RECEIPT OF ADDENDUM

I received addendum No. # 02 for April 26, 2022
Pike County Bridge Replacement on C.R. 103 & C.R. 318
Project Job # 4529

This addendum involves 46 pages including this sheet.

_____
Vendor's Name

_____

_____
Vendor's Address

_____
Signature / Date

Return completed acknowledgment to Great River Engineering ASAP

Email Back to:
Secretary@greatriv.com
or
Fax # 417-886-7591
Attention: Karissa Ostroski

GRE
GREAT RIVER ENGINEERING

Addendum NO 2

ISSUED BY: *Great River Engineering*
2826 S. Ingram Mill
Springfield, Missouri 65804
(417) 886-7171
(417) 886-7591 --- FAX

DATE: April 26, 2022

FOR: **Pike County Bridge Replacement on C.R. 103 & C.R. 318.**

The attached revisions hereby supersede any and all data with which they may conflict as indicated on the Drawings, Specifications and related documents issued in the original set. Each trade is responsible for changes in its work caused by changes in the work of other trades. This addendum is a part of and shall be attached to the original set of plans and specifications for the work.

Notification: There has been one addendum prior to this addendum.

Clarifications:

Question 1: Who is responsible for setting precast slab beams for CR318 & CR 103 and how will that work be paid for?

Answer: Lifting and Placing beams will be incidental to construction so no direct payment will be made. Please distribute your estimated cost for lifting and placing beams in other line items on estimate.

Question 2: Is the relocation of pipe on CR 103 incidental to construction?

Answer: Yes, Relocation of pipe on CR 103 will be incidental to construction so no direct payment will be made.

Question 3: Is Oden Enterprises furnishing the anchor bolts and grout for the beams?

Answer: Yes, Oden Enterprises will furnish the anchor bolts, joint filler and all connecting bolts for Guardrail.

Changes to:

Construction Plan C.R. 318 Bridge:

Sheet C2 – Updated Quantities

Sheet C4 –Added Fence and Fence note.

Contract Documents:

Itemized Bid Form – Use Type A Crashworthy End Terminal instead of Type A Crashworthy End Terminal (MASH), Updated Fence Quantities, revised all Itemized bid form.

Geotech Report – Full Geotech Report

There are no other clarifications or changes included with this Addendum.

ROADWAY QUANTITIES

ITEM	TOTAL	UNITS	
CLEARING AND GRUBBING	0.1	ACRE	
UNCLASSIFIED EXCAVATION (ROADWAY)	64	CU. YARD	
EMBANKMENT IN PLACE WITH COMPACTION	98	CU. YARD	
TYPE 1 AGGREGATE FOR BASE (5 IN. THICK)	712	SQ. YARD	
GUARDRAIL TYPE A	18.75	LIN. FOOT	1
TYPE A CRASHWORTHY END TERMINAL	4	EACH	
ASYMMETRICAL TRANSITION SECTION, 6.5 FT. POSTS	4	EACH	
WOVEN WIRE FENCE	142	LIN. FOOT	2
TYPE 2 ROCK BLANKET	306	CU. YARD	
CONSTRUCTION SIGNS	63	SQ. FEET	
TYPE III MOVEABLE BARRICADE WITH LIGHT	4	EACH	
MOBILIZATION	1	LUMP SUM	
SEEDING	0.1	ACRE	
SILT FENCE	336	LIN. FOOT	
ROCK DITCH CHECK	1	EACH	

CONTROL POINT TABLE

POINT #	NORTHING	EASTING	ELEVATION	DESCRIPTION
1	1241604.3657	639384.2070	745.44	CP1 60D
2	1241641.7381	638652.6951	692.65	CP2 60D
3	1241432.2950	638252.0732	692.02	CP3 60D
4	1241691.0602	637513.3299	735.75	CP4 60D

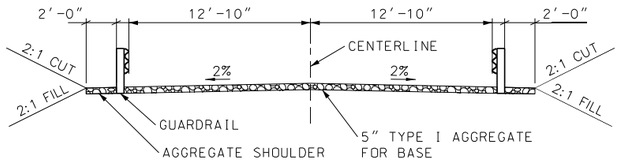
HORIZONTAL COORDINATES ARE BASED ON
THE MISSOURI COORDINATE SYSTEM OF
1983, WEST ZONE (SCALED TO GROUND)

BENCHMARK DATA

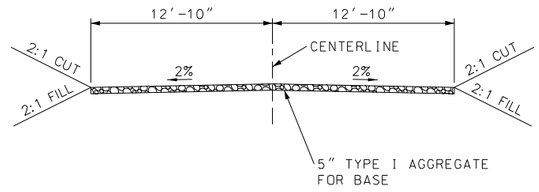
BM - SQUARE CUT IN SE CORNER OF CATTLE GUARD NORTH OF ROAD AND EAST OF CREEK

ELEVATION = 692.58

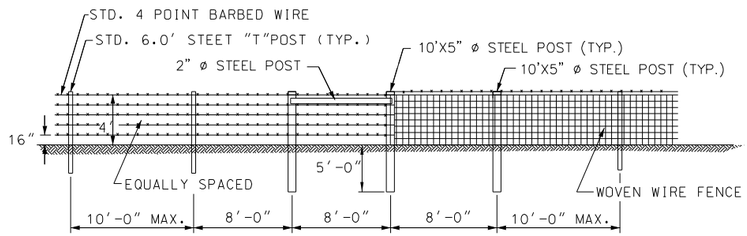
(VERTICAL DATUM : NAVD88)



TYPICAL SECTION ROADWAY WITH
CRASH RAILING



TYPICAL SECTION ROADWAY



TYPICAL CORNER AND BRACING

(FOR BARBED WIRE & WOVEN WIRE FENCING)

* CONTRACTOR SHALL MATCH EXISTING FENCE TYPE
(I.E. 5 STAND BARBED WIRE OR WOVEN WIRE FENCE)

NOTES:

1. FENCING SHOWN IN THIS DETAIL IS THE MINIMUM REQUIRED BY ENGINEER.
2. TIES TO EXISTING FENCE REQUIRE THE SAME LAYOUT AS FENCE CORNERS (I.E. CORNER POST WITH BRACING.)
3. CORNER AND BRACING POST SHALL BE BURIED A MINIMUM OF 5 FEET.
4. ALL 10'X5" ø STEEL PIPE MUST WELD ON DOME CAP. PLASTIC CAP WILL NOT BE ACCEPTED.
5. 3 STRAND BARBED WIRE TO BE USED FOR TEMPORARY FENCE, 48" WOVEN WIRE AND 1 STRAND BARBED WIRE TO BE USED FOR PERMANENT FENCE.
6 TEMPORARY GATES FOR TEMPORARY FENCE AND CORNER POSTS, TERMINAL POST AND GATE POSTS ARE INCIDENTAL TO THE FENCING BID ITEM.

GRE GREAT RIVER ENGINEERING
Great River Engineering • Missouri State Certificate of Authority Numbers: Engineering: 2007011476, Land Surveying: 2007013673, Landscape Architecture: 2007013673

No.	Revision/Issue	Date
1	ADDENDUM #1	4-15-22

IF A SEAL IS PRESENT ON THIS SHEET IT HAS BEEN ELECTRONICALLY SEALED AND DATED.

STATE OF MISSOURI MELISSA M. MASSAR NOTARY PUBLIC PE-2018000237 PROFESSIONAL ENGINEER
04/26/2022

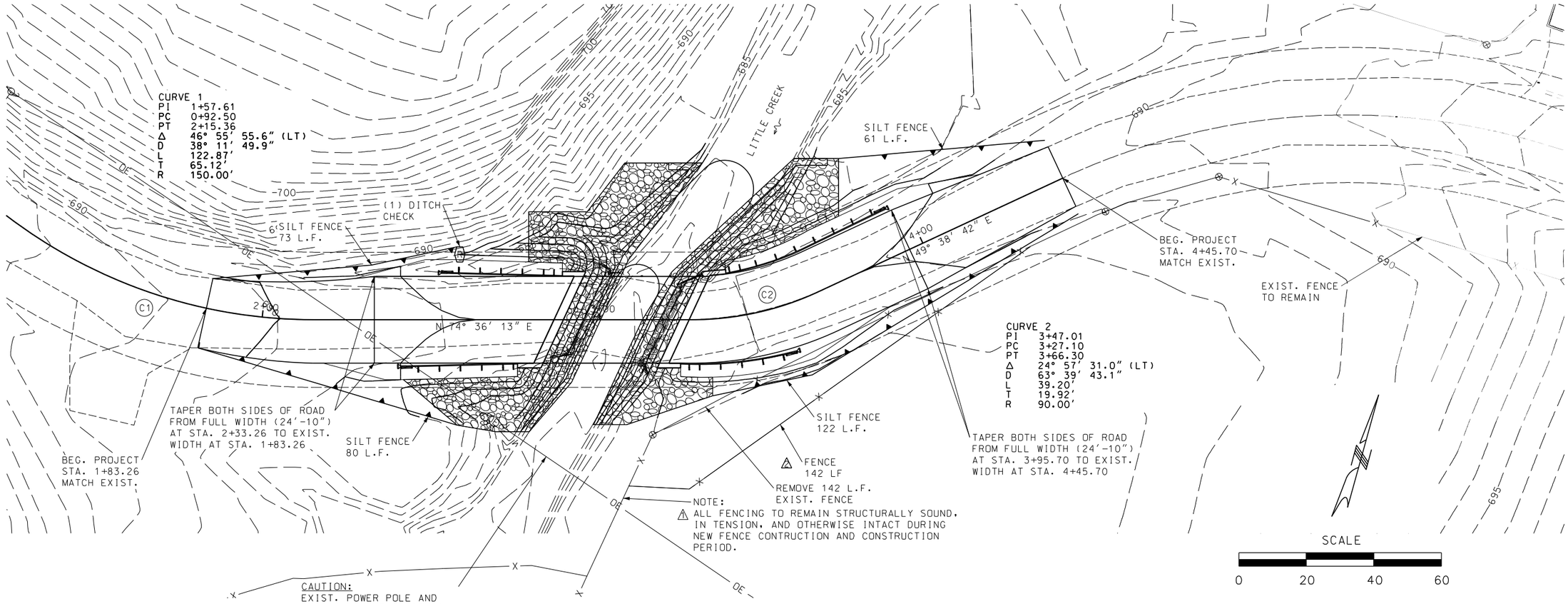
MELISSA M. MASSAR
MO# PE-2018000237

COUNTY ROAD 318 BRIDGE #18800291
PIKE COUNTY, MISSOURI

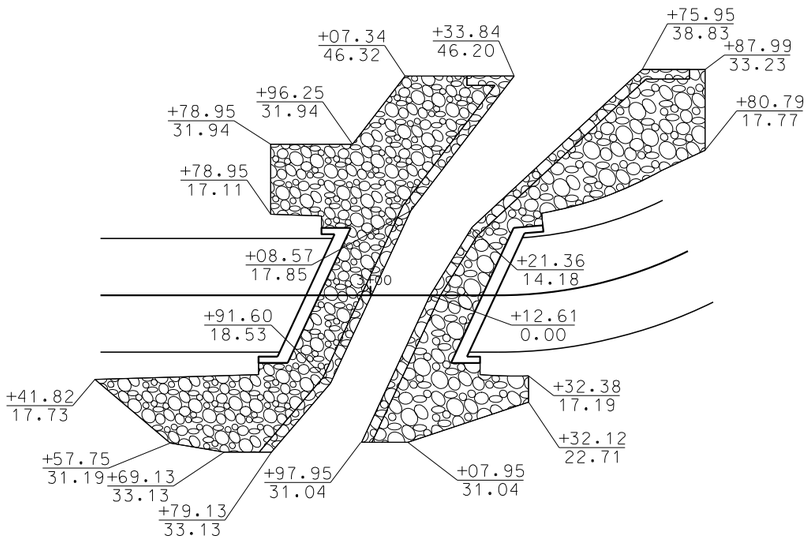
TYPICAL SECTIONS & QUANTITIES

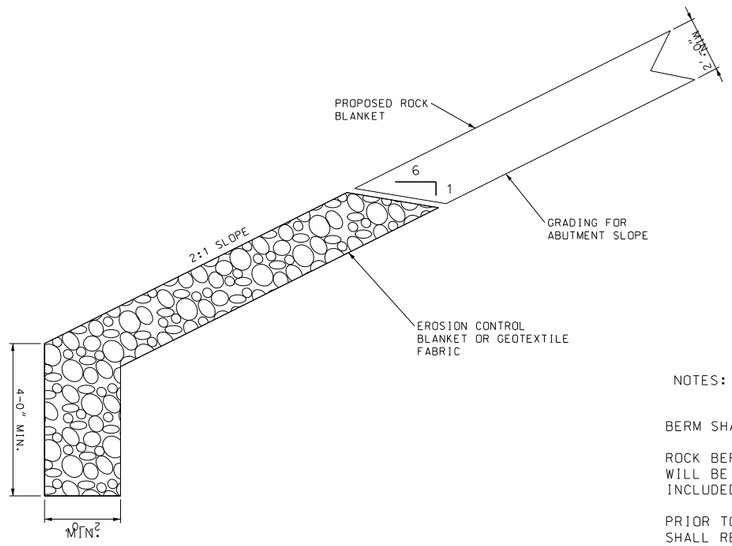
CHECKED BY: JAB
DRAWN BY: QJS
JOB NUMBER: 4529
SHEET NUMBER:

C2



GRADING AND EROSION CONTROL PLAN





ROCK BERM

NOTES:

BERM SHALL BE BUILT TO HANDLE SIGNIFICANT RUN-OFF EVENTS.

ROCK BERM SHALL BE PLACED AT THE BEGINNING OF CONTRUCTION AND WILL BE INCORPORATED INTO THE ROCK BLANKET. COST SHALL BE INCLUDED IN THE UNIT PRICE FOR THE TYPE 2 ROCK BLANKET.

PRIOR TO FINAL PLACEMENT OF TYPE 2 ROCK BLANKET, CONTRACTOR SHALL REMOVE GEOTEXTILE FABRIC AND ANY SILT BUILDUP ALONG TOP OF ROCK BERM. ALL WORK NECESSARY FOR REMOVAL SHALL BE INCIDENTAL TO BID ITEM TYPE 2 ROCK BLANKET.

GREAT RIVER ENGINEERING
Great River Engineering • Missouri State Certificate of Authority Numbers: Engineering: 2007011476, Land Surveying: 2007013673, Landscape Architecture: 2007013673

No.	Revision/Issue	Date
1	ADDENDUM #1	4-15-22
2	ADDENDUM #2	4-26-22

IF A SEAL IS PRESENT ON THIS SHEET IT HAS BEEN ELECTRONICALLY SEALED AND DATED.

STATE OF MISSOURI MELISSA M. MASSAR NOTARY PUBLIC PE-2018000237 PROFESSIONAL ENGINEER
04/26/2022

MELISSA M. MASSAR
MO# PE-2018000237

COUNTY ROAD 318 BRIDGE #18800291
PIKE COUNTY, MISSOURI

GRADING AND EROSION CONTROL PLAN

CHECKED BY: JAB
DRAWN BY: QJS
JOB NUMBER: 4529
SHEET NUMBER:

C4

GRE
GREAT RIVER ENGINEERING

CONTRACTOR NAME: _____

ADDRESS LINE 1: _____

ADDRESS LINE 2: _____

PHONE NUMBER: _____

EMAIL: _____

Pike County
CR 318 & CR 103
Option 1 Bidding

DATE: _____

ITEMIZED BID FORM

LINE	ITEM	DESCRIPTION	UNITS	QUANTITY	UNIT PRICE	AMOUNT
		County Road 318 Bridge #18800291				
ROADWAY ITEMS						
1	201	CLEARING AND GRUBBING	ACRE	0.1		
2	203	UNCLASSIFIED EXCAVATION (ROADWAY)	C.Y.	64		
3	203	EMBANKMENT IN PLACE W/COMPACTION	C.Y.	98		
4	304	TYPE 1 AGGREGATE FOR BASE (5 IN. THICK)	S.Y	712		
5	606	GUARDRAIL TYPE A	L.F.	18.75		
6	606	TYPE A CRASHWORTHY END TERMINAL	EACH	4		
7	606	ASYMETRICAL TRANSITION SECTION, 6.5 FT. POSTS	EACH	4		
8	607	WOVEN WIRE FENCE	L.F.	142		
9	611	TYPE 2 ROCK BLANKET	C.Y.	306		
				ROADWAY ITEMS SUBTOTAL		
SIGNAGE & EROSION CONTROL ITEMS						
10	616	CONSTRUCTION SIGNS	S.F.	63		
11	616	TYPE III MOVEABLE BARRICADE WITH LIGHT	EACH	4		
12	618	MOBILIZATION	L.S.	1		
13	805	SEEDING	ACRE	0.1		
14	806	SILT FENCE	L.F.	336		
15	806	ROCK DITCH CHECK	EACH	1		
				SIGNAGE & EROSION CONTROL ITEMS SUBTOTAL		
BRIDGE ITEMS						
16	206	CLASS 1 EXCAVATION	C.Y.	50		
17	216	REMOVAL OF BRIDGES	L.S.	1		
18	702	GALVANIZED STRUCTURAL STEEL PILES (12 IN)	L.F.	96		
19	702	PILE POINT REINFORCEMENT	EACH	8		
20	702	PRE-BORE FOR PILING	L.F.	80		
21	703	CLASS B CONCRETE (SUBSTRUCTURE)	EACH	23.6		
22	706	REINFORCING STEEL (BRIDGES)	LBS	3480		
23	713	BRIDGE GUARD RAIL (THRIE BEAM)	L.F.	92		
24	716	PLAIN NEOPRENE BEARING PAD	L.F.	58		
				BRIDGE ITEMS SUBTOTAL		
				COUNTY ROAD 318 SUBTOTAL		

CONTRACTOR NAME: _____

ADDRESS LINE 1: _____

ADDRESS LINE 2: _____

PHONE NUMBER: _____

EMAIL: _____

Pike County
CR 318 & CR 103
Option 1 Bidding

DATE: _____

ITEMIZED BID FORM

LINE	ITEM	DESCRIPTION	UNITS	QUANTITY	UNIT PRICE	AMOUNT
		County Road 103 #0070021				
ROADWAY ITEMS						
1	201	CLEARING AND GRUBBING	ACRE	0.1		
2	203	UNCLASSIFIED EXCAVATION (ROADWAY)	C.Y.	56		
3	203	EMBANKMENT IN PLACE W/COMPACTION	C.Y.	96		
4	304	TYPE 1 AGGREGATE FOR BASE (5 IN. THICK)	S.Y	903		
5	606	TYPE A CRASHWORTHY END TERMINAL	EACH	4		
6	606	ASYMETRICAL TRANSITION SECTION, 6.5 FT. POSTS	EACH	4		
7	607	WOVEN WIRE FENCE	L.F.	25		
8	611	TYPE 2 ROCK BLANKET	C.Y.	312		
				ROADWAY ITEMS SUBTOTAL		
SIGNAGE & EROSION CONTROL ITEMS						
9	616	CONSTRUCTION SIGNS	S.F.	63		
10	616	TYPE III MOVEABLE BARRICADE WITH LIGHT	EACH	4		
11	618	MOBILIZATION	L.S.	1		
12	805	SEEDING	ACRE	0.1		
13	806	SILT FENCE	L.F.	392		
14	806	ROCK DITCH CHECK	EACH	2		
				SIGNAGE & EROSION CONTROL ITEMS SUBTOTAL		
BRIDGE ITEMS						
15	206	CLASS 1 EXCAVATION	C.Y.	60		
16	216	REMOVAL OF BRIDGES	L.S.	1		
17	702	GALVANIZED STRUCTURAL STEEL PILES (12 IN)	L.F.	480		
18	702	PILE POINT REINFORCEMENT	EACH	8		
19	703	CLASS B CONCRETE (SUBSTRUCTURE)	EACH	25.8		
20	706	REINFORCING STEEL (BRIDGES)	LBS	3760		
21	713	BRIDGE GUARD RAIL (THRIE BEAM)	L.F.	92		
22	716	PLAIN NEOPRENE BEARING PAD	L.F.	64		
				BRIDGE ITEMS SUBTOTAL		
				COUNTY ROAD 103 SUBTOTAL		
				TOTAL COMBINED CONTRACT		

Addenda	Signature
1	_____
2	_____
3	_____

CONTRACTOR NAME: _____

ADDRESS LINE 1: _____

ADDRESS LINE 2: _____

PHONE NUMBER: _____

EMAIL: _____

Pike County
County Road 318 Bridge #18800291
Option 2 Bidding

DATE: _____

ITEMIZED BID FORM

LINE	ITEM	DESCRIPTION	UNITS	QUANTITY	UNIT PRICE	AMOUNT
ROADWAY ITEMS						
1	201	CLEARING AND GRUBBING	ACRE	0.1		
2	203	UNCLASSIFIED EXCAVATION (ROADWAY)	C.Y.	64		
3	203	EMBANKMENT IN PLACE W/COMPACTION	C.Y.	98		
4	304	TYPE 1 AGGREGATE FOR BASE (5 IN. THICK)	S.Y	712		
5	606	GUARDRAIL TYPE A	L.F.	18.75		
6	606	TYPE A CRASHWORTHY END TERMINAL	EACH	4		
7	606	ASYMETRICAL TRANSITION SECTION, 6.5 FT. POSTS	EACH	4		
8	607	WOVEN WIRE FENCE	L.F.	142		
9	611	TYPE 2 ROCK BLANKET	C.Y.	306		
					ROADWAY ITEMS SUBTOTAL	
SIGNAGE & EROSION CONTROL ITEMS						
10	616	CONSTRUCTION SIGNS	S.F.	63		
11	616	TYPE III MOVEABLE BARRICADE WITH LIGHT	EACH	4		
12	618	MOBILIZATION	L.S.	1		
13	805	SEEDING	ACRE	0.1		
14	806	SILT FENCE	L.F.	336		
15	806	ROCK DITCH CHECK	EACH	1		
					SIGNAGE & EROSION CONTROL ITEMS SUBTOTAL	
BRIDGE ITEMS						
16	206	CLASS 1 EXCAVATION	C.Y.	50		
17	216	REMOVAL OF BRIDGES	L.S.	1		
18	702	GALVANIZED STRUCTURAL STEEL PILES (12 IN)	L.F.	96		
19	702	PILE POINT REINFORCEMENT	EACH	8		
20	702	PRE-BORE FOR PILING	L.F.	80		
21	703	CLASS B CONCRETE (SUBSTRUCTURE)	EACH	23.6		
22	706	REINFORCING STEEL (BRIDGES)	LBS	3480		
23	713	BRIDGE GUARD RAIL (THRIE BEAM)	L.F.	92		
24	716	PLAIN NEOPRENE BEARING PAD	L.F.	58		
					BRIDGE ITEMS SUBTOTAL	
					TOTAL CONTRACT	

Addenda	Signature
1	_____
2	_____
3	_____

GRE GREAT RIVER ENGINEERING

CONTRACTOR NAME: _____

ADDRESS LINE 1: _____

ADDRESS LINE 2: _____

PHONE NUMBER: _____

EMAIL: _____

Pike County
County Road 103 #0070021
Option 2 Bidding

DATE: _____

ITEMIZED BID FORM

LINE	ITEM	DESCRIPTION	UNITS	QUANTITY	UNIT PRICE	AMOUNT
ROADWAY ITEMS						
1	201	CLEARING AND GRUBBING	ACRE	0.1		
2	203	UNCLASSIFIED EXCAVATION (ROADWAY)	C.Y.	56		
3	203	EMBANKMENT IN PLACE W/COMPACTION	C.Y.	96		
4	304	TYPE 1 AGGREGATE FOR BASE (5 IN. THICK)	S.Y	903		
5	606	TYPE A CRASHWORTHY END TERMINAL	EACH	4		
6	606	ASYMETRICAL TRANSITION SECTION, 6.5 FT. POSTS	EACH	4		
7	607	WOVEN WIRE FENCE	L.F.	25		
8	611	TYPE 2 ROCK BLANKET	C.Y.	312		
					ROADWAY ITEMS SUBTOTAL	
SIGNAGE & EROSION CONTROL ITEMS						
9	616	CONSTRUCTION SIGNS	S.F.	63		
10	616	TYPE III MOVEABLE BARRICADE WITH LIGHT	EACH	4		
11	618	MOBILIZATION	L.S.	1		
12	805	SEEDING	ACRE	0.1		
13	806	SILT FENCE	L.F.	392		
14	806	ROCK DITCH CHECK	EACH	2		
					SIGNAGE & EROSION CONTROL ITEMS SUBTOTAL	
BRIDGE ITEMS						
15	206	CLASS 1 EXCAVATION	C.Y.	60		
16	216	REMOVAL OF BRIDGES	L.S.	1		
17	702	GALVANIZED STRUCTURAL STEEL PILES (12 IN)	L.F.	480		
18	702	PILE POINT REINFORCEMENT	EACH	8		
19	703	CLASS B CONCRETE (SUBSTRUCTURE)	EACH	25.8		
20	706	REINFORCING STEEL (BRIDGES)	LBS	3760		
21	713	BRIDGE GUARD RAIL (THRIE BEAM)	L.F.	92		
22	716	PLAIN NEOPRENE BEARING PAD	L.F.	64		
					BRIDGE ITEMS SUBTOTAL	
					TOTAL CONTRACT	

Addenda	Signature
1	_____
2	_____
3	_____

Geotechnical Engineering Report

Pike County
County Road 318 Bridge No. 1880029 over Little Creek Replacement
GRE Project No. 4529

Prepared for:

Pike County Commission
115 W. Main Street
Bowling Green, MO 63334

Prepared by:

2826 S. Ingram Mill Road
Springfield, MO 65804
Phone (417) 886-7171
Fax (417) 886-7591
www.greatriv.com

January 3, 2022

STATE OF MISSOURI
AARON KIRK
BENSON
NUMBER
PE-2017018940
PROFESSIONAL ENGINEER

1/3/2022

Executive Summary

A subsurface investigation was conducted by Great River Engineering (GRE) on December 6, 2021, on the east and west ends of the County Road 318 Bridge No. 1880029 over Little Creek located approximately 8 miles south-southeast of Bowling Green, Missouri. Two bore holes were drilled within the centerline of County Road 318 and within approximately 20 feet of each end of the existing bridge deck for the purpose of collecting soil samples for classification and determining bedrock depth, type, and quality. The holes were drilled in close proximity to the proposed end bent locations of a planned replacement bridge on the existing roadway alignment. Bore Hole #1 (BH-1) was located approximately 12 feet west of the bridge deck. Bore Hole #2 (BH-2) was located approximately 16 feet east of the bridge deck.

Refusal with the augers used to drill the bore holes occurred at the following approximate subsurface depths: BH-1: 10.5 feet and BH-2: 10.9 feet. Refusals at the bore holes were assumed to be the result of encountering bedrock. Further evidence of encountering bedrock at BH-1 was that a solid 2-feet rock core sample was extracted and collected below the refusal depth. Bedrock was assumed to have been encountered because the exclusive rock core material extracted was rock. Soil samples were extracted and collected at BH-1 and BH-2. Laboratory analyses were conducted on the soil and rock core samples, and the analyses results are provided in this report. Groundwater was not encountered at either bore hole.

Based on various sources from the Missouri Department of Natural Resources to include the *Geologic Map of Missouri*, 2017, the predominant rock in this area is limestone of the Decorah Group. Net allowable bearing pressure is defined as the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation for footings founded in bedrock. Based on the predominant rock in this area of limestone and assuming the rock is in fair condition with moderate weathering or better condition, a conservative net allowable bearing pressure is 10,000 pounds/square foot. Driven pile foundation should be limited by pile strength.

1.0 Introduction

This report provides results of the subsurface investigation conducted by Great River Engineering (GRE) on December 6, 2021, on the east and west ends of the County Road 318 Bridge No. 1880029 over Little Creek located approximately 8 miles south-southeast of Bowling Green, Missouri. The investigation was authorized in accordance with the contract for engineering services between Pike County and Great River Engineering to "Conduct subsurface investigations."

2.0 Project Description

Provide professional services to replace existing bridge with a new structure.

3.0 Site Location

The project site is located on County Road 318 as shown on the below map.

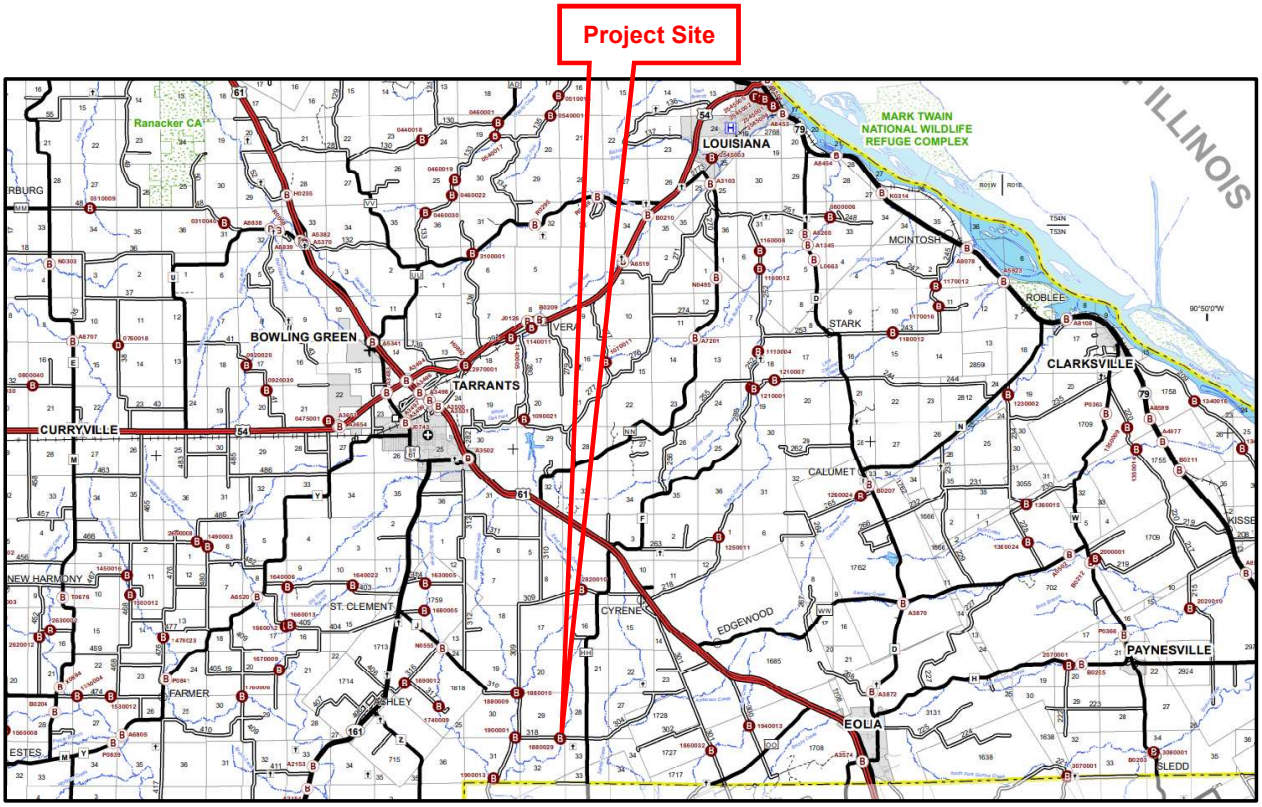


Figure 1. Project Site Locator

4.0 Site Geology

The project site is located specifically within the Paleozoic Erathem, Ordovician System (485.4 to 443.8 million years ago), Mohawkian Series, Decorah Group that consists of soil and rock characterized as various forms of limestone and dolomite (Reference: Missouri Department of Natural Resources, *Geologic Map of Missouri*, 2017). The Decorah Group consists of three formations in ascending order: the Spechts Ferry Formation of limestone and shale, Kings Lake Limestone, and Guttenburg Limestone. The Decorah Group varies in thickness from a few feet to more than 40 feet. In the subsurface of northern Missouri, the Decorah is almost entirely a cherty dolomite or limestone with minor amounts of shale (Reference: *The Stratigraphic Succession in Missouri, Volume 40 - Revised - 1995*, by Thomas L. Thompson). Figure 2 below depicts the stratigraphic column for the Ordovician System, Mohawkian Series bedrock formations to include the Decorah Group (Reference: *The Stratigraphic Succession in Missouri, Volume 40 - Revised - 1995*, by Thomas L. Thompson).

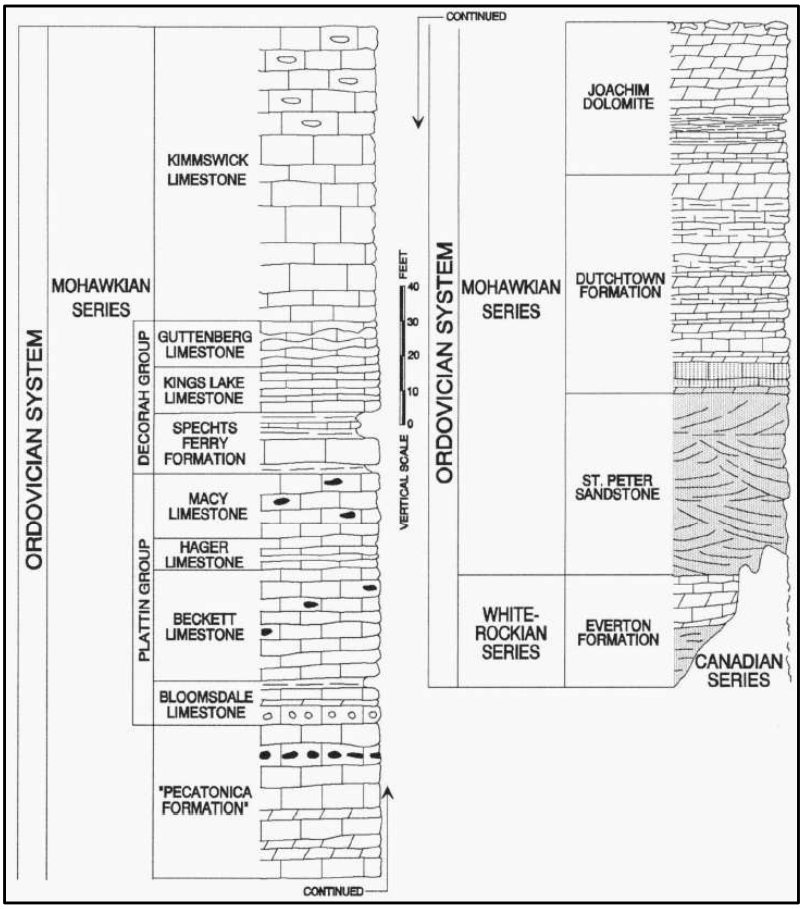


Figure 2. Ordovician System Stratigraphic Column

Alluvium deposits comprised of silt and clay with poorly sorted sand, granules, pebbles, and gravel, and other material transported and deposited by streams are known to exist above the bedrock within the Little Creek stream basin. (Reference: Missouri Department of Natural Resources, Missouri Geological Survey Geosciences Technical Resource Assessment Tool, *1982 Surficial Materials Map of Missouri*, by Whitfield, J.W.). Karst features of caves, sinkholes, springs, and gaining streams are somewhat common in this specific area (Reference: Missouri Department of Natural Resources, Missouri Geological Survey Geosciences Technical Resource Assessment Tool).

The nearest geologic structure is the Cap au Gres Fault located approximately 2.1 miles southwest of the project site.

5.0 Scope of Investigation and Laboratory Testing

On December 6, 2021, GRE performed field subsurface investigations on the east and west ends of the County Road 318 Bridge No. 1880029 over Little Creek which comprised of two (2) subsurface test borings identified as BH-1 and BH-2. The bore holes were drilled using a Central Mine Equipment Company (CME) 45C trailer-mounted drill rig with a 4-1/2 inch diameter solid stem auger that forms a 5-inch diameter bore hole. Both bores were drilled into the subsurface material until auger refusal was attained. Upon reaching auger refusal at BH-1, a 2-feet rock core was extracted and analyzed.

BH-1 was located approximately 12 feet west of the bridge deck and at the centerline of County Road 318. Specifically, BH1 was located at North Latitude 39.241220° and West Longitude 91.142015° at a surface elevation of 692 feet. BH-2 was located approximately 16 feet north of the bridge deck and and at the centerline of County Road 318. Specifically, BH2 was located at North Latitude 39.241270° and West Longitude 91.141852° at a surface elevation of 691 feet. Approximate bore hole locations are shown below.

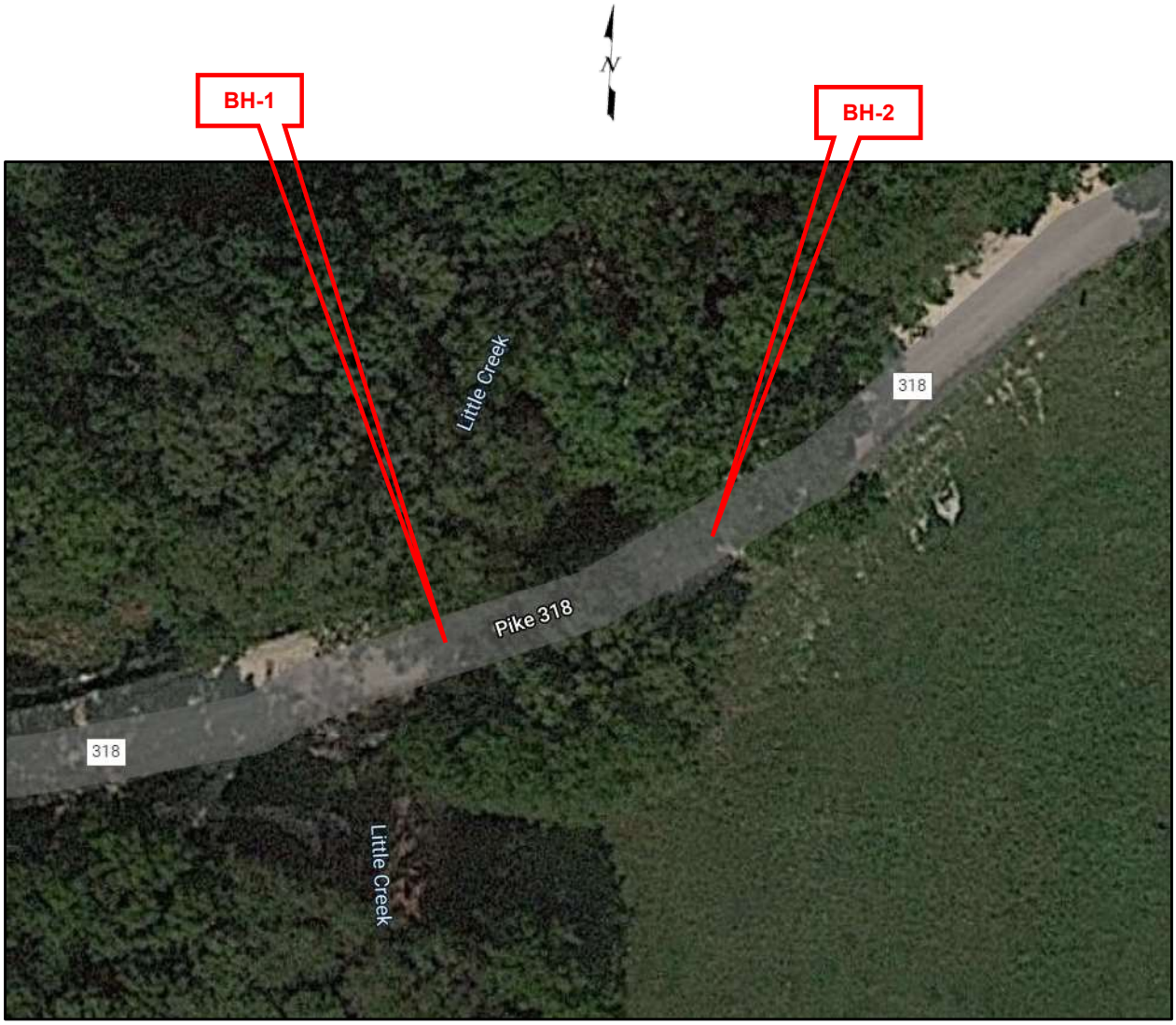


Figure 3. Bore Hole Locations

Following the field investigation, the soil samples were transported from the field site to the laboratory where they were then further classified. All procedures and testing performed in the field and laboratory were conducted in accordance with American Society for Testing and Materials (ASTM) standards.

While the information in the report may be useful to a construction contractor, it may not meet all their needs and they may need to seek additional studies. Based on the depths of construction activities below the ground surface elevation for the proposed project, it is assumed that much of the disturbed existing soil material within the project limits will be removed during construction

and replaced with compacted fill or structural materials in accordance with the engineering plans and specifications.

6.0 Field Subsurface Investigation Results

The general subsurface conditions and characteristics encountered for the two borings are identified in the logs at Appendix 1. Results of the borings should only apply to the locations and times as specified on the boring log. Soil conditions at other locations and times may vary from those identified in this report.

6.1 Auger Refusal

Auger refusal is the condition reached when the auger drill bit has negligible penetration and further penetration cannot be achieved with standard drilling equipment. Refusal typically occurs when very hard soil or rock is encountered. Auger refusal is subjective and is based on the type of drilling equipment, types of augers used, and effort exerted by the driller. For this project site at BH-1 and BH-2, auger refusals occurred at subsurface depths of approximately 10.5 feet and at 10.9 feet, respectively. Refusal was assumed to be the result of encountering the surface of a continuous bedrock. Further evidence of encountering bedrock at BH-1 was that a solid 2-feet rock core sample was extracted and collected below the refusal depth. Bedrock was assumed to have been encountered because the exclusive rock core material extracted was rock. The auger refusal depths identified in this report is specific to its location and time; thus, refusal depths may vary at other locations and times.

Encountering bedrock in this investigation is assumed based on auger refusals in which the auger could no longer advance with standard drilling equipment. However, refusals may also result from encountering other conditions such as those depicted in the following graphic:

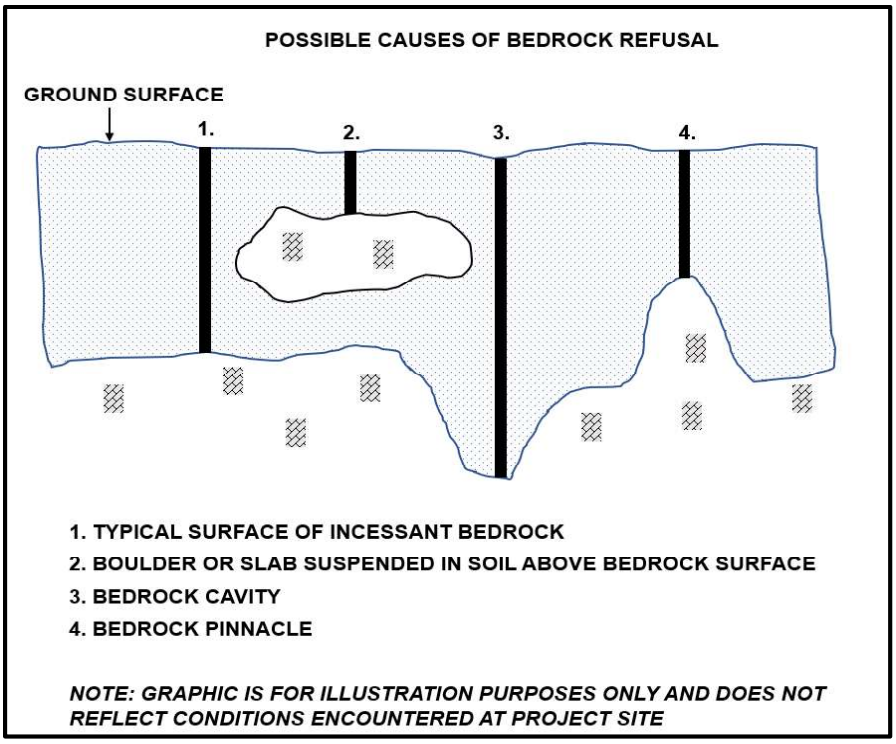


Figure 4. Possible Causes of Bedrock Refusal

Thus, even though evidence supports that bedrock was encountered, the extent of this investigation cannot confirm that refusal was the result of encountering bedrock versus other rock structures.

6.2 Groundwater

The surface level of the groundwater at a bore hole drilling site is assumed based on the depth at which a relatively significant amount of water and/or highly saturated soil discharges from the hole compared to all previous bore depths. For this project site, groundwater was not encountered at either bore hole. The presence or absence of groundwater as determined in this investigation does not dictate that groundwater will or will not be encountered at these locations at other times, or that groundwater will or will not exist at similar depths at other locations and times.

6.3 Soil

One soil sample was collected at BH-1 and one was collected at BH-2 for laboratory analysis purposes. At BH-1, the observed soil to a depth of 4 feet was reddish brown in color, low density and compaction, low moisture content, and some gravel with dimensions

less than 2 inches in size. At a depth between 4 feet and 10 feet, the soil became darker in color with moderate density, moderate moisture content, and some gravel with dimensions less than 2 inches in size. Soil observed at BH-2 was reddish brown in color, moderate density, moderate moisture content, and some gravel with dimensions less than 2 inches in size.

Based on sieve analyses and Atterberg tests that were conducted in the laboratory for the soil samples collected, the soil at BH-1 was classified as Poor/Uniform-Graded Sand, or "SP", and the soil moisture content was measured as 9%. The soil at BH-2 was classified as Well-Graded Sand, or "SW", and the soil moisture content was 11%. Boring logs depicting graphical representations of the classified subsurface materials are at Appendix 1, and soil general classification and information are at Appendix 2.

6.4 Rock

Upon encountering refusal at BH-1, a rock core extraction was conducted to a depth of 5 feet with consistent resistance experienced throughout the process. The result of the extraction was a solid 2-feet rock core that was collected between the assumed bedrock surface depth of 10.5 feet and 12.5 feet. The rock core was assumed to have been extracted from bedrock because the exclusive material extracted within the 2-feet core was rock versus other non-rock materials. Based on geological research of the area and observed physical characteristics of the rock core, the rock material extracted from the BH-1 coring indicates that the rock sample is consistent with various forms of limestone that are predominant in that area.

The Rock Quality Designation at BH-1 was 68% which is designated as "Fair" and defined as "moderately weathered rock." A photo of the rock core sample extracted from BH-1 is at Appendix 3 and bedrock general classification and information is at Appendix 4.

7.0 Foundation Recommendation

Bedrock was assumed to have been encountered because the exclusive rock core material extracted was rock. Net allowable bearing pressure is defined as the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation for footings founded in bedrock. Based on the limestone rock encountered in this investigation, the net allowable

bearing pressure is 10,000 pounds/square foot. Driven pile foundation should be limited by pile strength.

8.0 Limitations and Additional Considerations

GRE prepared this report based on our professional judgment and in accordance with American Society of Testing and Materials (ASTM) standards. Each boring only represent the conditions encountered on that day and at that specific location. Subsurface conditions are subject to change due to the effects of manmade undertakings, natural events, the passage of time, and others. Also, the conditions may be drastically different at other locations within the project area, even those in close proximity to a specific study location.

Geotechnical investigations are not exact in nature. No warranty is implied or intended.

Appendix 1

Boring Log
and
Key to Symbols

GRE GREAT RIVER ENGINEERING

BORING NUMBER 1

CLIENT Pike County Commission
PROJECT NAME CR 318 Bridge 18800029 over Little Creek
PROJECT NUMBER 4529
PROJECT LOCATION Pike County CR 318

DATE STARTED 12/6/21 **COMPLETED** 12/6/21
GROUND ELEVATION 692 ft **HOLE SIZE** 5 in
DRILLING CONTRACTOR Great River Engineering
GROUND WATER LEVELS:
DRILLING METHOD Solid Stem Auger
AT TIME OF DRILLING ---
LOGGED BY A. Brantley **CHECKED BY** A. Benson
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (FT)	GRAPHIC LOG	U.S.C.S.	MATERIAL DESCRIPTION	ROCK CORE NUMBER	RECOVERY % (RQD)	ALLOWABLE BEARING PRESSURE (PSF)	COMPRESSIVE STRENGTH (PSF)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0.0		GW	WELL GRADED GRAVEL, (GW) Gravel mix roadway surface course.									
			POORLY GRADED SAND, (SP) Observed soil is dry, loosely compacted, reddish brown in color, and containing some gravel less than 2 inches in dimension.									
2.5		SP	Rock hardpan/chert at 2 feet depth.									
			POORLY GRADED SAND, (SP) Observed soil is moderately moist, moderately dense, dark reddish brown in color, and containing some gravel less than 2 inches in dimension.									
5.0												
								9				8
7.5		SP										
10.0												
12.5				01	42 (68)							
15.0												

Refusal at 10.5 feet.
Bottom of borehole at 15.5 feet.

GRE GREAT RIVER ENGINEERING

BORING NUMBER 2

CLIENT Pike County Commission
PROJECT NAME CR 318 Bridge 18800029 over Little Creek
PROJECT NUMBER 4529
PROJECT LOCATION Pike County CR 318

DATE STARTED 12/6/21 COMPLETED 12/6/21
GROUND ELEVATION 691 ft HOLE SIZE 5 in
DRILLING CONTRACTOR Great River Engineering
GROUND WATER LEVELS:
DRILLING METHOD Solid Stem Auger
AT TIME OF DRILLING ---
LOGGED BY A. Brantley CHECKED BY A. Benson
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (FT)	GRAPHIC LOG	U.S.C.S.	MATERIAL DESCRIPTION	ROCK CORE NUMBER	RECOVERY % (RQD)	ALLOWABLE BEARING PRESSURE (PSF)	COMPRESSIVE STRENGTH (PSF)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0.0		GW	WELL GRADED GRAVEL, (GW) Gravel mix roadway surface course.									
			WELL GRADED SAND, (SW) Observed soil is dry, loosely compacted, reddish brown in color, and containing some gravel less than 2 inches in dimension.									
2.5												
5.0		SW						11				11
7.5												
10.0												

Refusal at 10.9 feet.
Bottom of borehole at 10.9 feet.

GRE GREAT RIVER ENGINEERING

KEY TO SYMBOLS

CLIENT Pike County Commission
PROJECT NAME CR 318 Bridge 18800029 over Little Creek
PROJECT NUMBER 4529
PROJECT LOCATION Pike County CR 318

LITHOLOGIC SYMBOLS
(Unified Soil Classification System)


BEDROCK: Bedrock


GW: USCS Well-graded Gravel


SHALE: Shale


SP: USCS Poorly-graded Sand


SW: USCS Well-graded Sand

SAMPLER SYMBOLS


Rock Core

WELL CONSTRUCTION SYMBOLS

ABBREVIATIONS

LL - LIQUID LIMIT (%)
PL - PLASTIC LIMIT (%)
MC - MOISTURE CONTENT (%)
PP - POCKET PENETROMETER (TSF)


Water Level at Time Drilling, or as Shown

Appendix 2

Soil

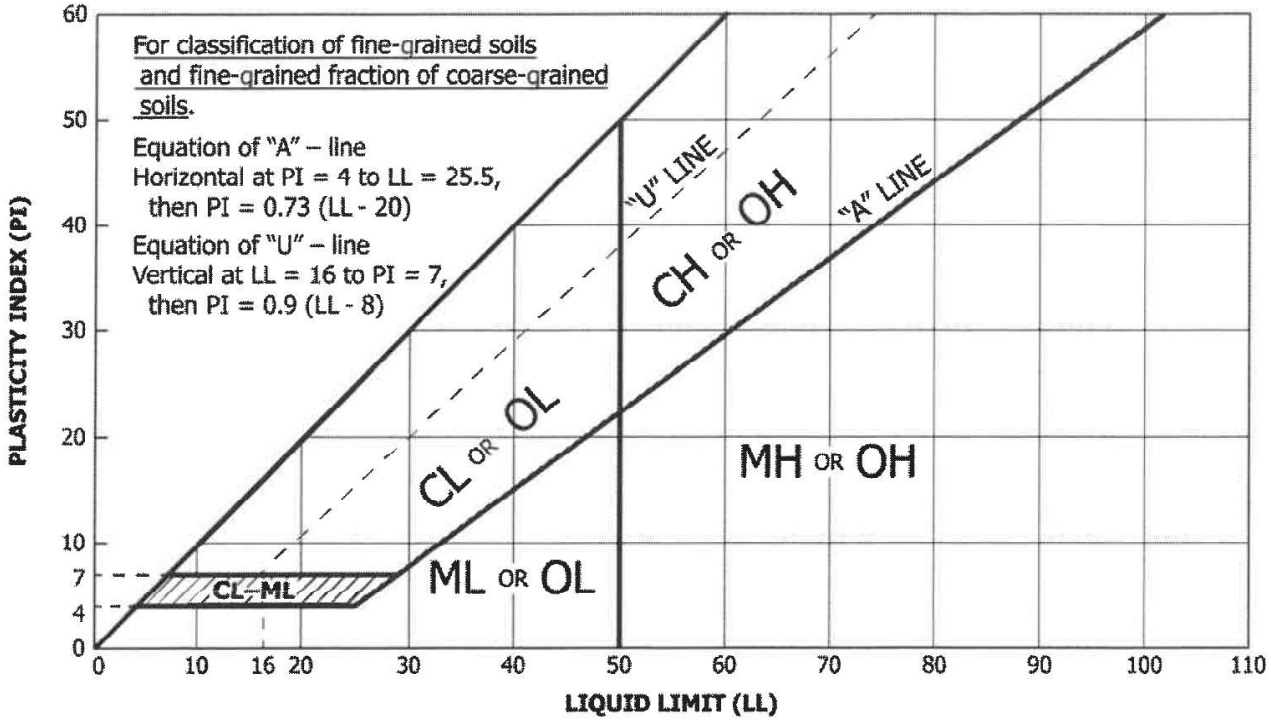
General Classification and Information

Soil Classification Chart (Ref. ASTM D2487)

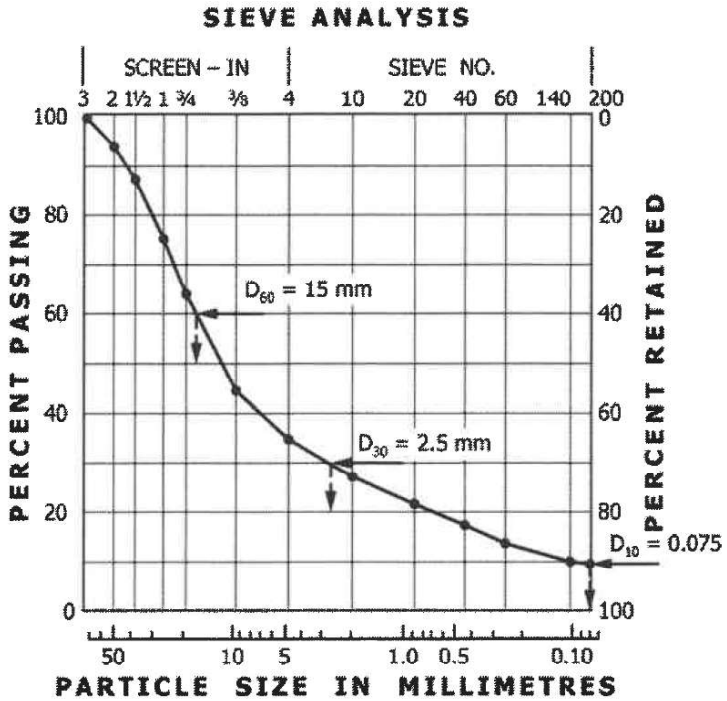
Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests[A]				Soil Classification	
				Group Symbol	Group Name[B]
COARSE-GRAINED SOILS	Gravels (More than 50 % of coarse fraction retained on No. 4 sieve)	Clean Gravels (Less than 5 % fines[C])	$Cu \geq 4.0$ and $1 \leq Cc \leq 3.0$[D]	GW	Well-graded gravel[E]
			$Cu < 4.0$ and/or $[Cc < 1$ or $Cc > 3.0]$[D]	GP	Poorly graded gravel[E]
		Gravels with Fines (More than 12 % fines[C])	Fines classify as ML or MH	GM	Silty gravel[E,F,G]
			Fines classify as CL or CH	GC	Clayey gravel[E,F,G]
More than 50 % retained on No. 200 sieve	Sands (50 % or more of coarse fraction passes No. 4 sieve)	Clean Sands (Less than 5 % fines[H])	$Cu \geq 6.0$ and $1.0 \leq Cc \leq 3.0$[D]	SW	Well-graded sand[I]
			$Cu < 6.0$ and/or $[Cc < 1.0$ or $Cc > 3.0]$[D]	SP	Poorly graded sand[I]
		Sands with Fines (More than 12 % fines[H])	Fines classify as ML or MH	SM	Silty sand[F,G,I]
			Fines classify as CL or CH	SC	Clayey sand[F,G,I]
FINE-GRAINED SOILS	Silts and Clays	inorganic	PI > 7 and plots on or above "A" line[J]	CL	Lean clay[K,L,M]
	Liquid limit less than 50		PI < 4 or plots below "A" line[J]	ML	Silt[K,L,M]
		organic	$\frac{\text{Liquid limit - oven dried}}{\text{Liquid limit - not dried}} < 0.75$	OL	Organic clay[K,L,M,N] / Organic silt[K,L,M,O]
50 % or more passes the No. 200 sieve	Silts and Clays	inorganic	PI plots on or above "A" line	CH	Fat clay[K,L,M]
	Liquid limit 50 or more		PI plots below "A" line	MH	Elastic silt[K,L,M]
		organic	$\frac{\text{Liquid limit - oven dried}}{\text{Liquid limit - not dried}} < 0.75$	OH	Organic clay[K,L,M,P] / Organic silt[K,L,M,Q]
HIGHLY ORGANIC SOILS	Primarily organic matter, dark in color, and organic odor			PT	Peat

[A] Based on the material passing the 3-in. (75-mm) sieve.
[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.
[C] Gravels with 5 to 12 % fines require dual symbols:
GW-GM well-graded gravel with silt
GW-GC well-graded gravel with clay
GP-GM poorly graded gravel with silt
GP-GC poorly graded gravel with clay
[D] $Cu = D_{60}/D_{10}$ $Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$
[E] If soil contains ≥15 % sand, add "with sand" to group name.
[F] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.
[G] If fines are organic, add "with organic fines" to group name.
[H] Sands with 5 to 12 % fines require dual symbols:
SW-SM well-graded sand with silt
SW-SC well-graded sand with clay
SP-SM poorly graded sand with silt
SP-SC poorly graded sand with clay
[I] If soil contains ≥15 % gravel, add "with gravel" to group name.
[J] If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay.
[K] If soil contains 15 to <30 % plus No. 200, add "with sand" or "with gravel," whichever is predominant.
[L] If soil contains ≥30 % plus No. 200, predominantly sand, add "sand" to group name.
[M] If soil contains ≥30 % plus No. 200, predominantly gravel, add "gravelly" to group name.
[N] PI ≥ 4 and plots on or above "A" line.
[O] PI < 4 or plots below "A" line.
[P] PI plots on or above "A" line.
[Q] PI plots below "A" line.

Plasticity Chart (Ref. ASTM D2487)



Cumulative Particle-Size Plot (Ref. ASTM D2487)



$$Cu = \frac{D_{60}}{D_{10}} = \frac{15}{0.075} = 200 \qquad Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}} = \frac{(2.5)^2}{0.075 \times 15} = 5.6$$

Appendix 3

Rock Core Sample

Geotechnical Data Report
County Road 318 Bridge No. 1880029 over Little Creek Replacement
GRE Project No. 4529
Rock Core extracted on 12-6-2021

BH-1 Rock Core at depth of 10.5 to 12.5 feet

Rock Quality Designation: 68% “Fair”

Appendix 4

Bedrock
General Classification and Information

Rock Quality Designation (RQD) (Ref. ASTM D6032)

Description of Rock Quality	RQD (%)
Very Poor - Completely weathered rock	0 - 25
Poor - Weathered rock	25 - 50
Fair - Moderately weathered rock	50 - 75
Good - Hard rock	75 - 90
Excellent - Fresh rock with little to no weathering	90 - 100

Degree of Weathering

Completely weathered	Rock > 50% decomposed with complete discoloration of rock fabric; rock core may be broken at several points
Weathered	Rock decomposed $\leq$ 50% with significant portions showing discoloration and weathering effects; rock cores cannot be broken by hand or scraped by knife
Moderately weathered	Rock generally fresh with stained joints

Bedrock Hardness

Mohs' Hardness Scale	Characteristics	Examples	Hardness Description	Cone Penetrometer Values
5.5 to 10	Rock will scratch knife blade	Sandstone, chert, schist, granite, gneiss, some limestone	Very hard	0 - 2 inches/100 blows
3 to 5.5	Rock can be scratched with knife blade	Most dolomite, most limestone, siltstone, shale iron deposits	Hard	1 - 5 inches/100 blows
1 to 3	Rock can be scratched with fingernail	Gypsum, calcite, evaporites, chalk, some shale	Soft	4 - 6 inches/100 blows

Geotechnical Engineering Report

Pike County
County Road 103 Bridge No. 0070021 over Tributary to Salt River Replacement
GRE Project No. 4529

Prepared for:

Pike County Commission
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Bowling Green, MO 63334

Prepared by:

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January 3, 2022

STATE OF MISSOURI
AARON KIRK
BENSON
NUMBER
PE-2017018940
PROFESSIONAL ENGINEER

1/3/2022

Executive Summary

A subsurface investigation was conducted by Great River Engineering (GRE) on December 7, 2021, on the east and west ends of the County Road 103 Bridge No. 0070021 over a tributary to the Salt River located approximately 15 miles north of Bowling Green, Missouri. Two bore holes were drilled within the centerline of County Road 103 and within approximately 20 feet of each end of the existing bridge deck for the purpose of collecting soil samples for classification and determining bedrock depth, type, and quality. The holes were drilled in close proximity to the proposed end bent locations of a planned replacement bridge on the existing roadway alignment. Bore Hole #1 (BH-1) was located approximately 10 feet west of the bridge deck. Bore Hole #2 (BH-2) was located approximately 12 feet east of the bridge deck.

After drilling to a depth of 100 feet at both bore holes, refusal with the augers used to drill the bore holes was not encountered. Soil samples were extracted and collected at BH-1 and BH-2. Laboratory analyses were conducted on the soil and rock core samples, and the analyses results are provided in this report. Groundwater was encountered at both bore holes at various depths.

Based on various sources from the Missouri Department of Natural Resources to include the *Geologic Map of Missouri*, 2017, the predominant rock in this area is Kimmswick Limestone of the Mohawkian Series. However, bedrock was assumed to have not been encountered at either bore hole because auger refusal was not attained. Based on the subsurface investigation results, a friction pile foundation is recommended to support the bridge.

1.0 Introduction

This report provides results of the subsurface investigation conducted by Great River Engineering (GRE) on December 7, 2021, on the east and west ends of the County Road 103 Bridge No. 0070021 over a tributary to the Salt River located approximately 15 miles north of Bowling Green, Missouri. The investigation was authorized in accordance with the contract for engineering services between Pike County and Great River Engineering to "Conduct subsurface investigations."

2.0 Project Description

Provide professional services to replace existing bridge with a new structure.

3.0 Site Location

The project site is located on County Road 103 as shown on the below map.

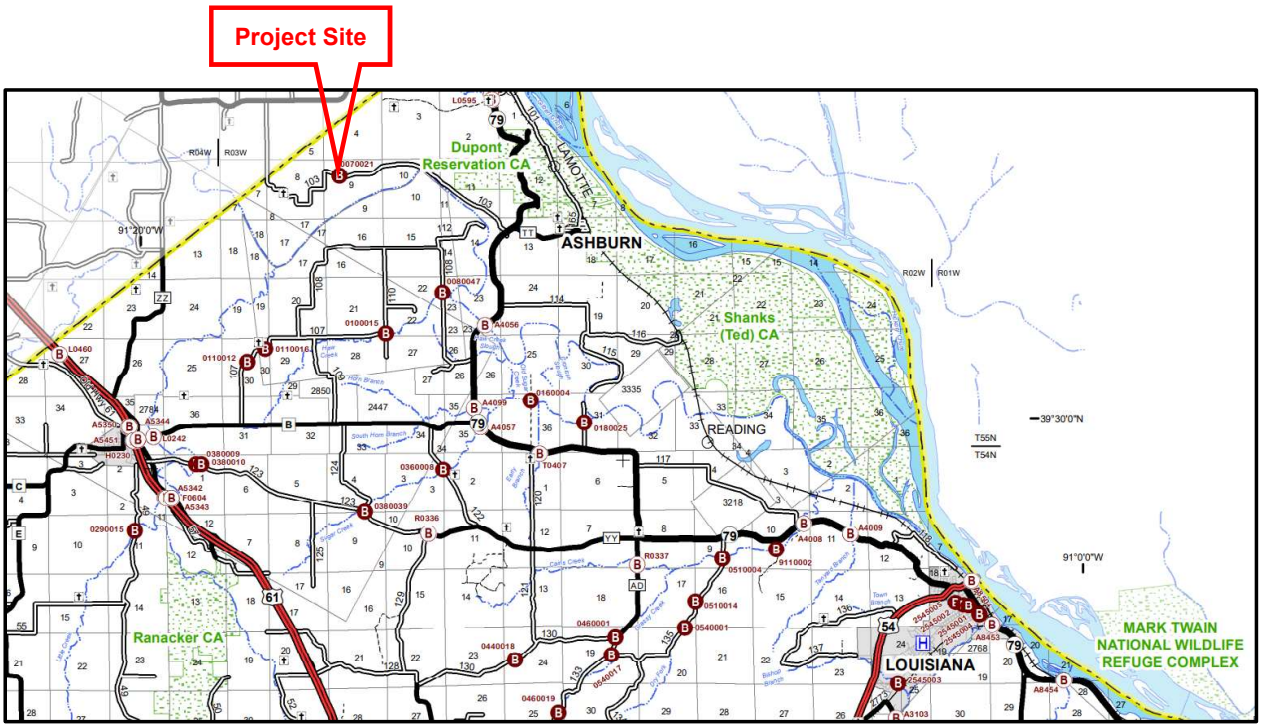


Figure 1. Project Site Locator

4.0 Site Geology

The project site is located specifically within the Paleozoic Erathem, Ordovician System (485.4 to 443.8 million years ago), Mohawkian Series that consists of soil and rock characterized as Kimmswick Limestone (Reference: Missouri Department of Natural Resources, *Geologic Map of Missouri*, 2017). Kimmswick Limestone is typically a coarsely crystalline, bioclastic, white to light-gray, medium- to massive-bedded limestone and is 50 to 150 feet thick in eastern Missouri (Reference: *The Stratigraphic Succession in Missouri, Volume 40 - Revised - 1995*, by Thomas L. Thompson). Figure 2 below depicts the stratigraphic column for the Ordovician System, Mohawkian Series bedrock formations to include the Kimmswick Limestone (Reference: *The Stratigraphic Succession in Missouri, Volume 40 - Revised - 1995*, by Thomas L. Thompson).

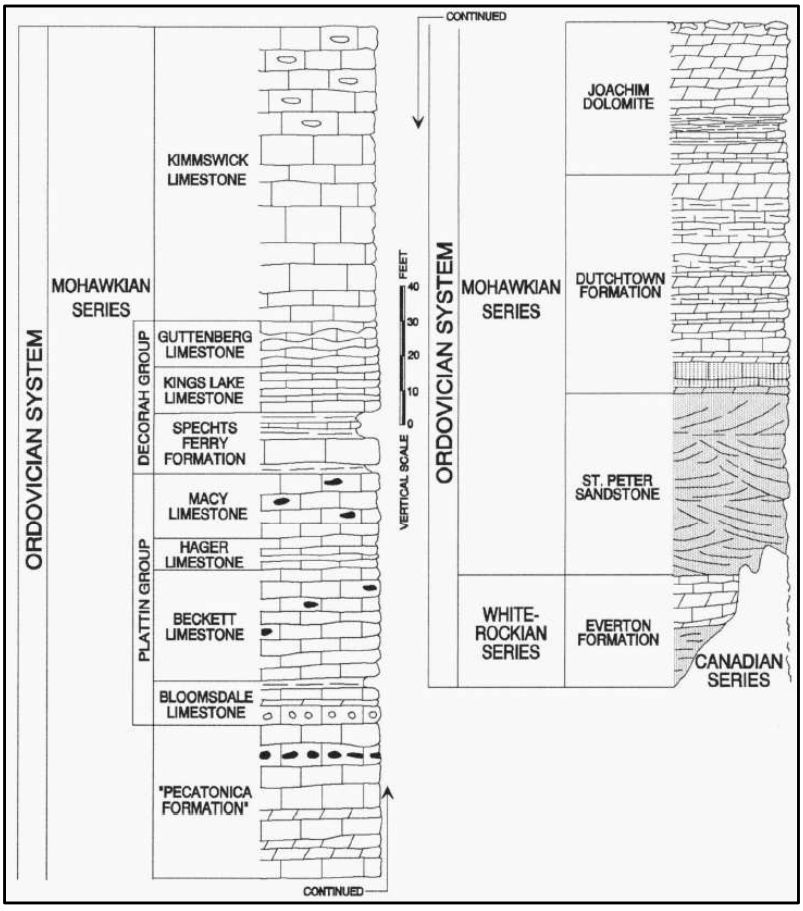


Figure 2. Ordovician System Stratigraphic Column

Alluvium deposits comprised of silt and clay with poorly sorted sand, granules, pebbles, and gravel, and other material transported and deposited by streams are known to exist above the

bedrock within the Salt River basin. (Reference: Missouri Department of Natural Resources, Missouri Geological Survey Geosciences Technical Resource Assessment Tool, *1982 Surficial Materials Map of Missouri*, by Whitfield, J.W.). Karst features of caves, sinkholes, springs, and gaining streams are somewhat uncommon in this specific area (Reference: Missouri Department of Natural Resources, Missouri Geological Survey Geosciences Technical Resource Assessment Tool).

The nearest geologic structure is the Sugar Grove School Anticline located approximately 1.6 miles southwest of the project site.

5.0 Scope of Investigation and Laboratory Testing

On December 7, 2021, GRE performed field subsurface investigations on the east and west ends of the County Road 103 Bridge No. 0070021 over a tributary to the Salt River which comprised of two (2) subsurface test borings identified as BH-1 and BH-2. The bore holes were drilled using a Central Mine Equipment Company (CME) 45C trailer-mounted drill rig with a 4-1/2 inch diameter solid stem auger that forms a 5-inch diameter bore hole. Both bores were drilled into the subsurface material until auger refusal was attained.

BH-1 was located approximately 10 feet west of the bridge deck and at the centerline of County Road 103. Specifically, BH1 was located at North Latitude 39.559424° and West Longitude 91.248496° at a surface elevation of 485 feet. BH-2 was located approximately 12 feet north of the bridge deck and at the centerline of County Road 103. Specifically, BH2 was located at North Latitude 39.559367° and West Longitude 91.248291° at a surface elevation of 488 feet. Approximate bore hole locations are shown below.

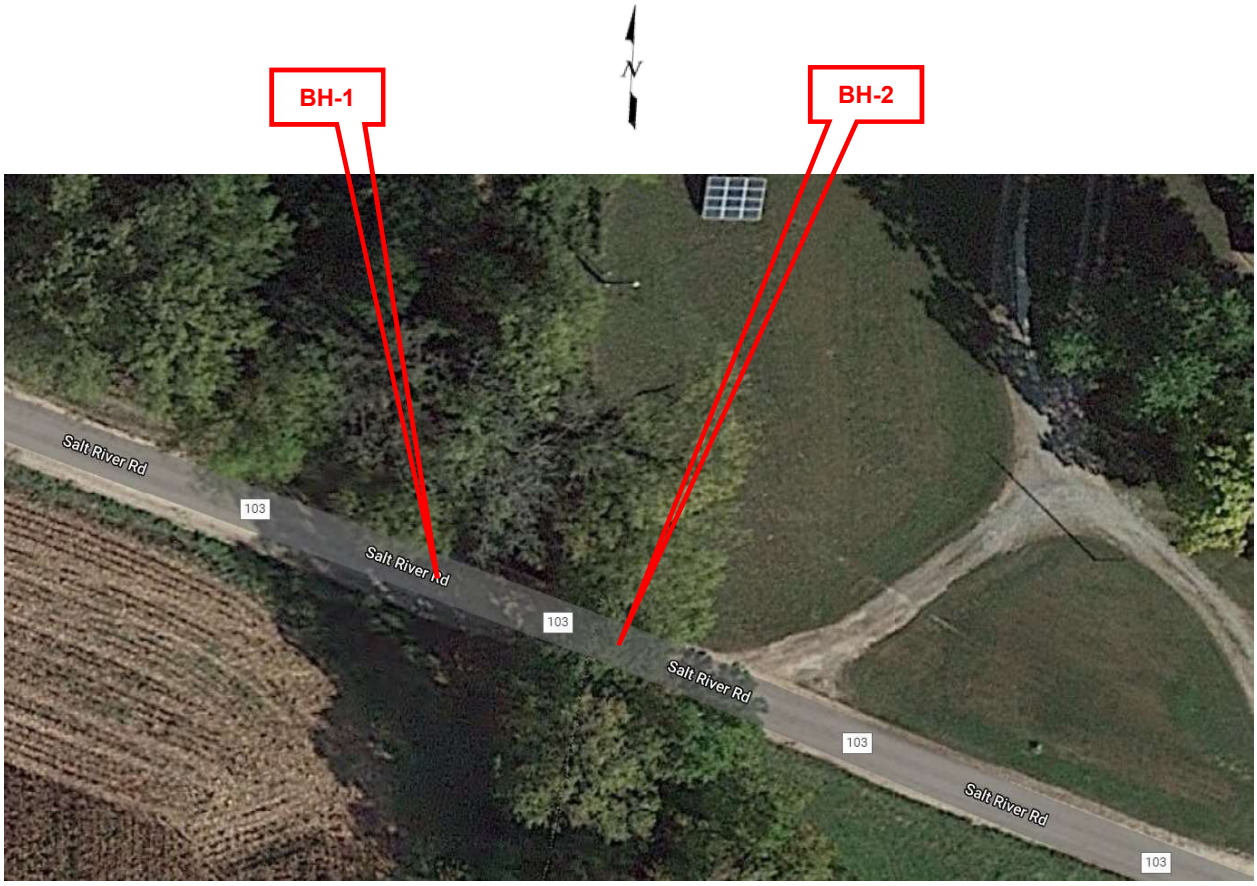


Figure 3. Bore Hole Locations

Following the field investigation, the soil samples were transported from the field site to the laboratory where they were then further classified. All procedures and testing performed in the field and laboratory were conducted in accordance with American Society for Testing and Materials (ASTM) standards.

While the information in the report may be useful to a construction contractor, it may not meet all their needs and they may need to seek additional studies. Based on the depths of construction activities below the ground surface elevation for the proposed project, it is assumed that much of the disturbed existing soil material within the project limits will be removed during construction and replaced with compacted fill or structural materials in accordance with the engineering plans and specifications.

6.0 Field Subsurface Investigation Results

The general subsurface conditions and characteristics encountered for the two borings are identified in the logs at Appendix 1. Results of the borings should only apply to the locations and times as specified on the boring log. Soil conditions at other locations and times may vary from those identified in this report.

6.1 Auger Refusal

Auger refusal is the condition reached when the auger drill bit has negligible penetration and further penetration cannot be achieved with standard drilling equipment. Refusal typically occurs when very hard soil or rock is encountered. Auger refusal is subjective and is based on the type of drilling equipment, types of augers used, and effort exerted by the driller. For this project site after drilling to a depth of 100 feet at both bore holes, refusal with the augers used to drill the bore holes was not encountered, although, layers of rock (e.g., gravel or shale) typically one inch thick were encountered at various depths as noted in the boring logs at Appendix 1.

The nonexistence of bedrock to depths of 100 feet in both of these bore hole investigations is assumed based on the auger continuing to advance to this depth without encountering refusals. However, refusals may result in this area at other specific locations and at other times due to encountering other conditions such as those depicted in the following graphic:

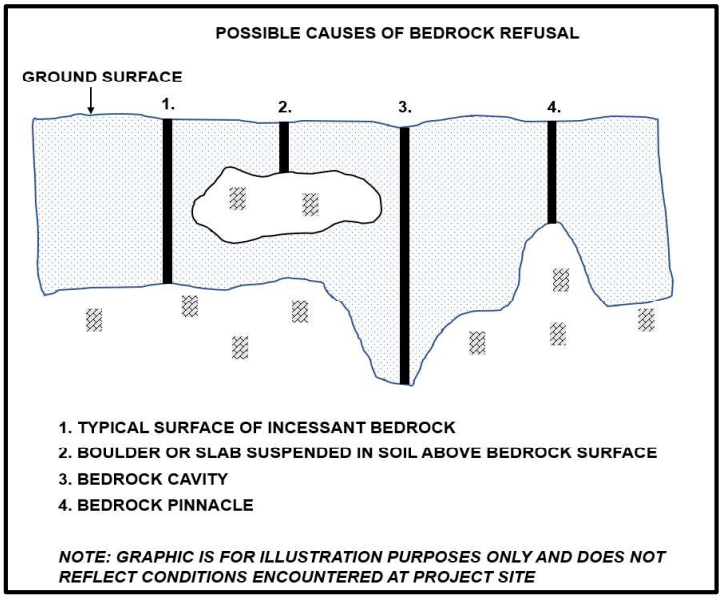


Figure 4. Possible Causes of Bedrock Refusal

Thus, even though evidence supports that bedrock was not encountered at both bore hole locations, the extent of this investigation cannot confirm that refusal may not occur at other specific locations in the area and that such encounters would be bedrock versus other rock structures.

6.2 Groundwater

The surface level of the groundwater at a bore hole drilling site is assumed based on the depth at which a relatively significant amount of water and/or highly saturated soil discharges from the hole compared to all previous bore depths. For this project site, groundwater was encountered at multiple depths for both bore holes as noted in the boring logs at Appendix 1. The presence or absence of groundwater as determined in this investigation does not dictate that groundwater will or will not be encountered at these locations at other times, or that groundwater will or will not exist at similar depths at other locations and times.

6.3 Soil

One soil sample was collected at BH-1 and one was collected at BH-2 for laboratory analysis purposes. The observed soil characteristics at both bore holes were consistent between the natural ground surface layer and auger refusal during drilling, thus, only one soil unit sample was collected at each bore hole. At BH-1, the observed soil to a depth of 20 feet was medium brown in color, moderately dense and compact, moderately moist, and containing a trace of gravel with dimensions less than 1/2 inches in size. Soil observed at BH-2 at a depth of 20 feet was medium brown in color, moderately dense and compact, moderately moist, and containing a trace of gravel with dimensions less than 1/2 inches in size.

Based on sieve analyses and Atterberg tests that were conducted in the laboratory for the soil samples collected, the soil at BH-1 was classified as Low Plasticity Silty-Clay, or “CL-ML”, and the soil moisture content was measured as 23%. The soil at BH-2 was classified as Silt, or “ML”, and the soil moisture content was 29%. Boring logs depicting graphical representations of the classified subsurface materials are at Appendix 1, and soil general classification and information are at Appendix 2.

7.0 Foundation Recommendation

Bedrock was assumed to have not been encountered at either bore hole because auger refusal was not attained. Based on the subsurface investigation results, friction pile foundation is recommended to support the bridge. Friction piles comprised of 14-inch outside diameter steel shell cast-in-place (CIP) pipe with a minimum nominal wall thickness of 1/2 inches and design bearing capacity of up to 55 tons may be used for support. The steel shell shall be welded or seamless and conform to ASTM 252 Grade 3. Due to rock layers (e.g., gravel or shale) encountered at various depths, typically one inch in thickness, a conical closed-ended pile technique is recommended to help prevent damage to the piling.

At both boring locations, it is estimated that an allowable design load of 55 tons will be reached at a depth of approximately 65 feet beneath the surface elevation. If the piling reaches refusal in the subsurface strata above this design load elevation, then the piles can be cut at that elevation and the design load may still be used for design purposes.

Prior to beginning friction pile installation, the pile drivability through the soil profile and the ability of the pile-hammer to attain the desired allowable bearing capacity should be verified using the Wave equation analysis program or other available software. Soil resistances may be imported from a static analysis program or soil values may be input directly into the Wave equation analysis program (or similar program) to verify drivability. Drivability analysis shall be performed using the Delmag D19-42 hammer and the Delmag D30-32 – Heavy Hammer. A drivability analysis shall be performed to select an appropriate hammer size to ensure the pile can be driven without overstressing the pile and to prevent refusal of the pile prior to reaching the minimum tip elevation. The hammer energy required must be determined to successfully drive the pile to the minimum tip elevation and to reach the minimum nominal axial compressive resistance as specified on the design plans. The engineer shall approve hammer energy requirements before driving. Practical refusal is defined at 20 blows/inch or 240 blows per foot. Driving should be terminated immediately once 30 blows/inch is encountered. For a 14-inch O.D. CIP pile, the maximum nominal driving resistance is 748 kips. If analysis indicates the piles do not have sufficient structural strength or geotechnical strength, or if drivability issues are experienced, then consider increasing the number of piles.

8.0 Limitations and Additional Considerations

GRE prepared this report based on our professional judgment and in accordance with American Society of Testing and Materials (ASTM) standards. Each boring only represent the conditions encountered on that day and at that specific location. Subsurface conditions are subject to change due to the effects of manmade undertakings, natural events, the passage of time, and others. Also, the conditions may be drastically different at other locations within the project area, even those in close proximity to a specific study location.

Geotechnical investigations are not exact in nature. No warranty is implied or intended.

Appendix 1

Boring Log
and
Key to Symbols

GRE GREAT RIVER ENGINEERING

BORING NUMBER 1

CLIENT Pike County Commission
PROJECT NAME CR 103 Bridge 0070021 over Tributary to Salt River
PROJECT NUMBER 4529
PROJECT LOCATION Pike County CR 103

DATE STARTED 12/7/21 COMPLETED 12/7/21
GROUND ELEVATION 485 ft HOLE SIZE 5 in
DRILLING CONTRACTOR Great River Engineering
GROUND WATER LEVELS:
DRILLING METHOD Solid Stem Auger
▽ AT TIME OF DRILLING 83.00 ft / Elev 402.00 ft
LOGGED BY A. Brantley CHECKED BY A. Benson
AT END OF DRILLING —
NOTES
AFTER DRILLING —

DEPTH (FT)	GRAPHIC LOG	U.S.C.S.	MATERIAL DESCRIPTION	ROCK CORE NUMBER	RECOVERY % (RQD)	ALLOWABLE BEARING PRESSURE (PSF)	COMPRESSIVE STRENGTH (PSF)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		GW	WELL GRADED GRAVEL, (GW) Gravel mix roadway surface course.									
10			(CL-ML) , LOW PLASTICITY SILTY-CLAY Observed soil is moderately moist, moderately dense, medium brown in color, and containing a trace amount of gravel less than 1/2 inches in dimension.									
			Water encountered at 13 feet depth.									
20								23	26	21	5	90
30												
40												
			Water encountererd at 41 feet depth.									
50		CL-ML										
			Water encountererd at 57 feet depth.									
60												
70												
80			Rock hardpan/chert at 79.6 feet depth.									
			▽ Water encountererd at 80 feet depth.									
90												
100												

Bottom of borehole at 100.0 feet.

GRE GREAT RIVER ENGINEERING

BORING NUMBER 2

CLIENT Pike County Commission
PROJECT NAME CR 103 Bridge 0070021 over Tributary to Salt River
PROJECT NUMBER 4529
PROJECT LOCATION Pike County CR 103

DATE STARTED 12/7/21 COMPLETED 12/7/21
GROUND ELEVATION 488 ft HOLE SIZE 5 in
DRILLING CONTRACTOR Great River Engineering
GROUND WATER LEVELS:
DRILLING METHOD Solid Stem Auger
▽ AT TIME OF DRILLING 57.00 ft / Elev 431.00 ft
LOGGED BY A. Brantley CHECKED BY A. Benson
AT END OF DRILLING —
NOTES
AFTER DRILLING —

DEPTH (FT)	GRAPHIC LOG	U.S.C.S.	MATERIAL DESCRIPTION	ROCK CORE NUMBER	RECOVERY % (RQD)	ALLOWABLE BEARING PRESSURE (PSF)	COMPRESSIVE STRENGTH (PSF)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		GW	WELL GRADED GRAVEL, (GW) Gravel mix roadway surface course.									
10			SILT, (ML) Observed soil is moderately moist, moderately dense, medium brown in color, and containing a trace amount of gravel less than 1/2 inches in dimension. Rock hardpan/chert at 6 feet depth.									
20								29	24	21	3	61
30			Water encountererd at 26 feet depth.									
40			Water encountererd at 38 feet depth.									
50			Rock hardpan/chert at 44 feet depth.									
60		ML	Water encountererd at 54 feet depth. ▽ Rock hardpan/chert at 56 feet depth, with approximate 22-inch rock layer (perhaps shale) starting at 56 feet depth.									
70			Rock hardpan/chert at 74 feet depth.									
80			Rock hardpan/chert at 79 feet depth.									
90			Rock hardpan/chert at 82 feet depth.									
100			Rock hardpan/chert at 85 feet depth.									

Bottom of borehole at 100.0 feet.

GRE GREAT RIVER ENGINEERING

KEY TO SYMBOLS

CLIENT Pike County Commission

PROJECT NAME CR 103 Bridge 0070021 over Tributary to Salt River

PROJECT NUMBER 4529

PROJECT LOCATION Pike County CR 103

LITHOLOGIC SYMBOLS
(Unified Soil Classification System)

- CL-ML: USCS Low Plasticity Silty Clay
- GW: USCS Well-graded Gravel
- ML: USCS Silt
- SHALE: Shale

SAMPLER SYMBOLS

WELL CONSTRUCTION SYMBOLS

ABBREVIATIONS

LL - LIQUID LIMIT (%)
PL - PLASTIC LIMIT (%)
MC - MOISTURE CONTENT (%)
PP - POCKET PENETROMETER (TSF)

Water Level at Time Drilling, or as Shown

KEY TO SYMBOLS - GINT STD US.GDT - 10/2/2023 - Z:\GRE\PROJECTS\PLANE\GEOTECH\GINT\PROJECT\MXD PDF COLOR 10.GPJ

Appendix 2

Soil

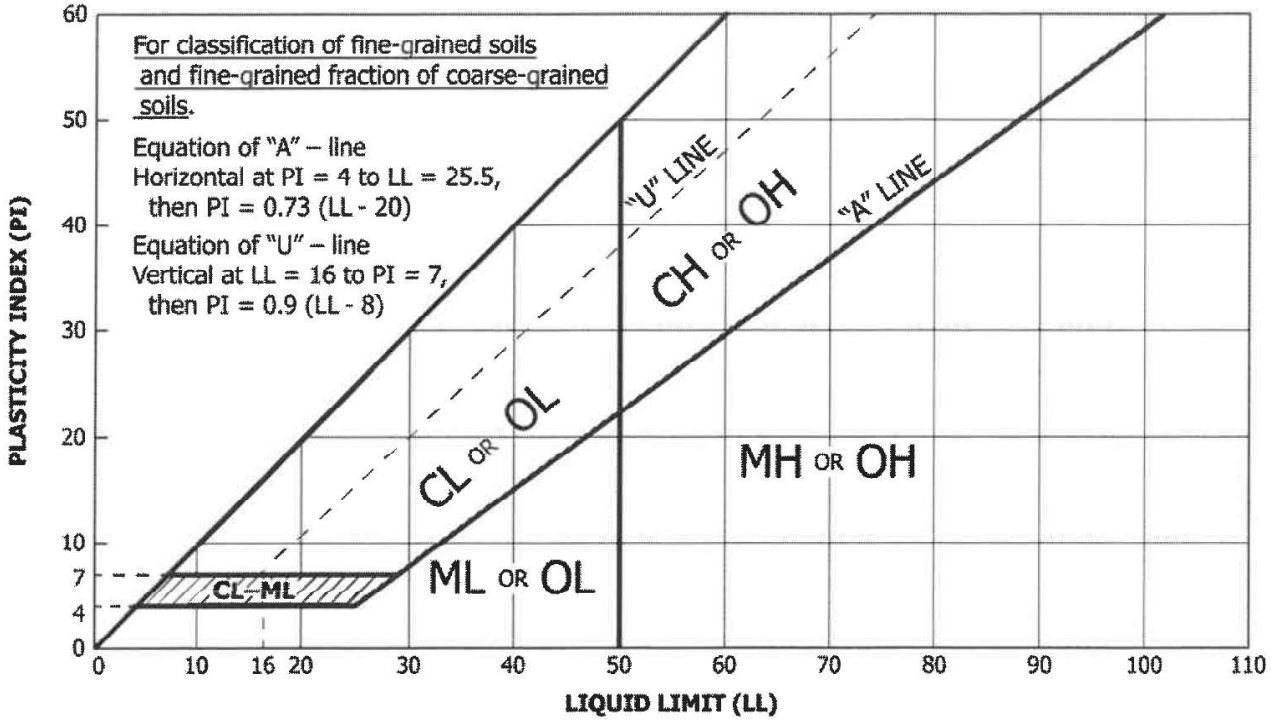
General Classification and Information

Soil Classification Chart (Ref. ASTM D2487)

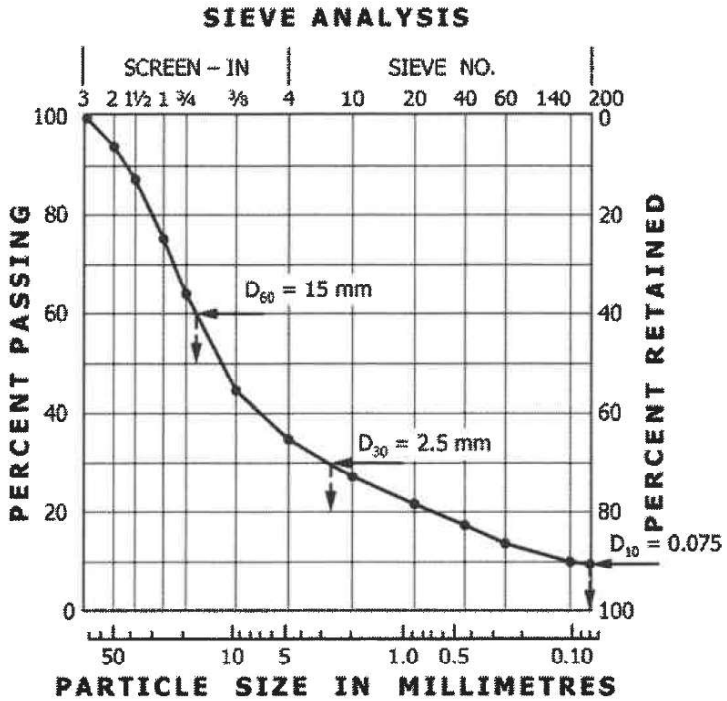
Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests[A]				Soil Classification	
				Group Symbol	Group Name[B]
COARSE-GRAINED SOILS	Gravels (More than 50 % of coarse fraction retained on No. 4 sieve)	Clean Gravels (Less than 5 % fines[C])	$Cu \geq 4.0$ and $1 \leq Cc \leq 3.0$[D]	GW	Well-graded gravel[E]
			$Cu < 4.0$ and/or $[Cc < 1$ or $Cc > 3.0]$[D]	GP	Poorly graded gravel[E]
		Gravels with Fines (More than 12 % fines[C])	Fines classify as ML or MH	GM	Silty gravel[E,F,G]
			Fines classify as CL or CH	GC	Clayey gravel[E,F,G]
More than 50 % retained on No. 200 sieve	Sands (50 % or more of coarse fraction passes No. 4 sieve)	Clean Sands (Less than 5 % fines[H])	$Cu \geq 6.0$ and $1.0 \leq Cc \leq 3.0$[D]	SW	Well-graded sand[I]
			$Cu < 6.0$ and/or $[Cc < 1.0$ or $Cc > 3.0]$[D]	SP	Poorly graded sand[I]
		Sands with Fines (More than 12 % fines[H])	Fines classify as ML or MH	SM	Silty sand[F,G,I]
			Fines classify as CL or CH	SC	Clayey sand[F,G,I]
FINE-GRAINED SOILS	Silts and Clays	inorganic	PI > 7 and plots on or above "A" line[J]	CL	Lean clay[K,L,M]
	Liquid limit less than 50		PI < 4 or plots below "A" line[J]	ML	Silt[K,L,M]
		organic	$\frac{\text{Liquid limit - oven dried}}{\text{Liquid limit - not dried}} < 0.75$	OL	Organic clay[K,L,M,N] / Organic silt[K,L,M,O]
50 % or more passes the No. 200 sieve	Silts and Clays	inorganic	PI plots on or above "A" line	CH	Fat clay[K,L,M]
	Liquid limit 50 or more		PI plots below "A" line	MH	Elastic silt[K,L,M]
		organic	$\frac{\text{Liquid limit - oven dried}}{\text{Liquid limit - not dried}} < 0.75$	OH	Organic clay[K,L,M,P] / Organic silt[K,L,M,Q]
HIGHLY ORGANIC SOILS	Primarily organic matter, dark in color, and organic odor			PT	Peat

[A] Based on the material passing the 3-in. (75-mm) sieve.
[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.
[C] Gravels with 5 to 12 % fines require dual symbols:
GW-GM well-graded gravel with silt
GW-GC well-graded gravel with clay
GP-GM poorly graded gravel with silt
GP-GC poorly graded gravel with clay
[D] $Cu = D_{60}/D_{10}$ $Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$
[E] If soil contains ≥15 % sand, add "with sand" to group name.
[F] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.
[G] If fines are organic, add "with organic fines" to group name.
[H] Sands with 5 to 12 % fines require dual symbols:
SW-SM well-graded sand with silt
SW-SC well-graded sand with clay
SP-SM poorly graded sand with silt
SP-SC poorly graded sand with clay
[I] If soil contains ≥15 % gravel, add "with gravel" to group name.
[J] If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay.
[K] If soil contains 15 to <30 % plus No. 200, add "with sand" or "with gravel," whichever is predominant.
[L] If soil contains ≥30 % plus No. 200, predominantly sand, add "sand" to group name.
[M] If soil contains ≥30 % plus No. 200, predominantly gravel, add "gravelly" to group name.
[N] PI ≥ 4 and plots on or above "A" line.
[O] PI < 4 or plots below "A" line.
[P] PI plots on or above "A" line.
[Q] PI plots below "A" line.

Plasticity Chart (Ref. ASTM D2487)



Cumulative Particle-Size Plot (Ref. ASTM D2487)



$$Cu = \frac{D_{60}}{D_{10}} = \frac{15}{0.075} = 200 \qquad Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}} = \frac{(2.5)^2}{0.075 \times 15} = 5.6$$