# Report of Geotechnical Overview

Corridor Study for the Proposed Heartland Parkway
Adair, Green, Taylor, Marion, Washington and Nelson Counties, Kentucky
Item No. 04-132

Prepared for
WMB Engineers, Inc.
Lexington, Kentucky

August, 2004

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August 6, 2004 O.1.1.LX2002273R01

Mr. Dan Byers, PE
WMB, Inc.
1950 Haggard Court
Lexington, Kentucky 40503

Re: Report of Geotechnical Overview
Proposed Heartland Parkway
Adair, Green, Taylor, Marion, Washington
And Nelson Counties, Kentucky
Item No. 4-132

Dear Mr. Byers:

Fuller, Mossbarger, Scott and May Engineers, Inc. (FMSM) is pleased to submit this report of our geotechnical overview for the proposed Heartland Parkway project situated between the Louie B. Nunn Parkway and the Blue Grass Parkway in Adair, Green, Taylor, Marion, Washington and Nelson Counties, Kentucky. The overview is based upon a site reconnaissance performed by FMSM personnel on December 10, 2004 and January 20, 2004, research of available published data, and input from various Project Team meetings.

WMB, Inc. provided FMSM with topographic mapping and preliminary locations for the environmental footprint and two proposed corridors. The scope of work performed and results of the overview are presented in the accompanying report. FMSM appreciates having the opportunity to provide these engineering services and would be happy to answer any questions and further assist you concerning this project.

Respectfully submitted,

FULLER, MOSSBARGER, SCOTT AND MAY
ENGINEERS, INC.

John D. Beam Jr., PG
Senior Geologist

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/me

c: Division of Planning (10 copies and electronic files)

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# Adair, Green, Taylor, Marion, Washington and Nelson Counties, Kentucky
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## 1. Project Description

The Kentucky Transportation Cabinet (KYTC) is in the process of reviewing potential corridors for a new route and/or improvements to existing routes along KY 55, US 68 and KY 555 from the vicinity of milepost 47 near KY 61 overpass on the Louie B. Nunn Parkway to milepost 42 on the Blue Grass Parkway. The review area has been titled as the Heartland Parkway.

The Project Team prepared an environmental footprint of the area to be studied. This area incorporates portions of Adair, Green, Taylor, Marion, Washington and Nelson Counties. Based on public input, two corridors have been identified within the environmental footprint for further review. The western most corridor would involve a new fully controlled parkway. The eastern corridor would upgrade the existing roads to a four-lane divided highway or an improved two lane with a truck passing lane one mile long, every three miles. Both corridors are approximately 63 miles in length. See Appendix I for a site location map.

## 2. Scope of Work

The scope of work for this study consists of performing a geotechnical overview for the proposed corridors based upon research of available published data; FMSM's experience with highway design and construction within the region; and a field reconnaissance of the preliminary corridors. General geotechnical and geologic characteristics of the study area have been identified and discussed in this report. FMSM personnel, using a variety of sources, performed a literature search. Tasks performed by FMSM 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);
- Karst Occurrence in Kentucky Map, published by the KGS, and other KGS sources referencing karst activity in the area;
- KGS Mineral and Fuel Resources Map of Kentucky, 1998;
- USGS Hydrologic Investigation Atlas HA-21, Availability of Groundwater in Marion, Nelson and Washington Counties, Kentucky, 1960;
- KGS Oil and Gas Development Activity Mapping, and Oil and Gas information provided by WMB, Inc.;

- United States Department of Agriculture, Soil Conservation Service (SCS) Soil Survey Publications for affected counties;
- Kentucky Department for Surface Mining Reclamation and Enforcement (KDSMRE) was contacted for Rock and Mineral Quarry Locations and Information. Permit mapping showing quarry locations and mine status information was obtained from KDSMRE;
- National Wetlands and Wildlife Management Areas as recognized by the U.S. Department of the Interior, Fish and Wildlife Service;

FMSM performed a preliminary study of the area within the environmental footprint. The preliminary study was conducted to assist the Project Team in determining potential corridors. The preliminary study consisted of literature and internet searches for geotechnical and geologic information that would effect the project. The results of the preliminary study were submitted to WMB, Inc. in letters dated July 14, 2003 and August 12, 2003. This information was incorporated into exhibits by WMB for use in public meetings.

Utilizing input from the public meetings, WMB identified two potential corridors. Field reconnaissance of the proposed corridors was performed by FMSM personnel on December 10, 2003 and January 20, 2004. Based upon the results of the field reconnaissance and review of the noted information, the general site geology has been summarized, along with corridor features of geotechnical significance that may influence selection in the following sections.

# 3. Physiographic and Stratigraphic Setting

## 3.1. Topography and Drainage

The proposed Heartland Parkway environmental footprint is located in Central–South Central Kentucky, situated on portions of seventeen USGS 7.5-minute topographic quadrangle maps. They are the Gradyville (1973), Columbia (1973, revised 1976), Gresham (1953, revised 1987), Cane Valley (1970, revised 1979), Greensburg (1961, revised 1987), Campbellsville (1970, revised 1976), Mannsville (1970), Saloma (1961), Spurlington (1953, revised 1994), Bradfordsville (1953, revised 1987), Raywick (1953, revised 1987), Lebanon West (1953, revised 1994), Lebanon East (1953), St. Catharine (1953, revised 1979), Springfield (1972, revised 1979), Maud (1972), and Brush Grove (1972) Quadrangles.

The study area is within the Mississippian Plateaus, The Knobs, and the Outer Blue Grass Physiographic Regions of Kentucky. See Appendix II for a generalized map of the physiographic regions for the Heartland Parkway. The Mississippian Plateaus Region is situated at the southern end of the environmental footprint. The Mississippian Plateaus contains gently to moderately rolling topography that has been partially influenced by karst weathering in some areas. Photo 1 shows a typical topographic setting affected by karst activity within the Mississippian Plateaus Region. The Knobs Region consists of a narrow belt of conical knobs situated in the center of the study area. Within the corridor area, the knobs are a 1.2- to 5.0-mile wide band of knobs situated in a general east–west direction on the south side of Lebanon, Kentucky. Muldraugh Hill is situated on the southern portion of The Knobs Region. The Outer Blue Grass Region is situated between the south side of Lebanon, Kentucky and extends beyond the Blue Grass Parkway. The Outer Blue Grass

Region consists of a well dissected upland with irregular hills and ridges. The Outer Blue Grass Region has some areas affected by karst activity. The karst areas in both the Mississippian Plateaus and Outer Blue Grass Regions are characterized by the existence of sinkholes, ridgetop ponds, sinking streams, springs, and various subterranean channels. Appendix III contains a drawing from KGS that depicts karst occurrence in Kentucky.
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**Photo 1. Large Karst Related Depression in Topography Typical of the Mississippian Plateaus Region Terrain Near Columbia, Kentucky**

Surface drainage within the region is directed towards numerous swales, ditches, creeks, and streams, including the Green River, Rolling Fork, and Beech Fork, as well as karst features in the area. The Green River Reservoir is located on the eastern side of the study area.

### 3.2. Stratigraphy

Corresponding USGS geologic quadrangles are available for the Gradyville (1963), Columbia (1963), Gresham (1953), Cane Valley (1964), Greensburg (1963), Campbellsville (1965), Mannsville (1966), Saloma (1976), Spurlington (1974), Bradfordsville (1965), Raywick (1973), Lebanon West (1978), Lebanon East (1978), St. Catharine (1975), Springfield (1977), Maud (1972), and Brush Grove (1973) Quadrangles.

Based on the various geologic mapping and literature reviewed, the proposed corridor is primarily underlain by limestones, shales and possibly some sandstones. Bedrock within the Mississippian Plateaus Region consists of Mississippian age limestones, shales and isolated sandstones. The limestones are predominantly gray, medium to coarse grained, zones argillaceous, with fossiliferous and cherty zones. The shales are gray, clayey to silty, with calcareous zones. The sandstones are generally light to yellowish gray, and very fine to medium grained.

The Knobs Region is underlain by shales and limestone that are Ordovician, Silurian, Devonian and Mississippian in age. The predominant rock type in the area are Devonian age dark gray carbonaceous shales of the New Albany Shale Formation. The New Albany Shale is often acidic and toxic when exposed to air and water. Ditches, soils and the surrounding bedrock often show mineralization deposits due to the acidity of the New Albany Shale. Guardrails showed corrosion at some locations because of the acidity of the shale. The Silurian age bedrock consists of sporadic layers of dolomitic limestone. Ordovician age limestone and shales are situated in the lower elevations within The Knobs area. Mississippian age limestones and shales, similar to the bedrock encountered in the Mississippian Plateaus Region, occurs in the upper elevations for portions of The Knobs.

The Outer Blue Grass Region is predominantly underlain by limestones and shales. The limestones are generally gray, micro-grained to coarsely crystalline grained, zones silty and/or argillaceous, and fossiliferous. The shales are usually gray, calcareous, and sometimes silty. Some shales throughout the corridor could be considered a siltstone. Photo 2 shows a typical rock cut in the Outer Blue Grass Region. Alluvial deposits of clay, silt, sand, and gravel are also present along major streams and rivers in the area.

**Photo 2. Typical Outer Blue Grass Stratigraphy Along Existing KY 555 Road Cut Showing Interbedded Limestones and Shales**

### 3.3. Faulting in the Area

Based on USGS Geologic mapping, an east-west trending unnamed fault crosses the environmental footprint studied approximately one mile south of Lebanon, Kentucky. The fault crosses both corridors studied in this report. The strike of the fault tends to be parallel with and is in the vicinity of KY 2741. Terrain in the area of the fault is generally covered by soils and vegetation. Several areas of irregular or abruptly changing topography was noted during field observations that may be associated with the fault. Several scarps and outcrops probably associated with the fault are visible along KY 2741. The displacement of the fault could not be determined during this study. See Photo 3 for a view of an apparent fault scarp in the area.

**Photo 3. Apparent Fault Scarp Along KY 2741 South of Lebanon, Kentucky**

USGS Geologic mapping also indicates that a series of east-west trending faults are situated within the environmental footprint in the vicinity of Springfield, Kentucky. One fault of this series is situated approximately 0.3 miles east of the proposed eastern corridor on the north side of Springfield. Another fault within this series of faults is noted approximately 3.5 miles southeast of Springfield. This fault is mapped within portions of the western corridor studied during this overview.

Another series of faults are shown on USGS Geologic mapping near the eastern edge of the environmental footprint near Salleetown, Marion County, Kentucky. These faults are not near the corridors studied in this report and are not likely to have an effect on this project.

The faults discussed are not considered to be active in recent geologic time. Fault locations are shown on the Physiographic Regions map presented in Appendix II. The faults described are as shown on USGS geologic mapping. No additional faults were found during our field reconnaissance of the area. It is possible that other faults exist within the environmental footprint that are not exposed at the ground surface and/or were not found during this overview.

### 3.4. Soils and Unconsolidated Materials

Residual soils are the predominant soil type within the environmental footprint. Soil descriptions contained herein are based upon SCS soil surveys, observations made during the field reconnaissance, and on FMSM's knowledge of the study area. Soils within the Mississippian Plateaus Region along the corridors are predominantly a clayey to silty clay and range in depths from four feet to greater than twelve feet. Soils can become very thin to very deep in karst areas within a relatively short distance. Soils associated with The Knobs Region are generally covered by a clayey to loamy soil that ranges from shallow to deep (zero to greater than six feet thick). In areas close to rock outcrops, the soils can be acidic because of the acidic nature of the New Albany Shales that exist in The Knobs area. Disturbed areas along existing roadways often exhibit shallow to no soils in The Knobs area. Soils within the Outer Blue Grass Region are generally moderately deep to deep (greater than five feet deep), clayey to silty loams, and contain karst areas.

Alluvial materials comprised of sands, silts and gravels cover the floodplains of major streams and tributaries in the study area. Major streams within the environmental footprint include Green River, Rolling Fork, and Beech Fork. Green River Lake is just east of the study area.

### 3.5. Groundwater

Groundwater flow is controlled by many factors throughout the study area. Groundwater flows primarily by secondary porosity such as along bedding planes, joints, fractures, and karst features such as sinkholes and subterranean channels. Groundwater also migrates through the fabric of the bedrock in the area. Many of the limestones and shales retard but do not prevent the flow of water because of their low permeability. Springs often occur at the intersection of the ground surface with the bedding planes of more durable, less permeable rock units. Springs occur where karst activity has developed in the bedrock above a more durable, less permeable rock unit.

Based on the USGS Hydrologic Atlas of the area, most drilled wells in the footprint area do not produce enough water for domestic purposes. Wells near bottom areas and drainage channels sometimes produce 100 to 500 gallons per day. The water is hard and may contain salt or hydrogen sulfide, especially at depths greater than 100 feet. No groundwater well inventory was performed during this overview.

### 3.6. 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. To assist designers in the Commonwealth of Kentucky, the KYTC began a research project in conjunction with the University of Kentucky and the Kentucky Transportation Center (KTC) in 1996. The products of this effort are documents in the publication "Source Zones, Recurrence Rates, and Time Histories for Earthquakes Affecting Kentucky", Research Report KTC-96-4, by Ron Street, et al., (1996). This document and other information available from the Kentucky Geological Survey (KGS) were reviewed in relation to the Heartland Parkway Corridor.

An Earthquake Epicenters and Magnitudes Map for the Central and Eastern United States from 1568 to 1987 is presented in Figure 1. This map indicates that earthquakes are uncommon within the Heartland Corridor area, but the area could be affected by earthquake events from other areas, particularly the New Madrid Seismic Zone (NMSZ). The NMSZ lies within the Central Mississippi Valley, extending from northeast Arkansas, southeast Missouri, western Tennessee, western Kentucky, and southern Illinois. The NMSZ is the most seismically active region in the United States east of the Rocky Mountains.

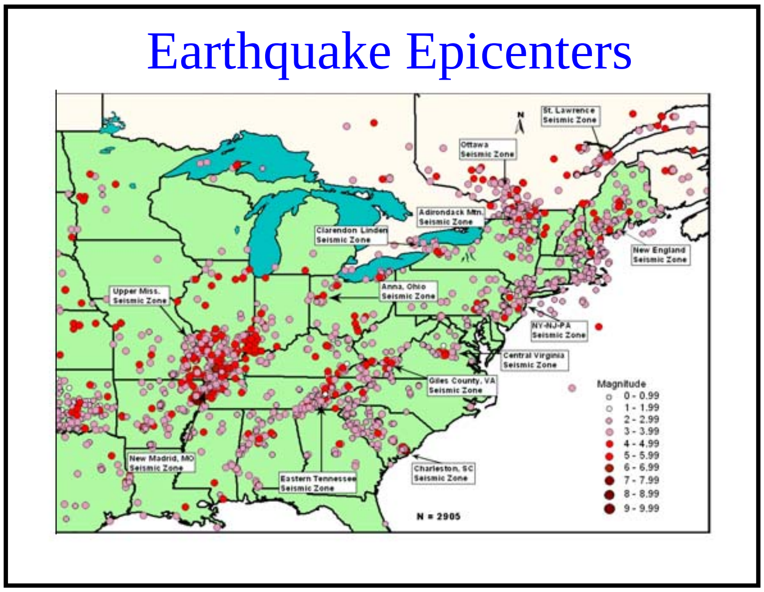


**Figure 1. Earthquake Epicenters and Magnitudes in the Central and Eastern United States from 1568 -1987**

The KTC-96-4 research report indicated that a Central Kentucky earthquake event occurred on February 28, 1854 and assigned a Modified Mercalli intensity of V. The most severe effects of that earthquake was reported in Lebanon, where dishes and windows rattled. The earthquake was felt at numerous other locations in Kentucky including Bardstown and Harrodsburg.

A time history response spectra identification map for Kentucky is presented in Figure 2. This map shows county groupings compiled by Street et. al. (1996) for earthquake events not exceeding 50-year intervals. The recommended design earthquakes in the KTC-96-4 report were the events that produced the largest peak-particle group accelerations. Subsequently, the counties were grouped into similar regions and a design response spectra and time history were determined for each region, consistent with event producing and peak ground acceleration.

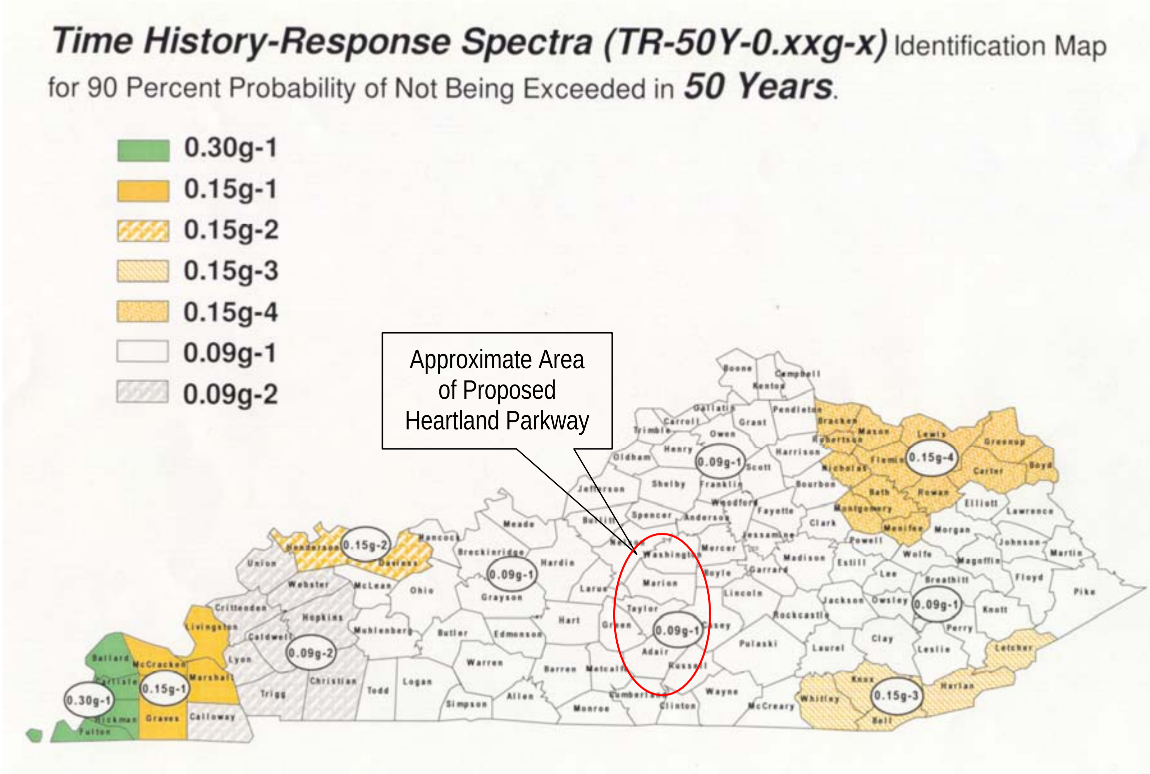


**Figure 2. County Groupings for 50 Year Event (475-Year Return Period) as Shown in Street et. al. (1996)**

Based upon Figure 2 and information contained in the KTC research report, the probability for an earthquake with damaging effects is low for this project.

# 4. Existing Corridor Features

## 4.1. General

The primary land uses within the project corridors are farmland, undeveloped forest, grasslands and wetlands; single family dwellings; and commercial entities commonly associated with communities. There are numerous limestone quarries within and surrounding the environmental footprint.

## 4.2. Domestic and Public Areas

Adair, Green, Taylor, Marion, Washington, and Nelson Counties are within a predominantly rural farm community setting. Communities such as Columbia, Campbellsville, Lebanon, and Springfield are situated at the intersection of county and state routes or historic railroad depots. Numerous schools and churches are located within the study area. Gas stations, stores, small commercial businesses and residences are common within these communities. Many small stores along the existing roadway sell gas and diesel. Existing gas stations and stores that handle petroleum products and chemicals often have numerous storage tanks for their products. Small businesses such as auto body and repair shops, farm equipment and supply stores, construction companies and equipment rental companies have tanks and other environmentally sensitive concerns. Locations of former gas stations, stores and other businesses may have abandoned storage tanks, unstable refuse storage areas, or debris dumpsites.

The rural areas generally have various homestead and farm situations that exist within sub-watersheds off a primary watershed. These properties are often owned by families that have been in the area for many decades. Lumberyards, farm equipment stores, and community groceries are commonplace in rural areas. Family and community cemeteries are common throughout the region.

Based on the observations made during the field reconnaissance, the Eastern Corridor has numerous towns and rural developments along its route. The western corridor is situated in a predominantly rural setting, with existing rural roads crossing the corridor periodically.

## 4.3. Quarry Locations

There are several active and inactive crushed stone and sand quarry sites within the environmental footprint. Specific locations of the quarries have been presented on individual location maps in Appendix IV showing the approximate permit boundaries of the quarries. The quarries are currently being mined or have been mined in the past for limestone, dolomitic limestone and/or dolomite rock, or sand and gravel materials for a variety of construction uses. FMSM has discussed the permit status of each quarry site with the Kentucky Department for Surface Mining Reclamation and Enforcement (KDSMRE) – London District Office. Table 1 presents a summary of information obtained from KDSMRE. Exhibit numbers referenced in Table 1 relate to the individual quarry location maps presented in Appendix IV.

**Table 1. Quarry Locations and Status**

| Quarry/ Exhibit No. | Quarry Name | County | Permit No. | Status* |
|---|---|---|---|---|
| 1 | Gaddie – Shamrock, Inc. | Adair | 001-9402 | Active |
| 2 | Burton Stone, Inc. | Adair | 001-9403 | Active |
| 3 | Henson Paving | Adair | 001-9600 | Active, No Significant Mining |
| 4 | Nally & Gibson Quarries, Inc. | Green | 044-9400 | Not Active, Not Disturbed |
| 5 | Nally & Gibson Quarries, Inc. | Green | 044-9401 | Active |
| 6 | Haydon Brothers Aggregate, LLC | Green | 044-9402 | Active, Mining Ceased, Being Reclaimed |
| 7 | Nally & Gibson Quarries, Inc. | Taylor | 109-9400 | Active |
| 8 | Nally & Haydon Surfacing, Inc. | Marion | 078-9400 | Active |
| 9 | Nally & Gibson Quarries, Inc. | Washington | 115-9400 | Active |
| 10 | David Butler owns property (not confirmed) | Adair | NA | Inactive |

* Based on conversations with KDSMRE- London District Office Personnel on August 1, 2003.

All quarries above are thought to involve surface mining of the surrounding bedrock, with the exception of Quarry No. 3. Quarry No. 3 apparently is involved with mining sand and gravel material from a bottom area. FMSM conducted site visits to each known quarry location that may have an effect on the proposed corridors. Based on the proximity of workings observed, the quarries referenced as 3, 8, and 10 are in the vicinity of the Eastern Corridor. Quarry No. 9 is between the western and eastern corridors and could have an effect on an alignment for either corridor should they be shifted towards the quarry. Quarry No. 10 is an abandoned quarry that is not thought to have been mined since the late 1960s, early 1970s according to Pyles Concrete Personnel. They said that the quarry is owned by David Butler, and that Randle Pyles has a lease on the mineral rights on the property. Photo 4 shows the inactive

**Photo 4. View of Abandoned Quarry East of KY 55 on North Side of Columbia, Kentucky**

and abandoned quarry north of Columbia (Quarry No. 10). The two corridors have been chosen to avoid or minimize impacts to these areas. If the Eastern Corridor is chosen, an additional study should be performed when choosing an alignment due to the close proximity of the quarries to the existing roadway.

# 5. Geotechnical Considerations

## 5.1. Karst Activity in the Area

Karst activity exists over portions of the project area. Based on existing occurrences of known karst in the area, bedrock in the Outer Blue Grass Region is considered to have a moderate potential for karst development over approximately half of the area within the project. The potential for moderate karst activity is greater between Springfield and Lebanon.

Karst activity within The Knobs area is generally considered to be limited. Limestone bedrock exists within the lower and upper elevations of The Knobs Region which is where karst activity may be encountered. The Knobs Region is roughly defined as being between Lebanon and the Marion/Taylor County line.

Moderate to high potential for karst development exists for a significant portion of the bedrock within the Mississippian Plateaus Region. The potential for karst activity is greatest in areas near Columbia, Kentucky. Photo 5 shows a collapsed sinkhole along KY 55 near Columbia. Based on observations made during the field reconnaissance and from reviews of USGS topographic mapping of the area, there are numerous sinkholes and depressions situated in the immediate vicinity of both corridors from the Louie B. Nunn Parkway to approximately five miles north of Columbia. Appendix III includes a map prepared by KGS titled “Karst Occurrence in Kentucky” showing the potential for karst activity throughout the State of Kentucky, including the Heartland Parkway study area. Solution weathering exposed in a rock cut along KY 55 is presented in Photo 6.

**Photo 5. Collapsed Sinkhole Within the Mississippian Plateaus Physiographic Region**

An inventory of karst features is recommended during the next phase of study in areas where there is potential for karst activity. The inventory may be utilized to refine alignments and account for environmental related concerns such as water runoff into such features.

**Photo 6. Solution Weathering Observed Within Cut Along KY 55 in the Mississippian Plateaus Physiographic Region**

### 5.2. Acid Drainage Potential

There is a significant potential for acidic drainage to occur within The Knobs Region where the New Albany Shale may be exposed to air and water. The Knobs Region is depicted on the Physiographic Regions map presented in Appendix II which is in the center portion of the environmental footprint. Acid drainage could be generated from exposed rock outcrops, embankment areas, and/or fill areas composed of New Albany Shale. New Albany Shale is generally dark gray to black, carbonaceous, often exhibits conchoidal fracturing, weathers with iron staining, and contains pyrite nodules and laminations. Existing roadways within The Knobs area exhibits very little or no vegetation in many areas along cut and fill areas. Photos 7 and 8 show affects of probable acidic drainage in rock cuts and fills along roadways within The Knobs Region. Existing vegetation often appears burned or dried out.

**Photo 7. Existing Roadway Cut Along KY 55 South of Lebanon Within The Knobs Region - Cut in New Albany Shales Exhibiting Sparse Vegetation Because of Acidic Drainage**

Cuts and existing embankments in this area should be assessed for acidity and remedial measures such as capping exposed acidic strata with four feet of clay-like, non-acidic material. Acidic materials used in embankments should be encapsulated in a similar manner. Capped areas should then be properly vegetated or protected with limestone aggregate. The use of limestone lined ditches or detention basins designed to neutralize acidic drainage should also be considered during the next phase of study.

**Photo 8. Existing Roadway Fill Composed of New Albany Shales - Shows Lack of Vegetation Probably Due to Acidic Drainage from the Shale**

## 5.3. Cut Slope Considerations

It is anticipated that roadway cuts within the Outer Blue Grass and The Knobs Regions would consist predominantly of a combination of soil and rock excavations. The majority of the cuts within the Mississippian Plateaus Region is likely to be shallow cuts in soils and bedrock. As previously discussed, rock types will consist of limestones, shales, and possibly sandstones. These rock types were observed along existing open cuts at several locations during the field reconnaissance. It is anticipated that the rock types will consist of durable and non-durable materials. 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. These type of cuts could be anticipated within the Mississippian Plateaus and Outer Blue Grass Regions. Situations where the bedrock is highly weathered and/or is non-durable (Type II and III non-durable), the cut slopes are laid back on 1.5H:1V to 2H:1V slopes. Non-durable shales should be anticipated within the Knobs Region. Vertical lifts are typically separated by 18-foot to 20-foot wide intermediate benches, the elevations of which are controlled by breaks in lithology. Overburden benches are typically placed at the base of the weathered rock zone (RDZ), and 2H:1V slopes utilized for weathered rock and soil overburden at the top of a cut. Shallow cuts in bedrock may be best handled on 2H:1V slopes, covered with a soil layer and vegetated. Once the roadway is built, less maintenance would be required in this situation.

Cut slopes in suspected acidic strata within the Knobs Region should be constructed no steeper than 2H:1V. A four-foot clay-like, non-acidic layer should then be placed on the reclaimed slopes as described in Section 5.2.

## 5.4. Embankment Considerations

The anticipated excavated rock materials should be suitable for use in project embankments. Select rock types for use as rock embankment, rock roadbed, channel lining, etc. would be durable limestones and/or durable shales. Foundation soils are likely to be clays, silty clays, clayey silts and clayey 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 or in areas where embankments are founded on alluvial, colluvial or mine spoil materials. Alluvial soils can be expected along Green River and Rolling Fork. Mine spoil materials should be expected at the quarry locations identified in Section 4.3.

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.

### 5.5. Seismic Concerns

Although faults are located in the area of study, the probability for an earthquake with damaging effects is low for this project. During a more comprehensive geotechnical exploration, site seismicity issues should be evaluated in conjunction with subsurface profiles to determine if earthquake loadings could be a problem with structures, cut slopes or embankments. If seismicity appears to be a problem, then common computer programs can be utilized to input dynamic conditions for evaluation of slope stabilities and a seismic site response analysis may be required to evaluate structures.

A seismic event could induce liquefaction of foundation soils beneath embankments and substructure locations. Liquefaction induces a reduction of the load bearing capacity of the soils in the affected areas. Liquefaction is typically associated with deep, loose soils. Liquefaction potential of soil is significantly affected by the soil structure, void ratio, soil type, initial confining stress and intensity/duration of ground motion. In review of the geologic quadrangles, alluvial soils on the order of 50 feet thick could be encountered along Green River and up to 40 feet thick within Rolling Fork. If liquefaction appears to be a concern after a comprehensive geotechnical exploration, detailed liquefaction potential studies should be performed in order to evaluate foundation recommendations.

### 5.6. Concerns Related to Faults in the Area

Faults known to exist in the area are not considered to be active, thus it is highly unlikely that the faults would shift causing an earthquake. Potential for slumping and other forms of slope failure exists because of unstable conditions of the bedrock and soils along the areas affected by the fault. Based on the known fault locations discussed in Section 3.3, the current corridors are positioned to encounter the faults perpendicular to the strike of the faults. This orientation should minimize typical problems associated with roadway construction in areas of known faults. Alignments trending parallel with the strike of a fault are more likely to encounter problems from unstable bedrock blocks and soil. Problems from the fault areas include folding of bedrock, significant fracturing and other localized faults. Areas of known faulting should be studied further and appropriately considered during the design phase of any chosen roadway corridor.

## 6. Conclusions and Recommendations

6.1. The purposes of this overview were to provide a general summary of the bedrock, soil and geomorphic features likely to be encountered within the proposed environmental footprint and corridors; and to identify geotechnical features that could have an adverse impact on the Heartland Parkway project. This overview has also been performed to assist the Project Team in choosing a preferred corridor.

6.2. Based on observations and information reviewed during this study, both corridors are feasible and would encounter similar geotechnical concerns and geologic conditions. The Eastern Corridor is the preferred roadway geotechnically because there would likely be less new disturbance to implement proposed improvements and require the least amount of new cut and fill situations. The main disadvantage of the Western Corridor may be from a cost perspective.

6.3. There are several active, inactive, and abandoned limestone and sand quarries known to exist in the immediate vicinity of the studied corridors. If the Eastern Corridor is selected as the preferred corridor, quarries situated near the existing roadways should be further evaluated for potential impacts.

6.4. The potential for encountering karst activity such as soil piping and solutioning of bedrock, as well as karst features such as sinkholes and subterranean channels, are significant over portions of both corridors. Potential for karst activity is greatest in the southern portion of the corridor within the Mississippian Plateaus Region near Columbia, Kentucky. FMSM recommends that an inventory of karst features be conducted during the geotechnical exploration to assist the Design Team in line and grade selection.

6.5. The potential exists for acid drainage from bedrock and soils within The Knobs Region. The New Albany Shale within that region is a known acidic stratum. Particular attention should be given to the design of cut slopes and embankments that are located in The Knobs Area. Cuts and embankments within the New Albany Shale and residual soils from the New Albany Shale should be encapsulated with a minimum of four feet of clay-like, non-acidic material.

6.6. Oil and gas wells could be encountered along any chosen corridor. It is generally good practice to avoid disturbing oil and gas wells, if possible.

6.7. Because of the clayey type soils within the corridors, a low CBR value should be anticipated. Therefore, if durable rock is not available for a rock roadbed, chemical modifications to the soils and thicker pavement sections may be required.

6.8. The information presented in this report should be viewed in the general nature in which it was intended. A more detailed study, which was beyond the scope of this work, will be required to more specifically define potential problem areas within any alternate corridor proposed for the Heartland Parkway. A thorough geotechnical exploration of the selected alignment(s) and grade(s) will be required to properly anticipate and plan for special requirements necessary for the design and construction of a roadway once a preferred corridor and alignment is chosen.