including KY 7, KY 173, KY 504, KY 556, KY 557 and KY 755. The study area varies in width from about ½ mile to the west near Elliotville to about 5½ miles to the east near Sandy Hook and Newfoundland, Kentucky.

Identifying improvements to safety, mobility and connectivity are the primary goals of the study. We understand that possible improvement alternatives will likely include the reconstruction, relocation, or realignment of a portion of KY 32.

The primary objectives of this geotechnical study were to review geological and geotechnical considerations presented by the Geotechnical Branch of the Kentucky Transportation Cabinet (KYTC) Division of Materials and the Kentucky Geological Survey, to review readily available site data, and to identify potential geotechnical and/or geological features that could impact the planning, design, and/or construction of new or modified roadways in the corridor.

2.0 SITE CONDITIONS

2.1 SITE VISIT OBSERVATIONS

A site visit was made on May 30, 2008 by Mr. James Vinson, a Professional Engineer with WSA. The visit included a visual survey of public and private properties that were observed from KY 32 and most of the crossroads within the study area.

In the study area, KY 32 tends to follow a tortuous path along the ridge tops between Elliottville and Sandy Hook. The slopes between the valleys and ridges tend to be vegetated with grass and forest as shown in Photograph 1 below.

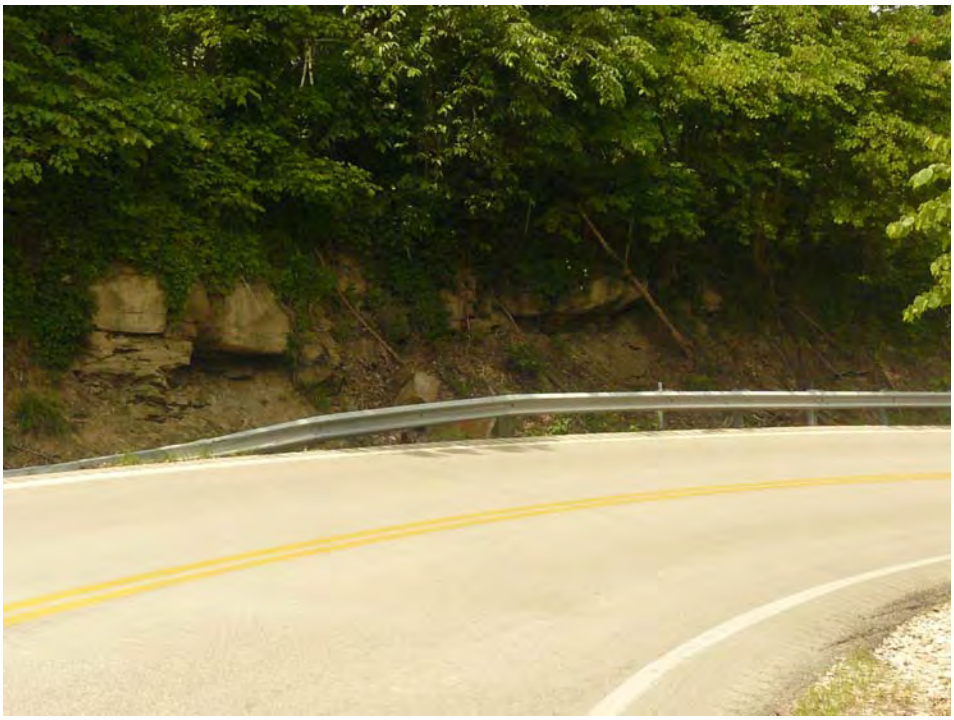
Photograph 1 – Rolling Terrain Adjacent to KY 32 at Eastern End of Study Area

Photograph 2 – Rolling Terrain Adjacent to KY 173 at Western End of Study Area

The land use along existing KY 32 was observed to be a mix of residential and pasture/farmland. Schools off Trent Ridge Road and KY 7 are present in the study area as well. Photograph 2 (see above), which was taken along KY 173 near the western terminus of the study area, depicts the typically rolling terrain away from KY 32. Several farm ponds were observed near KY 32 and its cross roads. Several creeks, branches and wet weather ditches occupy the lower elevations of the study area. The crossing of Big Caney Creek at Binion Ford Road is shown in Photograph 3 below.

A few rock cuts were observed along KY 32 at the eastern portion of the study area as shown in Photograph 4 below. These roadway cut areas give an indication of the relatively thin soil overburden along the ridges. While the soil overburden appeared to be less than 10 feet thick in these cut areas, no rock outcropping was observed on the ridges along KY 32 to the west of the community of Ordinary, Kentucky. Besides areas adjacent to KY 32, rock outcropping was only observed in the study area at lower elevations of Binion Ford Road near Big Caney Creek

Photograph 3 –Big Caney Creek at Binion Ford Road



Photograph 4 – Rock Cut Slope Off KY 32 Near Gray Road

2.2 TOPOGRAPHY

As mentioned above, KY 32 follows the ridges through the study area. From KY 504 in Elliottville to about 1 mile east of its intersection with the boundary between Rowan-Elliott Counties, KY 32 has gentle grade transitions and lies within an elevation range of +1,000± to +1,200± feet. From the county line to Sandy Hook, KY 32 tends to be within an elevation range of +800± and +1,000± feet. The lowest elevation of KY 32 is about +700± feet and occurs near the low-lying area adjacent to Laurel Creek near the intersection of KY 32 and KY 557.

The slopes between the valleys and ridges are often on the order of 2H:1V to 5H:1V with steeper terrain typically occurring near the base of the slopes. The elevation differences between the valleys and ridges are on the order of 100 to 250 feet.

3.0 GEOLOGIC CONDITIONS

3.1 GEOLOGIC OVERVIEW

Based on the published U.S. Geological Survey Geologic Quadrangle for the existing alignment, the study area is located in the Pennsylvanian System of the Eastern Kentucky Coal Field physiographic province. The Pennsylvanian System consists largely of sandstone, siltstone, and shale. Coal beds and thin marine shale and limestone units are widespread and occur in most parts of the stratigraphic section. These deposits indicate that in Pennsylvanian time, Kentucky was near sea level and alternately covered by lakes, extensive swamps, shallow bays, and estuaries.

3.2 GEOLOGIC FORMATIONS

The study area is underlain by several different geologic formations, including the Breathitt Formation, Lee Formation, Newman Limestone and associated quaternary alluvium along the valleys. The approximate locations of these formations are shown on the Geologic Map in Appendix A and on a similar map prepared by the KYTC Geotechnical Branch (see Appendix B).

The Breathitt Formation is comprised mostly of shale, but other materials are present including siltstone, sandstone and coal. The ridge tops in the study area are comprised of materials from the Breathitt Formation; therefore, most of the current KY 32 alignment is immediately underlain by the Breathitt Formation. Several coal seams have been identified within the Breathitt Formation in the study area, including the Mudseam, Fire Clay, Cannel City, Little Caney, and Bruin. These coal beds have irregular thicknesses between 0 and 85 inches.

The Lee Formation is comprised primarily of conglomeritic sandstone and minor amounts of shale in the study area. The Lee Formation lies beneath the Breathitt Formation and outcrops on the slopes in the lower elevations of the study area. The Olive Hill Clay Bed of Crider, a semiflint clay and flint clay bed,

is identified by the KYTC Geotechnical Branch's geologic map along several slopes in the western half of the study area.

The Newman Limestone lies beneath the Lee Formation. This massive limestone outcrops in most of the valleys or is underlain by Quaternary Alluvium.

Quaternary Alluvium is located along the rivers and tributaries. The alluvium primarily consists of sands, silts, and gravels.

3.3 FAULTS

The Little Sandy Hook Fault is less than 2 miles north of Sandy Hook and trends east-west. It can be located just north of the Sandy Hook Anticline on the Geologic Map in the KYTC Geotechnical Branch's memorandum.

3.4 UNDERGROUND OPENINGS AND SPRINGS

Available mapping indicates no sinkholes are present within the study area. Obvious signs of sinkhole activity were not observed during the site visit by Mr. Vinson.

According to published mapping of the Kentucky Geological Survey, the majority of the study area has a very low karst potential (i.e., karst features are rare or absent). The only portion of the study area with appreciable potential for developing karst features is in some of the valleys where the Newman Limestone is exposed or near the surface.

Based on published mapping, springs are not present within the study area. However, it is possible that some locations may contain wet-weather springs, especially in the vicinity of the Little Sandy Hook Fault and Sandy Hook Anticline.

3.5 SOIL SURVEY

Available soil survey mapping from the United States Department of Agriculture (USDA) indicates a number of soil units within the study area. The soil series mostly commonly identified are the Gilpin, Latham and Rigley. Strangely, the Gilpin soils are not identified in Rowan County, and Latham soils are not identified in Elliott County. The cause for these soils not being similarly identified in both counties may be due to performance of field mapping at different times and by different parties.

The most widespread soil series in the study area is the Gilpin which is primarily found along ridges and slopes. The Gilpin soils are identified as part of a complex with other soil units within the study area. A complex consists of two or more soils that are in such an intricate pattern that they cannot be separated on maps. Covering over 25 percent of the study area, the Gilpin-Shelocta complex, 25 to 45 percent slopes, is the most commonly occurring soil unit.

The Latham soil series is prevalent near Elliottville in Rowan County. Similar to the Gilpin soils, Latham soils are identified as being intermingled with other soils within the study area across ridges and slopes. The predominant Latham soil unit is the Latham-Shelocta silt loams, 20 to 30 percent slopes.

The Rigley soil series is identified in both Rowan and Elliott Counties. Most of the Rigley soils, which are typically present on slopes, are colluvium derived from sandstone. Rock outcropping can be present in the areas identified by Rigley soil units.

According to the Unified Soils Classification, most of the soils in the study area are typically low plasticity sands (SM, SC) or fine-grained silt (ML) and clay (CL) with plasticity indices in the range of 0 to 25 percent. A few clayey and silty gravels (GC, GM) are also present in the relatively thin overburden. High plasticity clay (CH) has been occasionally identified in the Latham series. The depth to bedrock is typically on the order of 3 to 6 feet.

The study area soils would generally appear suitable for use as roadway fill, except for the high plasticity clay. As described by the USDA, the most notable feature of these soils may be their relatively low pH values which are often between 3.5 and 5.5. The acidic nature of these soils may create an environment that can be conducive to corrosion of steel.

4.0 MISCELLANEOUS FEATURES

4.1 SURFACE OR DEEP MINING ACTIVITIES

Published digital maps and reports were reviewed by WSA in an attempt to identify areas of past surface or deep mining in the study area. Limited surface and deep mining records for mostly abandoned mines were found in areas outside the study area in Elliott County. Several abandoned coal mine locations are noted in the vicinity of Sandy Hook. Maps of three of these abandoned mines were obtained for review. Their locations are approximately ½ mile to the southwest of Sandy Hook and are not within the study area. The KYTC Geotechnical Branch cited the irregular thicknesses of the study area's coal beds as a primary reason for limited commercial mining. Localized stripping of coal has probably occurred in the study area by private property owners for their personal use.

The Olive Hill Clay Bed of Crider was commercially mined in the past in Rowan County. The locations of abandoned or active strip mines were not determined.

4.2 OIL, GAS AND WATER WELLS

Based on published maps, a number of oil, gas and water wells are present within and adjacent to the study area. The locations of these wells are shown on the Environmental Footprint drawing in Appendix A.

The Environmental Footprint drawing indicates that at least eighteen oil wells are present within the study area. Eight of these are within (or less than ¼ mile from) the city limits of Sandy Hook. The other ten oil wells in the study area are in close proximity to each other about 1½ to 2 miles to the north-northwest of Newfoundland. Another six oil wells are identified outside the study area at less than ¼ mile from the study area's perimeter. According to the Kentucky Geologic Map Information Service, these wells are typically 800 to 1,400 feet deep.

At least seventeen well locations are identified in the study area as being dry and abandoned. The majority of these are within a 3-mile radius of Sandy Hook. Another dry and abandoned well is present within ¼ mile of the study area's perimeter. It appears that most of these wells were originally used or intended as oil or injection wells.

Two gas wells over 1,200 feet deep are identified on the Environmental Footprint drawing. One gas well is located south of the intersection of KY 711 and Sandy Gap Road. The other gas well is located on the northeast side of Sandy Hook.

At least eighteen water wells are present within the study area. While being somewhat widely spaced, nearly all of the water wells are in the eastern half of the study area. Two additional water wells are identified within ¼ mile of the study area's perimeter. According to the Kentucky Geologic Map Information Service, bedrock was often encountered 3 to 10 feet deep during most of these well installations, and groundwater was typically found 100 to 200 feet below ground.

Another thirty-one well locations that are not identified with regard to their type are within the study area. Twenty-four of these unidentified wells are within (or less than ½ mile from) the city limits of Sandy Hook. Another two unidentified wells are identified less than ¼ mile east of Sandy Hook. The other seven wells are in close proximity to each other about 1½ to 2 miles to the north-northwest of Newfoundland.

4.3 UNDERGROUND STORAGE TANKS

No underground storage tanks were identified within the study area during our review of published documents. However, we would anticipate the potential for underground storage tanks associated with the schools in the study area as well as any fuel stations that are located within the study area.

4.4 GAS PIPELINE

Based on published maps, a Marathon/Ashland gas pipeline extends across the study area to the south of Elliottville. The approximately 2.5 miles of pipeline within the study area extends underneath KY 32 between its intersections with KY 504 and KY 173.

5.0 GEOTECHNICAL ISSUES AND RECOMMENDATIONS

We generally agree with the geotechnical concerns cited by the KYTC Geotechnical Branch and Kentucky Geological Survey in their memoranda attached in Appendices B and C, respectively. In our opinion, the most significant of these geotechnical challenges are as follows:

Slope stability: Stability of major cuts into hillsides would require close scrutiny before and during construction to minimize risk of failure due to groundwater seepage, unfavorably jointed bedrock, and layers of weak materials. As recommended by KYTC Geotechnical Branch, we agree that new roadway(s) should cross perpendicular to the Little Sandy Hook Fault to minimize slope design and maintenance issues.

Unidentified mines: Since unidentified mines for coal and the Olive Hill Clay Bed of Crider exist in the study area, the impacts to design and construction costs could be significant based on when and where such mines may be discovered. The risk of new alignments intersecting undocumented mine activity in the study area does not appear to be quantifiable.

Oil, gas and water wells: Avoidance of routes that would pass in close proximity to oil, gas, and water wells is strongly recommended.

The shallow depth to bedrock across the study area will impact the construction costs associated with mass grading. Deeper cuts will extend into bedrock requiring potentially mixed face (i.e., soil/rock) slope designs and/or encounter zones of weathered rock that require special consideration. Where shale is more prevalent, ripping by large excavation equipment may be feasible. We anticipate that areas comprised mostly of sandstone, siltstone or limestone will likely require blasting to allow efficient excavation.

It appears likely that roadway alternatives will involve construction of structures at stream crossings. While construction of these structures may be adversely impacted by shallow groundwater or weak bearing soils, the long-term impact of potential corrosion of steel components should also be considered.

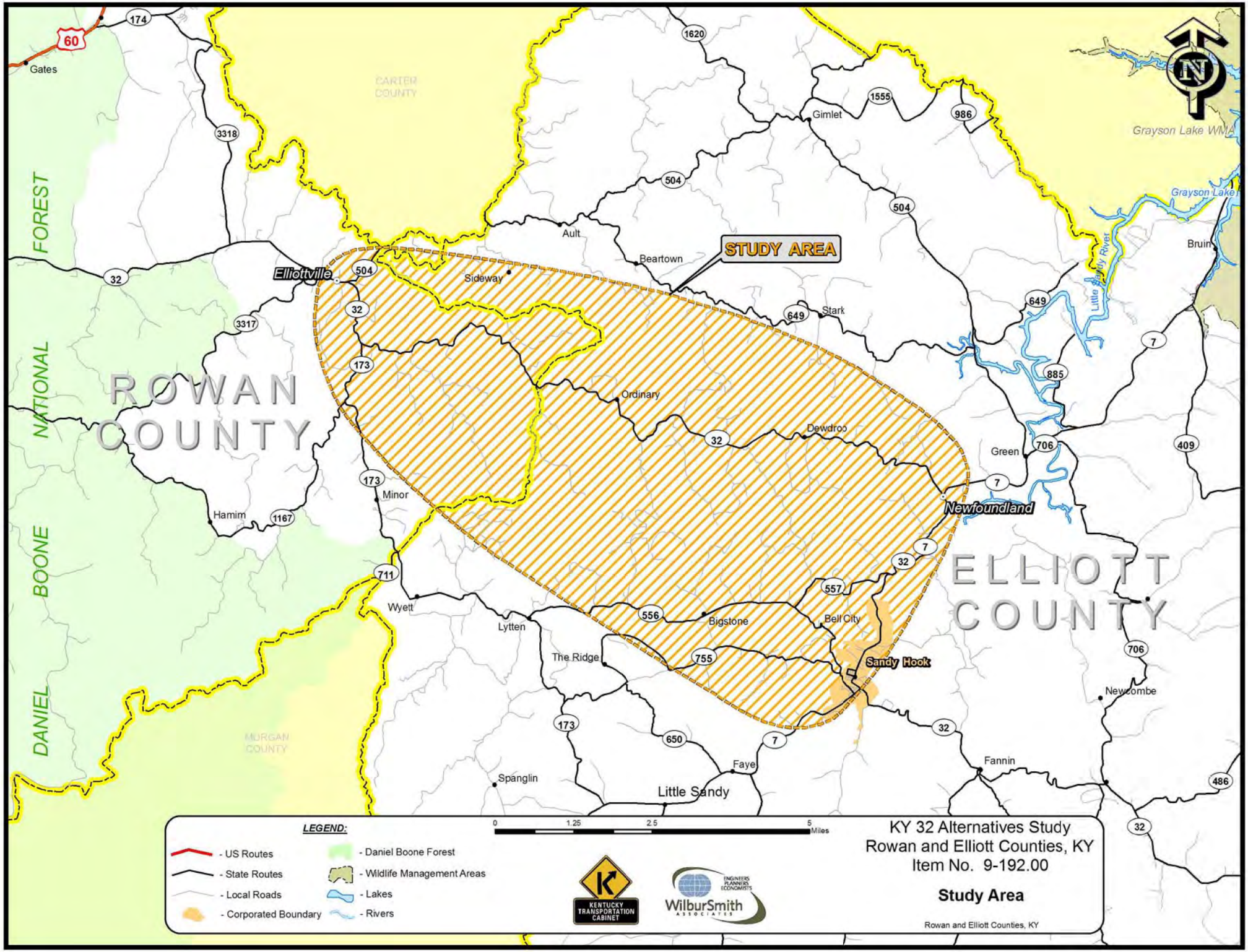
Concerns over corrosion can likely be mitigated by a complete geotechnical exploration and incorporating corrosion resistance measures into the design of structures.

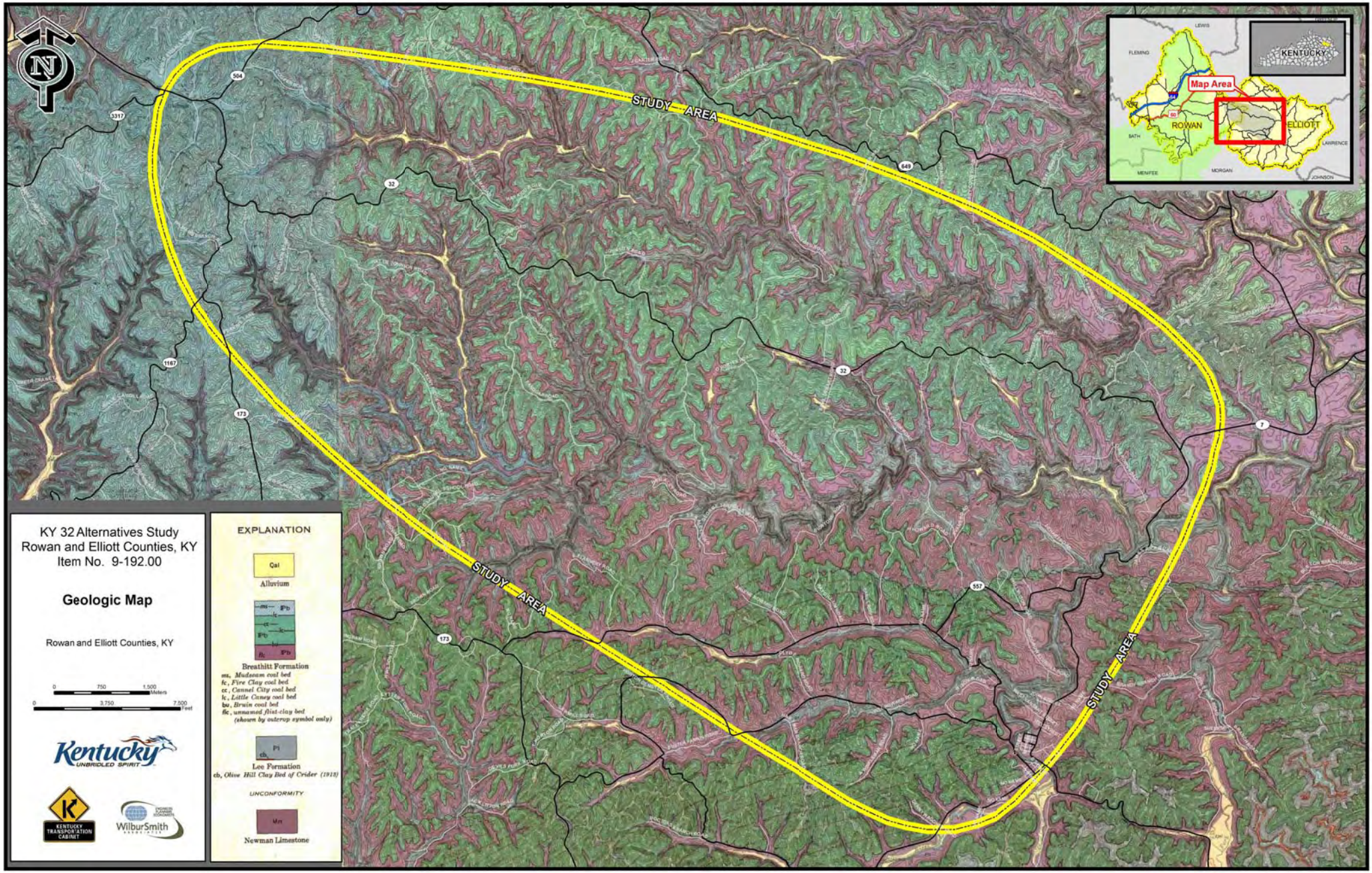
6.0 LIMITATIONS

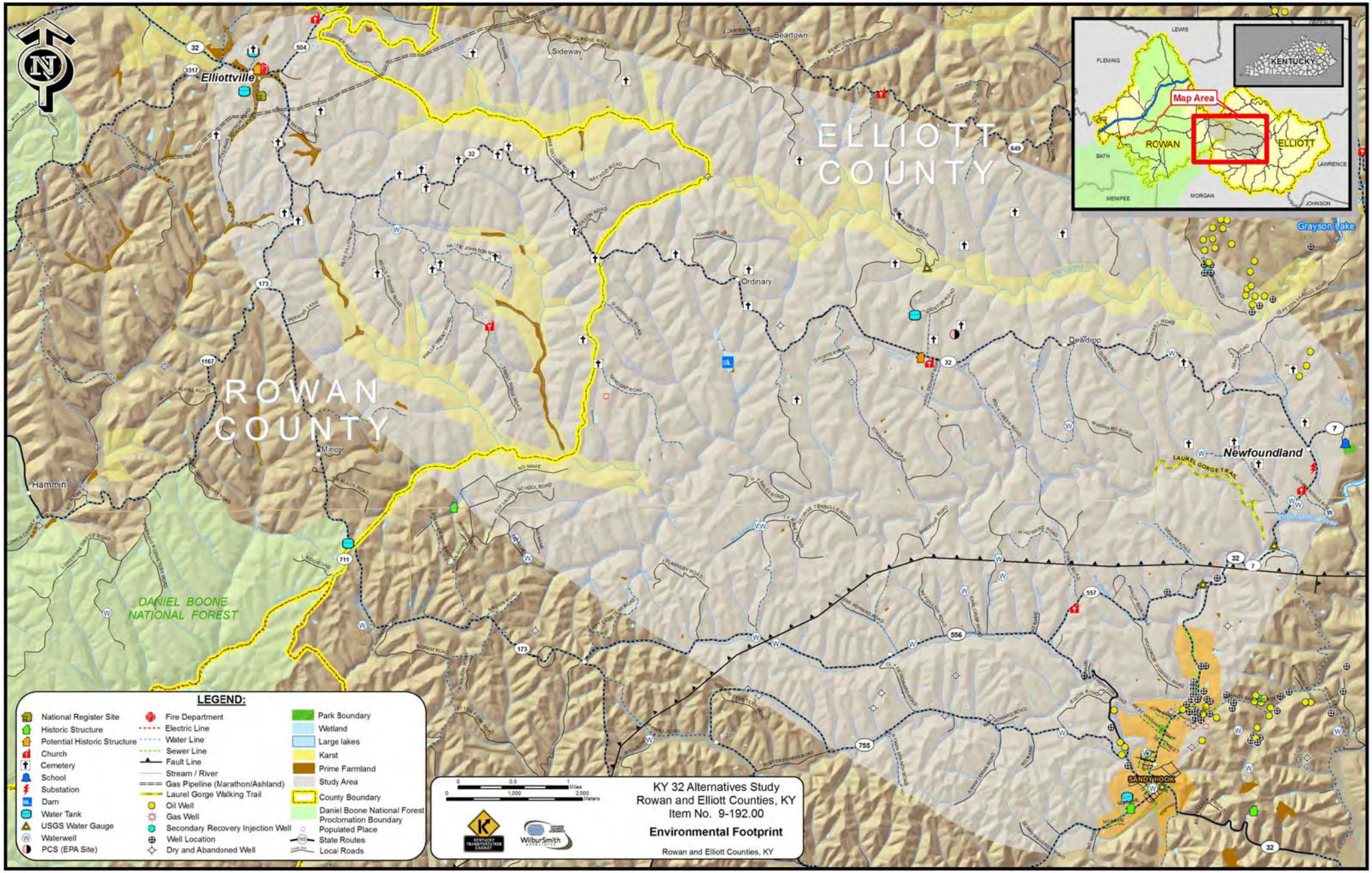
The evaluations within this report are based on review of available published information and limited site reconnaissance over a large study area. As such, the geotechnical recommendations are necessarily broad based and by no means comprehensively cover all potential geotechnical issues that may be associated with this project. Detailed geotechnical exploration should be performed for the final selected alignment in accordance with KYTC guidelines.

APPENDIX A

STUDY AREA
GEOLOGIC MAP
ENVIRONMENTAL FOOTPRINT


STUDY AREA
ROWAN COUNTY
ELLIOTT COUNTY
CARTER COUNTY
MORGAN COUNTY
DANIEL BOONE NATIONAL FOREST
Gates
Elliottville
Sideway
Ault
Beartown
Gimlet
Stark
Ordinary
Dewdroo
Green
Newfoundland
Bruin
Grayson Lake WMA
Grayson Lake
Little Sandy River
Hamim
Minor
Wyett
Lytten
The Ridge
Bigstone
Bell City
Sandy Hook
Newcombe
Fannin
Faye
Spanglin
Little Sandy
60
174
3318
1620
1555
986
504
32
3317
173
649
885
7
706
409
1167
711
557
556
755
650
486
LEGEND:
- US Routes
- State Routes
- Local Roads
- Corporated Boundary
- Daniel Boone Forest
- Wildlife Management Areas
- Lakes
- Rivers
0 1.25 2.5 5 Miles
KENTUCKY TRANSPORTATION CABINET
WilburSmith ASSOCIATES
ENGINEERS PLANNERS ECONOMISTS
KY 32 Alternatives Study
Rowan and Elliott Counties, KY
Item No. 9-192.00
Study Area
Rowan and Elliott Counties, KY


STUDY AREA
STUDY AREA
STUDY AREA
504
3317
32
649
1167
173
32
7
557
173
Map Area
KENTUCKY
ROWAN
ELLIOTT
LEWIS
FLEMING
BATH
MENIFEE
MORGAN
LAWRENCE
JOHNSON
KY 32 Alternatives Study
Rowan and Elliott Counties, KY
Item No. 9-192.00
Geologic Map
Rowan and Elliott Counties, KY
0 750 1,500 Meters
0 3,750 7,500 Feet
Kentucky
UNBRIDLED SPIRIT
KENTUCKY TRANSPORTATION CABINET
WilburSmith
EXPLANATION
Qal
Alluvium
Breathitt Formation
ms, Mudcoam coal bed
fc, Fire Clay coal bed
cc, Cannel City coal bed
lc, Little Caney coal bed
bu, Bruin coal bed
flc, unnamed flint-clay bed
(shown by outcrop symbol only)
Pl
cb
Lee Formation
cb, Olive Hill Clay Bed of Crider (1918)
UNCONFORMITY
Mn
Newman Limestone


ROWAN COUNTY
ELLIOTT COUNTY
Elliottville
Sideway
Beartown
Ordinary
Dewdrop
Grayson Lake
Newfoundland
Hammin
Minor
DANIEL BOONE NATIONAL FOREST
SANDY HOOK
LAUREL GORGE TRAIL
Map Area
KENTUCKY
LEWIS
FLEMING
ROWAN
ELLIOTT
BATH
MENIFEE
MORGAN
LAWRENCE
JOHNSON
LEGEND:
National Register Site
Historic Structure
Potential Historic Structure
Church
Cemetery
School
Substation
Dam
Water Tank
USGS Water Gauge
Waterwell
PCS (EPA Site)
Fire Department
Electric Line
Water Line
Sewer Line
Fault Line
Stream / River
Gas Pipeline (Marathon/Ashland)
Laurel Gorge Walking Trail
Oil Well
Gas Well
Secondary Recovery Injection Well
Well Location
Dry and Abandoned Well
Park Boundary
Wetland
Large lakes
Karst
Prime Farmland
Study Area
County Boundary
Daniel Boone National Forest Proclomation Boundary
Populated Place
State Routes
Local Roads
KY 32 Alternatives Study
Rowan and Elliott Counties, KY
Item No. 9-192.00
Environmental Footprint
Rowan and Elliott Counties, KY

APPENDIX B

MEMORANDUM FROM KYTC GEOTECHNICAL BRANCH

M E M O R A N D U M **P-005-2008**

TO: Steve Ross, PE
Transportation Engineer Branch Manager
Division of Planning

FROM: William Broyles, PE
Geotechnical Branch
Branch Manager
Division of Structural Design

BY: Christian Wallover, PG
Sean House
Geotechnical Branch

DATE: July 31, 2008

SUBJECT: Rowan and Elliot Counties
KY 32 from KY 504 in Elliotville to
KY 7 near Sandy Hook
FD04 103 0032 016-022
Item # 9-192.00
Mars # 8054301P

At your request, the Geotechnical Branch has completed a review of the project and outlined issues that may affect the project corridor.

The project study area is underlain by the Pennsylvanian rocks of the Breathitt and Lee Formations and the Mississippian rocks of the Newman Limestone Formation. The Breathitt Formation contains interbedded sandstone, shale, clay and coal which range from 230-710 feet thick. Coal beds that may be encountered in the Breathitt Formation are the Laurel Coal Bed (0-85" thick), Mud Seam Coal Bed (0-50" thick), Fire Clay Coal Bed (0-49" thick), Canel City Coal Bed (0-59" thick), Little Caney Coal Bed (0-32" thick), Grassy Coal Bed (0-32" thick), and the Bruin Coal Bed (0-30" thick). Some of the beds have been extensively strip and deep mined south of the study area. Due to the inconsistencies in thickness of these beds, economic mining within the study area has been discouraged. Although many coal beds are locally stripped for household usages.

The Lee Formation is made up of mostly conglomeritic sandstone and minor amounts of shale that range anywhere between 0-200 feet in thickness in the study area. Within the Lee Formation is the Olive Hill Clay Bed of Crider (CB). This is semiflint clay and flint clay bed that has been extensively stripped and underground mined along the Big Caney Creek. The locations of this bed are shown on the attached geologic map. Areas directly on top of and around this bed should be avoided.

Below the Lee Formation is the Newman Limestone Formation. It is composed of thick to massive, crossbedded limestone. The formation is exposed only within drainage valleys. The limestone is suitable for aggregate and road metal but has not been extensively mined in the area.

Quaternary alluvium is mainly identified along rivers and their tributaries in the study area. They range from 0-10 feet thick and consist of gravel, sand, and silt. Deep foundations for structures are not anticipated in alluvium.

The general dip of the bedrock is to the south-southeast direction. It is recommended that alignment should stay on the north side of the hills (upside of dip) to reduce encounters with spring lines.

Also located on the southeast part of the study area is the Sandy Hook Anticline which is labeled on the attached geologic map. Spring lines are likely to be encountered at the base of sandstone and coal beds on the north facing hillsides on the north side of the anticline and the south facing hillsides on the south side of the Sandy Hook Anticline. Side-hill cut and fill situations should be avoided if possible.

The Little Sandy Hook Fault, labeled on the geologic map, directly north of the Sandy Hook Anticline should be avoided. Dipping rock and springs or wet slopes may be encountered in this area. Any corridors that encounter faults should be crossed perpendicular to the fault line.

Gas and oil wells are located throughout the study area but there is a large concentration of them on the north and east side of Sandy Hook. Only the holes around Sandy Hook have had economic value, the rest have been just test holes. All oil and gas well should be avoided with any corridors.

Normal cut and fill slopes should be adequate for the project.

The project is located in the seismic risk zone 1 where minimal earthquake damage could occur.

If there are any questions, please advise.

cc. Thomas Witt
Ernest Polly

Elliott & Rowan County
KY 32
Planning Study
Project No. 9-0192.00

Elliottville

Study Area

Newfoundland

Sandy Hook

Sandy Hook Anticline

Little Sandy Hook Fault

cb

32

173

Legend

Pb	Breathitt Formation	p	Springs
Pl	Lee Formation		State Roads
Mn	Newman Limestone		Local Roads
Qal	Alluvium		County Lines
cb	Olive Hill clay bed of Crider		Geologic Faults
#	Oil Well		
1	Oil & Gas Well		
*	Gas Well		
:	Well Location		
a	Dry & Abandoned Well		

0 2,000 4,000 8,000 12,000 16,000 Feet

APPENDIX C

MEMORANDUM FROM KENTUCKY GEOLOGICAL SURVEY

UNIVERSITY OF KENTUCKY

RECEIVED
AUG 04 2008

Kentucky Geological Survey
Research
228 Mining & Mineral Resources Bldg.
Lexington, KY 40506-0107
Phone: (859) 257-5500
Fax: (859) 257-1147
www.uky.edu/kgs

July 29, 2008

Steve Ross, P.E.
Transportation Engineer Branch Manager
Division of Planning
Kentucky Transportation Cabinet
200 Mero Street
5th Floor
Frankfort, KY 40622

Dear Mr. Ross:

This letter is to summarize any geologic concerns for the project identified as:

Planning Study
Rowan and Elliott Counties
KY 32 from KY 504 to Elliottville to KY 7 near Sandy Hook
Item No. 9-192.00

The following comments reflect the review of maps, online searches, and documents available in the files and on the Web site of the Kentucky Geological Survey. No on-site investigation (except for the section on fracture orientations) of the planning study area was conducted.

Physiographic Region

The study area is in the Eastern Kentucky Coal Field physiographic region, which is underlain by gravel, sand, silt, clay, sandstone, argillaceous sandstone, conglomeritic sandstone, calcareous sandstone concretions, shale, silty shale, siltstone, limestone, dolomite, coal, and underclay.

Land-Use Planning Map

For a good geologic (with physical parameters) overview of the study area, refer to the county land-use planning map at www.uky.edu/KGS.

On the home page, click on GIS and Maps.
On this page, click on County Land-Use Planning Maps.
On this page, click on the county of interest on the index map or select the county name from the pull-down menu. A viewable and downloadable PDF of the map will be displayed.

KGS

Karst Potential
The study area might encounter karst features such as sinkholes or caves as identified on the map provided by Wilbur Smith and Associates for this study area.

Landslide Potential
The study area probably will encounter pre- or post-landslide hazards. The potential for landslides in the red and green shales of the Muldraugh Formation could be initiated or accentuated by removal of material at the base of the slope.

Unconsolidated Sediments
The study area will encounter unconsolidated sediments at or near stream drainage, such as sand, silt, and gravel.

Resource Conflicts
The study area might encounter resource conflicts such as prior ownership of oil and gas wells or Olive Hill Clay bed property and coal property for mining. Locations of oil and gas wells have been identified by the maps provided by Wilbur Smith and associates for this study. Coal mining information can be found at the Department of Mines and Minerals Web site, http://minemaps.ky.gov/.

Monitoring Wells, Domestic Water Wells, and Springs
The study area will encounter domestic and monitoring wells (included is a 1:100,000 scale map of the study area showing the locations of the monitoring and domestic water wells). Locations of monitoring wells, domestic water wells, and springs can be found by going to the Kentucky Geological Survey's Web site, http://kgsweb.uky.edu/DataSearching/Water/WaterWellSearch.asp, and inputting search parameters.

Subsidence
The study area might encounter underground voids that were left from previous deep mining activity, which could be a possible subsidence hazard. The Department of Mines and Minerals Web site would be helpful for locating deep mines in the area.

Materials Suitability
The study area will not encounter any material suitable for construction stone in the study area.

Fault Potential
The study area probably will encounter the Little Sandy Hook Fault in the southeastern end of the study area. It is identified on the map provided by Wilbur Smith and Associates for this study area.

Fracture Orientations
Field reconnaissance of the study area was conducted on July 23rd, by Steve Martin. The joint orientations are plotted as Rose diagrams and are included on the attached map. For more information, contact Steve Martin, 859.257.5500 ext. 179 or smartin401@uku.edu.

Earthquake Zone

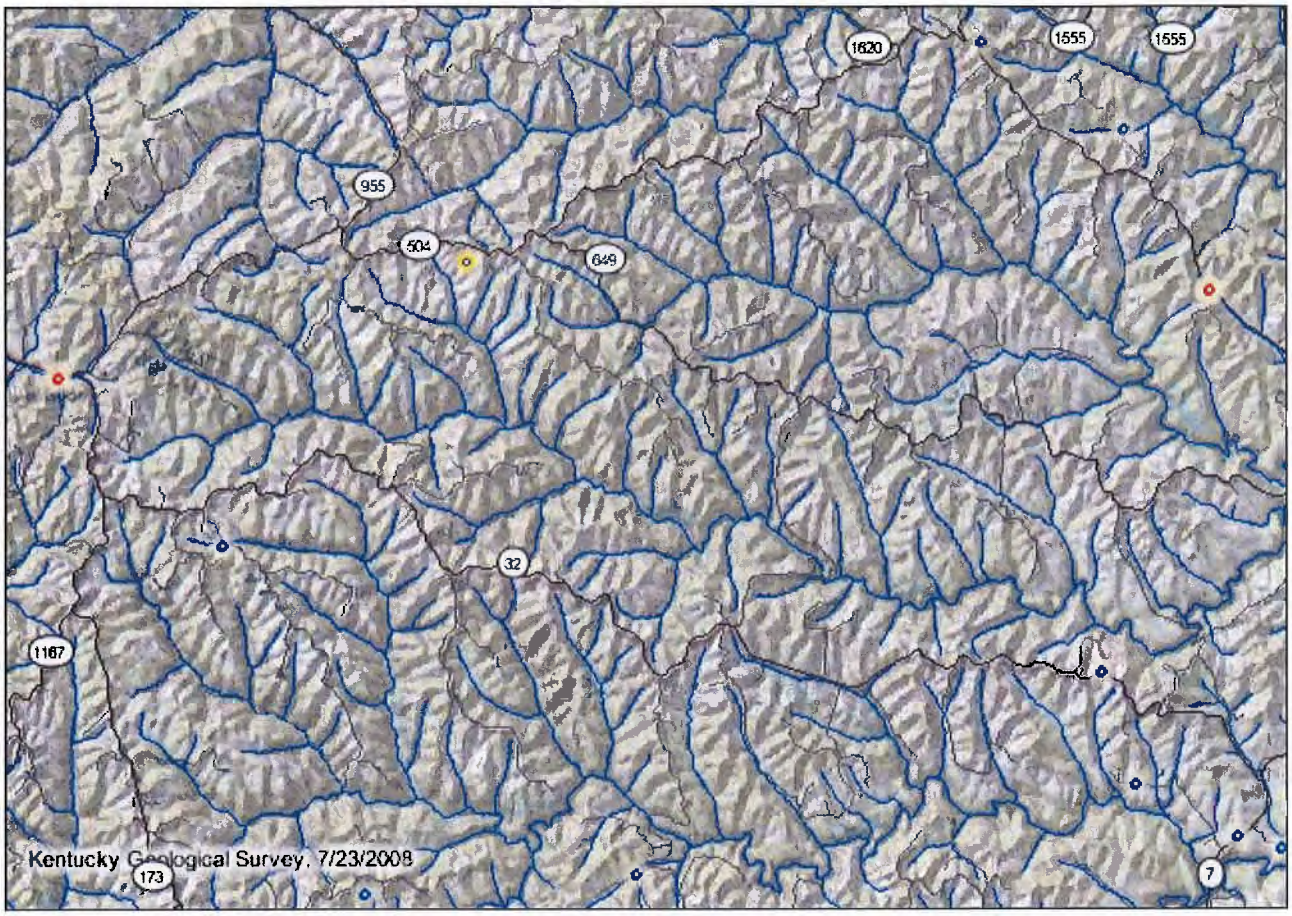
The study area has a probable peak ground acceleration (PGA) due to earthquake ground motion of 0.09g for Rowan County and 0.19g for Elliott County. There would be a low to moderate potential for liquefication or slope failure in the unconsolidated sediments at or near streams caused by earthquake bedrock ground motion.

Sincerely,

Richard A Smath
Geologist

Kentucky Groundwater Data Repository
Kentucky Geological Survey
Water Well and Spring Location Map
Note: please disable popup blocking software for full functionality.
KGS Home > Maps, Pubs, & Data > Groundwater Info > Water Well and Spring Map

Search Criteria:
ID #: **45592**
coords (lat,lon): **38.194444, -83.214444**
county: **Elliott**
7.5' quadrangle: **Ault**



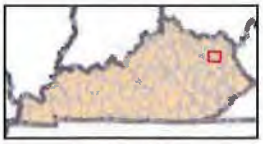
Current Scale = 1:100,000
Note: all wells and springs are displayed at scales below 1:100,000

Change Map Scale: 1:100,000

Change Basemap (background):
topo map w/ hillshade

Change Map Size: **half pg (6.8 x 4.7 in)** | **full pg (6.8 x 9.4 in)**
TIP: to print map to scale, be sure to "File --> Print Preview..." and print at 100% scaling.

Overview Map:



Map Tools:

zoom in | zoom out | zoom original
zoom last | pan | get coords
Move Map:

Other Tools:

zoom to a location

KY MAPS

Bookmark Map

Information about wells labeled on map above:

- - public water well sources
- **Tabular data of WATER WELLS in this view**
- **Tabular data of SPRINGS in this view**
- **Search for Groundwater Quality Data**

For information about the KY Groundwater Data Repository:

Bart Davidson (Kentucky Geological Survey)
859.257.5500 x162
bdavidson@uky.edu

Well Table:
IMPORTANT: wells may overlap on the map. Some wells listed below may not be visible unless highly zoomed in.
**click KGS ID number for more info about a well

minimize table below to show records in pages

Symbol	KGS ID	AKGWA #	Primary Use	Zoom
	1618	00000825	domestic	zoom to well

	3149	00002935	domestic	zoom to well
	3151	00002937	domestic	zoom to well
	5196	00010489	domestic	zoom to well
	45592	n/a	domestic	zoom to well

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Symbol	KGS ID	AKGWA #	Primary Use	Zoom
	45593	n/a	domestic	zoom to well
	76562	00006972	domestic	zoom to well
	80085	00015973	domestic	zoom to well
	83575	00025569	domestic	zoom to well
	85229	00029925	domestic	zoom to well

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Symbol	KGS ID	AKGWA #	Primary Use	Zoom
	116750	80035631	monitoring	zoom to well
	117540	80036797	monitoring	zoom to well
	117541	80036798	monitoring	zoom to well
	124706	80048681	monitoring	zoom to well
	124707	80048682	monitoring	zoom to well

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Symbol	KGS ID	AKGWA #	Primary Use	Zoom
	124708	80048683	monitoring	zoom to well
	124709	80048684	monitoring	zoom to well

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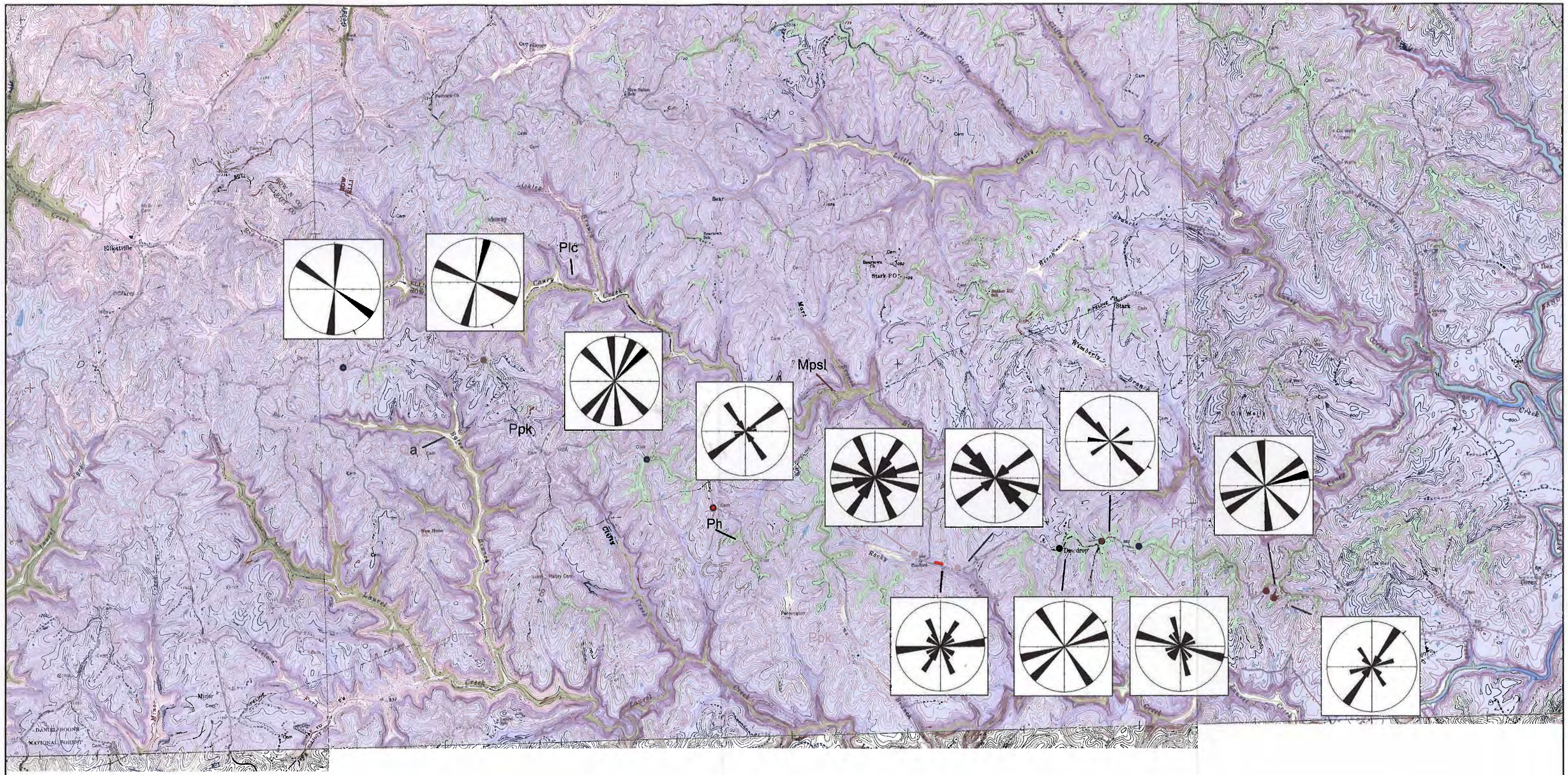
Spring Table:
IMPORTANT: springs may overlap on the map. Some springs listed below may not be visible unless highly zoomed in.
**no springs found in map area

PRINT THIS PAGE

TIP: to print map to scale, be sure to select "Print Preview..." from the "File" menu and print at 100% scaling.



Geologic map of the study area showing fracture orientations along KY 32. Rose diagrams show the location, frequency, and orientation of joint measurements from frield reconnaissance. Map unit abbreviations include Ph (Hyden Fromation), Ppk (Pikeville Formation), Plc (Corbin Sandstone Member of the Grundy Formation, Mpsl (Paragon and Slade Formations, undifferentiated), and Qal (alluvium). Map scale is 1:48,000.