REPORT OF GEOTECHNICAL OVERVIEW

Planning Study for US-42 Improvements
Between KY 841 and Rose Island Road
Prospect, Kentucky

Prepared For:
QK4, Inc.
1046 East Chestnut Street
Louisville, Kentucky 40204

Prepared By:
K. S. Ware and Associates, L.L.C.
350 Cal Batsel Road
Bowling Green, Kentucky 42101

KSWA Project No. 500-21-0007

April 15, 2022

December 20, 2021

Mr. Tom H. Springer, CICP, CEP
QK4, Inc.
1046 E. Chestnut Street
Louisville, Kentucky 40204

Subject: **Report of Geotechnical Overview**
Planning Study for US-42 Improvements
Between KY 841 and Rose Island Road
Prospect, Kentucky

Mr. Springer:

K. S. Ware and Associates, L.L.C. (KSWA) is pleased to present to you this this geotechnical overview report for Planning Study for US-42 Improvements project in Prospect, Kentucky. The attached report summarizes the project information provided to us, describes the site conditions observed during our site reconnaissance, and summarizes the general site geologic conditions. The Appendices include figures depicting topographic information and mapped geologic formations.

We appreciate the opportunity to be of service to you on this project. Please contact us if you have any questions regarding this report. We look forward to serving as your geotechnical consultant on the remainder of this project.

Respectfully submitted,

K. S. Ware and Associates, L.L.C.



Nathan Long
Digitally signed by Nathan Long
Date: 2022.04.15 08:57:40 -05'00'

Nathan Long, P.E.
VP of Geotechnical Services



Derek L. Hodnett, P.E.
VP of Engineering Services

Enclosures: Report of Geotechnical Overview

Distribution: File (1)

350 Cal Batsel Rd | Bowling Green, KY 42101
270.842.1070 phone | 615.256.5873 fax | info@kswarellc.com

TABLE OF CONTENTS

1.0 INTRODUCTION 1
1.1 PROJECT INFORMATION 1
1.2 PURPOSE AND SCOPE OF STUDY 1
2.0 SITE GEOLOGY 2
2.1 PHYSIOGRAPHIC PROVINCE 2
2.2 GEOLOGIC FORMATIONS 2
2.2.1 Q_o – Glacial Outwash 2
2.2.2 Q_{al} –Alluvium 2
2.2.3 Q_{at} – Terrace Deposits 2
2.2.4 D_{sj} – Sellersburg and Jeffersonville Limestones 2
2.2.5 S_{lv} – Louisville Limestone 3
2.2.6 A_f – Artificial Fill 3
2.3 KARST POTENTIAL 3
2.4 FAULTS 4
2.5 SEISMICITY 4
3.0 SITE CONDITIONS 5
4.0 GEOTECHNICAL CONSIDERATIONS 6
4.1 PAVEMENT SUBGRADE 6
4.2 EMBANKMENT AND CUT SLOPES 6
4.3 BRIDGES STRUCTURES 7
4.4 SINKHOLES 7
5.0 QUALIFICATIONS OF RECOMMENDATIONS 8

APPENDICES

APPENDIX A - PROJECT SITE MAP
APPENDIX B - GEOLOGIC MAP
APPENDIX C - KARST POTENTIAL MAP
APPENDIX D - PHOTOGRAPHS

1.0 INTRODUCTION

1.1 PROJECT INFORMATION

The project consists of identifying potential improvements to the existing US 42 roadway between KY 841 (Interstate 265) and KY 3222 (Rose Island Road). The existing roadway along this 2.3-mile alignment consists of a four-lane undivided highway. Paved shoulders are located along the outside lanes and are generally about 3 feet wide. One bridge is located along the roadway where it crosses over Harrods Creek. Additionally, KY 841 (I-265) passes beneath the alignment at the southern terminus of the project through the East End Tunnel.

We understand improvements may consist of new intersection designs and widening to add turn lanes, bicycle lanes, and/or sidewalks.

1.2 PURPOSE AND SCOPE OF STUDY

The purpose of the study was to perform a geotechnical overview for the project to address geotechnical issues that may affect the potential improvement options discussed above. To identify potential geotechnical issues, we performed a desktop study of available published geotechnical data/information for the proposed project area. We also performed a site visit to observe the project area, paying particular attention to existing cut and fill embankments within the area. We performed the geotechnical overview in accordance with Section 801 of the KYTC Geotechnical Guidance Manual. Below is a list of KYTC geotechnical reports reviewed as part of this study:

- US-42 widening in Oldham County from the county line north to Ridgemoor Drive (R-023-2012).
- US-42 widening in Prospect from Harrods Creek north to River Road (R-024-2012).
- Bridge rehabilitation and widening for River Road over Harrods Creek (S-085-2003).
- Existing Louisville East End Tunnel (R-029-2008)
- New bridge for KY 841 over Harrods Creek (S-083-2012)

2.0 SITE GEOLOGY

2.1 PHYSIOGRAPHIC PROVINCE

Prospect is located in the Outer Bluegrass Physiographic Region, which is characterized by rolling terrain with very little flat land. The bedrock of the Outer Bluegrass typically consists of limestone, dolomite, and shale of the Late Ordovician age. Additionally, limestones of the Mid-Silurian and Mid-Devonian ages are exposed in the Louisville area.

2.2 GEOLOGIC FORMATIONS

The Kentucky Geological Survey's (KGS) online Geologic Map Service indicates the US-42 alignment crosses 6 mapped geologic units. Appendix B includes a Geologic Map depicting each of these units, which are further discussed below.

2.2.1 Q_O – GLACIAL OUTWASH

Glacial outwash is mapped along the majority of the alignment. The outwash deposits consist of intermixed sand, gravel, silt, and clay. These materials were deposited as alluvium following release of glacial meltwater. The maximum thickness is about 120 feet.

2.2.2 Q_{AL} –ALLUVIUM

Alluvium is mapped within the Ohio River valley and along Harrods Creek. The US-42 alignment crosses Harrods Creek about 3,000 feet north of its intersection with I-265. The alluvium in this area is typically composed of varying quantities of clay, silt, sand, and gravel. Gravel is primarily composed of chert, dolomite, and limestone. Maximum thickness is approximately 20 feet along Harrods Creek.

2.2.3 Q_{AT} – TERRACE DEPOSITS

This unit is mapped at the far north end of the project alignment and east of the project along the eastern extent of the alluvium. These deposits generally represent older alluvium or outwash deposits along the margins of the Ohio River valley. The soil is silt over sand and gravel. Maximum thickness is approximately 70 feet.

2.2.4 D_{SJ} – SELLERSBURG AND JEFFERSONVILLE LIMESTONES

The Sellersburg and Jeffersonville Limestones are mapped as a single unit on the referenced geologic map at the south end of the project, where US-42 intersects I-265. The Sellersberg Limestone Formation is characterized by two distinct members; the Beechwood Limestone Member and the Silver Creek Limestone Member. The Beechwood Limestone member is a highly fossiliferous unit that is light-greenish-gray in color. The limestone contains coarse to very coarse white fossil fragments and whole fossils suspended in a very fine-grained brown matrix. Bedding is typically very thin to thin with local crossbedding. Beds of gray to pink chert reaching maximum thicknesses of 6 inches can be found throughout the member. Additionally, thin layers of pyrite and quartzose sand and phosphatic nodules are commonly found at the top and base of formation. Thickness of the member ranges from 2 to 15 feet.

The Silver Creek Limestone member is a silty, dolomitic limestone that varies from light-bluish-gray, olive-gray, and light-greenish-gray in color. The member is moderately fossiliferous and contains calcareous stringers throughout. Maximum thickness of the member is 5 feet. The overall distribution of this member is sporadic and is often missing from the stratigraphy.

The Jeffersonville Limestone is a fossiliferous, pyritic limestone bound in a matrix of sparry calcite or calcareous mudstone. Colors include various shades of gray. Scattered bands of chert found throughout the formation. Thickness ranges from zero feet to 25 feet and tend to increase in thickness to the north.

2.2.5 S_{LV} – LOUISVILLE LIMESTONE

This unit is below the Jeffersonville Limestone and mapped along the hillside as US-42 descends from the high point at the south end of the project. The Louisville Limestone is a dolomitic limestone found in various shades of gray, micro-grained to fine-grained, very thin to thick bedded, and fossiliferous. One to 2 feet of shale can be found approximately 6 to 10 feet above the base of the formation. Chert layers found in the upper portion of the formation. Calcite filled joints and vugs found throughout. Thickness ranges from 65 to 85 feet.

2.2.6 A_F – ARTIFICIAL FILL

Artificial fill is mapped in low-lying areas south of Harrods Creek where fill materials were likely placed during construction of the existing roadway.

2.3 KARST POTENTIAL

As mentioned above, significant portions of the southern portion of alignment is underlain by limestone formations, which are susceptible to solution weathering and sinkhole development. Therefore, we reviewed the KGS's online Karst Potential Map to evaluate the possibility of karst activity along the project alignment. The majority of the alignment was mapped as Non-Karst due to the alluvial deposits along the alignment. However, the areas within the Louisville Limestone were mapped as having a Medium karst potential, and the areas within the Sellersburg and Jeffersonville Limestones were mapped as having High karst potential. We have included KGS's Karst Potential Map in Appendix C.

We also reviewed the following maps for additional information about mapped closed depressions.

- Surficial Geologic Map of the Anchorage Quadrangle, North-Central Kentucky (GQ-906) (20144)
- USGS Topographic Map, Anchorage Quadrangle, Kentucky (2016)

The referenced maps did not depict any closed depressions along the alignment. However, the maps did indicate 16 closed depressions within ½-mile of the alignment. These closed depressions are located in nearby areas underlain by the Louisville, Sellersburg, and Jefferson Limestones and may be an indicator of sinkhole activity. We note that the scale of reviewed maps often precludes the mapping of smaller features.

2.4 FAULTS

The KGS's online maps and the geologic maps referenced above do not depict any mapped faults along the alignment or in the project area.

2.5 SEISMICITY

The subject area is located within a relatively stable seismographic area that it is influenced by seismic activity associated with the Wabash Valley seismic zone and, to a lesser extent, New Madrid seismic zone. The hazards associated with seismic activity at the site will need to be evaluated during the design phase geotechnical investigation. However, based on our review of AASHTO's LRFD Bridge Design Specifications (8th Edition), we anticipate a Seismic Performance Zone of 1 or 2 for the bridge along the alignment. We also anticipate Site Classes will range from C (Very Dense Soil and Soft Rock) to D (Stiff Soil) depending on overburden thickness at the structure.

3.0 SITE CONDITIONS

On November 30, 2021, KSWA's Nathan Long, PE performed a site reconnaissance to review the site conditions along the existing alignment. The reconnaissance was performed by visually observing features along the roadway while driving multiple times through the area. We also occasionally stopped along the shoulder to take photographs, which are included in Appendix D.

The US-42 alignment is predominately located within a relatively flat setting within the Ohio River valley. However, the ground surface at the south end of the project alignment is within rolling hill topography that is typical of the Outer Bluegrass Region. The roadway within Ohio River valley portion of the alignment is predominately within minor cut and fill settings (Photo Nos. 1, 2, and 3). We estimate cut and fill slopes generally less than 5 feet tall in this area. However, fill slopes up to 35 feet tall exist at the approaches for the bridge over Harrods Creek and where the roadway descends from the hill at the south end of the alignment to the river valley (Photo No. 4). The cut and fill slopes appear to generally be at about 2H:1V or flatter.

The south end of the alignment is located along a hill within a predominately cut setting. The cut slopes consist of pre-split rock faces up to about 31 feet tall (Photo Nos. 5 and 6).

4.0 GEOTECHNICAL CONSIDERATIONS

Based upon observations from our site reconnaissance, our review of the readily available reports and maps, and KSWA's understanding of the project, KSWA reached the conclusions provided herein. These general conclusions should be preliminary for planning purposes only. A detailed geotechnical investigation with borings, laboratory testing, and geotechnical analyses should be performed for the design phase of the project.

4.1 PAVEMENT SUBGRADE

Based on the reviewed information, we estimate the subgrade soils primarily consist of clay, either native or earthen fill, with some areas of silt and silty sand. We believe the potential exists for fill embankments to also consist of rock fill generated from existing rock cuts and a combination of soil and rock.

We anticipate that widening of the existing roadway would require placing new fill adjacent to and benched into the existing roadway embankment. The upper clay and silt in this area are moisture sensitive and may be soft and wet in low-lying areas adjacent to existing fill embankments. Therefore, stabilization prior to new fill placement will likely be required in some areas prior to new fill placement and is typically performed by constructing a working platform of granular soils or aggregate wrapped in geotextile fabric. Additionally, the subgrades beneath the existing pavement could be wet and may require stabilization if the pavements are removed. Stabilization using chemical modifications (i.e., lime or cement) or rock fill is often used in the project area.

Unimproved subgrade soils within the project area generally have design CBR values ranging from 2 to 6.

4.2 EMBANKMENT AND CUT SLOPES

We estimated the existing embankment fills were constructed at 2H:1V or flatter inclinations using excavated soil and rock from the project area. We anticipate similar slope inclinations can be used for new fill slopes, assuming proper fill placement and subgrade evaluations.

We expect both soil and rock cuts will be required if roadway widening extends beyond the existing outside edge of pavement. Cut slopes in soil may be assumed to be between 2H:1V based on our review of previous reports within the study area. Existing rock cuts at the south end of the alignment consist of near vertical, pre-split rock faces (1H:20V). We anticipate 0.5H:1V or steeper rock cuts may be used if these rock faces need to be pushed back.

We expect that fill embankments over 25 feet tall will be required at the south end for the project alignment between Bridgepointe Boulevard and Ken Carla Drive. We believe settlement due to embankment loading may be a concern due to of the unconsolidated nature of the alluvial and outwash deposits in this area. A waiting period between embankment construction and pavement construction may be necessary to reduce the potential for maintenance issues due to settlement.

A detailed geotechnical investigation should be performed during the design phase to analyze slope stability and settlement for embankments over 20 feet tall and cut slopes over 10 feet tall.

4.3 BRIDGES STRUCTURES

As previously mentioned, there is one existing bridge along the study alignment. We expect this bridge may need to be widened or replaced if additional traffic lanes are desired through that area. Based on our review of available geotechnical and geologic information, we expect the foundation conditions will consist of existing fill overlying alluvial soils and bedrock at the abutments. The bent locations will likely consist of alluvium over bedrock. Depending on the depth to bedrock, it may be possible to utilize spread foundations bearing on the underlying bedrock. However, if bedrock is at depths greater than 20 feet, then new foundations would likely consist of H-piles or drilled shafts bearing on the underlying limestone bedrock. We anticipate the overburden thickness at the abutments will be greater than 20 feet due to the existing fill embankment approaches.

A detailed geotechnical investigation should be performed during the design phase of the project to determine the appropriate foundation system for bridge widening or replacement.

4.4 SINKHOLES

The southern end of the study alignment is located within an area underlain by limestone bedrock having a medium to high risk of karst. We did not observe any indications of sinkhole activity along the project alignment, but these features could be discovered during grading activities. Any sinkholes identified during construction would need to be repaired in accordance with KYTC standards.

5.0 QUALIFICATIONS OF RECOMMENDATIONS

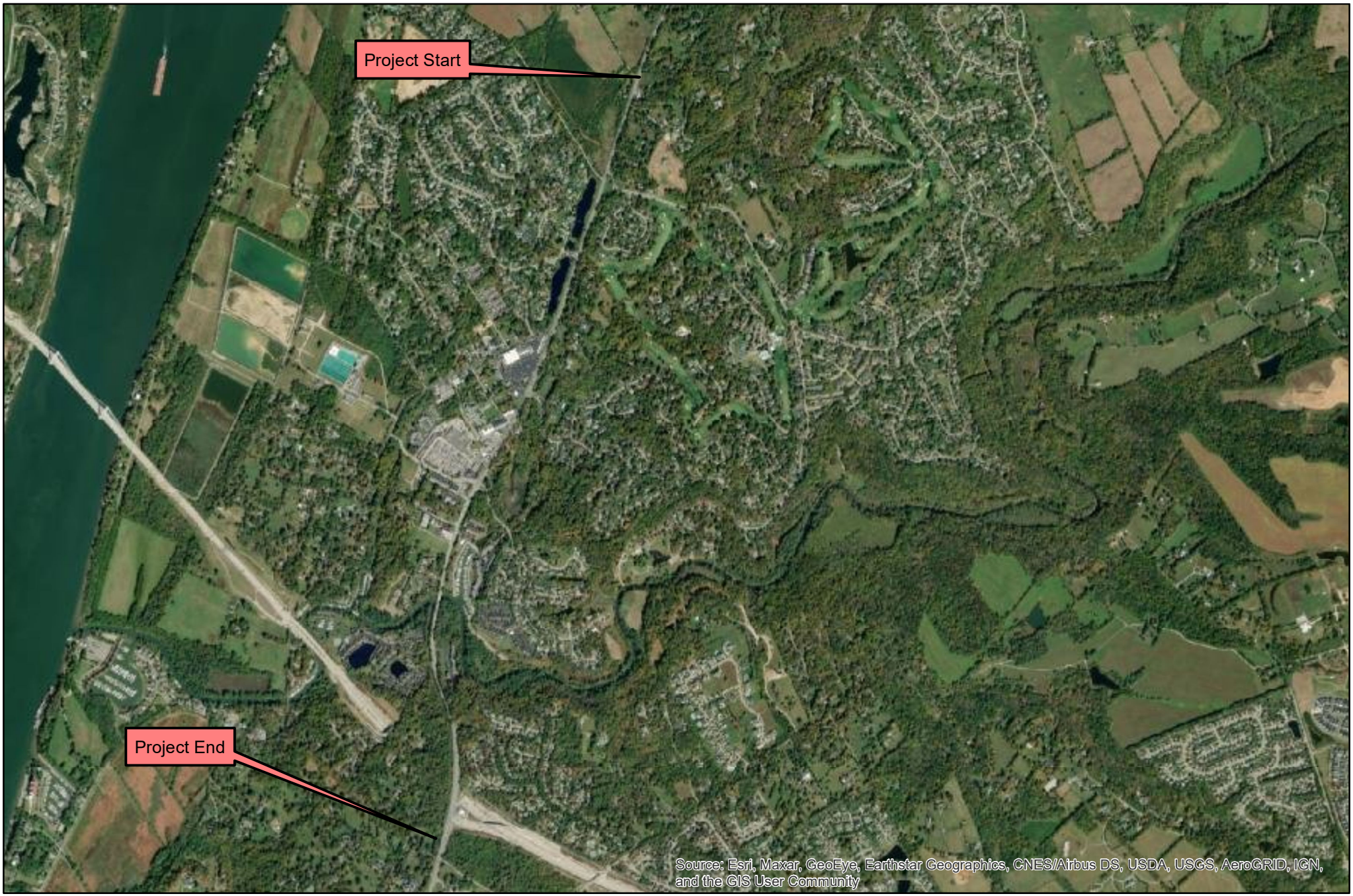
KSWA's professional services were performed, findings obtained, and recommendations prepared in accordance with generally accepted geotechnical engineering principles and practices. KSWA is not responsible for the conclusions, opinions, or recommendations made by others based upon the data included herein. The scope of this geotechnical exploration did not include assessment or exploration for the presence or absence of hazardous or toxic materials in the soil, rock, groundwater, surface water, or air within or beyond the site.

APPENDIX A

PROJECT LOCATION MAP

Site Map

KSWA
[KS WARE & ASSOCIATES]



US-42 Improvements
Prospect, Kentucky
KSWA Project No. 500-21-0007

0 0.25 0.5 0.75 1 Miles

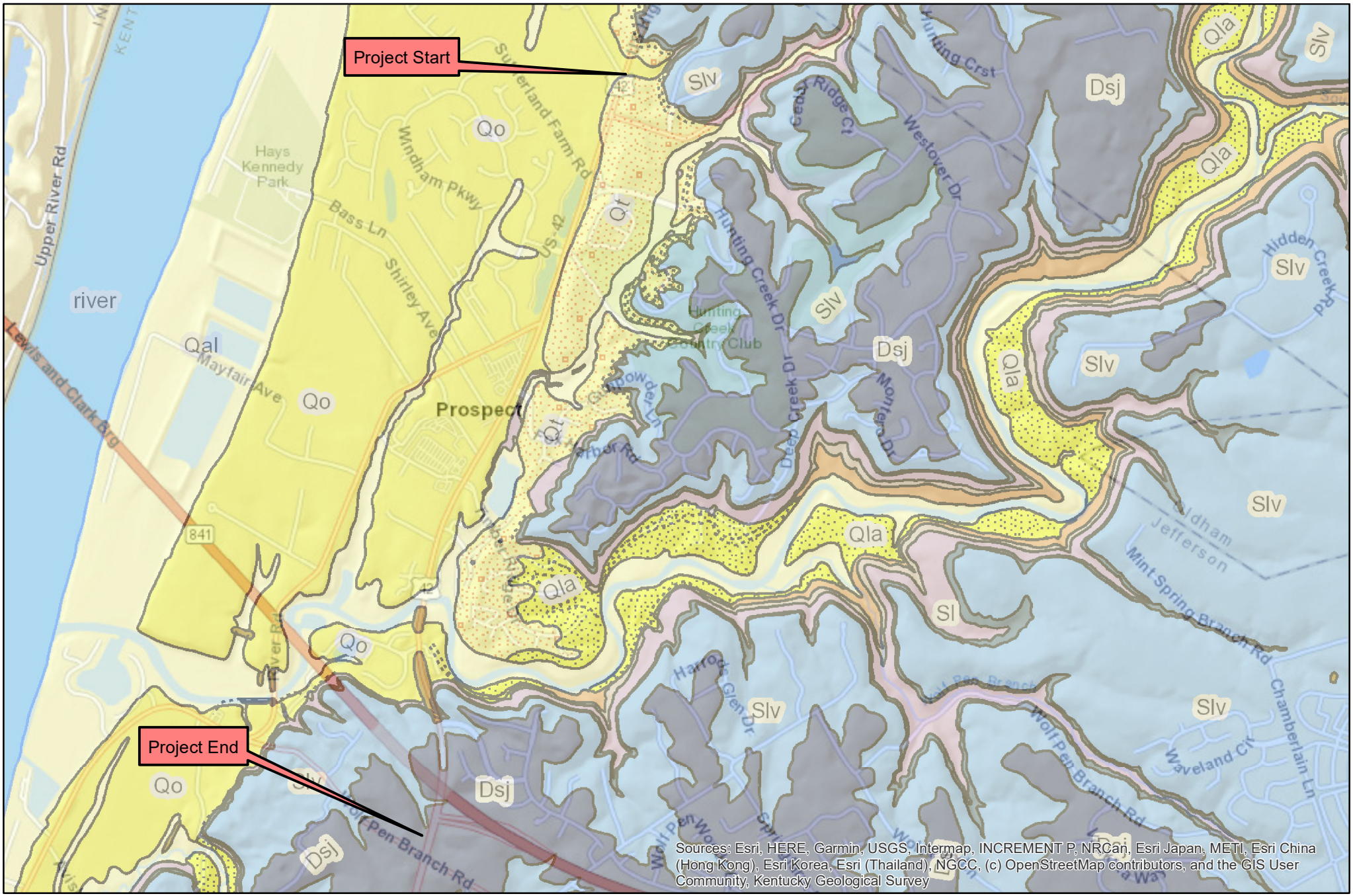
N

APPENDIX B

USGS GEOLOGIC MAP

Geologic Map

KSWA
[KS WARE & ASSOCIATES]



Qal - Alluvium
Qo - Glacial Outwash
Qt - Terrace Deposits
Slv - Louisville Limestone
Af - Artificial Fill
Dsj - Sellersburg and Jeffersonville Limestones

US-42 Improvements
Prospect, Kentucky
KSWA Project No. 500-21-0007

0 0.25 0.5 0.75 1 Miles

N

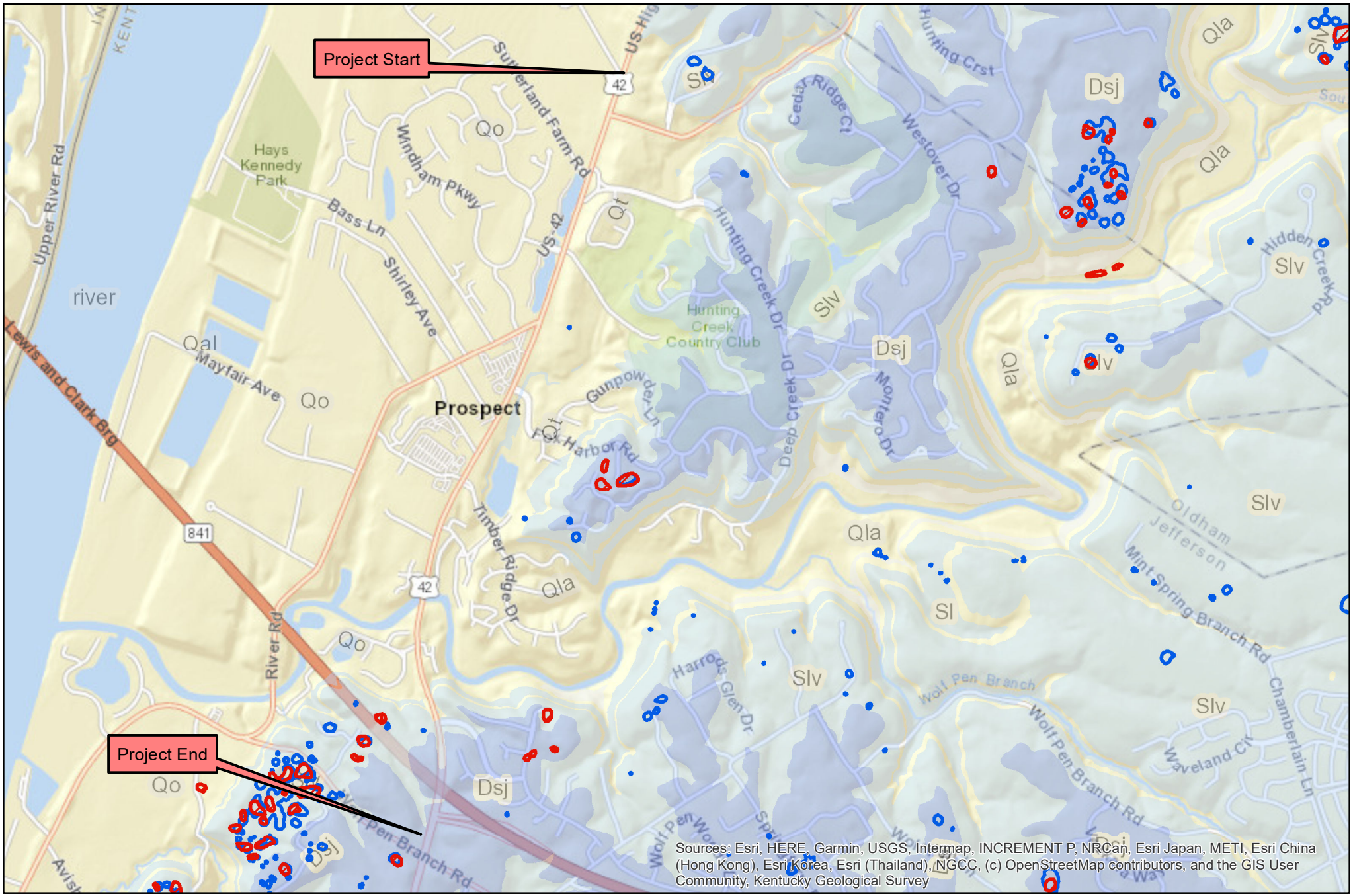
APPENDIX C

KARST POTENTIAL MAP

11/24/2021

Karst Potential Map

KSWA
[KS WARE & ASSOCIATES]



Karst Potential

- Very High
- High
- Medium
- Low
- Non-Karst
- Sinkhole

US-42 Improvements
Prospect, Kentucky
KSWA Project No. 500-21-0007

0 0.25 0.5 0.75 1 Miles

N

APPENDIX D

Photographs

Photographs
Planning Study for US-42 Improvements
November 30, 2021



Photo No. 1 – View of US-42 looking south from Sutherland Farm Road



Photo No. 2 – View of US-42 looking south from River Road

Photographs
Planning Study for US-42 Improvements
November 30, 2021



Photo No. 3 – View of US-42 looking south from City Hall



Photo No. 4 – View of bridge over Harrods Creek from Harrods Landing

Photographs
Planning Study for US-42 Improvements
November 30, 2021



Photo No. 5 – View of rock cuts looking north near I-265



Photo No. 6 – View of rock cut along south bond lanes near I-265