ARKANSAS DEPARTMENT OF TRANSPORTATION

SUBSURFACE INVESTIGATION

STATE JOB NO. 061507

FEDERAL AID PROJECT NO. NHPP-0060(58)

PALARM CREEK STR. & APPRS. (S)

STATE HIGHWAY 365 **SECTION** 11

IN PULASKI **COUNTY**

The information contained herein was obtained by the Department for design and estimating purposes only. It is being furnished with the express understanding that said information does not constitute a part of the Proposal or Contract and represents only the best knowledge of the Department as to the location, character and depth of the materials encountered. The information is only included and made available so that bidders may have access to subsurface information obtained by the Department and is not intended to be a substitute for personal investigation, interpretation and judgment of the bidder. The bidder should be cognizant of the possibility that conditions affecting the cost and/or quantities of work to be performed may differ from those indicated herein.

ARKANSAS DEPARTMENT OF TRANSPORTATION
ARDOT.gov | IDriveArkansas.com | Scott E. Bennett, P.E., Director
MATERIALS DIVISION
11301 West Baseline Road | P.O. Box 2261 | Little Rock, AR 72203-2261 | Phone: 501.569.2185 | Fax: 501.569.2368

October 5, 2017

TO: Mr. Trinity Smith, Engineer of Roadway Design

SUBJECT: Job No. 061507
Palarm Creek Str. & Apprs. (S)
Route 365 Section 11
Pulaski County

Transmitted herewith is the requested Soil Survey, strength data and Resilient Modulus test results for the above referenced job. The project consists of replacing the bridge crossing Palarm Creek on Highway 365. Samples were obtained in the existing travel lanes, and ditch line.

Based on laboratory results of samples obtained, the subgrade soils consist primarily of non-plastic sand. Cross-sections are not currently available, but it is assumed the construction grade line will closely match that of the existing roadway. The subgrade soils are expected to provide a stable working platform with normal drying and compactive effort, if the weather is favorable during construction. A high pressure gas line is located on the east side of the road south of the bridge. Near station 117+00 the gas line is exposed in the ditch line.

Approximately .4 miles south of the project is a slide on the western side of Highway 365, near a cross drain. The embankment in this location is very steep and a creek bed encroaches on the toe of the slope. A survey of this area has been requested and when cross-sections are complete, Geotechnical will make recommendations for the slide repair.

Listed below is the additional information requested for use in developing the plans:

1. The Qualified Products List (QPL) indicates that Aggregate Base Course (Class CL-7) is available from commercial producers located in the vicinity Maumelle.

2. Asphalt Concrete Hot Mix

Type	Asphalt Cement %	Mineral Aggregate %
Surface Course	5.9	94.1
Binder Course	4.0	96.0
Base Course	3.6	96.4

Michael C. Benson
Materials Engineer

MCB:pt:bjj
Attachment
cc: State Constr. Eng. – Master File Copy
District 6 Engineer
System Information and Research Div.
G. C. File

ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT - LITTLE ROCK, ARKANSAS
MATERIALS DIVISION
MICHAEL BENSON, MATERIALS ENGINEER
*** SOIL SURVEY STRENGTH TEST REPORT ***

DATE - 09/27/2017
JOB NUMBER - 061507

SEQUENCE NO. - 1
MATERIAL CODE - SSRV
SPEC. YEAR - 2014
SUPPLIER ID. - 1
COUNTY/STATE - 60
DISTRICT NO. - 06

JOB NAME - PALARM CREEK STR. & APPRS.(S)

STATION LIMITS	R-VALUE AT 240 psi
BEGIN JOB - END JOB	7
RESILIENT MODULUS	
STA. 124 + 00	6502

REMARKS -
-

AASHTO TESTS : T190

ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT
MATERIALS DIVISION

AASHTO T 307-99 - RESILIENT MODULUS OF SUBGRADE SOILS
RECOMPACTED SAMPLES

Job No.	061507	**Material Code**	SSRVPS
Date Sampled:	9/26/2017	**Station No.:**	124+00
Date Tested:	September 26, 2017	**Location:**	21'lLT
Name of Project:	Palarm Creek Str. & Apprs. (S)		
County:	**Code:** 60 **Name:** PULASKI		
Sampled By:	Thornton/Bates/Jordan	**Depth:**	0-5
Lab No.:	20172771	**AASHTO Class:**	A-4(0)
Sample ID:	RV562	**Material Type (1 or 2):**	2
LATITUDE:		**LONGITUDE:**	

1. Testing Information:

Preconditioning - Permanent Strain > 5% (Y=Yes or N= No)	N
Testing - Permanent Strain > 5% (Y=Yes or N=No)	N
Number of Load Sequences Completed (0-15)	15

2. Specimen Information:

Specimen Diameter (in):	
Top	3.94
Middle	3.94
Bottom	3.93
Average	3.94
Membrane Thickness (in):	0.01
Height of Specimen, Cap and Base (in):	8.02
Height of Cap and Base (in):	0.00
Initial Length, Lo (in):	8.02
Initial Area, Ao (sq. in):	12.10
Initial Volume, AoLo (cu. in):	97.02

3. Soil Specimen Weight:

Weight of Wet Soil Used (g):	3217.50

4. Soil Properties:

Optimum Moisture Content (%):	12.6
Maximum Dry Density (pcf):	117.3
95% of MDD (pcf):	111.4
In-Situ Moisture Content (%):	N/A

5. Specimen Properties:

Wet Weight (g):	3217.50
Compaction Moisture content (%):	12.0
Compaction Wet Density (pcf):	126.36
Compaction Dry Density (pcf):	112.82
Moisture Content After Mr Test (%):	12.3

6. Quick Shear Test (Y=Yes, N=No, N/A=Not Applicable): #VALUE!

7. Resilient Modulus, Mr: 6100(Sc)^-0.12291(S3)^0.42454

8. Comments ______________________

9. Tested By: B.H **Date:** September 26, 2017

ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT
MATERIALS DIVISION

AASHTO T 307-99 - RESILIENT MODULUS OF SUBGRADE SOILS
RECOMPACTED SAMPLES

Job No.	061507	**Material Code**	SSRVPS
Date Sampled:	9/26/2017	**Station No.:**	124+00
Date Tested:	September 26, 2017	**Location:**	21'lLT
Name of Project:	Palarm Creek Str. & Apprs. (S)		
County:	**Code:** 60 **Name:** PULASKI		
Sampled By:	Thornton/Bates/Jordan	**Depth:**	0-5
Lab No.:	20172771	**AASHTO Class:**	A-4(0)
Sample ID:	RV562	**Material Type (1 or 2):**	2
LATITUDE:		**LONGITUDE:**	

PARAMETER	*Chamber Confining Pressure*	*Nominal Maximum Axial Stress*	*Actual Applied Max. Axial Load*	*Actual Applied Cyclic Load*	*Actual Applied Contact Load*	*Actual Applied Max. Axial Stress*	*Actual Applied Cyclic Stress*	*Actual Applied Contact Stress*	*Average Recov Def. LVDT 1 and 2*	*Resilient Strain*	*Resilient Modulus*
DESIGNATION	S_3	S_{cyclic}	P_{max}	P_{cyclic}	$P_{contact}$	S_{max}	S_{cyclic}	$S_{contact}$	H_{avg}	ε_r	M_r
UNIT	psi	psi	lbs	lbs	lbs	psi	psi	psi	in	in/in	psi
Sequence 1	6.0	2.0	25.0	22.2	2.8	2.1	1.8	0.2	0.00119	0.00015	12,389
Sequence 2	6.0	4.0	47.1	44.3	2.8	3.9	3.7	0.2	0.00254	0.00032	11,554
Sequence 3	6.0	6.0	69.8	66.2	3.6	5.8	5.5	0.3	0.00406	0.00051	10,803
Sequence 4	6.0	8.0	93.4	87.5	6.0	7.7	7.2	0.5	0.00571	0.00071	10,160
Sequence 5	6.0	10.0	117.1	108.8	8.3	9.7	9.0	0.7	0.00737	0.00092	9,784
Sequence 6	4.0	2.0	24.9	22.2	2.7	2.1	1.8	0.2	0.00146	0.00018	10,073
Sequence 7	4.0	4.0	46.6	43.8	2.7	3.8	3.6	0.2	0.00315	0.00039	9,218
Sequence 8	4.0	6.0	67.9	65.2	2.7	5.6	5.4	0.2	0.00504	0.00063	8,574
Sequence 9	4.0	8.0	91.7	86.7	5.0	7.6	7.2	0.4	0.00676	0.00084	8,495
Sequence 10	4.0	10.0	115.4	107.8	7.6	9.5	8.9	0.6	0.00852	0.00106	8,392
Sequence 11	2.0	2.0	24.5	21.7	2.8	2.0	1.8	0.2	0.00189	0.00024	7,614
Sequence 12	2.0	4.0	45.3	42.4	2.8	3.7	3.5	0.2	0.00410	0.00051	6,856
Sequence 13	2.0	6.0	66.0	63.1	2.9	5.5	5.2	0.2	0.00630	0.00079	6,640
Sequence 14	2.0	8.0	88.7	84.4	4.3	7.3	7.0	0.4	0.00845	0.00105	6,625
Sequence 15	2.0	10.0	111.5	104.8	6.7	9.2	8.7	0.6	0.01068	0.00133	6,502

TESTED BY B.H DATE September 26, 2017

REVIEWED BY DATE

ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT

MATERIALS DIVISION

AASHTO T 307-99 - RESILIENT MODULUS OF SUBGRADE SOILS

RECOMPACTED / THINWALL TUBE SAMPLES

Job No.	061507	**Material Code**	SSRVPS
Date Sampled:	9/26/2017	**Station No.:**	124+00
Date Tested:	September 26, 2017	**Location:**	21'lLT
Name of Project:	Palarm Creek Str. & Apprs. (S)		
County:	**Code:** 60 **Name:** PULASKI		
Sampled By:	Thornton/Bates/Jordan	**Depth:**	0-5
Lab No.:	20172771	**AASHTO Class:**	A-4(0)
Sample ID:	RV562	**Material Type (1 or 2):**	2
LATITUDE:		**LONGITUDE:**	

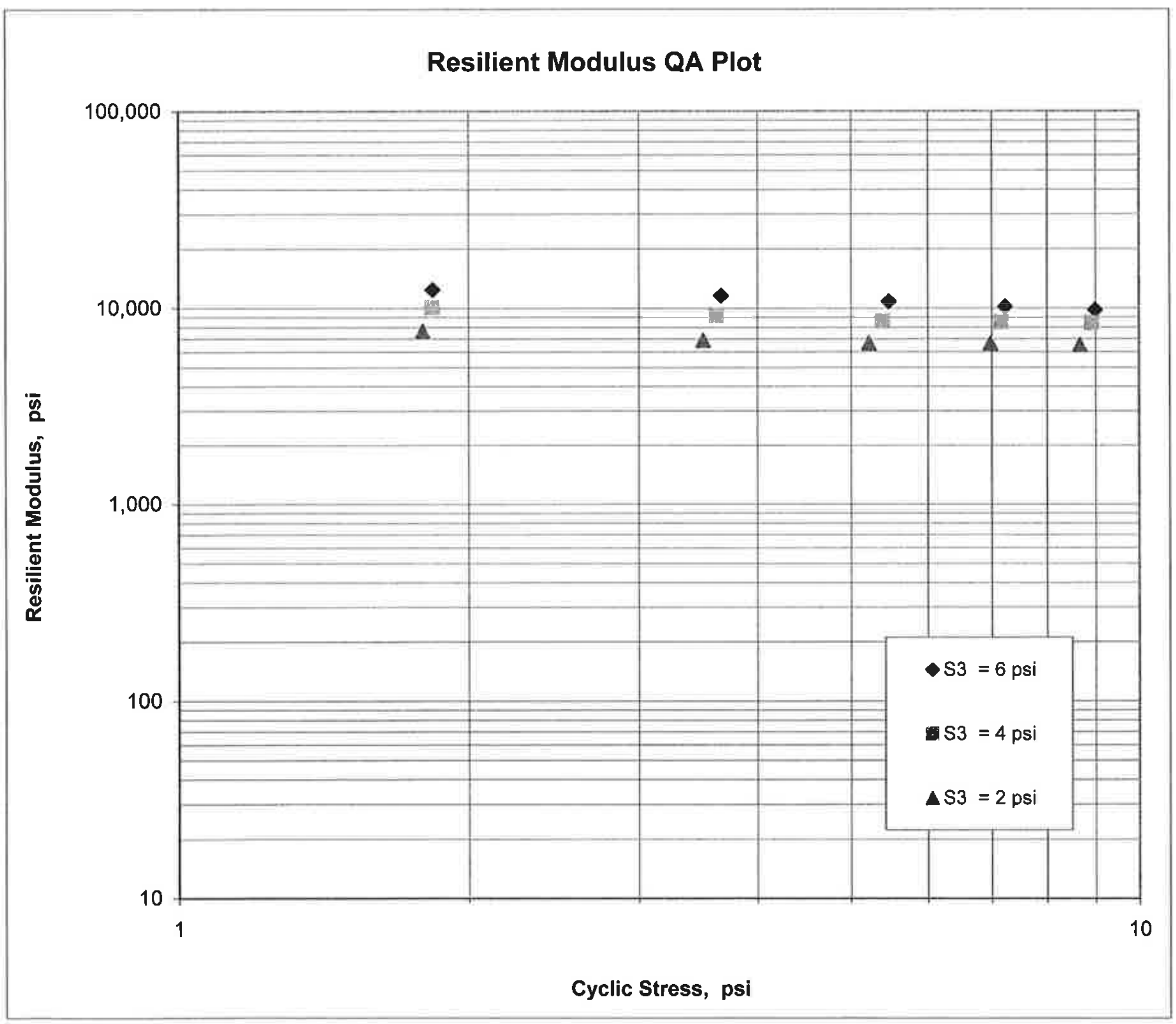
$$M_R = K1\,(S_C)^{K2}\,(S_3)^{K5}$$

K1 = 6,100

K2 = -0.12291

K5 = 0.42454

R^2 = 0.99



JOB: 061507

JOB NAME: PALARM CREEK STR. & APPRS.(S)

COUNTY NO. 60 **DATE TESTED** 9/12/2017

Arkansas State Highway Transporation Department

Materials Division

Michael Benson, Materials Engineer

STA.#	LOC.	DEPTH	COLOR	#4	#10	#40	#80	#200	L.L.	P.I.	SOIL CLASS	LAB #:	%MOISTURE
				SIEVES									
124+00	21LT	0-5	BROWN	94	88	81	75	60	ND	NP	A-4(0)	RV562	
117+10	06RT	0-1Z	BROWN	78	69	63	60	55	29	12	A-6(4)	S559	14.3
124+00	06LT	0-5	BROWN	95	85	76	66	37	ND	NP	A-4(0)	S560	29.8
124+00	21LT	0-5	BROWN	91	86	80	74	58	ND	NP	A-4(0)	S561	14.4

comments: W=MULTIPLE LAYERS, X=STRIPPED

Tuesday, October 03, 2017

JOB: 061507
JOB NAME: PALARM CREEK STR. & APPRS.(S)

COUNTY NO. 60

Arkansas State Highway Transporation Department
Materials Division
Michael Benson, Materials Engineer

DATE TESTED
9/12/2017

PAVEMENT SOUNDINGS

STA.#	LOC.						
117+10	06RT	ACHMSC	ACHMSC	ACHMSC	ACHMBC	PCCP	AGG BASE CRS CL-7
		4.5W	**2.5WX**	**7.0W**	---	---	---
124+00	06LT	ACHMSC	ACHMSC	ACHMSC	ACHMBC	PCCP	AGG BASE CRS CL-7
		2.5WX	**1.0W**	---	**2.0**	**7.5**	**5.0**
124+00	21LT	ACHMSC	ACHMSC	ACHMSC	ACHMBC	PCCP	AGG BASE CRS CL-7
		---	---	---	---	---	---

comments: W=MULTIPLE LAYERS, X=STRIPPED

Tuesday, October 03, 2017

ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT - LITTLE ROCK, ARKANSAS
MATERIALS DIVISION
MICHAEL BENSON, MATERIALS ENGINEER
*** SOIL SURVEY / PAVEMENT SOUNDING TEST REPORT ***

DATE - 10/02/17
JOB NUMBER - 061507
FEDERAL AID NO.- TO BE ASSIGNED
PURPOSE - SOIL SURVEY SAMPLE
SPEC. REMARKS - NO SPECIFICATION CHECK
SUPPLIER NAME - STATE
NAME OF PROJECT - PALARM CREEK STR. & APPRS.(S)
PROJECT ENGINEER - NOT APPLICABLE
PIT/QUARRY - ARKANSAS
LOCATION - PULASKI COUNTY
SAMPLED BY - THORNTON/BATES
SAMPLE FROM - TEST HOLE
MATERIAL DESC. - SOIL SURVEY - R VALUE- PAVEMENT SOUNDINGS

SEQUENCE NO. - 1
MATERIAL CODE - SSRVPS
SPEC. YEAR - 2014
SUPPLIER ID. - 1
COUNTY/STATE - 60
DISTRICT NO. - 06

DATE SAMPLED - 09/05/17
DATE RECEIVED - 09/07/17
DATE TESTED - 09/12/17

LAB NUMBER	20172768	20172769	20172770
SAMPLE ID	S559	S560	S561
TEST STATUS	INFORMATION ONLY	INFORMATION ONLY	INFORMATION ONLY
STATION	117+10	124+00	124+00
LOCATION	06RT	06LT	21LT
DEPTH IN FEET	0-1Z	0-5	0-5
MAT'L COLOR	BROWN	BROWN	BROWN
MAT'L TYPE			
LATITUDE DEG-MIN-SEC	34 54 10.60	34 54 16.60	34 54 16.60
LONGITUDE DEG-MIN-SEC	92 26 54.80	92 26 51.90	92 26 52.10
% PASSING 2 IN.			
1 1/2 IN.			
3/4 IN.	100	100	100
3/8 IN.	90	99	96
NO. 4	78	95	91
NO. 10	69	85	86
NO. 40	63	76	80
NO. 80	60	66	74
NO. 200	55	37	58
LIQUID LIMIT	29	ND	ND
PLASTICITY INDEX	12	NP	NP
AASHTO SOIL	A-6(4)	A-4(0)	A-4(0)
UNIFIED SOIL			
% MOISTURE CONTENT	14.3	29.8	14.4
ACHMSC (IN)	4.5W	2.5WX	---
ACHMSC (IN)	2.5WX	1.0W	---
ACHMSC (IN)	7.0W	---	---
ACHMBC (IN)	---	2.0	---
PCCP (IN)	---	7.5	---
AGG BASE CRS CL-7 (IN)	---	5.0	---

REMARKS - W=MULTIPLE LAYERS, X=STRIPPED

AASHTO TESTS : T24 T88 T89 T90 T265

ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT - LITTLE ROCK, ARKANSAS
MATERIALS DIVISION
MICHAEL BENSON, MATERIALS ENGINEER
*** SOIL SURVEY / PAVEMENT SOUNDING TEST REPORT ***

DATE - 09/12/17
JOB NUMBER - 061507
FEDERAL AID NO.- TO BE ASSIGNED
PURPOSE - SOIL SURVEY SAMPLE
SPEC. REMARKS - NO SPECIFICATION CHECK
SUPPLIER NAME - STATE
NAME OF PROJECT - PALARM CREEK STR. & APPRS.(S)
PROJECT ENGINEER - NOT APPLICABLE
PIT/QUARRY - ARKANSAS
LOCATION - PULASKI COUNTY
SAMPLED BY - THORNTON/BATES
SAMPLE FROM - TEST HOLE
MATERIAL DESC. - SOIL SURVEY - RESISTANCE R-VALUE ACTUAL RESULTS

SEQUENCE NO. - 1
MATERIAL CODE - RV
SPEC. YEAR - 2014
SUPPLIER ID. - 1
COUNTY/STATE - 60
DISTRICT NO. - 06

DATE SAMPLED - 09/05/17
DATE RECEIVED - 09/07/17
DATE TESTED - 09/12/17

LAB NUMBER	20172771		
SAMPLE ID	RV562		
TEST STATUS	INFORMATION ONLY		
STATION	124+00		
LOCATION	21LT		
DEPTH IN FEET	0-5		
MAT'L COLOR	BROWN		
MAT'L TYPE			
LATITUDE DEG-MIN-SEC	34 54 16.60		
LONGITUDE DEG-MIN-SEC	92 26 52.10		
% PASSING 2 IN.			
1 1/2 IN.			
3/4 IN.			
3/8 IN.	100		
NO. 4	94		
NO. 10	88		
NO. 40	81		
NO. 80	75		
NO. 200	60		
LIQUID LIMIT	ND		
PLASTICITY INDEX	NP		
AASHTO SOIL	A-4(0)		
UNIFIED SOIL			
% MOISTURE CONTENT			

REMARKS - W=MULTIPLE LAYERS, X=STRIPPED

AASHTO TESTS : T24 T88 T89 T90 T265

Geotechnical Engineering Report

Job No. 061507, Palarm Creek Structures and Approaches
Little Rock, Pulaski County, Arkansas

March 18, 2019

Terracon Project No. 35195010

Prepared for:

Michael Baker International, Inc.
Little Rock, Arkansas

Prepared by:

Terracon Consultants, Inc.
Little Rock, Arkansas

March 18, 2019

Michael Baker International, Inc.
1400 West Markham, Suite 204
Little Rock, Arkansas 72201

Attn: Mr. Scott Thornsberry
P: (501) 244-1004
E: scott.thornsberry@mbakerintl.com

Re: Geotechnical Engineering Report
Job No. 061507, Palarm Creek Structures and Approaches
Highway 365
Little Rock, Pulaski County, Arkansas
Terracon Project No. 35195010

Dear Mr. Thornsberry:

We have completed the Geotechnical Engineering services for the above referenced project. This study was performed in general accordance with Task Order Number 059. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning the proposed bridge replacement for the proposed project.

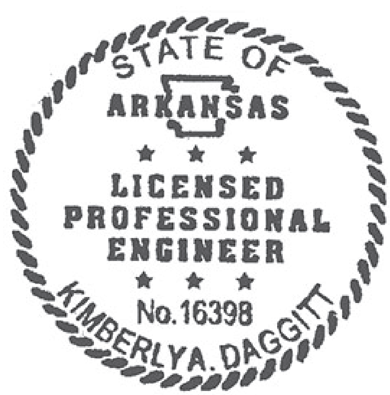
We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report or if we may be of further service, please contact us.

Sincerely,
Terracon Consultants, Inc.
Certificate of Authorization #223 Expires 12/31/2019

Kimberly A. Daggitt, P.E.
Project Engineer

Christopher S. Handley, P.E.
Geotechnical Department Manager

Steven M. Levorson, Ph.D., P.E. (KS & MO)
Senior Engineering Consultant



REPORT TOPICS

Note: This report was originally delivered in a web-based format. For more interactive features, please view your project online at client.terracon.com.

ATTACHMENTS

Note: Refer to each individual Attachment for a listing of contents.

Geotechnical Engineering Report

Job No. 061507, Palarm Creek Structures and Approaches
Highway 365
Little Rock, Pulaski County, Arkansas
Terracon Project No. 35195010
March 18, 2019

INTRODUCTION

This report presents the results of our subsurface exploration and geotechnical engineering services performed for the proposed Palarm Creek Bridge Replacement to be located along Highway 365 in Little Rock, Pulaski County, Arkansas. The purpose of these services is to provide information and geotechnical engineering recommendations relative to:

- Subsurface soil and rock conditions
- Groundwater conditions
- Site preparation and earthwork
- Excavation considerations
- Foundation design and construction
- Lateral earth pressures
- Seismic site classification per AASHTO

The geotechnical engineering Scope of Services for this project included the advancement of four test borings to depths ranging from approximately 26.5 to 80.5 feet below existing site grades.

Maps showing the site and boring locations are shown in the **Site Location** and **Exploration Plan** sections, respectively. The results of the laboratory testing performed on soil samples obtained from the site during the field exploration are included on the boring logs and/or as separate graphs in the **Exploration Results** section.

SITE CONDITIONS

The following description of site conditions is derived from our site visit in association with the field exploration and our review of publicly available geologic and topographic maps.

Item	Description
Parcel Information	A bridge approximately 202.5 feet in length along Highway 365 is being replaced. See **Site Location**
Existing Improvements	Existing Bridge over Palarm Creek
Current Ground Cover	Existing Bridge and Roadway. Bridge surrounded by steep embankments to an existing creek.

Item	Description
Existing Topography	From provided plans of the existing bridge it appears the existing ground surface is at an elevation of about 272 feet. Steep embankments exist down to water surface. It appears that the ground surface at the intermediate bents is about 252 feet.
Geology	From our experience in the project area, we expected soils typical of the Jackfork Sandstone. The soils observed at the project location matched the expectations.

PROJECT DESCRIPTION

Our initial understanding of the project was provided in our proposal and was discussed during project planning. A period of collaboration has transpired since the project was initiated, and our final understanding of the project conditions is as follows:

Item	Description
Project Description	An approximately 202.5 foot bridge over Palarm Creek is being replaced
Bridge Construction	We understand that the bridge abutments will be supported on pile foundations driven to bedrock The intermediate bents of the bridge will be supported on driven pier foundations. A 66-inch diameter pier was provided as the initial size of the pier to be considered for bridge support at the intermediate bents.
Finished Floor Elevation	We understand that the new bridge will be at or near the elevation of the existing bridge and roadway alignment. Terracon should be notified if any major changes are made to the roadway alignment or planned bridge elevation that will affect the bridge replacement.
Maximum Loads	Maximum bridge loads were not provided at the time of the report. We must be notified if any uplift or lateral load resistance is required by design.
Pavements	Pavement sections or recommendations are not in the scope of work for this project
Estimated Start of Construction	2019

GEOTECHNICAL CHARACTERIZATION

We have developed a general characterization of the subsurface conditions based upon our review of the subsurface exploration, laboratory data, geologic setting and our understanding of the project. This characterization, termed GeoModel, forms the basis of our geotechnical calculations and evaluation of site preparation and foundation options. Conditions encountered at each exploration point are indicated on the individual logs. The individual logs can be found in the **Exploration Results** section and the GeoModel can be found in the **Figures** section of this report.

As part of our analyses, we identified the following model layers within the subsurface profile. For a more detailed view of the model layer depths at each boring location, refer to the GeoModel.

Model Layer	Layer Name	General Description
1	**Embankment and Creek Bed Soils**	Lean and fat clay soils with varying amounts of sand and sand soils with varying amounts of clay and silt
2	**Bedrock**	Sandstone and Interbedded sandstone and shale

The boreholes were observed for groundwater while drilling by dry auger. The water levels observed in the boreholes can be found on the boring logs in **Exploration Results**, and are summarized below.

Boring Number	Approximate depth to groundwater while drilling (feet)	Approximate elevation of groundwater while drilling (feet)
B-1	5	266
B-2	13.5	247
B-4	24	246

Boring B-3 was drilled by barge in the existing creek, therefore it was under the existing water level. Groundwater level fluctuations occur due to seasonal variations in the amount of rainfall, runoff and other factors not evident at the time the borings were performed. Therefore, groundwater levels during construction or at other times in the life of the structures may be higher or lower than the levels indicated on the boring logs. The possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project.

GEOTECHNICAL OVERVIEW

The Arkansas Department of Transportation is proposing a bridge replacement along Highway 365 over Palarm Creek in Pulaski County, Arkansas. The native soils and rock encountered at the boring locations are associated with alluvial deposits and the Jackfork Sandstone group. Variable layers of clays and sands were observed in the borings at the bridge structure location. The results of our study indicate that the site can be developed for the proposed bridge replacement. During our study the following geotechnical conditions were identified:

- Low-strength soils

- Existing fill
- Moisture-sensitive soils
- Variablility of Bedrock

The following discussion addresses these items and provides the basis for design recommendations present in the subsequent sections. Additional construction-related concepts are provided in the various **Construction Consideration** sections of this report.

Low-strength Soils

Low-strength (soils with SPT N-values less than or equal to 5 blows per foot) existing fill and native soils were observed in Borings B-2 through B-4 typically from the existing ground surface to depths of about 30 to 60 feet below the existing surface. The low-strength soils were typically observed to elevations ranging from 212 to 228.5 feet. In their present condition, the low-strength soils are not suitable for providing direct support to shallow foundations associated with the bridge structure such as bridge abutments or wingwalls. These low-strength soils are expected to be compressible under new embankment fills. It is our understanding that the bridge abutments will be supported on pile foundations and the intermediate bents will be supported on drilled pier foundations. These low-strength alluvial soils would provide a low skin friction and lateral resistance, which were factored into the deep foundation parameters and axial resistances provided in the Deep Foundation section.

Existing Fill

Existing fill consisting of clayey sand was observed to a depth of 5 feet in Borings B-1 and B-4. Information regarding placement of that existing fill was not available. There is an inherent risk to the owner that otherwise unsuitable material within or buried by the fill will not be discovered that could result in unpredictable post-construction performance if the bridge or wingwall foundations were supported on existing fill. We understand that the bridge abutments will be supported on driven pile foundations; therefore, the existing fill can be left in place. If the design changes, and bridge foundations or abutment wingwalls will be supported on shallow foundations, we should be notified to revise our recommendations as necessary.

Moisture-Sensitive Soils

The lean clay and clayey sand soils that were observed at or near the ground surface at the boring locations are moisture-sensitive and prone to further strength loss with increased moisture content. These soils could become unstable with typical earthwork and construction traffic, especially after precipitation events; therefore, effective drainage should be completed early in the construction sequence and maintained during and after construction. If possible, the construction should be performed during warmer and drier times of the year. If construction is performed during the winter months, an increased risk for unstable subgrade conditions will occur.

Variability of Bedrock

Sandstone and interbedded sandstone and shale was observed in all the bridge borings. Top of rock was observed at elevations ranging from 256 to 205.5 feet. It appears that the bedrock is dipping to the north. It was also noted during the field exploration that the bedding planes of the bedrock at the project site are at a 45-degree angle to the horizontal. The bedrock formation in the project area was formed by submarine slumping of an older stratigraphic unit, producing the observed bedding. Due to this, the depth to bedrock can vary greatly within the project site. Rock excavation considerations are discussed in the Deep **Foundations** section.

Based on the subsurface conditions observed as well as the conversations with the client, we understand that drilled piers and driven piles are being considered for the support of the bridge. The **Deep Foundations** section addresses the support of the bridge on drilled piers and driven piles. The **General Comments** section provides an understanding of the report limitations.

EARTHWORK

Earthwork should be performed as required in the ArDOT Standard Specification for Highway Construction. The following recommendations for site preparation, excavation, subgrade preparation and placement of engineered fills on the project are considered general recommendations for earthwork on-site. The evaluation of earthwork should include observation and testing of engineered fill, subgrade preparation, and other geotechnical conditions during construction of the project. Terracon should be retained during the site preparation operations.

Site Preparation

We understand that deep foundations are being utilized for the support of the bridge. Because of this we anticipate that preparation of the subgrade may not be necessary. Where site preparation and grading are necessary for the roadway and approach apron to the bridge, surface vegetation, topsoil, pavements and any other surface and subsurface structures should be removed from the construction areas. Unstable subgrade conditions will likely develop during site clearing operations, particularly near the creek and if the soils are wet and/or subjected to repetitive construction traffic. Using low ground pressure (tracked or balloon tired) construction equipment would aid in reducing subgrade disturbance. Even with using low ground pressure equipment, difficult conditions should be expected if the ground surface is disturbed and wetted.

After stripping, completing grading operations, and prior to placing fill, the subgrade should be proof-rolled to aid in locating loose of soft areas. Proof-rolling can be performed with a loaded tandem axle dump truck. Where unstable soils are identified by proof-rolling, stabilization could include scarification, moisture-conditioning and compaction; or removal and replacement of unstable materials with aggregate (with or without geosynthetics). The appropriate method of improvement, if required, would depend on factors such as schedule, weather, the size of the are to be treated, and the nature of the instability. More detailed recommendations can be provided during construction. Construction during warm, dry periods would help reduce the amount of subgrade stabilization required.

Fill Material Types

Fil materials should be free of organic matter and debris. The upper on-site soils or approved imported borrow material may be used as fill material. Based on the limited lab testing performed, the existing fill material and native soils sampled on-site appear to be suitable for use as engineered fill. Though on-site soils appear suitable, we recommend thorough testing prior to reuse. Materials with plasticity indices greater than 20 should not be used within the upper 2 feet of the finished pavement subgrade.

While ArDOT has no specific requirement for borrow materials, they do require that the material be capable of forming and maintaining stable embankment when compacted. Therefore, we recommend specifically avoiding elastic silts (MH) and organic soils (OL, OH and PT) when considering materials for use as borrow.

We suggest that approved imported borrow soils meet the following material property requirements:

Sieve Size	Percent Finer by Weight (ASTM C136)
3 inch	100
No. 4	50-100
No. 200	15-50

- Plasticity Index…………………………………………………………..20(max)

Fill Placement

Where fill is placed on existing slopes steeper than 4H:1V, benches should be cut into the existing slopes prior to fill placement. The benches should have a minimum vertical face height of 1 foot and a maximum vertical face height of 3 feet and should be cut wide enough to accommodate the compaction equipment. This benching will help provide a positive bond between the fill and natural soils and reduce the possibility of failure along the fill/natural soil interface. We recommend that fill slopes be filled beyond the planned final slope face and then cut back to develop an adequately compacted slope face.

Utility Trench Backfill

All trench excavations should be made with sufficient working space to permit construction including backfill placement and compaction. It is strongly recommended that a qualified person provide full-time observation and compaction testing of trench backfill within the pavement areas.

Earthwork Construction Considerations

Unstable subgrade conditions are likely to develop during general construction operations, particularly where the soils are wetted and/or subjected to repetitive construction traffic. Unstable soils, where encountered, should be improved in-place prior to placing new engineered fill. In some areas, it may be necessary to strip and/or undercut the rutted and wet surface soils prior to performing ground improvement. Subgrade improvement techniques are discussed in detail in the following paragraphs.

The near-surface lean clay and clayey sand soils observed at this site are moisture-sensitive and susceptible to disturbance from construction activity, particularly when the soil has a high natural moisture content or is wetted by surface water or seepage. During wetter periods of the year, these soils will pump and rut under the weight of heavy construction equipment, especially rubber-tired vehicles. The contractor should consider using track-mounted (low ground pressure) equipment to reduce subgrade disturbance and/or instability.

If unstable subgrade conditions are encountered, the methods described below can be considered to improve subgrade strength. Common methods include scarification, moisture conditioning and compaction, removal of unstable materials and replacement with granular fill (with or without geosynthetics), and chemical stabilization. The appropriate method of improvement, if required, depends on factors such as schedule, weather, the size of area to be stabilized, and the nature of the instability.

If the exposed subgrade becomes unstable, methods outlines below can be considered.

- **Scarification and Compaction –** It may be feasible to scarify, dry and compact the exposed soils. The success of this procedure would depend primarily upon favorable weather and sufficient time to dry the soils. Stable subgrades likely would not be achievable if the thickness of the unstable soil is greater than about 1 foot, if the unstable soil is at or near the groundwater levels, or if construction is performed during a period of wet or cool weather when drying is difficult.

- **Crushed Stone –** The use of crushed stone or crushed gravel is the most common procedure to improve subgrade stability. Typical undercut depths would be expected to range from about 6 to 30 inches below the finished subgrade elevation. The use of high modulus geosynthetics (i.e., geotextile or geogrid) can also be considered after underground work such as utility construction is completed. Prior to placing the geotextile or geogrid, we recommend that all below-grade construction, such as utility line installation, be completed to avoid damaging the geosynthetics. Equipment should not be operated above the geosynthetics until one full lift of crushed stone fill is placed above it. The maximum particle size of granular material placed over the geosynthetics should conform to the manufacturer's recommendations and generally should not exceed 1½ inches.

Further evaluation of the need for subgrade stabilization should be provided by a qualified geotechnical engineer during construction as the subgrade conditions are exposed on a broad scale.

Temporary excavations will probably be required during grading operations. As a minimum, excavations should be performed in accordance with OSHA 29 CFR, Part 1926, Subpart P, "Excavations" and its appendices, and in accordance with any applicable local, and/or state regulations.

Construction site safety is the sole responsibility of the contractor who controls the means, methods, and sequencing of construction operations. Under no circumstances shall the information provided herein be interpreted to mean Terracon is assuming any responsibility for construction site safety, or the contractor's activities; such responsibility shall neither be implied nor inferred.

Construction Observation and Testing

The earthwork efforts should be monitored under the direction of the Geotechnical Engineer. Monitoring should include documentation of adequate removal of vegetation and topsoil, proofrolling, and mitigation of areas delineated by the proof-roll to require mitigation.

In addition to the documentation of the essential parameters necessary for construction, the continuation of the Geotechnical Engineer into the construction phase of the project provides the continuity to maintain the Geotechnical Engineer's evaluation of subsurface conditions, including assessing variations and associated design changes.

DEEP FOUNDATIONS

Drilled Shaft and Dirven Pile Design Parameters

The project is located within the Arkansas Valley Region, which contains Pennsylvanian clastic sediments deposited on the margin of a continental shelf through marine processes. Geological features in the area are typical of both the Ozarks and the Ouachitas, including dissected plateaus and folded ridges. The project area contained alluvial deposits overlying Jackfork Sandstone. The Jackfork Sandstone is thin- to massive-bedded sandstones with subordinate shales. The bedrock at the project site appeared to be uplifted, with 45-degree observed bedding angles. It appeared that the bedrock is generally dipping to the north; therefore, the depth of bedrock could be highly variable within the project site. For analysis purposes, the following elevations were used for determination for drilled pier and driven pile design.

Boring Number	Approximate elevation of top of Observed Rock Stratum (feet)
B-1	256
B-2	228.5
B-3	213
B-4	205.5

The upper portions of the rock in the Borings should be neglected when determining pier resistance because of apparent weathering and low-strength in that rock. The top 1.5 feet of bedrock at Boring B-3 was neglected in the following analyses.

Design parameters for drilled shafts were evaluated in accordance with the FHWA-NHI-10-016 Drilled Shafts: Construction Procedures and LRFD Design Method as well as AASHTO LRFD Section 10 and are provided below in the Drilled Shaft Design Parameters table. The values were developed based on our analysis of the rock mass quality, degree of alteration, degree of interbedding and our interpretation of the stratigraphy at the intermediate bent (Boring B-3).. Suggested resistance factors for the Structural limit state for the rock types observed at this project are included in the table below.

Boring B-3 (Intermediate Bent)

Bottom of Stratum Elevation	Material Observed	Total Unit Weight (pcf)	Nominal Skin Friction (ksf)	Nominal End Bearing (ksf)
213	Creekbed soils (Alluvium)	125	Ignore resistance	
202	Sandstone	130	34.9	5,400
192	Interbedded sandstone and shale	130	34.9	255
172	Sandstone	135	34.9	5,400

Resistance Factors for Geotechnical Resistance of Drilled Shafts, [AASHTO 10.5.5.2.4-1]
Geotechnical Resistance Factors for Single Drilled Shafts
Side Resistance in Rock = 0.55
Tip Resistance in Rock = 0.50

From a compressive load standpoint, the factored resistances of the rock observed at the intermediate bent are much higher than the structural resistance of the shaft. No rock socket is needed if the pier is founded on competent sandstone such as was encountered in Boring B-3 and a clean base can be achieved and verified using conventional clean-out equipment. About 1.5 feet of weathered shale was observed in Boring B-3. This shale bedrock was ignored in the analyses due to the amount of weathering. We recommend that the upper 2 feet, of rock be ignored in the evaluation of drilled pier depths to account for the low-strength shale bedrock and an additional 6 inches of sandstone for clean-out during construction.

Settlements of drilled shafts under Service Load conditions are expected to be very small (essentially elastic compression of the shaft).

Terracon must be notified if any of the Service, Structural or Extreme Limit states for the bridge structure will require uplift or lateral resistance. Low-strength overburden soils observed above the existing bedrock will not provide adequate resistance; therefore, to resist uplift and lateral loads, a rock socket may be necessary. We understand that a 66-inch drilled pier is currently being considered, but due to the strength of rock observed at the intermediate bent location, it will be very difficult to drill a large socket in the observed rock. We recommend that a smaller diameter drilled pier should be considered if there is a necessity to have a rock socket to provide uplift and lateral resistance. Terracon will be happy to evaluate drilled piers for lateral and uplift resistance.

Drilled Shaft Construction Considerations

A full-depth temporary steel casing may be required to stabilize the sides of the shaft excavations in the overburden. Hard drilling conditions within the bedrock should be expected. Any water or loose soil should be removed from the bottom of the drilled shafts prior to placement of the concrete.

While withdrawing casing, care should be exercised to maintain concrete inside the casing at a sufficient level to resist earth and hydrostatic pressures acting on the casing exterior. Arching of the concrete, loss of seal and other problems can occur during casing removal and result in contamination of the drilled shaft. These conditions should be considered during the design and construction phases. Placement of loose soil backfill should not be permitted around the casing prior to removal.

Use of a telescoping casing arrangement can be considered to avoid handling long casing lengths. The lower casing should be of sufficient length and stiffness and have an appropriate cutting edge to allow it to be firmly seated into the bedrock to seal out groundwater. If possible, excess water should be evacuated from the casing to place concrete in the "dry."

Care should be taken to not disturb the sides and bottom of the excavation during construction. The bottom of the shaft excavation should be free of loose material before concrete placement. Concrete should be placed as soon as possible after the foundation excavation is completed, to reduce potential disturbance of the bearing surface.

"Wet" shafts should be constructed by slurry displacement techniques. In this process, the shaft excavation is filled with approved polymer-based slurry to counter-balance the hydraulic forces below the water level and stabilize the wall of the shaft. Concrete would then be placed using a tremie that extends to within 6 inches of the shaft base of the slurry-filled excavation. The tremie remains inserted several feet into the fresh concrete as it displaces the slurry upward and until placement is complete. The slurry should have a sand content no greater than 1 percent at the time concrete placement commences. The maximum unit weight of the slurry should be established in consultation with Terracon.

We recommend the integrity of completed drilled shafts be tested using the crosshole sonic logging (CSL) method. CSL tubes should be installed full-length in each shaft and socket. The CSL testing report should include interpretation of the percentage decrease in velocity as correlated to the Concrete Condition Rating Criteria (CCRC). The velocity of sound concrete should be established from a nearby zone of visibly sound concrete. Suspected anomalies, honeycombing or poor concrete quality detected by CSL testing should be further tested to evaluate the extent of anomalies. Confirmed defects should be remediated, as appropriate, to the acceptance of the engineer."

The drilled shaft installation process should be performed under the observation of experienced Terracon personnel. Terracon should document the shaft installation process including soil/rock and groundwater conditions encountered, consistency with expected conditions, and details of the installed shaft.

Driven Pile Design Parameters

Driven Pile Axial Resistance

We understand that the bridge abutments will be supported on driven piles. Driven pile foundations have been analyzed for support of the proposed bridge bents based on the geotechnical data available from the borings performed near the structure. Driven pile resistances for compressive loads were estimated in accordance with procedures and recommendations outlined in Article 10.7 of 2012 AASHTO LRFD Bridge Design Specifications, 6th Edition.

Driven pile axial resistance of each pile is estimated to be the structural resistance of the piles since each pile will be driven to refusal in bedrock. A structural resistance factor of 0.5 was used in the analysis per AASHTO for refusal of piles in bedrock. To achieve the axial resistance provided, each pile should be driven with a shoe fitted to the end of the pile.

Boring Number	Approximate elevation of observed bedrock
B-1	256
B-4	205

Driven Pile Lateral Loading

The strength parameters listed below can be used as input values for use in LPILE analyses. LPILE will estimate values of k_h and E_{50} based on the provided strength values.

Boring B-1

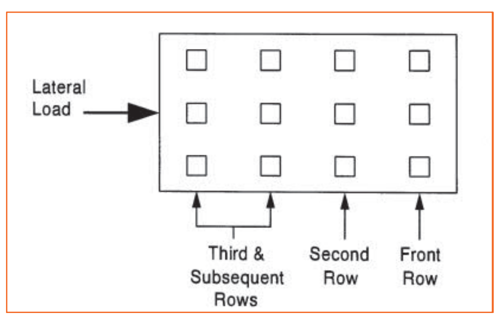
Approximate elevation at Bottom of Stratum (feet)	Material Description	Effective Unit Weight (pcf)	Undrained Shear Strength (psf)	Friction Angle (°)
266	Fill: Clayey sand	115	0	28
256	Clayey sand	52	0	30

Boring B-4

Approximate elevation at Bottom of Stratum (feet)	Material Description	Effective Unit Weight (pcf)	Undrained Shear Strength (psf)	Friction Angle (°)
264.5	Fill: Clayey sand	115	0	26
225.5	Lean clay and fat clay	52	250	0
205.5	Silty sand and clayey sand	52	0	26

When piles are used in groups, the lateral resistances of the piles in the second, third, and subsequent rows of the group should be reduced as compared to the resistance of a single, independent pile. Guidance for applying p-multiplier factors to the p values in the p-y curves for each row of pile foundations within a pile group are as follows:

- Front row: P_m = 0.8;
- Second row: P_m = 0.4
- Third and subsequent row: P_m = 0.3.



The load resistances provided herein are based on the stresses induced in the supporting soil strata. The structural resistance of the piles should be checked to assure they can safely accommodate the combined stresses induced by axial and lateral forces. Lateral deflections of piles should be evaluated using an appropriate analysis method, and will depend upon the pile's diameter, length, configuration, stiffness and "fixed head" or "free head" condition. We can provide additional analyses and estimates of lateral deflections for specific loading conditions upon request.

Settlement

Since piles will be driven to refusal in bedrock, settlements experienced by the foundations will be the result of the elastic shortening of the piles.

Construction Considerations

The contractor should select a driving hammer and cushion combination which can install the selected piling without overstressing the pile material. The hammer should have a rated energy in foot-pounds at least equal to 15 percent of the design compressive load resistance in pounds. The contractor should submit the pile driving plan and the pile hammer-cushion combination to the engineer for evaluation of the driving stresses in advance of pile installation. During driving a maximum of 10 blows per inch is recommended to reduce the potential of damage to the piles.

If practical refusal is experienced above the anticipated rock surface elevation, then the pile may be on a boulder or other obstruction and a replacement pile should be driven. If this occurs, the situation should be evaluated by Terracon during the pile driving operations.

Difficult driving could also be encountered in the observed rock at this project site. Consideration should be given to using protective points and/or flange stiffening if H-piles are used. The contractor should be prepared to cut or splice piles, as necessary. Splicing of piles should be in accordance with specifications provided by the project structural engineer.

Pile driving conditions, hammer efficiency, and stress on the pile during driving could be better evaluated during installation using a Pile Driving Analyzer (PDA). A Terracon representative should observe pile driving operations. Each pile should be observed and checked for buckling, crimping and alignment in addition to recording penetration resistance, depth of embedment, and general pile driving operations.

The pile driving process should be performed under the observation of experienced Terracon personnel. Terracon should document the pile installation process including soil/rock and groundwater conditions encountered, consistency with expected conditions, and details of the installed pile.

SEISMIC CONSIDERATIONS

The seismic design requirements for buildings and other structures are based on Seismic Design Category. Site Classification is required to determine the Seismic Design Category for a structure. The Site Classification is based on the upper 100 feet of the site profile defined by a weighted average value of either shear wave velocity, standard penetration resistance, or undrained shear strength in accordance with AASHTO 2009. Based on the soil/bedrock properties encountered at the site and as described on the exploration logs and results, it is out professional opinion that the **Seismic Site Classification is D**. Subsurface explorations at this site were extended to a maximum depth of 79.2 feet. The site properties below the boring depth to 100 feet were estimated based on our experience and knowledge of geologic conditions of the general area. Additional deeper borings or geophysical testing may be performed to confirm the conditions below the current boring depth.

Per a request from the client via email dated on March 12, 2019, the following spectral accelerations were calculated for the Palarm Creek Bridge.

Description	Value
2009 AASHTO Guide Specifications for LRFD Seismic Bridge Design	D [1]
Site Latitude	34.9039 ° N
Site Longitude	92.4478 ° W
S_{DS} Spectral Acceleration for a Short Period [2]	0.458g
S_{D1} Spectral Acceleration for a 1-Second Period [2]	0.214g

1. The 2009 AASHTO Guide Specifications for LRFD Seismic Bridge Design uses a site profile extending to a depth of 100 feet for seismic site classification. Borings at this site were extended to a maximum depth of 79.2 feet. The site properties below the boring depth to 100 feet were estimated based on our experience and knowledge of geologic conditions of the general area. Additional deeper borings or geophysical testing may be performed to confirm the conditions below the current boring depth.
2. These values were obtained using online seismic design maps and tools provided by the USGS (http://earthquake.usgs.gov/hazards/designmaps/).

GENERAL COMMENTS

Our analysis and opinions are based upon our understanding of the project, the geotechnical conditions in the area, and the data obtained from our site exploration. Natural variations will occur between exploration point locations or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. Terracon should be retained as the Geotechnical Engineer, where noted in this report, to provide observation and testing services during pertinent construction phases. If variations appear, we can provide further evaluation and supplemental recommendations. If variations are noted in the absence of our observation and testing services on-site, we should be immediately notified so that we can provide evaluation and supplemental recommendations.

Our Scope of Services does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

Our services and any correspondence or collaboration through this system are intended for the sole benefit and exclusive use of our client for specific application to the project discussed and are accomplished in accordance with generally accepted geotechnical engineering practices with no third-party beneficiaries intended. Any third-party access to services or correspondence is solely for information purposes to support the services provided by Terracon to our client. Reliance upon the services and any work product is limited to our client, and is not intended for third parties. Any use or reliance of the provided information by third parties is done solely at their own risk. No warranties, either express or implied, are intended or made.

Site characteristics as provided are for design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly impact excavation cost. Any parties charged with estimating excavation costs should seek their own site characterization for specific purposes to obtain the specific level of detail necessary for costing. Site safety, and cost estimating including, excavation support, and dewatering requirements/design are the responsibility of others. If changes in the nature, design, or location of the project are planned, our conclusions and recommendations shall not be considered valid unless we review the changes and either verify or modify our conclusions in writing.

FIGURES

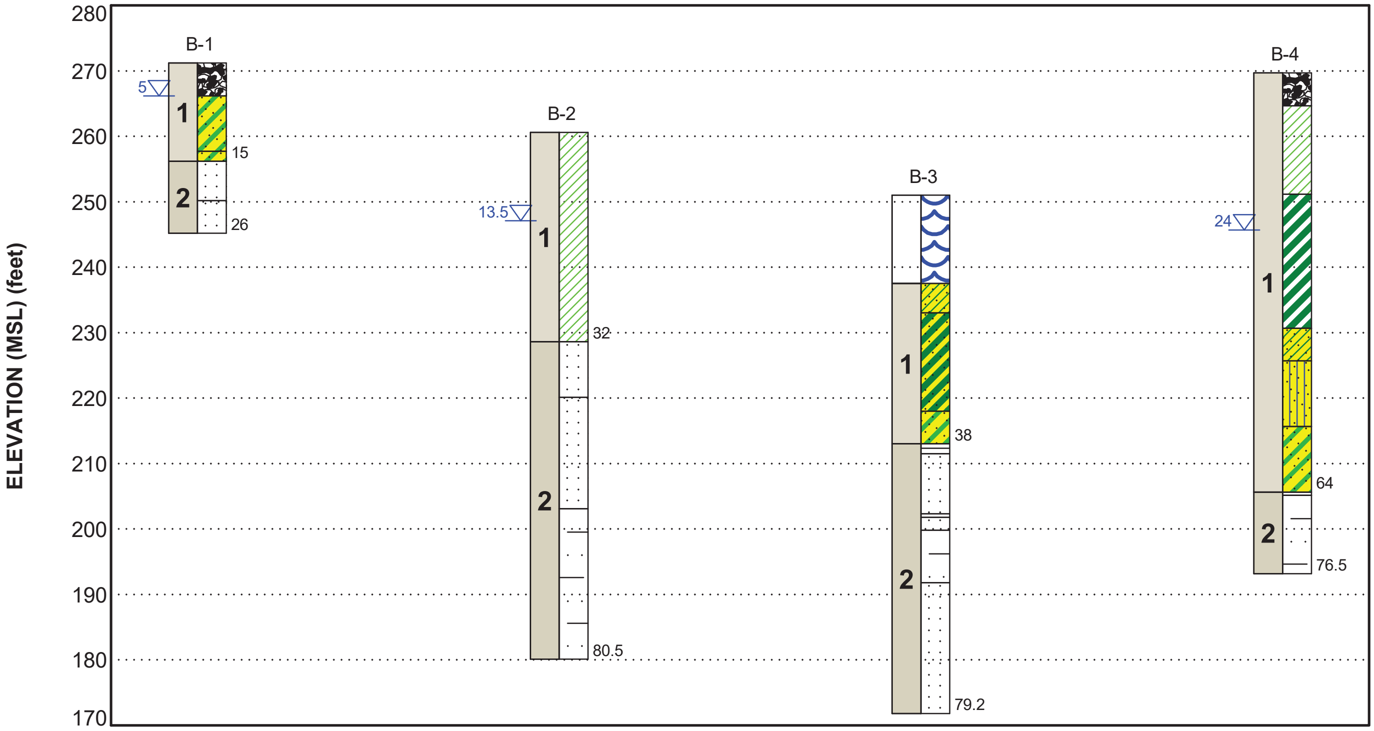
Contents:

GeoModel

GEOMODEL

ArDOT 061507 Palarm Creek Bridge ■ Maumelle, Arkansas
3/14/2019 ■ Terracon Project No. 35195010

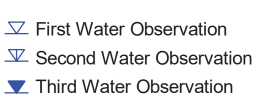
Terracon GeoReport



This is not a cross section. This is intended to display the Geotechnical Model only. See individual logs for more detailed conditions.

Model Layer	Layer Name	General Description
1	**Embankment and Creek Bed Soils**	Lean and fat clay soils with varying amounts of sand and sand soils with varying amounts of clay and silt
2	**Bedrock**	Sandstone and Interbedded sandstone and shale

LEGEND



Groundwater levels are temporal. The levels shown are representative of the date and time of our exploration. Significant changes are possible over time. Water levels shown are as measured during and/or after drilling. In some cases, boring advancement methods mask the presence/absence of groundwater. See individual logs for details.

NOTES:
Layering shown on this figure has been developed by the geotechnical engineer for purposes of modeling the subsurface conditions as required for the subsequent geotechnical engineering for this project. Numbers adjacent to soil column indicate depth below ground surface.

ATTACHMENTS

EXPLORATION AND TESTING PROCEDURES

Field Exploration

Number of Borings	Boring Depth (feet)	Planned Location
4	26 to 79.2	Bridge borings

Boring Layout and Elevations: The locations of the field exploration (borings) were measured in the field by Terracon's exploration team using a hand-held GPS unit to measure the latitude and longitude coordinates. The accuracy of the exploration points is usually within about +/- 20 feet horizontally of the noted location. Michael Baker also surveyed the boring locations. The northing and Easting coordinates and ground surface elevations of the borings were provided by Michael Baker from a performed field survey.

Subsurface Exploration Procedures: We advanced the borings with a truck-mounted, drill rig using continuous flight augers (solid stem and/or hollow stem, as necessary, depending on soil conditions). Boring B-3 was advance in the middle of the existing creek via barge. Five samples were obtained in the upper 10 feet of each boring and samples were obtained at intervals of 5 feet thereafter. In the split-barrel sampling procedure, a standard 2-inch outer diameter split-barrel sampling spoon was driven into the ground by a 140-pound automatic hammer falling 30 inches. The number of blows required to advance the sampling spoon the last 12 inches of a normal 18-inch penetration is recorded as the Standard Penetration Test (SPT) resistance value. The SPT resistance values, also referred to as N-values, are indicated on the boring logs at the test depths. We observed and recorded groundwater levels during drilling and sampling. For safety purposes, all borings, except Boring B-3, were backfilled with auger cuttings after their completion.

The sampling depths, penetration distances, and other sampling information was recorded on the field boring logs. The samples were placed in appropriate containers and taken to our soil laboratory for testing and classification by a Geotechnical Engineer. Our exploration team prepared field boring logs as part of the drilling operations. These field logs included visual classifications of the materials encountered during drilling and our interpretation of the subsurface conditions between samples. Final boring logs were prepared from the field logs. The final boring logs represent the Geotechnical Engineer's interpretation of the field logs and include modifications based on observations and tests of the samples in our laboratory.

Laboratory Testing

Representative soil samples were tested in the laboratory to measure their natural water content, gradation and Atterberg limits. The test results are provided on the appended boring logs and laboratory test reports.

The soil samples were classified in the laboratory based on visual observation, texture, plasticity, and the laboratory testing described above. The soil descriptions presented on the boring logs are in accordance with the enclosed General Notes and Unified Soil Classification System (USCS). The estimated USCS group symbols for native soils are shown on the boring logs, and a brief description of the USCS is included in this report.

The bedrock materials encountered in the borings were described in accordance with the appended Description of Rock Properties on the basis of visual classification of disturbed auger cuttings and drilling characteristics. Core samples and petrographic analysis may indicate other rock types.

SITE LOCATION AND EXPLORATION PLANS

Contents:

Note: All attachments are one page unless noted above.

SITE LOCATION

Job No. 061507, Palarm Creek Structures and Approaches ■ Little Rock, Pulaski County, Arkansas

March 18, 2019 ■ Terracon Project No. 35195010

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

EXPLORATION RESULTS

Contents:

Boring Logs (B-1 through B-4)

Note: All attachments are one page unless noted above.

BORING LOG NO. B-1

PROJECT: ArDOT 061507 Palarm Creek Bridge

CLIENT: Michael Baker International LLC
Little Rock, Arkansas

SITE: HIghway 365
Maumelle, Arkansas

LOCATION See Exploration Plan

Latitude: 34.9035° Longitude: -92.448°

Surface Elev.: 271.184 (Ft.)

MODEL LAYER	GRAPHIC LOG	DEPTH		ELEVATION (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	STRENGTH TEST: TEST TYPE	COMPRESSIVE STRENGTH (psi)	STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
1		5.0	**FILL - CLAYEY SAND (SC)**, with gravel, brown	266			3-5-7 N=12				15		38-23-15	36
							8-3-3 N=6				14			
							3-3-6 N=9				16			
		13.5	**CLAYEY SAND (SC)**, with gravel, brown and reddish-brown, medium dense	257.5	▽ (5 ft)		5-10-8 N=18				13			
							11-6-10 N=16				9		27-14-13	24
		15.0	**CLAYEY SAND (SC)**, with highly weathered sandstone gravel, brown and gray, very dense	256			5-8-50/3"				23			
2		21.0	**HIGHLY WEATHERED SANDSTONE**, with clay filled fractures, gray and reddish-brown	250			REC = 100% RQD = 0%							
							REC = 80% RQD = 49%							
		26.0	**SANDSTONE**, with clay filled joints, gray, slightly fractured, moderately weathered	245			REC = 97% RQD = 75%							
			at 26 Feet											

Stratification lines are approximate. In-situ, the transition may be gradual.
Auger refusal at 15 feet

Hammer Type: Automatic

Advancement Method:
0 to 15 feet: 31/4" Hollow-stem auger
15 to 26 feet: NQ core

Abandonment Method:
Boring backfilled with Auger Cuttings and/or Bentonite

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *5 feet while sampling*

Terracon
25809 I 30
Bryant, AR

Boring Started: 02-12-2019 | Boring Completed: 02-12-2019

Drill Rig: ACKER RENEGADE 679 | Driller: JB

Project No.: 35195010

BORING LOG NO. B-2

PROJECT: ArDOT 061507 Palarm Creek Bridge

CLIENT: Michael Baker International LLC
Little Rock, Arkansas

SITE: HIghway 365
Maumelle, Arkansas

LOCATION See Exploration Plan

Latitude: 34.9036° Longitude: -92.448°

Surface Elev.: 260.614 (Ft.)

MODEL LAYER	GRAPHIC LOG	DEPTH / ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (psi)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
1		**LEAN CLAY (CL)**, brown, very soff to medium stiff			X	2-3-3 N=6				22		37-14-23	89
					X	1-2-3 N=5				28			
					X	1-2-2 N=4				21			
			5		X	1-2-2 N=4 No recovery							
			10		X	0-2-2 N=4				25			
			15	▽	X	1-0-1 N=1				29		29-15-14	93
			20		X	0-0-1 N=1				50			
			25		X	0-1-2 N=3				36		38-17-21	99

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:

Abandonment Method:
Boring backfilled with Auger Cuttings and/or Bentonite

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *13.5 feet while sampling*

Terracon
25809 I 30
Bryant, AR

Boring Started: 02-05-2019	Boring Completed: 02-12-2019
Drill Rig: ACKER RENEGADE 679	Driller: JB
Project No.: 35195010	

BORING LOG NO. B-2

PROJECT: ArDOT 061507 Palarm Creek Bridge

CLIENT: Michael Baker International LLC Little Rock, Arkansas

SITE: HIghway 365 Maumelle, Arkansas

LOCATION See Exploration Plan

Latitude: 34.9036° Longitude: -92.448°

Surface Elev.: 260.614 (Ft.)

MODEL LAYER	GRAPHIC LOG	DEPTH / Description / ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (psi)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
1		**LEAN CLAY (CL)**, brown, very soff to medium stiff *(continued)*	30			1-3-1 N=4				31			
		32.0 — 228.5											
2		**SANDSTONE**, with weathered fractures and iron staining, gray, moderately fractured, highly weathered	35			REC = 44% RQD = 30%	UC						
		40.5 — 220	40										
		SANDSTONE, with shale seams, gray and dark gray, moderately fractured, 45 degree bedding. sandstone is solid, moderate factures in shale seams						15651					
			45			REC = 75% RQD = 55%	UC						
			50					17606					
						REC = 89% RQD = 67%	UC						
			55										

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:

Abandonment Method:
Boring backfilled with Auger Cuttings and/or Bentonite

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *13.5 feet while sampling*

Terracon
25809 I 30
Bryant, AR

Boring Started: 02-05-2019	Boring Completed: 02-12-2019
Drill Rig: ACKER RENEGADE 679	Driller: JB
Project No.: 35195010	

BORING LOG NO. B-2

PROJECT: ArDOT 061507 Palarm Creek Bridge

CLIENT: Michael Baker International LLC Little Rock, Arkansas

SITE: HIghway 365 Maumelle, Arkansas

LOCATION See Exploration Plan

Latitude: 34.9036° Longitude: -92.448°

Surface Elev.: 260.614 (Ft.)

MODEL LAYER	GRAPHIC LOG	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (psi)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
2		57.5	**INTERBEDDED SANDSTONE AND SHALE**, gray and dark gray, moderately fractured, 45 degree bedding. sandstone is solid, moderate factures in shale seams	203				REC = 100% RQD = 78%	UC	930					
					60										
								REC = 100% RQD = 100%	UC						
					65										
								REC = 95% RQD = 95%	UC						
					70										
								REC = 82% RQD = 73%	UC						
					75										
								REC = 97% RQD = 90%	UC						
		80.5		180	80										
			at 80.5 Feet												

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:

Abandonment Method:
Boring backfilled with Auger Cuttings and/or Bentonite

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *13.5 feet while sampling*

Terracon
25809 I 30
Bryant, AR

Boring Started: 02-05-2019	Boring Completed: 02-12-2019
Drill Rig: ACKER RENEGADE 679	Driller: JB
Project No.: 35195010	

BORING LOG NO. B-3

PROJECT: ArDOT 061507 Palarm Creek Bridge

CLIENT: Michael Baker International LLC
Little Rock, Arkansas

SITE: HIghway 365
Maumelle, Arkansas

LOCATION See Exploration Plan

Latitude: 34.9039° Longitude: -92.4478°

Surface Elev.: 251 (Ft.)

MODEL LAYER	GRAPHIC LOG	DEPTH / DESCRIPTION / ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (psi)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
		Water - Barge Drilling											
		13.5 — 237.5											
1		**SANDY LEAN CLAY (CL)**, dark brown, very soft	13.5–15		X	0-0-0 N=0				63			
			16–17.5		X	1-1-0 N=1				49			
		18.0 — 233											
		SANDY FAT CLAY (CH), brown and dark brown, soft to medium stiff	18–19.5		X	2-3-2 N=5				30			
			20–21.5		X	0-2-2 N=4							
			22–23.5		X	0-1-2 N=3				31			
			28		X								

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
0 to 20 feet: 4 inch casing
20 to 40 feet: 3 inch casing with wash boring
40 to 79.2 feet: Rock coring

Abandonment Method:
Boring not backfilled

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

Water level not determined

Terracon
25809 I 30
Bryant, AR

Boring Started: 02-28-2019	Boring Completed: 02-28-2019
Drill Rig: CME 603	Driller: JB
Project No.: 35195010	

BORING LOG NO. B-3

PROJECT: ArDOT 061507 Palarm Creek Bridge

CLIENT: Michael Baker International LLC
Little Rock, Arkansas

SITE: HIghway 365
Maumelle, Arkansas

LOCATION See Exploration Plan

Latitude: 34.9039° Longitude: -92.4478°

Surface Elev.: 251 (Ft.)

MODEL LAYER	GRAPHIC LOG	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	TEST TYPE	COMPRESSIVE STRENGTH (psi)	STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
1			**SANDY FAT CLAY (CH)**, brown and dark brown, soft to medium stiff *(continued)*		30			0-2-6 N=8				32			
		33.0	**CLAYEY SAND (SC)**, brown, loose	218	35			1-2-2 N=4							
2		38.0	**SHALE**, with sandstone seams, dark gray, sound, strong rock, bedding at 45 degrees	213				50/6"				14			
		39.5	**SANDSTONE**, with shale seams, gray, sound, massive bedding, strong rock	211.5	40, 45			REC = 100% RQD = 71%	UC	23450					
		48.7	**SHALE**, dark gray, sound, strong rock, bedding at 45 degrees	202.5											
		49.2	**SANDSTONE**, gray, slightly fractured, strong rock, vertical fractures	202	50										
		51.2	**INTERBEDDED SANDSTONE AND SHALE**, with quartz viens, gray and dark gray, moderately fractured, strong rock, highly fractured from about 51.2 feet to 59.2 feet	200	55			REC = 97% RQD = 32%	UC	21731					

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
0 to 20 feet: 4 inch casing
20 to 40 feet: 3 inch casing with wash boring
40 to 79.2 feet: Rock coring

Abandonment Method:
Boring not backfilled

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

Water level not determined

Terracon
25809 I 30
Bryant, AR

Boring Started: 02-28-2019	Boring Completed: 02-28-2019
Drill Rig: CME 603	Driller: JB
Project No.: 35195010	

BORING LOG NO. B-3

PROJECT: ArDOT 061507 Palarm Creek Bridge

CLIENT: Michael Baker International LLC
Little Rock, Arkansas

SITE: HIghway 365
Maumelle, Arkansas

LOCATION See Exploration Plan

Latitude: 34.9039° Longitude: -92.4478°

Surface Elev.: 251 (Ft.)

MODEL LAYER	GRAPHIC LOG	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (psi)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
2		59.2		192											
2			**SANDSTONE**, gray, sound, strong rock		60					11154					
2					65			REC = 100% RQD = 100%	UC						
2			- shale seam at about 70.7 feet		70										
2					75			REC = 100% RQD = 78%	UC	19917					
2		79.2		172											
			Boring Terminated at 79.2 Feet												

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
0 to 20 feet: 4 inch casing
20 to 40 feet: 3 inch casing with wash boring
40 to 79.2 feet: Rock coring

Abandonment Method:
Boring not backfilled

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

Water level not determined

Terracon
25809 I 30
Bryant, AR

Boring Started: 02-28-2019	Boring Completed: 02-28-2019
Drill Rig: CME 603	Driller: JB
Project No.: 35195010	

BORING LOG NO. B-4

PROJECT: ArDOT 061507 Palarm Creek Bridge

CLIENT: Michael Baker International LLC
Little Rock, Arkansas

SITE: HIghway 365
Maumelle, Arkansas

LOCATION See Exploration Plan

Latitude: 34.9041° Longitude: -92.448°

Surface Elev.: 269.664 (Ft.)

MODEL LAYER	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (psi)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
1		**FILL - CLAYEY SAND (SC)**, brown				X	6-5-3 N=8				14			
						X	2-1-3 N=4							
						X	2-2-3 N=5				15		34-12-22	38
	5.0	**LEAN CLAY (CL)**, brown, soft to medium stiff	264.5	5		X	2-2-3 N=5				28			
				10		X	1-2-1 N=3				26		41-14-27	98
				15		X	3-2-0 N=2				29			
	18.5	**FAT CLAY (CH)**, brown, medium stiff	251	20		X	2-2-3 N=5				30		54-17-37	100
				25	▽ (24 ft)	X	2-3-3 N=6				26			

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
0 to 64.5 feet: Hollow-stem auger
64.5 to 80 feet: Rock Coring

Abandonment Method:
Boring backfilled with Auger Cuttings and/or Bentonite

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *24 feet while drilling*

Terracon
25809 I 30
Bryant, AR

Boring Started: 01-29-2019	Boring Completed: 01-31-2019
Drill Rig: CME 840	Driller: JB
Project No.: 35195010	

BORING LOG NO. B-4

PROJECT: ArDOT 061507 Palarm Creek Bridge

CLIENT: Michael Baker International LLC Little Rock, Arkansas

SITE: HIghway 365 Maumelle, Arkansas

LOCATION See Exploration Plan

Latitude: 34.9041° Longitude: -92.448°

Surface Elev.: 269.664 (Ft.)

MODEL LAYER	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	TEST TYPE	COMPRESSIVE STRENGTH (psi)	STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
1		**FAT CLAY (CH)**, brown, medium stiff *(continued)*		30		X	2-2-3 N=5				24			
				35		X	2-3-3 N=6				29		53-15-38	95
	39.0	**SANDY LEAN CLAY (CL)**, brown, soft	230.5	40		X	1-1-2 N=3				47			
	44.0	**SILTY SAND (SM)**, brown, very loose to loose	225.5	45		X	0-0-1 N=1				59			
				50		X	0-3-3 N=6				25		NP	26
	54.0	**CLAYEY SAND (SC)**, brown, loose to medium dense	215.5	55		X	0-2-2 N=4				24			

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
0 to 64.5 feet: Hollow-stem auger
64.5 to 80 feet: Rock Coring

Abandonment Method:
Boring backfilled with Auger Cuttings and/or Bentonite

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *24 feet while drilling*

Terracon
25809 I 30
Bryant, AR

Boring Started: 01-29-2019	Boring Completed: 01-31-2019
Drill Rig: CME 840	Driller: JB
Project No.: 35195010	

BORING LOG NO. B-4

PROJECT: ArDOT 061507 Palarm Creek Bridge

CLIENT: Michael Baker International LLC
Little Rock, Arkansas

SITE: HIghway 365
Maumelle, Arkansas

LOCATION See Exploration Plan

Latitude: 34.9041° Longitude: -92.448°

Surface Elev.: 269.664 (Ft.)

MODEL LAYER	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	TEST TYPE	COMPRESSIVE STRENGTH (psi)	STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
1		**CLAYEY SAND (SC)**, brown, loose to medium dense *(continued)*												
				60		Split spoon	11-11-10 N=21				13		49-14-35	25
	64.0	- with shale pieces at about 64 feet	205.5											
2	64.5	**SHALE**, dark gray, soft	205			Split spoon	50/6"							
		INTERBEDDED SANDSTONE AND SHALE, gray and dark gray, moderately fractured		65		Rock core	REC = 0% RQD = 0%							
				70		Rock core	REC = 58% RQD = 7%							
	76.5		193	75		Rock core	REC = 97% RQD = 92%							

Boring Terminated at 76.5 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
0 to 64.5 feet: Hollow-stem auger
64.5 to 80 feet: Rock Coring

Abandonment Method:
Boring backfilled with Auger Cuttings and/or Bentonite

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

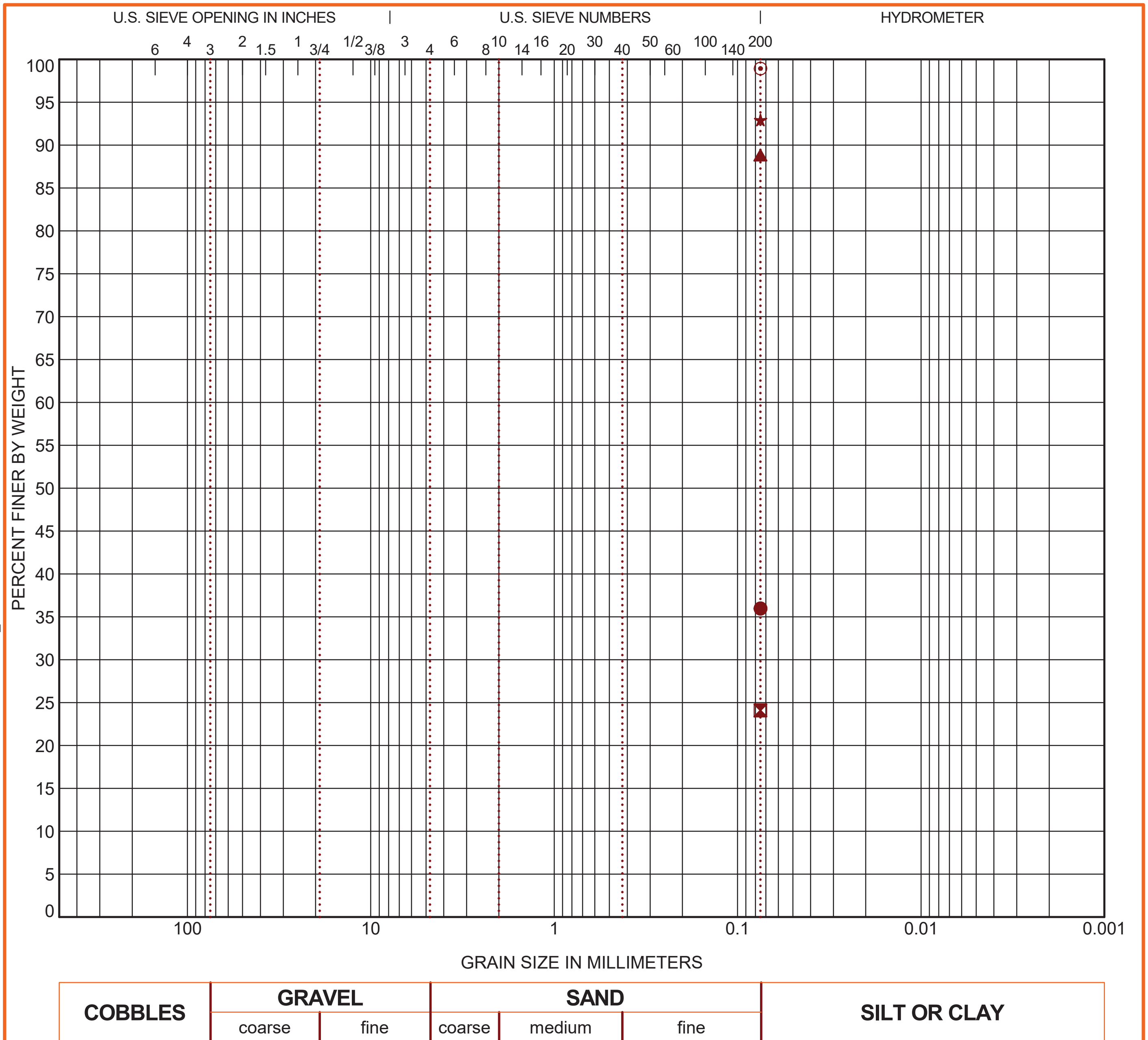
▽ *24 feet while drilling*

25809 I 30
Bryant, AR

Boring Started: 01-29-2019	Boring Completed: 01-31-2019
Drill Rig: CME 840	Driller: JB
Project No.: 35195010	

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



	Boring ID	Depth	USCS Classification	WC (%)	LL	PL	PI	Cc	Cu
●	B-1	0.5 - 2	CLAYEY SAND (SC)	15	38	23	15		
⊠	B-1	8.5 - 10	CLAYEY SAND (SC)	9	27	14	13		
▲	B-2	0.5 - 2	LEAN CLAY (CL)	22	37	14	23		
★	B-2	13.5 - 15	LEAN CLAY (CL)	29	29	15	14		
⊙	B-2	23.5 - 25	LEAN CLAY (CL)	36	38	17	21		

	Boring ID	Depth	D_{100}	D_{60}	D_{30}	D_{10}	%Gravel	%Sand	%Silt	%Fines	%Clay
●	B-1	0.5 - 2	0.075				0.0			36.0	
⊠	B-1	8.5 - 10	0.075				0.0			24.1	
▲	B-2	0.5 - 2	0.075				0.0			88.8	
★	B-2	13.5 - 15	0.075				0.0			92.9	
⊙	B-2	23.5 - 25	0.075				0.0			98.9	

PROJECT: ArDOT 061507 Palarm Creek Bridge

SITE: HIghway 365
Maumelle, Arkansas

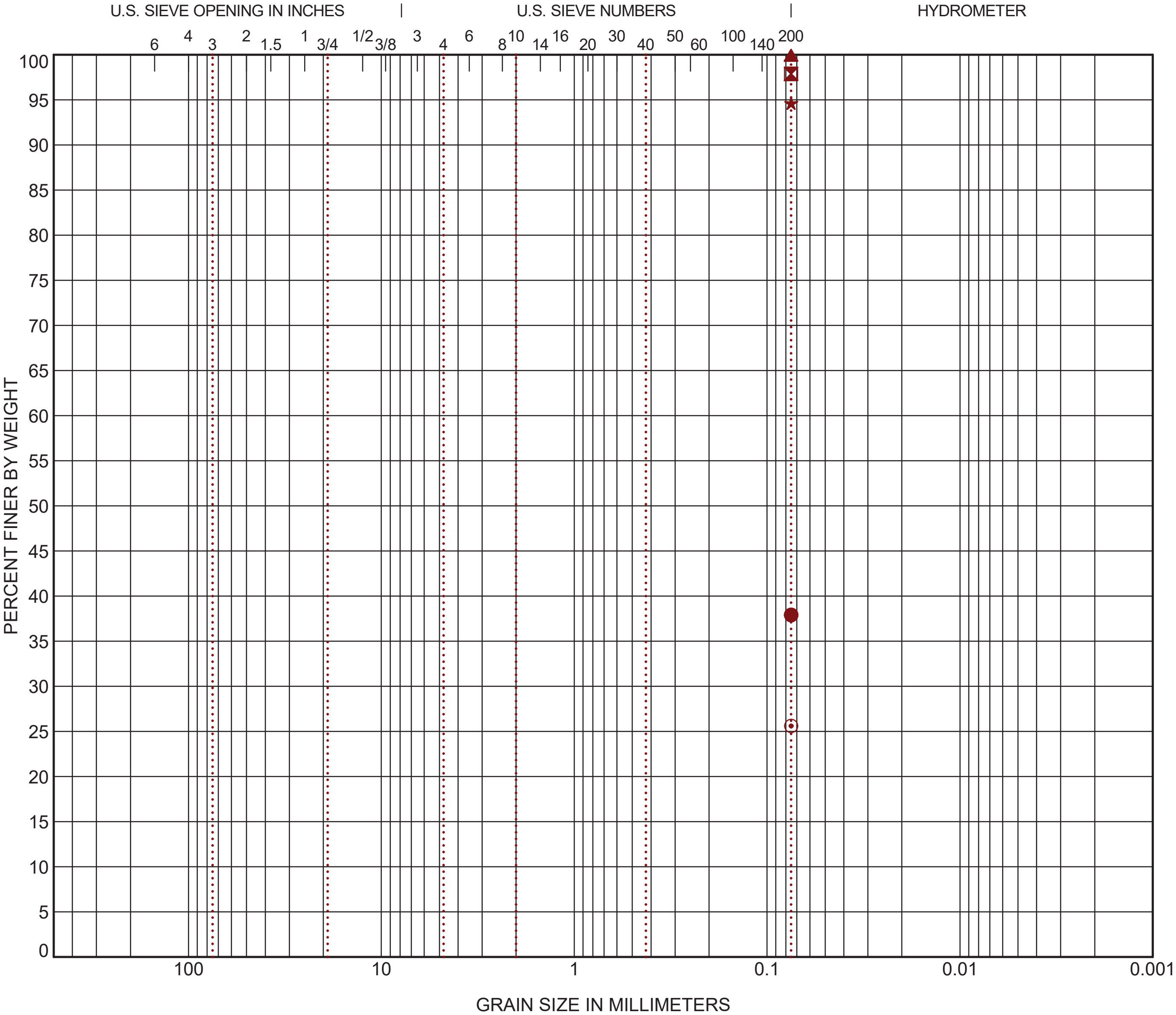
Terracon
25809 I 30
Bryant, AR

PROJECT NUMBER: 35195010

CLIENT: Michael Baker International LLC
Little Rock, Arkansas

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring ID	Depth	USCS Classification	WC (%)	LL	PL	PI	Cc	Cu
●	B-4	3.5 - 5	CLAYEY SAND (SC)	15	34	12	22		
⊠	B-4	9 - 10.5	LEAN CLAY (CL)	26	41	14	27		
▲	B-4	19 - 20.5	FAT CLAY (CH)	30	54	17	37		
★	B-4	34 - 35.5	FAT CLAY (CH)	29	53	15	38		
⊙	B-4	49 - 50.5	SILTY SAND (SM)	25	NP	NP	NP		

	Boring ID	Depth	D_{100}	D_{60}	D_{30}	D_{10}	%Gravel	%Sand	%Silt	%Fines	%Clay
●	B-4	3.5 - 5	0.075				0.0			37.9	
⊠	B-4	9 - 10.5	0.075				0.0			97.9	
▲	B-4	19 - 20.5	0.075				0.0			99.9	
★	B-4	34 - 35.5	0.075				0.0			94.6	
⊙	B-4	49 - 50.5	0.075				0.0			25.6	

PROJECT: ArDOT 061507 Palarm Creek Bridge

SITE: HIghway 365
Maumelle, Arkansas

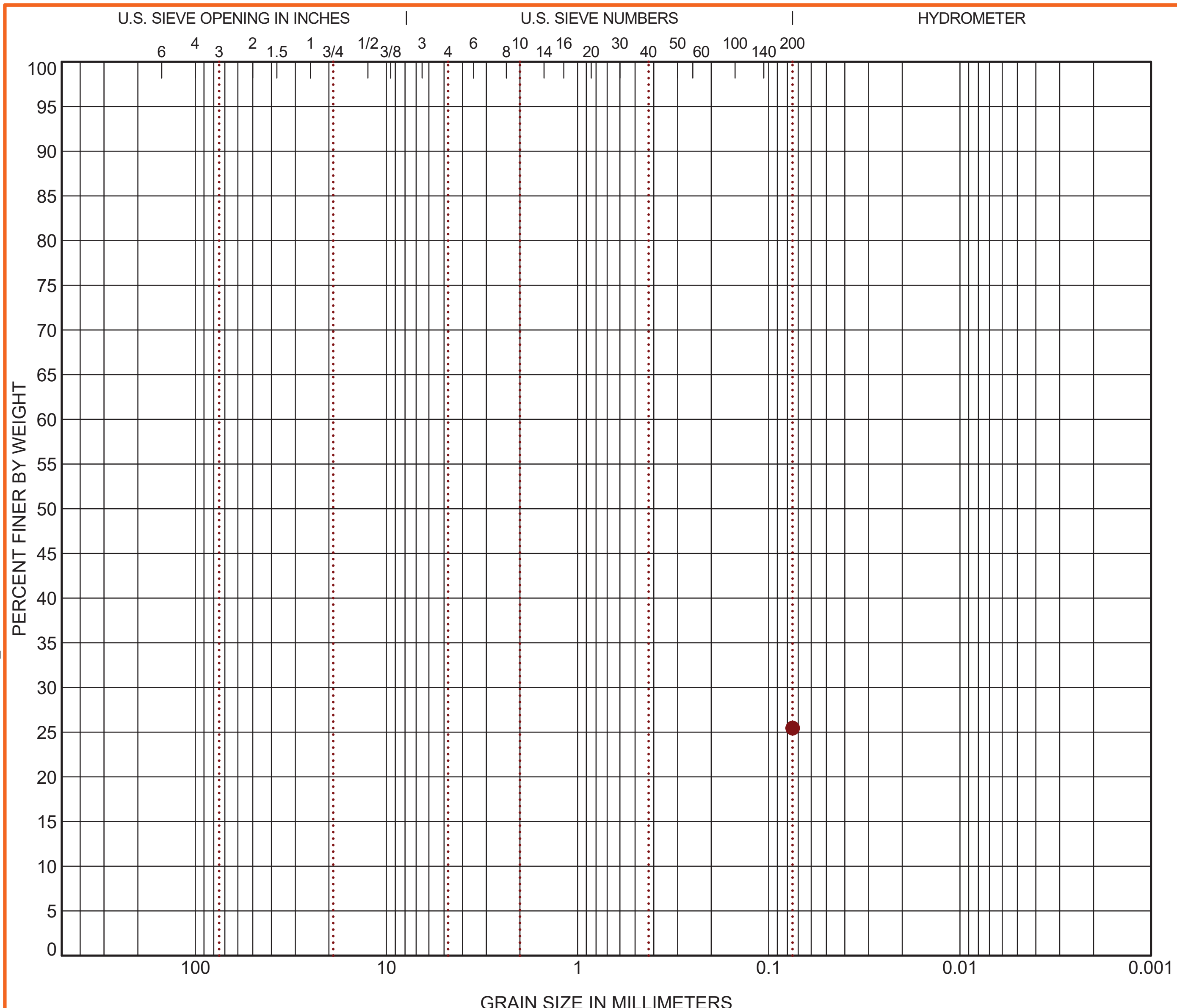
Terracon
25809 I 30
Bryant, AR

PROJECT NUMBER: 35195010

CLIENT: Michael Baker International LLC
Little Rock, Arkansas

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring ID	Depth	USCS Classification	WC (%)	LL	PL	PI	Cc	Cu
●	B-4	59 - 60.5	CLAYEY SAND (SC)	13	49	14	35		

	Boring ID	Depth	D_{100}	D_{60}	D_{30}	D_{10}	%Gravel	%Sand	%Silt	%Fines	%Clay
●	B-4	59 - 60.5	0.075				0.0			25.5	

PROJECT: ArDOT 061507 Palarm Creek Bridge

SITE: HIghway 365
Maumelle, Arkansas

Terracon
25809 I 30
Bryant, AR

PROJECT NUMBER: 35195010

CLIENT: Michael Baker International LLC
Little Rock, Arkansas

SUPPORTING INFORMATION

Contents:

Note: All attachments are one page unless noted above.

Terracon GeoReport

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]				Soil Classification: Group Symbol	Soil Classification: Group Name [B]
Coarse-Grained Soils: More than 50% retained on No. 200 sieve	**Gravels:** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels:** Less than 5% fines [C]	$Cu \geq 4$ and $1 \leq Cc \leq 3$ [E]	GW	Well-graded gravel [F]
			$Cu < 4$ and/or [Cc<1 or Cc>3.0] [E]	GP	Poorly graded gravel [F]
		Gravels with Fines: More than 12% fines [C]	Fines classify as ML or MH	GM	Silty gravel [F, G, H]
			Fines classify as CL or CH	GC	Clayey gravel [F, G, H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines [D]	$Cu \geq 6$ and $1 \leq Cc \leq 3$ [E]	SW	Well-graded sand [I]
			$Cu < 6$ and/or [Cc<1 or Cc>3.0] [E]	SP	Poorly graded sand [I]
		Sands with Fines: More than 12% fines [D]	Fines classify as ML or MH	SM	Silty sand [G, H, I]
			Fines classify as CL or CH	SC	Clayey sand [G, H, I]
Fine-Grained Soils: 50% or more passes the No. 200 sieve	**Silts and Clays:** Liquid limit less than 50	**Inorganic:**	$PI > 7$ and plots on or above "A"	CL	Lean clay [K, L, M]
			$PI < 4$ or plots below "A" line [J]	ML	Silt [K, L, M]
		Organic:	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OL	Organic clay [K, L, M, N]
					Organic silt [K, L, M, O]
	Silts and Clays: Liquid limit 50 or more	**Inorganic:**	PI plots on or above "A" line	CH	Fat clay [K, L, M]
			PI plots below "A" line	MH	Elastic Silt [K, L, M]
		Organic:	Liquid limit - oven dried / 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-inch (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] 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.

[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains $\geq$ 15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains $\geq$ 15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

[L] If soil contains $\geq$ 30% plus No. 200 predominantly sand, add "sandy" to group name.

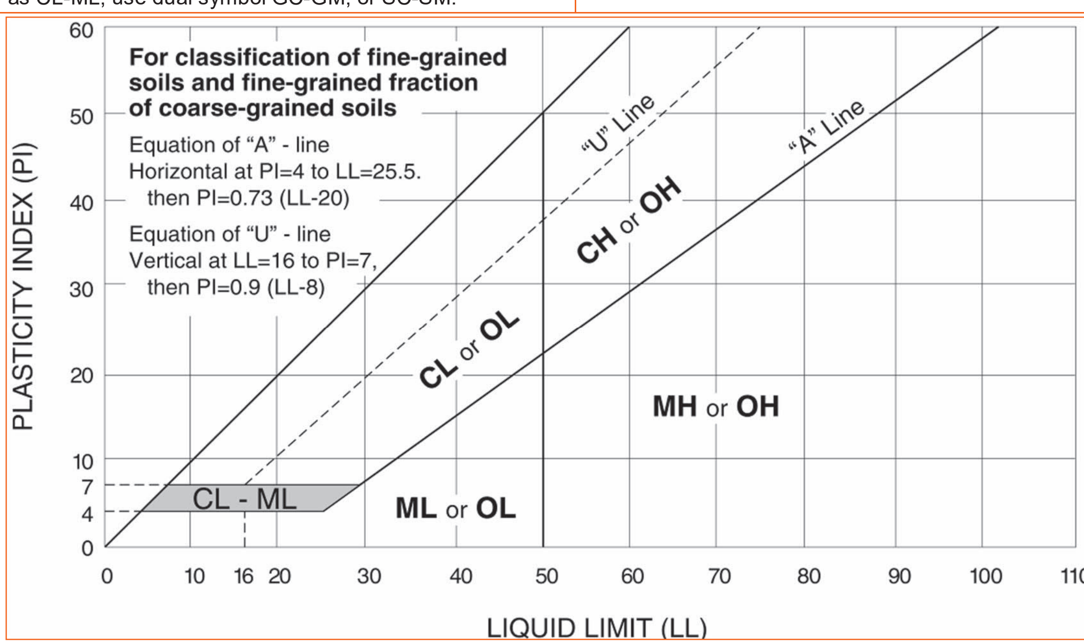
[M] If soil contains $\geq$ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] $PI \geq 4$ 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.



DESCRIPTION OF ROCK PROPERTIES

Terracon GeoReport

WEATHERING	
Fresh	Rock fresh, crystals bright, few joints may show slight staining. Rock rings under hammer if crystalline.
Very slight	Rock generally fresh, joints stained, some joints may show thin clay coatings, crystals in broken face show bright. Rock rings under hammer if crystalline.
Slight	Rock generally fresh, joints stained, and discoloration extends into rock up to 1 in. Joints may contain clay. In granitoid rocks some occasional feldspar crystals are dull and discolored. Crystalline rocks ring under hammer.
Moderate	Significant portions of rock show discoloration and weathering effects. In granitoid rocks, most feldspars are dull and discolored; some show clayey. Rock has dull sound under hammer and shows significant loss of strength as compared with fresh rock.
Moderately severe	All rock except quartz discolored or stained. In granitoid rocks, all feldspars dull and discolored and majority show kaolinization. Rock shows severe loss of strength and can be excavated with geologist's pick.
Severe	All rock except quartz discolored or stained. Rock "fabric" clear and evident, but reduced in strength to strong soil. In granitoid rocks, all feldspars kaolinized to some extent. Some fragments of strong rock usually left.
Very severe	All rock except quartz discolored or stained. Rock "fabric" discernible, but mass effectively reduced to "soil" with only fragments of strong rock remaining.
Complete	Rock reduced to "soil". Rock "fabric" no discernible or discernible only in small, scattered locations. Quartz may be present as dikes or stringers.

HARDNESS (for engineering description of rock – not to be confused with Moh's scale for minerals)	
Very hard	Cannot be scratched with knife or sharp pick. Breaking of hand specimens requires several hard blows of geologist's pick.
Hard	Can be scratched with knife or pick only with difficulty. Hard blow of hammer required to detach hand specimen.
Moderately hard	Can be scratched with knife or pick. Gouges or grooves to ¼ in. deep can be excavated by hard blow of point of a geologist's pick. Hand specimens can be detached by moderate blow.
Medium	Can be grooved or gouged 1/16 in. deep by firm pressure on knife or pick point. Can be excavated in small chips to pieces about 1-in. maximum size by hard blows of the point of a geologist's pick.
Soft	Can be gouged or grooved readily with knife or pick point. Can be excavated in chips to pieces several inches in size by moderate blows of a pick point. Small thin pieces can be broken by finger pressure.
Very soft	Can be carved with knife. Can be excavated readily with point of pick. Pieces 1-in. or more in thickness can be broken with finger pressure. Can be scratched readily by fingernail.

Joint, Bedding, and Foliation Spacing in Rock [1]

Spacing	Joints	Bedding/Foliation
Less than 2 in.	Very close	Very thin
2 in. – 1 ft.	Close	Thin
1 ft. – 3 ft.	Moderately close	Medium
3 ft. – 10 ft.	Wide	Thick
More than 10 ft.	Very wide	Very thick

1. Spacing refers to the distance normal to the planes, of the described feature, which are parallel to each other or nearly so.

Rock Quality Designator (RQD) [1]

RQD, as a percentage	Diagnostic description
Exceeding 90	Excellent
90 – 75	Good
75 – 50	Fair
50 – 25	Poor
Less than 25	Very poor

1. RQD (given as a percentage) = length of core in pieces 4 inches and longer / length of run

Joint Openness Descriptors

Openness	Descriptor
No Visible Separation	Tight
Less than 1/32 in.	Slightly Open
1/32 to 1/8 in.	Moderately Open
1/8 to 3/8 in.	Open
3/8 in. to 0.1 ft.	Moderately Wide
Greater than 0.1 ft.	Wide

References: American Society of Civil Engineers. Manuals and Reports on Engineering Practice - No. 56. Subsurface Investigation for Design and Construction of Foundations of Buildings. New York: American Society of Civil Engineers, 1976. U.S. Department of the Interior, Bureau of Reclamation, Engineering Geology Field Manual.