ARKANSAS DEPARTMENT OF TRANSPORTATION



# SUBSURFACE INVESTIGATION

STATE JOB NO.		090069	
FEDERAL AID PROJE	CT NO.	CPFCDS-0004(80)	
NORTHWEST ARKANSAS NATIONAL AIRPORT ACCESS (F)			
STATE HIGHWAY	NEW	SECTION	NEW
IN		BENTON	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 | Lorie H. Tudor, 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

November 10, 2021

TO: Mr. Trinity Smith, Engineer of Roadway Design

SUBJECT: Job No. 090069 Northwest Arkansas National Airport Access (F) Route X Section N/A Benton County

Based on soil information from projects in the surrounding area, an estimated R-Value of 20 is appropriate for pavement design.

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

Asphalt Concrete Hot Mix PG 76-22			
Туре	Asphalt Cement %	Mineral Aggregate %	
Surface Course	5.3	94.7	
Binder Course	4.5	95.5	
Base Course	4.1	95.9	

Jonathan A. Annable

Materials Engineer

JAA:yz:bjj

Attachment cc: State Constr. Eng. – Master File Copy District 9 Engineer System Information and Research Div. G. C. File



Materials Testing Geotechnical Engineering Environmental Building Sciences & Safety Inspections & Code Compliance Virtual Design Consulting

September 30, 2023 Job No. 19-118

Garver LLC 4701 Northshore Drive North Little Rock, Arkansas 72118

Attn: Mr. Adam Wierciak, P.E.

### RESULTS of GEOTECHNICAL INVESTIGATION ARDOT JOB 090069 XNA ACCESS ROAD - ROADWAY BENTON COUNTY, ARKANSAS

#### **INTRODUCTION**

Provided herewith are the final results of the geotechnical investigation performed for the roadway portion of the XNA Access Road in Benton County, Arkansas. This investigation is one facet of the ARDOT Job 090069 Northwest Arkansas Regional Airport Access (Benton Co) (F). This geotechnical investigation was authorized by the Garver, LCC Subconsultant Agreement for Task Order No. 061 on August 27, 2019. Notice to proceed with the field studies was received on August 30, 2019. Results and recommendations have been provided throughout the course of this study. A preliminary report providing recommendations for subgrade support was submitted on February 18, 2023.

The project consists of construction of a new access road extending from the Northwest Arkansas Regional Airport (XNA) approximately 4 miles southeast to the planned terminus at Highways 70 and 71. The south end of the project begins at approximately Sta 100+00 and ends to the north at approximately Sta 310+00. For the most part, the main lane roadway section will consist of two (2), 12-ft-wide traffic lanes, a 6-ft-wide inside shoulder and, generally, a 10-ft-wide outside shoulder for each directional lane. The directional main lanes will be separated by a concrete median barrier or 48-ft-wide median.

Site grading in the roadway will include significant cut and fill. Fills on the order of 42 ft are anticipated near Sta 107, 53 ft at Sta 125, 57 ft near Sta 215, 55 ft near Sta 267 and 37 ft near Sta 284. Cuts on the order of 33 ft near Sta 135, 43 ft near Sta 170, and 22 ft near Sta 252 are expected.

The purposes of this study phase have been to develop geotechnical recommendations related

to development of project roadways. To accomplish these purposes, the following multi-phased study has been performed.

- Sample borings were drilled along the proposed roadway alignments to define soil, rock, and groundwater conditions.
- Bulk samples were obtained from representative locations along the project alignment for use in laboratory testing used to develop subgrade support parameter recommendations.
- A laboratory testing program was performed to establish general soil classification and basic engineering properties for use in developing geotechnical parameters for roadway design and construction.
- The results of the field and laboratory studies were utilized in engineering analyses performed to develop conclusions and recommendations related to roadway design and site grading planning.

The results of the roadway study are discussed in the following report sections. Recommendations for design and construction are provided in subsequent report sections.

### SUBSURFACE EXPLORATION

Subsurface conditions in the XNA Access Road project alignment were explored by drilling a total of 66 sample borings. Of these borings, 14 were drilled for bridge ends (designated as "S" borings). The remainder of the borings were drilled for the roadway alignment. In addition, bulk samples for use in laboratory testing were obtained from five (5) test pits. The site vicinity is shown on Plate 1. The approximate boring locations are shown on the Plans of Borings, Plates 2a through 2k. The subsurface exploration program is summarized in Appendix A.

Logs of the roadway borings, presenting descriptions of the subsurface conditions encountered and the results of field and laboratory tests, are included as Plates 3 through 54. Logs of the end bent borings of the bridges are included as Plates 55 through 78. The centerline station and offset of the boring locations and approximate ground surface elevation, as inferred from the topographic information provided by the Engineer (Garver, LLC) or as inferred from available topographic information, are also shown on the logs. It must be recognized that the surface elevations shown are <u>approximate</u> and actual elevations may vary. Keys to the terms and symbols used on the logs are presented as Plates 79 and 80.

The borings were drilled with CME-55 HTX and SIMCO 2800 truck-mounted drill rigs and CME-55, CME-850, and Geoprobe 3230DT track-mounted drill rigs. Sample borings were advanced

using dry-auger drilling procedures or a combination of dry-auger and rotary-wash drilling methods.. Samples were obtained at approximately 2-ft intervals to 10-ft depth and at 5-ft intervals thereafter. The boring completion depths are shown on the summary in Appendix A.

Soil and weathered rock samples were obtained using a combination of dry-auger and rotarywash drilling methods. Samples were typically obtained at 2-ft intervals to 10-ft depth and at 5-ft intervals thereafter. Samples were recovered using a 2-in.-diameter split-barrel sampler driven into the strata by blows of a 140-lb automatic hammer with 30-in. drop in accordance with Standard Penetration Test (SPT) procedures. The number of blows required to drive the standard split-barrel sampler the final 12 in. of an 18-in. total drive, or a portion thereof, is defined as the Standard Penetration Number (N). Recorded N-values are shown on the boring logs in the "Blows Per Ft" column.

At selected locations where cut was anticipated, samples of the cherty limestone bedrock were obtained using a 5-ft-long NQ-size double-tube core barrel with a diamond bit. For each core run, the percent recovery was determined as the ratio of recovery to total length of core run. Rock Quality Designation (RQD) was also determined for the core run as the sum of intact, sound rock core greater than 4-in. length divided by the total length of the run and expressed in percent. Both these values are presented in the right-hand columns of the log forms, opposite the corresponding core run. Photographs of the recovered rock cores are provided in Appendix B.

All samples were removed from sampling tools in the field, examined and visually classified by the field geologist or field engineer. Samples were then placed in appropriate containers to prevent moisture loss and/or change in condition during transfer to our laboratory for further examination and testing.

As noted, the roadway borings were advanced using dry-auger drilling procedures to the extent possible to facilitate evaluation of groundwater conditions. Observations regarding groundwater levels are noted in the lower-right portion of each log and are discussed in subsequent sections of this report. All boreholes were backfilled after obtaining the final water level readings.

#### **LABORATORY TESTING**

To evaluate pertinent properties of the soil and rock encountered in the roadway borings, laboratory tests consisting of classification and natural water content determinations were performed. A total of 246 natural water content determinations were performed to develop information on *in*- *situ* soil water content in the borings. Water content results are plotted on the log forms in accordance with the scale and symbols shown in the legend located in the upper-right corner of the logs.

To verify field classification and to evaluate soil plasticity, 70 Atterberg limit (liquid and plastic limits) determinations and 77 sieve analyses were performed on selected representative soil and weathered rock samples. The Atterberg limits are plotted on the boring logs as plus signs connected with a dashed line. The percentage by weight of soil passing the No. 200 sieve is noted in the "- No. 200%" column on the far-right side of the log forms.

A summary of classification test results and classification by the Unified Soil Classification System and AASHTO Classification System is presented in Appendix C. Grain-size distribution curves are also included in Appendix C.

To develop information on the range of subgrade support properties, five (5) laboratory Moisture-Density Relationship (Proctor) tests were performed on representative bulk samples. These tests were performed in accordance with AASHTO T 99 and T 180 methods, depending on sample gradation. Pavement subgrade support properties were evaluated by performing nine (9) California Bearing Ratio (CBR) tests (AASHTO T 193). For the CBR tests, the specimens were molded at approximately the optimum water content and 95 percent of the maximum dry density as determined by the laboratory Proctor tests.

The Proctor and CBR test results are summarized in Appendix D. The test results for both the Proctor and CBR tests are also shown graphically in Appendix D.

#### **GENERAL SITE and SUBSURFACE CONDITIONS**

#### Site Conditions

The project begins at the Highways 70 and 71 interchange, Sta 100+00, and extends north to Airport Boulevard, Sta 310+00. The alignment locale consists of a mixture of undeveloped pasture and woodlands with scattered residential houses. The alignment crosses several rural roads: Wager, Haden, Holmes, and Malone. The existing roads are generally bordered by shallow ditches. The alignment also crosses Osage Creek and Little Osage Creek. The site terrain consists of steep, rolling hills with deep valleys. Surface drainage of the project area is highly variable, with drainage varying from poor to good.

#### Site Geology

The project alignment is located in the mapped exposure of the Boone Formation. The early and middle Mississippian Period Boone consists of fine- to coarse-grained limestone interbedded

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with chert. The chert content can vary widely, both horizontally and vertically, and limestone or chert may be predominant. The Boone Formation is known for dissolutional features such as sinkholes, caves, and enlarged fissures. Typically, the limestone/cherty limestone units of the Boone decompose (weather) to erratic blends of chert fragments and clay/silty clay. The residual soil mantle may extend to significant depths on higher terrain and may contain hard chert seams and/or layers. The thickness of the Boone Formation is reported to be 300 to 350 ft in northern Arkansas. The Boone is generally disconformable to the underlying Chattanooga Shale and St. Joe Limestone member, with some areas having a conformable contact.

#### Subsurface Conditions

The subsurface conditions revealed by the roadway borings are shown in detail on the boring logs. The surficial soils in the roadway alignment consist primarily of loose to dense silt and fine sandy silt and soft to stiff clayey silt and silty clay. This stratum contains variable chert fragments. The silt and clayey silt exhibit low plasticity, moderate to high compressibility, and low shear strength. The low-plasticity and silty soils are moisture-sensitive and will lose considerable strength when saturated. Some of this material is locally fill. The compactness of the fill ranges from poor to fair.

Below the surficial silty soils is firm to very stiff clay, silty clay and fine sandy clay units with variable, but generally numerous, chert fragments and discontinuous chert seams and layers. The clay, silty clay, and fine sandy clay are residual in origin and have weathered from the underlying cherty limestone bedrock. The predominant silty clay exhibits low plasticity. However, the localized clay units have moderate plasticity. The potential for volume change with changes in water content is considered low due to the presence of numerous limestone and chert fragments.

The overburden soils are underlain by low hardness to moderately hard gray and light gray weathered cherty limestone. The weathered cherty limestone exhibits differential weathering with frequent chert and clay seams and layers, which represent zones of completely weathered limestone. Rock core recovery values range from 10 to 55 percent and rock quality designation (RQD) values were 0 percent. These RQD values are indicative of very poor to poor rock quality. Rock quality generally increases with depth.

Based on the results of the borings, the subgrade soil classification varies from AASHTO Soil Classification A-1-b, A-2-6, A-2-7, A-4, A-6, A-7-5, and A-7-6. The predominant subgrade soils in the project alignment appear to be A-2-4 and A-4 soils, which correlate with variable

excellent to poor soils. Given these classifications and the determination of CBR values ranging from approximately 8 to 16 for the on-site soils, subgrade conditions are considered to be medium to good. <u>Groundwater Conditions</u>

The roadway borings were advanced by dry-auger procedures to the extent possible to facilitate observation of groundwater conditions. Groundwater was locally encountered at 7.9- to 10.2-ft depth in March 2022 through July 2023 (see Borings R23 and R34). This likely represents perched water on top of the cherty limestone bedrock. However, given the rolling terrain over the alignment and the variable depth to rock, downgradient seepage through the overburden soils and fractured zones of the weathered limestone is considered likely. Seasonal seeps and springs could develop in the areas of lower terrain, hillside slopes, and/or on exposed cut slopes. Groundwater conditions will vary with seasonal precipitation, surface runoff and infiltration, and water levels in nearby streams and drainage features.

### ANALYSES and RECOMMENDATIONS

#### **General Considerations**

It is understood that the scope of the roadway phase of this project includes site grading, subgrade preparation, and pavement construction. The conclusions and recommendations developed in this study phase are discussed in the following report sections.

#### Embankment Slopes

The project scope includes cuts of up to 43 feet and fills of up to 57 ft. it is understood that embankment configurations of 3-horizontal to 1-vertical (3H:1V) are generally planned along the roadway. Where cuts are advanced through competent cherty limestone, consideration may be given to the use of near-vertical cuts with horizontal benches at approximately 15-ft vertical intervals. However, it must be recognized that rock conditions are highly variable and the height and configuration of cut slopes in rock are likely to require field adjustment.

To evaluate suitability of the plan slope configurations, slope stability analyses were performed using the computer program SLOPE/W 2020<sup>1</sup> and utilizing a Morgenstern-Price analysis. Representative sections of cut and fill were selected for analysis. The selected sections are summarized in Appendix E. For the embankment slopes, three (3) general loading conditions were evaluated, i.e., End of Construction, Long Term, and Seismic Conditions were evaluated. A 250 lbs

<sup>&</sup>lt;sup>1</sup> <u>Slope/W 2020;</u> GEO-SLOPE International; 2020.

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per sq ft uniform surcharge from vehicles was included for the purposes of stability analyses. For analysis of the seismic condition, a horizontal seismic acceleration coefficient ( $k_h$ ) of one-half the peak acceleration ( $A_s$ ) was used, a value of 0.025.

The stability analyses results summarized in Appendix E include the results of evaluation of embankment slopes. The results of the stability analyses indicate that plan configurations of the slopes are acceptable with respect to stability of all loading conditions evaluated. The analyses also indicate that a cut slope in rock with near-vertical 15-ft cuts and nominal 10-ft horizontal benches is a stable configuration.

#### Pavement Subgrade Support

Site grading includes both cut and fill. Based on the results of the borings and test pits, the on-site subgrade soils are expected to be predominantly silt, clayey silt, clay, and silty clay with chert fragments (AASHTO A-2-6, A-4, A-6, and A-7-6). Locally-available borrow, which is likely to be used as unclassified embankment fill, is expected to have similar classification.

In light of the results of the borings, laboratory CBR tests, and correlation with the AASHTO classification of the on-site and anticipated subgrade soils, subgrade support in the road alignments is expected to be medium to good. In light of the correlation with medium to good subgrade support and factoring for environmental and serviceability criteria, the following subgrade support parameters are recommended.

•	CBR:	8.3
•	Resilient Modulus (MR):	3260 lbs per sq in.

- R value: 13
- Modulus of Subgrade Reaction (k): 100 lbs per cu in.

Subgrade preparation and site grading should be performed in accordance with ARDOT criteria (ARDOT Standard Specifications Sections 210 and 214) and the recommendations of the <u>Site Grading and Subgrade Preparation</u> section of this report. We recommend that soils classifying as A-7-5 or A-7-6 with a plasticity index (PI) in excess of 18 be excluded from use as subgrade within 18 in. of the plan subgrade elevation. The top 18 in. of subgrade soils should have a maximum plasticity index (PI) of 18. The as-built pavement subgrade should be evaluated by the Engineer. Areas of unsuitable subgrade should be improved by undercut and replacement or addition of stabilization additives.

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#### Site Grading and Subgrade Preparation

In areas where silty soils comprise the subgrade, these surface soils are moisture-sensitive. Site grading operations will be more difficult to perform during wet seasons of the year.

Site preparation will require some clearing and grubbing and stripping the zone of organiccontaining soils. The depth of stripping will be variable, with deeper stripping depths in wooded areas, and less stripping required in open areas. In general, the stripping depth is estimated to be about 6 to 9 inches in clear areas but may be 18 to 24 in. or more in areas where trees and thick underbrush are present. The zone of organic surface soils should be completely stripped in the embankment footprint areas and at least 5 ft beyond the projected embankment toes. Particular care must be taken to muck out all saturated and/or organic-laden soils in existing drainage features. Site preparation may include demolition of some existing buildings. All areas where abandoned utilities or foundations are removed should be properly backfilled. Hillsides should be benched to allow placement of embankment fill in horizontal lifts. The maximum vertical cut on benches should be limited to about 18 to 24 inches.

Following demolition, stripping, and any cut, and prior to fill placement, the extent of weak and unsuitable soils should be determined. Thorough proof-rolling should be performed to verify subgrade stability. Proof-rolling should be performed with a loaded tandem-wheel dump truck or similar equipment. Unstable soils exhibiting a tendency to rut and/or pump should be undercut and replaced with suitable fill. Care should be taken that undercuts, stump holes, and other excavations or low areas resulting from subgrade preparation are properly backfilled with compacted fill.

Depending on seasonal conditions and site grading plans, undercuts of 2 to 6 ft below existing grades, more or less, could be required. General undercuts for site grading may be backfilled with unclassified borrow as used for embankment fill. As-built undercut or improvement requirements will depend on seasonal site conditions and final site grading plans. The required depth of improvement will vary with seasonal site conditions and final grading plans and must be field verified.

In lieu of undercutting and replacing unsuitable soils, consideration may be given to using additives to improve soil workability and stabilize weak areas. Hydrated lime, quick lime, Portland cement, fly ash, or suitable alternate materials may be used as verified by appropriate testing and approved by the Engineer. Additives can be effective where the depth of unstable soils is relatively shallow. Treatment will be less effective in areas where the zone of unstable soils is deep. The

optimum application rate of stabilization additive must be determined by specific laboratory tests performed on the alignment subgrade soils.

All roadway subgrade should be evaluated by the Engineer or Department during site grading operations. Specific improvement requirements must be field verified. Subgrade preparation and mass undercuts should extend at least 5 ft beyond the embankment toes to the extent possible. Subgrade preparation for the approach roads should extend at least 3 ft outside pavement shoulder edges to the extent possible.

Fill and backfill may consist of unclassified borrow free of organics and other deleterious materials as per ARDOT Standard Specifications Subsection 210.06. Where A-7-5 or A-7-6 soils are encountered at the subgrade elevation, we recommend that these soils be undercut as required to provide at least 18 in. of suitable low-plasticity subgrade soils, i.e., with a maximum PI of 18, or approved "hillside" cherty clay with a maximum of 35 percent passing the No. 200 sieve. Alternatively, stabilization additives may be utilized to develop a stable subgrade with a PI of 18 or less. Granular soils must be protected from erosion with a minimum 18-in.-thick armor of clayey soil.

Subgrade preparation should comply with ARDOT Standard Specifications Section 212. Embankments should be constructed in accordance with ARDOT criteria (ARDOT Standard Specifications Section 210). Fill and backfill should be placed in nominal 6- to 10-in.-thick loose lifts. All fill and backfill must be placed in horizontal lifts. Hillsides and cut slopes should be benched as required to facilitate placing horizontal fill lifts. The in-place density and water content should be determined for each lift and should be tested to verify compliance with the specified density and water content prior to placement of subsequent lifts.

### **CONSTRUCTION CONSIDERATIONS**

Positive surface drainage should be established at the start of the work, be maintained during construction and following completion of the work to prevent surface water ponding and subsequent saturation of subgrade soils. Density and water content of all earthwork should be maintained until embankments and pavements are completed.

Localized perched groundwater was encountered between 8- to 10-ft in March 2022 through July 2023. Shallow perched groundwater may be encountered in the near-surface soils, particularly during wet seasons. The volume of groundwater produced can be highly variable depending on the

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condition of the soil in the immediate vicinity of the excavation. In addition, seasonal surface seeps or springs could develop.

Seepage into excavations and cuts can typically be controlled by ditching or sump-and-pump methods. If seepage infiltration cannot be controlled, construction of drains and/or the use of Select Granular Backfill (AASHTO M 43 No. 57), stone backfill (ARDOT Standard Specifications Section 207), or approved alternates to an elevation above the inflow of seepage will be warranted. In areas of seepage infiltration, the granular fill should be encapsulated with a filter fabric complying with ARDOT Standard Specifications Subsection 625.02, Type 2 and vented to positive discharge. Where surface seeps or springs are encountered during site grading, we recommend the seepage be directed via French drains or blanket drains to positive discharge at daylight or to storm drainage lines.

Site preparation should also include construction of blanket drains in all existing drainage features which will be covered by fill. All loose and/or organic materials should be excavated from drainage features prior to drain construction. Blanket drains should consist of at least 8 to 12 in. of select granular backfill (AASHTO M 43 No. 57) fully encapsulated by a filter fabric. A fabric complying with ARDOT Standard Specifications Subsection 625.02, Type 2 is recommended. Drains should direct water to positive discharge at daylight or into storm drain lines.

The results of the roadway borings indicate that the silt, clay, and silty clay overburden soils can be excavated with conventional heavy-duty excavation equipment. The low hardness highly weathered limestone can also typically be excavated with conventional heavy-duty excavation equipment. Where cuts or excavations encounter moderately hard weathered cherty limestone and cherty limestone, rock excavation methods will likely be required. This may include use of a hoeram, jackhammers, blasting, or other rock excavation methods.

The potential for rock excavation should be anticipated. Contract documents should include a unit price for removal and disposal of materials and obstructions that cannot be excavated with conventional heavy-duty excavating equipment. The conventional heavy-duty excavating equipment may be defined as a Caterpillar D-7 bulldozer with single tooth ripper, a Caterpillar 312 track excavator equipped with rock teeth, or equipment of similar power and capability. Rock excavation volumes should be determined based on in-place measurements via cross sectioning. If excavation is to be unclassified, the Contractor must be responsible for assessing rock excavation requirements. Project No. 19-118 - XNA ACCESS ROAD - ROADWAY

#### **CLOSURE**

The Engineer or Department should monitor site grading, subgrade preparation, and all pavement construction. Subsurface conditions significantly at variance with those encountered in the borings should be brought to the attention of the Geotechnical Engineer. The conclusions and recommendations of this report should then be reviewed in light of the new information.

\* \* \* \*

We appreciate the opportunity to be of service to you in this phase of the project. Should you have any questions regarding this report, or if we may be of additional assistance during final design or construction, please call on us.

Sincerely,

GRUBBS, HOSKYN, BARTON & WYATT, INC.

Vellet M. Sett

Velleta M. Scott, P.E. Sr. Project Engineer

Mark E. Wyatt, P.E. President

VMS/MEW:jw

Copies Submitted:

Garver LLC Attn: Mr. Adam Wierciak, P.E. Attn: Mr. Joel Skinner, P.E.

(1-email) (1-email)





SITE VICINITY MAP

090069 XNA Access Road Benton County, Arkansas Job No. 19-118

Plate 1



Grubbs, Hoskyn, Barton & Wyatt, LLC CONSULTING ENGINEERS	<u>PLAN of BORINGS</u> 090069 XNA Access Road	Scale: As s
A UES Company	Benton County, Arkansas	



Grubbs, Hoskyn, Barton & Wyatt, LLC CONSULTING ENGINEERS A UES Company	<u>PLAN of BORINGS</u> 090069 XNA Access Road Benton County, Arkansas	Scale: As s
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Grubbs, Hoskyn, Barton & Wyatt, LLC CONSULTING ENGINEERS A UES Company	<u>PLAN of BORINGS</u> 090069 XNA Access Road Benton County, Arkansas	Scale: As
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Grubbs, Hoskyn,	PLAN of BORINGS	
Barton & Wyatt, LLC CONSULTING ENGINEERS	090069 XNA Access Road	Scale: As
A UES Company	Benton County, Arkansas	



Grubbs, Hoskyn, Barton & Wyatt, LLC	<u>PLAN of BORINGS</u> 090069 XNA Access Road	Scale: As
A UES Company	Benton County, Arkansas	





Grubbs, Hoskyn, Barton & Wyatt, LLC CONSULTING ENGINEERS	<u>PLAN of BORINGS</u> 090069 XNA Access Road	Scale: As
A UES Company	Benton County, Arkansas	





Grubbs, Hoskyn,	PLAN of BORINGS	
CONSULTING ENGINEERS	090069 XNA Access Road	Scale: As
A UES Company	Benton County, Arkansas	



Grubbs, Hoskyn,	PLAN of BORINGS	
Barton & Wyatt, LLC CONSULTING ENGINEERS	090069 XNA Access Road	Scale: As
A UES Company	Benton County, Arkansas	





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Barton & Wyatt, LLC CONSULTING ENGINEERS	090069 XNA Access Road	Scale: As
A UES Company	Benton County, Arkansas	







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A UES Company	

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19-118	
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## LOG OF BORING NO. R7

090069 XNA Access Road Benton Co., Arkansas

TYPE: HSA to 8.5 ft /Core

Grubbs, Hoskyn, Barton & Wyatt, Inc. <sup>Consulting Engineers</sup>

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			reddish tan clay w/chert nodules, fragments, and	50/4"													
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			w/red clay seams and pockets														
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- 15	-																
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6 GBJ	-																
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Щ	DATE	. 0	-2 1-23			G. DI	yiUč	J.J IL					DA	i⊑. 0/	× 1/2	υZ	5

	19-118	}													
		ton & Wyatt, Inc. ting Engineers Ben	<b>B (</b> 9 XN ton (	<b>D R I</b> IA Aco Co., A	N G cess rkans	N ( Road sas	<b>). I</b>	R8							
	TYPE	: HSA to 28 ft /Core		LO		N: Ap	prox	Sta 1	35+00	), CL					
			Ŀ	Ţ		(	СОН	ESIO	N, TO	N/SQ	FT				
H, FT	BOL		PER	RY √ U FT	0	.2 0	.4	0.6	0.8	1.0	1.2	1.4	500 %	overy	B
DEPT	SYM		SWC	LB/C	PL/ L	ASTIC IMIT		W CO	ATER	г	LI	QUID	No.	6 Rec	% R
		SURF. EL: 1220±	BLO	5	1	+ 0 2	<u>20</u>	30	40 40	50	60	- <b>+</b> 70	'	6	
		Stiff red clay w/numerous chert fragments and nodules	11												
		- firm at 2 to 4 ft	9												
		- stiff below 4 ft													
5 -			11												
		Stiff red and reddish tan clay	13												
- 10 -		// - with chert fragments and	23					•	<b></b>			+	55		
		nodules below 10 ft													
		- soft at 13 to 18 ft													
- 15 -		X	5						_				_		
		stiff bolow 18 ft													
20			11												
20															
		$\nabla$	17			•			<b></b>				10		
- 25 -						-			-						
			50/1												
		Moderately hard gray highly	50/1											50	0
- 30 -		w/red clay seams							_						
														33	0
														42	0
- 35 -			<b> </b>												
	-														
	COMF	PLETION DEPTH: 35.0 ft	DE IN	PTH T BORIN	O WA G: Dr	TER y to 28	8 ft					DATE: 8	8/20/2	023	;

	TYPE	A	uger	LC		ON:	Appro	x Sta	148+9	90, 20	ft Rt			
тн,	MBOL	<b>NPLES</b>	DESCRIPTION OF MATERIAL	S PER FT	DRY WT CU FT	c	).2 0	20HE 	SION 	, TON/ ).8 1	/SQ F 	Г .2 1	.4	. 200 %
DEP	λs	SAI	SURF. EL: 1143±	BLOW	UNIT LB/	PL L	ASTIC .IMIT +		WA CON 	TER ITENT ● 40 5		LIQU LIM <del>- 1</del> 50 7		No No
		S w fr	tiff dark brown clayey silt /numerous chert and limestone agments	26			•	++						38
		S W d la	tiff reddish brown clay /numerous chert fragments and iscontinuous chert seams and ayers	16			•							39
5 -		-	very stiff below 4 ft	50/8'			•							_
				33			•							-
10 -				37			•							_

_	1	9-118	5												
		Gru Barl	ob or	s, Hoskyn, & Wyatt, Inc. Engineers Benton	<b>D R I</b> NA Ac Co., <i>P</i>	<b>NG</b> cess Arkan	<b>N (</b> Roa sas	<b>D. I</b> d	<b>२</b> 11						
		TYPE	: .	Auger	LC	CATI	ON:	Appr	ox Sta	a 155+	30, CL				-
					FT	νT			СОН	ESION		/SQ F	Г		<u>`0</u>
	-	BOL	LES		PER	RY √ U FT	c	).2	0.4	0.6	0.8 1	.0 1	.2 1	.4	% 00
DEDT	- -	SYM	SAMF		LOWS	JNIT DI LB/CI	PL L		C	W. COI	ATER NTENT		LIQU LIM	JID IT	- No. 2
	-			SURF. EL: 1096±	B	<u> </u>		10	20	30	40 5	50 6	60 7	0	
	_			fragments and nodules											
			X		7										
				- stiff at 2 to 4 ft											-
			Ń		13										
			1												
				soft below 4 ft											
- 5	5 -		X		6										-
	_														
-	_		-	Very stiff reddish brown silty clay					-						
	_			w/numerous chert fragments and nodules and discontinuous chert											
-	_		X	seams	31										
-	_								_						-
	_														
_															
			]												
			X		50/8"										
<u> </u> 1	0 -														
			X		25/2"										
	ľ		1	Note: Refusal at 11 ft on apparent	+		+	+		-	_	+	+	+	
				cherty limestone											
-23															
J 9-27															1
ES.GP															
D HOL															
<sup>3</sup> ROA															
19-11	5														
BNEW	с Г		LE	TION DEPTH: 11.0 ft DE									TE 8	/20/20	123
Ū	L		0	IN	2010	.э. D								., 20, 20	.20

	19-11	3													
	Gru Bar <sub>Consu</sub>	bbs, Hoskyn, on & Wyatt, Inc. ting Engineers 090069 Bent	<b>BO</b> XN ton C	<b>RI</b> A Acc co., A	<b>N G</b> cess R rkansa	<b>N O</b> . load as	. R1	2							
	TYPE	: Auger to 5 ft /Wash to 20 ft /Core		LO		I: App	orox S	ta 17	0+00	, CL					
H, FT	BOL		PER FT	RY WT U FT	0.2	C 0.4		SION 6 0		1/SQ	FT 1.2	1.4	200 %	overy	QD
DEPT	SYM		TOWS	UNIT D LB/C	PLA: LIN	STIC /IT		WA CON			L  		- No. 2	% Rec	8 8 8
<u> </u>		SURF. EL: 1146±			10	20	30	) 2	40	50	60	70	_		
		clay	2												
		- very stiff with chert fragments below 2 ft	27			•		-					49		
- 5 -		- with numerous chert fragments below 4 ft	50/10'												
		X	50/4"												
- 10 -		Moderately hard light gray and tan weathered cherty limestone fractured w/some	50/3"												
		silty clay filled fractures													
		Mederately band to band ton	25/0"												
- 15 -		and light gray weathered chert and limestone, flat bedded, highly fractured w/red clay infill													
- 20 -		Τ													
		- with some calcareous seams below 20 ft													
														52	0
- 25 -													_		
														50	0
														50	
- 30 -		╨─────										_	_	-	-
	-														
	-														
		LETION DEPTH: 30.0 ft			O WAT	ER	 't						3/13/3	02 <sup>.</sup>	3
1			IIN L		С. Dry	001	•				L	<i></i>	5, 15/2	.02	2

L <th></th> <th>Auger to 10 ft /Wash</th> <th>LC</th> <th>CATIO</th> <th>DN: A</th> <th>opprox S</th> <th>Sta 174+</th> <th>50, CL</th> <th></th> <th></th> <th></th>		Auger to 10 ft /Wash	LC	CATIO	DN: A	opprox S	Sta 174+	50, CL			
best of the second s	l, FT SOL		ER FT	۲ WT FT	0.2	2 0.4	0.6	N, ION/ 	SQ F I 	1.4	% 00
Soft reddish brown silty clay   4     Very stiff reddish brown and tan silty clay w/numerous chert fragments   32     - 5   50/6"     - with chert layers below 6 ft   50/6"     - with chert layers below 6 ft   50/10"     - 10   25/0"     - 10   25/0"     - 25/0"   25/0"	SYME	DESCRIPTION OF MATERIAL	LOWS F	JNIT DR LB/CU	PLA		W CO		L		- No. 2(
Very stiff reddish brown and tan silty clay winumerous chert fragments     32     Image: Construction of the second secon		SURF. EL: 1126± Soft reddish brown silty clay w/chert fragments	4		10	20	30	40 5	0 60	70	
5   50/6"   50/6"   50/6"   1   <		Very stiff reddish brown and tan silty clay w/numerous chert fragments	32								_
- With chert layers below 6 it 50/8" Moderately hard tan and gray weathered limestone w/reddish brown silty clay filled fractures and seams 50/10" 25/0" 25/0" 25/0" 25/0" 25/0" 25/0"	5	with chart lowers halow C ft	50/6"								_
Moderately hard tan and gray weathered limestone w/reddish brown silty clay filled fractures and seams   50/10"     10   25/0"     25/0"   25/0"     20   25/0"		- with chert layers below 6 ft	50/8"								_
25/0" 25/0" 25/0" 25/0" 25/0"		Moderately hard tan and gray weathered limestone w/reddish brown silty clay filled fractures and seams	50/10								-
			25/0"								_
20 25/0"											_
	20		25/0"	·							-
25 -	25 -										

T	YPE:	Auger	LC	CATIO	ON:	Appro	ox Sta	185+0	0, CL				
DEPTH, FT	SYMBOL	DESCRIPTION OF MATERIAL SURF. EL: 1095±	BLOWS PER FT	UNIT DRY WT LB/CU FT	0. PLA LI	2 0 ASTIC IMIT +	COHE	SION, 	TON/ .8 1 TER TENT	(SQ F 	[2 1. LIQU LIMI 	4 IID T 0	- No. 200 %
		Loose brown silt w/chert fragments and rootlets - medium dense, light brown with more chert fragments below 2 ft	5			•	•	-NON	-PLAS	TIC-			24
5 -		Very stiff reddish brown silty clay w/numerous chert and limestone fragments	38			•	<b>+</b> -	-+					1:
		- with chert seams and weathered limestone seams below 6 ft	50/6"		•	•							
10			25/0"	- <u></u>									

	TYPE	: /	Auger	LC	CATIO	ON:	Appro	x Sta	a 188+5	50, CL				_
<b>DEPTH</b> , FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL SURF. EL: 1101±	BLOWS PER FT	UNIT DRY WT LB/CU FT	PL.	ASTIC		ESION	, TON/	SQ F	Г .2 1 LIQL LIQL LIM 	.4 JID IT	- No. 200 %
		Ì	Very loose to loose brown silt w/rootlets and occasional chert ragments	4				•	-NON	I-PLAS	TIC-			6
			Firm reddish brown and light brown silty clay w/numerous chert and imestone fragments	9			•	+-	+					2:
5 -		Ĭ	- stiff to very stiff, reddish brown below 4 ft	17				•						-
		X		35			•							-
10 -				26			•							
	-													
														-

	Gru Bar Consi	8 Ibb toi ulting	os, Hoskyn, n & Wyatt, Inc. g Engineers 090069 XN Benton (	<b>) R I</b> IA Ac Co., A	<b>N G</b> cess arkan	<b>N</b> Roa sas	<b>O.</b> ad	R16	3					
	TYP	E:	Auger	LC	CATIO	ON:	Ар	orox S	Sta 196+	-75, CL				
⊢			DESCRIPTION OF MATERIAL	2 FT	JNIT DRY WT LB/CU FT			СО	HESIO		I/SQ F	Q FT		
Ξ, F	ABOL	PLE PLE		OWS PEF			0.2	0.4	0.6	0.8	1.0	1.2 1	.4	200
DEP.	SYN	SAN				PLAST LIMI		IC	w co	WATER CONTENT				- No.
	and a state		SURF. EL: 1190±	В			10	20	30	40	50	60 7	• 70	
			fine sandy clay w/numerous chert and limestone fragments	15				+		•				26
	Ż	X		16					•					-
- 5 -		X	- stiff to very stiff at 4 to 13 ft	29					•	•				-
			- with discontinuous chert seams and layers at 6 to 13 ft	50/6"					•					_
- 10 -				50/5"					•					-
- 15			- stiff below 13 ft	22					+•	+				32
														-
- 20 -		X		12					•					
	-													
9-27-23	-													
	- - - -													-
LGBNEW 19-118		 PLE E: 4	ETION DEPTH: 20.0 ft DE -6-22 IN	PTH <sup>-</sup> BORII		ATEF Dry	२				DA	 ATE: 4	/6/202	22

<b></b>	19-11	8												
	Grubbs, Hoskyn, Barton & Wyatt, Inc. Consulting Engineers LOG OF BORING NO. R17 090069 XNA Access Road Benton Co., Arkansas													
	TYPE	E: .	Auger	LC	CATIO	ON:	Appro	x Sta	200+0	0, CL				
	SYMBOL	3		ΕT	٧T		(							
Ц Ц Ц		PLES	DESCRIPTION OF MATERIAL	PER	NY V U FT	0							4	200 %
DEPT		SAM		SWO	LB/C	PL/ Li			WA CON	TER TENT		LIQU LIMI	ID T	- No.
	8 Z 8 Z 8		SURF. EL: 1202±	B		1	<b>T</b> 2	20 3	80 4	40 5	0 6	0 7	0	
		X	fine sandy silt w/chert fragments	15			•	#						36
		X	Stiff to very stiff reddish brown silty	- 24			•							
- 5 -		X	limestone fragments and occasional clay pockets	27				• +	-+					17
		X		39					•					
- 10 -		X	Stiff reddish brown clay w/chert and limestone fragments	13				+	•		•	÷		63
- 15 -		X	- with more chert and limestone fragments below 13 ft	17				•						
- 20 -		X		12					•					
9-21-23														
25 -														
	COMF DATE	LLE 2 E	TION DEPTH: 20.0 ft D -11-22 II	DEPTH T N BORI	TO WA	ATER vry			1		DA	TE: 5	/11/20	)22
	19-11 Gru Bar Consu	8 Ibb tor	s, Hoskyn, h & Wyatt, Inc. Bengineers 090069 XN Benton (	<b>D R I</b> NA Ac Co., A	<b>N G</b> cess arkan	<b>N</b> Roa sas	<b>D. F</b> d	<b>R</b> 19						
--------------------	------------------------------	-----------------	---	---------------------------------	-----------------------------	------------------------	------------------	-------------	-----------	--------	--------------------	----------	-----------	-----------
	TYPI	≣:	Auger	LC	CATI	ON:	Appr	ox Sta	a 209+	00, CL				1
	5	ES.		ER FT	TWT T		12			I, TON	/SQ F <sup>-</sup>	Γ 2 1	Δ	% (
DEPTH,	SYMBC	SAMPLI	DESCRIPTION OF MATERIAL	OWS PE	INIT DRY LB/CU I	PL	ASTIC	2	W/ COT				JID IT	- No. 20(
			SURF. EL: 1215±	B			10	20	30	40	50 E		'0 I	
- 1 -			Stiff tan and reddish brown slity clay w/numerous chert fragments and occasional organics	14			•	•						33
- 3			fewer organics below 2 ft	50/3"			•							
4			- auger refusal in cherty limestone	25/0"			•							
- 5														
- 7														
.GPJ 9-27-23														
19-118_ROAD HOLES.	-													
LGBNEW	COMI DATE	PLE : 3	TION DEPTH: 4.5 ft DE -15-22 IN	EPTH T BORII	FO WANG: D	ATER )ry			·	·	DA	TE: 3	/15/20	)22

LI TO BW S HILA DESCRIP SURF. EL: 12 Very soft brow w/numerous	2TION OF MATERIAL 236± wn clayey silt chert fragments	BLOWS PER FT	T DRY WT 3/CU FT	0.2	0.4		n, i on/s -0			-
Image: Supervision of the second s	2TION OF MATERIAL 236± wn clayey silt chert fragments	BLOWS PI	T DR 3/CU	I		0.0	0.8 1.0	0 1.2	1.4	%
SURF. EL: 12	236± wn clayey silt chert fragments		ΞΞ			W		LI L	QUID IMIT	- No. 20
w/númerous	chert fragments			10	20	30	40 50	) 60	70	
		3				•				33
Very stiff rede w/numerous	lish tan silty clay chert fragments	29								
5 -		45			•					_
- With discont and layers be	Inuous chert seams low 6 ft	50/3"				•				_
10		25/0"								_
										_

	Gru Bar Consu	8 Ibb tor ulting	s, Hoskyn, <b>&amp; Wyatt, Inc.</b> LOGOFE <sup>Engineers</sup> 090069 Bento	<b>ORI</b> XNA Ad n Co., A	<b>NG</b> cess arkan	<b>N C</b> Road sas	<b>D. R2</b>	2				
ЕРТН, FT	SYMBOL		Auger DESCRIPTION OF MATERIAL	WS PER FT	IT DRY WT B/CU FT	ON: /		Sta 225+( HESION	00, CL I, TON/S 0.8 1.0	Q FT 		Vo. 200 %
			SURF. EL: 1243± Very soft brown silty clay w/occasional chert fragments	BLC		1	0 <u>20</u>	30	● — — — — — — — — — — — — — — — — — — —		70	-
				4			+	+			7	76
			Very stiff reddish brown clay w/numerous chert fragments	33			•					
- 5			- with discontinuous chert seams and layers below 4 ft	50/8"				•				
				50/6"			•					
- 10 -				25/0"								
9-27-23	-											
9-118_ROAD HOLES.GPJ	-											
-15 -15	COM DATE	⊥⊥ PLE E: 2·	TION DEPTH: 10.0 ft -23-23	DEPTH <sup>-</sup> IN BORII	I FO WA NG: D	ATER vry		I		DATE: 2	2/23/2023	3

	19-11	8												
	Gru Bar <sub>Consu</sub>		s, Hoskyn, n & Wyatt, Inc. <sup>B Engineers</sup> LOGOFBC 090069 XN Benton (	<b>D R I</b> NA Ac Co., A	<b>NG</b> cess Arkan	<b>N (</b> Road sas	<b>). R</b>	23						
	TYPE	≣:	Auger	LC	CATIO	ON:	Appro	x Sta	230+0	0, CL				
				FT	ΥT.			СОН	ESION	, TON/	SQ F1	Г		6
ц Ц Ц	1BOL	PLES	DESCRIPTION OF MATERIAL	PER	NY V U FT	0	.2 0	.4	0.6 0	).8 1.	.0 1.	.2 1.	4	200 %
DEP1	SYN	SAM		OWS	NIT D LB/C	PL/ L	ASTIC		WA CON	TER TENT		LIQU LIM	ID T	No.
			SURF. EL: 1245±	BL	5	1	+ 0 2	20	30 4	• 10 5	0 6	0 7	0	
			Stiff tan and brown silty clay w/occasional chert fragments											
		Ň		20			-	••		⋳				88
		Ĥ												
		M	- with more chert fragments below											
		Ŵ	2.5 IL	12										
			Stiff reddish brown clay w/numerous chert fragments											
- 5		M		21					•					
		Ĥ												
		M												
		Ŵ		20										
			- with discontinuous chert seams and layers below 8.5 ft											
		X		50/5"			•							
10		1		+										
27-23	_													
GPJ 9-	-													
HOLES.	-													
ROAD F	-													
9-118	-													
5 <b>  15</b>	COM		TION DEPTH: 10.0 ft DE	EPTH			1	1		I			100100	
LGB	DATE	: 2	-23-23 IN	ROKI	NG: 7	.9 ft					DA	1E: 2	/23/20	023

_		19-11	8												
		Gru Bar <sub>Consu</sub>	bb toi	<b>bs, Hoskyn,</b> n <b>&amp; Wyatt, Inc.</b> g Engineers Benton	<b>O R I</b> NA Ac Co., A	<b>NG</b> cess Arkan	<b>N (</b> Road sas	<b>). R</b>	24						
		TYPI	Ξ:	Auger	LC	CATIO	ON:	Appro	x Sta :	235+0	0, CL				
	_				FT	ΥT.			COHE	SION	, TON/	SQ F1	Г		6
	L Ĺ	IBOL	PLES	DESCRIPTION OF MATERIAL	PER	RY V U FT	0	.2 0	.4 0	.6 0	).8 1.	.0 1.	.2 1.	4	200 %
		SYN	SAM		OWS	NIT D LB/O	PL/	ASTIC		WA CON	TER TENT		LIQU	ID T	No.
		8 % 9 % ;		SURF. EL: 1233±	В		1	+	20 3	0 4	0 5	0 6	0 7	0	
			X	Medium dense brown w/reddish tan fine sandy silt, slightly clayey w/chert fragments	18			•	++						51
				- dense below 2 ft											
			M		41			•							
_ į	5 -			Very stiff reddish brown clay, slightly silty w/numerous chert fragments	40				•						
			N	- with discontinuous chert seams and layers below 6 ft	50/6"			•							
				- with less silt below 8 ft											
$\vdash$			X		50/10			•							
<u> </u> 1	0 -		$\square$		+										
"—															
9-27-2															
ES.GP.															
AD HOL															
-118_RC															
BNEM 19	5	COMI DATE	_ PLE : 2	ETION DEPTH: 10.0 ft E	EPTH <sup>-</sup>		 ATER )rv						TE: 2	/27/20	)23
Ľ2				· _ · _ •			• •					5,1	2	, 20	

	19-118 Grub Barto Consulti	bs, Hoskyn, on & Wyatt, Inc. LOGOFE <sup>ng Engineers</sup> 090069 Bento	<b>B O R I</b> XNA Ac on Co., A	<b>NG</b> cess arkan	<b>N O.</b> Road sas	R25					
	TYPE:	Auger	LC	CATIO	DN: Ap	prox Sta	a 240+00	), CL			I
DEPTH, FT	SYMBOL	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	0.2 PLAS LIMI + 10	COH 0.4 TIC T		TON/SQ 3 1.0 ER ENT	FT 1.2 1 LIQL LIQL LIM 	1.4 JID IIT •	- No. 200 %
- 1		Dense tan fine sandy silt, slightly clayey w/numerous chert fragments	35			• ++					32
- 3		Very stiff reddish brown silty clay w/numerous chert fragments	35 50/6"			• +	•				48
18_ROAD HOLES.GPJ 9-27-23		NOTE: Auger refusal in cherty limestone layer.									
LGBNEW 19-1	COMPL DATE:	ETION DEPTH: 5.5 ft 2-28-23	DEPTH <sup>-</sup> IN BORII	     NG: D	ATER ry			 I	DATE: 2	2/28/20	23

	19-11	8												
	Gru Bar <sub>Consu</sub>	bb tor	s, Hoskyn, <b>&amp; Wyatt, Inc.</b> Engineers Bent	<b>BORI</b> 9 XNA Ad ton Co., <i>I</i>	<b>NG</b> ccess Arkan	<b>N (</b> Road sas	D. F	26						
	TYPE	:	Auger	LC	CATI	ON:	Appro	ox Sta	245+0	00, CL				
				FT	Υ			COHE	SION		I/SQ F	Г		<b>`</b> 0
н Т.	BOL			PER	RY V U FT	0	.2 (	0.4 0	.6 (	0.8	1.0 1	.2 1	.4	200 %
DEPT	SYM	SAMF		SMOUS	UNIT D LB/C	PL/ L	ASTIC IMIT			ATER		LIQU LIM	IID IT	- No.
		$\left  \right $	Soft reddish brown silty clay	ш		1	0	20 3	<u> </u>	40	50 6	60 7 	0	
		X		5				•						
		X	Stiff reddish brown clay w/numerous chert fragments	18				•	,					-
- 5 -		X	- stiff to very stiff with discontinuous chert seams and layers below 4 ft	50/10	,			•						-
		X		50/6			•	+			+			20
		Μ		50/2										
- 10 -		Δ		30/3										-
														-
- 15 -				25/0										
														-
- 20 -														-
3														
z-12-6 C10.0														
- 25 -														-
	COMF DATE	PLE : 2	TION DEPTH: 15.0 ft -28-23	DEPTH IN BORI	TO WA NG: D	ATER Dry					DA	TE: 2	/28/20	)23

	19-	118													
		rub arto	bbs, Hoskyn, on & Wyatt, Inc. LO ing Engineers	GOFBO 090069 XNA Benton Co	<b>R I</b> A Ac o., A	N G cess rkans	<b>N</b> Roa sas	<b>O.</b>   d	R27						
	ΤY	PE:	Auger		LO	CATIC	DN:	Арр	rox St	a 250+(	00, CL				
					FT	Υ			COF	IESION		/SQ F	Т		
I II					PER	RY V U FT	(	).2	0.4	0.6	0.8	1.0 1	1.2 1	.4	200 %
DEPT	MAS				LOWS	LB/C	PL L		C		ATER NTENT		LIQU LIM	JID IIT	- No.
	- <b>n</b>	r /	SURF. EL: 1233±		В	_		10	20	30	40	50 (	60 7	70	
			w/occasional chert fragr	nents	9				•						
			Very stiff reddish brown w/numerous chert fragm discontinuous chert sea layers	silty clay lents and y ms and	50/5"	-		•							-
- 5				:	50/4"	-			-	<u>+</u>	- +				15
				ł	50/3"	-	•								-
- 1(	) -				25/0"	-	•								-
			- with more silt at 12 to <sup>2</sup>	17 ft		-									-
- 15	5-0			ł	50/5"	-					•				-
						-									-
- 20	) - ()				34	-			•	-	┝╶╼				18
S.GPJ 9-27-23			7												-
LOAD HOLE	5				50/6"										-
JEW 19-118	CO	MPL	LETION DEPTH: 25.0 ft	DEF	тн т	O WA	TER								
LGBN	DA	TE:	2-28-23	IN B	ORIN	NG: D	ry					DA	ATE: 2	2/28/20	)23
													P	LATE	21

	19-11	8												
	Gru Bar <sub>Consu</sub>	bb toi Iting	s, Hoskyn, & Wyatt, Inc. Engineers Benton	<b>D R I</b> NA Ac Co., A	<b>NG</b> cess Arkan	<b>N C</b> Road sas	). R	29						
	TYPE	Ξ:	Auger	LC	CATIO	ON: A	Appro	x Sta	260+0	0, CL				
L		0		FT	۲×.		(		SION	, TON	'SQ F1	Г		%
LΗ, F	ABOL	IPLE(	DESCRIPTION OF MATERIAL	) PER	SU FT	0.2	2 0	.4 0	0.6 0	0.8 1	.0 1	.2 1.	.4	200 9
DEP.	SYN	SAN		MO	JNIT I LB/(	PLA LII	STIC		WA CON	TER TENT			ID T	No.
			SURF. EL: 1218±	Ē		10	) 2	:0 :	30 4	40 5	06	0 7	0	
		X	slightly clayey	15										
		X	Dense reddish tan fine sandy silt w/numerous chert fragments and discontinuous chert seams and layers	50/8"		•								
- 5 -		X		50/6"		•								
		X	Stiff to very stiff reddish brown silty clay w/numerous chert fragments and discontinuous chert seams and layers	50/5"				•						
- 10 -		X		50/4"					•					
			- with more silt below 12 ft - stiff at 12 to 18 ft											
- 15 -		X		18					+		÷			47
- 20 -		X	- very stiff below 18 ft	30					•					
- 25 -														
	COMF	PLE : 3	TION DEPTH: 20.0 ft DE -1-23 IN	EPTH <sup>-</sup> BORII	TO WANG: D	ATER Pry					DA	TE: 3	/1/202	23

<b></b>	19-11	3												
	Gru Bar Consu	bb tor	s, Hoskyn, <b>&amp; Wyatt, Inc.</b> Engineers Engineers LOGOFE 090069 Bento	<b>B O R I</b> XNA Ac on Co., /	<b>NG</b> ccess Arkan	<b>N C</b> Road sas	<b>).</b> R	30						
	TYPE	:	Auger	LC	CATI	ON: /	Appro	ox Sta	265+0	00, CL				
				FT	F			COHE	ESION	, TON/	SQ F1	Γ		
Ť I	30L	LES		PER	ZY √	0.	2 (	).4	0.6 0	).8 1.	.0 1.	.2 1.	4	% 00
DEPTH	SYME	SAMP		TOWS F	UNIT DF LB/CL	PLA LI	ASTIC MIT		WA CON				ID T	- No. 2
	82923	$\left  \right $	Medium dense brown fine sandv			1	0 2	20	30 4	40 5	06	0 7	0	
		X	silt w/chert fragments and rootlets	s 27				•	-NON	I-PLAS	TIC-			40
		X	Stiff reddish brown silty clay w/numerous chert fragments	13			+	•	+	÷				36
- 5 -		X	- very stiff below 4 ft - with fine sand at 4 to 6 ft	42				•						
		X	- with discontinuous chert seams and layers below 6 ft	50/7			•							
- 10 -		X		50/5	•		•							
- 15 -		X_		50/6			•							
	-													
	-													
- 20 -	-													
	-													
	-													
- 25 -														
	COMF DATE	PLE : 3	TION DEPTH: 15.0 ft -1-23	DEPTH IN BORI	TO WA	ATER Pry					DA	TE: 3,	/1/202	23

	19-11	8												
	Gru Bar <sub>Consu</sub>	bb toi	s, Hoskyn, & Wyatt, Inc. Engineers Bentor	<b>ORI</b> KNA Ad n Co., <i>F</i>	<b>NG</b> cess Arkan	<b>N (</b> Road sas	<b>). I</b>	R31						
	TYPE	Ξ:	Auger	LC	CATI	ON:	Аррі	ox St	a 270+(	00, CL				
				E	T.			COF	ESION	, TON/	SQ FT	-		6
Ц Ц Ц	1BOL	PLES	DESCRIPTION OF MATERIAL	PER	NY V U FT	0	.2	0.4	0.6 (	0.8 1.	0 1.	2 1.	4	200 %
DEP1	SYN	SAM		SWO	NIT D	PL/ L	ASTIO	С	WA CON			LIQU LIM	ID T	No.
			SURF. EL: 1184±	BL		1	• <b>†</b> 0	20	30	40 5	0 6	0 7	0	
		X	silt, sandy w/occasional chert fragments	4				•	++					61
		X	Stiff reddish brown silty clay	12				•			•			84
			- stiff to verv stiff with numerous											
- 5 -		X	chert fragments and discontinuous chert seams and layers below 4 ft	50/7'			•							-
				50/11				•						
10-		X		25						•				
- 15 -				50/4'					•					
20-														
2														
7-17-6 C														
- 25 -														
	DATE	: 3	-1-23	IN BORI	NG: D	)ry					DA	TE: 3	/1/202	23

	TYPE	<u>:</u> /	Auger	LC		ON:	Approx	Sta 275+	00, CL			
, FT	οΓ	ES		ER FT	Y WT FT	0	C .2 0.4		N, TON/S 	SQ FT	1.4	% 00
DEPTH	SYMB	SAMPI	DESCRIPTION OF MATERIAL	OWS F	LB/CU	PL/ L		W. CO				- No. 20
			SURF. EL: 1210± /ery soft reddish tan silty clay			1	0 20	30	40 50	60	70	
		Ň	w/occasional chert fragments	3			<b>+</b>	• - +				73
			Stiff reddish tan and gray silty clay w/chert fragments	12			-	#				6
5 -			Stiff to very stiff reddish brown silty clay w/numerous chert fragments and discontinuous chert seams and layers	50/10				•				-
		X		50/5"			•					
10 -		7		25/0"		•						_
	-											
	-											_
	-											

	TYPE	:	Auger	LC		ON: /	Appro	x Sta 2	280+0	0, CL				<del></del>
E	Ы	S		ER FT	Υ WT FT	0.	( .2 0.	COHE .4 0	SION,	, TON/S	SQ FT 	2 1.	4	% 0
DEPTH,	SYMB0	SAMPL	DESCRIPTION OF MATERIAL	ILOWS PI	UNIT DR' LB/CU	PLA LI	ASTIC		WA CON	TER TENT			ID T	- No. 20
	SUBALAN PADA PADA		Very loose to loose brown fine sandy silt, slightly clayey w/occasional chert fragments	4		1	0 2	•	04	0 50	) 60	) 7(	0	68
			Medium dense reddish tan w/tan fine sandy silt w/numerous chert fragments	25			•	•						
5		X	- with discontinuous chert seams and layers below 4 ft	50/10				•						
				50/8"				•						
		X	Stiff to very stiff reddish brown silty clay w/numerous chert fragments and occasional discontinuous chert seams	50/4"			•	•						
10 -														

	19-11	8											
	Gru Bar <sub>Consu</sub>		es, Hoskyn, n & Wyatt, Inc. g Engineers G Engineers Benton C	<b>) R I</b> A Ac Co., <i>A</i>	<b>NG</b> cess Arkan	<b>NO</b> Road sas	. R3	34					
	TYPE	Ξ:	Auger	LC	CATIO	ON: A	pprox	Sta 28	35+00	, CL			
ЭЕРТН, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	DWS PER FT	IT DRY WT LB/CU FT	0.2 PLAS		0HES		ER =NT	2 FT - 1.2 LIC		No. 200 %
			SURF. EL: 1183±	BLO	5			 30			 60	<b>+</b> 70	
		X	Medium dense light brown fine sandy silt w/numerous chert fragments	13			•						22
		X	- loose, slightly clayey below 2 ft	9			•						
- 5 -		X	Stiff tan silty clay w/numerous chert fragments	16			•						
		X	<ul> <li>very stiff at 6 to 8 ft</li> <li>with highly weathered chert seams and layers below 6 ft</li> </ul>	46				•					_
		X	- stiff at 8 to 18 ft - with less silt at 8 to 12 ft	17				•					
- 10 -				16									_
- 15 -			- very stiff below 18 ft										_
- 20 -				40					•				_
	-												-
- 25 -													-
	СОМ		TION DEPTH: 20.0 ft DE	PTH T		ATER							
	DATE	: 3	-4-23 IN	BORI	NG: 1	0.2 ft					DATE:	3/4/20	23

	19-11	8												
	Gru Bar <sub>Consu</sub>	bb tor	s, Hoskyn, & Wyatt, Inc. Engineers Bento	<b>B O R I</b> XNA Ac on Co., <i>A</i>	<b>NG</b> cess Arkan	N ( Road sas	<b>). R</b>	35						
	TYPE	Ξ:	Auger	LC	CATIO	ON:	Appro	ox Sta	290+0	0, CL				
F		S		R FT	νT				SION	, <b>TON</b> /	/SQ F	Г		%
TH, F	MBOL	<b>APLE</b>	DESCRIPTION OF MATERIAL	S PEF	DRY CU F	0	.2 0	).4 (	).6 C	).8 1	.0 1	.2 1.	4	200
DEF	S	SAN		ROW	UNIT LB/	PL/ L	ASTIC IMIT		WA CON	TER TENT		LIQU LIMI 	ID T	No No
			Medium dense tan fine sandy silt	ш		1	0 2	20	30 4	40 5	50 6	0 7	0	
	ŻŻ	M	w/chert fragments (fill)	21							TIC-			12
		Δ		21										43
	<u>44</u>		Very stiff reddish brown silty clay											
		M	w/numerous chert fragments	10					•					
		Д		40										
			- with larger chert fragments and											
		M	some chĕrt seams bĕlow 4 ft	05/01						+				41
- 5 -		Ň		25/0"										
		M												
		Ň		30					•					
		M		05/01										
- 10 -		Д												
	-													
	-													
07-17-0	-													
	-													
	-													
15	COMF		TION DEPTH: 10.0 ft	DEPTH <sup>-</sup>	 TO W <i>I</i>	L ATER								
	DATE	: 3	-4-22	IN BORI	NG: D	ry					DA	TE: 3	/4/202	22

	TYPE	E: /	Auger	LC	CATIO	ON: /	Approx S	Sta 295+0	00, CL			
I, FT	ы С	ES		ER FT	Y WT FT	0.	.2 0.4	0.6 C	, TON/SQ 	FI 1,2 1	.4	% 00
DEPTH	SYMB	SAMPI	DESCRIPTION OF MATERIAL	OWS F	NIT DR LB/CU	PLA LI	ASTIC IMIT	WA CON		LIQU	JID IT	- No. 20
			SURF. EL: 1221± Stiff brown and reddish tan silty	BL		1	•	30 4	40 50	60 <b></b>	• 70	
			with silt pockets below 2 ft	14			•					
		X		19			•	-NON	-PLASTIC	-		4
5 -		X		23			•					-
			Very stiff reddish brown silty clay w/numerous chert fragments and chert seams and layers	50/8"			•					_
10 -				50/4"			•					-
	-											-

	Gru Bar Consu	o Ibb toi	os, Hoskyn, n & Wyatt, Inc. g Engineers 090069 X Benton	<b>O R I</b> NA Ac Co., A	<b>NG</b> cess Arkan	<b>N</b> Roa sas	O. Ra	37						
	TYPE	E:	Auger	LC		SN:	Approx	< Sta 3	00+00	), CL				
<b>DEPTH</b> , FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL SURF. EL: 1226±	BLOWS PER FT	UNIT DRY WT LB/CU FT	PI	0.2 0. 	COHES 4 0.6		TON/S	SQ FT	2 1. LIQU LIMI — - <b>+</b>	4 ID T	- No. 200 %
			Stiff brown and dark brown silty clay w/silt pockets and chert fragments (fill)	23				•	•	<u>, , , , , , , , , , , , , , , , , , , </u>		<u>, , , , , , , , , , , , , , , , , , , </u>	<u>.</u>	30
			Stiff to very stiff reddish brown silty clay w/numerous chert fragments and discontinuous chert seams and layers	50/6'	,		• +							21
- 5				50/10			•							
				50/8'					•					
- 10				50/8'						•				
	_													
OLES.GPJ 9-2/-23	-													
H NEON 811-61 M				рерти .										
GBN	DATE	: 3	i-4-22	N BORI	NG: D	ry					DA	TE: 3	/4/202	22

	TYP	E:	Auger	LC	CATI	ON:	Approx	: Sta 305	5+00, CL				
<b>DEPTH</b> , FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	0 PL/	C 2 0.2 ASTIC IMIT +		N, TON	/SQ F1	2 1. LIQU LIMI	4 ID T	- No. 200 %
			Medium dense brown and dark brown silt w/chert fragments (fill)	19		1	•	) 30 -N(		50 6 TIC-	0 70	0	31
			Very stiff reddish brown silty clay w/numerous chert fragments	35			•						
5			- with more chert fragments and	47			•						
			chert seams below 6 ft	50				•					
10				50/11					•				
	-												

	Gru Barl <sup>Consul</sup>	bbs on ting f	s, Hoskyn, & Wyatt, Inc. Engineers Benton (	<b>) R I</b> IA Ac Co., A	<b>NG</b> cess arkan:	NC Road sas	<b>). R</b> (	39						
DEPTH, FT	TYPE SAMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	ON: 0 0. PL4 LI	Approx C 2 0 ASTIC MIT +	< Sta 3 COHE 4 0.	809+0 SION, 6 0 WA CON	0, 20 ff , TON/3 .8 1.1 TER TENT	t Lt SQ FT 0 1.	- 2 1 LIQU LIMI		- No. 200 %
		V	/ery stiff brown and tan silty clay v/chert fragments (fill)	26		1	•	) 3 +	0 4	0 50	06	07	0	42
			Stiff to very stiff reddish brown silty slay w/numerous chert fragments	25			•	<b>+</b>						41
- 5 -		X		22				•						
		X		35					•					
- 10		<u> </u>		44					•					-
S.GPJ 9-27-23	-													
NEW 19-118 ROAD HOLE:	COMF	PLET	TION DEPTH: 10.0 ft DE	PTH 1		ATER								

19-118												
Grubb Barto Consultin	os, Hoskyn, n & Wyatt, Inc. g Engineers Benton (	<b>) R I</b> IA Ac Co., A	<b>N G</b> cess arkan:	N C Road sas	). R	40						
TYPE:	Auger	LC	CATIO	DN: A	Approx	x Sta ź	253+0	0, CL ·	- Airpc	ort Blvc	I	
DEPTH, FT SYMBOL SAMPLES	DESCRIPTION OF MATERIAL	-OWS PER FT	JNIT DRY WT LB/CU FT	0.2 PLA LII	2 0. STIC	20HE 4 0	SION 6 0 WA CON	, TON/	/SQ F 1	.2 1. LIQU	4 ID T	- No. 200 %
	URF. EL: 1217± Loose to medium dense fine sandv	B		10	) 2	0 3	80 4	10 5	06	0 7	0	
	silt w/rootlets and chert fragments - dense below 2 ft - with chert layer at 2 to 3 ft	10 33			•	•						41
- 5 - 2 2 2	sandy silt w/numerous chert fragments and chert seams	50/4"					•					
	Very stiff reddish brown silty clay w/numerous chert fragments and discontinuous chert seams and layers	50/4"			•							
- 10 -		25/0"				•						
15	- dense at 12 to 17 ft - with highly weathered chert layer at 12 to 17 ft	39					-NON	-PLAS	TIC-			24
-20		50/6"										_
25 -												
COMPLE DATE: 3	ETION DEPTH: 20.0 ft DE 3-3-23 IN	PTH T BORII	OWA NG: D	ATER ry			1	1	DA	TE: 3	/3/202	23

	19-118										
	Grubi Barto Consultin	n & Wyatt, Inc. g Engineers Benton	<b>D R I</b> NA Ac Co., <i>F</i>	<b>NG</b> cess Arkan	<b>NO.</b>   Road Isas	R41					
	TYPE:	Auger to 10 ft /Wash	LC	CATI	ON: Appi	rox Sta	a 258+0	)0, CL - A	virport Blv	/d	
			FT	Т		СОН	IESION	, TON/SO	Q FT		. 0
L T	BOL		PER	N F K	0.2	0.4	0.6 (	0.8 1.0	1.2	1.4	00%
DEPT	SYMI	DESCRIPTION OF MATERIAL	OWS	UNIT DI LB/CI		с				UID /IIT	- No. 2
		SURF. EL: 1229±		Ľ	10	20	30 4	40 50	60	70	
		Soft reddish brown and tan silty clay w/numerous chert fragments	6								_
		Very stiff reddish brown silty clay w/discontinuous chert seams and	42			•					
- 5 -		seams	50/4"	,	•	_					
			50/6"		•						
10-			50/5"		•	+	+				17
											_
	- 21 2	Dense to very dense reddish tan fine sandy silt w/numerous chert fragments and chert seams and									
15		layers	50/10								_
	1212										
20		Moderately hard tan and reddish tan weathered cherty limestone w/red silty clay seams, clay-filled	25/0"								-
		fractures, occasional vugs and discontinuous chert seams and									
		layers	25/0"	,							
25											-
30			25/0"								_
			25/0"	,							
35											
40			25/0"	'			_				-
CONEM	COMPLE DATE: 3	ETION DEPTH: 40.0 ft D 3-3-23 IN	EPTH BORI	to W. NG: E	ATER Dry to 10 ft				DATE:	3/3/202	23
· • • • • • • • • • • • • • • • • • • •											

	19-11	8											
	Gru Bar <sub>Consu</sub>	bb tor	s, Hoskyn, & Wyatt, Inc. Engineers Bentor	<b>ORI</b> (NA Ad n Co., <i>F</i>	<b>NG</b> ccess Arkan	<b>N (</b> Roa sas	<b>D. F</b> d	R42					
	TYPE	Ξ:	Auger	LC	CATIO	DN:	Appro	ox Sta	263+0	0, CL	Airport	Blvd	
			0	ЕТ	F			СОН	ESION	, TON/S	Q FT		
, FT	30L	LES		PER	SY W	C	).2	0.4	0.6 0	).8 1.0	1.2	1.4	% 00
DEPTH	SYME	SAMP	DESCRIPTION OF MATERIAL	STOWS F	UNIT DF LB/CL	PL	ASTIC IMIT	;	WA CON	TER ITENT	L		- No. 2
		$\left  \right $	Loose light brown fine sandy silt				10	20	30 4	40 50	60	70	
		X	w/occasional chert fragments	5				•					
		X	Very stiff reddish brown w/tan silty clay w/numerous chert fragments	42			•						_
- 5 -		X	- with discontinuous chert seams and layers below 4 ft	50/6'		•	•						_
		M		50/4'					•				
- 10 -		X		50/5'					•				_
		Z		25/0'				-					55
- 15 -													
													-
		M		50/6'	,								
	<i>n</i>												
62-12-6													
25													
	COMP DATE	 PLE : 3	TION DEPTH: 20.0 ft [	DEPTH <sup>-</sup> N BORI	TO WA NG: D	ATER vry	<u> </u>				DATE	E: 3/2/20	23
· <b>L</b>													- 05

	Gru Bar Consu	8 Ibb tor	os, Hoskyn, n & Wyatt, Inc. g Engineers 090069 XN Benton C	<b>) R I</b> A Ac Co., A	<b>NG</b> cess Arkan	<b>N C</b> Road sas	<b>). R4</b>	3				
	TYPI	<u>=:</u>	Auger	LC	CATIO	DN: /	Approx	Sta 267+0	00, CL -	Airport Bl	/d	
		S		R FT	×⊥ T		C			SQ FT	1.4	%
DEPTH,	SYMBC	SAMPLE	DESCRIPTION OF MATERIAL	-OWS PE	JNIT DRY LB/CU F	PL/ LI	ASTIC	0.0 W/ CON				- No. 200
			SURF. EL: 1177±	B		1	0 20	30	40 50	60	70	
	- 14 A - 24 A - 4 A	X	chert fragments	7			•					44
		X	Stiff reddish brown silty clay w/numerous chert fragments	15			•					38
5				12			•	•				
			- firm at 6 to 8 ft - with less chert at 6 to 12 ft	8				•				
		M	- stiff at 8 to 12 ft	10								
- 10 -			- stiff to very stiff with weathered chert seams and layers below 12 ft	13								
- 15 -		1		31				•				
	-											
	-											
- 20 -	-											
8.GPJ 9-27-												
118 KOAD HOLES												
LGBNEW 19-	COMI DATE	 PLE :: 3	-2-23 IN	PTH <sup>-</sup> BORII	TO WANG: D	ATER iry				DATE:	3/2/202	23

	Grubi Barto Consultin	os, Hoskyn, n & Wyatt, Inc. LOGOFE g Engineers 090069 Bento	<b>B O R I</b> XNA Ac on Co., A	<b>N G</b> cess arkan:	<b>NO</b> Road sas	. R44						
	TYPE:	Auger		CATIO	DN: A	pprox St	a 272+(	00, CL -	Airpoi	rt Blvd		
DEPTH, FT	SYMBOL	DESCRIPTION OF MATERIAL	BLOWS PER F	UNIT DRY WT LB/CU FT	0.2 PLAS LIN		0.6 W/ CON		0 1.2	2 1.4 LIQUII LIMIT	D	- No. 200 %
		Loose brown w/tan silt, slightly clayey w/chert fragments	7			•	30	40 50				
		Stiff reddish brown clay w/occasional chert fragments	11				+ +		-+			82
- 5 -		- very stiff with numerous chert fragments below 4 ft	41				•					
		- with discontinuous chert seams and layers below 6 ft	50/10			•						
- 10 -			50/7"			•						
15 (	COMPLI DATE: 3	ETION DEPTH: 10.0 ft 3-2-23	DEPTH T IN BORI	TO WA	TER ry				DA	TE: 3/2	2/2023	3

-		19-11	8												
		Gru Bar <sub>Consu</sub>	bb tor	<b>bs, Hoskyn,</b> <b>a &amp; Wyatt, Inc.</b> <sup>g Engineers</sup> <b>LOGOFB</b> 090069 X Benton	<b>O R I</b> NA Ac Co., A	<b>NG</b> cess Arkan	<b>N (</b> Road sas	<b>). R</b>	45						
		TYPE	=:	Auger	LC	CATI	ON:	Appro	x Sta	277+0	0, CL ·	- Airpo	ort Blvo	b	
ŀ				5					СОНЕ	SION	. TON/	SQ F1	-		
	F	2	ပ္ပ		L L L L	∑⊢		2 0		(	$\rightarrow$		<b>2</b> 1	4	%
	ΤΉ,	ABC	Ы	DESCRIPTION OF MATERIAL	L L L	NA NA		.2 0	1	.0 0	1.0 1.	.0 1.	2 1.	4	200
	ЕЬ	SYN	SAN		MO	LB/(	PL/	ASTIC		WA CON	TER TFNT		LIQU	ID T	°. N
				SURF. EL: 1219±	BL(	5		+	— — — 20	( 30 4	•	 0 6	· — - <b>+</b>	0	'
F				Firm tan clayey silt w/chert								0 0		0	
ŀ			$\overline{\mathbf{M}}$	fragments (fill)				•	╞╶╼╋╸						46
┢			1)		9			• .							
┢			Н												
┢				Stiff red ailty along w/abort											
				fragments											
			M		11				<b>-</b>		↓ <b>₽</b>				57
			$\square$												
			1												
	_		$\mathbb{N}$	- firm with some silt pockets below					•						
F	5		Ŵ	4 11	8										
F			H												
F															
ŀ				Very stiff reddish brown silty clay											
ŀ			X	w/numerous chert fragments and occasional chert seams	50			•							
┢			Ĥ												
┢															
╞															
			M		50/3"			•							
	10 -		4												
	10														
		1													
53															
9-27-		1													
S.GPJ		1													
HOLE		-													
OAD		-													
118 R		-													
W 19-	15	COM	기 ᄃ												
GBNE		DATE	: 3	-3-22 IN	BORI	NG: D	)ry					DA	TE: 3	/3/202	22

19-118											
Grube Barto Consultin	os, Hoskyn, n & Wyatt, Inc. <sub>g Engineers</sub> LOGOFBO 090069 XN Benton C	<b>) R I</b> A Ac Co., <i>F</i>	<b>NG</b> ccess Arkan	<b>N C</b> Road sas	<b>). R</b>	48					
TYPE:	Auger	LC	CATIO	ON:	Appro	x Sta	459+00,	CL - Ram	ıp 1		
DEPTH, FT SYMBOL SAMPLES	DESCRIPTION OF MATERIAL SURF. EL: 1267±	BLOWS PER FT	UNIT DRY WT LB/CU FT	0 PLA Ll	( 2 0. ASTIC IMIT + 0 2	20HE 4 0	SION, TO .6 0.8 WATE CONTE	ON/SQ F 1.0 1 R NT 50 0	T LIQUI LIQUI – – – <del>– –</del>	4 D T	- No. 200 %
	Medium dense brown and gray fine sandy silt w/chert fragments (fill)	11				•	-NON-PI	LASTIC-			44
	Very stiff reddish brown silty clay w/numerous chert nodules and fragments	32				•	· +				47
5 - 2 - 2 - 2 - 2 - 2 - 2 - 2 - 2 - 2 -		47					•				
		40					•	•			
10		50				•					
15 COMPLI	ETION DEPTH: 10.0 ft DE 3-3-22 IN I	PTH <sup>-</sup> BORI	TO WA	ATER iry				DA	TE: 3/	3/202:	2

	19-118	3											
	Gru Bar <sub>Consu</sub>	bb tor	s, Hoskyn, & Wyatt, Inc. LOGOF <sub>Engineers</sub> 090069 Bent	<b>BORI</b> XNA Ac on Co., <i>A</i>	<b>NG</b> cess Arkan	NC Road sas	<b>). R</b>	49					
	TYPE	:	Auger	LC	CATIO	ON: /	Appro	x Sta 465+0	00, CL -	Ramp	o 1		
ДЕРТН, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	LOWS PER FT	JNIT DRY WT LB/CU FT	0. PLA LI	2 0 ASTIC MIT	COHESION		SQ FT	2 1. LIQU LIMI	4 ID T	- No. 200 %
	YLKY		SURF. EL: 1265±	B		1	0 2	20 30	40 50	60	) 70 0 70	0	
		X	fragments	9				●+ +					52
		X	Very stiff reddish brown clay w/chert fragments and discontinuous chert seams and layers	50/5"				•					
- 5 -		X		28				•					
				50/5"				•					
- 10 -				38									
15	COMF DATE	PLE : 1	TION DEPTH: 10.0 ft .11-23	DEPTH <sup>-</sup> IN BORII	TO WA	ATER Dry		<u> </u>		DA	TE: 1,	/12/20	23

	<u>19-11</u>	bb	s, Hoskyn, LOGOEB(	ואר	NG	NO	<b>R50</b>					
	Consu	t <b>Ol</b>	Benton (	NA Ac Co., A	cess	Road sas						
	ТҮРР		Auger	IC	CATIO	ON: Ar	oprox St	a 469+00. C	I-Ram	o 1		
							COF	ESION. TO	N/SQ F	<u>р.</u> Г		
뵤	Ы	ŝ		ERF	ΥΥ	0.2	- 0.4	0.6 0.8	1.0 1	.2 1.4	4	% 0
DEPTH	SYMB	SAMPL	DESCRIPTION OF MATERIAL	OWS P	NIT DR' LB/CU	PLAS		WATER CONTEN	т	LIQUI	ID T	No. 20
			SURF. EL: 1271±	BL	5	10	20	 30 40	50 6	<b>+</b> 0 70	D	•
			Stiff brown silty clay w/chert fragments									64
		Ň		12								04
		X	Very stiff reddish brown clay w/chert fragments and discontinuous chert seams and layers	50/11			•					
- 5 -		X		50/7"			•					
		X	- stiff at 6 to 8 ft	23				•				
			- very stiff below 8 ft									
- 10 -		Å	- auger refusal in limestone at 10.5 ft	50/10				•				
		<u>Х</u>		50/6"						+		
	-											
		PLE : 1	TION DEPTH: 10.5 ft DE -13-23 IN	BORII	ro W <i>i</i> NG: D	ATER Pry			DA	TE: 1/	/12/20	23

	19-11 Gru Bar Consu	8 bb tor	s, Hoskyn, <b>&amp; Wyatt, Inc.</b> LOGOF <sub>Engineers</sub> 090069 Bent	<b>BORI</b> XNA Action Co., A	<b>NG</b> cess Arkan	N C Road sas	). R51					
	TYPI	≣: . 	Auger	LC		DN: A	Approx S CO	ta 475+0 HESION	00, CL -	Ramp 1		
DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	LOWS PER F	JNIT DRY WT LB/CU FT	0. PLA LI	2 0.4 STIC MIT	0.6 ( WA CON		1.2 1.2 LIC	1.4 ↓ ↓ UID MIT	- No. 200 %
			Firm brown silty clay w/chert fragments and some rootlets (possible fill)	8		10	20	30 ·	40 50	60	70	50
		X	Very stiff reddish brown and reddish tan silty clay w/chert fragments and chert seams and layers	31			•+	+				54
- 5		M		50/11			•					-
				50/2"					•			-
- 10 -				40					•			-
	_											
ROAD HOLES.GPJ 9-27-	-											
-GBNEW 19-118	COMI	PLE : 3	TION DEPTH: 10.0 ft -4-22	DEPTH IN BORI	FO WANG: D	ATER				DATE:	3/4/202	22

	19-118	3											
	Gru Bar Consu	bbs on Iting E	, Hoskyn, & Wyatt, Inc. Ingineers Benton (	<b>D R I</b> NA Ac Co., <i>A</i>	<b>NG</b> cess arkan	<b>N O</b> Road sas	. R	53					
	TYPE	: A	uger	LC	CATIO	ON: A	pprox	Sta 425	+75, CL ·	- Ram	o 2		
ДЕРТН, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	SLOWS PER FT	UNIT DRY WT LB/CU FT	0.2 PLA: LIN	C 2 0.4 STIC MIT H		N, TON/	/SQ F1 .0 1.	- 2 1. LIQU LIMI	4 ID T	- No. 200 %
		sg fr	tiff reddish brown, brown and ray silty clay w/numerous chert agments	21 23			• •	30			0 70	0	63
- 5		Sw d	tiff red and reddish tan silty clay /occasional chert fragments and iscontinuous chert seams	18 50/11				•	•				
- 10		-	chert seam at 7.5 ft	18					•				
19-118_ROAD HOLES.GPJ 9-27-23													
	COMF DATE	PLET : 11-	ION DEPTH: 10.0 ft DE 4-22 IN	EPTH BORII	ro WA NG: D	ATER Pry			·	DA	TE: 1	1/4/20	22

<b></b>	19-11	8												
	Gru Bar <sub>Consu</sub>	bb tor	s, Hoskyn, & Wyatt, Inc. Engineers Engineers Bentor	<b>SORI</b> XNA Ac n Co., A	<b>N G</b> cess arkan	<b>N (</b> Road sas	<b>D. F</b>	R54						
	TYPE	E: .	Auger	LC	CATIO	ON:	Appro	ox Sta	435+0	0, CL ·	- Ram	p 2		
⊢		0		R FT	νT			COHE	SION	, TON/	'SQ F	Г		%
TH, F	ABOL	IPLE!	DESCRIPTION OF MATERIAL	DEF	CU FI	0	.2	0.4 (	0.6 0	.8 1	.0 1	.2 1.	4	200
DEP.	SYN	SAN		LOWS	LB/G	PL/ L	ASTIC	; 	WA CON	TER TENT		LIQU LIMI	ID T	- No.
	82923		SURF. EL: 1268± Medium dense brown fine sandy	B		1	10	20	30 4	40 5	io e	50 7(	0	
		X	silt w/chert fragments	12				•	-NON	-PLAS	TIC-			59
		X	Stiff reddish brown clay w/chert fragments	19				•						
- 5 -		X		21				+	•		- <b>+</b>			41
		X	- with discontinuous chert seams and layers below 6 ft	50/10				•						
		M		50/8"										
- 10 -														
- 15 -				50/5"				•						
	-													
	-													
- 20 -	-													
	-													
GPJ 9-27-22	-													
25 -														
х 81	-													
		└-└ PLE : 1.	TION DEPTH: 15.0 ft 13-23			ATER Drv	1		1	1	ΠA	TE: 1/	/12/20	23
2	<i>,</i> , , L											1/ PI		44

	Gru Bar <sub>Consu</sub>	ibb tor	<b>s, Hoskyn,</b> <b>&amp; Wyatt, Inc.</b> <sup>J Engineers</sup> LOGOFE 090069 Bento	<b>B O R I</b> XNA Ac n Co., A	<b>N G</b> cess trkan	<b>N O</b> Road sas	). R55					
	TYPI	<u>=:</u>	Auger	LC E		ON: A	Approx St	a 440+0 IESION	0, CL -	Ramp 2		.0
DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL SURF. EL: 1261±	BLOWS PER	UNIT DRY W LB/CU FT	0.2 PLA LII -	2 0.4 STIC MIT +	0.6 0 WA CON	TER TENT	1.2 LIQ LIQ	1.4 UID //IT F	- No. 200 %
			Firm brown clayey silt w/chert fragments and organics	9			•					
			Very stiff reddish brown silty clay w/numerous chert fragments	48			•+					39
- 5 -			- with discontinuous chert seams and layers below 4 ft	50/10	,			•				
		Ň		50/10				•				
- 10 -				50/6"				•				
	-											
	-											
15	COMI	 PLE :: 3	TION DEPTH: 10.0 ft -3-22	DEPTH T	-0 WA NG: D	ATER				DATE:	3/3/2022	 2

1	19-118											
	Grubbs, Hoskyn, Barton & Wyatt, Inc. Consulting Engineers LOGOFE 090069 Bento	<b>B O R I</b> XNA Ac on Co., A	<b>NG</b> cess Arkan	<b>N C</b> Road sas	<b>). R</b>	56						
-	TYPE: Auger	LC	CATIO	ON: /	Approx	: Sta 4	145+0	0, CL	- Ram	p 2		
TH, FT		) PER FT	DRY WT SU FT	0.	C 2 0.4		SION, 6 0	, <b>TON</b> /	/SQ F1	Г .2 1.	4	200 %
DEP.		SMOT	UNIT [ LB/0	PLA LI	ASTIC MIT <b>+</b>		WA CON	TER TENT		Liqu Limi	ID T	- No.
	Medium dense brown silt, slightly clayey w/chert fragments and occasional organics	13		1	0 20	) <u>3</u>	0 4	0 5	50 6	0 7	0	52
	Very stiff reddish brown silty clay w/numerous chert fragments	37					•					
- 5 -	- with discontinuous chert seams and layers below 4 ft	50/8"				•	<b></b>		- +			32
		50/8"				•						
10		50/2"				•						
15 C	COMPLETION DEPTH: 10.0 ft DATE: 3-3-22	DEPTH <sup>-</sup> IN BORII	FO WANG: D	ATER Pry					DA	TE: 3	/3/202	22

	TYPE	: /	Auger	LC		ON: /	Approx \$	Sta 440+0	0, CL - R	amp 3		T
ЕРТН, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	DWS PER FT	IT DRY WT LB/CU FT	0. PLA	CC 2 0.4 ASTIC	0HESION	, TON/SC	2 FT 	1.4 UID	Nn 200 %
			SURF. EL: 1299±	BLG	5	1	╋ 0 20		0 50		<b>F</b> 70	'
			Stiff reddish brown and tan silty clay w/silt pockets and chert fragments (possible fill)	23			•	-NON	-PLASTI	C-		42
		,	Stiff reddish brown silty clay w/numerous chert fragments	21			+•	-+				3
5			- with more chert fragments and discontinuous chert seams and layers below 4 ft	50/10				•				-
		X		50/8'				•				_
10				39				•				-
	-											
	-											-

<b></b>	19-11	8												
	Gru Bar <sub>Consu</sub>		es, Hoskyn, n & Wyatt, Inc. g Engineers 090069 Bento	<b>B O R I</b> XNA Ac on Co., <i>A</i>	<b>NG</b> cess Arkan	<b>N C</b> Road sas	<b>).</b> F	R61						
	TYPE	Ξ:	Auger	LC	CATIO	ON:	Appro	ox Sta	445+0	0, CL	- Ram	р3		
			5		F	-		СОНЕ	SION	, TON/	/SQ F	Γ		
, FT	gL	LES		PER I	₹ N FT	0	.2 (	0.4 (	0.6 0	).8 1	.0 1	.2 1.	4	% OC
DEPTH	SYMB	SAMPI	DESCRIPTION OF MATERIAL	LOWS F	JNIT DR LB/CU	PL/ L	ASTIC IMIT	;	WA CON				ID T	- No. 2(
			SURF. EL: 1290±	B		1	0	20	30 4	40 5	50 <u>6</u>	60 70	0	
		X	fragments	8			1	•						
		X	Very stiff brown and gray silty clay w/chert fragments	y 30				•+		•				40
- 5 -			Stiff to very stiff reddish brown sill clay w/numerous chert fragments	ty 50/10			•							
		X	<ul> <li>with discontinuous chert seams and layers below 6 ft</li> </ul>	50/8"				•						
- 10 -		X		50/6"					-NON	PLAS				20
		X		40										
- 15 -														
- 20 -														
- 25 -														
	DATE	-LE : 3	-4-22	IN BORI	NG: D	vi ER vry					DA	TE: 3/	/4/202	2

	Gru Bar Consu	Ibb tor	ps, Hoskyn, n & Wyatt, Inc. <sup>J Engineers</sup> LOGOFBC 090069 XN Benton (	<b>) R I</b> IA Ac Co., A	<b>NG</b> cess Arkan	<b>N (</b> Road sas	<b>).</b> F	863						
	TYPI	E:	Auger	LC S E1		ON:	Appro	ox Sta	432+0 ESION	0, CL - , TON/	- Ram	o 4		%
DEPTH, F	SYMBOI	SAMPLE		BLOWS PER	UNIT DRY LB/CU F	0 PL/ L	ASTIC	).4	WA	0.8 1. TER TENT	.0 1	2 1 LIQU LIMI	.4 JID IT	- No. 200
		X	Medium dense tan w/reddish tan fine sandy silt w/numerous chert fragments	11		1	0	20	30 4	10 5	06	07	0	40
			Very stiff reddish brown silty clay w/numerous chert fragments	30				•+		<b></b>				44
- 5 -			- with discontinuous chert seams and layers below 4 ft	50/10					•					-
			- with more chert seams and layers	50/8"					•					-
- 10 -				50/9"		•	•							-
	-													
AD HOLES.GPJ 9-27-23	-													
118 KOV		    PLE	TION DEPTH: 10.0 ft DE			ATER						TE: 1	1///20	122
	19-11	8												
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	Gru Bar <sub>Consu</sub>	bb tor	s, Hoskyn, & Wyatt, Inc. Engineers Benton	<b>D R I</b> NA Ac Co., <i>A</i>	<b>NG</b> cess Arkan	<b>NO</b> Road sas	. R6	64						
	TYPE	:	Auger	LC	CATI	ON: A	pprox	Sta 437+	00, CL -	Ramp	o 4			
				FT	νT		С	OHESIO	N, TON/S	SQ FT			<u>`0</u>	
Ξ	BOL	LES		PER	RY V U FT	0.2	2 0.4	0.6	0.8 1.0	) 1.2	2 1.	4	000	
)EPT	SYM	SAMF	DESCRIPTION OF MATERIAL	SWC	LB/C	PLAS	STIC	W	ATER		LIQU	ID T	No.	
			SURF. EL: 1290±	BLG	5	10	► — — 20	30	40 50	— — — ) 60		D		
			Stiff tan silty clay w/chert nodules and fragments											
		M		11			●	<b>+</b>					67	
		Δ												
			yony stiff with discontinuous											
-			weathered chert seams below 2 ft											
		X		36										
		Ĥ												
			Stiff to very stiff reddish brown clay											
		M	w/numerous chert hodules and fragments					•						
- 5		Ŵ		37										
			Stiff to very stiff reddish tan silty clay w/chert nodules and											
		M	fraģments and discontinuous chert seams	50/9"				•						
		Δ							_					
		X		37				•						
- 10 ·				+										
	_													
	]													
7-23														
5-6 Fdg	_													
DLES.G	-													
DAD HC														
118_R(														
<sup>¢</sup> 15	COMF	_ 2LE	TION DEPTH: 10.0 ft DE	 EPTH <sup>-</sup>	 TO W <i>i</i>	 Ater								
LGBN	DATE	: 1	1-4-22 IN	BORI	NG: D	)ry				DA	TE: 1	1/4/20	22	

	19-118	3												
	Gru Bart <sub>Consu</sub>		s, Hoskyn, & Wyatt, Inc. Engineers Benton (	<b>D R I</b> NA Ac Co., A	<b>NG</b> cess arkan	<b>N (</b> Road sas	<b>). R</b>	65						
	TYPE	:	Auger	LC	CATIO	DN:	Appro	x Sta	14+40	, CL -	Malon	e Ln		
⊢ ⊢		S		R FT	NT		(		SION	, TON/	/SQ F1	Г		%
TH, F	MBOL	APLE	DESCRIPTION OF MATERIAL	S PEF	DRY -	0	.2 0	.4 (	0.6 0	).8 1	.0 1.	.2 1.	.4	200
DEP	SΥΙ	SAN		LOW	JNIT LB/	PL/ Ll	ASTIC IMIT		WA CON	TER TENT		LIQU LIMI	ID T	No.
	74	$\uparrow$	SURF. EL: 1250±	8	_	1	0 2	20 ;	30 4	40 5	6 6	07	0	
		X	tan clay w/chert nodules and fragments and discontinuous chert seams and layers	50/8"			•							
		X		50/10					• -				_ <del>77</del> _ <b>∔</b> ▶	66
- 5 -				25/0"		•								
		X		50/5"			•							
- 10 -		X_		50/4"					•					
15	COMF DATE	PLE : 1	TION DEPTH: 10.0 ft DE -24-23 IN	 EPTH <sup>-</sup> BORII	     O W#   NG: D	ATER iry					DA	TE: 1	/24/20	23

	19-118	3									
	Grul Bart <sub>Consul</sub>	bbs, Hoskyn, on & Wyatt, Inc. ting Engineers Benton (	<b>) R I</b> IA Ac Co., <i>A</i>	<b>NG</b> cess Arkan	<b>NO</b> Road sas	. R66	6				
	TYPE	: Auger	LC	CATIO	ON: A	pprox S	Sta 18+40,	, CL - Mal	one Ln		
<b>DEPTH</b> , FT	SYMBOL	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	0.2 PLAS LIV <b>1</b> 0		0.6 0 0.6 0 WA CON 30 4	TON/SQ .8 1.0 TER TENT 0 50	FT 1.2 1 LIQL LIM + 60 7	.4 JID IT 70	- No. 200 %
		Stiff tan silty clay w/chert fragments (fill)	19			•+	+				87
		Very stiff reddish brown and tan clay w/chert nodules and fragments and discontinuous chert seams	50/9"				•				
- 5 -			47				-NON	● -PLASTIC	)-		30
			38				•				
- 10 -			50/8"			•					-
GPJ 9-27-23											
W 19-118_ROAD HOLES.											
LGBNE	DATE:	1-24-23 IN	BORI	NG: D	)ry			I	DATE: 1	/24/20	)23

	19-11 Gru Bar Consu	8 Ibb tor <sup>Ilting</sup>	s, Hoskyn, & Wyatt, Inc. Engineers Benton (	<b>D R I</b> NA Ac Co., A	<b>NG</b> cess Arkan	<b>N O.</b> Road sas	R67					
	TYPI	E: .	Auger	LC		ON: App	orox Sta COHE	28+40, SION,	CL - M	lalone Q FT	Ln	
ЕРТН, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	WS PER	IT DRY W -B/CU FT	0.2 PLAST	0.4 ( IC	0.6 0.	8 1.0 ER	 1.2		No. 200 %
		l <sup>o</sup>	SURF. EL: 1249±	BLC	L N	10				- — — - 60	<b>+</b>	
			Stiff reddish tan silty clay w/a little crushed stone (fill)	23		•-	<b>+</b>	· – +				74
			Stiff to very stiff reddish brown clay w/chert nodules and fragments and discontinuous chert seams and layers	50/6"		•	<b>+</b> -	- +				48
- 5		Ň		50/8"			•					
		X		50/4"			•					
- 10				50/6"			•					
23	-											
18_ROAD HOLES.GPJ 9-27-	-											
15-15-	COMI DATE	 PLE : 1	TION DEPTH: 10.0 ft DE -23-23 IN	PTH <sup>-</sup> BORII	FO WA	ATER Pry				DAT	E: 1/23	8/2023

	19-11	8									
	Gru Bar <sub>Consu</sub>	bbs, Hoskyn, ton & Wyatt, Inc. Iting Engineers Bento	BORI XNA Ac on Co., A	<b>NG</b> cess arkan	N C Road sas	<b>). R</b> 6	58				
	TYPE	E: Auger	LC	CATIO	ON: A	Approx	Sta 32+4	40, CL -	Malon	e Ln	
DEPTH, FT	SYMBOL	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	0.2 PLA LII -	C 2 0.4 STIC MIT ╋ — — 20 20			/SQ FT .0 1. 	- 2 1.4 LIQUI LIMIT + 0 70	- No. 200 %
		Medium dense brown fine sandy silt w/silty clay pockets and crushed stone (fill)	23			•	-NC	N-PLAS	TIC-		68
		Firm to stiff brown and tan silty cl w/some chert nodules and fragments	ay 10			e		+			56
- 5 -		Stiiff to very stiff reddish brown au tan clay w/chert nodules and fragments and discontinuous che seams and layers	nd ert 50/6"								
			50/5"								
- 10 -			25/0"								
2	•										
15	COMF DATE	 PLETION DEPTH: 8.5 ft :: 1-23-23	DEPTH <sup>-</sup> IN BORII	TO WA	ATER Pry				DA	TE: 1/2	23/2023

19-118														
Grub Barto Consulti	bs, Hoskyn, on & Wyatt, Inc. <sub>ng Engineers</sub> LOGOF 090069 XNA A Ben	<b>BC</b> Acces ton C	<b>) R I</b> s Roa co., A	<b>N G</b> ad ov rkans	<b>N C</b> er Wa as	<b>). S</b> ager	5 <b>1</b> Rd							
TYPE:	Auger to 6 ft /Core		LO	CATIO	N: Ap	prox	Sta 14	2+80,	60 ft L	.t				
EPTH, FT SYMBOL		WS PER FT	IT DRY WT -B/CU FT	0. PLA	2 0. STIC		SION,		(SQ F1	Γ .2 1 LIQL	.4 IID	No. 200 %	Recovery	% RQD
	SURF. EL: 1157±	BLG	5	1	╋ 	- — — 0	( 30 4	• 0 5	0 6	<b>+</b> 0 7	0	-	%	
	Loose to medium dense brown and tan silt w/numerous chert fragments	10			•							21		
	Very stiff reddish brown silty clay w/numerous chert fragments and discontinuous chert seams and layers	50/6" 50/3" 50/1"		•										
	Moderately hard to hard light gray w/tan weathered cherty limestone, fractured w/vugs, stylolites and calcite inclusions												56	0
													40	8
													48	20
	Moderately hard to hard light gray cherty limestone w/stylolites and occassional weathered partings and seams						q <sub>u</sub> = 8	3420 p	si, TU	W= 14	0 pcf		100	57
							q <sub>u</sub> = 2	2940 p	si, TU	W= 14	2 pcf		98	80
35-														
COMPL DATE:	ETION DEPTH: 30.0 ft 7-20-23	DEI IN E	PTH T BORIN	O WA <sup>:</sup> G: Dr	TER y to 6	ft	<u> </u>	<u> </u>	<u> </u>	DA	TE: 7/	20/2	2023	3

19-118	
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#### LOG OF BORING NO. S4

090069 XNA Access Road over Wager Rd Benton Co., Arkansas

TYPE: Auger to 22 ft /Core

Grubbs, Hoskyn,

Consulting Engineers

Barton & Wyatt, Inc.

LOCATION: Approx Sta 145+75, 60 ft Lt COHESION, TON/SQ FT **BLOWS PER FT** UNIT DRY WT LB/CU FT % F % Recovery SAMPLES SYMBOL % RQD 0.2 0.4 0.6 0.8 1.0 1.2 1.4 - No. 200 DEPTH, DESCRIPTION OF MATERIAL PLASTIC LIMIT WATER CONTENT LIQUID LIMIT + -+-SURF. EL: 1123± 10 20 30 60 70 40 50 Loose brown silt w/numerous 9 chert fragments - medium dense below 2 ft NON-PLASTIC 13 38 5 13 22 19 10 19 15 Moderately hard to hard light gray slightly weathered cherty limestone, fractured w/vugs and stylolites 4 50/1" 212 20 Δ  $\Delta$ 50/1" ₼ 4 83 0 h Λ 4 25 10 0 q\_= 4990 psi, TUW= 140 pcf  $\Delta$ 4 - less fractured with fewer vugs below 27 ft Δ  $\Delta$ Α 4 10085 30 hA 4 8-10-23 WAGER ROAD.GPJ 35 19-118 RECRODN200-2 COMPLETION DEPTH: 32.0 ft DEPTH TO WATER DATE: 7-19-23 IN BORING: Dry to 22 ft DATE: 7/19/2023



	Түрг		Bent	ton C	o., A	rkans	as N· Ar		Sta 1/	5+55	60 ft F	2t				
				F			<u>νΝ. Α</u> μ (			TON	SO F1	<u>г</u>				_
뵤	Ъ	ŝ		L R	N L N L	0	2 0	4 (		$\bigcirc$	1	2 1	4	% (	ery	~
ОЕРТН,	SYMBC	SAMPLI	DESCRIPTION OF MATERIAL	DWS PE	LB/CU I	PL/			WA				ID T	No. 200	Recov	% ROI
			SURF. EL: 1120±	BLO	5	1	╋ 0 2		———— 30         4	• – – 40 5	— — — 60 6	<b>-+</b> 0 7(	0	•	%	
			Loose dark brown silt w/rootlets and occasional chert fragments	5							•					
		X	Firm to stiff tan and brown silty clay w/numerous chert fragments	10			•		ŧ					49		
- 5 -		X	- stiff from 4 to 8 ft	13			•									
		X	- with reddish brown below 6 ft	11			•									
- 10 -		X	- very stiff below 8 ft	40			•									
			Stiff top and raddiab brown													
- 15 -		X	silty clay w/numerous chert fragments	16			•+	· ·	+					20		
- 20 -			Moderately hard light gray w/tan highly weathered cherty limestone w/silty clay filled fractures	50/6"												
			Moderately hard to hard gray cherty limestone												94	0
- 25 -									q <sub>u</sub> =	3330 p	si, TU	W= 14	8 pcf		88 4	46
- 30 -															88 4	42
		T														
- 35 -																
		PLE : 7-	TION DEPTH: 31.0 ft -19-23	DEI IN E	 PTH T BORIN	O WA G: Di	TER	2 ft					- F· 7/	19/2	023	

	19-11	8														
	Gru Bar <sub>Const</sub>	bbs, ton a liting Er	, Hoskyn, LOGOF & Wyatt, Inc. 090069 XNA Ad Bento	B C ccess on Co	<b>) R I</b> Road unty,	<b>N G</b> d ove Arka	r Osansas	<b>0. S</b> age (	<b>39</b> Creel	κ						
	TYPI	E: HS	SA to 18.5 ft /Core		LO	CATIC	N: A	oprox	Sta 1	58+30,	60 ft	Lt				
DEPTH, FT	SYMBOL	SAMPLES		SLOWS PER FT	UNIT DRY WT LB/CU FT	0 PL/ L	.2 ( ASTIC IMIT <b>+</b> –	COHE 	2.6 0.6 		/SQ F	T 1.2 1 LIQU LIQU	.4 JID IT	- No. 200 %	% Recovery	% ROD
		M	edium dense reddish tan silt /numerous chert fragments	15		1	0 :	20 :	30	40	50	60 7	0			
		Si si no	tiff to very stiff reddish brown Ity clay w/numerous chert odules and fragments	22												
- 5		X		29										-		
		X		29			•		-+					27		
- 10		X		11												
- 15		Vi cli fra	ery soft brown and tan silty ay w/occasional chert agments	2				<b>+</b> - ●-		+				86		
		M	oderately hard light gray and	50/4"	,									_		
- 20 -		M gr	oderately hard to hard light ray and gray cherty limestone												64	44
-30-23		in    - \    be	clusions and layers with medium close stylolites elow 22.5 ft													
8 CREEK.GPJ 8															98	77
-2 19-118_OSAG				<b>-</b>								<b>-</b> ·				
RECRQDN200	COMI DATE	 PLETI :: 8-1	ON DEPTH: 27.0 ft 5-23	DE IN E	PTH T BORIN	0 WA IG: 18	TER 3 ft	<u> </u>				DA	TE: 8	/15/2	02	3

	19-11	8														
	Gru Bar Consu		os, Hoskyn, n & Wyatt, Inc. LOGOF g Engineers 090069 XNA Ac Bento	BC cess n Co	<b>RI</b> Road unty,	<b>N G</b> d ove Arka	<b>N C</b> r Osa nsas	<b>). S</b> ' age (	<b>18</b> Creek							
	TYP	Ξ:	HSA to 16 ft /Core		LO	CATIC	)N: Ap	prox	Sta 15	57+85,	60 ft	t Rt				
		S		RFT	×⊢				SION	, <b>TON</b>	/SQ	FT		%	١Ŋ	
PTH, F	MBO	MPLE	DESCRIPTION OF MATERIAL	/S PE	DRY /CU F	0		0.4 C	).6 (	).8 1	1.0	1.2	1.4	. 200	ecove	RQD
DEI	S	SA	SURF FL: 1091+	BLOW									AIT F	N V	% R	%
			Medium dense reddish brown silt w/numerous chert fragments	16		1	0 2	20 :	30 4	40 5	50	60	70			
		X		25												
5	- 4 4 - 4 4 - 4 4	X		27										-		
	<b>{4(</b> 4)  	X	Very loose reddish brown silt, slightly clayey	2										-		
	- Z. Z. - A. A - Z. Z.	X	Medium dense reddish tan silt w/chert fragments	20				•						53		
- 10	- 4. 4. - 4. 4. - 4. 4. - 4. 4.													-		
		X	Moderately hard reddish tan and light gray weathered cherty limestone	50/6"												
- 15			Moderately hard to hard light gray and gray cherty limestone	25/0"												
															29	25
20																
20		-													95	70
				<u> </u>								-+				
	-															
	-															
9-118_OSA	-															
0N200-2 1																
RECRQL	COMI DATE	PLE E: 8	ETION DEPTH: 23.0 ft 3-17-23	DE IN E	PTH T BORIN	0 WA IG: 13	TER 3.7 ft					DA	.TE: 8	/17/2	023	3

19-118														
	os, Hoskyn, LOGOF n & Wyatt, Inc. LOGOF g Engineers 090069 XNA Acces Bent	<b>BO</b> ss Ro ton C	<b>RI</b> bad o o., A	<b>N G</b> ver Li rkans	<b>N O</b> ttle C as	<b>). S</b> ź )sago	<b>27</b> e Cre	ek						
TYPE:	Auger to 10 ft /Core		LOC		N: Ap	prox	Sta 17	5+45,	45 ft L	.t				
E L		ER FT	FT T	0.	<b>(</b> 2 0.			, TON/	/SQ F	T .2 1.	4	% (	ery	0
DEPTH, SYMB( SAMPL	DESCRIPTION OF MATERIAL	INS PI	VIT DRY LB/CU	PLA	STIC		WA	TER	1	LIQU	ID T	No. 20(	Recov	% RQI
	SURF. EL: 1085±	BLO	5	1(	╋ ) 2	 0 3		• — — — 0 5	io e		0	'	8	
	Very soft brown fine sandy clay, silty w/occasional chert fragments	1							•					
		2					•							
- 5 -	- soft at 4 to 6 ft	5					+ +					63		
	- firm below 6 ft	7												
	- with discontinuous chert seams below 8 ft	50/8"												
	Moderately hard to hard gray and tan cherty limestone, slightly weathered w/styolitic joints	00/0												
	Jointe												100	25
- 20 -														
COMPLE DATE: 4	ETION DEPTH: 15.0 ft I-4-23	DEF IN E	PTH T BORIN	O WA <sup>-</sup> G: 1 f	TER t		1	1	1	DAT	ΓE: 4/	11/2	023	3

	19-118														
	Grul Bart Consul	obs, Hoskyn, LOGOF on & Wyatt, Inc. LOGOF <sup>ting Engineers</sup> 090069 XNA Acces Ben	BO ss Ro ton C	<b>RI</b> bad o co., A	<b>N G</b> ver Li rkans	NC ttle ( as	<b>). S:</b> Dsage	<b>32</b> e Cre	ek						
	TYPE	: Auger to 11 ft /Wash to 13 ft /Core		LO		N: Ap	prox S	Sta 18	1+45,	60 ft L	.t				
Ŀ	٦L	S	ER FT	^ WT =T	0	( 2 0		SION	, TON/	SQ F1	Г 2 1	А	% (	ery	
DEPTH,	SYMBO	DESCRIPTION OF MATERIAL	INS PE	VIT DRY LB/CU	PLA	STIC	<u> </u>	WA	TER	1	LIQU	IID IT	No. 20(	6 Recov	% RQI
		SURF. EL: 1080±	BLO	5	1	╋ 0 2	 10 3	— — — 10	• – – 10 5	0 6		0	<b>'</b>	%	
		Firm brown clayey silt w/chert fragments	9			•	╞╌╼						48		
	Ż	Stiff to very stiff reddish brown fine sandy clay, silty w/numerous chert fragments and inclusions	40			•									
- 5 -	$\mathbb{Z}$		24			•	╋╋						22		
	Ż		29												
- 10 -		- with more chert fragments and chert seams below 8 ft	50/7"												
		- auger refusal at 11 ft - rock bit refusal at 13 ft													
		Moderately hard to hard gray cherty limestone, flat bedded												100	75
- 15 -		w/stylonuc joints						q <sub>u</sub> = 9	9240 p	si, TU	W= 16	1 pcf		100	67
		-													
20 -		with coloite inclusions at 22.5												80	58
		L								 				100	75
	COMP DATE:	LETION DEPTH: 27.0 ft 4-7-22	DE IN E	PTH T BORIN	O WA <sup>.</sup> IG: 10	TER ft	<u> </u>	<u> </u>	1	<u> </u>	DA	ГЕ: 4/	/8/20	22	

	19-11	8														
	Gru Bar <sub>Consu</sub>		s, Hoskyn, LOGOF & Wyatt, Inc. LOGOF Engineers 090069 XNA Acces Bent	<b>BO</b> ss Ro ton C	<b>RI</b> bad ov co., Al	<b>N G</b> ver Li rkans	NC ttle C	<b>). S</b> : Dsag	<b>33</b> e Cre	ek						
	TYPI	≣:	Auger to 11 ft /Core		LOC		N: Ap	prox	Sta 17	6+00,	60 ft	Rt				
				Ē	۲		(		SION		/SQ F	Т			_	
н Н Н	BOL	LES		PER	RY V U FT	0.	2 0	.4 0	0.6 0	.8 1	.0	1.2 1	.4	× 00	overy	DD
DEPT	SYM	SAMF	DESCRIPTION OF MATERIAL	OWS	LB/C	PL/ LI			WA CON	TER TENT			JID IT	- No. 2	% Rec	% R
			SURF. EL: 1078±	B		1	<b>T</b> 2	20 3	30 4	0 5	50	60 7	70		_	
			Very soft to soft brown clayey silt w/trace fine to coarse gravel	4												
			- very soft at 2 to 4 ft	2												
- 5 -			- with numerous chert fragments below 4 ft - soft at 4 to 6 ft	6												
		1   	- stiff below 6 ft	14				<b> -</b>	│ ┤ — ♣					28		
			Very loose to loose tan sandy fine to coarse chert gravel,											-		
- 10 -		X	silty	4										-		
		-	Moderately hard light gray and gray cherty limestone, flat bedded w/stylolites and													
			renealed fractures												100	71
- 15 -																
															100	85
- 20 -																
Ē	4 4	Щ.		<u> </u>				<u> </u>				+			100	100
25-														1		
	-															
	-															
	COMI DATE	 PLE :: 9	TION DEPTH: 21.0 ft -18-23	DE IN E	 PTH T BORIN	O WA G: 5.8	TER 3 ft					DA	 TE: 9/	/18/2	023	 3
<u> </u>			-				-					2.1			`	

	19-118	3													
	Gru Barl	bbs, Hoskyn, con & Wyatt, Inc. LOGOF ting Engineers 090069 XNA Acces Bent	<b>B O</b> ss Ro on C	<b>RI</b> ad ov o., Ai	<b>N G</b> ver Li rkans	<b>NC</b> ttle C	<b>). S</b> : )sag	<b>38</b> e Cre	ek						
	TYPE	: Auger to 10 ft /Wash to 12 ft /Core		LOC		N: Ap	prox	Sta 18	2+15,	60 ft F	٦t				
			FT	۲.		(		SION	, TON	/SQ F	Т		6	y	
TH, F	MBOL	입 같 DESCRIPTION OF MATERIAL	S PER	DRY V CU FT	0.	2 0	.4 0	.6 0	.8 1	.0 1	.2 1	.4	200 %	cover	ZQD
DEP	SYI	SAM	ROW	UNIT   LB/(	PLA LI	ASTIC MIT <b>+</b>		WA CON	TER TENT		LIQU LIM	IID IT	- No.	% Re	%
	rur	Very soft to soft brown clayey	<u> </u>		1	0 2	0 3	30 <u> </u>	10 E	50 <del>6</del>	<u>50</u> 7	0			
		silt w/occasional rootlets	4				♣	+					90		
		Stiff to very stiff reddish brown silty clay w/numerous chert and limestone fragments	32			•									
- 5 -		Stiff to very stiff reddish brown fine sandy clay w/numerous chert and limestone fragments	45			•									
		- with discontinuous chert seams and layers below 6 ft	50/6"			•									
		7	25/0"												
- 10 -		- auger refusal at 10 ft				•									
		Moderately hard to hard gray													
		cherty limestone, flat bedded w/stylolitic joints						q <sub>u</sub> = \$	610 p	si, TU	W= 15	9 pcf			
														100	83
- 15 -															
														100	92
														100	02
- 20 -															
ç.														100	94
0 7 7															
5 - <b>25</b> -														87	85
		<u>+</u>	<u> </u>							+	+				
					0.14/4										
	DATE	: 4-8-22	IN E	BORIN	G: Dr	ı ⊨R y to 10	O ft				DA	ΓE: 4/	5/20	22	

		8 Ibb toi Ilting	s, Hoskyn, n & Wyatt, Inc. <sup>J Engineers</sup> LOGOF 090069 XNA A Ben	BC Acces	<b>) R I</b> s Roa Co., A	<b>N G</b> ad ove rkans	N ( er H as	<b>D. S</b> aden	<b>39</b> Rd.							
	TYPI	E:	HSA to 22 ft /Wash to 23 ft /Core	ET		CATIO	N: A	pprox COHE	Sta 19 ESION	0+90, , TON	60 ft L /SQ F <sup></sup>	.t Г				
EPTH, FT	YMBOL	AMPLES	DESCRIPTION OF MATERIAL	NS PER	T DRY W B/CU FT	0. PLA	2 ( ASTIC	).4 (	0.6 ( WA	0.8 1	.0 1	.2 1 LIQU	.4 JID	lo. 200 %	Recovery	% ROD
	0	Ś	SURF. EL: 1106 <del>.</del>	BLO		LI	МІТ <b>+</b>						IT	~	%	0
			Very soft to soft brown and reddish brown clay w/rootlets	4		1	0	20	30 4	+0 5						
			Soft brown, reddish brown and	5				<b></b>	<b>_</b>					77		
- 5 -			fragments and nodules and ferrous stains - stiff to very stiff below 4 ft	11												
		X	- with more chert fragments below 6 ft	27				•								
- 10 -		X	Firm to stiff tan and brown silty clay w/some chert fragments and nodules	10			-	+	÷					90		
- 15 -		X	- stiff to very stiff below 13 ft - with numerous chert fragments at 13 to 18 ft	41			•									
- 20 -		X	- with more clay and fewer chert fragments below 18 ft	13				•						-		
- 25 -			<u>- HSA refusal at 22 ft</u> Moderately hard to hard light gray cherty limestone, stylolitic joints - chert seam at 24 ft						q <sub>u</sub> = ·	4670 p	si, TU	W= 15	6 pcf	-	97	87
- 30 -															89	78
															96	83
- 35 -	+_f*_ 41 - - - - - - - - - - -			+				+ 			+ — — -   	+ — — ·	+ 			
אַרכאגעטיא	COMI	PLE	TION DEPTH: 33.0 ft -26-22	DE	PTH T BORIN	O WA G: 19	TER .5 ft			<u> </u>		DA	TE: 4/	26/2	022	2

	Gru Barl Consu	bb or	s, Hoskyn, A & Wyatt, Inc. Engineers 090069 XNA A Ben	BC Acces ton C	<b>R I</b> s Roa co., A	<b>N G</b> ad ov rkans	<b>N (</b> rer H sas	<b>D. S</b> aden	<b>42</b> Rd.						
	TYPE		HSA to 30 ft /Core		LO	CATIC	DN: A	pprox	Sta 19	93+20,	60 ft	Lt			
				ЕT	F			COHE	SION	I, TON	/SQ F	-T			
Т, Т	BOL	LES		PER	N FT N	0	.2	).4 (	0.6	0.8	1.0	1.2	1.4	00 %	overy QD
DEPTI	SYMI	SAMF		SMOJ	UNIT DI LB/CI	PL/ L	ASTIC IMIT <b>+</b>			ATER		LIQI LIN		- No. 2	% Rec % R(
			SURF. EL: 1120±			1	0	20	30	40	50	60	70		
		X	and cherty limestone fragments	14				•							
		X	Stiff light brown silty clay w/numerous chert and limestone fragments	21				<b>∳</b>	H					36	
- 5 -		X	- very stiff, reddish tan below 4 ft	27				•						_	
		X	Stiff reddish brown clay w/numerous chert and limestone fragments	23				•							
- 10 -		X		21				<b>+</b> •		+				52	
- 15 -		X	- with discontinuous chert seams below 13 ft	50/4'			•								
- 20 -		X	Stiff to very stiff tan and light gray silty clay w/numerous chert and limestone fragments and chert seams and layers (completely weathered limestone)	27											
		V	- soft to firm below 22 ft	5											
- 25 -				25/0'										-	
		/ _ 'LE	TION DEPTH: 45.0 ft	DE	<u> </u> РТН Т	O WA									
	DATE	4	-20-22	IN I	BORIN	IG: D	ry to 3	30 ft				DA	TE: 4	4/20/2	2022

	19-11	3														
	Gru Bar <sub>Consu</sub>	bbs, Hoskyn, ton & Wyatt, Inc. <sup>Iting Engineers</sup> 090	OGOFB 0069 XNA Acco Benton	O ess i C	<b>R I I</b> s Roa o., Ar	<b>N G</b> id ove kans	<b>N C</b> er Ha as	<b>). S</b> aden	<b>42</b> Rd.							
	TYPE	E: HSA to 30 ft /Core			LOC	CATIO	N: Ap	prox	Sta 19	3+20,	60 ft L	_t				
		(0)	Ľ	_ L	₽.		(		SION,		/SQ F	Т		%	y	
н Н	1BOL			к Ц L	NRY U FI	0.	2 0	.4 (	0.6 0	.8 1	.0 1	.2 1	.4	200 %	cover	
DEP1	SYN	(continued)			UNIT D	PLA LI	\STIC MIT ╋ ───		WA CON	TER TENT		Liqu Lim	JID IT	- No.	% Re	Ч %
	44	Moderately hard to h	ard light	-		1	0 2	20 3	30 4	0 5	50 E	50 7	0			
		gray w/gray cherty lii stylolitic joints	mestone,													
															85	28
- 35 -					-											
															98	88
- 40 -					-											
															100	7
- 45 -																
	-															
- 50 -	-				-											
	-															
	-															
	-															
- 55 -	-				-											
	-															
	-															
	-															
	-															
	COMF DATE	PLETION DEPTH: 45.0 ft : 4-20-22	C 	DEF N B	orin	O WA G: Dr	TER y to 3	0 ft				DA	TE: 4/	20/2	022	2
L																_

	Gru Bar	bb tor	s, Hoskyn, A Wyatt, Inc. LOGOF	BO	RI	NG	N (	D. S	43							
	/ Consu	lting	Engineers U90009 XNA A Ben	ton C	s коа ю., А	rkans	er H Sas	auen	RU.							
	TYPE	:	HSA to 20 ft /Core	1	LO	CATIC	DN: A	pprox	Sta 19	1+60,	60 ft F	Rt				
		S		RFT	ТWТ						'SQ F1	Г		%	Ŋ	
PTH, F	MBO	MPLE	DESCRIPTION OF MATERIAL	S PEI	DRY /CU F	0	.2	0.4	0.6 0		.0 1.	.2 1	.4	. 200	ecove	RQD
DEI	Ś	SA	SURE EL: 1106+	BLOW	UNIT		IMIT	, 					IT	- No	% R	%
			Stiff gray, reddish tan and red	13		1	0	20	30 2	10 5	0 6	0 7	0			
			and ferrous stains													
		X		26				<b>+</b>		+				58		
- 5 -		X	- stiff, silty below 4 ft	17				•								
		X	Stiff brown, tan and reddish	16					+					82		
			and ferrous stains													
- 10 -		X	fragments below 8 ft	23			•	•								
		X	- with discontinuous chert seams and inclusions below	50/7"			•									
- 15 -			13 11													
		_	Moderately hard to hard light grav cherty limestone, stylolitic													
20-		/ T	joints	50/1"												
			- with rehealed high-angle shear at 21 ft						q_= 8	3260 p	si, TU	W= 16	1 pcf			
			- with vertical shear and calcite-filled vugs at 22.5 to												98	82
- 25 -			22.7 ft													
S															100	93
30 -				<u>+</u>											_	
-6																
	COMF	۱LE	TION DEPTH: 30.0 ft	DE	PTH T	O WA	TER		1							
	DATE	: 4	-29-22	in e	BORIN	IG: 13	3.8 ft					DA	IE: 4/	29/2	022	<u>′</u>

Crubbs, Hoskyn, Borruba, Hoskyn, Burner, Burner, Swalt, Starter, Swalt, Starter, Swalt, Swal
TYPE:       HSA to 23 ft //Core       LOCATION: Approx Sta 193+90, 60 ft Rt         Line
Line       Contestion
L       000000000000000000000000000000000000
E       0       DESCRIPTION OF MATERIAL       0
10       20       30       40       50       60       70         10       20       30       40       50       60       70         10       20       30       40       50       60       70         10       20       30       40       50       60       70         10       20       30       40       50       60       70         10       10       10       10       10       10       10       10         10       10       10       10       10       10       10       10       10         10       10       10       10       10       10       10       10       10         10       10       10       10       10       10       10       10       10         10
10       21       21       29       0
Since state and the second of the second
5       50/6"         50/6"       50/6"         50/6"       50/6"         - firm from 8 to 13 ft       8         - very stiff from 13 to 18 ft       50/5"         - soft below 18 ft       50/5"         - soft below 18 ft       5         - soft below 18 ft       5         - soft below 18 ft       5         - with cober rehealed fractures below 24.5 ft       - with high-angle shears at 26.5 to 26.7 ft and 27.7 and 28 ft         - with high-angle shears at 26.5 to 26.7 ft and 27.7 and 28 ft       - 0         - 30       - 10
3       -
- firm from 8 to 13 ft       50/6"         - very stiff from 13 to 18 ft       50/5"         - soft below 18 ft       5         - soft below 24.5 ft       50/3"         - with high-angle shears at 26.5 to 26.7 ft and 27.7 and 28       10068         - soft below 24.5 ft       10073         - soft below 24.5 ft       10073
- firm from 8 to 13 ft       8       • + +       27         10       - very stiff from 13 to 18 ft       50/5"       •       -         - very stiff from 13 to 18 ft       50/5"       •       -       -         - soft below 18 ft       5       50/3"       •       -       -         - very stiff from 13 to 18 ft       50/5"       •       -       -       -         - soft below 18 ft       5       •       -       -       -       -         - very stiff from 13 to 18 ft       50/5"       •       •       -       -       -         - soft below 18 ft       5       50/3"       •       •       -       -       -         - very stiff from 13 to 18 ft       50/5"       •       •       -       -       -       -         - very stiff from 13 to 18 ft       50/3"       •       •       -<
10       3       • • • • • • • • • • • • • • • • • • •
- very stiff from 13 to 18 ft 15 - soft below 18 ft 5 - soft below 18 ft - soft
- very stiff from 13 to 18 ft 15 - soft below 18 ft - soft below 18 ft - soft below 18 ft - soft below 18 ft - a
15       50/5"       •
- soft below 18 ft - soft below 18 ft - soft below 18 ft - control of the soft belo
- soft below 18 ft - soft below 18 ft 5 - soft below 18 ft 5 - soft below 18 ft 5 - soft below 18 ft 5 - soft below 18 ft - soft below 18 ft - with close reheated fractures - with close reheated fractures - with close reheated fractures - with high-angle shears at 26.5 to 26.7 ft and 27.7 and 28 ft - soft below 24.5 ft - with high-angle shears at 26.5 to 26.7 ft and 27.7 and 28 ft - soft below 24.5 ft - with high-angle shears at 26.5 to 26.7 ft and 27.7 and 28 ft - soft below 24.5 ft - with high-angle shears at 26.5 to 26.7 ft and 27.7 and 28 ft - soft below 24.5 ft - soft below
- soft below 18 ft -20 - 20 - 20
20     50/3"       30     A       A     Moderately hard to hard gray w/tan cherty limestone, stylolitic joints       • With close rehealed fractures below 24.5 ft       • with high-angle shears at 26.5 to 26.7 ft and 27.7 and 28 ft       • A <tr< td=""></tr<>
50/3"     50/3"       A     Moderately hard to hard gray w/tan cherty limestone, stylolitic joints       - A     - with close rehealed fractures below 24.5 ft       - with high-angle shears at 26.5 to 26.7 ft and 27.7 and 28 ft       - 30     - A       - A     - with high-angle shears at 26.5 to 26.7 ft and 27.7 and 28 ft       - 35     - 35
A     Moderately hard to hard gray w/tan cherty limestone, stylolitic joints       - 25     - 4       A     - 4       A     - 4       A     - 4       A     - 4       A     - 4       A     - 4       A     - 4       A     - 4       A     - 4       A     - 4       A     - 4       A     - 4       A     - 4       A     - 4       A     - 4       A     - 4       A     - 4       A     - 4       A     - 4       - 4     - 4       - 4     - 4       - 4     - 4       - 5     to 26.7 ft and 27.7 and 28       ft     - 4       - 30     - 4       - 4     - 4       - 4     - 4       - 5     - 4       - 4     - 4       - 4     - 4       - 5     - 4       - 6     - 4       - 7     - 4       - 7     - 4       - 7     - 4       - 7     - 4       - 7     - 4       - 7     - 4       - 7     -
25     A A       <
$\begin{array}{c c c c c c c c c c c c c c c c c c c $
- with high-angle shears at 26.5 to 26.7 ft and 27.7 and 28 ft 30 30 30 30 30 30 30 30 30 30 30 30 30
26.5 to 26.7 ft and 27.7 and 28 30 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4
COMPLETION DEPTH: 33.0 ftDEPTH TO WATERDATE: 4-28-22IN BORING: Dry to 23 ftDATE: 4/28/2022

	19-11	8															
	Gru Bar <sub>Consu</sub>	bb tor	s, Hoskyn, & Wyatt, Inc. Engineers 090069 XNA Ad Bent	BO ccess ton C	<b>R I</b> Roa to., A	<b>N G</b> Id ove rkans	<b>N (</b> er Ho sas	<b>D.</b> S	<b>S47</b> es Rd								
	TYPE	≣:	HSA to 51 ft /Wash		LO	CATIC	DN: A	ppro	x Sta 2	211+4	0, 40	ft Lt					
				FT	Л			COF	IESIO	N, TC	N/SC	۶FT					
L L	30L	LES		PER	X √ J FT	0	.2	0.4	0.6	0.8	1.0	1.2	1.	4	% 00	very	Q
DEPTH	SYME	SAMP	DESCRIPTION OF MATERIAL	-ows F	JNIT DF LB/CL	PL/ L	ASTIC	;	N CC		T		LIQU LIMI	ID T	- No. 2	% Reco	% RC
			SURF. EL: 1220±			1	0	20	30	40	50	60	7(	)			
			Very stiff light brown clayey silt w/chert nodules and fragments, dry	32													
		X	Very stiff red silty clay w/numerous chert nodules and	66													
- 5 -		X	tragments	50/2"													
		X	<ul> <li>with discontinuous chert seams and layers below 4 ft</li> </ul>	50/6"													
10		X		80													
- 15 -		X		43						_							
		-	Low hardness light yellowish														
- 20 -	Â		weathered cherty limestone	64						_							
			Stiff to very stiff red silty clay w/chert nodules and fragments														
		X	J	28													
- 25 -																	
30		X		19													
35		X		19						_	_						
			Very soft light gray and light							+	+						
40 -		X	yenowish red highly weathered cherty limestone, fractured w/red silty clay seams	9						+	+						
			- with grayish brown below 42														
Z-00-		X	π	11													
	COM		TION DEPTH: 61.0 ft	DEI		O WA	TER	-4 0				I					
	DATE	: 7	-28-23	IN E	SORIN	ig: Di	ry to §	o1 ft					DAT	E: 7/	28/2	:023	3

	TYPE:	HSA to 51 ft /Wash		LOC	CATIC	N: A	pprox	Sta 2	11+40	, 40 ft	Lt			
F		D	R FT	⊢∧∟			COH	ESION	1, TON	I/SQ I	-T		%	2
TH, F		لُا الا الا DESCRIPTION OF MATERIAL	S PEF	CU F	0	.2 (	0.4	0.6	0.8	1.0	1.2	1.4	200	covel
DEP	SYN		-OWO	LB/0	PL/ L			W. COI			LIC		No.	% Re
		(continued)	B		1	0	20	30	40	50	60	<b>T</b> 70		
50 ·		- auger refusal at 51 ft	11										-	
		Moderately hard to hard gray cherty limestone											<u>––</u>	100
									1700			150		
55								q <sub>u</sub> =	4760	psi, i	000-		-	92
		- chert layers at 58.2 to 58.5 ft and 59.2 to 59.4 ft												100
60 -						<u> </u>	<u> </u>						·	
<u> </u>														
00.														
70 -														
75													-	
80 -													-	
85 -								_					-	

	19-118	3													
	Gru Barl <sub>Consu</sub>	bbs, Hoskyn, ton & Wyatt, Inc. <sub>Iting Engineers</sub> LOGOF 090069 XNA Ad Bent	BC ccess ton C	<b>RI</b> Roa co., Ai	<b>N G</b> d ove rkans	NC er Ho sas	). S	5 <b>1</b> s Rd.							
	TYPE	: HSA to 28 ft /Wash		LOC	CATIC	N: Ap	prox	Sta 21	4+80,	55 ft L	.t				
			FT	/T			сон	ESION	, TON/	'SQ F	Г			,	
L E	30L		PER	λ ν FT	0	.2 0	.4	0.6 (	).8 1	.0 1	.2 1	.4	% 00	over)	g
DEPTI	SYMI		-OWS	JNIT DF LB/CL	PL/ L							JID IT	- No. 2	% Rec	% R(
		SURF. EL: 1182±	B		1	0 2	20	30 4	40 5	6 6	i0 7	0			
		w/organics and numerous chert nodules and fragments	13												
		<ul> <li>A fewer organics below 2 ft</li> <li>Medium dense brown fine to</li> </ul>	11												
- 5 -		medium sand w/fine limestone	14												
		Medium dense reddish brown sandy fine to coarse chert	23												
- 10 -		fragments w/red silty clay seams	17												
- 15		Stiff to very stiff yellowish red fine to coarse sandy clay w/numerous chert nodules and	32												
		fragments													
		$_{ m V}$ - moist at 18 to 20 ft	17												
- 20 -															
		- very soft to soft below 23 ft													
- 25 -		X	4												
		- auger refusal at 28 ft							5290 n	ei TII	W= 16	6 ncf			
- 30 -		weathered cherty limestone						Yu						89	89
														-	
														97	90
- 35 ·															
		- chert layer at 37.3 ft	<u> </u>			 	L					L		100	50
40 ·															
ν 0 															
RECKUD.	COMF DATE	PLETION DEPTH: 38.7 ft : 7-26-23	DE IN I	PTH T BORIN	O WA G: Di	TER y to 2	8 ft				DA	TE: 7/	26/2	023	3

	TYP	E:	Auger	LC		ON: Ap	prox St	a 210+5	55, 45 ft F	Rt		
РТН, FT	MBOL	MPLES	DESCRIPTION OF MATERIAL	/S PER F1	- DRY WT //CU FT	0.2			).8 1.0	1.2	1.4	o. 200 %
B	ۍ ا	SA	SURF. EL: 1229±	BLOV			T				ИГ <b>Н</b>	Ž
			Firm to stiff light brown clayey silt w/chert nodules and fragments and occasional organics	10			•	30 4		60		
			Stiff to very stiff red and brownish gray silty clay w/chert fragments and discontinuous chert seams and layers	50/5'	,		•	<b>+</b>	-+			31
- 5			- red and reddish brown with very close chert inclusions, seams, and layers below 4 ft	25/0'		•						
				25/0'		•						-
			- auger refusal in cherty limestone at 9 ft	25/0'		••						
- 10	-		NOTE: Boring abandoned									
	_											
	_											

	19-11	3														
	Gru Bar <sub>Consu</sub>	bbs ton	s, Hoskyn, & Wyatt, Inc. Engineers Bent	BO ccess ton C	<b>R I</b> Roa Co., A	<b>N G</b> d ove rkans	<b>N C</b> er Ho sas	<b>). S</b> olmes	<b>56</b> 8 Rd.							
	TYPE	: F	ISA to 31.5 ft /Wash		LOC	CATIC	N: A	oprox	Sta 21	3+65,	55 ft F	Rt				
Ι.				L L	E			COHE	SION		/SQ F	Г			,	
	30L	LES		PER	N K ≤	0	.2 (	).4	0.6 0	).8 1	.0 1	.2 1	.4	% 00	very	g
DEPTI	SYME	SAMP	DESCRIPTION OF MATERIAL	OWSI	NIT DF LB/CL	PL/ L	ASTIC IMIT		WA CON	TER TENT		LIQL LIM	ID T	- No. 2	% Reco	% RC
			SURF. EL: 1208±	В		1	+ - 0	 20	30 4		50 6	0 7	0		0,	
			Stiff dark brown silty clay w/chert nodules and fragments/	20												
		Z	Stiff to very stiff red clay //numerous chert nodules and	28												
- 5		X	raginents	60												
		XI	Medium dense to dense eddish brown and light gray	35												
10		X Y	w/numerous chert nodules and ragments	16												
			°													
			Stiff to very stiff reddish brown													
- 15			and light gray line to medium sandy clay w/numerous chert nodules and fragments	50												
			5													
- 20		X		19												
			with highly weathered cherty	47												
25			pelow 23 ft													
		-														
- 30		Χ.	chert layer at 28 Tt	50/5"												
		-	auger refusal at 31.5 ft													
			cherty limestone						q <sub>u</sub> = \$	5930 p	si, TU	W= 16	6 pcf			
- 35									q_= 1	0,990	psi, Tl	JW= 1	56 pcf		73	65
															100	100
															100	100
40															91	67
				<u>+</u>				<b> </b>								
		LL PLE <sup>-</sup> · 7.	FION DEPTH: 42.5 ft			ו OWA ו⊂י ח	TER	   5 ft						31/2	02'	
	DATE					J. D	y 10 C						· <b>-</b> . //·	0 1/Z	520	, 

	19-11	8														
	Gru Bar <sub>Consu</sub>	bb tor	s, Hoskyn, <b>&amp; Wyatt, Inc.</b> <sup>Engineers</sup> LOGOF 090069 Malone Ben	<b>BO</b> Lane ton C	<b>RI</b> over co., A	<b>N G</b> r XNA rkans	N C A Acc sas	<b>). S</b> cess	<b>57</b> Road							
	TYPE	E: /	Auger to 15 ft /Wash		LO	CATIC	N: Ap	oprox	Sta 22	2+36, C	L					
		S		R FT	Т×г		_	СОН		, TON/	SQ F	Г		%	٩Ŋ	
PTH, F	MBO	MPLE	DESCRIPTION OF MATERIAL	'S PE DRY /CU F			.2 (	).4	0.6 0		.0 1.	.2 1.	.4 	. 200	ecove	RQD
DE	S	SA	SURF. EL: 1241±	BLOM									IT	N V	% R	%
			Medium dense reddish brown	17		1		•	30 2	40 5	0 6	0 7	0			
	- 4. 4. - 4. 4.		fragments	15						-NOM	I-PI A	STIC-		30		
- 5 -	AA 74		Moderately hard very light grav	20												
		X	weathered cherty limestone w/very close reddish brown	50/5"												
- 10 -		X	and discontinuous chert beds											-		
- 15 -		X		50/3"												
				25/0"												
- 20 -		Ź		20/0												
		Z		25/0"												
- 25 -																
- 30 -		Z		25/0"												
35				25/0"										-		
				25/0"												
	COM	PLE	TION DEPTH: 62.0 ft	DE		O WA	TER									
	DATE	. 2	-13-23	IN E		ig: Di	y to 1	jî c				DA	IE: 2/	15/2	023	5

	19-118	8													
	Gru Bart <sub>Consul</sub>	obs, Hoskyn, on & Wyatt, Inc. <sup>ting Engineers</sup> LOGOF 090069 Malone Ben	<b>BO</b> Lane ton C	<b>RI</b> e over co., A	<b>N G</b> XNA rkans	NC A Acc sas	<b>). S</b> æss	57 Road	1						
	TYPE	: Auger to 15 ft /Wash		LOO	CATIC	N: Ap	oprox	Sta 2	2+36,	CL					
<b>⊢</b>		(0	R FT	۲ <sup>۷</sup>			COHE	ESION		I/SQ	FT		%	Y	
TH, F	MBOL		S PEF	DRY CU F	0	0.2 0.4		0.6 0.8		1.0	1.2	1.4	200	ecover	RQD
DEF	SΥ	S (continued)	3LOW	UNIT LB/	PL/ L	ASTIC IMIT +					LIQUID LIMIT 		No -	% R(	%
					1	0 2	20	30	40	50	60	70			
			25/0"	,											
- 45 -		2											-		
		Moderately hard gray and tan											-		
		w/clay seams and pockets	25/0"	,											
- 50 -		Moderately hard gray cherty limestone, flat bedded													
														33	0
- 55															
- 55		- highly fractured with clay laminations and seams to 55 ft													
								q <sub>u</sub> =	5840	psi, i	UVV= 1	53 pcr		100	100
- 60 -		-													
														99	85
- 65 -	-												-		
	-														
- 70 -									-				-		
- 75 -													-		
	COMF	LETION DEPTH: 62.0 ft 2-15-23	DEI		O WA G· ח	TER	5 ft				<u> </u> ער		/15/3	>02'	3
		2 10 20	11 N L		J. D	, .0 1	<b>U</b> II								~

19-118													
Grubbs, Hoskyn, Barton & Wyatt, Inc. LO Consulting Engineers 090065	Grubbs, Hoskyn, Barton & Wyatt, Inc. Consulting Engineers USDOG OF BORING NO. S59 090069 Malone Lane over XNA Access Road Benton Co., Arkansas												
TYPE: Auger to 15 ft /Wash		LOC	CATIO	N: Ap	prox	Sta 24	+57, C	CL					
L S JOB DESCRIPTION OF MAT	ERIAL S	F DRY WT 8/CU FT	0.	2 0 2 0				/SQ F 	Г .2 1. ПОП	4	o. 200 %	Recovery	RQD
日本 (から) SURF. EL: 1243±	BLOV	UNI	Ĺ				ÌTENT ●			Ť	Ž	Я 8	~
Firm brown and tan clav w/occasional chert frag	yey silt ments <sup>8</sup>			•		30 4	40 5			0			
Stiff to very stiff reddish silty clay w/chert fragme	n brown ents 50/4"				•								
5 Stiff to very stiff reddish	ו brown <sub>50/7"</sub>					•					-		
chert seams and layers	nuous 50/5"			ſ		+	+	+			36		
	25/0"			•							-		
	25/0"												
A A A A A A A A A A A A A A A A A A A	h brown ed / close ay ds											30	0
- highly fractured, limite recovery	ed core												
	25/0"										-		
	25/0"										-		
	25/0"										-		
	25/0"												
COMPLETION DEPTH: 55.0 ft DATE: 1-25-23	DEI IN E	PTH T BORIN	O WA G: Dr	TER y to 1	5 ft	1	1	I	DAT	ΓE: 1,	/25/2	023	3

	19-11	8														
	Gru Bar Consu		<b>ps, Hoskyn,</b> n <b>&amp; Wyatt, Inc.</b> LOGOF <sup>g Engineers</sup> 090069 Malone Ber	<b>BO</b> Lane ton C	<b>RI</b> e over co., A	<b>N G</b> · XNA rkans	N C Acc as	). S ess	5 <b>9</b> Road	b						
	TYPI	≣:	Auger to 15 ft /Wash		LO	CATIC	N: Ap	prox	Sta 2	4+57,	CL					
FT	ог	ES		ER FT	Y WT FT	0	.2 0			SION, TON/SQ I			Q FT 		/ery	
DEPTH	SYMB	SAMPL	DESCRIPTION OF MATERIAL	OWS P	JNIT DR LB/CU	PL/ L		·	W. CO					- No. 20	% Recov	% RQ
	<u> </u>		(continued)	B		1	<b>-</b> 2	20	30	40	50	60	<b>T</b> 70		_	<u> </u>
45				25/0"												
- 45 -			Moderately hard light gray and gray slightly weathered cherty													
			innesione, nai beudeu												87	70
- 50 -																
		-													97	55
<b></b>																
- 55 -																
- 60 -														-		
	-															
65																
	-															
- 70 -														-		
75 -																
	-															
	COMI		TION DEPTH: 55.0 ft	DE	 PTH T	O WA	TER									
	DATE	: 1	-25-23	IN	SORIN	ig: Di	y to 1	5 ft				D	41E: 1	1/25/2	:02	3

Grubbs, Hoskyn, Barton & Wyatt, Inc. Consulting Engineers	SYMBOLS	AND TER	MS US		N BOF	RINGL	.OGS					
SO (SHOWN IN CO Gravel Sand Predominal	VIL TYPES SYMBOLS COLUM Silt nt type shown heavy	N) Clay	(SHO	SAMPL WN ON S	ER TYI AMPLES Split Spoon	COLUM	N) Cutting					
TERM	S DESCRIBING	G CONSISTE	ENCY C	OR CON		N						
COARSE GRAINED SOILS (major portion retained on No. 200 sieve): Includes (I) Clean gravels and sands, and (2) silty or clayey gravels and sands. Condition is rated according to relative density, as determined by laboratory tests.												
DESCRIPT VERY LOOS LOOSE MEDIUM DE DENSE VERY DENS	IVE TERM SE ENSE SE	N-VALUE 0-4 4-10 10-30 30-50 50 and at	F	RELATIN	/E DEN 0-15% 15-35% 35-65% 65-85% 85-100%	ISITY						
FINE GRAINED SOILS (major portion passing No. 200 sieve): Includes (1) Inorganic and organic silts and clays, (2) gravelly, sandy, or silty clays, and (3) clayey silts. Consistency is rated according to shearing strength, as indicated by penetrometer readings or by unconfined compression tests.												
DESCRIP	UNCONFINED DESCRIPTIVE TERM COMPRESSIVE STRENGTH											
VER SOF FIRM STIF VER HAR	VERY SOFT SOFT FIRM STIFF VERY STIFF					Less than 0.25 0.25-0.50 0.50-1.00 1.00-2.00 2.00-4.00 4.00 and higher						
NOTE: Slick strengths that The consister	tensided and fissure n shown above, beca ncy ratings of such s	d clays may hav ause of planes c oils are based o	ve lower un of weaknes n penetror	nconfined ss or crack meter reac	compress is in the s lings.	sive soil.						
ТЕ	RMS CHARAC	TERIZING S	SOIL ST	RUCTU	IRE							
SLICKENSIDED - ha FISSURED - containi or less LAMINATED - compo	ving inclined planes ng shrinkage cracks vertical. bsed of thin layers of	of weakness tha , frequently filled varying color ar	at are slick d with fine nd texture.	and gloss sand or si	sy in appe It; usually	earance. more						
INTERBEDDED - cor CALCAREOUS - con WELL GRADED - hav pa	INTERBEDDED - composed of alternate layers of different soil types. CALCAREOUS - containing appreciable quantities of calcium carbonate. WELL GRADED - having a wide range in grain sizes and substantial amounts of all intermediate particle sizes.											
	intermediate sizes	missing.										
Terms used on this report for describing soils according to their texture or grain size distribution are in accordance with the UNIFIED SOIL CLASSIFICATION SYSTEM, as described in Technical Memorandum No.3-357, Waterways Experiment Station, March 1953												

Grubbs, Hoskyn,	Inc									
Consulting Engineers		DONING LOG TERMIS - ROCK								
ROCK TYPES (SHOWN IN SYMBOLS COLU	IMN)	Sandstone	Siltstone	Coal Shale						
Joint Characteristics – Bedding Characteristics – Lithologic Characteristics –	Spacing Very Close Close Moderately Close Wide Very Wide Very Thin Thin Medium Thick Massive Clayey Shaly Calcareous (limy) Silliceous	0.75 to 2.5 in. 2.5 to 8 in. 8 to 24 in. 2 to 6 ft More than 6 ft 0.75 to 2.5 in. 2.5 to 8 in. 8 to 24 in. 2 to 6 ft More than 6 ft	Degree of Weathering –	Fresh — No visible signs of decomposition or discoloration. Rings under hammer impact. Slighty Weathered — Slight discoloration inwards from open fractures, otherwise similar to fresh. Moderately Weathered — Discoloration throughout. Weaker minerals such as feldspar decomposed. Strength somewhat less than fresh rock, but cores cannot be broken by hand or scraped by knife. Texture preserved.						
Parting – Seam – Layer – Stratum – Hardness–	Sandy (Arenaceous) Silty Plastic Seams Less than 1/1 6incl 1/1 fo 1 /2inch 1/2 to 1 2inches Greater than 1 2inc Soft (S) – Reserved Friable (F) – Easily pulverized or reduce	h hes I for plastic material alone. crumbled by hand, ed to powder and is too sof	ł	Somewhat decomposed. Specimens can be broken by hand with effort or shaved with knife. Core stones present in rock mass. Texture becoming indistinct but fabric Completely Weathered – Minerals decomposed to soil but fabric and structure preserved (Saprolite). Specimens easily crumbled or penetrated.						
	to be cut with a po Low Hardness (LH) or carved with a po Moderately Hard (MH scratched by a knif heavy trace of dust visible after the pov Hard (H) – Can be scratch produces lit faintly visible; traces be visible. Very hard (VH) – C a pocket knife. Knit	<ul> <li>bcket knife.</li> <li>Can be gouged deeply bcket knife.</li> <li>Can be readily</li> <li>blade; scratch leaves a and scratch is readily wder has been blown away.</li> <li>scratched with difficulty; the powder and is often as of the knife steel may</li> </ul>	Solution and Void Conditions – Swelling	Residual Soil — Advanced state of decomposition resulting in plastic soils. Rock fabric and structure completely destroyed. Large volume change. Solid, contains no voids Vuggy (pitted) Vesicular (igneous) Porous Cavities Cavernous						
Texture -	surface. Fine - Barely seen	with naked eye	Properties — Slaking Properties —	Nonswelling Swelling Nonslaking Slakes slowly on exposure Slakes readily on exposure						
Structure -	Bedding Flat – 0" – 5" Gently Dipping – Moderately Dippi Steeply Dipping Fractures, scattered Open Cemented Brecciated (Sheared Open Cemented Joints Faulted	or Tight and Fragmented) or Tight	Rock Quality Designation (RQD) —	RQD (Percent)Diagnostic DescriptionGreater than 90Excellent75 - 90Good50 - 75Fair25 - 50PoorLess than 25Very Poor						

APPENDIX A

## **Summary of Roadway Exploration Program**

ARDOT 090069 XNA Access Road - Roadway GHBW Job No. 19-118 Benton County, Arkansas

Boring No.	Approx Sta	Approx Offset, ft	Approx Surf El, ft	Completion Depth, ft
R1	101+00	CL	1284	10
R7	131+00	CL	1219	14
R8	135+00	CL	1220	35
S1	142+80	60 Lt	1157	30
S4	145+75	60 Rt	1123	32
S5	142+60	70 Rt	1149	36
S8	145+55	60 Rt	1120	31
R10	148+90	20 Rt	1143	10
R11	155+30	CL	1098	11
S9	158+30	60 Lt	1098	27
S18	157+85	60 Rt	1091	23
R12	170+00	CL	1146	30
R13	174+50	CL	1126	20
S27	175+45	45 Lt	1085	15
S32	181+45	60 Lt	1080	27
S33	176+00	60 Rt	1078	21
S38	182+15	60 Rt	1080	27.5
R14	185+00	CL	1095	10
R15	188+50	CL	1101	10
S39	190+90	60 Lt	1106	33
S42	193+20	60 Lt	1126	45
S43	191+60	60 Rt	1106	30
S46	193+90	60 Rt	1134	33
R16	196+75	CL	1190	20
R17	200+00	CL	1202	20
R19	209+00	CL	1215	4.5
R21	220+00	CL	1236	10
R22	225+00	CL	1243	10
R23	230+00	CL	1245	10
R24	235+00	CL	1233	10
R25	240+00	CL	1221	5.5
R26	245+00	CL	1237	15
R27	250+00	CL	1233	25
R29	260+00	CL	1218	20
R30	265+00	CL	1188	15
R31	270+00	CL	1184	15
R32	275+00	CL	1210	10
		-	-	

# **Summary of Roadway Exploration Program**

ARDOT 090069 XNA Access Road - Roadway GHBW Job No. 19-118 Benton County, Arkansas

Boring No.	Approx Sta	Approx Offset, ft	Approx Surf El, ft	Completion Depth_ft
R33	280+00	CL	1213	10
R34	285+00	CL	1183	20
R35	290+00	CL	1217	10
R36	295+00	CL	1221	10
R37	300+00	CL	1226	10
R38	305+00	CL	1225	10
R39	309+00	20 L	1235	10
R40	253+00	CL	1217	20
R41	258+00	CL	1229	40
R42	263+00	CL	1212	20
R43	267+00	CL	1177	15
R44	272+00	CL	1207	10
R45	277+00	CL	1219	10
R48	459+00	CL	1267	10
R49	465+00	CL	1265	10
R50	469+00	CL	1271	10.5
R51	475+00	CL	1289	10
R53	425+75	CL	1295	10
R54	435+00	CL	1268	15
R55	440+00	CL	1261	10
R56	445+00	CL	1264	10
R60	440+00	CL	1299	10
R61	445+00	CL	1290	15
R63	432+00	CL	1268	10
R64	437+00	CL	1290	10
R65	14+40	CL	1250	10
R66	18+40	CL	1244	10
R67	28+40	CL	1249	10
R68	32+40	CL	1246	8.5

### **APPENDIX B**

# **B-R7**: Run 1 (8.5-11.5 ft), Run 2 (11.5-14 ft), Run 3 (14-18 ft)





**<u>ROCK CORE PHOTOS</u>** 090069 XNA Access Road

Benton County, Arkansas

Job No. 19-118

Plate
# B-R8: Run 1 (28-30 ft), Run 2 (30-32 ft), Run 3 (32-35 ft)





A UES Company

### **<u>ROCK CORE PHOTOS</u>** 090069 XNA Access Road

Benton County, Arkansas

Job No. 19-118

Plate

# B-R12: Run 1 (20-25 ft), Run 2 (25-30 ft)





A UES Company

### **<u>ROCK CORE PHOTOS</u>** 090069 XNA Access Road

Benton County, Arkansas

Job No. 19-118

Plate

**APPENDIX C** 

#### PROJECT: 090069 XNA Access Road LOCATION: Benton County, Arkansas GHBW JOB NUMBER: 19-118

DODING	CAMDI E	WATER	AT	TERBERG LIM	IITS			SIEV	E ANA	LYSIS			USCS	
BURING	SAMPLE	CONTENT	LIQUID	PLASTIC	PLASTICITY			PERCE	ENT PA	SSING				CLASS
110.		(%)	LIMIT	LIMIT	INDEX	1 in.	3/4 in.	3/8 in.	#4	#10	#40	#200	CLASS.	CLASS.
R1	0.5-1.5	18	26	16	10				92			54	CL	A-4
R8	9-10	32	67	40	27				69			55	MH	A-7-5
R8	24-25	18	51	38	13				46			19	MH	A-7-5
R10	0.5-1.5	15	27	23	4				73			38	SM	A-4
R10	2.5-3.5	17							63			39	GC	A-7-6
R12	2.5-3.5	17.3	30	20	10				82			49	SC	A-4
R14	2.5-3.5	15		NON-PLASTI	C				44			24	GM	A-1-b
R14	4.5-5.5	15	34	24	10				30			13	GM	A-2-4
R15	0.5-1.5	20		NON-PLASTI	C				78			63	ML	A-4
R15	2.5-3.5	18	37	23	14				37			25	GC	A-2-6
R16	0.5-1.5	40	42	20	22				46			26	GC	A-2-7
R16	14-15	30	38	27	11				64			32	GM	A-2-6
R17	0.5-1.5	17	24	23	1				60			36	GM	A-4
R17	4.5-5.5	19	34	27	7				30			17	GM	A-2-4
R17	9-10	36	61	28	33				81			63	CH	A-7-6
R19	0.5-1.5	12	35	20	15				67			33	SC	A-2-6
							1							
R21	0.5-1.5	24							57			33	GM-GC	A-2-4
R22	0.5-1.5	23	26	18	8				91			76	CL	A-4

**Grubbs, Hoskyn, Barton & Wyatt, LLC** CONSULTING ENGINEERS

#### PROJECT: 090069 XNA Access Road LOCATION: Benton County, Arkansas GHBW JOB NUMBER: 19-118

DODING	SAMDI E	WATER	AT	TERBERG LIN	IITS			SIEV	E ANA	LYSIS			USCS	
DUKING	SAMPLE DEPTH (ft)	CONTENT	LIQUID	PLASTIC	PLASTICITY			PERCE	ENT PA	ASSING	ř		CLASS	CLASS
110.		(%)	LIMIT	LIMIT	INDEX	1 in.	3/4 in.	3/8 in.	#4	#10	#40	#200	CLASS.	CLASS.
R23	0.5-1.5	23	42	20	22				96			88	CL	A-7-6
R24	0.5-1.5	16	27	24	3				74			51	ML	A-4
R25	0.5-1.5	13	23	20	3	100	100	89	76	53	37	32	SM	A-2-4
R25	2.5-3.5	14	30	25	5								SM	A-4
R25	4.5-5.5	30							79			48	SM	A-4
R26	6.5-7.5	12	51	27	24				81			20	SC	A-2-7
R27	4.5-5.5	9	44	27	17				78			15	SM	A-2-7
R27	19-20	21	45	38	7				70			18	SM	A-2-5
R29	14-15	44	51	37	14				91			47	SM	A-2-7
R30	0.5-1.5	23	1	NON-PLASTI	C				71			40	SM	A-4
R30	2.5-3.5	20	41	18	23				70			36	SC	A-7-6
R31	0.5-1.5	22	33	28	5				85			61	ML	A-4
R31	2.5-3.5	21	49	22	27				98			84	CL	A-7-6
R32	0.5-1.5	25	34	18	16				86			73	CL	A-6
R32	2.5-3.5	20	29	19	10				82			65	CL	A-4
R33	0.5-1.5	23				100	89	86	79	75	71	68	ML	A-4
R34	0.5-1.5	14							40			22	GM	A-1-b

**Grubbs, Hoskyn, Barton & Wyatt, LLC** CONSULTING ENGINEERS

#### PROJECT: 090069 XNA Access Road LOCATION: Benton County, Arkansas GHBW JOB NUMBER: 19-118

DODING	SAMDI E	WATER	AT	TERBERG LIN	1ITS			SIEVI	E ANA	LYSIS			USCS	
BURING	SAMPLE	CONTENT	LIQUID	PLASTIC	PLASTICITY	T		PERCE	ENT PA	ASSING	Ì			CLASS
110.	DEFIH(II)	(%)	LIMIT	LIMIT	INDEX	1 in.	3/4 in.	3/8 in.	#4	#10	#40	#200	CLASS.	CLASS.
R35	0.5-1.5	17		NON-PLASTI	C	100	100	82	73	59	47	43	SM	A-4
R35	4.5-5.5	25	55	24	31				79			41	SC	A-7-6
R36	2.5-3.5	20		NON-PLASTI	C				94			45	SM	A-4
R37	0.5-1.5	21	34	26	8				77			30	SM	A-2-4
R37	2.5-3.5	9	30	18	12				73			21	SC	A-2-6
R38	0.5-1.5	17	í	NON-PLASTI	C				57			31	GM	A-2-4
R39	0.5-1.5	15	28	20	8				82			42	SC	A-4
R39	2.5-3.5	18	49	22	27				76			41	SC	A-7-6
R40	0.5-1.5	21							62			41	GM	A-4
R40	14-15	31	<u> </u>	NON-PLASTI	C				72			24	SM	A-2-4
R41	9-10	14	37	23	14				73			17	SC	A-2-6
R42	14-15	25	34	24	10				94			55	ML	A-4
R43	0.5-1.5	18				100	86	77	63	54	47	44	GM	A-4
R43	2.5-3.5	18	35	20	15				79			38	SC	A-6
R44	2.5-3.5	34	55	28	27				97			82	CH	A-7-6
R45	0.5-1.5	15	25	19	6				65			46	GM-GC	A-4
R45	2.5-3.5	23	49	24	25				80			57	CL	A-7-6

**Grubbs, Hoskyn, Barton & Wyatt, LLC** CONSULTING ENGINEERS

#### PROJECT: 090069 XNA Access Road LOCATION: Benton County, Arkansas GHBW JOB NUMBER: 19-118

DODING		WATER	AT	TERBERG LIM	IITS			SIEV	E ANA	LYSIS			USCS	
BURING	SAMPLE	CONTENT	LIQUID	PLASTIC	PLASTICITY			PERCE	ENT PA	SSING	r			CLASS
INU.		(%)	LIMIT	LIMIT	INDEX	1 in.	3/4 in.	3/8 in.	#4	#10	#40	#200	CLASS.	CLASS.
R48	0.5-1.5	21	1	NON-PLASTI	С				75			44	SM	A-4
R48	2.5-3.5	21	42	21	21				76			47	SC	A-7-6
R49	0.5-1.5	26	33	28	5				70			52	ML	A-4
R50	0.5-1.5	30	35	21	14				86			64	CL	A-6
R51	0.5-1.5	22	33	23	10				76			50	SC	A-4
R51	2.5-3.5	20	36	23	13				93			54	CL	A-6
R53	2.5-3.5	19	48	20	28				79			63	CL	A-7-6
R54	0.5-1.5	20	1	NON-PLASTI	С				83			59	ML	A-4
R54	4.5-5.5	32	54	27	27				82			41	SC	A-7-6
R55	2.5-3.5	21	33	25	8				79			39	SM	A-4
R56	0.5-1.5	20	24	21	3				71			52	ML	A-4
R56	4.5-5.5	25	55	35	20				74			32	SM	A-2-7
R60	0.5-1.5	16	1	NON-PLASTI	C	-		-	61			42	GM	A-4
R60	2.5-3.5	21	29	17	12				65			35	GC	A-2-6
R61	2.5-3.5	20	40	24	16				77			40	SC	A-6
R61	9-10	9	1	NON-PLASTI	C	100	100	92	72	53	29	20	SM	A-1-b
R63	0.5-1.5	15							54			40	GM	A-4
R63	2.5-3.5	19	39	23	16				70			44	GC	A-6

Grubbs, Hoskyn,

#### PROJECT: 090069 XNA Access Road LOCATION: Benton County, Arkansas GHBW JOB NUMBER: 19-118

DODING	SAMDI E	WATER	AT	TERBERG LIM	IITS			SIEV	E ANA	LYSIS			USCS	
DUKING	SAMPLE DEPTH (ft)	CONTENT	LIQUID	PLASTIC	PLASTICITY			PERCI	ENT PA	SSING	r F		CLASS	
110.		(%)	LIMIT	LIMIT	INDEX	1 in.	3/4 in.	3/8 in.	#4	#10	#40	#200	CLASS.	CLASS.
R64	0.5-1.5	17	31	19	12				78			67	CL	A-6
R65	2.5-3.5	31	77	39	38	100	100	100	92	86	72	66	CH	A-7-5
R66	0.5-1.5	20	35	22	13				97			87	CL	A-6
R66	4.5-5.5	41		NON-PLASTI	C				80			30	ML	A-4
R67	0.5-1.5	12	36	16	20				95			74	CL	A-6
R67	2.5-3.5	14	35	22	13	100	100	92	79	67	55	48	SC	A-6
R68	0.5-1.5	17		NON-PLASTI	С				94			68	ML	A-4
R68	2.5-3.5	19	39	21	18				81			56	CL	A-6
S1	0.5-1.5	14							45			21	GM	A-1-b
S4	2.5-3.5	15	1	NON-PLASTI	С				57			38	GM	A-4
S5	6.5-7.5	16	32	25	7				74			30	SM	A-2-4
S8	2.5-3.5	19	30	19	11				77			49	SC	A-6
S8	14-15	13	32	18	14				65			20	SC	A-2-6
S9	6.5-7.5	16	34	17	17				71			27	SC	A-2-6
S9	14-15	26	40	21	19				98			86	CL	A-6
S18	9-10	23				100	100	87	83	78	62	53	ML	A-4
S27	4.5-5.5	50	38	32	6				100			63	ML	A-4

Grubbs, Hoskyn, Barton & Wyatt, LLC

CONSULTING ENGINEERS

#### PROJECT: 090069 XNA Access Road LOCATION: Benton County, Arkansas GHBW JOB NUMBER: 19-118

DODING	SAMDI E	WATER	AT	TERBERG LIN	1ITS			SIEV	E ANA	LYSIS			USCS	
DUKING	SAMPLE DEPTH (ft)	CONTENT	LIQUID	PLASTIC	PLASTICITY			PERCE	ENT PA	SSING	r F		CLASS	CLASS
110.		(%)	LIMIT	LIMIT	INDEX	1 in.	3/4 in.	3/8 in.	#4	#10	#40	#200	CLASS.	CLASS.
S32	0.5-1.5	17	27	20	7				64			48	GM-GC	A-4
S32	4.5-5.5	13	25	21	4				58			22	GM-GC	A-1-b
S33	6.5-7.5	20	37	21	16				50			28	SC	A-2-6
S38	0.5-1.5	25	37	26	11	-			98	1		90	ML	A-6
S39	2.5-3.5	26	38	22	16	1			100	1		77	CL	A-6
S39	9-10	22	32	19	13				98			90	CL	A-6
S42	2.5-3.5	20	29	20	9				60			36	GC	A-4
S42	9-10	25	63	21	42				72			52	CH	A-7-6
S43	2.5-3.5	20	42	23	19				94			58	CL	A-7-6
S43	6.5-7.5	21	39	18	21				97			82	CL	A-6
S46	9-10	17	29	23	6				58			27	GM	A-2-4
S52A	2.5-3.5	18	45	29	16				52			31	GM	A-2-7
S57	2.5-3.5	15		NON-PLASTIC					73			39	SM	A-4
S59	6.5-7.5	19	56	32	24				80			36	SM	A-7-5

















# **APPENDIX D**

## SUMMARY of PROCTOR and CBR TEST RESULTS

PROJECT: 090069 XNA Access Road LOCATION: Benton County, Arkansas GHBW JOB NUMBER: 19-118

PHR         PHR <th></th> <th></th> <th></th> <th></th> <th></th> <th colspan="5"></th> <th></th> <th></th> <th>PROCTOR TE</th> <th>ST RESULTS</th> <th>CBR TE</th> <th>ST RESULTS</th>													PROCTOR TE	ST RESULTS	CBR TE	ST RESULTS	
1/5A       0.5-1.5       305+00       CL       Brown clayey SUT w/ fine to coarse chert       22       34       24       10       37       51       ML       A.4       110.2       13.2       95.0       7.8         1/5A       0.5-1.5       305+00       CL       fine to coarse chert       22       34       24       10       37       51       ML       A.4       110.2       13.2       95.0       7.8         1/5A       0.5-1.5       305+00       CL       fine to coarse chert       22       34       24       10       37       51       ML       A.4       110.2       13.2       96.0       90.0         1/5A       0.5-1.5       305+00       CL       fine to coarse chert       22       34       24       100       37       51       ML       A.4       110.2       13.2       96.0       90.0         1/5B       0.5-1.5       305+00       CL       Brown clayey SUT w/ fine to coarse chert       22       34       24       100       37       51       ML       A.4       110.2       13.2       98.0       14.2         1/5B       0.5-1.5       445+00       CL       Reddish brown and reddish trun clayey chert       20	TEST PIT No.	SAMPLE DEPTH (ft)	APPROX STATION	APPROX OFFSET (ft)	SOIL DESCRIPTION	WATER CONTENT (%)	A' LIQUID LIMIT	TTERBERG PLASTIC LIMIT	LIMITS PLASTICITY INDEX	PERCENT RETAINED #4	PERCENT PASSING #200	UNIFIED CLASS.	AASHTO CLASS.	MAX DRY UNIT WT (pcf)	OPTIMUM MOISTURE (%)	PERCENT COMPACTION of MAX DRY UNIT WT	LABORATORY CBR VALUE
1/5A       0.5-1.5       305+00       CL       fine to coarse chert gravel       22       34       24       10       37       51       ML       A-4       110.2       13.2       95.0       7.8         1/5A       0.5-1.5       305+00       CL       fine to coarse chert gravel       22       34       24       10       37       51       ML       A-4       110.2       13.2       95.0       7.8         1/5A       0.5-1.5       305+00       CL       fine to coarse chert gravel       22       34       24       10       37       51       ML       A-4       110.2       13.2       96.0       9.0         1/5A       0.5-1.5       305+00       CL       fine to coarse chert gravel       22       34       24       10       37       51       ML       A-4       110.2       13.2       96.0       9.0         1/5A       0.5-1.5       305+00       CL       fine to coarse chert gravel       22       34       24       10       37       51       ML       A-4       110.2       13.2       96.0       9.0         1/5B       0.5-1.5       445+00       CL       fine to coarse chert gravel       20       37       23					Brown clayey SILT w/												
interpretation         interp	1/5A	0.5-1.5	305+00	CL	fine to coarse chert	22	34	24	10	37	51	ML	A-4	110.2	13.2	95.0	7.8
1/5A       0.5-1.5       305+00       CL       Brown clayey SLT w/ fine to coarse chert       22       34       24       10       37       51       ML       A.4       110.2       13.2       91.6       3.6         1/5A       0.5-1.5       305+00       CL       fine to coarse chert       22       34       24       10       37       51       ML       A.4       110.2       13.2       91.6       3.6         1/5A       0.5-1.5       305+00       CL       fine to coarse chert       22       34       24       10       37       51       ML       A.4       110.2       13.2       98.3       14.2         1/5B       0.5-1.5       305+00       CL       fine to coarse chert       22       34       24       10       37       51       ML       A.4       110.2       13.2       98.3       14.2         1/5B       0.5-1.5       445+00       CL       reddish brown and reddish brown and GRAVEL, sandv       7       23       14       35       46       GC       A.6       111.2       12.4       90.1       99.9       10.9         1/5B       0.5-1.5       445+00       CL       reddish brown and GRAVEL, sandv       7 <td< td=""><td></td><td></td><td></td><td></td><td>gravel</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></td<>					gravel												
1/5A       0.5-1.5       305+00       CL       fine to coarse chert gravel with uncrouse chert       22       34       24       10       37       51       ML       A.4       110.2       13.2       91.6       3.6         1/5A       0.5-1.5       305+00       CL       fine to coarse chert       22       34       24       10       37       51       ML       A.4       110.2       13.2       96.0       9.0         1/5A       0.5-1.5       305+00       CL       Brown clayey SILT w/ fine to coarse chert       22       34       24       10       37       51       ML       A.4       110.2       13.2       96.0       9.0         1/5A       0.5-1.5       305+00       CL       Brown clayey SILT w/ fine to coarse chert       22       34       24       10       37       51       ML       A.4       110.2       13.2       98.3       14.2         1/5B       0.5-1.5       445+00       CL       Reddish brown and reddish tan clayey chert       20       37       23       14       35       46       GC       A-6       111.2       12.4       95.0       10.9         1/5B       0.5-1.5       445+00       CL       reddish brown and reddi					Brown clayey SILT w/												
interpretation         interp	1/5A	0.5-1.5	305+00	CL	fine to coarse chert	22	34	24	10	37	51	ML	A-4	110.2	13.2	91.6	3.6
1/5A       0.5-1.5       305+00       CL       Brown clayey SLT w/ fine to coarse chert       22       34       24       10       37       51       ML       A.4       110.2       13.2       96.0       9.0         1/5A       0.5-1.5       305+00       CL       Brown clayey SLT w/ fine to coarse chert       22       34       24       10       37       51       ML       A.4       110.2       13.2       96.0       9.0         1/5B       0.5-1.5       305+00       CL       Eddish brown and GRAVEL sandy       20       37       23       14       35       46       GC       A.6       111.2       12.4       95.0       10.9         1/5B       0.5-1.5       445+00       CL       reddish brown and GRAVEL sandy       20       37       23       14       35       46       GC       A.6       111.2       12.4       90.1       9.9         1/5B       0.5-1.5       445+00       CL       reddish brown and GRAVEL sandy       20       37       23       14       35       46       GC       A-6       111.2       12.4       90.1       9.9       10.9         1/5B       0.5-1.5       445+00       CL       reddish brown and GRAVEL s					gravel												
1/5A       0.5-1.5       305+00       CL       fine to coarse chert       22       34       24       10       37       51       ML       A.4       110.2       13.2       96.0       9.0         1/5A       0.5-1.5       305+00       CL       fine to coarse chert       22       34       24       10       37       51       ML       A.4       110.2       13.2       96.0       9.0         1/5B       0.5-1.5       305+00       CL       fine to coarse chert       22       34       24       10       37       51       ML       A.4       110.2       13.2       98.3       14.2         array       gravel       gravel       gravel       20       37       23       14       35       46       GC       A.6       111.2       12.4       95.0       10.9         1/5B       0.5-1.5       445+00       CL       reddish brown and reddish brown and reddi					Brown clayey SILT w/												
interpretation         interp	1/5A	0.5-1.5	305+00	CL	fine to coarse chert	22	34	24	10	37	51	ML	A-4	110.2	13.2	96.0	9.0
1/5A       0.5-1.5       305+00       CL       Brown clayey SILT w/ fine to coarse cher       22       34       24       100       37       51       ML       A.4       110.2       13.2       98.3       14.2         1/5B       0.5-1.5       445+00       CL       Redish brown and redish tan clayey chert       20       37       23       14       35       46       6C       A.6       111.2       12.4       95.0       10.9         1/5B       0.5-1.5       445+00       CL       Redish brown and GRAVEL, sandy       20       37       23       14       35       46       6C       A.6       111.2       12.4       95.0       10.9         1/5B       0.5-1.5       445+00       CL       Redish brown and GRAVEL, sandy       20       37       23       14       35       46       6C       A.6       111.2       12.4       90.01       90.9       90.9         1/5B       0.5-1.5       445+00       CL       Redish brown and redish tan clayey chert       20       37       23       14       35       46       6C       A.6       111.2       12.4       90.1       90.9       11.0         1/5B       0.5-1.5       445+00       CL					gravel												
1/5A $0.5-1.5$ $305+00$ CL       fine to coarse chert gravel $22$ $34$ $24$ $10$ $37$ $51$ ML $A.4$ $110.2$ $13.2$ $98.3$ $14.2$ $1/5B$ $0.5-1.5$ $445+00$ CL       reddish brown and GRAVEL, sandy $20$ $37$ $23$ $14$ $35$ $46$ $GC$ $A-6$ $111.2$ $12.4$ $95.0$ $10.9$ $1/5B$ $0.5-1.5$ $445+00$ CL       reddish brown and GRAVEL, sandy $20$ $37$ $23$ $14$ $35$ $46$ $GC$ $A-6$ $111.2$ $12.4$ $95.0$ $10.9$ $1/5B$ $0.5-1.5$ $445+00$ CL       reddish brown and reddish brown and Reddish brown and Reddish brown and GRAVEL, sandy $37$ $23$ $14$ $35$ $46$ $GC$ $A-6$ $111.2$ $12.4$ $95.5$ $11.0$ $1/5B$ $0.5-1.5$ $445+00$ CL       reddish torown and reddish torown and reddish torown and GRAVEL, sandy $20$ $37$ $23$ $14$ $35$ $46$ $GC$ $A-6$ $111.2$ $12.4$ <					Brown clayey SILT w/												
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	1/5A	0.5-1.5	305+00	CL	fine to coarse chert	22	34	24	10	37	51	ML	A-4	110.2	13.2	98.3	14.2
1/5B       0.5-1.5       445+00       CL       Reddish brown and reddish tan clayey chert GRAVEL, sandy       20       37       23       14       35       46       GC       A-6       111.2       12.4       95.0       10.9         1/5B       0.5-1.5       445+00       CL       reddish brown and reddish tan clayey chert GRAVEL, sandy       20       37       23       14       35       46       GC       A-6       111.2       12.4       90.1       9.9         1/5B       0.5-1.5       445+00       CL       reddish brown and reddish brown and reddish tan clayey chert GRAVEL, sandy       20       37       23       14       35       46       GC       A-6       111.2       12.4       90.1       9.9         1/5B       0.5-1.5       445+00       CL       reddish brown and reddish tan clayey chert GRAVEL, sandy       20       37       23       14       35       46       GC       A-6       111.2       12.4       95.5       11.0         1/5B       0.5-1.5       445+00       CL       sandy       37       23       14       35       46       GC					gravel												
1/5B $0.5-1.5$ $445+00$ CL       reddish tan clayey chert $20$ $37$ $23$ $14$ $35$ $46$ GC $A-6$ $111.2$ $12.4$ $95.0$ $10.9$ $1/5B$ $0.5-1.5$ $445+00$ CL       reddish tan clayey chert $20$ $37$ $23$ $14$ $35$ $46$ GC $A-6$ $111.2$ $12.4$ $95.0$ $10.9$ $1/5B$ $0.5-1.5$ $445+00$ CL       reddish tan clayey chert $20$ $37$ $23$ $14$ $35$ $46$ GC $A-6$ $111.2$ $12.4$ $90.1$ $9.9$ $1/5B$ $0.5-1.5$ $445+00$ CL       reddish tan clayey chert $20$ $37$ $23$ $14$ $35$ $46$ GC $A-6$ $111.2$ $12.4$ $98.7$ $11.0$ $1/5B$ $0.5-1.5$ $445+00$ CL       reddish tan clayey chert $20$ $37$ $23$ $14$ $35$ $46$ GC $A-6$ $111.2$ $12.4$ $98.7$ $13.4$ $10.6$ $11.6$ $96.5$ <td></td> <td></td> <td></td> <td></td> <td>Reddish brown and</td> <td></td>					Reddish brown and												
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	1/5B	0.5-1.5	445 + 00	CL	reddish tan clayey chert	20	37	23	14	35	46	GC	A-6	111.2	12.4	95.0	10.9
$\begin{array}{c c c c c c c c c c c c c c c c c c c $					GRAVEL, sandy												
1/5B $0.5-1.5$ $445+00$ CL       reddish tan clayey chert GRAVEL, sandy $20$ $37$ $23$ $14$ $35$ $46$ $GC$ $A-6$ $111.2$ $12.4$ $90.1$ $9.9$ $1/5B$ $0.5-1.5$ $445+00$ CL       reddish brown and GRAVEL, sandy $20$ $37$ $23$ $14$ $35$ $46$ $GC$ $A-6$ $111.2$ $12.4$ $90.1$ $9.9$ $1/5B$ $0.5-1.5$ $445+00$ CL       reddish brown and GRAVEL, sandy $20$ $37$ $23$ $14$ $35$ $46$ $GC$ $A-6$ $111.2$ $12.4$ $95.5$ $11.0$ $1/5B$ $0.5-1.5$ $445+00$ CL       reddish tan clayey chert GRAVEL, sandy $20$ $37$ $23$ $14$ $35$ $46$ $GC$ $A-6$ $111.2$ $12.4$ $98.7$ $13.4$ $1/7A$ $0.5-2.0$ $245+00$ CL       Brown SIL1, slightly sandy, with some chert fragments $22$ $Non-Plastic$ $55$ $85$ ML $A-4$ $106.6$ $14.5$ $96.5$ $13.0$ $17$					Reddish brown and												
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	1/5B	0.5-1.5	445+00	CL	reddish tan clayey chert	20	37	23	14	35	46	GC	A-6	111.2	12.4	90.1	9.9
1/5B0.5-1.5445+00CLreddish brown and reddish tan clayey chert GRAVEL, sandy203723143546GCA-6111.212.495.511.01/7B0.5-1.5445+00CLReddish brown and reddish tan clayey chert GRAVEL, sandy203723143546GCA-6111.212.498.713.41/7B0.5-2.0245+00CLsandy, with some chert fragments22 $Non-Plastic$ 585MLA-4106.614.596.513.01/7B0.5-2.0185+00CLBrown silty chert GRAVEL, sandy22 $Non-Plastic$ 3749GMA-4105.214.696.614.81/7C0.5-2.0121+00CLwith numerous chert23 $Non-Plastic$ 3257MLA-4107.311.996.916.0					GRAVEL, sandy												
1/5B $0.5-1.5$ $445+00$ CL       reddish tan clayey chert $20$ $37$ $23$ $14$ $35$ $46$ $GC$ $A-6$ $111.2$ $12.4$ $95.5$ $11.0$ $1/5B$ $0.5-1.5$ $445+00$ CL       reddish tan clayey chert $20$ $37$ $23$ $14$ $35$ $46$ $GC$ $A-6$ $111.2$ $12.4$ $95.5$ $11.0$ $1/5B$ $0.5-1.5$ $445+00$ CL       reddish tan clayey chert $20$ $37$ $23$ $14$ $35$ $46$ $GC$ $A-6$ $111.2$ $12.4$ $95.5$ $11.0$ $1/7B$ $0.5-2.0$ $245+00$ CL       Brown silty chert fragments $20$ $-7$ -Non-Plastic $55$ $85$ ML $A-4$ $106.6$ $14.5$ $96.5$ $13.0$ $1/7B$ $0.5-2.0$ $185+00$ CL       Brown silty chert GRAVEL, sandy $22$ $Non-Plastic$ $37$ $49$ $GM$ $A-4$ $105.2$ $14.6$ $96.6$ $14.8$ $1/7C$ $0.5-2.0$ $121+00$ <t< td=""><td></td><td></td><td></td><td></td><td>Reddish brown and</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></t<>					Reddish brown and												
$\frac{1}{178} \begin{array}{ c c c c c c c c c c c c c c c c c c c$	1/5B	0.5-1.5	445+00	CL	reddish tan clayey chert	20	37	23	14	35	46	GC	A-6	111.2	12.4	95.5	11.0
1/5B $0.5-1.5$ $445+00$ $CL$ Reddish brown and reddish tan clayey chert GRAVEL, sandy $20$ $37$ $23$ $14$ $35$ $46$ $GC$ $A-6$ $111.2$ $12.4$ $98.7$ $13.4$ $1/7A$ $0.5-2.0$ $245+00$ $CL$ Brown SIL1, slightly fragments $22$ $Non-Plastic$ $5$ $85$ $ML$ $A-4$ $106.6$ $14.5$ $96.5$ $13.0$ $1/7B$ $0.5-2.0$ $185+00$ $CL$ Brown silty chert GRAVEL, sandy $22$ $Non-Plastic$ $37$ $49$ $GM$ $A-4$ $105.2$ $14.6$ $96.6$ $14.8$ $1/7C$ $0.5-2.0$ $121+00$ $CL$ With numerous chert $23$ $Non-Plastic$ $32$ $57$ $ML$ $A-4$ $107.3$ $11.9$ $96.9$ $16.0$					GRAVEL, sandy												
1/5B       0.5-1.5       445+00       CL       reddish tan clayey chert       20       37       23       14       35       46       GC       A-6       111.2       12.4       98.7       13.4         1/7A       0.5-2.0       245+00       CL       sandy, with some chert fragments       22      Non-Plastic       5       85       ML       A-4       106.6       14.5       96.5       13.0         1/7B       0.5-2.0       185+00       CL       Brown silty chert GRAVEL, sandy       22      Non-Plastic       37       49       GM       A-4       105.2       14.6       96.6       14.8         1/7C       0.5-2.0       121+00       CL       with numerous chert       23      Non-Plastic       32       57       ML       A-4       107.3       11.9       96.9       16.0	1/100			~	Reddish brown and	•									10.1		10.1
I/7A $0.5-2.0$ $245+00$ $CL$ $Brown SIL1, slightly sandy, with some chert fragments22Non-Plastic585MLA-4106.614.596.513.01/7B0.5-2.0185+00CLBrown silty chert GRAVEL, sandy22Non-Plastic3749GMA-4105.214.696.614.81/7C0.5-2.0121+00CLBrown silty chert GRAVEL, sandy22Non-Plastic3257MLA-4107.311.996.916.0$	1/5B	0.5-1.5	445+00	CL	reddish tan clayey chert	20	37	23	14	35	46	GC	A-6	111.2	12.4	98.7	13.4
1/7A $0.5-2.0$ $245+00$ $CL$ Brown SiL1, singing fragments $22$ $Non-Plastic$ $5$ $85$ $ML$ $A-4$ $106.6$ $14.5$ $96.5$ $13.0$ $1/7B$ $0.5-2.0$ $185+00$ $CL$ Brown silty chert GRAVEL, sandy $22$ $Non-Plastic$ $37$ $49$ $GM$ $A-4$ $105.2$ $14.6$ $96.6$ $14.8$ $1/7E$ $0.5-2.0$ $121+00$ $CL$ $Brown silty chert GRAVEL, sandy       22 Non-Plastic 37 49 GM A-4 105.2 14.6 96.6 14.8 1/7C 0.5-2.0 121+00 CL       with numerous chert       23 Non-Plastic 32 57 ML A-4 107.3 11.9 96.9 16.0$					GRAVEL, sandy Brown SILT slightly												
1/7A       0.5-2.0       245+00       CL       sandy, with some client fragments       22      Non-Plastic       5       85       ML       A-4       106.6       14.5       96.5       13.0         1/7B       0.5-2.0       185+00       CL       Brown silty chert GRAVEL, sandy       22      Non-Plastic       37       49       GM       A-4       105.2       14.6       96.6       14.8         1/7C       0.5-2.0       121+00       CL       with numerous chert       23      Non-Plastic       32       57       ML       A-4       107.3       11.9       96.9       16.0	1 /7 4	0520	245+00	CI	sandy with some chert	22		Man Dla	-4:-	5	0.5	М		106.6	145	06.5	12.0
$\frac{1}{1/7E} \begin{array}{c c c c c c c c c c c c c c c c c c c $	1//A	0.5-2.0	245+00	CL	fragmonts	22	-	Non-Plas	suc	2	85	ML	A-4	106.6	14.5	96.5	13.0
1/7B       0.5-2.0       185+00       CL       Blown sity clift       22      Non-Plastic       37       49       GM       A-4       105.2       14.6       96.6       14.8         1/7C       0.5-2.0       121+00       CL       Image: state of the st					Brown silty chert												
1/7C         0.5-2.0         121+00         CL         Vith numerous chert         23        Non-Plastic         32         57         ML         A-4         107.3         11.9         96.9         16.0	1/7B	0.5-2.0	185+00	CL	GPAVEL condu	22	-	-Non-Plas	stic	37	49	GM	A-4	105.2	14.6	96.6	14.8
1/7C 0.5-2.0 121+00 CL with numerous chert 23Non-Plastic 32 57 ML A-4 107.3 11.9 96.9 16.0					Tan and brown SILT												
1//C 0.5-2.0 121+00 CL	1/70	0520	121+00	CI	with numerous chert	22		Non Dia	stic	22	57	МТ	A 4	107.2	11.0	06.0	16.0
tragments	1//C 0.5-2.0 1	121700		fragments	23	-	-inon-ria	5110	32	57	IVIL	A-4	107.5	11.7	90.9	10.0	



Project:	090069 XNA A	Access Road	- Benton	County, Arkansas		Job No:	19-118
Material Descrip	otion:	Brown claye	y SILT w	/ fine to coarse chert gra	vel and	rootlets	
Location Sample	ed/Source:	On-Site (App	orox Sta	305+00, CL)			
Sample No:	01/05A						
Date Sampled:	1/5/2022						
Sampled By:	JDF						
Date Tested:	1/9/2022			ATTERBERG LIMITS		GRAD	DATION
Tested By:	Robert Brewe	<sup>-</sup> (CTTP #251	6)	AASHTO T 89, T 90		AASHTO	T 11, T 27
Report Date:	1/26/2022			Liquid Limit: 34		Sieve	Percent
				Plastic Limit: 24		Number	Passing
LAB COMP	ACTION PROC	EDURE:		Plasticity Index: 10		2"	96
AASHT	OT 180 Metho	od: D			•	1 1/2"	86
Maximum Unit	Dry Wt. (pcf):	110.2		Unified Classification/		1"	82
<b>Optimum Wate</b>	r Content (%):	13.2		AASHTO M145-91		3/4"	78
*Includes rock replacem	ent of +3/4" Material			ML A-4		3/8"	71
					•	#4	63
						#10	57
						#40	53

As Received Water Content: 21.5%

Zero Air Voids Line of Optimum -Est. Gs = 2.50 **Dry Unit Wt. (pcf)** 109 108 102 Water Content (%)

#200











Project:	090069 XNA A	ccess Road	- Benton	Count	y, Arkansas	_	Job No:	19-118
Material Descrip	tion:	Reddish Bro	wn and I	Reddis	h Tan clayey cher	t GRAVI	EL, sandy	
Location Sample	ed/Source:	On-Site (App	orox Sta	445+00	), CL)			
Sample No:	01/05B							
Date Sampled:	1/5/2022							
Sampled By:	JDF							
Date Tested:	1/9/2022			ATTE	RBERG LIMITS		GRAD	DATION
Tested By:	Robert Brewer	(CTTP #251	6)	AAS	HTO T 89, T 90		AASHTO	T 11, T 27
Report Date:	1/10/2022			Liquid	Limit: 37		Sieve	Percent
				Plastic	c Limit: 23		Number	Passing
LAB COMP.	ACTION PROC	EDURE:		Plastic	city Index: 14		2"	100
AASHT	OT 180 Metho	od: D			•	•	1 1/2"	95
Maximum Unit	Dry Wt. (pcf):	111.2		Unifie	d Classification/		1"	91
<b>Optimum Wate</b>	r Content (%):	12.4		AASH	TO M145-91		3/4"	87
*Includes rock replacem	ent of +3/4" Material			GC	A-6		3/8"	77
							#4	65
							#10	55
							#40	50

As Received Water Content: 20.4%



#200











#### REPORT OF STANDARD PROCTOR (AASHTO T 99)

Project:	090069 XNA A	ccess Road	- Benton	County, Arkansas		Job No:	19-118
Material Description	tion:	Brown SILT,	slighty s	andy, with some chert frag	ments		
Location Sample	d/Source:	Boring R26 (	Approx S	Sta 245+00, CL)			
Sample No:	01/07A						
Date Sampled:	1/7/2023						
Sampled By:	JDF						
Date Tested:	2/10/2023			ATTERBERG LIMITS		GRAD	DATION
Tested By:	Robert Brewer	· (CTTP #251	6)	AASHTO T 89, T 90		AASHTO	T 11, T 27
Report Date:	2/20/2023			Liquid Limit: NP		Sieve	Percent
				Plastic Limit: NP		Number	Passing
LAB COMP/	ACTION PROC	EDURE:		Plasticity Index: NP		2"	100
AASHT	OT99 Metho	d: D				1 1/2"	100
Maximum Unit	Dry Wt. (pcf):	106.6		Unified Classification/		1"	100
Optimum Water	Content (%):	14.5		AASHTO M145-91		3/4"	99
				ML A-4		3/8"	98
						#4	95
						#10	92

As Received Water Content: 2

22.1%



#40

#200

88





Project:	090069 XNA A	ccess Road ·	- Benton	County, Arkansas	Job No:	19-118
Material Descrip	tion:	Brown silty c	hert GR	AVEL, sandy		
Location Sample	ed/Source:	Boring R14	(Approx	Sta 185+00, CL)		
Sample No:	01/07B					
Date Sampled:	1/7/2023					
Sampled By:	JDF					
Date Tested:	2/8/2023			ATTERBERG LIMITS	GRAI	DATION
Tested By:	Robert Brewer	(CTTP #251	6)	AASHTO T 89, T 90	AASHTO	T 11, T 27
Report Date:	2/20/2023			Liquid Limit: NP	Sieve	Percent
-				Plastic Limit: NP	Number	Passing
LAB COMP.	ACTION PROCE	EDURE:		Plasticity Index: NP	2"	100
AASHT	OT 180 Metho	d: D		-	1 1/2"	95
Maximum Unit	Dry Wt. (pcf):	105.2		Unified Classification/	1"	91
<b>Optimum Wate</b>	r Content (%):	14.6		AASHTO M145-91	3/4"	85
				GM A-4	3/8"	72
					#4	64
					#10	56

As Received Water Content: 22.1%



#40

#200

52





Project:		lob No:	10 110					
Project.	090009 XNA A	Access Road	- Denion	Coun	ly, Arkansas	-	JOD NO.	19-110
Material Descrip	tion:	Tan and bro	wn SILT	with n	umerous chert fragm	nents		
Location Sample	ed/Source:	Boring R5 (A	Approx St	ta 121 <sup>.</sup>	+00, CL)			
Sample No:	01/07C							
Date Sampled:	1/7/2023							
Sampled By:	JDF							
Date Tested:	2/10/2023			ATTE	RBERG LIMITS		GRAD	DATION
Tested By:	Robert Brewe	r (CTTP #251	6)	AA	SHTO T 89, T 90		AASHTO	T 11, T 27
Report Date:	2/20/2023			Liquic	I Limit: NP		Sieve	Percent
				Plasti	c Limit: NP	1	Number	Passing
LAB COMP.	ACTION PROC	EDURE:		Plasti	city Index: NP		2"	100
AASHT	OT 180 Metho	od: D				_	1 1/2"	99
Maximum Unit	Dry Wt. (pcf):	107.3		Unifie	d Classification/		1"	93
<b>Optimum Wate</b>	r Content (%):	11.9		<b>AASH</b>	ITO M145-91		3/4"	88
				ML	A-4		3/8"	77
						-	#4	68
							#10	62
							#40	59

As Received Water Content: 22.8%



#200



# **APPENDIX E**
## Summary of Stability Analysis Results ARDOT 090069 XNA Access Road: Roadway Sections GHBW Job No. 19-118 Benton County, Arkansas

	Design Loading Condition	Calculated Minimum Factor of Safety
STA 135+00	End of Construction	3.86
Cut Slope; $H = 33$ ft	Long Term	2.02
3H:1V	Seismic ( $k_h = A_S/2 = 0.025$ )	3.54
STA 170±00	End of Construction	3.09
Cut Slope; H=43 ft	Long Term	2.55
3H:1V	Seismic ( $k_h = A_S/2 = 0.025$ )	3.01
STA 215+40	End of Construction	2.50
Fill Slope; $H = 57$ ft	Long Term	2.37
3H:1V	Seismic ( $k_h = A_S/2 = 0.025$ )	2.29
STA 252±00	End of Construction	5.93
Cut Slope; $H = 22$ ft	Long Term	3.36
3H:1V	Seismic ( $k_h = A_S/2 = 0.025$ )	5.25
STA 266+60	End of Construction	2.44
Fill Slope; $H = 53$ ft	Long Term	2.41
3H:1V	Seismic ( $k_h = A_S/2 = 0.025$ )	2.23



Results of Stability Analyses – End of Construction STA 135+00 3H:1V Slope, H=33 ft ± 19-118 – ARDOT 090069 XNA Access Road – Roadway Section



Results of Stability Analyses – Long Term Condition STA 135+00 3H:1V Slope, H=33 ft ± 19-118 – ARDOT 090069 XNA Access Road – Roadway Section



 $\begin{array}{c} \mbox{Results of Stability Analyses - Seismic Condition (k_h = A_S / 2 = 0.025) \\ STA 135 + 00 \\ 3H: 1V \ Slope, \ H = 33 \ ft \pm \\ 19 - 118 - \ ARDOT \ 090069 \ XNA \ Access \ Road - \ Roadway \ Section \\ \end{array}$ 



 $\begin{array}{c} \mbox{Results of Stability Analyses}-\mbox{End of Construction} \\ \mbox{STA 170+00} \\ \mbox{3H:1V Slope, H=43 ft } \pm \\ \mbox{19-118}-\mbox{ARDOT 090069 XNA Access Road}-\mbox{Roadway Section} \end{array}$ 



Results of Stability Analyses – Long Term Condition STA 170+00 3H:1V Slope, H=43 ft ± 19-118 – ARDOT 090069 XNA Access Road – Roadway Section



 $\label{eq:kinetic} \begin{array}{l} \mbox{Results of Stability Analyses - Seismic Condition} (k_h = A_S \slashed{A_S} \slashed{A_S} (2=0.025) \\ \mbox{STA 170+00} \\ \mbox{3H:1V Slope, H=43 ft } \pm \\ \mbox{19-118} - \mbox{ARDOT 090069 XNA Access Road} - \mbox{Roadway Section} \end{array}$ 



Results of Stability Analyses – End of Construction STA 215+40 3H:1V Slope, H=57 ft ± 19-118 – ARDOT 090069 XNA Access Road – Roadway Section



Results of Stability Analyses – Long Term Condition STA 215+40 3H:1V Slope, H=57 ft ± 19-118 – ARDOT 090069 XNA Access Road – Roadway Section



 $\begin{array}{l} \mbox{Results of Stability Analyses - Seismic Condition (k_h = A_S / 2 = 0.025) \\ STA \ 215 + 40 \\ 3H: 1V \ Slope, \ H = 57 \ ft \pm \\ 19 \ -118 - \ ARDOT \ 090069 \ XNA \ Access \ Road - Roadway \ Section \end{array}$ 



Results of Stability Analyses – End of Construction STA 252+00 3H:1V Slope, H=22 ft ± 19-118 – ARDOT 090069 XNA Access Road – Roadway Section



Results of Stability Analyses – Long Term Condition STA 252+00 3H:1V Slope, H=22 ft ± 19-118 – ARDOT 090069 XNA Access Road – Roadway Section



 $\begin{array}{c} \text{STA 252+00} \\ 3\text{H:1V Slope, H=22 ft} \pm \\ 19\text{-}118 - \text{ARDOT 090069 XNA Access Road} - \text{Roadway Section} \end{array}$ 



Results of Stability Analyses – End of Construction STA 266+60 3H:1V Slope, H=53 ft ± 19-118 – ARDOT 090069 XNA Access Road – Roadway Section



Results of Stability Analyses – Long Term Condition STA 266+60 3H:1V Slope, H=53 ft ± 19-118 – ARDOT 090069 XNA Access Road – Roadway Section



 $\begin{array}{l} \mbox{Results of Stability Analyses - Seismic Condition (k_h = A_S / 2 = 0.025) \\ \mbox{STA 266+60} \\ \mbox{3H:1V Slope, H=53 ft } \pm \\ \mbox{19-118 - ARDOT 090069 XNA Access Road - Roadway Section} \end{array}$ 



Materials Testing Geotechnical Engineering Environmental Building Sciences & Safety Inspections & Code Compliance Virtual Design Consulting

September 26, 2023 Job No. 19-118

Garver LLC 4701 Northshore Drive North Little Rock, Arkansas 72118

Attn: Mr. Joel Skinner, P.E.

# RESULTS of GEOTECHNICAL INVESTIGATION ARDOT JOB 090069 XNA ACCESS ROAD OVER WAGER ROAD BRIDGE BENTON COUNTY, ARKANSAS

# **INTRODUCTION**

The results of the geotechnical investigation performed for the XNA Access Road over Wager Road twin bridges in Benton County, Arkansas are provided in this report. The Wager Road overpass is one facet of ARDOT Job 090069 Northwest Arkansas Regional Airport Access (Benton Co) (F). This geotechnical investigation was authorized by the Garver, LCC Subconsultant Agreement for Task Order No. 061 of August 27, 2019. Notice to proceed with the field studies was initially received on August 30, 2019. Results and recommendations have been provided throughout the course of this study. A preliminary report for the Wager Road bridge was submitted on August 23, 2023.

We understand the new Wager Road twin bridges will be continuous plate girder structures with four (4) bents, three (3) spans, and a total length of approximately 257 to 257.5 feet. We also understand that a foundation system consisting of steel H-piles is planned. Foundation loads of the new bridges are anticipated to be moderate. The new Wager Road twin bridges will include simple slopes with 2-horizontal to 1-vertical (2H:1V) and 3-horizontal to 1-vertical (3H:1V) configurations for the embankment ends and sides, respectively. Site grading is expected to include up to 35 ft of fill. Preliminary bridge layouts are provided in Appendix A.

The purposes of this study phase were to explore subsurface conditions in the alignments of the twin bridges and to develop recommendations to guide design and construction of foundations and earthwork. These purposes have been achieved by a multi-phased study that included the following.

- Drilling sample and core borings at the planned bridge locations to evaluate subsurface conditions and obtain samples of the subgrade and foundation soil and rock for laboratory testing.
- Performing laboratory tests to evaluate pertinent engineering properties of the foundation and subgrade strata.
- Analyzing field and laboratory data to develop recommendations for seismic site class, seismic performance zone/seismic design category, foundation and subgrade support, slope stability, site grading, and construction considerations.

The relationship of these factors to design and construction of the new bridge has been considered in developing the recommendations and considerations discussed in the following report sections.

# SUBSURFACE EXPLORATION

Subsurface conditions at the Wager Road twin bridge locations were investigated by drilling eight (8) sample and core borings to depths of 28 to 43 ft below existing grades. The Wager Road site vicinity is shown on Plate 1. The approximate boring locations are shown on the bridge layout drawing on Plate 2. The subsurface exploration program is summarized in Table 1 below.

Boring No.	Approx Sta	Approx Offset, ft	Approx Surf El, ft	Completion Depth, ft
S1	142+80	60 L	1157	30
S2	143+70	60 L	1144	28
S3	144+83	15 L	1126	35
S4	145+75	60 L	1123	32
S5	142+60	70 R	1149	36
<b>S</b> 6	143+50	60 R	1137	43
S7	144+66	60 R	1128	39
<b>S</b> 8	145+55	60 R	1120	31

 Table 1: Summary of Exploration Program

The boring logs, presenting descriptions of the soil and rock strata encountered in the borings and the results of the field and laboratory tests, are included as Plates 3 through 10. The centerline station and offset of the boring locations and approximate ground surface elevation, as inferred from the topographic information provided by the Engineer (Garver, LLC) or as inferred from available topographic information, are also shown on the logs. It must be recognized that the surface elevations shown are <u>approximate</u> and actual elevations may vary. Keys to the terms and symbols used on the logs are presented as Plates 11 and 12.

The borings were drilled with a track-mounted CME 850 rotary-drilling rig and a truckmounted SIMCO 2800 rotary-drilling rig using a combination of dry-auger and rotary-wash drilling methods. Samples were typically obtained at 2-ft intervals to 10-ft depth and at 5-ft intervals thereafter. Samples were recovered using a 2-in.-diameter split-barrel sampler driven into the strata by blows of a 140-lb automatic hammer with 30-in. drop in accordance with Standard Penetration Test (SPT) procedures. The number of blows required to drive the standard split-barrel sampler the final 12 in. of an 18-in. total drive, or a portion thereof, is defined as the Standard Penetration Number (N). Recorded N-values are shown on the boring logs in the "Blows Per Ft" column.

Representative samples of the cherty limestone/limestone bedrock were obtained using a 5ft-long NQwL-size double-tube core barrel with a diamond bit. For each core run, the percent recovery was determined as the ratio of recovery to total length of core run. Rock Quality Designation (RQD) was also determined for the core run as the sum of intact, sound rock core greater than 4-in. length divided by the total length of the run and expressed in percent. Both these values are presented in the right-hand columns of the log forms, opposite the corresponding core run. Selected photographs of the recovered rock cores are provided in Appendix B.

All samples were removed from sampling tools in the field, examined and visually classified by the field geologist. Samples were then placed in appropriate containers to prevent moisture loss and/or change in condition during transfer to our laboratory for further examination and testing.

The borings were advanced using dry-auger procedures to the extent possible to facilitate evaluation of shallow groundwater conditions. Observations regarding groundwater levels are noted in the lower-right portion of each log and are discussed in subsequent sections of this report. All boreholes were backfilled after obtaining the final water level readings.

#### **LABORATORY TESTING**

Laboratory testing was performed to evaluate subgrade and foundation plasticity and to confirm visual classification. The testing program included natural water content determinations (AASHTO T 265), liquid and plastic (Atterberg) limit determinations (AASHTO T 89 and T 90), and sieve analyses through the No. 200 sieve (AASHTO T 88). Soil shear strength was estimated in the field using SPT results.

A total of 32 natural water content determinations were performed to develop information on *in-situ* soil water content for each boring. Water content results are plotted on the boring log forms in accordance with the scale and symbols shown in the legend located in the upper-right corner of the logs.

To verify field classification and to evaluate soil plasticity, six (6) liquid and plastic limit (Atterberg limits) determinations and eight (8) sieve analyses were performed on selected representative samples. The Atterberg limits are plotted on the logs as pluses inter-connected with a dashed line using the water content scale. The percentage of soil passing through the No. 200 Sieve is noted in the "- No. 200 %" column on the appropriate log forms.

A summary of classification test results and classification by the Unified Soil Classification System and AASHTO Classification System is presented in Appendix C. Grain-size distribution curves are also included in Appendix C.

## **GENERAL SITE and SUBSURFACE CONDITIONS**

#### Site Conditions

The overall alignment of the XNA Access Road extends from the Northwest Arkansas Regional Airport (XNA) about 4 miles southeast to the planned project terminus at Highways 70 and 71. The Wager Bridge site crosses Wager Road approximately 4750 ft west of the intersection of Wager Road and Robbins Road. The site locale is presently open, agricultural pastureland with a few mature trees. A farm lane and house are located west of the proposed alignment, and a barn is located north of the site. The site terrain is highest to the southeast and slopes steeply to the north and northwest, with a total change in elevation of approximately 42 ft over the length of the bridge alignment. Surface drainage is considered good.

## Site Geology

The project alignment is located in the mapped exposure of the Boone Formation. The early and middle Mississippian Period Boone consists of fine- to coarse-grained limestone interbedded with chert. The chert content can vary widely, both horizontally and vertically, and limestone or chert may be predominant. The Boone Formation is known for dissolutional features such as sinkholes, caves, and enlarged fissures. Typically, the limestone/cherty limestone units of the Boone decompose (weather) to erratic blends of chert fragments and clay/silty clay. The residual soil mantle may extend to significant depths on higher terrain and may contain hard chert seams and/or layers. The thickness of the Boone Formation is reported to be 300 to 350 ft in

northern Arkansas. The Boone is generally disconformable to the underlying Chattanooga Shale and St. Joe Limestone member, with some areas having a conformable contact.

## Seismic Conditions

In light of the results of the borings, a Seismic Site Class C (very dense soil and soft rock profile) is considered applicable for the site with respect to the criteria of the <u>AASHTO LRFD</u> <u>Bridge Design Specifications Eighth Edition 2017<sup>1</sup></u>.

Given the location and AASHTO code-based values, the 1.0-sec period spectral acceleration coefficient for Site Class C (S<sub>1</sub>) is 0.049 and the 1.0-sec period spectral acceleration coefficient (S<sub>D1</sub>) value for Site Class C is 0.051. Utilizing these parameters, Table  $3.10.6-1^2$  indicates that a <u>Seismic Performance Zone 1</u> is fitting for the Wager Road bridge site. In reference to the 2012 edition of the AASHTO Guide Specifications, the Peak Ground Acceleration (PGA) having a 7 percent chance of exceedance in 75 years (or mean return period of approximately 1000 years) is predicted to be 0.049 for a Seismic Site Class C for the bridge location. The liquefaction potential is considered low for the predominantly cohesive overburden soils and underlying rock units encountered in the borings drilled for this study.

# Subsurface Conditions

Based on the results of the borings, the subsurface stratigraphy may be generalized into three (3) primary strata as follows.

- Stratum I: The Stratum I soils extend to depths of 1 to 18 ft and are comprised of loose to dense brown, dark brown, gray, tan, and reddish tan silt and stiff brown clayey silt. This stratum has variable, but generally numerous chert fragments and organics. The subgrade soils typically classify as A-1-b, A-2-4, A-4, and A-6 by the AASHTO classification system. The silt and clayey silt exhibit low plasticity, moderate to high compressibility, and low shear strength. The low-plasticity and silty soils are moisture-sensitive and will lose considerable strength when saturated.
- Stratum II: Below the surficial silty soils to 6- to 32-ft depth is a localized stratum of firm to very stiff brown, reddish brown, and tan silty clay and clayey silt with variable content of chert fragments. This stratum contains increasing chert seams and layers with depth. The silty clay and clayey silt are residual in origin and have weathered from the underlying cherty limestone bedrock. The Stratum II silty clay and clayey silt have low to moderate plasticity, low to moderate shear strength, and low compressibility. The potential for volume change with changes in water content is considered low due to the

<sup>&</sup>lt;sup>1</sup> <u>AASHTO LRFD Bridge Design Specifications</u>, 8<sup>th</sup> Edition; AASHTO; 2017

<sup>&</sup>lt;sup>2</sup> AASHTO LRFD Bridge Design Specification, AASHTO; 2012

relatively high content of limestone and chert fragments. This stratum was not encountered in Borings S2 or S4.

Stratum III: The basal stratum encountered in the borings is moderately hard to hard gray and light gray cherty limestone. The cherty limestone is flat bedded. Rock core recovery values range from 10 to 100 percent and rock quality designation (RQD) values range from 0 to 85 percent. These RQD values are indicative of variable poor to fair rock quality. Rock quality generally increases with depth.

To aid in visualizing subsurface conditions, generalized subsurface profiles are presented in Appendix D. It should be recognized that the stratigraphy illustrated by the profiles has been inferred between discrete boring locations. In view of the natural variations in stratigraphy and conditions, variations from the stratigraphy illustrated by the profiles should be anticipated. Additionally, the natural transition between strata is generally gradual, and the stratigraphy described in the sections above may vary.

#### Groundwater Conditions

Groundwater was not encountered within the dry auger range of the borings drilled in January and July 2023. It has been our experience in the area that localized shallow perched groundwater can be present in the silty overburden soils and fractured zones of the cherty limestone. Given the variable site terrain, seasonal seeps or springs could develop during wet seasons and as infiltrated surface water migrates downgradient. Groundwater levels will vary, depending on seasonal precipitation and surface runoff and infiltration.

## **ANALYSES and RECOMMENDATIONS**

## Foundation Design

Foundations for the new bridge must satisfy two (2) basic and independent design criteria: a) foundations must have an acceptable factor of safety against bearing failure under maximum design loads, and b) foundation movement due to consolidation or swelling of the underlying strata should not exceed tolerable limits for the structures. Construction factors, such as installation of foundations, excavation procedures and surface and groundwater conditions, must also be considered.

Based on the results of the borings performed at the Wager Road bridge site and our understanding of the project, we recommend that foundation loads at the abutments and interior bents be supported on steel piling. Recommendations for pile foundations are discussed in the following report sections.

## **Piling Foundations**

The foundation loads of the bridge may appropriately be supported on steel piles. We understand that HP12x53 steel piles are planned for the end bents and HP14x73 steel piles are planned for the intermediate bents. Point-bearing steel piles driven to refusal should extend through any new embankment fill, the natural overburden soils (Strata I and II), and zones of low hardness weathered cherty limestone with clay seams and layers to develop safe bearing capacity in the competent moderately hard slightly weathered cherty limestone or cherty limestone (Stratum III). End-bearing piles should be driven to practical refusal. All steel piles should be fitted with rock points. Hard driving or preboring should be anticipated.

Steel piles driven to refusal should be designed for the structural capacity of the pile, as per applicable AASHTO Load and Resistance Factor Design (LRFD) procedures<sup>3</sup>. An effective resistance factor ( $\varphi_c$ ) of 0.50 is recommended for structural determination of factored bearing capacities. This effective resistance factor for steel piles has been based on the assumption of severe driving conditions.

For determination of bearing capacities of steel piles driven to refusal, we recommend that nominal resistance (P<sub>n</sub>) of HP piles be determined based on the yield strength of steel H piles ( $f_y$ ) and the net end area (A<sub>net</sub>) of the section. It has been our experience that allowable pile capacities of 96 tons for HP12x53 piles and 133 tons for HP14x73 piles are typical for  $f_y = 50$  ksi steel pile sections. These capacities are based on allowable stress design (ASD). However, the appropriate factored bearing capacity should be confirmed by the Engineer. Post-construction settlement of piles driven to refusal will be negligible.

The nominal axial capacities are based on single, isolated foundations. Piles spaced closer than three (3) pile widths may develop lower individual capacity due to group effects. The potential for group capacity reductions should be evaluated for pile spacing closer than three (3) widths (center to center).

Preboring should be anticipated for pile installation. Prebores should extend to the required minimum tip elevation in the competent moderately hard slightly weathered cherty limestone or cherty limestone (Stratum III) as field verified by the Engineer or Department. The depth to the moderately hard slightly weathered cherty limestone and cherty limestone can vary widely and

<sup>&</sup>lt;sup>3</sup> <u>Load and Resistance Factor Design (LRFD) for Highway Bridge Substructures</u>, Publication No. FHWA HI-98-032, National Highway Institute, May 2001.

required prebore depth could vary as well. Where the Contractor drives a heavy pile section (HP14x73 or heavier) through the cherty clay (Stratum II) to the recommended bearing stratum, the depth of piles should be consistent with the results of the borings. Where piles encounter refusal at unusually shallow depths, the suitability of the bearing stratum should be verified by drilling soundings or probe holes to confirm the bearing stratum.

Bridge	Bent No.	Estimated Prebore depth, ft (below existing grade)	Estimated Pile Tip Elevation, ft	Comments
	1A (South Bridge End)	12	1144	Refusal in moderately hard cherty limestone
А	2A	23	1120	Refusal in moderately hard weathered cherty limestone
	3A	18	1107	Refusal in moderately hard slightly weathered cherty limestone
	4A (North Bridge End)	0	1105	Refusal in moderately hard slightly weathered cherty limestone
	1B (South Bridge End)	24	1125	Refusal in hard cherty limestone or chert
5	2B	0	1105	Refusal in moderately hard weathered cherty limestone
Б	3B	0	1100	Refusal in moderately hard cherty limestone
-	4B (North Bridge End)	0	1102	Refusal in moderately hard cherty limestone

Estimated prebore depths and pile tip elevations are summarized below in Table 2.

It should be noted that the prebore depths and tip elevations shown in the table above are <u>estimates</u> only based on the results of the relevant borings and the inferred surface elevations at the particular locations. The estimated prebore depth is based on achieving required pile embedment to refusal for compression loads only. Additional prebore depths could be required to develop specified uplift resistance. Pile refusal and final depth must be field verified.

Steel piles may be subjected to uplift loads. Nominal single pile uplift capacity curves for steel HP piles are provided in Appendix E. Where preboring is expected for pile installation, uplift capacities are based upon a prebored section. In this case, the prebore annulus around steel piles must be backfilled with approved grout or concrete.

Nominal axial pile uplift capacities have been developed using static pile capacity formulae, the results of the borings, and the plan pile caps elevations shown on the preliminary bridge layout drawings. Based on AASHTO LRFD geotechnical design procedures, a resistance

factor ( $\varphi_{up}$ ) of 0.25 is recommended for evaluation of factored uplift capacity. This resistance factor is based on Strength Limit States. For Extreme Events Limit States such as earthquake loading and collision, a resistance factor of 0.8 for uplift is recommended.

Piles should be installed in compliance with Standard Specifications for Highway Construction, 2014 Edition, Section 805. We recommend a hammer delivering a minimum energy of 34,000 ft-lbs per blow. A specific review and analysis of the pile-hammer system proposed by the Contractor should be performed by the Engineer prior to hammer acceptance and start of driving. We recommend that all piles be fitted with rock points.

A minimum pile length of 10 ft is recommended. As noted, preboring will be required for some piles to facilitate installation through more resistant chert seams, layers, and beds that may be encountered at shallow depth. Rock drilling methods could be required for prebores extending through thicker intervals of chert and/or weathered limestone. Following pile acceptance, the annulus around the installed piles in prebores should be expeditiously backfilled with grout or concrete as per ARDOT Standard Specifications Section 805. The grout should have a minimum compressive strength pf 4000 psi, as per ARDOT Section 501 or an alternate approved by the Engineer.

As a minimum, safe bearing capacity of piles should be determined by ARDOT Standard Specifications Section 805.09, Method A. Driving records should be available for review by the Engineer during pile installation. Blow counts on steel piles should be limited to about 20 blows per inch. Practical pile refusal may be defined as a penetration of 0.5 in. or less for the final 10 blows. Driving records should be available for review by the Engineer during pile installation. Embankment Slopes

The project scope includes new embankments at each bridge end. Bridge end embankment configurations are 2-horizontal to 1-vertical (2H:1V) with 3-horizontal to 1-vertical (3H:1V) side slope configurations. The embankment heights are expected to be a maximum of 35 feet.

To evaluate suitability of the plan earth slope configurations, slope stability analyses have been performed. A 250 lbs per sq ft uniform surcharge from vehicles was included for the stability analyses. Stability analyses were performed using the computer program SLOPE/W 2021<sup>4</sup> and a Morgenstern-Price analysis. For the embankment slopes, three (3) general loading conditions were evaluated, i.e., End of Construction, Long Term, and Seismic. For analysis of the seismic

<sup>&</sup>lt;sup>4</sup> <u>Slope/W 2021;</u> GEOSLOPE Ltd.

condition, a horizontal seismic acceleration coefficient ( $k_h$ ) of one-half the peak acceleration ( $A_s$ ) was used, a value of 0.0245.

Stability analyses results are summarized and presented graphically in Appendix F. The results of the stability analyses indicate that plan configurations of the embankment end and side slopes are acceptable with respect to stability of all loading conditions evaluated.

## Subgrade Support

The results of the borings indicate the on-site subgrade soils generally consist of silt, clayey silt, and silty clay with chert fragments (AASHTO A-2-6, A-4, and A-6). Given the anticipated new embankment, the approach roadway subgrade is likely to consist of embankment fill. Locally-available borrow, which is likely to be used as unclassified embankment fill, is expected to have similar classification.

We recommend that any soils classifying as A-7-5 or A-7-6 soils be excluded from use as subgrade within 18 in. of the plan subgrade elevation. The top 18 in. of subgrade soils should have a maximum plasticity index (PI) of 18. The as-built pavement subgrade should be evaluated by the Engineer. Areas of unstable or otherwise unsuitable subgrade should be improved by undercut and replacement or treatment with additives approved by the Engineer.

Based on the results of previous laboratory CBR tests on the silty clay with chert fragments subgrade and correlation with the AASHTO classification, we recommend the following parameters for use in design of pavements.

•	CBR:	8.3
•	Resilient Modulus (M <sub>R</sub> ):	3260 lbs per sq in.
•	R value:	13
•	Modulus of Subgrade Reaction (k):	100 lbs per cu in.

## Site Grading and Subgrade Preparation

As noted, the surface soils are moisture-sensitive. Though stable in dry conditions, at elevated water contents the silt and clayey silt subgrade is likely to be soft and unstable. Consequently, site grading operations will be significantly easier to perform during dry seasons of the year.

Site preparation will require localized clearing and grubbing and stripping the zone of organic-containing soils. The depth of stripping will be variable, with deeper stripping depths in wooded areas, and less stripping required in open land. In general, the stripping depth is estimated to be about 6 to 9 inches in clear areas but may be 18 to 24 in. or more in the localized areas where

trees are present. The zone of organic surface soils should be completely stripped in the embankment footprint areas and at least 5 ft beyond the projected embankment toes.

Following stripping and prior to fill placement, the extent of weak and unsuitable soils should be determined. Thorough proof-rolling should be performed to verify subgrade stability. Proof-rolling should be performed with a loaded tandem-wheel dump truck or similar equipment. Unstable soils exhibiting a tendency to rut and/or pump should be undercut and replaced with suitable fill. Care should be taken that undercuts, stump holes, and other excavations or low areas resulting from subgrade preparation are properly backfilled with compacted fill.

Depending on seasonal conditions, undercuts of about 2 to 4 ft below existing grades, more or less, could be required. Deeper undercuts may be required in wet seasons. General undercuts for site grading may be backfilled with unclassified borrow used for embankment fill.

In lieu of undercutting and replacing unsuitable soils in approach road alignments, consideration may be given to using additives to improve soil workability and to stabilize weak areas. Hydrated lime, quick lime, Portland cement, fly ash, or suitable alternate materials may be used as verified by appropriate testing and approved by the Engineer. Additives can be effective where the depth of unstable soils is relatively shallow. Treatment will be less effective in areas where the zone of unstable soils is deep. The optimum application rate of stabilization additive must be determined by specific laboratory tests performed on the alignment subgrade soils. We recommend a minimum treatment depth of 8 inches.

Subgrade preparation and mass undercuts should extend at least 5 ft beyond the embankment toes to the extent possible. Subgrade preparation for the approach roads should extend at least 3 ft outside pavement shoulder edges to the extent possible.

Fill and backfill may consist of unclassified borrow free of organics and other deleterious materials as per ARDOT Standard Specifications Subsection 210.06. Where A-7-5 or A-7-6 soils are encountered at the subgrade elevation, we recommend that these soils be undercut as required to provide at least 18 in. of suitable low-plasticity subgrade soils, i.e., with a maximum PI of 18, or approved "hillside" cherty clay with a maximum of 35 percent passing the No. 200 sieve. Alternatively, stabilization additives may be utilized to develop a stable subgrade with a PI of 18 or less. Granular soils must be protected from erosion with a minimum 18-in.-thick armor of clayey soil.

Subgrade preparation should comply with ARDOT Standard Specifications Section 212. Embankments should be constructed in accordance with ARDOT criteria (ARDOT Standard Specifications Section 210). Fill and backfill should be placed in nominal 6- to 10-in.-thick loose lifts. All fill and backfill must be placed in horizontal lifts. The in-place density and water content should be determined for each lift and should be tested to verify compliance with the specified density and water content prior to placement of subsequent lifts.

# **CONSTRUCTION CONSIDERATIONS**

#### Groundwater and Seepage Control

Positive surface drainage should be established at the start of the work, be maintained during construction and following completion of the work to prevent surface water ponding and subsequent saturation of subgrade soils. Density and water content of all earthwork should be maintained until embankments, bridge work, and pavements are completed.

Shallow groundwater was not encountered in the borings drilled in January and July 2023. Shallow perched groundwater may be encountered in the near-surface soils, particularly during wet seasons. Seepage into excavations and cuts can typically be controlled by ditching or sump-and-pump methods. If seepage infiltration cannot be controlled, construction of drains and/or the use of Select Granular Backfill (AASHTO M 43 No. 57), stone backfill (ARDOT Standard Specifications Section 207), or approved alternates to an elevation above the inflow of seepage will be warranted. In areas of seepage infiltration, the granular fill should be encapsulated with a filter fabric complying with ARDOT Standard Specifications Subsection 625.02, Type 2 and vented to positive discharge. Where surface seeps or springs are encountered during site grading, we recommend the seepage be directed via French drains or blanket drains to positive discharge at daylight or to storm drainage lines.

Site preparation should also include construction of blanket drains in all existing drainage features which will be covered by fill. All loose and/or organic materials should be excavated from drainage features prior to drain construction. Blanket drains should consist of at least 8 to 12 in. of select granular backfill (AASHTO M 43 No. 57) fully encapsulated by a filter fabric. A fabric complying with ARDOT Standard Specifications Subsection 625.02, Type 2 is recommended. Drains should direct water to positive discharge at daylight or into storm drain lines. Piling

Piles should be installed in compliance with ARDOT Standard Specifications, Section 805. Piles should be carefully examined prior to driving and piles with structural defects should be rejected. Any splices in steel piles should develop the full cross-sectional capacity of un-spliced piles. Preboring should be anticipated for pile installation. Some rock drilling could be required for prebores. Where piles are prebored to develop uplift resistance, the annulus between the steel piles and the prebore should be expeditiously backfilled with approved grout or concrete.

Pile installation should be monitored by qualified personnel to maintain specific and complete driving records and observe pile installation procedures. Safe bearing capacity of production piles should be determined by ARDOT Standard Specifications Section 805.09, Method A. Driving records should be available for review by the Engineer during pile installation. For driving steel piles on this project, we recommend a minimum hammer energy of 34,000 ft-lbs per blow. Blow counts on steel piles should be limited to about 20 blows per inch. Practical pile refusal may be defined as a penetration of 0.5 in. or less for the final 10 blows.

# **CLOSURE**

The Engineer or Department or a designated representative thereof should monitor site preparation, grading work and foundation and bridge construction. Subsurface conditions significantly at variance with those encountered in the borings should be brought to the attention of the Geotechnical Engineer. The conclusions and recommendations of this report should then be reviewed in light of the new information.

The following illustrations are attached and complete this final report.

Plate 1	Site Vicinity
Plate 2	Plan of Borings
Plates 3 through 10	Boring Logs
Plates 11 and 12	Keys to Terms and Symbols
Appendix A	Preliminary Bridge Layout
Appendix B	Selected Rock Core Photographs
Appendix C	Classification Test Results
Appendix D	Generalized Subsurface Profile
Appendix E	Nominal Uplift Pile Capacity Curves
Appendix F	Stability Analyses Results

\* \* \* \* \*

We appreciate the opportunity to be of service to you on this project. Should you have any

questions regarding this report, or if we may be of additional assistance, please call on us.

Sincerely,

GRUBBS, HOSKYN, BARTON &WYATT, LLC

Velleto M. Sett

Velleta M. Scott, P.E. Sr. Project Engineer Mark E. Wyatt, P.E. No. 7791 President

VMS/MEW:jw

Copies Submitted:	Garver	·LLC	
	Attn:	Mr. Joel Skinner, P.E.	(1-email)
	Attn:	Mr. Lawren Wilcox, P.E.	(1-email)
	Attn:	Mr. John H. Ruddell, P.E., S.E.	(1-email)
	Attn:	Mr. Adam Wierciak, P.E.	(1-email)



A UES Company

090069 XNA Access Road over Wager Road **Benton County, Arkansas** 

Job No. 19-118

Plate 1



	19-11	8														
	Gru Bar <sub>Consu</sub>		os, Hoskyn, n & Wyatt, Inc. g Engineers D & O G O F 090069 XNA A Bent	B C Acces ton C	<b>) R I</b> s Roa o., A	<b>NG</b> ad ov rkans	<b>N (</b> er W as	<b>). S</b> ager	5 <b>1</b> Rd							
	TYPE	≣:	Auger to 6 ft /Core		LO	CATIO	N: Ap	prox	Sta 14	2+80,	60 ft L	t				
'H, FT	1BOL	PLES	<b>IPLES</b>		PER FT	IRY WT SU FT	0.	<b>(</b> 2 0.		SION,	SQ F1	Q FT 			sovery	gD
DEP1	SYN	SAM		SMOUS	UNIT D	PLA LI	\STIC MIT ╋ ─ ─ ─		WA CON	TER TENT		LIQU LIM	IID IT	- No.	% Re	Я %
	<b>Y</b> pG	$\overline{\mathbf{A}}$	Loose to medium dense brown	10		1	0 2	0 (	30 4	0 5	06	07	0	21		
			and tan silt w/numerous chert fragments	50/6"			<u> </u>							21		
- 5 -			clay w/numerous chert fragments and discontinuous chert seams and layers	50/3" 50/1"		•										
10			Moderately hard to hard light gray w/tan weathered cherty limestone, fractured w/vugs, stylolites and calcite inclusions												56	0
															40	8
- 15 -															48	20
20 -			Moderately hard to hard light gray cherty limestone w/stylolites and occassional weathered partings and seams						q <sub>u</sub> = 8	3420 p	si, TU	W= 14	0 pcf		100	57
- 30 -									q <sub>u</sub> = 2	2940 p	si, TU	W= 14	2 pcf		98	80
- 35 -																
	COMF DATE	 PLE : 7	TION DEPTH: 30.0 ft -20-23	DEF IN E	PTH T BORIN	O WA G: Dr	TER y to 6	ft				DA	ГЕ: 7/	20/2	023	3





# LOG OF BORING NO. S2

090069 XNA Access Road over Wager Rd Benton Co., Arkansas

TYPE: Auger to 5 ft /Core

Grubbs, Hoskyn, Barton & Wyatt, Inc. <sup>Consulting Engineers</sup>

LOCATION: Approx Sta 143+70, 60 ft Lt

	L			뵤	5		(		SION		'SQ F	Г		, v	~								
	Ŀ Ţ	BOL	PLES	PLES	PLES	JLES	PLES	PLE	ЫЦ		PER	RY V U FT	0	2 0	.4 (	0.6 0	.8 1	.0 1	.2 1	.4	200 %	over	ДÖ
	DEPT	SYM			SWO	NIT D LB/C	PL/ Ll	ASTIC MIT		WA CON	TER TENT		LIQU LIM	ID T	No. 2	6 Rec	Ж К						
				SURF. EL: 1144±	BLo	5	1	╋ 0 2	0		0 5	io 6	<b>+</b> 0 7	0	'	~							
			X	Medium dense tan silt w/numerous chert fragments	23																		
			$\nabla$	- dense below 2 ft	50/7"																		
F			Δ		30/7																		
E	5 -			Moderately hard to hard light	50/3"											_							
F				gray w/tan slightly weathered cherty limestone																			
E				,												72	0						
E																							
Ľ	10 -			- with vugs below 10 ft												-							
E																32	0						
E	15																						
F	15			Moderately hard to hard gray w/light gray cherty limestone,						q.=2	2690 p	si, TU	W= 14	5 pcf									
E				slightly weathered, w/some						, 'u						77	43						
E				stylolites													-						
	20 -															_							
E																							
E																83	17						
				Modorately hard to hard gray																			
	25 -			and light gray cherty limestone												-							
																83	75						
8-10-23			1		<u> </u>											_							
D.GPJ																							
ER ROA	30 -																						
2 WAGE																							
19-116																							
N200-2																							
ECROD		COMF DATE	PLE : 7	TION DEPTH: 28.0 ft -26-23	DEF IN E	PTH T BORIN	O WA G: Dr	TER y to 5	ft				DA	FE: 7/	26/2	023	3						

	Gru Bar Consu	bb or	s, Hoskyn, & Wyatt, Inc. Engineers Ben	B ( Acces ton C	<b>) R I</b> s Roa co., A	<b>N G</b> ad ov rkans	i <b>N</b> ( ver W sas	<b>D. \$</b> age	<b>53</b> r Rd							
	TYPE	:	HSA to 23 ft /Wash		LO	CATIC	N: Ap	oprox	Sta 14	4+83,	15 ft L	.t				
				ЕЧ	F			СОН	ESION	, TON	/SQ F	Г				
H H	BOL	LES		PER	N FT √	0	.2 0	.4	0.6 (	).8 1	.0 1	.2 1	.4	% 00	overy	b
DEPT	SYM	SAMF		SMOT	UNIT DI LB/CI	PL/ L			WA CON	TER TENT		LIQU LIM	JID IT	- No. 2	% Rec	% R
		$ \downarrow$	SURF. EL: 1120±			1	0 2	20	30 4	10 5	50 6	<u>60</u> 7	0			
		4	w/numerous chert fragments /	11												
		X	Stiff to Very stiff reddish brown silty clay w/highly weathered limestone seams and chert nodules and fragments	24												
- 5 -		Å V		24												
		Δ		37												
- 10 -		X		46												
- 15 -		X		20												
- 20 -		X	Moderately hard gray, light gray and tan weathered cherty limestone w/silty clay-filled fractures and joints	50/2"												
	44	f	Moderately hard to hard light	25/0"												
- 25 -			gray and gray cherty limestone w/stylolitic joints and occasional calcareous nodules and inclusions						q <sub>u</sub> = :	3820 p	si, TU	W= 14	2 pcf		100	75
- 35 -															100	83
	COMF DATE	PLE : 7	TION DEPTH: 35.0 ft -24-23	DE IN E	PTH T BORIN	O WA IG: Di	TER ry to 2	3 ft				DA	TE: 7/	24/2	02	3

19-118	
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# LOG OF BORING NO. S4

090069 XNA Access Road over Wager Rd Benton Co., Arkansas

TYPE: Auger to 22 ft /Core

Grubbs, Hoskyn,

Consulting Engineers

Barton & Wyatt, Inc.

LOCATION: Approx Sta 145+75, 60 ft Lt COHESION, TON/SQ FT **BLOWS PER FT** UNIT DRY WT LB/CU FT % F % Recovery SAMPLES SYMBOL % RQD 0.2 0.4 0.6 0.8 1.0 1.2 1.4 - No. 200 DEPTH, DESCRIPTION OF MATERIAL PLASTIC LIMIT WATER CONTENT LIQUID LIMIT + -+-SURF. EL: 1123± 10 20 30 60 70 40 50 Loose brown silt w/numerous 9 chert fragments - medium dense below 2 ft NON-PLASTIC 13 38 5 13 22 19 10 19 15 Moderately hard to hard light gray slightly weathered cherty limestone, fractured w/vugs and stylolites 4 50/1" 212 20 Δ  $\Delta$ 50/1" ₼ 4 83 0 h Λ 4 25 10 0 q\_= 4990 psi, TUW= 140 pcf  $\Delta$ 4 212 - less fractured with fewer vugs below 27 ft Δ  $\Delta$ Α 4 10085 30 ЬЛ <u>4 '</u> 8-10-23 WAGER ROAD.GPJ 35 19-118 RECRODN200-2 COMPLETION DEPTH: 32.0 ft DEPTH TO WATER DATE: 7-19-23 IN BORING: Dry to 22 ft DATE: 7/19/2023


	TYPE	<u>:</u>	Auger to 32 ft /Wash		LOC	CATIO	N: A	pprox	sta14	13+50,	60 ft R	t				
⊢		6		ET	۲ ۲			COF	IESIO	N, TON -⊖	I/SQ F	Г		%	Y	
ΓH, F	ABOL	Ы БГ	DESCRIPTION OF MATERIAL	DEF	NRY /	0.	.2	0.4	0.6	0.8	1.0 1	.2 1.	.4	200	cover	gg
DEP <sup>-</sup>	SYN	SAM		ROWS	UNIT D LB/C	PLA LI	ASTIC IMIT +	;	CO CO	ATER NTENT		Liqu Limi	IID IT	- No.	% Re	Ч %
	X 4 F		SURF. EL: 1137±			1	0	20	30	40	50 6	0 7	0	50		
		X	w/numerous chert fragments	13					┦	_				58		
	59K	X	Dense brown slity chert gravel	44			•							34		
- 5 -		X	Very stiff reddish brown silty clay w/chert nodules and	50/8"	-											
		X	fragments and discontinuous chert seams and layers	50/8"			•									
				29										30		
- 10 -				20										39		
		X		25												
- 15 -																
20-		X	- stiff at 18 to 22 ft	23			•									
			- very stiff below 22 ft													
25 -		X		29					•	_						
- 30 -		М		50/7"			•									
			Moderately bard light grov													
			cherty limestone w/numerous													
- 35 -			calcite-filled vugs												27	0
															67	0
40-									q <sub>u</sub> =	3520	psi, TU	W= 15	9 pcf		90	67
				L							<u> </u>					
15																
49-																
						0.14/4										
l		1LE	HUN DEPTH: 43.0 T	DE		JVVA	IER									



	TYPE	:	Auger to 22 ft /Core	1	LO	CATIC	DN: Ap	prox	Sta 14	5+55,	60 ft F	Rt				
F		S		R FT	×⊢		(		SION	, TON/	'SQ F1	Г		%	Z	
TH, F	MBOI	APLE	DESCRIPTION OF MATERIAL	S PEF	DRY CU F	C	0.2 0	.4 0	).6 (	).8 1 I	.0 1.	.2 1.	4	200	scove	RgD
DEP	SΥΙ	SAN		LOW:	JNIT LB/	PL.	ASTIC IMIT			TER TENT		- No.	% Re	%		
			SURF. EL: 1120±	<u> </u>	<b>–</b>		10 2	:0 (	30 4	40 5	0 6	0 70	0			
	Ш	X	w/rootlets and occasional chert	5							•					
		X	Firm to stiff tan and brown silty clay w/numerous chert	10					ŧ					49		
- 5 -		X	fragments - stiff from 4 to 8 ft	13			•									
			- with reddish brown below 6 ft													
		Å	very stiff below 8 ft													
- 10 -		X		40			•									
15		Χ	silty clay w/numerous chert	16			•+		+					20		
- 15 -			nagments													
		X	Moderately hard light gray w/tan highly weathered cherty	50/6"												
- 20 -			fractures	50/4												
			Moderately hard to hard gray	50/1												
			cherty imestone												94	0
- 25 -										2220 -	-: TU	NI- 1 A	0 nof			
									$q_u = $	3330 p	si, tu	vv= 14	в рсі		88	46
- 30 -				L			<u> </u>								88 4	42
- 35 -	-															
	COMF	LE PLE	TION DEPTH: 31.0 ft	DEI	 PTH T	O WA										
	DATE	: 7	-19-23	IN E	BORIN	IG: D	ry to 2	2 ft				DAT	E: 7/	19/2	023	,

Grubbs, Hoskyn, Barton & Wyatt, Inc. Consulting Engineers	SYMBOLS	S AND TE	RMS US	SED OI	N BOR	ING	OGS					
SC (SHOWN IN C Gravel Sand Predomina	IL TYPES SYMBOLS COLUN Silt Silt type shown heav	/IN) Clay	(SHC	SAMPL OWN ON S Rock Core	ER TYF AMPLES Split Spoon	PES COLUM No Recover	N) Cutting					
TERMS COARSE GRAINED SOI sands, and (2) silty or cla determined by laboratory	TERMS DESCRIBING CONSISTENCY OR CONDITION COARSE GRAINED SOILS (major portion retained on No. 200 sieve): Includes (I) Clean gravels and sands, and (2) silty or clayey gravels and sands. Condition is rated according to relative density, as determined by laboratory tests.											
DESCRIPT VERY LOOS LOOSE MEDIUM DE DENSE VERY DENS FINE GRAINED SOILS silts and clays, (2) grave according to shearing s	IVE TERM SE ENSE SE (major portion pas elly, sandy, or silty trength, as indicate	N-VALU 0-4 4-10 10-30 30-50 50 and sing No. 200 s clays, and (3) ed by penetron	IE f above sieve): Includ clayey silts. ( neter reading	RELATIN es (1) Inor Consistenc s or by un	/E DEN 0-15% 15-35% 35-65% 65-85% 85-100% ganic and cy is rated confined	SITY organic						
compression tests. DESCRIP VER SOF FIRM STIF VER HAR NOTE: Slick strengths that	TIVE TERM Y SOFT F Y STIFF O ensided and fissur a shown above, bed	ed clays may cause of plane	COMF L C 1 2 4 nave lower u s of weaknes	UNCON PRESSIV TON/S ess than ( ).25-0.50 ).50-1.00 .00-2.00 .00-2.00 .00-4.00 .00 and hi nconfined ss or crack	NFINED /E STRE Q. FT. 0.25 gher compress as in the so	ENGTH ive bil.	ł					
The consister TE SLICKENSIDED - hav FISSURED - containi or less LAMINATED - compo INTERBEDDED - cor CALCAREOUS - cor WELL GRADED - hav pa POORLY GRADED -	cy ratings of such RMS CHARAC ving inclined planes ng shrinkage crack vertical. sed of thin layers of nposed of alternate aining appreciable ving a wide range ir riticle sizes. predominantly of o intermediate sizes	soils are base CTERIZING s of weakness s, frequently fi portion of varying color e layers of diffe quantities of diffe quantities of diffe and grain sizes a ne grain size, s missing.	d on penetro SOIL ST that are slick lled with fine and texture. rent soil type alcium carbo nd substantia or having a r	RUCTU and gloss sand or si es. onate. al amounts ange of siz	IRE y in appea it; usually of all inte	arance. more rmediat	е					
Terms used on this repor are in accordance with th Technical Memorandum	t for describing soil e UNIFIED SOIL C No.3-357, Waterwa	ls according to LASSIFICATI ays Experimen	their texture ON SYSTEM t Station, Ma	or grain s l, as descr rch 1953	ize distribi ibed in	ution						

Grubbs Hoskyn								
Barton & Wyatt, Consulting Engineers	Inc.	BORING	LOG TERMS	– ROCK				
ROCK TYPES (Shown in Symbols Col)	им) Sandstone	Limestone	Siltstone	Coal	Shale			
Joint	<u>Spacing</u>		Degree of					
Characteristics –	Very Close0.75 to 2.5Close2.5 to 8 in.Moderately Close8 to 24 in.Wide2 to 6 ftVery WideHore there the	in.	Weathering —	Fresh — No visible decomposition or o Rings under hamm	signs of discoloration. ner impact. – Slight			
Bedding Characteristics —	Very Thin 0.75 to 2.5 i   Thin 2.5 to 8 in.   Medium 8 to 24 in.	in.		discoloration inward fractures, otherwise fresh.	ds from open e similar to			
Lithologic Characteristics —	Thick 2 to 6 ft Massive More than 6 Clayey Shaly Calcareous (limy)	ft		Moderately Weather throughout. Weaker as feldspar decom somewhat less tha cores cannot be b scraped by knife.	ed – Discoloration r minerals such posed. Strength n fresh rock, but roken by hand or Texture preserved.			
Parting -	Siliceous Sandy (Arenaceous) Silty Plastic Seams Less than 1/16 inch			Highly Weathered - somewhat decompor can be broken by or shaved with kni present in rock mo	- Most minerals osed. Specimens hand with effort ife. Core stones nes Texture			
Seam — Layer — Stratum —	1/16 to 1/2 inch 1/2 to 12 inches Greater than 12 inches			becoming indistinct but fabric Completely Weathered – Minerals decomposed to soil but fabric and structure preserved (Saprolite). Specimens easily crumbled or penetrated. Residual Soil – Advanced state of decomposition resulting in plastic soils. Rock fabric and structure completely destroyed. Large volume change. Solid, contains no voids Vuggy (pitted) Vesicular (igneous) Porous Cavities				
Hardness-	Soft (S) – Reserved for plastic m Friable (F) – Easily crumbled by l pulverized or reduced to powder o to be cut with a pocket knife.	aterial alone. hand, and is too soft						
	Low Hardness (LH) – Can be gou or carved with a pocket knife.	ged deeply						
	Moderately Hard (MH) — Can be re scratched by a knife blade; scratc heavy trace of dust and scratch i visible after the powder has been	eadily ch leaves a is readily blown away.	Solution and					
	Hard (H) — Can be scratched with scratch produces little powder and faintly visible; traces of the knife be visible.	h difficulty; I is often steel may	You conumons -					
	Very hard (VH) – Cannot be scrat a pocket knife. Knife steel marks surface.	tched with left on	Swelling Properties –	Nonswelling Swelling				
Texture -	Fine - Rarely seen with naked ev	e	Slaking Properties —	Nonslaking Slakes slowly on e	xposure			
	Medium – Barely seen up to 1/8 Coarse – 1/8 in to 1/4 in	in.	Rock Quality	Slakes readily on (	exposure			
Structure —	Bedding Flat - 0° - 5° Gently Dipping - 5° - 35° Moderately Dipping - 55° - 85 Steeply Dipping - 55° - 85°	5°	Designation (RQD) –	RQD (Percent) Greater than 90 75 - 90 50 - 75 25 - 50 Less than 25	<u>Diagnostic Description</u> Excellent Good Fair Poor Very Poor			
	Fractures, scattered Open Cemented or Tight Fractures, closely spaced Open							
	Cemented or light Brecciated (Sheared and Fragment Open Cemented or Tight	ted)						
	Faulted Slickensides							

**APPENDIX A** 



DATE REVISED	DATE REVISED	FED. ROAD DIST. NO. STATE JOB NO.		JOB NO.	SHEET NO.	TOTAL SHEETS	
		6	ARK.	090069	5N3101	\$ \$ST\$	
		\$BN03A	\$	LAYOUT	\$[	DN3101\$	

Use Type F Approach Slab at each end of bridge. See Std. Dwg. No. 55040F1.

Use Type F Approach Gutters at each end of bridge. See Std. Dwg. No. 55030F.

### EXISTING UTILITIES LEGEND

FOC = Fiber Optic Cable

NOTE:

Utilities shown are based on locations at time of survey and do not reflect any potential utility relocations prior to construction.

#### HORIZONTAL CURVE DATA

XNA Access Rd. Median

- PI = 156+17.12  $\Delta = 14^{\circ}18'07''$  Rt
- $D = 0^{\circ}30'00''$
- T = 1437.67
- L = 2860.39'
- e = 0.02% R = 11459.16'

NOTES: For "PROJECT GENERAL NOTES", see Dwg. No. \$DN0201\$.

For "GENERAL NOTES" and "LOCATION SKETCH", see Dwg. No. \$DN3103\$.

For "ELEVATION OF SOIL BORINGS - BRIDGE A", "BORING LEGEND" and "N-VALUES", see Dwg. No. \$DN3104\$.

CL Construction is on a 0°30'00" curve right. CL Girders and the longitudinal lines of the bridge and approach slabs and gutters shall be constructed on curves concentric with CL Construction.

(1) Point of Minimum Vertical Clearance

2 Angle measured at point of intersection between line tangent to CL XNA Access Rd. Median and line tangent to CL Wager Rd

(3) For Bents 1A & 4A: Measured from CL Joint to a line radial to CL Bridge A at CL Joint.

For Bents 2A & 3A: Measured from CL Bent to a line radial to CL Bridge A at CL Bent.

	PVI Sta. 103+50.00 Elev. 1290.07 V.C. = 480' PVI Sta. 159+00.00 Elev. 1110.81 V.C. = 1000' -0.51%
. BORING: LABLE AT RINTING	S NOT TIME
	SHEET 1 OF 4 LAYOUT OF BRIDGES XNA ACCESS RD. OVER WAGER RD. NORTHWEST ARKANSAS NATIONAL AIRPORT ACCESS (F) BENTON COUNTY
MINARY FOR RUCTION	ROUTE \$RT\$SEC. \$SC\$ ARKANSAS STATE HIGHWAY COMMISSION LITTLE ROCK, ARK. DRAWN BY: <u>CSW</u> DATE: <u>MAR. 2022</u> FILENAME: <u>b090069x3_L1.dgn</u> CHECKED BY: MRA DATE: JULY 2022 SCALE. 1" = 20'-0"

DESIGNED BY: CSW DATE: MAR. 2022 BRIDGE NO. \$BN03A\$ DRAWING NO. \$DN3101\$



VORKSF WORKSF

DATE REVISED	DATE REVISED	FED. ROAD DIST. NO. STATE JOB NO.		JOB NO.	SHEET NO.	TOTAL SHEETS	
		6	ARK.	090069	5N3102	\$ \$ST\$	
		\$BN03B	\$	LAYOUT	\$[	DN3102\$	

Use Type F Approach Slab at each end of bridge. See Std. Dwg. No. 55040F1.

Use Type F Approach Gutters at each end of bridge. See Std. Dwg. No. 55030F.

### EXISTING UTILITIES LEGEND

FOC = Fiber Optic Cable

NOTE:

Utilities shown are based on locations at time of survey and do not reflect any potential utility relocations prior to construction.

#### HORIZONTAL CURVE DATA

XNA Access Rd. Median PI = 156+17.12 $\Delta = 14^{\circ}18'07''$  Rt.

- $D = 0^{\circ}30'00''$ T = 1437.67'
- L = 2860.39'
- = 0.02%R = 11459.16'

NOTES: For "PROJECT GENERAL NOTES", see Dwg. No. \$DN0201\$.

For "GENERAL NOTES" & "LOCATION SKETCH", see Dwg. No. \$DN3103\$.

For "ELEVATION OF SOIL BORINGS - BRIDGE B", BORING LEGEND" and "N-VALUES", see Dwg. No. \$DN3104\$.

CL Construction Is on a  $0^\circ30'00"$  curve right. CL Girders and the longitudinal lines of the bridge and approach slabs and gutters shall be constructed on curves concentric with CL Construction.

(1) Point of Minimum Vertical Clearance

(2) Angle measured at point of intersection between line tangent to CL XNA Access Rd. Median and line tangent to CL Wager Rd

 $\overset{\textcircled{3}}{3}$  For Bents 1B & 4B: Measured from CL Joint to a line radial to CL Bridge B at CL Joint.

Measured from CL Bent to a line radial to CL Bridge B at CL Bent.

		PVI Sta. 103+50.00 Elev. 1290.07 V.C. = 480'	
	-1.41%		PVI Sta. 159+00.00 Elev. 1110.81 V.C. = 1000'
		€ <u>-3.23%</u>	-0.51%
	VER	FICAL CURVE	DATA
	(Profile	Grade 14' Left of CL B	ridge B)
E AT TIME			
	1		
	LAY	OUT OF BRID	GES
	XNA ACCES	SS RD. OVER \	VAGER RD.
	NOR	THWEST ARKA	NSAS
	NATIONA	L AIRPORT A	CCESS (F)
	BI	ENTON COUN	ΓY
	R	OUTE \$RT\$SEC. \$S	
Y	ARKANSAS ST		COMMISSION
	CCW	LITTLE ROCK, ARK.	b000060v2 12 dan
с	HECKED BY: MRA	DATE: <u>JULY 2022</u> FI	SCALE: $1'' = 20'-0''$
DE	ESIGNED BY: CSW	DATE: MAR. 2022	

BRIDGE NO. \$BN03B\$

DRAWING NO. \$DN3102\$

### **APPENDIX B**

# **B-S1**: Run 1 (6-10 ft), Run 2 (10-15 ft), Run 3 (15-20 ft)



# **B-S2**: Run 1 (5-10 ft), Run 2 (10-15 ft)







**<u>ROCK CORE PHOTOS</u>** 090069 XNA Access Road

Benton County, Arkansas

Job No. 19-118

# B-S3: Run 1 (23-25 ft), Run 2 (25-30 ft)



**B-S3**: Run (30-35 ft)



090069 XNA Access Road **Benton County, Arkansas** 

**A UES Company** 

Job No. 19-118

# **B-S4**: Run 1 (5-10 ft), Run 2 (10-15 ft)







A UES Company

#### **<u>ROCK CORE PHOTOS</u>** 090069 XNA Access Road

Benton County, Arkansas

Job No. 19-118

# **B-S5**: Run 1 (24-26 ft), Run 2 (26-31 ft), Run 3 (31-34 ft)



B-S6: Run 1 (33-37 ft), Run 2 (37-38 ft), Run 3 (38-43 ft)





A UES Company

**ROCK CORE PHOTOS** 090069 XNA Access Road Benton County, Arkansas Job No. 19-118

## **B-S7**: Run 1 (28.5-30 ft), Run 2 (30-35 ft)







A UES Company

**<u>ROCK CORE PHOTOS</u>** 090069 XNA Access Road

Benton County, Arkansas

Job No. 19-118

### **APPENDIX C**

# SUMMARY of CLASSIFICATION TEST RESULTS

PROJECT: 090069 XNA Access Road

LOCATION: Benton County, Arkansas

#### GHBW JOB NUMBER: 19-118

PODINC	SAMPLE	WATER	AT	FERBERG LIN	4ITS			SI	EVE AI	NALY	SIS			USCS	AASHTO CLASS
No	DEPTH	CONTENT	LIQUID	PLASTIC	PLASTICITY			PEF	CENT	PASS	ING			CLASS	
110.	(ft)	(%)	LIMIT	LIMIT	INDEX	2 in.	1 in.	3/4 in.	3/8 in.	#4	#10	#40	#200	CLASS.	CLASS.
S1	0.5-1.5	14								45			21	GM	A-1-b
S4	2.5-3.5	15	Ν	ION-PLASTI	C					57			38	GM	A-4
S5	6.5-7.5	16	32	25	7					74			30	SM	A-2-4
S6	0.5-1.5	22	29	24	5					85			58	CL-ML	A-4
S6	2.5-3.5	12				100	80	79	66	54	43	37	34	SM	A-2-4
S6	9-10	17	34	21	13					67			39	SC	A-6
<b>S</b> 8	2.5-3.5	19	30	19	11					77			49	SC	A-6
<b>S</b> 8	14-15	13	32	18	14					65			20	SC	A-2-6



A UES Company



### **APPENDIX D**





**APPENDIX E** 









ULTIMATE SINGLE PILE CAPACITY, TONS

Note: 1. Piles driven from cap bottom elevation

2. Pile penetration limited in moderately hard weathered limestone below El.  $1105\pm$ 













2. Pile penetration limited in moderately hard weathered limestone below El.  $1102\pm$ 

### **APPENDIX F**
# Summary of Stability Analysis Results ARDOT 090069 XNA Access Road over Wager Road GHBW Job No. 19-118 Benton County, Arkansas

	Design Loading Condition	Calculated Minimum Factor of Safety
	End of Construction	3.15
South End Slope (Bent 1) (2H:1V)	Long Term	2.59
	Seismic ( $k_h = A_S/2 = 0.0245$ )	2.90
	End of Construction	4.65
South Side Slope (Bent 1) (3H:1V)	Long Term	3.97
	Seismic ( $k_h = A_S/2 = 0.0245$ )	4.50
	End of Construction	2.78
North End Slope (Bent 5) (2H:1V)	Long Term	2.55
	Seismic ( $k_h = A_S/2 = 0.0245$ )	2.63
	End of Construction	2.93
North Side Slope (Bent 5) (3H:1V)	Long Term	2.76
× ,	Seismic ( $k_h = A_S/2 = 0.0245$ )	2.69





Results of Stability Analyses – End of Construction Bent 1 End Slope 2H:1V Slope, H=34 ft ± 19-118 – ARDOT Job No.090069 – XNA Access Road over Wager Road





Results of Stability Analyses – Long Term Condition Bent 1 End Slope 2H:1V Slope, H=34 ft ± 19-118 – ARDOT Job No.090069 – XNA Access Road over Wager Road





 $\begin{array}{l} \mbox{Results of Stability Analyses - Seismic Condition} (k_h = A_S \ /2 = 0.0245) \\ \mbox{Bent 1 End Slope} \\ \ 2H: 1V \ Slope, \ H = 34 \ ft \pm \\ 19\text{-}118 - \ ARDOT \ Job \ No.090069 - \ XNA \ Access \ Road \ over \ Wager \ Road \\ \end{array}$ 





Results of Stability Analyses – End of Construction Bent 1 Side Slope 3H:1V Slope, H=16 ft ± 19-118 – ARDOT Job No.090069 – XNA Access Road over Wager Road





Results of Stability Analyses – Long Term Condition Bent 1 Side Slope 3H:1V Slope, H=16 ft ± 19-118 – ARDOT Job No.090069 – XNA Access Road over Wager Road

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Results of Stability Analyses – End of Construction Bent 4 End Slope 2H:1V Slope, H=30 ft ± 19-118 – ARDOT Job No.090069 – XNA Access Road over Wager Road





Results of Stability Analyses – Long Term Condition Bent 4 End Slope 2H:1V Slope, H=30 ft ± 19-118 – ARDOT Job No.090069 – XNA Access Road over Wager Road





 $\begin{array}{l} \mbox{Results of Stability Analyses - Seismic Condition (k_h = A_S / 2 = 0.0245) \\ \mbox{Bent 4 End Slope} \\ \mbox{2H:1V Slope, H=30 ft } \pm \\ \mbox{19-118 - ARDOT Job No.090069 - XNA Access Road over Wager Road} \end{array}$ 





Results of Stability Analyses – End of Construction Bent 4 Side Slope 3H:1V Slope, H=35 ft ± 19-118 – ARDOT Job No.090069 – XNA Access Road over Wager Road





Results of Stability Analyses – Long Term Condition Bent 4 Side Slope 3H:1V Slope, H=35 ft ± 19-118 – ARDOT Job No.090069 – XNA Access Road over Wager Road









Materials Testing Geotechnical Engineering Environmental Building Sciences & Safety Inspections & Code Compliance Virtual Design Consulting

September 28, 2023 Job No. 19-118

Garver LLC 4701 Northshore Drive North Little Rock, Arkansas 72118

Attn: Mr. Joel Skinner, P.E.

# RESULTS of GEOTECHNICAL INVESTIGATION ARDOT JOB 090069 XNA ACCESS ROAD BRIDGE OVER OSAGE CREEK BENTON COUNTY, ARKANSAS

# **INTRODUCTION**

Submitted herein are the final results of the geotechnical investigation performed for the XNA Access Road Twin Bridges over Osage Creek in Benton County, Arkansas. The Osage Creek bridge is one facet of ARDOT Job 090069 Northwest Arkansas Regional Airport Access (Benton Co) (F). This geotechnical investigation was authorized by the Garver, LCC Subconsultant Agreement for Task Order No. 061 on August 27, 2019. Notice to proceed with the field studies was received on August 30, 2019. Results and recommendations have been provided throughout the course of this study. A preliminary report was submitted on August 31, 2023.

We understand the new bridges will be continuous plate girder structures with nine (9) bents, eight (8) spans, and total bridge lengths of approximately 1022 ft each. We also understand that a foundation system consisting of steel piles and drilled piers are planned at the bridge ends and intermediate bents, respectively. Foundation loads of the new bridge are anticipated to be moderate. The bridge end embankments will utilize simple slopes with end slopes at approximate 2-horizontal to 1-vertical (2H:1V) configurations and side slopes at 3-horizontal to 1-vertical (3H:1V) configurations. Site grading is expected to include up to 34 ft of embankment fill and 42 ft of cut. Preliminary bridge layouts are provided in Appendix A.

The purposes of this study were to explore subsurface conditions in the twin bridge alignments and to develop recommendations to guide design and construction of foundations and earthwork. These purposes have been achieved by a multi-phased study that included the following.

- Drilling sample and core borings at the planned bridge location to evaluate subsurface conditions and obtain samples of the subgrade and foundation soil and rock for laboratory testing.
- Performing laboratory tests to evaluate pertinent engineering properties of the foundation and subgrade strata.
- Analyzing field and laboratory data to develop recommendations for seismic site class, seismic performance zone/seismic design category, foundation and subgrade support, slope stability, site grading, and construction considerations.

The relationship of these factors to design and construction of the new bridges has been considered in developing the recommendations and considerations discussed in the following report sections.

# SUBSURFACE EXPLORATION

Subsurface conditions at the Osage Creek bridge location were investigated by drilling 16 sample and core borings to depths of 23 to 55 feet. The site vicinity is shown on Plate 1. The approximate boring locations are shown on the bridge layout drawings on Plates 2a and 2b. The planned Boring S12 was not drilled due to the boring location in the creek channel with steep banks and seasonally high water levels. Planned Borings S17 and S26 were located on a steep hillside and were not accessible to drilling equipment. Boring R12, a roadway boring, was drilled about 150 ft north of the north bridge ends and was utilized to develop subsurface profiles at the A and B Bridges.

The subsurface exploration program is summarized in Table 1 below.

Boring No.	Approx Sta	Approx Offset, ft	Approx Surf El, ft	Completion Depth, ft
R12	170+99	CL	1146	30
S9	158+30	60 Lt	1098	27
S10	159+40	60 Lt	1089	52
S11	160+85	60 Lt	1080	52
S13	163+40	60 Lt	1079	55
S14	164+50	60 Lt	1078	51
S15	165+95	60 Lt	1078	52
S16	166+95	65 Lt	1072	44.2
S18	157+85	60 Rt	1091	23

Table 1: Summary of Osage Creek Bridges Exploration Program

Boring No.	Approx Sta	Approx Offset, ft	Approx Surf El, ft	Completion Depth, ft
S19	158+95	60 Rt	1084	48
S20	160+20	10 Rt	1078	46
S21	161+85	45 Rt	1078	52
S22	162+95	60 Rt	1072	50
S23	164+05	75 Rt	1078	48
S24	165+50	60 Rt	1076	50
S25	166+24	60 Rt	1070	48

The boring logs, presenting descriptions of the soil and rock strata encountered in the borings and the results of the field and laboratory tests, are included as Plates 3 through 31. The centerline station and offset of the boring locations and approximate ground surface elevation, as inferred from the topographic information provided by the Engineer (Garver, LLC) or as inferred from available topographic information, are also shown on the logs. It must be recognized that the surface elevations shown are <u>approximate</u> and actual elevations may vary. Keys to the terms and symbols used on the logs are presented as Plates 32 and 33.

The borings were drilled with a truck-mounted CME-55 HTX and a track-mounted Geoprobe 3230DT rotary-drilling rigs using a combination of dry-auger and rotary-wash drilling methods. Samples were typically obtained at 2-ft intervals to 10-ft depth and at 5-ft intervals thereafter. Samples were recovered using a 2-in.-diameter split-barrel sampler driven into the strata by blows of a 140-lb automatic hammer with 30-in. drop in accordance with Standard Penetration Test (SPT) procedures. The number of blows required to drive the standard split-barrel sampler the final 12 in. of an 18-in. total drive, or a portion thereof, is defined as the Standard Penetration Number (N). Recorded N-values are shown on the boring logs in the "Blows Per Ft" column.

Representative samples of the cherty limestone bedrock were obtained using a 5-ft-long NQ2size double-tube core barrel with a diamond bit. For each core run, the percent recovery was determined as the ratio of recovery to total length of core run. Rock Quality Designation (RQD) was also determined for the core run as the sum of intact, sound rock core greater than 4-in. length divided by the total length of the run and expressed in percent. Both these values are presented in the righthand columns of the log forms, opposite the corresponding core run. Selected photographs of the recovered rock cores are provided in Appendix B.

All samples were removed from sampling tools in the field, examined and visually classified by the field geologist or field engineer. Samples were then placed in appropriate

containers to prevent moisture loss and/or change in condition during transfer to our laboratory for further examination and testing.

The borings were advanced using dry-auger procedures to the extent possible to facilitate evaluation of shallow groundwater conditions. Observations regarding groundwater levels are noted in the lower-right portion of each log and are discussed in subsequent sections of this report. All boreholes were backfilled after obtaining the final water level readings.

## **LABORATORY TESTING**

Laboratory testing was performed to evaluate subgrade and foundation plasticity and to confirm visual classification. The testing program included natural water content determinations (AASHTO T 265), liquid and plastic (Atterberg) limit determinations (AASHTO T 89 and T 90), and sieve analyses through the No. 200 sieve (AASHTO T 88). Soil shear strength was estimated in the field using SPT results.

A total of 16 natural water content determinations were performed to develop information on *in-situ* soil water content in the borings. Water content results are plotted on the boring log forms in accordance with the scale and symbols shown in the legend located in the upper-right corner of the logs.

To verify field classification and to evaluate soil plasticity, seven (7) liquid and plastic limit (Atterberg limits) determinations and 14 sieve analyses were performed on selected representative samples. The Atterberg limits are plotted on the logs as pluses inter-connected with a dashed line using the water content scale. The percentage of soil passing through the No. 200 Sieve is noted in the "- No. 200 %" column on the appropriate log forms.

A summary of classification test results and classification by the Unified Soil Classification System and AASHTO Classification System is presented in Appendix C. Grain-size distribution curves are also included in Appendix C.

Results of the laboratory compression tests are shown in lbs per sq inch at the appropriate depth on the boring logs. The total unit weight of intact cores was also measured and these data are also shown on the logs.

#### **GRUBBS, HOSKYN, BARTON & WYATT, LLC** Job No. 19-118 – OSAGE CREEK OVER XNA ACCESS ROAD

# **GENERAL SITE and SUBSURFACE CONDITIONS**

### Site Conditions

The overall alignment of the XNA Access Road extends from the Northwest Arkansas Regional Airport (XNA) about 4 miles southeast to the planned terminus at Highways 70 and 71. The bridge alignments cross Osage Creek approximately 5300 ft northeast of the intersection of Haden Road and Snavely Road. The site locale is presently open agricultural and pastureland away from the creek; the immediate vicinity of the creek is covered with mature trees. The Osage Creek channel at the bridge location is narrow with well-defined banks. The banks are steep with tall grass and thick underbrush. Shifting gravel bars are in the channel and stream levels fluctuated broadly during drilling operations. The site terrain slopes gently to the creek from the northwest and the southeast. Surface drainage is considered very poor to good.

## Site Geology

The project alignment is located in the mapped exposure of the Boone Formation. The early and middle Mississippian Period Boone consists of fine- to coarse-grained limestone interbedded with chert. The chert content can vary widely, both horizontally and vertically, and limestone or chert may be predominant. The Boone Formation is known for dissolutional features such as sinkholes, caves, and enlarged fissures. Typically, the limestone/cherty limestone units of the Boone decompose (weather) to erratic blends of chert fragments and clay/silty clay. The residual soil mantle may extend to significant depths on higher terrain and may contain hard chert seams and/or layers. The thickness of the Boone Formation is reported to be 300 to 350 ft in northern Arkansas. The Boone is generally disconformable to the underlying Chattanooga Shale and St. Joe Limestone member, with some areas having a conformable contact.

## Seismic Conditions

In light of the results of the borings performed for the Osage bridge, a Seismic Site Class B (rock profile) is considered applicable for the site with respect to the criteria of the <u>AASHTO</u> <u>LRFD Bridge Design Specifications Eighth Edition 2017<sup>1</sup></u>.

Given the location and AASHTO code-based values, the 1.0-sec period spectral acceleration coefficient for Site Class B (S<sub>1</sub>) is 0.051 and the 1.0-sec period spectral acceleration coefficient (S<sub>D1</sub>) value for Site Class B is 0.051. Utilizing these parameters, Table  $3.10.6-1^2$ 

<sup>&</sup>lt;sup>1</sup> <u>AASHTO LRFD Bridge Design Specifications</u>, 8<sup>th</sup> Edition; AASHTO; 2017

<sup>&</sup>lt;sup>2</sup> AASHTO LRFD Bridge Design Specification, AASHTO; 2012

indicates that a <u>Seismic Performance Zone 1</u> is fitting for the Osage Creek bridge site. In reference to the 2011 edition of the AASHTO Guide Specifications, the Peak Ground Acceleration (PGA) having a 7 percent chance of exceedance in 75 years (or mean return period of approximately 1000 years) is predicted to be 0.049 for a Seismic Site Class B for the bridge location. The liquefaction potential is considered low for the predominantly cohesive overburden soils and underlying rock units encountered in the borings drilled for this study.

## Subsurface Conditions

The results of the borings indicate that the surface and near-surface soils in the new twin bridge alignments typically consist of natural very soft to soft brown, reddish brown, and tan clayey silt and silty clay and very loose to medium dense tan, brown, reddish brown, and reddish tan silt, fine sandy silt, silty fine sand, and silty, sandy fine to coarse gravel to 2- to 13-ft depth. This stratum contains variable chert fragments and cobbles. This stratum represents recent stream bed deposits, which typically classify as A-1-a, A-1-b, A-2-4, A-4, and A-6 by the AASHTO classification system. The silt and clayey silt exhibit low plasticity, moderate to high compressibility, and low shear strength. The low-plasticity and silty soils are moisture-sensitive and will lose considerable strength when saturated.

Below the silt/clayey silt, silty sand, and gravel to approximately 9- to 18-ft depth is very soft to very stiff brown, reddish brown, and tan silty clay with numerous chert fragments. These soils typically classify as A-2-6, A-4, and A-6 by the AASHTO classification system. The natural surface and near-surface soils are highly variable with respect to strength and subgrade support for pavement structures. Some areas will warrant localized undercut for subgrade preparation.

The overburden soils are underlain by moderately hard to hard gray and light gray weathered to fresh cherty limestone. The competence of the cherty limestone increases with depth. The cherty limestone is flat-bedded with healed fractures and interbedded chert inclusions, seams, and layers. The core sample recovery ranges from 29 to 100 percent and the core sample RQD ranges from 0 to 100 percent in this stratum. The cherty limestone exhibits high strength with laboratory compressive strength values ranging from 3920 to 8480 lbs per sq inch.

To aid in visualizing subsurface conditions, generalized subsurface profiles are presented in Appendix D. It should be recognized that the stratigraphy illustrated by the profiles has been inferred between discrete boring locations. In view of the natural variations in stratigraphy and conditions, variations from the stratigraphy illustrated by the profiles should be anticipated. Additionally, the natural transition between strata is generally gradual, and the stratigraphy described in the sections above may vary.

#### Groundwater Conditions

Groundwater was encountered at variable depths ranging from 3 ft to 18 ft in March, April, July, and August 2023. It has been our experience in the area that localized shallow perched groundwater can be present in the silty overburden soils and fractured zones of the cherty limestone. Groundwater levels will vary, depending on seasonal precipitation, surface runoff and infiltration, and stream levels in Osage Creek.

## **ANALYSES and RECOMMENDATIONS**

### Foundation Design

Foundations for the new bridge must satisfy two (2) basic and independent design criteria: a) foundations must have an acceptable factor of safety against bearing failure under maximum design loads, and b) foundation movement due to consolidation or swelling of the underlying strata should not exceed tolerable limits for the structures. Construction factors, such as installation of foundations, excavation procedures and surface and groundwater conditions, must also be considered.

Based on the results of the borings performed at the Osage Creek bridge site and our understanding of the project, we recommend that foundation loads at the south bridge ends (Bents 1A and 1B) be supported on steel piles. At the north bridge ends (Bents 9A and 9B), foundation loads may be supported on footings. Alternatively, steel piles may be used in conjunction with preboring. The foundation loads at the intermediate bents (Bents 2 through 8) may be supported on drilled shaft foundations. Recommendations for foundations are discussed in the following report sections.

## **Piling Foundations**

We recommend that the foundation loads at the south bridge end be supported on HP12x53 steel piles. Point-bearing steel piles driven to refusal should extend through any new embankment fill, the natural overburden soils, and any zones of highly weathered cherty limestone to develop safe bearing capacity in the competent moderately hard to hard limestone. End-bearing piles should be driven to practical refusal in the moderately hard to hard limestone. We recommend that all steel piles be fitted with rock points.

Steel piles driven to refusal should be designed for the structural capacity of the pile, as per applicable AASHTO Load and Resistance Factor Design (LRFD) procedures<sup>3</sup>. An effective resistance factor ( $\varphi_c$ ) of 0.50 is recommended for structural determination of factored bearing capacities. This effective resistance factor for steel piles has been based on the assumption of severe driving conditions.

For determination of bearing capacities of steel piles driven to refusal, we recommend that nominal (ultimate) resistance (P<sub>n</sub>) of HP piles be determined based on the yield strength of steel H piles ( $f_y$ ) and the net end area (A<sub>net</sub>) of the section. It has been our experience that allowable pile capacities of 96 tons for HP12x53 piles are typical for  $f_y = 50$  ksi steel pile sections. These capacities are based on allowable stress design (ASD). However, the appropriate factored bearing capacity should be confirmed by the Engineer. Post-construction settlement of piles driven to refusal will be negligible.

The nominal axial capacities are based on single, isolated foundations. Piles spaced closer than three (3) pile widths may develop lower individual capacity due to group effects. The potential for group capacity reductions should be evaluated for pile spacing closer than three (3) widths (center to center).

Estimated pile tip elevations are summarized below in Table 2.

Bent No.	Estimated Pile Tip Elevation, ft	Comments
1A (South Bridge End)	1078	Refusal in moderately hard to hard slightly weathered cherty limestone
1B (South Bridge End)	1076	Refusal in moderately hard to hard cherty limestone
9A (North Bridge End)	1088	Prebore 10 ft into hard cherty limestone
9B (North Bridge End)	1185	Prebore 10 ft into hard cherty limestone

 Table 2: Estimated Tip Elevations of Steel Piles Driven to Refusal

It should be noted that the prebore depths and tip elevations shown in the table above are <u>estimates</u> only based on the results of the relevant borings and the inferred surface elevations at the particular locations. Pile refusal and final pile depth must be field verified.

<sup>&</sup>lt;sup>3</sup> <u>Load and Resistance Factor Design (LRFD) for Highway Bridge Substructures</u>, Publication No. FHWA HI-98-032, National Highway Institute, May 2001.

Steel piles at the end bents may be subjected to uplift loads. Nominal single pile uplift capacity curves for steel HP12x53 piles are provided in Appendix E. Nominal axial pile capacities have been developed using static pile capacity formulae, the results of the borings, and the plan site grading shown on the preliminary bridge layout drawings. We recommend that compression loads be designed for end-bearing alone, as discussed above.

Based on AASHTO LRFD geotechnical design procedures, a resistance factor ( $\varphi_{up}$ ) of 0.25 is recommended for evaluation of factored uplift capacity. This resistance factor is based on Strength Limit States. For Extreme Events Limit States such as earthquake loading and collision, a resistance factor of 0.8 for uplift is recommended.

Given the anticipated site grading raising grades at the south bridge ends, downdrag loads from embankment and overburden soil settlement are anticipated. We recommend a minimum period of 45 days after completion of fill placement before pile driving. Alternatively, piling may be installed prior to the recommended 45 days if piles are pre-bored to the cherty limestone bearing stratum. Downdrag loads on piles constructed as recommended are expected to be negligible. Preboring is not expected to be required for pile installation on the south bent other than installing pile casing.

A minimum pile length of 10 ft is recommended. As noted, preboring is expected to be required for pile installation at the north bent. Rock drilling methods will be required for prebores extending through the competent limestone. Following pile acceptance, the annulus around the installed piles in prebores should be expeditiously backfilled with grout as per ARDOT Standard Specifications Section 805. The grout should have a minimum compressive strength pf 4000 psi, as per AHTD Section 501 or an alternate approved by the Engineer.

Piles should be installed in compliance with Standard Specifications for Highway Construction, 2014 Edition, Section 805. We recommend a hammer delivering a minimum energy of 22,000 ft-lbs per blow. A specific review and analysis of the pile-hammer system proposed by the Contractor should be performed by the Engineer prior to hammer acceptance and start of driving. We recommend that all piles be fitted with rock points.

As a minimum, safe bearing capacity of piles should be determined by ARDOT Standard Specifications Section 805.09, Method A. Driving records should be available for review by the Engineer during pile installation. Blow counts on steel piles should be limited to about 20 blows per inch. Practical pile refusal may be defined as a penetration of 0.5 in. or less for the final 10 blows. Driving records should be available for review by the Engineer during pile installation.

### Footings - Bents 9A and 9B

The results of the borings indicate that moderately hard to hard cherty limestone is present at the plan cap bottom elevations. Consequently, consideration can be given to supporting the end bent foundation loads on footings bearing in the cherty limestone.

Footings founded with a minimum embedment of 1 ft into the moderately hard to hard cherty limestone may be sized based on a maximum <u>nominal</u> bearing pressure  $(q_n)$  of 20 kips per sq foot. A resistance factor  $(\phi_b)$  of 0.45 is recommended for footings fully bearing in the competent moderately hard limestone. Accordingly, a factored unit bearing resistance  $(q_R)$  of 9 kips per sq ft is anticipated. Post-construction settlement of footings bearing in the recommended bearing strata is expected to be less than 0.5 inch. Final footing bottom elevations and suitable bearing must be field verified.

Uplift resistance of footings will be developed by the weight of the structure and the foundation units. The passive resistance of the overburden soils and rock within 2 ft below final grade should be neglected. In excess of depths at least 2 ft below lowest adjacent grade, resistance to sliding can be evaluated using a <u>nominal</u> friction factor (tan  $\delta$ ) value of 0.49 between the foundation concrete and the competent cherty limestone bearing stratum. A resistance factor ( $\varphi_{\tau}$ ) of 0.80 should be applied to sliding resistance. The passive resistance of the upper 2 ft of limestone embedment should be neglected. Below the greater depth, a <u>nominal</u> unit passive resistance of 2000 lbs per sq ft of foundation area in hard contact with the competent limestone can be utilized. A resistance factor ( $\varphi_{ep}$ ) of 0.50 should be applied to passive resistance.

Footings must extend through the overburden soils and any weathered limestone or chert zones to bear in <u>competent</u> moderately hard to hard limestone. A minimum embedment of 12 in. into the competent weathered limestone is recommended. Any overexcavation of footings must be backfilled with concrete. Weathered zones or open fractures in the limestone bearing stratum which are exposed at the bearing elevation should be excavated, cleaned out, and filled with concrete. Footing bottoms should be essentially horizontal. Use of dental concrete to level footing bottoms and to repair minor deficient areas is suitable.

Footings should have a minimum width of 5 feet. All footing excavations should be observed by the Engineer or Department to verify suitable bearing. Any footing undercuts or overbreaks should be backfilled with concrete.

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Job No. 19-118 – OSAGE CREEK OVER XNA ACCESS ROAD

#### Drilled Shaft Foundations - Bents 2 through 8

Drilled straight shafts are recommended for support of foundation loads at the intermediate bents, Bents 2 through 8. Drilled shafts should be founded with a minimum embedment of 1.5 shaft diameters or 6 ft, whichever is greater, into the moderately hard to hard gray and tan cherty limestone. Drilled shafts founded as recommended may be sized using a maximum nominal end-bearing pressure ( $R_n$ ) of 125 kips per sq foot. A resistance factor ( $\varphi_{stat}$ ) of 0.50 is recommended for drilled shaft end bearing. Total and differential settlement of properly installed drilled shafts founded in the competent moderately hard to hard limestone as recommended is expected to be negligible. We also recommend that drilled shafts be sized for axial compression loads based on end bearing alone.

Resistance to uplift loads will be developed by circumferential shaft friction. Drilled shafts will penetrate the overburden soils to bear in the competent moderately hard to hard cherty limestone. Uplift resistance for the top 5 ft of shaft length, all penetration through the overburden soils, and the length of permanent casing should be neglected. For shaft penetration through the competent cherty limestone, a maximum nominal skin resistance value of 12 kips per sq ft is recommended. For evaluation of uplift capacity, a resistance factor ( $\varphi_{up}$ ) of 0.40 is recommended for shaft skin friction.

A minimum shaft rock socket length of 1.5 shaft diameters or 6 ft, whichever is greater, is recommended for drilled shafts. The as-built shaft length will vary with location and depth of overburden. In general, rock strata are 7 to 10 ft below the ground line at the bent locations. It is expected that permanent casing will extend to the top of rock and slightly into the rock.

The depths to suitable rock strata are estimates only, and are based on the results of the borings, the inferred surface elevation at the particular bent location, and existing grades. Suitable bearing stratum and final shaft lengths must be field verified. Plan shaft lengths and shaft tip elevations must be based on the magnitude of foundation loads, specific subsurface conditions, and actual shaft diameters. Depending on specific subsurface conditions and rock quality, localized deepening or shortening of shaft depths can be warranted.

All drilled shaft excavations should be observed by the Engineer to verify suitable bearing and adequate penetration. Heavy-duty drilling equipment will be required to advance the shaft excavations. The moderately hard to hard limestone bearing stratum will be resistant to drilling and rock drilling methods are expected to be required to achieve the required shaft penetration. To verify competence of the moderately hard to hard limestone bearing stratum, we recommend that all shaft excavations be probed. Probe holes should consist of continuous rock core borings advanced from the shaft bottom elevation into the bearing stratum a depth of at least one-and-one-half (1.5) shaft diameters. Rock cores from probe holes should be reviewed by the Engineer to verify foundation stratum competence and suitability of the plan shaft bottom elevation.

# Embankment Slopes

The south bridge embankments will utilize simple slopes of 2-horizontal to 1-vertical (2H:1V) and 3-horizontal to 1-vertical (3H:1V) configurations on the embankment end and side slopes, respectively. Site grading on the south embankment is expected to include up to 34 ft of fill. The north embankment is expected to have cuts of up to 42 ft, with near-vertical cuts on the end embankment and 3-horizontal to 1-vertical (3H:1V) configurations on the side embankment.

To evaluate suitability of the side slope plan configurations, slope stability analyses were performed using the computer program SLOPE/W 2020<sup>4</sup> and utilizing a Morgenstern-Price analysis. For the embankment slopes, four (4) general loading conditions were evaluated, i.e., End of Construction, Long Term, Rapid Drawdown, and Seismic Conditions were evaluated. A 250 lbs per sq ft uniform surcharge from vehicles was included for the purposes of stability analyses. For analysis of the seismic condition, a horizontal seismic acceleration coefficient (k<sub>h</sub>) of one-half the peak acceleration (A<sub>s</sub>) was used, a value of 0.0245. For evaluation of the rapid drawdown condition, a water surface elevation drop from El 1085 to El 1074 was assumed.

The stability analyses results summarized in Appendix F include the results of evaluation of side slopes. The results of the stability analyses indicate that plan configurations of the slopes are acceptable with respect to stability of all loading conditions evaluated.

# Subgrade Support

The results of the borings indicate the on-site subgrade soils generally consist of silt, clay and silty clay with chert fragments (AASHTO A-2-6, A-4, A-6, and A-7-5). Given the anticipated new embankment, the approach roadway subgrade is likely to consist of embankment fill. Locallyavailable borrow, which is likely to be used as unclassified embankment fill, is expected to have similar classification.

<sup>&</sup>lt;sup>4</sup> ibid

We recommend that any soils classifying as A-7-5 or A-7-6 soils be excluded from use as subgrade within 18 in. of the plan subgrade elevation. The top 18 in. of subgrade soils should have a maximum plasticity index (PI) of 18. The as-built pavement subgrade should be evaluated by the Engineer. Areas of unstable or otherwise unsuitable subgrade should be improved by undercut and replacement or treatment with additives approved by the Engineer.

Based on the results of previous laboratory CBR tests on the silty clay with chert fragments subgrade and correlation with the AASHTO classification, we recommend the following parameters for use in design of pavements.

•	CBR:	8.3
•	Resilient Modulus (MR):	3260 lbs per sq in.
•	R value:	13
•	Modulus of Subgrade Reaction (k):	100 lbs per cu in.

### Site Grading and Subgrade Preparation

As noted, the surface soils are moisture-sensitive. Though presently stable, at elevated water contents the silt, fine sandy silt, and clayey silt subgrade are likely to be soft and unstable. Consequently, site grading operations will be significantly easier to perform during dry seasons of the year.

Site preparation will require some clearing and grubbing and stripping the zone of organiccontaining soils. The depth of stripping will be variable, with deeper stripping depths in wooded areas, and less stripping required in open areas. In general, the stripping depth is estimated to be about 6 to 9 inches in clear areas but may be 18 to 24 in. or more in the localized areas where trees and thick underbrush are present. The zone of organic surface soils should be completely stripped in the embankment footprint areas and at least 5 ft beyond the projected embankment toes. Particular care must be taken to muck out all saturated and/or organic-laden soils in the existing drainage features. Hillsides should be benched to allow placement of embankment fill in horizontal lifts. The maximum vertical cut on benches should be limited to about 18 to 24 inches.

Following stripping and prior to fill placement, the extent of weak and unsuitable soils should be determined. Thorough proof-rolling should be performed to verify subgrade stability. Proof-rolling should be performed with a loaded tandem-wheel dump truck or similar equipment. Unstable soils exhibiting a tendency to rut and/or pump should be undercut and replaced with suitable fill. Care should be taken that undercuts, stump holes, and other excavations or low areas resulting from subgrade preparation are properly backfilled with compacted fill.

Depending on seasonal conditions, undercuts of about 2 to 3 ft below existing grades, more or less, could be required. Deeper undercuts may be required in wet seasons. General undercuts for site grading may be backfilled with unclassified borrow used for embankment fill.

In lieu of undercutting and replacing unsuitable soils in approach road alignments, consideration may be given to using additives to improve soil workability and to stabilize weak areas. Hydrated lime, quick lime, Portland cement, fly ash, or suitable alternate materials may be used as verified by appropriate testing and approved by the Engineer. Additives can be effective where the depth of unstable soils is relatively shallow. Treatment will be less effective in areas where the zone of unstable soils is deep. The optimum application rate of stabilization additive must be determined by specific laboratory tests performed on the alignment subgrade soils. We recommend a minimum treatment depth of 8 inches.

Subgrade preparation and mass undercuts should extend at least 5 ft beyond the embankment toes to the extent possible. Subgrade preparation for the approach roads should extend at least 3 ft outside pavement shoulder edges to the extent possible.

Fill and backfill may consist of unclassified borrow free of organics and other deleterious materials as per ARDOT Standard Specifications Subsection 210.06. Where A-7-5 or A-7-6 soils are encountered at the subgrade elevation, we recommend that these soils be undercut as required to provide at least 18 in. of suitable low-plasticity subgrade soils, i.e., with a maximum PI of 18, or approved "hillside" cherty clay with a maximum of 35 percent passing the No. 200 sieve. Alternatively, stabilization additives may be utilized to develop a stable subgrade with a PI of 18 or less. Granular soils must be protected from erosion with a minimum 18-in.-thick armor of clayey soil.

Subgrade preparation should comply with ARDOT Standard Specifications Section 212. Embankments should be constructed in accordance with ARDOT criteria (ARDOT Standard Specifications Section 210). Fill and backfill should be placed in nominal 6- to 10-in.-thick loose lifts. All fill and backfill must be placed in horizontal lifts. Hillsides should be benched as required to facilitate placing horizontal fill lifts. The in-place density and water content should be determined for each lift and should be tested to verify compliance with the specified density and water content prior to placement of subsequent lifts.

#### GRUBBS, HOSKYN, BARTON & WYATT, LLC

Job No. 19-118 - OSAGE CREEK OVER XNA ACCESS ROAD

#### **CONSTRUCTION CONSIDERATIONS**

### Groundwater and Seepage Control

Positive surface drainage should be established at the start of the work, be maintained during construction and following completion of the work to prevent surface water ponding and subsequent saturation of subgrade soils. Density and water content of all earthwork should be maintained until embankments, bridge work, and pavements are completed.

Groundwater was encountered between 3- to 18-ft depth in March, April, July, and August 2023. Shallow perched groundwater may be encountered in the near-surface soils, particularly during wet seasons. The volume of groundwater produced can be highly variable depending on the condition of the soil in the immediate vicinity of the excavation. In addition, seasonal surface seeps or springs could develop.

Seepage into excavations and cuts can typically be controlled by ditching or sump-and-pump methods. If seepage infiltration cannot be controlled, construction of drains and/or the use of Select Granular Backfill (AASHTO M 43 No. 57), stone backfill (ARDOT Standard Specifications Section 207), or approved alternates to an elevation above the inflow of seepage will be warranted. In areas of seepage infiltration, the granular fill should be encapsulated with a filter fabric complying with ARDOT Standard Specifications Subsection 625.02, Type 2 and vented to positive discharge. Where surface seeps or springs are encountered during site grading, we recommend the seepage be directed via French drains or blanket drains to positive discharge at daylight or to storm drainage lines.

Site preparation should also include construction of blanket drains in all existing drainage features which will be covered by fill. All loose and/or organic materials should be excavated from drainage features prior to drain construction. Blanket drains should consist of at least 8 to 12 in. of select granular backfill (AASHTO M 43 No. 57) fully encapsulated by a filter fabric. A fabric complying with ARDOT Standard Specifications Subsection 625.02, Type 2 is recommended. Drains should direct water to positive discharge at daylight or into storm drain lines. Piling

Piles should be installed in compliance with ARDOT Standard Specifications, Section 805. Piles should be carefully examined prior to driving and piles with structural defects should be rejected. Any splices in steel piles should develop the full cross-sectional capacity of un-spliced piles. Preboring should be anticipated for pile installation on the north bents. Some rock drilling could be required for prebores. Where piles are prebored to develop uplift resistance, the annulus between the steel piles and the prebore should be expeditiously backfilled with approved grout or concrete.

Pile installation should be monitored by qualified personnel to maintain specific and complete driving records and observe pile installation procedures. Safe bearing capacity of production piles should be determined by ARDOT Standard Specifications Section 805.09, Method A. Driving records should be available for review by the Engineer during pile installation. For driving steel piles on this project, we recommend a minimum hammer energy of 34,000 ft-lbs per blow. Blow counts on steel piles should be limited to about 20 blows per inch. Practical pile refusal may be defined as a penetration of 0.5 in. or less for the final 10 blows.

#### Shallow Footings

All footing excavations should be observed by the Engineer to verify suitable bearing and adequate undercut. Concrete should be placed in footing excavations expeditiously following final clean up and approval to limit changes in foundation conditions. Footing excavations should be clean and dry at the time of concrete placement.

#### Drilled Shafts

As noted, groundwater was encountered in the bridge boring at about 3 - to 18-ft depth between March and August 2023. Groundwater could be encountered in drilled shaft excavations. Limited seepage into drilled shaft excavations can probably be controlled by close coordination of drilling, cleanup and concrete placement. We recommend that casing be on site in the event it is needed to control seepage and/or caving into shaft excavations. Drilled shaft excavations should essentially be dry at the time of concrete placement. Where more than about 3 in. of water is present in shaft excavations, the excavation should be dewatered prior to concrete placement. Where shaft excavations cannot be dewatered, underwater concrete placement should be performed with a concrete pump fitted with a rigid end extension. A muck bucket or similar tools should be utilized to clean the shaft excavation bottom prior to underwater concrete placement.

Some hard drilling will be experienced when advancing drilled shaft excavations into the moderately hard to hard limestone. Heavy-duty drilling equipment and rock drilling tools will be required to advance shaft excavations to the recommended minimum penetration into the competent limestone. Coring or other rock excavation methods will be required to achieve the recommended penetration into the rock bearing stratum. All drilled shaft excavations should be observed by the Engineer or Department to verify suitable bearing and adequate penetration.

### **CLOSURE**

The Engineer or Department or a designated representative thereof should monitor site preparation, grading work and foundation and pavement construction. Subsurface conditions significantly at variance with those encountered in the borings should be brought to the attention of the Geotechnical Engineer. The conclusions and recommendations of this report should then be reviewed in light of the new information.

The following illustrations are attached and complete this final report.

Plate 1	Site Vicinity
Plates 2a and 2b	Plans of Borings
Plates 3 through 31	Boring Logs
Plates 32 and 33	Keys to Terms and Symbols
Appendix A	Preliminary Bridge Layout
Appendix B	Selected Rock Core Photographs
Appendix C	Classification Test Results
Appendix D	Generalized Subsurface Profiles
Appendix E	Nominal HP12x53 Uplift Pile Capacity Curves
Appendix F	Stability Analyses Results

We appreciate the opportunity to be of service to you on this project. Should you have any questions regarding this report, or if we may be of additional assistance, please call on us.

Sincerely,

**GRUBBS, HOSKYN, BARTON & WYATT, LLC** 

Vellet M. Sett

Velleta M. Scott, P.E. Sr. Project Engineer

Mark E. Wyatt, P.E. President

VMS/MEW:jw

**Copies Submitted:** 

Garver LLC Attn: Mr. Joel Skinner, P.E. Attn: Mr. Lawren Wilcox, P.E. Attn: Mr. Adam Wierciak, P.E.

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A UES Company

090069 XNA Access Road over Osage Creek **Benton County, Arkansas** 

Plate 1





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LOG OF BORII         Consulting Engineers       090069 XNA Access Road Benton County,         TYPE: HSA to 15 ft /Core       LOC         Image: Consulting Engineers       DESCRIPTION OF MATERIAL       Image: Consulting Engineers         Image: Consulting Engineers       DESCRIPTION OF MATERIAL       Image: Consulting Engineers         Image: Consulting Engineers       DESCRIPTION OF MATERIAL       Image: Consulting Engineers         Image: Consult of the consu</td> <td>19-118         Grubbs, Hoskyn, Barton &amp; Wyatt, Inc. Consulting Engineers       LOG OF BORING 090069 XNA Access Road ove Benton County, Arka         TYPE: HSA to 15 ft /Core       LOCATIC         Of an analysis       DESCRIPTION OF MATERIAL       Image: Consulting Engineers         OB       DESCRIPTION OF MATERIAL       Image: Consulting Engineers       Image: Consulting Engineers         OB       DESCRIPTION OF MATERIAL       Image: Consulting Engineers       Image: Consulting Engineers         Image: Consulting Engineers       DESCRIPTION OF MATERIAL       Image: Consulting Engineers       Image: Consulting Engineers         Image: Consulting Engineers       DESCRIPTION OF MATERIAL       Image: Consulting Engineers       Image: Consulting Engineers         Image: Consulting Engineers       DESCRIPTION OF MATERIAL       Image: Consulting Engineers       Image: Consulting Engineers         Image: Consulting Engineers       DESCRIPTION OF MATERIAL       Image: Consulting Engineers       Image: Consulting Engineers         Image: Consulting Engineers       DESCRIPTION OF MATERIAL       Image: Consulting Engineers       Image: Consulting Engineers         Image: Consulting Engineers       DESCRIPTION OF MATERIAL       Image: Consulting Engineers       Image: Consulting Engineers         Image: Consulting Engineers       Image: Consulting Engineers       Image: Consulting Engineers       Image: Consulting</td> <td>19-118         Grubbs, Hoskyn, Barton &amp; Wyatt, Inc. Consulting Engineers         LOG OF BORING NG 090069 XNA Access Road over Os Benton County, Arkansas         TYPE: HSA to 15 ft /Core         LOCATION: A         Image: State of the stat</td> <td>19-118       Grubbs, Hoskyn, Densutting Engineers       LOG OF BORING NO. 090069 XNA Access Road over Osage Benton County, Arkansas       TYPE: HSA to 15 ft/Core       LOCATION: Approvide the second oper operation of the second oper operation operatio</td> <td>19-118       Grubbs, Hoskyn, Consulting Engineers     LOG OF BORING NO. S13       Og0069 XNA Access Road over Osage Cree Benton County, Arkansas       TYPE: HSA to 15 ft /Core     LOCATION: Approx Star       Image: Continued     Image: Continued       Image: Continued     Image: Continue       Image: Continue     Image: Continue       Image: Co</td> <td>19-118         Grubbs, Hoskyn, Densuting Engineers         Consulting Engineers         Consulting Engineers         TYPE: HSA to 15 ft /Core         LOCATION: Approx Sta 163:44         Image: Consulting Engineers         TYPE: HSA to 15 ft /Core         LOCATION: Approx Sta 163:44         Image: Consulting Engineers         Im</td> <td>19-118       Grubbs, Hoskyn, Doneuting Engineers       LOG OF BORING NO. S13       Denceuting Engineers       Description OF MATERIAL       Image: State of the stat</td> <td>Barton &amp; Wyatt, Inc.     LOG OF B OR ING NO. S13       Demonstring Engineers     090089 XNA Access Road over Osage Creek Benton County, Arkansas       TYPE:     HSA to 15 ft /Core     LOCATION: Approx Sta 163+40, 60 ft Lt       Image: Continued of the state of th</td> <td>19-113 Grubbs, Hoskyn, Consulting Engineers  LOG OF BORING NO. S13 90009 XNA Access Road over Osage Creek Benton County, Arkansas  TYPE: HSA to 15 ft /Core  LOCATION: Approx Sta 163+40, 60 ft Lt  COHESION TON/SQ FT  COHESION TON/SQ FT  CONTENT CONTEN</td> <td>19-112 Grubs, Hoskyn, Barton &amp; Wyati, Inc. Comuniting Engineers  DESCRIPTION OF MATERIAL Continued)  DESCRIPTION OF MATERIAL Continued  DESCRIPTION OF MATERIAL CONTENT  DESCRIPTION  DESCRIPTION DES</td> <td>19-113 Grubbs, Hoskyn, Consulting Engineers  LOG OF BORING NO. S13 090069 XNA Access Road over Osage Creek Benton County, Arkansas  TYPE: HSA to 15 ft/Core  LOCATION: Approx Sta 183:40, 00 ft Lt  COHESION, TONSO FT  Continued)  Continued)  Continued  Continued</td> <td>19-119 Grubbs, Hoskyn, Barton &amp; Wyat, Inc. Demoking Engineers TYPE: HSA to 15 ft /Core UCCATION: Approx Sta 163+40, 60 ft L1 DESCRIPTION OF MATERIAL Continued) Continued) Continued) Continued Continue</td>	19-118         Grubbs, Hoskyn, Barton & Wyatt, Inc.         Consulting Engineers         Description         Description of MATERIAL         Ogeneration         Ogeneration         Ogeneration         Description of MATERIAL         Ogeneration         Ogeneration	19-118         Grubbs, Hoskyn, Barton & Wyatt, Inc.       LOG OF BORII         Consulting Engineers       090069 XNA Access Road Benton County,         TYPE: HSA to 15 ft /Core       LOC         Image: Consulting Engineers       DESCRIPTION OF MATERIAL       Image: Consulting Engineers         Image: Consulting Engineers       DESCRIPTION OF MATERIAL       Image: Consulting Engineers         Image: Consulting Engineers       DESCRIPTION OF MATERIAL       Image: Consulting Engineers         Image: Consult of the consu	19-118         Grubbs, Hoskyn, Barton & Wyatt, Inc. Consulting Engineers       LOG OF BORING 090069 XNA Access Road ove Benton County, Arka         TYPE: HSA to 15 ft /Core       LOCATIC         Of an analysis       DESCRIPTION OF MATERIAL       Image: Consulting Engineers         OB       DESCRIPTION OF MATERIAL       Image: Consulting Engineers       Image: Consulting Engineers         OB       DESCRIPTION OF MATERIAL       Image: Consulting Engineers       Image: Consulting Engineers         Image: Consulting Engineers       DESCRIPTION OF MATERIAL       Image: Consulting Engineers       Image: Consulting Engineers         Image: Consulting Engineers       DESCRIPTION OF MATERIAL       Image: Consulting Engineers       Image: Consulting Engineers         Image: Consulting Engineers       DESCRIPTION OF MATERIAL       Image: Consulting Engineers       Image: Consulting Engineers         Image: Consulting Engineers       DESCRIPTION OF MATERIAL       Image: Consulting Engineers       Image: Consulting Engineers         Image: Consulting Engineers       DESCRIPTION OF MATERIAL       Image: Consulting Engineers       Image: Consulting Engineers         Image: Consulting Engineers       DESCRIPTION OF MATERIAL       Image: Consulting Engineers       Image: Consulting Engineers         Image: Consulting Engineers       Image: Consulting Engineers       Image: Consulting Engineers       Image: Consulting	19-118         Grubbs, Hoskyn, Barton & Wyatt, Inc. Consulting Engineers         LOG OF BORING NG 090069 XNA Access Road over Os Benton County, Arkansas         TYPE: HSA to 15 ft /Core         LOCATION: A         Image: State of the stat	19-118       Grubbs, Hoskyn, Densutting Engineers       LOG OF BORING NO. 090069 XNA Access Road over Osage Benton County, Arkansas       TYPE: HSA to 15 ft/Core       LOCATION: Approvide the second oper operation of the second oper operation operatio	19-118       Grubbs, Hoskyn, Consulting Engineers     LOG OF BORING NO. S13       Og0069 XNA Access Road over Osage Cree Benton County, Arkansas       TYPE: HSA to 15 ft /Core     LOCATION: Approx Star       Image: Continued     Image: Continued       Image: Continued     Image: Continue       Image: Continue     Image: Continue       Image: Co	19-118         Grubbs, Hoskyn, Densuting Engineers         Consulting Engineers         Consulting Engineers         TYPE: HSA to 15 ft /Core         LOCATION: Approx Sta 163:44         Image: Consulting Engineers         TYPE: HSA to 15 ft /Core         LOCATION: Approx Sta 163:44         Image: Consulting Engineers         Im	19-118       Grubbs, Hoskyn, Doneuting Engineers       LOG OF BORING NO. S13       Denceuting Engineers       Description OF MATERIAL       Image: State of the stat	Barton & Wyatt, Inc.     LOG OF B OR ING NO. S13       Demonstring Engineers     090089 XNA Access Road over Osage Creek Benton County, Arkansas       TYPE:     HSA to 15 ft /Core     LOCATION: Approx Sta 163+40, 60 ft Lt       Image: Continued of the state of th	19-113 Grubbs, Hoskyn, Consulting Engineers  LOG OF BORING NO. S13 90009 XNA Access Road over Osage Creek Benton County, Arkansas  TYPE: HSA to 15 ft /Core  LOCATION: Approx Sta 163+40, 60 ft Lt  COHESION TON/SQ FT  COHESION TON/SQ FT  CONTENT CONTEN	19-112 Grubs, Hoskyn, Barton & Wyati, Inc. Comuniting Engineers  DESCRIPTION OF MATERIAL Continued)  DESCRIPTION OF MATERIAL Continued  DESCRIPTION OF MATERIAL CONTENT  DESCRIPTION  DESCRIPTION DES	19-113 Grubbs, Hoskyn, Consulting Engineers  LOG OF BORING NO. S13 090069 XNA Access Road over Osage Creek Benton County, Arkansas  TYPE: HSA to 15 ft/Core  LOCATION: Approx Sta 183:40, 00 ft Lt  COHESION, TONSO FT  Continued)  Continued)  Continued  Continued	19-119 Grubbs, Hoskyn, Barton & Wyat, Inc. Demoking Engineers TYPE: HSA to 15 ft /Core UCCATION: Approx Sta 163+40, 60 ft L1 DESCRIPTION OF MATERIAL Continued) Continued) Continued) Continued Continue

	19-118	8													
	Gru Bar <sub>Consu</sub>	bbs, Hoskyn, ton & Wyatt, Inc. <sup>Ilting Engineers</sup> 090069 XNA Ad Bento	BC ccess on Co	<b>) R I</b> Road unty,	<b>N G</b> l ove Arka	<b>N C</b> r Osa nsas	<b>). S</b> age	<b>614</b> Cree	k						
	TYPE	E: HSA to 12 ft /Core		LO	CATIO	N: Ap	prox	sta 1	64+5	0, 60	ft Lt				
		(A)	FT	۷T		(	СОН	ESIO	N, TO	N/SC	) FT			Z	
Ξ	1BOL		PER	SRY V SU FT	0.	.2 0	.4	0.6	0.8	1.0	1.2	1.4	200 %	cover	gD
DEP1	SYN	SAM	SWO	INIT D	PLA LI			W CO		т	L		- No.	% Re	Ч К
		SURF. EL: 1078±	В		1	0 2	20	30	40	50	60	- <b>T</b> 70			
		Loose brown silt w/fine to coarse gravel	5												
		Very loose to loose brown and tan silty fine to coarse gravel, sandy	4												
- 5 -	000	- loose at 4 to 8 ft	5							_					
			8												
		- medium dense below 8 ft	15												
- 10 -			15												
		and light gray cherty limestone w/very close interbedded chert seams and lavers and close												100	56
15		limestone seams, layers, and inclusions - vertical fracture at 12.8 to													
		13.5 ft													
														92	85
- 20 -															
CZ-00														100	87
- 25 -													_		
														100	70
		PLETION DEPTH: 51.0 ft		 РТН Т	O W A	TFR									
	DATE	: 8-24-23	IN	BORIN	G: 6.	5 ft						DATE:	8/24/2	202	3

	<u>19-11</u> Gru Bar	8 bb toi	n & Wyatt, Inc. LOGOF	BC	) R I	N G	N C	). (	<b>614</b>	k						
	/ Consu	nni	Bento	on Co	unty,	Arka	nsas	uge	oree	'IX						
	TYPE	<u>:</u>	HSA to 12 ft /Core		LO		N: Ap	oprox	c Sta 1	64+5	0, 60	) ft Lt				
⊢		0 0		2 FT	×∟			COH	IESIO	N, TC 	)N/S(	ຊ FT -			%	~
Ц Н, F	ABOL	ЫГЁ	DESCRIPTION OF MATERIAL	DEF	SRY V	0	.2 (	).4	0.6	0.8	1.0	1.2	1.	4	200	cover
DEP.	SYN	SAN		OWS	LB/0	PL/	ASTIC		W CO		ξ IT		LIQU	ID T	Ň	% Re
			(continued)	ВГ		1	+ - ·	 20	30	- <b></b>	50	60	<b>+</b>	)		•
			- with less chert at 32 to 35 ft													95 7
- 35 -			- vertical fracture at 38.7 to 39.3 ft													1007
- 40 -																98 8
																1007
- 50 -																10010
				T				<b>—</b>								
	-															
	-															
- 55 -									_		_					
	-															
	-															
	COMI DATE	 PLE : 8	TION DEPTH: 51.0 ft -24-23	DE IN	PTH T BORIN	0 WA IG: 6.	TER 5 ft						DAT	E: 8/	24/2	2023

19-118														
Grubb Barton Consulting	os, Hoskyn, n & Wyatt, Inc. LOGOF g Engineers 090069 XNA Ac Bento	BO cess n Cor	<b>R I</b> Roac unty,	<b>N G</b> I over Arkar	<b>N O</b> Osa Isas	. <b>S1</b> ge C	l <b>5</b> reek							
TYPE:	Auger to 4 ft /Wash to 10 ft /Core		LOC		N: Apj	prox S	Sta 16	5+95,	60 ft L	.t				
EPTH, FT ;YMBOL AMPLES	DESCRIPTION OF MATERIAL	WS PER FT	T DRY WT B/CU FT	0.: PLA	C 2 0.4 STIC	COHE:	SION, 6 0 WA	TON/	SQ F <sup>-</sup>	T .2 1 LIQU	.4 IID	lo. 200 %	Recovery	% RQD
	SURF. EL: 1078±	BLO	UNI L	LI - 1(	MIT + ) 20		CON 	TENT 	0 6	LIM 	IT ro	-	%	U
*0° *0°	Loose tan and brown sandy fine to coarse gravel, slightly silty w/cobbles (gravel bar)	6		•		<u>, , , , , , , , , , , , , , , , , , , </u>	<u></u>	NON	I-PLA	STIC		11		
		8												
	sand w/numerous chert fragments	31						NON	I-PLA	STIC		18		
		35												
		50/10												
	Moderately hard to hard light gray and gray cherty limestone w/interbedded chert inclusions, seams, and layers, stylolites, and rehealed fractures						q <sub>u</sub> = 6	340 p	si, TU	W= 15	7 pcf		93	48
							$q_u = 2$ $q_u = 6$	150 p 230 p	si, TU si, TU	W= 15 W= 16	6 pcf		73	63
													100	83
													100	90
COMPLE DATE: 8	ETION DEPTH: 52.0 ft -27-23	DEI IN E	PTH T BORIN	0 WA G: 3.2	TER 2 ft					DA	TE: 4/	25/2	023	}

	19-118															
	Grub Barto Consulti	bs, Hoskyn, on & Wyatt, Inc. <sub>ng Engineers</sub> 090	L OGOF 0069 XNA Ac Bento	BC cess n Co	<b>R I</b> Road unty,	<b>N G</b> l ove Arka	<b>N C</b> r Osa nsas	<b>). S</b> age (	3 <b>15</b> Creek	ζ.						
	TYPE:	Auger to 4 ft /Wash to 1	0 ft /Core		LOC	CATIC	N: Ap	prox	Sta 16	§5+95,	60 ft L	.t				
F		o		R FT	ΨΤ T				ESION	I, TON	/SQ F	Г		%	ry	
PTH, F			MATERIAL	S PEF	DRY /CU F	0	2 0	.4	0.6	0.8 1	1.0 1	2 1	.4	. 200	ecove	ROD
DEF	S o	(continued)		BLOW	UNIT	PL/ L	ASTIC MIT <b>+</b>					LIQU LIM	IT I	- No	% R	%
		(continuou)		-		1	0 2	20	30	40 !	50 6	0 7	0			
															97	93
35																
															100	68
- 40 -																
															95	82
- 45 -																
															100	75
50																
50															96	96
				+					-	-		·				
- 55																
	COMPL	ETION DEPTH: 52.0 ft		DE	PTH T	O WA	TER									
	DATE:	8-27-23		IN I	BORIN	G: 3.	2 ft					DA.	IE: 4/	25/2	023	3

	19-11	8														
	Gru Bar <sub>Consu</sub>	bb tor	<b>s, Hoskyn, LOGOF</b> <b>&amp; Wyatt, Inc.</b> 090069 XNA Ac Bento	BC cess n Co	<b>RI</b> Road unty,	<b>N G</b> l ove Arka	<b>N C</b> r Osa nsas	<b>). S</b> age (	5 <b>16</b> Creek							
	TYPE	Ξ:	HSA to 10 ft /Core		LOC	CATIC	N: A	oprox	Sta 16	6+95,	65 ft L	_t				
Ŀ		S		R FT	WΤ			СОН	ESION	, <b>TON</b>	/SQ F	Г		%	Z	
тн, F	MBOI	MPLE	DESCRIPTION OF MATERIAL	S PEI	DRY CU F	0	.2 (	).4	0.6 0	.8 1 I	.0 1	.2 1	.4	. 200	ecove	RQD
DEF	SY	SAI		ILOW	UNIT LB/	PL/ L	ASTIC IMIT +		WA CON	TER TENT		LIQU LIM 	IID IT	- No	% R	%
		$\parallel$	Very loose to loose brown and			1	0 2	20	30 4	40 5 	50 E	50 7 	0			
		X	tan silty fine sand w/fine to coarse gravel and cherty limestone cobbles	4												
		X	- loose below 2 ft	9												
	000		Loose tan sandy fine to coarse													
- 5 -		Д	gravel, slightly śilty w/cobbles	9										5		
	\$0°<	X		8												
	$\frac{1}{2}$															
	0°C			50/1'												
- 10 -			w/light gray cherty limestone w/very close chert seams and													
		-	layers and numerous stylolites													~-
															98	67
- 15 -									q_= (	3760 p	si, TU	W= 16	3 pcf			
			- with very close rehealed fractures at 15 to 16 ft													
		-													95	72
		-														
- 20 -																
		-														
		-													100	67
									q <sub>u</sub> = 8	3120 p	si, TU	W= 15	3 pcf			
- 25 -																
									q.,= (	3800 p	si, TU	W= 15	8 pcf		100	78
		-∐ PLE	TION DEPTH: 44.2 ft	DE	 PTH T	O WA	TER							<u> </u>		
	DATE	: 7	-27-23	IN I	BORIN	G: 6	ft					DA	ΓE: 7/	27/2	023	}

19-118														
	os, Hoskyn, n & Wyatt, Inc. <sub>g Engineers</sub> LOGOF 090069 XNA Ad Bento	BC cess n Co	<b>RI</b> Road unty,	<b>N G</b> l ove Arka	<b>N C</b> r Osa nsas	). S age (	<b>16</b> Cree	k						
TYPE:	HSA to 10 ft /Core		LOC		N: Ap	oprox	Sta 1	66+9	5, 65	ft Lt				
		FT	F		(	сон	ESIO	<b>N</b> , ТО	N/SC	) FT				
H, FT 30L		DER	SY W	0.	2 0	.4	0.6	0.8	1.0	1.2	1.4	% 00	very	g
DEPTH SYME	DESCRIPTION OF MATERIAL	LOWS F	JNIT DF LB/CL	PL/ Ll	ASTIC MIT		W CO	ATER	Т	L	IQUID LIMIT	- No. 2(	% Reco	% RC
	(continued)	<u> </u>	_	1	0 2	20	30	40	50	60	70			_
	fractures below 30 ft												100	75
													98	78
													100	74
- 45 -	Note: Core barrel refusal at 44.2 ft on chert											_		
- 555												_		
COMPLE DATE: 7	ETION DEPTH: 44.2 ft -27-23	DE IN I	PTH T BORIN	O WA G: 61	TER ft						DATE:	7/27/2	2023	3

L Grubbs, Hoskyn,			
Barton & Wyatt, Inc. LOGOF BORING NO. S18 Consulting Engineers 090069 XNA Access Road over Osage Creek Benton County, Arkansas			
TYPE: HSA to 16 ft /Core LOCATION: Approx Sta 157+85, 60	60 ft Rt		
	SQ FT	u % ery	0
H     M     M     DESCRIPTION OF MATERIAL     Image: Constraint of the second seco		6 Recov	% RQI
SURF. EL: 1091± $\square$ $\square$ $\square$ $\square$ $\square$ $\square$ $\square$ 10 20 30 40 50			
A A A A A A A A A A A A A A A A A A A			
Very loose reddish brown silt, slightly clayey 2			
A A A A A A A A A A A A A A A A A A A	5	3	
A A A A A A A A A A A A A A A A A A A			
and light gray weathered cherty limestone 50/6"			
Moderately hard to hard light gray and gray cherty limestone	_	29 2	25
		95	70
			, ,
	+		
OpenationCOMPLETION DEPTH: 23.0 ftDEPTH TO WATERDATE: 8-17-23IN BORING: 13.7 ft	DATE: 8/17	7/2023	

	19-11	8															
	Gru Bar Consu		s, Hoskyn, LOGOF Wyatt, Inc. LOGOF 9 Engineers 9 Engineers Bento	<b>BO</b> ccess on Co	<b>R I</b> Road unty,	<b>N G</b> d ove Arka	<b>N C</b> r Osa nsas	<b>). S</b> age	<b>619</b> Cree	k							
	TYPI	≣:	HSA to 8 ft /Core		LO	CATIC	N: Ap	prox	c Sta 1	58+9	5, 60	) ft R	t				
F		0		R FT	MT _		(	СОН	IESIO	N, TO	N/S	Q FT			%	Y	
TH, F	MBOL	<b>IPLE</b>	DESCRIPTION OF MATERIAL	S PEF	DRY CU F	0	.2 0	.4	0.6	0.8	1.0	1.2	2 1	.4	200	ecover	RQD
DEP	SΥ	SAN		FOW	UNIT LB/	PL/ L	ASTIC IMIT +				т		LIQU LIM	JID IT	No.	% Re	%
			Verv soft reddish brown silty			1	0 2	20	30	40	50	60	) 7	70			
		A	clay	3													
		X	- stiff with chert fragments below 2 ft	12			•-		- +						61		
	ÍĤ		Dense reddish brown fine														
- 5 -	Ź. Z.	Д	sandy slit w/numerous chert fragments	42											25		
		X	Moderately hard light gray and gray cherty limestone, flat	50/2"													
			bedded	50/1"												_	
																83	11
- 10 -																05	44
																100	83
- 15 -															-		
																_	
																100	73
20 -																	
															-		
																93	68
- 25 -																	
<b>–</b>																	
			- vertical fracture at 27 to 27.4														
			ft													100	78
	COMI	PLE : 8	TION DEPTH: 48.0 ft -16-23	DE IN I	PTH T BORIN	O WA IG: Di	TER y to 8	ft					DA	TE: 8	3/15/2	2023	3
L							~										

	TYPE	:	ISA to 8 ft /Core			CATIC	N: Ap	oprox COHE	Sta 15 ESION	8+95, , TON	60 ft /SQ I	Rt T				
ΓH, FT	1BOL	PLES	DESCRIPTION OF MATERIAL	PERI	NRY W	0	.2 0	.4	0.6 (	).8 1	1.0	1.2	1.4	200 %	covery	gD
DEP1	SYN	SAM		SMOJ8	UNIT D LB/O	PL/ L	ASTIC IMIT			TER		LIQI LIN — — — —	JID 1IT	- No.	% Re	Ч %
	4 4 4 4		(continued)			1	0 2	20	30 4	40 t	50	60	70			
															100	92
35 -																
00																
															100	88
40 -																
															100	85
45 -																
															_	
															100	100
50 -																
- 55 -																
00																

19-11	8														
Gru Bar Consu	ibb toi <sup>Ilting</sup>	es, Hoskyn, n & Wyatt, Inc. LOGOF <sup>g Engineers</sup> 090069 XNA Ac Bento	BO cess n Co	<b>RI</b> Roac unty,	<b>N G</b> l ove Arka	<b>N C</b> r Osa nsas	<b>). S</b> age	<b>520</b> Cree	k						
TYPI	E:	HSA to 6 ft /Core		LOC	CATIC	N: A	oprox	sta 1	60+2	0, 10	) ft Rt				
			H	L I			сон	ESIO	N, TC	N/S	ຊ FT				
30L	LES		PER	SY W	0	.2 (	).4	0.6	0.8	1.0	- 1.2	1.4	% UC		ļ
SYME	SAMP	DESCRIPTION OF MATERIAL	LOWS	JNIT DF LB/CL	PL/ L					IT		LIQUID LIMIT	- No	% Reco	% R(
		SURF. EL: 1078±			1	0 2	20	30	40	50	60	70		_	
		chert fragments	8												
	X	Medium dense tan fine sandy silt w/numerous chert fragments and nodules	26												
	X	Moderately hard gray and light	50/3"												
		and layers and rehealed	25/0"												
		Moderately hard to hard gray													
		w/interbedded chert seams													
		rehealed fractures												97	80
													_	_	
														97	57
														98	883
														_	
														10	082
									_	_					
													-		
														93	87
COMI DATE	PLE	TION DEPTH: 46.0 ft -18-23	DE IN I	PTH T BORIN	O WA G: Di	TER ry to 6	ft				I	DATE	: 8/18	/202	23
	Image: Second	TYPE: Salues Sources Salues Sources Salue	Image: Second	19-118         Grubbs, Hoskyn, Consulting Engineers         COGO OF B CO 090069 XNA Access Benton Co         TYPE: HSA to 6 ft /Core         Image: Colspan="2">Image: Colspan="2" Image: Colspan="2" Image	19-118         Grubbs, Hoskyn, Barton & Wyatt, Inc. Consulting Engineers       LOG OF BORII 090069 XNA Access Road Benton County,         TYPE: HSA to 6 ft /Core       Loc         U       U       DESCRIPTION OF MATERIAL       U         SURF. EL: 1078±       8       I         U       Locse brown silt W/numerous chert fragments and nodules       50/3"         U       Moderately hard gray and light gray chert wilmestone eams and layers and rehealed       50/3"         U       Moderately hard gray and light gray chert wilmestone wiln frequent rehealed fractures       50/3"         U       Moderately hard to hard gray and layers with frequent rehealed fractures       50/3"         U       Moderately hard to hard gray and layers with frequent rehealed fractures       50/3"         U       Moderately hard to hard gray and layers with frequent rehealed fractures       50/3"         U       Moderately hard to hard gray and layers with frequent rehealed fractures       50/3"         U       Moderately hard to hard gray and layers       50/3"         U       Moderately hard to hard gray and layers       50/3"         U       <	19-118         Grubbs, Hoskyn, Barton & Wyati, Inc.         Consulting Engineers         Description         Descriptin         Descripti	19-118       Grubbs, Hoskyn, Barton & Wyati, Inc.     D90069 XNA Access Road over Os: Benton County, Arkansas       TYPE: HSA to 6 ft /Core     LOCATION: Ar       Upper HSA to 6 ft /Core     Locati / Ar <t< td=""><td>19-118         Grubbs, Hoskyn, Barton &amp; Wyatt, Inc. Consulting Engineers       LOG OF BORING NO. S         090069 XNA Access Road over Osage Benton County, Arkansas         TYPE: HSA to 6 ft /Core       LOCATION: Approx         UPE: TION defined and rebealed       50/3*         UPE: the add fractures       50/3*         UPE: the add fractures       LOCATION: Approx         UPE: the add fractures       LOCATION: Approx         UPE: the add fractures       LOCATION: Approx      <tr< td=""><td>19-118       Grubbs, Hoskyn, Barton &amp; Wyatt, Inc. Consulting Engineers       LOG OF BORING NO. S20 090069 XNA Access Road over Osage Cree Benton County, Arkansas       TYPE: HSA to 6 ft /Core       LOCATION: Approx Sta 1       UPE: HSA to 6 ft /Core       UCATION: Approx Sta 1       UPE: HSA to 6 ft /Core       UCATION: Approx Sta 1       UPE: HSA to 6 ft /Core       UCATION: Approx Sta 1       UPE: HSA to 6 ft /Core       UCATION: Approx Sta 1       UPE: HSA to 6 ft /Core       UCATION: Approx Sta 1       UPE: HSA to 6 ft /Core       UCATION: Approx Sta 1       UPE: HSA to 6 ft /Core       UCATION: Approx Sta 1       UPE: HSA to 6 ft /Core       UCATION: Approx Sta 1       UPE: HSA to 6 ft /Core       UP</td><td>Subs. Hoskyn, Barton &amp; Wyatt, Inc.       LOG OF BORING NO. S20         Consulting Engineers       090069 XNA Access Road over Osage Creek Benton County, Arkansas         TYPE:       HSA to 6 ft /Core       LOCATION: Approx Sta 160+2         Type:       HSA to 6 ft /Core       LOCATION: Approx Sta 160+2         Understand       Understand       Understand         SURF. EL:       1078±       Understand         SURF. EL:       1078±       Understand         Vertication       Surgents and nodules       8         Medium dense tan fine sandy silt w/numerous chert fragments and nodules       50/3*         Tradition of layers and rehealed       25/0*         Moderately hard to hard gray and light fractures       50/3*         Mark       Fractures         Mark       Haratures         Mark</td><td>Strubbs, Hoskyn, Darton &amp; Wyatt, Inc. Degree Strubbs, Hoskyn, Degree St</td><td>Type:     HSA to 6 ft /Core     LOCATION: Approx Sta 160+20, 10 ft Rt       Type:     HSA to 6 ft /Core     LOCATION: Approx Sta 160+20, 10 ft Rt       Type:     HSA to 6 ft /Core     LOCATION: Approx Sta 160+20, 10 ft Rt       Type:     HSA to 6 ft /Core     LOCATION: Approx Sta 160+20, 10 ft Rt       Type:     HSA to 6 ft /Core     LOCATION: Approx Sta 160+20, 10 ft Rt       Type:     HSA to 6 ft /Core     LOCATION: Approx Sta 160+20, 10 ft Rt       Type:     LOCose brown silt w/numerous     8       Locose brown silt w/numerous     8     Location: Approx Sta 160+20, 10 ft Rt       Hedium dense tan fine sandy     26     PLASTIC       Year     Hodium dense tan fine sandy     26       Year     Hodium dense tan fine sandy     200*       Year     Hodium dense tan fine sandy     200*       Year     Hodiavers and nodules     50/3*       Year     Hodiavers and nehealed     50/3*       Year     Hodiavers and nehealed     50/3*       Year     Hodiavers and nehealed     50/3*       Year     Hodiavers and hodiues     50/3*       Year     Hodiavers and hodiue     50/3*       Year     Hodiavers and hodiue     50/3*       Year     Hodiavers and hodiue     Hodiavers and hodiue       Year     Hodiavers and hodiavers</td><td>Type:     Image: Substrate Sub</td><td>19110       Chubbs, Hoskyn, Darton &amp; Wyati, Inc.       Dowuting Engineers       Consuming Engineers       Description of MATERIAL       Og gege       Og gege       Og gege       Description of MATERIAL       Og gege       SURF. EL: 1078±       SURF. EL: 1078±       Converting Engineers       Nedium dense tan fine sandy sitt winumerous and reprovements and nocidles       And Horderately part of the Part of the Seams and repeated fractures       Moderately part of the Part of the Seams and layers with frequent rehealed fractures       And And Anderately part of the Part of the Seams and layers with requent rehealed fractures       And Anderately part of the Part of the Seams and layers with requent rehealed fractures       And Anderately part of the Part of the Seams and layers with requent rehealed fractures       And Anderately part of the Part of the Seams and layers with requent rehealed fractures       And Anderately part of the Part of the Seams and layers with requent rehealed fractures       And Anderately part of the Part of the Seams and layers with requent rehealed fractures       And Anderately part of the Seams and layers of the Part of the Seams and layers with requent rehealed fractures       And Anderately part of the Part of the Seams and layers of the Seams and layers by the Seams and Layers with requent rehealed fractures       And Anderately part of the Part of the Seams and Layers by the Seams and Layers of the Seams and Layers by the State Seams and Layers</td><td>TYPE: HSA to 6 ft /Core Consulting Engineer Consulting Engineer Consu</td></tr<></td></t<>	19-118         Grubbs, Hoskyn, Barton & Wyatt, Inc. Consulting Engineers       LOG OF BORING NO. S         090069 XNA Access Road over Osage Benton County, Arkansas         TYPE: HSA to 6 ft /Core       LOCATION: Approx         UPE: TION defined and rebealed       50/3*         UPE: the add fractures       50/3*         UPE: the add fractures       LOCATION: Approx         UPE: the add fractures       LOCATION: Approx         UPE: the add fractures       LOCATION: Approx <tr< td=""><td>19-118       Grubbs, Hoskyn, Barton &amp; Wyatt, Inc. Consulting Engineers       LOG OF BORING NO. S20 090069 XNA Access Road over Osage Cree Benton County, Arkansas       TYPE: HSA to 6 ft /Core       LOCATION: Approx Sta 1       UPE: HSA to 6 ft /Core       UCATION: Approx Sta 1       UPE: HSA to 6 ft /Core       UCATION: Approx Sta 1       UPE: HSA to 6 ft /Core       UCATION: Approx Sta 1       UPE: HSA to 6 ft /Core       UCATION: Approx Sta 1       UPE: HSA to 6 ft /Core       UCATION: Approx Sta 1       UPE: HSA to 6 ft /Core       UCATION: Approx Sta 1       UPE: HSA to 6 ft /Core       UCATION: Approx Sta 1       UPE: HSA to 6 ft /Core       UCATION: Approx Sta 1       UPE: HSA to 6 ft /Core       UP</td><td>Subs. Hoskyn, Barton &amp; Wyatt, Inc.       LOG OF BORING NO. S20         Consulting Engineers       090069 XNA Access Road over Osage Creek Benton County, Arkansas         TYPE:       HSA to 6 ft /Core       LOCATION: Approx Sta 160+2         Type:       HSA to 6 ft /Core       LOCATION: Approx Sta 160+2         Understand       Understand       Understand         SURF. EL:       1078±       Understand         SURF. EL:       1078±       Understand         Vertication       Surgents and nodules       8         Medium dense tan fine sandy silt w/numerous chert fragments and nodules       50/3*         Tradition of layers and rehealed       25/0*         Moderately hard to hard gray and light fractures       50/3*         Mark       Fractures         Mark       Haratures         Mark</td><td>Strubbs, Hoskyn, Darton &amp; Wyatt, Inc. Degree Strubbs, Hoskyn, Degree St</td><td>Type:     HSA to 6 ft /Core     LOCATION: Approx Sta 160+20, 10 ft Rt       Type:     HSA to 6 ft /Core     LOCATION: Approx Sta 160+20, 10 ft Rt       Type:     HSA to 6 ft /Core     LOCATION: Approx Sta 160+20, 10 ft Rt       Type:     HSA to 6 ft /Core     LOCATION: Approx Sta 160+20, 10 ft Rt       Type:     HSA to 6 ft /Core     LOCATION: Approx Sta 160+20, 10 ft Rt       Type:     HSA to 6 ft /Core     LOCATION: Approx Sta 160+20, 10 ft Rt       Type:     LOCose brown silt w/numerous     8       Locose brown silt w/numerous     8     Location: Approx Sta 160+20, 10 ft Rt       Hedium dense tan fine sandy     26     PLASTIC       Year     Hodium dense tan fine sandy     26       Year     Hodium dense tan fine sandy     200*       Year     Hodium dense tan fine sandy     200*       Year     Hodiavers and nodules     50/3*       Year     Hodiavers and nehealed     50/3*       Year     Hodiavers and nehealed     50/3*       Year     Hodiavers and nehealed     50/3*       Year     Hodiavers and hodiues     50/3*       Year     Hodiavers and hodiue     50/3*       Year     Hodiavers and hodiue     50/3*       Year     Hodiavers and hodiue     Hodiavers and hodiue       Year     Hodiavers and hodiavers</td><td>Type:     Image: Substrate Sub</td><td>19110       Chubbs, Hoskyn, Darton &amp; Wyati, Inc.       Dowuting Engineers       Consuming Engineers       Description of MATERIAL       Og gege       Og gege       Og gege       Description of MATERIAL       Og gege       SURF. EL: 1078±       SURF. EL: 1078±       Converting Engineers       Nedium dense tan fine sandy sitt winumerous and reprovements and nocidles       And Horderately part of the Part of the Seams and repeated fractures       Moderately part of the Part of the Seams and layers with frequent rehealed fractures       And And Anderately part of the Part of the Seams and layers with requent rehealed fractures       And Anderately part of the Part of the Seams and layers with requent rehealed fractures       And Anderately part of the Part of the Seams and layers with requent rehealed fractures       And Anderately part of the Part of the Seams and layers with requent rehealed fractures       And Anderately part of the Part of the Seams and layers with requent rehealed fractures       And Anderately part of the Part of the Seams and layers with requent rehealed fractures       And Anderately part of the Seams and layers of the Part of the Seams and layers with requent rehealed fractures       And Anderately part of the Part of the Seams and layers of the Seams and layers by the Seams and Layers with requent rehealed fractures       And Anderately part of the Part of the Seams and Layers by the Seams and Layers of the Seams and Layers by the State Seams and Layers</td><td>TYPE: HSA to 6 ft /Core Consulting Engineer Consulting Engineer Consu</td></tr<>	19-118       Grubbs, Hoskyn, Barton & Wyatt, Inc. Consulting Engineers       LOG OF BORING NO. S20 090069 XNA Access Road over Osage Cree Benton County, Arkansas       TYPE: HSA to 6 ft /Core       LOCATION: Approx Sta 1       UPE: HSA to 6 ft /Core       UCATION: Approx Sta 1       UPE: HSA to 6 ft /Core       UCATION: Approx Sta 1       UPE: HSA to 6 ft /Core       UCATION: Approx Sta 1       UPE: HSA to 6 ft /Core       UCATION: Approx Sta 1       UPE: HSA to 6 ft /Core       UCATION: Approx Sta 1       UPE: HSA to 6 ft /Core       UCATION: Approx Sta 1       UPE: HSA to 6 ft /Core       UCATION: Approx Sta 1       UPE: HSA to 6 ft /Core       UCATION: Approx Sta 1       UPE: HSA to 6 ft /Core       UP	Subs. Hoskyn, Barton & Wyatt, Inc.       LOG OF BORING NO. S20         Consulting Engineers       090069 XNA Access Road over Osage Creek Benton County, Arkansas         TYPE:       HSA to 6 ft /Core       LOCATION: Approx Sta 160+2         Type:       HSA to 6 ft /Core       LOCATION: Approx Sta 160+2         Understand       Understand       Understand         SURF. EL:       1078±       Understand         SURF. EL:       1078±       Understand         Vertication       Surgents and nodules       8         Medium dense tan fine sandy silt w/numerous chert fragments and nodules       50/3*         Tradition of layers and rehealed       25/0*         Moderately hard to hard gray and light fractures       50/3*         Mark       Fractures         Mark       Haratures         Mark	Strubbs, Hoskyn, Darton & Wyatt, Inc. Degree Strubbs, Hoskyn, Degree St	Type:     HSA to 6 ft /Core     LOCATION: Approx Sta 160+20, 10 ft Rt       Type:     HSA to 6 ft /Core     LOCATION: Approx Sta 160+20, 10 ft Rt       Type:     HSA to 6 ft /Core     LOCATION: Approx Sta 160+20, 10 ft Rt       Type:     HSA to 6 ft /Core     LOCATION: Approx Sta 160+20, 10 ft Rt       Type:     HSA to 6 ft /Core     LOCATION: Approx Sta 160+20, 10 ft Rt       Type:     HSA to 6 ft /Core     LOCATION: Approx Sta 160+20, 10 ft Rt       Type:     LOCose brown silt w/numerous     8       Locose brown silt w/numerous     8     Location: Approx Sta 160+20, 10 ft Rt       Hedium dense tan fine sandy     26     PLASTIC       Year     Hodium dense tan fine sandy     26       Year     Hodium dense tan fine sandy     200*       Year     Hodium dense tan fine sandy     200*       Year     Hodiavers and nodules     50/3*       Year     Hodiavers and nehealed     50/3*       Year     Hodiavers and nehealed     50/3*       Year     Hodiavers and nehealed     50/3*       Year     Hodiavers and hodiues     50/3*       Year     Hodiavers and hodiue     50/3*       Year     Hodiavers and hodiue     50/3*       Year     Hodiavers and hodiue     Hodiavers and hodiue       Year     Hodiavers and hodiavers	Type:     Image: Substrate Sub	19110       Chubbs, Hoskyn, Darton & Wyati, Inc.       Dowuting Engineers       Consuming Engineers       Description of MATERIAL       Og gege       Og gege       Og gege       Description of MATERIAL       Og gege       SURF. EL: 1078±       SURF. EL: 1078±       Converting Engineers       Nedium dense tan fine sandy sitt winumerous and reprovements and nocidles       And Horderately part of the Part of the Seams and repeated fractures       Moderately part of the Part of the Seams and layers with frequent rehealed fractures       And And Anderately part of the Part of the Seams and layers with requent rehealed fractures       And Anderately part of the Part of the Seams and layers with requent rehealed fractures       And Anderately part of the Part of the Seams and layers with requent rehealed fractures       And Anderately part of the Part of the Seams and layers with requent rehealed fractures       And Anderately part of the Part of the Seams and layers with requent rehealed fractures       And Anderately part of the Part of the Seams and layers with requent rehealed fractures       And Anderately part of the Seams and layers of the Part of the Seams and layers with requent rehealed fractures       And Anderately part of the Part of the Seams and layers of the Seams and layers by the Seams and Layers with requent rehealed fractures       And Anderately part of the Part of the Seams and Layers by the Seams and Layers of the Seams and Layers by the State Seams and Layers	TYPE: HSA to 6 ft /Core Consulting Engineer Consulting Engineer Consu

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	Gru Barl <sub>Consu</sub>	ob or	<b>s, Hoskyn,</b> <b>&amp; Wyatt, Inc.</b> <sup>Engineers</sup> Bento	BC ccess on Co	<b>) R I</b> Road ounty,	<b>N G</b> d ove Arka	<b>N (</b> er Os ansas	<b>D. S</b> age	<b>320</b> Cree	k							
	TYPE		HSA to 6 ft /Core		LO	CATI	ON: A	pprox	sta 1	60+2	0, 10	ft Rt					
				FT	Τ			сон	ESIO	N, TO	N/SC	۲ FT			<i>、</i> 0	~	
Ц Ц	BOL	PLES		PER	RY V U FT		0.2	0.4	0.6	0.8	1.0	1.2	1.	4	200 %	over	DO
DEPT	SYN	SAM	DEGORI HON OF MATERIAL	OWS	LB/O	PL		;	W CO	ATER	т		LIQU LIMI	ID T	No.	6 Rec	ж  %
			(continued)	BL	5		+ − 10	 20	30	40	50	60	<b>+</b>	0	'	6	
- 35 -																95	73
- 40 -			- with vertical fracture at 39 to 39.4 ft													98	80
- 45 -																	
	COMF DATE	LE 8	TION DEPTH: 46.0 ft -18-23	DE IN	PTH T BORIN	iow, IG: E	ATER	6 ft					DAT	E: 8/	/18/2	023	3
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	Grul Bart <sup>Consul</sup>	obs, Hoskyn, on & Wyatt, Inc. <sup>LOGOF</sup> 090069 XNA Ac Bento	BO cess n Co	<b>R I</b> Road unty,	<b>N G</b> l ove Arka	<b>N C</b> r Osa nsas	<b>). S</b> age	<b>321</b> Cree	k						
	TYPE	: HSA to 12 ft /Core		LO		N: Ap	oprox	Sta 1	61+85	5, 45	ft Rt				
Ŀ	_	S	R FT	WΤ		(	СОН	ESIO	N, TOI	N/SC	Q FT		%	ry	
отн, F	MBOI	비 BESCRIPTION OF MATERIAL	S PEF	DRY CU F	0.	2 0	).4 I	0.6	0.8	1.0	1.2	1.4	200	ecove	ROD
DEF	γs		BLOW	UNIT	PLA LI	MIT <b>H</b>		00 		г 	ן 	_IQUID LIMIT <b>+</b>	- No	% R	%
		Loose brown silt w/some fine to coarse gravel	5		1	0 2	20	30	40	50	60	70			
			5												
- 5 -		Firm brown and tan silty clay	9												
	0.0	Medium dense brown silty fine to coarse gravel, sandy	15												
0	0.0° 0°0° 0°0°														
			14												
	00														
		Moderately hard to hard gray	25/0"											-	
		w/very close interbedded chert seams, layers, and inclusions and close limestone seams												100	)17
- 15 -		and layers													
														100	)65
- 20 -									_	_					
														95	88
- 25 -		1													
														100	998
				 ртµ т	O \\/ A	TEP									
	DATE:	8-25-23	INE	BORIN	G: 81	ft						DATE	: 8/25/	202	3

	19-118 Grul Bart Consul		s, Hoskyn, & Wyatt, Inc. LOG Engineers 090069 XN	<b>OFB</b> IA Acces	0 ss Coi	<b>RII</b> Road	<b>N G</b> l ove Arka	<b>N C</b> r Osa	<b>). S</b> age	<b>521</b> Cre	ek							
	TVDE	. г							brow	Sta	161+	05 A	5 ft [	⊃+				
, FT	Ы	SEI				L M	0.	<u>1N: Ap</u> ( 2 0		ESIC 0.6	DN, T	05, 4 ON/S	SQ F - 1	T .2	1.4	% 0	very	Ω
DEPTH	SYMB	SAMPI	DESCRIPTION OF MATERIA			UNIT DR LB/CU	PL/ Ll	ASTIC MIT <b>+</b>	I	L C		R NT		LIQI LIN <b>-</b>	JID IIT	- No. 20	% Reco	% RQ
			(continueu)				1	0 2	20	30	40	50	6	60	70		98	87
- 35 -																	98	93
- 45 -																	100	98
- 50 -																	100	95
																	100	100
- 55 -																-		
	COMP DATE:	LE <sup>-</sup>	TION DEPTH: 52.0 ft 25-23		DEF N E	PTH TO BORIN	O WA G: 81	TER ft						DA	 TE: 8	/25/2	202:	3

19-118														
Grub Barto Consulti	bbs, Hoskyn, on & Wyatt, Inc. LOGOF 090069 XNA Ad Bento	<b>BO</b> ccess on Co	<b>R I</b> Road unty,	<b>N G</b> d over Arkan	<b>N O</b> Osa Isas	. <b>S2</b> ige C	2 <b>2</b> reek							
TYPE:	HSA to 10 ft /Core		LO		N: Ap	prox S	Sta 16	2+95,	60 ft F	Rt				
DL FT	n	ER FT	^ WT =T	0.2	C				/SQ F	T 2 1	Д	% (	ery	
SYMBC	DESCRIPTION OF MATERIAL	OWS PE	IT DRY B/CU I	PLA					.0 1			No. 200	Recov	% RQI
	") SURF. EL: 1072±	BLO	5	10	╋ 			•		<del>  </del>	0	'	%	
:00 :00	Very loose to loose brown and tan sandy fine to coarse gravel, slightly silty w/cobbles	4												
-0-5 -0-5	- loose at 2 to 6 ft	7												
		5			•	+						6		
.00 .00 .00	- very loose at 6 to 8 ft	o/woi	-1											
	- medium dense below 8 ft	14												
	Moderately hard to hard light gray and gray cherty limestone w/ very close interbedded chert inclusions, seams, and layers, stylolites, and rehealed fractures												78	53
							q <sub>u</sub> = 8	3480 p	si, TU	W= 15	7 pcf		10	80
													75	43
							q <sub>u</sub> = 3	3920 p	si, TU	W= 15	5 pcf		97	78
COMPL DATE:	LETION DEPTH: 50.0 ft 7-31-23	DEI IN E	PTH T BORIN	O WAT IG: 6 ft	TER					DA	TE: 7/	31/2	023	3

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	Grul Bart Consul	bbs, Hoskyn, L on & Wyatt, Inc. L ting Engineers 0900	OGOFB 069 XNA Acces Benton C	<b>O R I</b> s Roa ounty,	<b>N G</b> d ove Arka	<b>N C</b> r Osa nsas	<b>). S</b> age (	<b>22</b> Creek							
	TYPE	: HSA to 10 ft /Core		LO	CATIO	DN: Ap	oprox	Sta 16	2+95,	60 ft F	Rt				
Ŀ		N	R FT	TWT			COHE	SION		/SQ F	Г		%	Z	
PTH, F	MBOI		ATERIAL / م	DRY CU F	0	0.2 (	).4 ( I	0.6 0	.8 1	.0 1	.2 1	.4	. 200	ecove	RQD
DEF	S	(continued)		UNIT	PL L	ASTIC IMIT + -		CON	TER TENT		LIQU LIM	JID IT	No -	% R	%
						10 2	20 :	30 4	0 5	50 6	<u>60 7</u>	0			
														100	90
25															
- 35															
								q <sub>u</sub> = 5	490 p	si, TU	W= 15	6 pcf		100	70
- 40 -		-													
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- 45															
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- 50	-														
-30-23															
- 55 ·															
-L-6L Z-6															
		LETION DEPTH: 50.0 ft	D	 EPTH <sup>-</sup>	FO WA	TER									
С. Ч	DATE:	7-31-23	11	BORI	NG: 6	ft					DA	TE: 7/	31/2	2023	3

	19-11	8															
	Gru Bar Consu	bb tor	s, Hoskyn, & Wyatt, Inc. LOGOF Engineers 090069 XNA Ac Bentor	BO cess n Co	<b>R I</b> Road unty,	<b>N G</b> d ove Arka	<b>N C</b> r Osa nsas	<b>). S</b> age	<b>323</b> Cree	k							
	TYPE	Ξ:	HSA to 7 ft /Core		LO		N: Ap	oprox	: Sta 1	64+0	5, 75	i ft Ri	t				
				FT	Ţ			СОН	ESIO	N, TO	N/S	Q FT			<u>`</u> 0	٨	
H, FI	BOL	PLES		PER	N V U FT	0	.2 0	).4	0.6	0.8	1.0	1.2	2 1	.4	200 %	overy	DO
DEPT	SYN	SAM	DESCRIPTION OF MATERIAL	-OWS	LB/C	PL/ L			W CC		т			ID T	- No.	% Rec	ж К
			SURF. EL: 1078±	B	<u> </u>	1	0 2	20	30	40	50	60	7	0			
		X	Loose tan sandy fine to coarse gravel	5													
	ŝ	M		6													
	°0° °0°,<																
- 5 -		X		5											_		
	°°C	M		50/5"	,												
			Moderately hard gray and light gray cherty limestone	50/5													
			w/stylolites, very close interbedded chert inclusions,													100	88
- 10 -			frequent rehealed fractures - moderately hard to hard														
		-	below 8 ft - 4 in. void at 10 to 10.3 ft														
																93	72
		-															
- 15 -																	
																100	05
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20																	
20																	
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- 25 -									_	_							
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		1   PLE	TION DEPTH: 48.0 ft	DE	 PTH T	O WA	TER								<u> </u>		
	DATE	: 8	-26-23	IN E	BORIN	G: 4.	U ft						DA	IE: 8	/25/2	:02:	3

	Gru Barl Consu	bb con ting	s, Hoskyn, LOGOF A & Wyatt, Inc. Engineers 090069 XNA Ac Bento	BO cess n Co	<b>RI</b> Road unty,	<b>N G</b> d ove Arka	<b>N C</b> r Osa nsas	<b>). S</b> ž age C	<b>23</b> Creek							
	TYPE	: 1	HSA to 7 ft /Core		LO	CATIC	N: Ap	prox \$	Sta 16	4+05,	75 ft F	Rt				
				ЕЧ	۲			COHE	SION	, TON	'SQ F	Т		-		
Ť ET	30L	LПS		DER	N FT	0	.2 0	.4 0	.6 0	.8 1	.0 1	.2 1	.4	% 00	very	ב
DEPTI	SYME	SAMP	DESCRIPTION OF MATERIAL	LOWS I	JNIT DF LB/CL	PL/ L	ASTIC		WA CON	TER TENT			JID IT	- No. 2	% Reco	2 %
	<u> </u>		(continued)	B	<u> </u>	1	0 2	20 3	30 4	40 5	io e	50 7	0			
- 35 -															98 9	0 
- 45 -															1009	7
0V200-2 19-118 0SAGE CREEK GPJ 8-30-23														-		
RECROD	COMF DATE	LE 8-	TION DEPTH: 48.0 ft 26-23	DEI IN E	PTH T BORIN	O WA G: 4.	TER 0 ft					DA	TE: 8	/25/2	023	

1	9-11	8														
	Gru Bar <sub>Consu</sub>	bb tor	s, Hoskyn, <b>&amp; Wyatt, Inc.</b> Engineers Bento	BO cess n Co	<b>RI</b> Road unty,	<b>N G</b> d over Arkar	<b>N O</b> Osa Isas	<b>). S</b> i age C	<b>24</b> Creek							
-	TYPE	:	HSA to 10 ft /Core		LOC		N: Ap	prox	Sta 16	5+50,	60 ft F	Rt				
FT	ЭL	ES		ER FT	/ WT FT	0.3	( 2 0.			, TON/	/SQ F1	Г .2 1	4	% (	ery	
DEPTH,	SYMB(	SAMPL	DESCRIPTION OF MATERIAL	IA SWC	VIT DRY LB/CU	PLA	STIC	<u> </u>	WA	TER	1	LIQU	ID T	No. 20(	6 Recov	% RQI
			SURF. EL: 1076±	BL	5	·   10	╋ — - ) 2		——— 30         4	• – – – 0 5	— — — 60       6	<b>+</b> 0 7	0	'	6	
		Ŕ	Loose brown silty fine to medium sand w/ fine to coarse gravel and cobbles	7									-			
		X		6												
- 5 - 2		X	Loose tan sandy fine to coarse gravel w/cobbles	5			•							4		
		X	- very loose below 6 ft	2												
iá		X	Moderately hard slightly weathered chert w/limestone seams and interbeds	50/3"												
			Moderately hard to hard light gray and gray cherty limestone w/interbedded chert seams and layers, stylolites, and rehealed fractures												100	75
									q <sub>u</sub> = 6	3890 p	si, TU	W= 15	2 pcf		98	95
															100	78
									q <sub>u</sub> = 6	3810 p	si, TU	W= 16	3 pcf		100	72
	COMF	PLE : 7	TION DEPTH: 50.0 ft -29-23	DEI IN E	PTH T BORIN	O WA IG: 5.5	TER 5 ft			·	·	DA	ΓE: 7/	29/2	023	3

	19-118														
	Grut Bart Consult	obs, Hoskyn, on & Wyatt, Inc. LOGOF ong Engineers Bento	BC cess on Co	<b>R I</b> Road unty,	<b>N G</b> d ove Arka	<b>N C</b> r Osa nsas	<b>). S</b> age (	<b>24</b> Creek							
	TYPE	HSA to 10 ft /Core		LOO	CATIC	N: Ap	oprox	Sta 16	5+50,	60 ft F	٦t				
<b>⊢</b>			R FT	۲۸ <sup>۲</sup>			COHE	SION		/SQ F	Т		%	У	
TH, F	MBOL	DESCRIPTION OF MATERIAL	S PEF	DRY /	0	.2 0	).4 ( 	0.6 0	.8 1	1.0 1	.2 1	.4	200	scover	ROD
DEP	SYI	SAN	LOW:	UNIT LB/	PL/ L	ASTIC IMIT +		WA CON	TER TENT		LIQU LIM	JID IT	- No.	% R€	%
					1	0 2	20 ;	30 4	10 E	50 <del>(</del>	50 7	70			
														98	65
- 35 -		-												_	
								q <sub>u</sub> = 6	690 p	osi, TU	W= 15	3 pcf		98	90
- 40 -															
														100	93
- 45 -															
														100	07
														100	01
50															
	-														
30-23															
- 55 -															
				 оти т	0 \// ^										
3 VECKC	DATE:	7-29-23	IN	BORIN	G: 5.	5 ft					DA	TE: 7/	29/2	023	3

19-118														
	os, Hoskyn, n & Wyatt, Inc. LOGOF g Engineers 090069 XNA Ac Bento	BO cess n Col	<b>R I</b> Roac unty,	<b>N G</b> d over Arkar	<b>N O</b> Osa Isas	. <b>S</b> 2 ige C	2 <b>5</b> Greek							
TYPE:	Auger to 10 ft /Core		LO		N: Ap	prox S	Sta 16	6+64,	60 ft F	Rt				
PTH, FT MBOL MPLES	DESCRIPTION OF MATERIAL	S PER FT	DRY WT (CU FT	0.:	2 0	20HE 4 0	SION .6 0	, <b>TON</b> /	/SQ F	Г .2 1	.4	. 200 %	ecovery	RQD
SA SA	SURF. FL : 1070+	BLOW	UNIT		MIT <b>+</b>					LIQU LIM		- No	% R	%
	Loose tan and brown sandy fine to coarse gravel, slightly silty w/cobbles (gravel bar)	4		10	) 20	03	0 4	05	06	07	0			
		16			•							7		
5	Medium dense to dense reddish brown silty fine sand w/numerous chert fragments	30			•			NOM	I-PLA	STIC		14		
	- dense below 6 ft	38												
	Moderately hard light gray and tan slightly weathered cherty limestone, flat bedded w/some	25/0"												
	stylolites													
							q <sub>u</sub> = 6	3780 p	si, TU	W= 15	56 pcf		83	60
- 15 - <u>A</u> A A A A A														
							q <sub>u</sub> = 8	3040 p	si, TU	W= 15	1 pcf		80	75
													97	70
													100	93
COMPLE DATE: 8	ETION DEPTH: 48.0 ft 3-28-23	DEI IN E	 PTH T BORIN	0 WA <sup>-</sup> IG: 4.0	TER ) ft					DA	 TE: 4/	28/2	023	3

	19-118														
	Grub Barto Consult	bs, Hoskyn, <b>LOGOF</b> 090069 XNA Ac Bento	BC cess n Co	<b>R I</b> Road unty,	<b>N G</b> d ove Arka	<b>N C</b> r Osa nsas	<b>). S</b> age C	<b>25</b> Creek							
	TYPE:	Auger to 10 ft /Core		LO	CATIC	N: Ap	prox	Sta 16	6+64,	60 ft	Rt				
Ŀ		n	R FT	WT		(		SION	, TON	/SQ F	Т		%	Z	
TH, F	MBOI		S PEF	DRY CU F	0	.2 0	.4 0	0.6 0	).8 1	1.0	1.2 1	.4	200	acove	
DEF	S		BLOW	UNIT LB/	PL/ L	ASTIC IMIT <b>+</b>		WA CON	TER TENT		LIQU LIM 	JID IT •	- No	% %	%
					1	0 2	20 :	30 4	40 £	50	60 7	70			
														90 8	35
- 35 -														_	
														1009	<i>)</i> 5
- 40 -															
														1009	)(
45															
														1009	)/
			+				+			+	+	+		_	
- 50 -															
27-02-															
55 -													-		
	DATE:	8-28-23	IN I	BORIN	G: 4.	0 ft					DA	TE: 4/	28/2	023	

	19-11	8														
	Gru Bar <sub>Consu</sub>	bb toi Iting	os, Hoskyn, n & Wyatt, Inc. LOGOF g Engineers 090069 XNA Ac Bentc	BO ccess on Co	<b>R I</b> Road unty,	<b>N G</b> d ove Arka	<b>N C</b> r Osa nsas	<b>). R</b> age C	<b>12</b> Creek							
	TYPE	:	Auger to 5 ft /Wash to 20 ft /Core		LO	CATIC	N: Ap	prox	Sta 17	0+00,	CL					
тн,	MBOL	APLES	DESCRIPTION OF MATERIAL	S PER FT	DRY WT CU FT	0	( .2 0	COHE 	SION,	, TON/	SQ F	T .2 1	.4	. 200 %	ecovery	RQD
DEP	SΥ	SAN	SURF. FI : 1146+	BLOW	UNIT LB/	PL/ L	ASTIC IMIT +		WA CON			LIQU LIM 	IID IT	- No	% R6	%
			Very soft reddish brown silty clay	2		1	02	20 3	30 4	05	<u>0 6</u>	<u>50 7</u>	0			
		X	- very stiff with chert fragments below 2 ft	27												
- 5		X	- with numerous chert fragments below 4 ft	50/10										-		
		X		50/4"												
- 10 -			Moderately hard light gray and tan weathered cherty limestone, fractured w/some silty clay filled fractures	50/3"										-		
- 15			Moderately hard to hard tan and light gray weathered chert and limestone, flat bedded, highly fractured w/red clay infill	20/0										-		
- 20															52	0
C C C C C C C C C C C C C C C C C C C															50	0
00-2 19-118 OSAGE CRE																
RECRODNS	COMF DATE	PLE : 3	ETION DEPTH: 30.0 ft -13-23	DE IN E	PTH T BORIN	O WA IG: D	TER ry to 5	ft		1	1	DA	ΓE: 3/	/13/2	2023	3

Grubbs, Hoskyn, Barton & Wyatt, Inc. Consulting Engineers	SYMBOLS	AND TER	MS US	SED OI	N BOF	RINGL	.OGS				
SC (SHOWN IN CO Gravel Sand Predomina	IL TYPES SYMBOLS COLUM IIII Silt nt type shown heavy	N) Clay	(SHO Shelby Tube	SAMPL WN ON S	ER TYPE SAMPLES Split Spoon	PES COLUM No Recover	N) Cutting				
TERM	S DESCRIBING	G CONSISTE	ENCY C	OR CON		N					
COARSE GRAINED SO sands, and (2) silty or cla determined by laboratory	LS (major portion re yey gravels and sar tests.	etained on No. 2 nds. Condition is	00 sieve): rated acc	Includes ( ording to r	I) Clean g elative de	gravels a ensity, as	nd				
DESCRIPT VERY LOO LOOSE MEDIUM DI DENSE VERY DEN	IVE TERM SE ENSE SE	N-VALUE 0-4 4-10 10-30 30-50 50 and at	F	RELATIN	/E DEN 0-15% 15-35% 35-65% 65-85% 85-100%	ISITY					
FINE GRAINED SOILS (major portion passing No. 200 sieve): Includes (1) Inorganic and organic silts and clays, (2) gravelly, sandy, or silty clays, and (3) clayey silts. Consistency is rated according to shearing strength, as indicated by penetrometer readings or by unconfined compression tests.											
DESCRIP	TIVE TERM		COMP		NFINED /E STRI	) ENGTH	4				
VER SOF FIRM STIF VER HAR	Y SOFT T I F Y STIFF D		Less than 0.25 0.25-0.50 0.50-1.00 1.00-2.00 2.00-4.00 4.00 and higher								
NOTE: Slick strengths that The consister	ensided and fissure n shown above, bec ncy ratings of such s	ed clays may hav ause of planes o oils are based o	ve lower u of weaknes n penetror	nconfined ss or crack meter read	compress (s in the s lings.	sive soil.					
ТЕ	RMS CHARAC		SOIL ST	RUCTL	IRE						
SLICKENSIDED - having inclined planes of weakness that are slick and glossy in appearance. FISSURED - containing shrinkage cracks, frequently filled with fine sand or silt; usually more or less vertical. LAMINATED - composed of thin layers of varying color and texture.											
INTERBEDDED - cor CALCAREOUS - con WELL GRADED - ha pa POORLY GRADED -	nposed of alternate taining appreciable over ving a wide range in article sizes. predominantly of on	layers of differen quantities of calo grain sizes and ne grain size, or	nt soil type cium carbo substantia having a ra	s. onate. al amounts ange of siz	s of all inte	ermediat	e				
	intermediate sizes	missing.									
Terms used on this report are in accordance with the Technical Memorandum	Terms used on this report for describing soils according to their texture or grain size distribution are in accordance with the UNIFIED SOIL CLASSIFICATION SYSTEM, as described in Technical Memorandum No.3-357, Waterways Experiment Station, March 1953										

Grubbs, Hoskyn						
Barton & Wyatt, Consulting Engineers	Inc.	BORING	G LOG TERMS	S – ROCK		
ROCK TYPES (SHOWN IN SYMBOLS COL	UMN)	e Limestone	Siltstone	Coal		
Joint Characteristics — Bedding Characteristics — Lithologic Characteristics —	SpacingVery Close0.75 toClose2.5 to 2Moderately Close8 to 24Wide2 to 6Very WideMore thatVery Thin0.75 toThin2.5 to 8Medium8 to 24Thick2 to 6 fMassiveMore thatClayeyShalyCalcareous (limy)SiliceousSandy (Arangeaous)	2.5 in. 3 in. ft an 6 ft 2.5 in. in. in. t m 6 ft	Degree of Weathering —	Fresh — No visible decomposition or of Rings under hamn Slighty Weathered discoloration inwar fractures, otherwis fresh. Moderately Weather throughout. Weake as feldspar decom somewhat less that cores cannot be b scraped by knife.	e signs of discoloration. ner impact. — Slight ds from open e similar to red — Discoloration r minerals such posed. Strength in fresh rock, but oroken by hand or Texture preserved. — Most minerals	
Parting – Seam – Layer – Stratum – Hardness–	Sanay (Arenaceous) Silty Plastic Seams Less than 1/16 inch 1/16 to 1/2 inch 1/2 to 12 inches Greater than 12 inches Soft (S) – Reserved for plasti Friable (F) – Easily crumbled pulverized or reduced to powo	ic material alone. by hand, ler and is too soft	ſ	somewhat decomp can be broken by or shaved with kn present in rock m becoming indistinc Completely Weather decomposed to so structure preserved Specimens easily of penetrated	red – Minerals hand with effort ife. Core stones ass. Texture t but fabric red – Minerals il but fabric and d (Saprolite). crumbled or	
	to be cut with a pocket knife Low Hardness (LH) – Can be or carved with a pocket knife Moderately Hard (MH) – Can scratched by a knife blade; s heavy trace of dust and scrat visible after the powder has b	gouged deeply be readily cratch leaves a tch is readily been blown away.	Solution and Void Conditions —	Residual Soil — Advanced state of decomposition resulting in plastic soils. Rock fabric and structure completely destroyed. Large volume change. Solid, contains no voids		
	Hard (H) – Can be scratched scratch produces little powder faintly visible; traces of the k be visible. Very hard (VH) – Cannot be a pocket knife. Knife steel ma surface.	with difficulty; and is often nife steel may scratched with arks left on	Swelling Properties —	Vuggy (pitted) Vesicular (igneous) Porous Cavities Cavernous Nonswelling Swelling	)	
Texture -	Fine — Barely seen with naked	d eye	Slaking Properties —	Sweiling Nonslaking Slakes slowly on e Slakes readily on	exposure exposure	
Structure –	Meaium - Barely seen up to Coarse - 1/8 in. to 1/4 in. Bedding Flat - 0° - 5° Gently Dipping - 5° - 35' Moderately Dipping - 55° Steeply Dipping - 55° - 8 Fractures, scattered Open Cemented or Tight Fractures, closely spaced Open Cemented or Tight Brecciated (Sheared and Frag Open Cemented or Tight Joints	1 / ∂ IN. - 85° 35°	Rock Quality Designation (RQD) —	RQD (Percent) Greater than 90 75 – 90 50 – 75 25 – 50 Less than 25	<u>Diagnostic Description</u> Excellent Good Fair Poor Very Poor	

APPENDIX A





Ŧ 4:14:37 9/30/2021 Bridge (2019 - Access - NE JESkinner WORKSPA L-\Z017\17

BRIDGE ENGINEER

DATE REVISED	DATE FILMED	DATE REVISED	DATE FILMED	PED. ROAD DEST. NO.	STATE	FED. AID PROJ. NO.	SHEET NO.	TOTAL SHEETS	
				6	6	ARK.			
				JOB N	0.	090069	iβN4102	\$ \$5T\$	
			Ο	\$BN04B	ţ.	LAYOUT	\$I	DN4102\$	

-3.23% -0.51% PVI Sta. 159+00 Elev. 1110.81 V.C. = 1000'

# XNA Access Rd. (Profile Grade 14' Right of CL Bridge A)

VERTICAL CURVE DATA

SHEET 2 OF 2 LAYOUT OF BRIDGE A XNA ACCESS RD. OVER OSAGE CREEK NORTHWEST ARKANSAS NATIONAL AIRPORT ACCESS (F) BENTON COUNTY ROUTE SEC. ARKANSAS STATE HIGHWAY COMMISSION LITTLE ROCK, ARK.

CWT DATE: SEPT. 2021 FILENAME: b090069xA4\_L2.dgn DRAWN BY: JES DATE: SEPT. 2021 SCALE: <u>1" = 30'-0"</u> CHECKED BY: ERM DATE: SEPT. 2021 DESIGNED BY: BRIDGE NO. \$BN04A\$ DRAWING NO. \$DN4102\$



Ł 4:14:38 9/30/2021 Bridge (2019) \ Access - NFPA JESkinner WORKSPA L-\Z017\17



BRIDGE ENGINEER

DATE REVISED	DATE FILMED	DATE REVISED	DATE FILMED	PED. ROAD DEST. NO.	STATE	FED. AID PROJ. NO.	SHEET NO.	TOTAL Sheets
				6	ARK.			
				JOB N	0.	090069 \$	5N4104	\$ \$ST\$
			0	\$BN04B		LAYOUT	\$I	DN4104\$

-3.23% -0.51% PVI Sta. 159+00 Elev. 1110.81 V.C. = 1000'

VERTICAL CURVE DATA XNA Access Rd. (Profile Grade 14' Left of CL Bridge B)

SHEET 2 OF 2 LAYOUT OF BRIDGE B XNA ACCESS RD. OVER OSAGE CREEK NORTHWEST ARKANSAS NATIONAL AIRPORT ACCESS (F) BENTON COUNTY ROUTE SEC. ARKANSAS STATE HIGHWAY COMMISSION

LITTLE ROCK, ARK.

DRAWN BY:	CWT	DATE:	SEPT. 2021	FILENAME:	
CHECKED BY:	JES	DATE:	SEPT. 2021	SCALE:	$1^{n} = 30^{\circ} - 0^{n}$
DESIGNED BY:	ERM	DATE:	SEPT. 2021	<u> </u>	
BRIDGE NO.	\$BN04B	\$	DRAW	ING NO. <b>\$[</b>	ON4104\$

### **APPENDIX B**

### **B-S9**: Run 1 (19-22 ft), Run 2 (22-27 ft)





## ROCK CORE PHOTOS

090069 XNA Access Road Benton County, Arkansas Job No. 19-118

Plate




# **B-S10**: Run 9 (51-52 ft)





**<u>ROCK CORE PHOTOS</u>** 090069 XNA Access Road

Benton County, Arkansas

Job No. 19-118

#### **B-S11B**: Run 1 (12-15 ft), Run 2 (15-20 ft),



# **B-S11B**: Run 5 (30-35 ft), Run 6 (35-40 ft),



# **B-S13**: Run 1 (15-20 ft), Run 2 (20-25 ft)



#### **B-S13**: Run 5 (35-40 ft), Run 6 (40-45 ft)



# **B-S14**: Run 1 (11-15 ft), Run 2 (15-20 ft)





**B-S14**: Run 9 (50-51 ft)





**<u>ROCK CORE PHOTOS</u>** 090069 XNA Access Road

Benton County, Arkansas

Job No. 19-118



# **B-S15B**: Run 7 (32-35 ft), Run 8 (35-40 ft), Run 9 (40-42 ft)





**<u>ROCK CORE PHOTOS</u>** 090069 XNA Access Road

Benton County, Arkansas

Job No. 19-118

## **B-S16**: Run 1 (10-20 ft), Run 2 (15-20 ft)





**B-S16**: Run 7 (40-44 ft)



Benton County, Arkansas

**A UES Company** 





**<u>ROCK CORE PHOTOS</u>** 

Job No. 19-118

090069 XNA Access Road Benton County, Arkansas

# **B-S19**: Run 1 (8-11 ft), Run 2 (11-16 ft)



### **B-S19**: Run 5 (26-31 ft), Run 6 (31-36 ft)



# **B-S19**: Run 9 (46-48 ft





**<u>ROCK CORE PHOTOS</u>** 090069 XNA Access Road

Benton County, Arkansas

Job No. 19-118



# **B-S20**: Run 7 (36-41 ft), Run 8 (41-46 ft)





**<u>ROCK CORE PHOTOS</u>** 090069 XNA Access Road

Benton County, Arkansas

Job No. 19-118

#### **B-S21**: Run 1 (12-15 ft), Run 2 (15-20 ft)



**B-S21**: Run 5 (30-35 ft), Run 6 (35-40 ft)



#### **B-S22**: Run 1 (10-15 ft), Run 2 (15-20 ft)



**B-S22**: Run 5 (30-35 ft), Run 6 (35-40 ft)



#### **B-S23**: Run 1 (8-10 ft), Run 2 (10-15 ft)



#### **B-S23**: Run 5 (25-30 ft), Run 6 (30-35 ft)



# **B-S23**: Run 9 (45-48 ft)





**<u>ROCK CORE PHOTOS</u>** 090069 XNA Access Road

Benton County, Arkansas

Job No. 19-118

### **B-S24**: Run 1 (10-15 ft), Run 2 (15-20 ft)







# **B-S25B**: Run 7 (28-30 ft), Run 8 (30-35 ft), Run 9 (35-38 ft)



#### **B-R12**: Run 1 (20-25 ft), Run 2 (25-30 ft)





**<u>ROCK CORE PHOTOS</u>** 090069 XNA Access Road

Benton County, Arkansas

Job No. 19-118

#### **APPENDIX C**

#### SUMMARY of CLASSIFICATION TEST RESULTS

PROJECT: 090069 XNA Access Road

LOCATION: Benton County, Arkansas

GHBW JOB NUMBER: 19-118

BORING No.	SAMPLE DEPTH (ft)	WATER CONTENT (%)	ATTERBERG LIMITS			SIEVE ANALYSIS								USCE	
			LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	PERCENT PASSING								CLASS	AASHTU CLASS
						2 in.	1 in.	3/4 in.	3/8 in.	#4	#10	#40	#200		
R12	2.5-3.5	17.3	30	20	10					82			49	SC	A-4
S9	6.5-7.5	16	34	17	17					71			27	SC	A-2-6
S9	14-15	26	40	21	19					98			86	CL	A-6
S10	4.5-5.5	18	35	23	12	100	100	100	100	87	74	64	55	CL	A-6
S13	2.5-3.5	21	26	22	4					100			82	CL-ML	A-4
S15	1.5-4.5	11	NON-PLASTIC							79			18	SM	A-2-4
S16	4.5-5.5	13				100	61	55	46	31	18	10	5	GW-GM	A-1-b
S18	9-10	23				100	100	100	87	83	78	62	53	ML	A-4

#### SUMMARY of CLASSIFICATION TEST RESULTS

PROJECT: 090069 XNA Access Road

LOCATION: Benton County, Arkansas

#### GHBW JOB NUMBER: 19-118

RODINC	SAMPLE DEPTH (ft)	WATER CONTENT (%)	ATTERBERG LIMITS			SIEVE ANALYSIS								USCS	AASHTO
No.			LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	PERCENT PASSING								CLASS.	CLASS.
1.00						2 in.	1 in.	3/4 in.	3/8 in.	#4	#10	#40	#200	01100	02.100.
S19	2.5-3.5	15								83			61	CL	A-6
S19	4.5-5.5	17				1				56			25	SM	A-2-4
S22	4.5-5.5					100	89	77	43	32	21	11	6	GP-GM	A-1-b
S24	4.5-5.5	15				100	78	64	40	22	13	7	4	GW	A-1-a
S25	2.5-3.5	13				100	86	71	53	40	27	15	7	GM-GP	A-1-a
S25	4.5-5.5	16	NON-PLASTIC							78			14	GM	A-1-b










# **APPENDIX D**









**APPENDIX E** 







2. Pile penetration limited in moderately hard weathered limestone below El 1078±

Grubbs, Hoskyn, Barton & Wyatt, LLC Consulting Engineers





2. Preboring and grouting required in moderately hard weathered limestone below El  $1137\pm$ 







2. Pile penetration limited in moderately hard weathered cherty limestone below El 1076±

**Grubbs, Hoskyn, Barton & Wyatt, LLC** Consulting Engineers



Note: 1. Piles driven from cap bottom elevation. 2. Grouting required in moderately hard weathered cherty limestone below El 1088±.

Grubbs, Hoskyn, Barton & Wyatt, LLC Consulting Engineers

# **APPENDIX F**

### Summary of Stability Analysis Results ARDOT 090069 XNA Access Road over Osage Creek GHBW Job No. 19-118 Benton County, Arkansas

	Design Loading Condition	Calculated Minimum Factor of Safety
	End of Construction	2.34
South End Slope (Bent 1) (2H:1V)	Long Term	2.21
	Rapid Drawdown from El 1085 to El 1074	2.19
	Seismic ( $k_h = A_S/2 = 0.0245$ )	2.21
South Side Slope (Bent 1) (3H:1V)	End of Construction	2.79
	Long Term	2.64
	Rapid Drawdown from El 1085 to Existing Grade	2.57
	Seismic ( $k_h = A_S/2 = 0.0245$ )	2.59
North End Slope (Bent 9) (Cut Slope)	End of Construction	4.70
	Long Term	4.70
	Rapid Drawdown from El 1085 to El 1074	4.27
	Seismic ( $k_h = A_S/2 = 0.0245$ )	4.40
North Side Slope (Bent 9) (Cut Slope - 3H:1V)	End of Construction	5.14
	Long Term	4.91
	Seismic ( $k_h = A_S/2 = 0.0245$ )	4.75





Results of Stability Analyses – End of Construction Bent 1 End Slope 2H:1V Slope, H=34 ft ± 19-118 – ARDOT 090069 XNA Access Road over Osage Creek





Results of Stability Analyses – Long Term Condition Bent 1 End Slope 2H:1V Slope, H=34 ft ± 19-118 – ARDOT 090069 XNA Access Road over Osage Creek





Results of Stability Analyses – Rapid Drawdown Condition from El 1085 to El 1074 Bent 1 End Slope 2H:1V Slope, H=34 ft ± 19-118 – ARDOT 090069 XNA Access Road over Osage Creek





 $\label{eq:kappa} \begin{array}{l} \mbox{Results of Stability Analyses - Seismic Condition} (k_h = A_S / 2 = 0.0245) \\ \mbox{Bent 1 End Slope} \\ \mbox{2H:1V Slope, H=34 ft } \pm \\ \mbox{19-118 - ARDOT 090069 XNA Access Road over Osage Creek} \end{array}$ 





Results of Stability Analyses – End of Construction Bent 1 Side Slope 3H:1V Slope, H=34 ft ± 19-118 – ARDOT 090069 XNA Access Road over Osage Creek





Results of Stability Analyses – Long Term Condition Bent 1 Side Slope 3H:1V Slope, H=34 ft ± 19-118 – ARDOT 090069 XNA Access Road over Osage Creek





Results of Stability Analyses – Rapid Drawdown El 1085 to Existing Grade Bent 1 Side Slope 3H:1V Slope, H=34 ft ± 19-118 – ARDOT 090069 XNA Access Road over Osage Creek









Results of Stability Analyses – End of Construction Bent 4 End Slope Cut Slope, H=36 ft ± 19-118 – ARDOT 090069 XNA Access Road over Osage Creek





Results of Stability Analyses – Long Term Condition Bent 4 End Slope Cut Slope, H=36 ft ± 19-118 – ARDOT 090069 XNA Access Road over Osage Creek

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Results of Stability Analyses – Rapid Drawdown Condition, El 1085 to El 1074 Bent 4 End Slope Cut Slope, H=36 ft ± 19-118 – ARDOT 090069 XNA Access Road over Osage Creek





 $\label{eq:kappa} \begin{array}{l} \mbox{Results of Stability Analyses - Seismic Condition} (k_h = A_S \ /2 = 0.0245) \\ \mbox{Bent 4 End Slope} \\ \mbox{Cut Slope, H=36 ft } \pm \\ \ 19\mbox{-}118\ -\ \mbox{ARDOT 090069 XNA Access Road over Osage Creek} \end{array}$ 





Results of Stability Analyses – End of Construction Bent 4 Side Slope 3H:1V Slope, H=42 ft ± 19-118 – ARDOT 090069 XNA Access Road over Osage Creek





Results of Stability Analyses – Long Term Condition Bent 4 Side Slope 3H:1V Slope, H=42 ft ± 19-118 – ARDOT 090069 XNA Access Road over Osage Creek





 $\begin{array}{l} \mbox{Results of Stability Analyses - Seismic Condition} (k_h = A_S \slashed{A_S} = 0.0245) \\ \mbox{Bent 4 Side Slope} \\ \slashed{3H:1V Slope, H=42 ft $\pm$} \\ \mbox{19-118 - ARDOT 090069 XNA Access Road over Osage Creek} \end{array}$ 





Materials Testing Geotechnical Engineering Environmental Building Sciences & Safety Inspections & Code Compliance Virtual Design Consulting

September 29, 2023 Job No. 19-118

Garver LLC 4701 Northshore Dr North Little Rock, Arkansas 72118

Attn: Mr. Joel Skinner, P.E.

## RESULTS of GEOTECHNICAL INVESTIGATION ARDOT JOB 090069 XNA ACCESS ROAD BRIDGE OVER LITTLE OSAGE CREEK BENTON COUNTY, ARKANSAS

## **INTRODUCTION**

This report provides the final results of the geotechnical investigation performed for the XNA Access Road Twin Bridges over Little Osage Creek in Benton County, Arkansas. The Little Osage Creek Bridges are one facet of the ARDOT Job 090069 Northwest Arkansas Regional Airport Access (Benton Co) (F). This geotechnical investigation was authorized by the Garver, LCC Subconsultant Agreement for Task Order No. 061 on August 27, 2019. Notice to proceed with the field studies was received on August 30, 2019. Results and recommendations have been provided throughout the course of this study. A preliminary report for the Little Osage Creek Bridges was submitted on July 18, 2023.

We understand the new bridges will be continuous plate girder structures with four (4) bents, three (3) spans, and total lengths of approximately 592.5 feet each. We also understand that a foundation system consisting of steel H-piles and drilled piers are planned at the bridge ends and intermediate bents, respectively. Foundation loads of the new bridge are anticipated to be moderate. The bridge end embankments will utilize simple slopes with end slopes at approximate 2-horizontal to 1-vertical (2H:1V) configurations and side slopes at 3-horizontal to 1-vertical (3H:1V) configurations. Site grading is expected to include up to 34 ft of embankment fill. Preliminary bridge layouts are provided in Appendix A.

The purposes of this study were to explore subsurface conditions in the bridge alignments

and to develop recommendations to guide design and construction of foundations and earthwork.

These purposes have been achieved by a multi-phased study that included the following.

- Drilling sample and core borings at the planned bridge location to evaluate subsurface conditions and obtain samples of the subgrade and foundation soil and rock for laboratory testing.
- Performing laboratory tests to evaluate pertinent engineering properties of the foundation and subgrade strata.
- Analyzing field and laboratory data to develop recommendations for seismic site class, seismic performance zone/seismic design category, foundation and subgrade support, slope stability, site grading, and construction considerations.

The relationship of these factors to design and construction of the new bridges has been considered in developing the recommendations and considerations discussed in the following report sections.

## **SUBSURFACE EXPLORATION**

Subsurface conditions at the Little Osage Creek bridge location were investigated by drilling 13 sample and core borings to depths of 15 to 59 feet. The site vicinity is shown on Plate 1. The approximate boring locations are shown on the bridge layout drawing on Plate 2. Boring R13, a roadway boring, was drilled about 95 ft south of the south bridge ends and was utilized to develop subsurface profiles for the A and B Bridges. The subsurface exploration program is summarized in Table 1 below.

Boring No.	Approx Sta	Approx Offset, ft	Approx Surf El, ft	Completion Depth, ft
R13	174+50	CL	1126	20
S27	175+45	45 Lt	1085	15
S28	176+60	60 Lt	1076	48
S29	177+35	60 Lt	1076	57
S30	179+15	60 Lt	1078	45
S31	180+45	60 Lt	1078	56.5
S32	181+45	60 Lt	1080	27
S33	176+00	60 Rt	1078	21
S34	177+00	60 Rt	1076	59
S35	178+40	75 Rt	1075	51

**Table 1: Summary of Exploration Program** 

Boring No.	Approx Sta	Approx Offset, ft	Approx Surf El, ft	Completion Depth, ft
S36	179+85	60 Rt	1074	58
S37	181+10	60 Rt	1079	58
S38	182+15	60 Rt	1080	27.5

The boring logs, presenting descriptions of the soil and rock strata encountered in the borings and the results of the field and laboratory tests, are included as Plates 3 through 23. The centerline station and offset of the boring locations and approximate ground surface elevation, as inferred from the topographic information provided by the Engineer (Garver, LLC) or as inferred from available topographic information, are also shown on the logs. It must be recognized that the surface elevations shown are <u>approximate</u> and actual elevations may vary. Keys to the terms and symbols used on the logs are presented as Plates 24 and 25.

The borings were drilled with a track-mounted CME 850 and Geoprobe 3230DT rotarydrilling rigs using a combination of dry-auger and rotary-wash drilling methods. Samples were typically obtained at 2-ft intervals to 10-ft depth and at 5-ft intervals thereafter. Samples were recovered using a 2-in.-diameter split-barrel sampler driven into the strata by blows of a 140-lb automatic hammer with 30-in. drop in accordance with Standard Penetration Test (SPT) procedures. The number of blows required to drive the standard split-barrel sampler the final 12 in. of an 18-in. total drive, or a portion thereof, is defined as the Standard Penetration Number (N). Recorded Nvalues are shown on the boring logs in the "Blows Per Ft" column.

Representative samples of the limestone bedrock were obtained using a 5-ft-long NQ-size double-tube core barrel with a diamond bit. For each core run, the percent recovery was determined as the ratio of recovery to total length of core run. Rock Quality Designation (RQD) was also determined for the core run as the sum of intact, sound rock core greater than 4-in. length divided by the total length of the run and expressed in percent. Both these values are presented in the right-hand columns of the log forms, opposite the corresponding core run. Selected photographs of the recovered rock cores are provided in Appendix B.

All samples were removed from sampling tools in the field, examined and visually classified by the field geologist or field engineer. Samples were then placed in appropriate containers to prevent moisture loss and/or change in condition during transfer to our laboratory for further examination and testing.

The borings were advanced using dry-auger procedures to the extent possible to facilitate evaluation of shallow groundwater conditions. Observations regarding groundwater levels are noted in the lower-right portion of each log and are discussed in subsequent sections of this report. All boreholes were backfilled after obtaining the final water level readings.

### **LABORATORY TESTING**

Laboratory testing was performed to evaluate subgrade and foundation plasticity and to confirm visual classification. The testing program included natural water content determinations (AASHTO T 265), liquid and plastic (Atterberg) limit determinations (AASHTO T 89 and T 90), and sieve analyses through the No. 200 sieve (AASHTO T 88). Soil shear strength was estimated in the field using SPT results.

A total of 27 natural water content determinations were performed to develop information on *in-situ* soil water content in the borings. Water content results are plotted on the boring log forms in accordance with the scale and symbols shown in the legend located in the upper-right corner of the logs.

To verify field classification and to evaluate soil plasticity, 11 liquid and plastic limit (Atterberg limits) determinations and 12 sieve analyses were performed on selected representative samples. The Atterberg limits are plotted on the logs as pluses inter-connected with a dashed line using the water content scale. The percentage of soil passing through the No. 200 Sieve is noted in the "- No. 200 %" column on the appropriate log forms.

A summary of classification test results and classification by the Unified Soil Classification System and AASHTO Classification System is presented in Appendix C. Grain-size distribution curves are also included in Appendix C.

Results of the laboratory compression tests are shown in lbs per sq inch at the appropriate depth on the boring logs. The total unit weight of intact cores was also measured and these data are also shown on the logs. Compression results are also summarized in Appendix C.

#### **GENERAL SITE and SUBSURFACE CONDITIONS**

#### Site Conditions

The overall alignment of the XNA Access Road extends from the Northwest Arkansas Airport (XNA) about 4 miles southeast to the planned terminus at Highways 70 and 71. The bridge site crosses Little Osage Creek approximately 1400 ft southeast of Haden Road. The site locale is

presently open agricultural/pasture land away from the creek; the immediate vicinity of the creek is covered with mature trees. The Little Osage Creek channel at the bridge location is narrow with poorly-defined banks. The creek channel banks are shallow with tall grass and thick underbrush. The site terrain slopes gently to the creek from the northeast to the southwest. Surface drainage is considered good overall, but there are some localized low areas with poor drainage.

### Site Geology

The project alignment is located in the mapped exposure of the Boone Formation. The early and middle Mississippian Period Boone consists of fine- to coarse-grained limestone interbedded with chert. The chert content can vary widely, both horizontally and vertically, and limestone or chert may be predominant. The Boone Formation is known for dissolutional features such as sinkholes, caves, and enlarged fissures. Typically, the limestone/cherty limestone units of the Boone decompose (weather) to erratic blends of chert fragments and clay/silty clay. The residual soil mantle may extend to significant depths on higher terrain and may contain hard chert seams and/or layers. The thickness of the Boone Formation is reported to be 300 to 350 ft in northern Arkansas. The Boone is generally disconformable to the underlying Chattanooga Shale and St. Joe Limestone member, with some areas having a conformable contact.

## Seismic Conditions

In light of the results of the borings performed for the Little Osage bridge, a Seismic Site Class B (rock profile) is considered applicable for the site with respect to the criteria of the <u>AASHTO LRFD Bridge Design Specifications Seventh Edition 2014<sup>1</sup></u>.

Given the location and AASHTO code-based values, the 1.0-sec period spectral acceleration coefficient for Site Class B (S<sub>1</sub>) is 0.051 and the 1.0-sec period spectral acceleration coefficient (S<sub>D1</sub>) value for Site Class B is 0.051. Utilizing these parameters, Table  $3.10.6-1^2$  indicates that a <u>Seismic Performance Zone 1</u> is fitting for the Little Osage Creek bridge site. In reference to the 2011 edition of the AASHTO Guide Specifications, the Peak Ground Acceleration (PGA) having a 7 percent chance of exceedance in 75 years (or mean return period of approximately 1000 years) is predicted to be 0.049 for a Seismic Site Class B for the bridge location. The liquefaction potential is considered low for the predominantly cohesive overburden soils and underlying rock units encountered in the borings drilled for this study.

<sup>&</sup>lt;sup>1</sup> AASHTO LRFD Bridge Design Specifications, 8<sup>th</sup> Edition; AASHTO; 2017

<sup>&</sup>lt;sup>2</sup> <u>AASHTO LRFD Bridge Design Specification</u>, AASHTO; 2012

#### Subsurface Conditions

The results of the borings indicate that the surface and near-surface soils in the new twin bridge alignments typically consist of natural very soft to firm brown, dark brown, and reddish brown clayey silt and silty clay and very loose to medium dense brown silt, fine sandy silt, and sandy fine to coarse gravel to 1- to 11-ft depth. This stratum contains variable chert fragments and cobbles. This stratum represents recent stream bed deposits, which typically classify as A-1-a, A-1-b, A-2-4, A-4, and A-6 by the AASHTO classification system. The silt and clayey silt exhibit low plasticity, moderate to high compressibility, and low shear strength. The low-plasticity and silty soils are moisture-sensitive and will lose considerable strength when saturated.

Below the silt/clayey silt and gravel to approximately 7- to 13-ft depth is very soft to very stiff brown, reddish brown, and tan silty clay and fine sandy clay with numerous chert fragments. These soils typically classify as A-2-6, A-4, and A-6 by the AASHTO classification system. The natural surface and near-surface soils are highly variable with respect to strength and subgrade support for pavement structures. Some areas will warrant localized undercut for subgrade preparation.

The overburden soils are underlain by low hardness to hard gray and tan weathered to fresh cherty limestone. The competence of the limestone increases with depth. The limestone is flatbedded with healed fractures. The core sample recovery ranges from 53 to 100 percent and the core sample RQD ranges from 25 to 100 percent in this stratum. The cherty limestone exhibits high strength, with laboratory compressive strength values ranging from 4810 to 14,180 lbs per sq inch.

To aid in visualizing subsurface conditions, a generalized subsurface profile is presented in Appendix D. It should be recognized that the stratigraphy illustrated by the profile has been inferred between discrete boring locations. In view of the natural variations in stratigraphy and conditions, variations from the stratigraphy illustrated by the profile should be anticipated. Additionally, the natural transition between strata is generally gradual, and the stratigraphy described in the sections above may vary.

#### Groundwater Conditions

Localized perched groundwater was encountered at variable depths ranging from 1 ft to 10 ft in March and April 2023. It has been our experience in the area that localized shallow perched groundwater can be present in the silty overburden soils and fractured zones of the cherty limestone. Hillside seeps can also develop as infiltrated surface water from areas of higher terrain
migrate downgradient. Groundwater levels will vary, depending on seasonal precipitation, surface runoff and infiltration, and water levels in Little Osage Creek.

# ANALYSES and RECOMMENDATIONS

### Foundation Design

Foundations for the new bridge must satisfy two (2) basic and independent design criteria: a) foundations must have an acceptable factor of safety against bearing failure under maximum design loads, and b) foundation movement due to consolidation or swelling of the underlying strata should not exceed tolerable limits for the structures. Construction factors, such as installation of foundations, excavation procedures and surface and groundwater conditions, must also be considered.

Based on the results of the borings completed at the Little Osage Creek location and our understanding of the project, we recommend that foundation loads at the bridge ends (Bents 1 and 4) be supported on steel piles. The foundation loads at the interior bents (Bents 2 and 3) may be supported on drilled shaft foundations. Recommendations for foundations are discussed in the following report sections.

## Piling Foundations - Bents 1 and 4

We recommend that the foundation loads at the bridge ends be supported on HP12x53 steel piles. Point-bearing steel piles driven to refusal should extend through any new embankment fill, the natural overburden soils, and any zones of highly weathered cherty limestone to develop safe bearing capacity in the competent moderately hard to hard limestone. End-bearing piles should be driven to practical refusal in the moderately hard to hard limestone. We recommend that all steel piles be fitted with rock points.

Steel piles driven to refusal should be designed for the structural capacity of the pile, as per applicable AASHTO Load and Resistance Factor Design (LRFD) procedures<sup>3</sup>. An effective resistance factor ( $\varphi_c$ ) of 0.50 is recommended for structural determination of factored bearing capacities. This effective resistance factor for steel piles has been based on the assumption of severe driving conditions.

For determination of bearing capacities of steel piles driven to refusal, we recommend that nominal (ultimate) resistance  $(P_n)$  of HP piles be determined based on the yield strength of steel H

<sup>&</sup>lt;sup>3</sup> Load and Resistance Factor Design (LRFD) for Highway Bridge Substructures, Publication No. FHWA HI-98-032, National Highway Institute, May 2001.

piles  $(f_y)$  and the net end area (A<sub>net</sub>) of the section. It has been our experience that allowable pile capacities of 96 tons for HP12x53 piles are typical for  $f_y = 50$  ksi steel pile sections. These capacities are based on allowable stress design (ASD). However, the appropriate factored bearing capacity should be confirmed by the Engineer. Post-construction settlement of piles driven to refusal will be negligible.

The nominal axial capacities are based on single, isolated foundations. Piles spaced closer than three (3) pile widths may develop lower individual capacity due to group effects. The potential for group capacity reductions should be evaluated for pile spacing closer than three (3) widths (center to center).

Estimated pile tip elevations are summarized below in Table 2 below.

Bent No.	Estimated Pile Tip Elevation, ft	Comments
1A (South Bridge End)	1075	Refusal in moderately hard cherty limestone
1B (South Bridge End)	1067	Refusal in moderately hard cherty limestone
4A (North Bridge End)	1067	Refusal in moderately hard cherty limestone
4B (North Bridge End)	1070	Refusal in moderately hard cherty limestone

 Table 2: Estimated Tip Elevations of Steel Piles Driven to Refusal

It should be noted that the tip elevations shown in the table above are <u>estimates</u> only based on the results of the relevant borings and the inferred surface elevations at the particular locations. Pile refusal and final depth must be field verified. Additional pile depth may be required to resist uplift loads.

Steel piles at the end bents may be subjected to uplift loads. Nominal single pile uplift capacity curves for steel HP12x53 piles are provided in Appendix E. Nominal axial pile capacities have been developed using static pile capacity formulae, the results of the borings, and the plan site grading shown on the preliminary bridge layout drawings.

Based on AASHTO LRFD geotechnical design procedures, a resistance factor ( $\varphi_{up}$ ) of 0.25 is recommended for evaluation of factored uplift capacity. This resistance factor is based on Strength Limit States. For Extreme Events Limit States such as earthquake loading and collision, a resistance factor of 0.8 for uplift is recommended.

Piles should be installed in compliance with Standard Specifications for Highway Construction, 2014 Edition, Section 805. We recommend a hammer delivering a minimum energy of 34,000 ft-lbs per blow. A specific review and analysis of the pile-hammer system proposed by the Contractor should be performed by the Engineer prior to hammer acceptance and start of driving. We recommend that all piles be fitted with rock points.

A minimum pile length of 10 ft is recommended. In general, preboring is not expected to be required for pile installation. Where insufficient soil axial capacity necessitates pile penetration into the resistant limestone, preboring could be required for pile installation. Rock drilling methods will be required for prebores extending through the competent limestone. Following pile acceptance, the annulus around the installed piles in prebores should be expeditiously backfilled with grout as per ARDOT Standard Specifications Section 805. The grout should have a minimum compressive strength pf 4000 psi, as per ARDOT Section 501 or an alternate approved by the Engineer.

As a minimum, safe bearing capacity of piles should be determined by ARDOT Standard Specifications Section 805.09, Method A. Driving records should be available for review by the Engineer during pile installation. Blow counts on steel piles should be limited to about 20 blows per inch. Practical pile refusal may be defined as a penetration of 0.5 in. or less for the final 10 blows. Driving records should be available for review by the Engineer during pile installation. Drilled Shaft Foundations – Bents 2 and 3

Drilled straight shafts are recommended for support of foundation loads at the interior bents, Bents 2 and 3. Drilled shafts should be founded with a minimum embedment of 1.5 shaft diameters or 6 ft, whichever is greater, into the moderately hard to hard gray and tan cherty limestone. Drilled shafts founded as recommended may be sized using a maximum nominal end-bearing pressure ( $R_n$ ) of 125 kips per sq foot. A resistance factor ( $\varphi_{stat}$ ) of 0.50 is recommended for drilled shaft end bearing. Total and differential settlement of properly installed drilled shafts founded in the competent moderately hard to hard limestone as recommended is expected to be negligible. We also recommend that drilled shafts be sized for axial compression loads based on end bearing alone.

Resistance to uplift loads will be developed by circumferential shaft friction. Drilled shafts will penetrate the overburden soils to bear in the competent moderately hard to hard cherty limestone. Uplift resistance for the top 5 ft of shaft length, all penetration through the overburden soils, and the length of permanent casing should be neglected. For shaft penetration through the

competent cherty limestone, a maximum nominal skin resistance value of 12 kips per sq ft is recommended. For evaluation of uplift capacity, a resistance factor ( $\varphi_{up}$ ) of 0.40 is recommended for shaft skin friction.

A minimum shaft rock socket length of 1.5 shaft diameters or 6 ft, whichever is greater, is recommended for drilled shafts. The as-built shaft length will vary with location and depth of overburden. In general, rock strata are 7 to 10 ft below the ground line at the bent locations. It is expected that permanent casing will extend to the top of rock and slightly into the rock.

The depths to suitable rock strata are estimates only, and are based on the results of the borings, the inferred surface elevation at the particular bent location, and existing grades. Suitable bearing stratum and final shaft lengths must be field verified. Plan shaft lengths and shaft tip elevations must be based on the magnitude of foundation loads, specific subsurface conditions, and actual shaft diameters. Depending on specific subsurface conditions and rock quality, localized deepening or shortening of shaft depths can be warranted.

All drilled shaft excavations should be observed by the Engineer to verify suitable bearing and adequate penetration. Heavy-duty drilling equipment will be required to advance the shaft excavations. The moderately hard to hard limestone bearing stratum will be resistant to drilling and rock drilling methods are expected to be required to achieve the required shaft penetration.

To verify competence of the moderately hard to hard limestone bearing stratum, we recommend that all shaft excavations be probed. Probe holes should consist of continuous rock core borings advanced from the shaft bottom elevation into the bearing stratum a depth of at least one-and-one-half (1.5) shaft diameters. Rock cores from probe holes should be reviewed by the Engineer to verify foundation stratum competence and suitability of the plan shaft bottom elevation.

## Embankment Slopes

The new bridges include embankments at each bridge end. Plan bridge end embankment configurations are 2-horizontal to 1-vertical (2H:1V) with 3-horizontal to 1-vertical (3H:1V) side slope configurations. The bridge embankments will have maximum heights of about 34 feet.

To evaluate suitability of the side slope plan configurations, slope stability analyses were performed using the computer program SLOPE/W 2020<sup>4</sup> and utilizing a Morgenstern-Price analysis. For the embankment slopes, four (4) general loading conditions were evaluated, i.e., End

<sup>&</sup>lt;sup>4</sup> ibid

of Construction, Long Term, Rapid Drawdown, and Seismic Conditions were evaluated. A 250 lbs per sq ft uniform surcharge from vehicles was included for the purposes of stability analyses. For analysis of the seismic condition, a horizontal seismic acceleration coefficient ( $k_h$ ) of one-half the peak acceleration ( $A_s$ ) was used, a value of 0.0245. For evaluation of the rapid drawdown condition, a water surface elevation drop from El 1085 to El 1074 was assumed.

The stability analyses results summarized in Appendix F include the results of evaluation of end and side slopes. The results of the stability analyses indicate that plan configurations of the slopes are acceptable with respect to stability of all loading conditions evaluated.

### Subgrade Support

The results of the borings indicate the on-site subgrade soils generally consist of silt and silty clay with chert fragments (AASHTO A-2-6, A-4, and A-6). Given the anticipated new embankment, the approach roadway subgrade is likely to consist of embankment fill. Locally-available borrow, which is likely to be used as unclassified embankment fill, is expected to have similar classification.

We recommend that any soils classifying as A-7-5 or A-7-6 soils be excluded from use as subgrade within 18 in. of the plan subgrade elevation. The top 18 in. of subgrade soils should have a maximum plasticity index (PI) of 18. The as-built pavement subgrade should be evaluated by the Engineer. Areas of unstable or otherwise unsuitable subgrade should be improved by undercut and replacement or treatment with additives approved by the Engineer.

Based on the results of previous laboratory CBR tests on the silty clay with chert fragments subgrade and correlation with the AASHTO classification, we recommend the following parameters for use in design of pavements.

٠	CBR:	8.3
•	Resilient Modulus (M <sub>R</sub> ):	3260 lbs per sq in.
٠	R value:	13
•	Modulus of Subgrade Reaction (k):	100 lbs per cu in.

### Site Grading and Subgrade Preparation

As noted, the surface soils are moisture-sensitive. Though presently stable, at elevated water contents the silt and clayey silt subgrade is likely to be soft and unstable. Consequently, <u>site grading</u> <u>operations will be significantly easier to perform during dry seasons of the year</u>.

Site preparation will require some clearing and grubbing and stripping the zone of organiccontaining soils. The depth of stripping will be variable, with deeper stripping depths in wooded areas, and less stripping required in open areas. In general, the stripping depth is estimated to be about 6 to 9 inches in clear areas but may be 18 to 24 in. or more in the localized areas where trees and thick underbrush are present. The zone of organic surface soils should be completely stripped in the embankment footprint areas and at least 5 ft beyond the projected embankment toes. Particular care must be taken to muck out all saturated and/or organic-laden soils in the existing drainage features. Hillsides should be benched to allow placement of embankment fill in horizontal lifts. The maximum vertical cut on benches should be limited to about 18 to 24 inches.

Following stripping and prior to fill placement, the extent of weak and unsuitable soils should be determined. Thorough proof-rolling should be performed to verify subgrade stability. Proof-rolling should be performed with a loaded tandem-wheel dump truck or similar equipment. Unstable soils exhibiting a tendency to rut and/or pump should be undercut and replaced with suitable fill. Care should be taken that undercuts, stump holes, and other excavations or low areas resulting from subgrade preparation are properly backfilled with compacted fill.

Depending on seasonal conditions, undercuts of about 4 to 6 ft below existing grades, more or less, could be required in embankment areas. General undercuts for site grading may be backfilled with unclassified borrow used for embankment fill. Where embankment subgrade undercuts extend into wet subgrade areas or into the channel, use of stone backfill (ARDOT Standard Specifications Section 207) or shot rock fill will be warranted. An example special provision for shot rock fill is provided in Appendix G.

In lieu of undercutting and replacing unsuitable soils in the embankment subgrade or approach road alignments, consideration may be given to using additives to improve soil workability and to stabilize weak areas. Hydrated lime, quick lime, Portland cement, fly ash, or suitable alternate materials may be used as verified by appropriate testing and approved by the Engineer. Additives can be effective where the depth of unstable soils is relatively shallow. Treatment will be less effective in areas where the zone of unstable soils is deep. The optimum application rate of stabilization additive must be determined by specific laboratory tests performed on the alignment subgrade soils. We recommend a minimum treatment depth of 8 inches.

Subgrade preparation and mass undercuts should extend at least 5 ft beyond the embankment toes to the extent possible. Subgrade preparation for the approach roads should extend at least 3 ft outside pavement shoulder edges to the extent possible.

Fill and backfill may consist of unclassified borrow free of organics and other deleterious materials as per ARDOT Standard Specifications Subsection 210.06. Where A-7-5 or A-7-6 soils are encountered at the subgrade elevation, we recommend that these soils be undercut as required

to provide at least 18 in. of suitable low-plasticity subgrade soils, i.e., with a maximum PI of 18, or approved "hillside" cherty clay with a maximum of 35 percent passing the No. 200 sieve. Alternatively, stabilization additives may be utilized to develop a stable subgrade with a PI of 18 or less. Granular soils must be protected from erosion with a minimum 18-in.-thick armor of clayey soil.

Subgrade preparation should comply with ARDOT Standard Specifications Section 212. Embankments should be constructed in accordance with ARDOT criteria (ARDOT Standard Specifications Section 210). Fill and backfill should be placed in nominal 6- to 10-in.-thick loose lifts. All fill and backfill must be placed in horizontal lifts. Hillsides should be benched as required to facilitate placing horizontal fill lifts. The in-place density and water content should be determined for each lift and should be tested to verify compliance with the specified density and water content prior to placement of subsequent lifts.

# **CONSTRUCTION CONSIDERATIONS**

### Groundwater and Seepage Control

Positive surface drainage should be established at the start of the work, be maintained during construction and following completion of the work to prevent surface water ponding and subsequent saturation of subgrade soils. Density and water content of all earthwork should be maintained until embankments, bridge work, and pavements are completed.

Localized perched groundwater was encountered between 1- to 10-ft in March and April 2023. Shallow perched groundwater may be encountered in the near-surface soils, particularly during wet seasons. The volume of groundwater produced can be highly variable depending on the condition of the soil in the immediate vicinity of the excavation. In addition, seasonal surface seeps or springs could develop.

Seepage into excavations and cuts can typically be controlled by ditching or sump-and-pump methods. If seepage infiltration cannot be controlled, construction of drains and/or the use of Select Granular Backfill (AASHTO M 43 No. 57), stone backfill (ARDOT Standard Specifications Section 207), or approved alternates to an elevation above the inflow of seepage will be warranted. In areas of seepage infiltration, the granular fill should be encapsulated with a filter fabric complying with ARDOT Standard Specifications Subsection 625.02, Type 2 and vented to positive discharge. Where surface seeps or springs are encountered during site grading, we recommend the seepage be directed via French drains or blanket drains to positive discharge at daylight or to storm drainage lines.

Site preparation should also include construction of blanket drains in all existing drainage features which will be covered by fill. All loose and/or organic materials should be excavated from drainage features prior to drain construction. Blanket drains should consist of at least 8 to 12 in. of select granular backfill (AASHTO M 43 No. 57) fully encapsulated by a filter fabric. A fabric complying with ARDOT Standard Specifications Subsection 625.02, Type 2 is recommended. Drains should direct water to positive discharge at daylight or into storm drain lines. Piling

Piles should be installed in compliance with ARDOT Standard Specifications, Section 805. Piles should be carefully examined prior to driving and piles with structural defects should be rejected. Any splices in steel piles should develop the full cross-sectional capacity of un-spliced piles. Where piles are prebored to develop uplift resistance, the annulus between the steel piles and the prebore should be expeditiously backfilled with approved grout or concrete. Some rock drilling could be required for prebores. Where piles are prebored to develop uplift resistance, the annulus between the steel piles and the prebore should be expeditiously backfilled with approved grout or concrete.

Pile installation should be monitored by qualified personnel to maintain specific and complete driving records and observe pile installation procedures. Safe bearing capacity of production piles should be determined by ARDOT Standard Specifications Section 805.09, Method A. Driving records should be available for review by the Engineer during pile installation. For driving steel piles on this project, we recommend a minimum hammer energy of 34,000 ft-lbs per blow. Blow counts on steel piles should be limited to about 20 blows per inch. Practical pile refusal may be defined as a penetration of 0.5 in. or less for the final 10 blows.

## Drilled Shafts

As noted, groundwater was encountered in the bridge borings at about 1- to 10-ft depth in March and April 2023. Groundwater could be encountered in drilled shaft excavations. Limited seepage into drilled shaft excavations can probably be controlled by close coordination of drilling, cleanup and concrete placement. We understand that the shaft construction will include permanent casing. Casing should extend to competent rock to the extent possible. Drilled shaft excavations should essentially be dry at the time of concrete placement. Where more than about 3 in. of water is present in shaft excavations, the excavation should be dewatered prior to concrete placement. Where shaft excavations cannot be dewatered, underwater concrete placement should be performed with a

concrete pump fitted with a rigid end extension. A muck bucket or similar tools should be utilized to clean the shaft excavation bottom prior to underwater concrete placement.

Some hard drilling will be experienced when advancing drilled shaft excavations into the moderately hard to hard limestone. Heavy-duty drilling equipment and rock drilling tools will be required to advance shaft excavations to the recommended minimum penetration into the competent limestone. Coring or other rock excavation methods will be required to achieve the recommended penetration into the rock bearing stratum. All drilled shaft excavations should be observed by the Engineer or Department to verify suitable bearing and adequate penetration.

### Rock Excavation

Rock excavation will likely be required for site grading. Cuts and excavations extending into the cherty limestone will be required to advance through hard rock zones which will require rock excavation methods. This may include ripping with a single-tooth ripper on a track excavator, a hoeram or jackhammer, or blasting.

The need for rock excavation should be anticipated. Contract documents should include a unit price for removal and disposal of materials and obstructions that cannot be excavated with conventional heavy-duty excavating equipment. The conventional heavy-duty excavating equipment may be defined as a Caterpillar D-7 bulldozer with single tooth ripper, a Caterpillar 312 track excavator equipped with rock teeth, or equipment of similar power and capability. Rock excavation volumes should be determined based on in-place measurements via cross sectioning. If excavation is to be unclassified, the Contractor must be responsible for assessing rock excavation requirements.

### **CLOSURE**

The Engineer or Department or a designated representative thereof should monitor site preparation, grading work and all construction. Subsurface conditions significantly at variance with those encountered in the borings should be brought to the attention of the Geotechnical Engineer. The conclusions and recommendations of this report should then be reviewed in light of the new information. The following attachments are included and complete this final submittal.

Plate 1	Site Vicinity
Plate 2	Plan of Borings
Plates 3 through 16	Boring Logs
Plates 17 and 18	Keys to Terms and Symbols
Appendix A	Preliminary Bridge Layout
Appendix B	Selected Rock Core Photographs
Appendix C	Classification Test Results
Appendix D	Generalized Subsurface Profile
Appendix E	Nominal HP12x53 Uplift Pile Capacity Curves
Appendix F	Stability Analyses Results
Appendix G	Example Special Provision – Shot Rock Fill

\* \* \*

We appreciate the opportunity to be of service to you on this project phase. Should you have any questions regarding this report, or if we may be of additional assistance, please call on us.

Sincerely,

GRUBBS, HOSKYN, BARTON &WYATT, LLC

Villeto M. Sett

Velleta M. Scott, P.E. Sr. Project Engineer Mark E. Wyatt, P.E. President

VMS/MEW:jw

Copies Submitted:	Garve	r LLC	
	Attn:	Mr. Joel Skinner, P.E.	(1-email)
	Attn:	Mr. Lawren Wilcox, P.E.	(1-email)
	Attn:	Mr. Adam Wierciak, P.E.	(1-email)



**A UES Company** 

090069 XNA Access Road over Little Osage Creek **Benton County, Arkansas** 

Plate 1



Grubbs, Hoskyn, Barton & Wyatt, LLC	PLAN of BORINGS	Scale: As
CONSULTING ENGINEERS	070007 ANA Access Road over Little Osage Creek	Statt. As
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		Stiff reddish brown silty clay w/chert fragments, dry	18												
- 5 -		- with discontinuous chert seams and layers below 4 ft	50/4												
		- auger refusal at 8 ft	17												
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- 10 -		gray weathered cherty limestone, fractured												100	58
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Ž		<b></b>				,	-					•/			-

Grubbs, Hoskyn, Barton & Watt, Inc. 200 OF BORING NO. S30       Barton & Watt, Inc. 200069 XNA Access Road over Little Osage Creek Benton Co., Arkansas       TYPE: Auger to 8 ft /Core     LOCATION: Approx Sta 179+15, 60 ft Lt       Lag     Description OF MATERIAL     Location: Approx Sta 179+15, 60 ft Lt       Lag     Description OF MATERIAL     Location: Approx Sta 179+15, 60 ft Lt       Lag     Description OF MATERIAL     Location: Approx Sta 179+15, 60 ft Lt       Lag     Description OF MATERIAL     Location: Approx Sta 179+15, 60 ft Lt       Lag     Description OF MATERIAL     Location: Approx Sta 179+15, 60 ft Lt       Lag     Description OF MATERIAL     Location: Approx Sta 179+15, 60 ft Lt       Lag     Description OF MATERIAL     Location: Approx Sta 179+15, 60 ft Lt       Lag     Description OF MATERIAL     Location: Approx Sta 179+15, 60 ft Lt       Lag     Description: Approx Sta 179+15, 60 ft Lt     Location: Approx Sta 179+15, 60 ft Lt       Lag     Description: Approx Sta 179+15, 60 ft Lt     Location: Approx Sta 179+15, 60 ft Lt       Lag     Description: Approx Sta 179+15, 60 ft Lt     Location: Approx Sta 179+15, 60 ft Lt       Lag     Description: Approx Sta 179+15, 60 ft Lt     Location: Approx Sta 179+15, 60 ft Lt       Approx Sta 179+15, 60 ft Lt     Location: Approx Sta 179+15, 60 ft Lt     Location: Approx Sta 179+15, 60 ft Lt       Approx Sta 179+15, 60 ft Lt     Location: Appro		19-11	8															
TYPE:         Auger to 8 ft /Core         LOCATION:         Approx Sta 179+15, 60 ft Lt           Line         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0		Gru Bar <sub>Consu</sub>	bb tor	s, Hoskyn, LO & Wyatt, Inc. LO Engineers 090069 X	GOF NA Acces Bent	<b>BO</b> ss Ro ton C	<b>RI</b> bad ov co., A	<b>N G</b> ver L rkans	NC ittle C sas	<b>). S</b> : Dsage	<b>30</b> e Cre	ek						
L         L         COMESION, TON/SQ FT         S00		TYPE	Ξ: .	Auger to 8 ft /Core			LOC	CATIC	N: Ap	prox \$	Sta 17	9+15,	60 ft	Lt				
u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u         u	<b>⊢</b>		S			R FT	ΓVT		(		SION	, TON/	'SQ F	Т		%	У	
B     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S <td>TH, F</td> <td>MBOL</td> <td><b>APLE</b></td> <td>DESCRIPTION OF MAT</td> <td>ERIAL</td> <td>S PEF</td> <td>DRY /</td> <td>0</td> <td>2 0</td> <td>.4 0</td> <td>.6 0</td> <td>.8 1</td> <td>.0 ^</td> <td>1.2 1</td> <td>.4</td> <td>200 9</td> <td>cover</td> <td>RQD</td>	TH, F	MBOL	<b>APLE</b>	DESCRIPTION OF MAT	ERIAL	S PEF	DRY /	0	2 0	.4 0	.6 0	.8 1	.0 ^	1.2 1	.4	200 9	cover	RQD
Image: continued)     Image: continu	DEP	SYI	SAN			LOW:	UNIT LB/	PL/ L	ASTIC IMIT +		WA CON	TER TENT		LIQU LIM	JID IT	- No.	% R€	%
$ \begin{array}{c}                                     $		44		(continued)				1	0 2	0 3	30 4	0 5	0	60 7	0			
$ \begin{array}{c}                                     $																		
																	100	95
	- 35 -																	
																	97	83
	- 40 -																	
																	100	82
	45																	
	45		Π															
	- 50 -															_		
	2																	
	- 55 -																	
COMPLETION DEPTH: 45.0 ft     DEPTH TO WATER       DATE: 9-15-23     IN BORING: Dry to 8 ft     DATE: 9/15/2		COMI DATE	PLE : 9-	TION DEPTH: 45.0 ft -15-23		DE IN E	PTH T BORIN	O WA G: Di	TER y to 8	ft				DA	 TE: 9/	/15/2	02:	3

	19-11	8														
	Gru Bar <sub>Consu</sub>	bb tor	es, Hoskyn, h & Wyatt, Inc. LOGOF g Engineers 090069 XNA Access Ben	<b>BO</b> ss Ro ton C	<b>RI</b> bad o co., A	<b>N G</b> ver Li rkans	NC ttle (	<b>). S</b> : Dsage	<b>31</b> e Cre	ek						
	TYPE	:	Auger to 7 ft /Core		LO		N: Ap	oprox \$	Sta 18	0+45,	60 ft L	.t				
Ŀ		S		R FT	νT		(	COHE	SION	, TON	'SQ F	Г		%	Z	
EPTH, F	YMBOI	AMPLE	DESCRIPTION OF MATERIAL	NS PEI	T DRY 3/CU F	0. PLA		.4 0	0.6 0	.8 1 TER	.0 1	LIQU	.4 IID	o. 200	Recove	% RQD
B	S S	S	SURF. EL: 1078±	BLO		LI	MIT ╋ 0 2	20 3	CON  30 4	TENT ● Ю 5		LIM 	IT O	Z '	%	
		$\mathbb{H}$	Stiff brown silty clay w/chert													
		X	Stiff to very stiff reddish brown and brown fine sandy clay w/numerous chert fragments, inclusions and discontinuous seams	23 50/6"			•	++						18		
- 5 -		X		50/2"												
			a company matrix at at 7 ft	50/1"			•									
- 10 -			<ul> <li><u>- auger refusal at 7 ft</u></li> <li>Moderately hard to hard gray and tan cherty limestone, flat bedded w/styolitic joints</li> <li>- calcite inclusions at 11 ft</li> </ul>												82	80
- 15 -			- cavity at 13 to 14 ft												75	70
- 20 -									q <sub>u</sub> = 1	0,940	psi, Tl	JW= 1	55 pcf		100	98
															77	72
		PLE	TION DEPTH: 56.5 ft	DE	 	O WA	TER		q <sub>u</sub> = 7	7320 p	si, TU	W= 15	2 pcf		93	78
	DATE	: 4	-14-22	IN E	BORIN	IG: Dr	y to 7	ft				DA	ΓE: 4/	5/20	22	

19-118														
Grubb Bartor Consulting	os, Hoskyn, n & Wyatt, Inc. LOGOF g Engineers 090069 XNA Acces Bent	<b>B C</b> ss Ro ton C	<b>RII</b> bad ov co., Ar	<b>N G</b> /er Li kans	NC ttle (	<b>). S</b> Dsag	<b>31</b> e Cre	ek						
TYPE:	Auger to 7 ft /Core		LOC	CATIO	N: Ap	prox	Sta 18	0+45,	60 ft I	_t				
		R FT	۲۷		(		SION		/SQ F	Т		%	2	
TH, F MBOL	DESCRIPTION OF MATERIAL	S PEF	DRY /	0.	2 0	.4 (	0.6 0	.8 1	.0 1	.2	1.4	200	scover	RQD
DEP SAN		FOW	UNIT LB/	PLA LI	ASTIC MIT <del>†</del> – –		WA CON	TER TENT		Liqi Lin	JID 1IT	- No.	% R	%
	(continued)			10	0 2	20 3	30 4	40 5	50 (	50	70		_	
													98	88
													97	77
							q <sub>u</sub> = \$	9010 p	si, TL	IW= 1	50 pcf		98	88
	- vertical shear at 46 to 46.1 ft											-	90	85
												-	100	96
		 								 	 		90	70
COMPLE DATE: 4	TION DEPTH: 56.5 ft -14-22	DE IN I	PTH TO BORIN	O WA <sup>:</sup> G: Dr	TER y to 7	ft				DA	TE: 4/	/5/20	22	

	19-11	8														
	Gru Bar <sub>Consu</sub>	bb toi	os, Hoskyn, LOGOF n & Wyatt, Inc. LOGOF g Engineers 090069 XNA Acce Ben	BO ss Ro iton C	<b>RI</b> bad o co., A	<b>N G</b> ver Li rkans	NC ttle ( as	<b>). S</b> Dsage	<b>32</b> e Cre	ek						
	TYPE	≣:	Auger to 11 ft /Wash to 13 ft /Core		LOC		N: Ap	oprox S	Sta 18	1+45,	60 ft L	.t				-
I, FT	OL	ES		ER FT	Y WT FT	0.	2 0		SION	, <b>TON</b> /	/SQ F1	Г .2 1	.4	% 00	very	Q
DEPTH	SYME	SAMP	DESCRIPTION OF MATERIAL	ILOWS F	UNIT DF LB/CL	PLA LI	\STIC MIT ╋ —		WA CON			LIQU LIM	IID IT	- No. 2(	% Reco	% RC
			SURF. EL: 1080±	<u> </u>		1(	) 2	20 3	30 <u>4</u>	40 5	6 6	0 7	0			
			Firm brown clayey silt w/chert fragments	9			•	<mark>₽ -₽</mark>						48		
		X	Stiff to very stiff reddish brown fine sandy clay w/numerous chert fragments and inclusions	40			•									
- 5 -	$\mathcal{U}$	X		24			•	╈╼						22		
		X		29			•									
		X	- silty with more chert fragments and chert seams below 8 ft	50/7"												
10-																
			- auger refusal at 11 ft													
			- rock bit refusal at 13 ft													
		-	Moderately hard to hard gray cherty limestone, stylolitic joints												100	75
- 15 -									q <sub>u</sub> =	9240 p	si, TU	W= 16	1 pcf		100	67
- 20 -		-													80	58
			- calcite inclusions at 22 ft												00	
			ound monoiun at 22 it													
- 25 -															100	75
				+												
	COMF DATE	⊥⊥ PLE ∷4	TION DEPTH: 27.0 ft -7-22	DEI IN E	PTH T BORIN	O WA <sup>-</sup> G: 10	TER ft	<u> </u>	<u> </u>	1	<u> </u>	DA	ГЕ: 4/	8/20	22	

	19-118	3														
	Gru Barl <sub>Consu</sub>	bbs on ting E	, Hoskyn, LOGOF & Wyatt, Inc. LOGOF ingineers 090069 XNA Acces Bent	<b>BO</b> ss Ro ton C	<b>RI</b> bad ov co., A	<b>N G</b> ver L rkans	NC ittle ( as	<b>). S</b> Dsag	<b>33</b> e Cre	ek						
	TYPE	: A	uger to 11 ft /Core	_	LOC		N: Ap	prox	Sta 17	6+00,	60 ft	Rt				
Ι.				L L	F		(	COHE	SION		/SQ F	Т				
H, FT	1BOL	PLES	DESCRIPTION OF MATERIAL	PER	RY M U FT	0	.2 0	.4 0	0.6 0	.8 1	.0	1.2 1	.4	200 %	sovery	gD
DEPT	SYN	SAM		OWS	JNIT D LB/O	PL/ L			WA CON	TER TENT			JID IT	- No.	% Re	% Е
			SURF. EL: 1078±			1	0 2	20 3	30 4	40 E	50	60	0			
		s g	′ery soft to soft brown clayey ilt w/trace fine to coarse ravel	4												
		-	very soft at 2 to 4 ft	2												
- 5 -		∏ ∏ ft	with chert fragments below 4	6												
Ĕ		4 -	soft at 4 to 6 ft													
		X -	stiff below 6 ft	14												
		V ∏ fi ∑ s	′ery loose to loose tan sandy ne to coarse chert gravel, iltv	4												
- 10 -			,													
		l N g	loderately hard light gray and ray cherty limestone													
		fr	actures												100	71
- 15 -		$\left  \right $														
															100	05
															100	85
20 -															100	4.00
		Щ		+								+	+			
- 25 -														-		
	COMF DATE	LET 9-1	ION DEPTH: 21.0 ft 8-23	DE IN E	PTH T BORIN	O WA G: 5.	TER 8 ft	1	I	1	1	DA	TE: 9/	/18/2	023	3
·																

	19-118														
	Grub Barte Consult	bs, Hoskyn, LOGOF on & Wyatt, Inc. LOGOF ing Engineers 090069 XNA Acce Ben	BO ss Ro ton C	<b>RI</b> bad o co., A	<b>N G</b> ver Li rkans	NC ittle C	<b>). S</b> Dsag	3 <b>4</b> je Cre	ek						
	TYPE:	Auger to 10 ft /Wash to 15 ft /Core		LO		N: Ap	prox	Sta 17	7+00,	60 ft F	٦t				
			FT	μ		(	COHE	ESION	, TON	/SQ F	Т				
Η, Π	BOL		PER	RY V U FT	0	2 0	.4	0.6 (	).8 1	.0 1	.2 1	.4	% 00	overy	g
DEPT	SYM		SLOWS	UNIT D LB/C	PL/ Ll	ASTIC MIT			TER		LIQU LIM	JID IT	- No. 2	% Rec	% R
	* * 5 6 *	Voru loogo brown fing condu			1	0 2	20	30 4	40 <u></u>	50 E	50 7	0			
	X	silt	2				•								
		Soft brown silty clay w/numerous chert fragments	6												
- 5 -		- stiff at 4 to 6 ft	23				<b>+</b> •-	+	╈				20		
		- very stiff below 6 ft	26												
- 10 -		Moderately hard gray and tan highly weathered cherty limestone w/discontinuous chert seams and layers	50/4"										-		
- 15 -		- moderately hard to hard below 13 ft	25/0"												
		and tan cherty limestone, slightly weathered w/some stylolitic joints, flat bedded												88	88
		Moderately hard to hard gray and tan cherty limestone w/stylolitic joints, flat bedded												97	72
														100	92
	COMPI DATE:	LETION DEPTH: 59.0 ft 4-12-23	DEI IN E	PTH T BORIN	O WA G: Dr	TER y to 1	0 ft				DA	TE: 4	/12/2	023	3

	19-11	8															
	Gru Bar <sub>Consu</sub>	bb tor	s, Hoskyn, h & Wyatt, Inc. LOG Bengineers 090069 XNA	<b>OFB(</b> Access F Benton	<b>D R</b> Road Co., <i>i</i>	<b>I N</b> ove Ark	<b>G</b> er Li	NC ttle C as	<b>). S</b> Dsag	<b>34</b> e Cre	ek						
	TYPE	Ξ:	Auger to 10 ft /Wash to 15 ft /Cor	е	L	OCA		N: Ap	prox	Sta 17	7+00,	60 ft F	Rt				
ДЕРТН, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIA	LOWS PER FT	UNIT DRY WT		0.: PLA LII	2 0 STIC MIT +	20HE	U.6 CON		/SQ F .0 1	T .2 1 LIQU LIQU +	.4 JID IT	- No. 200 %	% Recovery	% RQD
								, <u> </u>		$q_u = 3$ $q_u = 4$	8200 p 4810 p	si, TU	W= 15 W= 15	56 pcf 54 pcf		100	92
																98	68
40-										q <sub>u</sub> = 0	6970 p	si, TU	W= 15	56 pcf		97	93
																88	75
										q <sub>u</sub> = 0	6220 p	si, TU	W= 16	30 pcf		98	98
													·			98	98
	COMF		TION DEPTH: 59.0 ft	DI	EPTH	то	WA	TER							<u> </u>		
	DATE	: 4	-12-23	IN	BOR	ING	: Dr	y to 1	U ft				DA	IE: 4/	/12/2	023	3

	19-11	8														
	Gru Bar Consu	bb tor	s, Hoskyn, LOGOF & Wyatt, Inc. LOGOF Engineers 090069 XNA Acce Ben	BO ss Ro ton C	<b>R I</b> bad o co., A	<b>N G</b> ver L rkans	NC ittle ( sas	<b>D. S</b> Osa	<b>335</b> ge Cro	eek						
	TYPE	<u>:</u>	Auger to 11 ft /Core		LO		N: A	pprox	sta 1	78+40	, 75 f	t Rt				
⊢		0		2 FT	۲× ۲				ESION		I/SQ	FT		%	~	
TH, F	MBOL	APLES	DESCRIPTION OF MATERIAL	S PEF	DRY / CU F1	0	.2 (	).4	0.6	0.8	1.0	1.2	1.4	200	scover	RQD
DEF	SΥ	SAN		BLOW	UNIT LB/	PL/   L	ASTIC IMIT <b>+</b> -			ATER NTENT		LIC 	DUID MIT <b>+</b>	- No	% R	%
			Medium dense brown and tan			1	0 2	20	30	40	50	60	70			
	$\mathcal{O}$		ine to coarse graver w/cobbles													
		X	- sandy below 2 ft	13												
5		M	- very loose at 4 to 6 ft	2												
		Δ	- loose to medium dense, silty													
		X	below 6 ft	10												
			Moderately hard gray and light	50/1"	,									_		
- 10 -			gray cherty limestone w/rehealed fractures and stylolites													
															92	83
- 15																
															97	82
- 20 -																
z-1 z-6 r															92	75
															98	90
		 >LE	TION DEPTH: 51.0 ft	DE	 PTH T	O WA	TER									
	DATE	: 9	-19-23	IN E	BORIN	IG: Al	Surfa	ace				D	ATE:	9/19/2	202	3

	19-118	3															
	Gru Bart Consul	bbs on	s, Hoskyn, L & Wyatt, Inc. L Engineers 090069	OGOF XNA Acces Ben	BC ss Ro ton C	<b>RI</b> bad ov co., Ai	<b>N G</b> ver L rkans	NC ittle ( sas	<b>). S</b> Dsag	<b>335</b> ge Cre	eek						
	TYPE	E A	uger to 11 ft /Core			LOC		N: Ap	oprox	sta 17	78+40,	75 ft I	٦t				
					L L	٧T			СОН	ESION	I, TON	/SQ F	Т		、o	~	
Н Н Н	1BOL	PLES		ΔΤΕΡΙΔΙ	PER	RY V U FT	0	.2 0	.4	0.6	0.8	1.0 1	.2 1	.4	200 %	over	gD
DEPT	SΥΝ	SAM			OWS	NIT D LB/C	PL/ L	ASTIC		WA CON			LIQU	JID IT	No.	6 Rec	ж Ж
			(continued)		В		1	╋ 0 2	20	30	●- — - 40   ÷	50 (	<b>+</b> 50 7	• 70		0`	
																98	93
- 35 -																	
																97	68
- 40 -																97	93
- 45 -																100	90
- 50 -		İ.			L											100	100
							0 \A/A	TEP									
	DATE	: 9-	19-23		IN I	BORIN	G: At	Surfa	ice				DA	TE: 9/	/19/2	023	3

	Gru Bar Consu	bb tor	os, Hoskyn, n & Wyatt, Inc. LOGOF <sub>g Engineers</sub> 090069 XNA Acces	<b>BO</b> ss Ro	RI bad o	<b>N G</b> ver Li	N C	). S3 Dsage	<b>36</b> e Cre	ek						
			Bent	ton C	o., A	rkans	as									
	TYPE	:	Auger to 8 ft /Wash to 8 ft /Core	1	LOC		N: Ap	prox S	Sta 17	9+85,	60 ft F	Rt				
		0		L L	۲.		(		SION,	TON	'SQ F	Г		Ŷ	V	
ц Т	BOL	LE0		PER	RY V U FT	0.	2 0	.4 0	.6 0	.8 1	.0 1	.2 1.	.4	000	over	gD
DEPT	SYM	SAMF	DESCRIPTION OF MATERIAL	SMOJ	UNIT D LB/C	PLA LI	ASTIC MIT <b>+</b>		WA CON	TER TENT		LIQU LIMI	ID T	- No. 2	% Rec	% R
			Soft clavev silt w/occasional	ш		1	0 2	0 3	0 4	0 5	600	0 7	0			
			decayed organics and rootlets / Stiff to very stiff light tan and light gray silty clay w/chert and limestone fragments and chert	50/6"						•						
			seams and layers	50/0												
- 5		X		50/3"				•••-•	┙╋					24		
		X		25/0"												
		-	Moderately hard to hard light gray w/gray cherty limestone, flat bedded, stylolitic joints												79	50
- 10			- with vertical shears at 8.6 to 9.1 ft, 24 to 26 ft, and 34 to 34.2 ft													
															95	88
- 15																
		-													97	86
- 20		-													100	93
		-														
25															78	25
									a - 9	2000 ~	сі ти	\\/- 1E	4 nof			
									Y <sub>u</sub> - (	1090 p	ы, IU	vv— 10	н рсі			
RECRUC	COMF DATE	PLE : 4	TION DEPTH: 58.0 ft -19-22	DEI In e	PTH T BORIN	O WA G: 21	TER ft					DAT	ΓE: 4/	19/2	022	2

	19-118	8											
	Gru Barl <sub>Consu</sub>	obs, Hoskyn, on & Wyatt, Inc. LOGOF ting Engineers 090069 XNA Acces Bent	<b>BC</b> ss Ro con C	<b>RI</b> bad ov co., Ai	N G N O. ∕er Little O 'kansas	<b>. S36</b> sage Cre	ek						
	TYPE	: Auger to 8 ft /Wash to 8 ft /Core	-	LOC	CATION: App	orox Sta 17	9+85, (	60 ft F	Rt				
ДЕРТН, FT	SYMBOL	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	C 0.2 0.4 PLASTIC LIMIT +			SQ F1	2 1.2 LIQUI LIMI +	4 D F	- No. 200 %	% Recovery	% RQD
						30 2		0 6		)		100	100
- 35 -						q_u= -	7190 ps	si, TU	W= 15	1 pcf		98	95
- 40 -						q_u= 3	3310 p	si, TU	W= 14	7 pcf		100	93
- 45 -		with rehealed fractures below				q_u= 8	3120 p	si, TU	W= 15	7 pcf		90	90
- 50 -		48 ft				q <sub>u</sub> =	7710 p	si, TU	W= 14	9 pcf		100	100
												95	95
	COMF DATE	LETION DEPTH: 58.0 ft 4-19-22	DE IN I	PTH T BORIN	O WATER G: 2 ft		I		DAT	E: 4/	19/2	022	2

	19-11	3														—
	Gru Bar <sub>Consu</sub>	bb tor	s, Hoskyn, LOGOF & Wyatt, Inc. LOGOF Engineers 090069 XNA Acce Ben	BO ss Ro ton C	<b>RI</b> bad o co., A	<b>N G</b> ver Li rkans	NO ittle C as	) <b>. S</b> : )sage	<b>37</b> e Cre	ek						
	TYPE	:	Auger to 6.5 ft /Wash to 8 ft /Core		LO	CATIO	N: Ap	prox \$	Sta 18	1+10,	60 ft F	٦t				
		0		۲ FT	۲۷-		(		SION	, TON	/SQ F	Т		%	۲	
TH, F	ABOL	IPLE 9	DESCRIPTION OF MATERIAL	) PER	DRY /	0.	.2 0.	4 0	.6 0	0.8 1	.0 1	.2 1	.4	200 9	cover	gD
DEP.	SYN	SAN		SMO	JNIT D LB/G	PLA LI	ASTIC MIT		WA CON				JID IT	No.	% Re	% F
	<b>**</b> **		SURF. EL: 1079±	Ē		1	0 2	0 3	80 <u>/</u>	40 5	50 6	50 7	70			
		X	fine sandy clay w/numerous chert and limestone fragments	28			•	₽┥						15		
	Ż	X		34			•									
- 5		X	Stiff to very stiff brown fine sandy clay w/chert and limestone fragments	50/3"			•									
		X	- with numerous chert and limestone fragments and chert seams below 6 ft	50/1"			•	•								
		$\square$	Moderately hard to hard gray													
- 10			stylolitic joints													
															97	60
															67	0
			- caicite inclusions at 13.5 It													
- 15															00	63
															50	
20															98	87
											. <b>-</b> -		50			
07-17-6									q_= 1	0,930	psi, T	JVV= 1	bu pci			
- 25															-	
									q <sub>u</sub> = 1	4,180	psi, Tl	JW= 1	49 pcf		95	92
o 																
		PLE : 4	TION DEPTH: 58.0 ft -12-22	DEI IN F	PTH T	O WA IG: Dr	TER v to 6	5 ft				DA	TE: 4/	5/20	22	
2		•					,					2				

19-118																				
	Grubbs, Hoskyn, Barton & Wyatt, Inc. LOG OF BORING NO. S37 Consulting Engineers 090069 XNA Access Road over Little Osage Creek Benton Co., Arkansas																			
	TYPE	E: /	Auger to 6.5 ft /Wash to 8 ft	/Core		LOC	CATIO	N: Ap	prox	Sta 18	1+10,	60 ft F	Rt							
<b> </b> _						۸T		(		SION		/SQ F	Г		%	Y				
TH, F	SYMBOL	SAMPLES	<b>IPLES</b>	IPLES	IPLES	DESCRIPTION OF MAT	ERIAL	S PER	DRY / CU F1	0.	2 0	.4 0	0.6 0	.8 1	.0 1	.2 1	.4	200 9	scover	ROD
DEP					FOW	UNIT LB/	PLA LI	ASTIC MIT		WA CON	TER TENT	LIQUID LIMIT			No.	% Re	%			
			(continued)		<u> </u>		1	0 2	20 3	30 4	10 5	50 6	0 7	0		100	85			
- 35 -						-										100	98			
- 40 -						-														
										q <sub>u</sub> = t	3990 p	SI				100	92			
- 45 -						-				q_= 4	760 p	si, TU	W= 14	1 pcf		100	82			
- 50 -						-				q_= 4	160 p	si, TU	W= 16	7 pcf		100	95			
55						-														
																93	93			
	<u> - ~</u> ~- - -			+				- <u> </u>				+		<u> </u>						
	COMF	PLE	TION DEPTH: 58.0 ft		DEF	PTH T	AW C	TER												
	DATE: 4-12-22 IN BORING: Dry to 6.5 ft DATE: 4/5/2022																			

Grubbs, Hoskyn, Barton & Wyatt, Inc. LOG OF BORING NO. S38 Consulting Engineers 090069 XNA Access Road over Little Osage Creek																						
	/ Consu	ung	Ben	ton C	o., A	rkans	Sas	, say														
	TYPE	:	Auger to 10 ft /Wash to 12 ft /Core		LOC	CATIO	N: Ap	prox	Sta 18	2+15,	60 ft F	Rt										
				L L	۲۸.		(		SION,		/SQ F	Г		9	λ							
Ц Т	BOL	2 LES		PER	RY V U FT	0.	.2 0	.4 0	0.6 0	.8 1	.0 1	.2 1.	.4	00 %	over	g						
DEPT	SYM	SAMF	SAMF	SAMP	SAMP	SAMP	SAMP	SAMP	DESCRIPTION OF MATERIAL	SMOJ	UNIT DI LB/CI	PL/ Ll	ASTIC IMIT		WA CON	TER TENT		LIQU LIMI	ID T	- No. 2	% Rec	% R
		$\left  \right $	Very soft to soft brown clavey	ш		1	0 2	0 3	30 4	0 5	50 6	0 7	0									
		X	silt w/occasional rootlets	4				•	+					90								
		X	Stiff to very stiff reddish brown silty clay w/numerous chert and limestone fragments	32			•															
- 5 -		X	Stiff to very stiff reddish brown fine sandy clay w/numerous chert and limestone fragments	45			•															
		X	- with chert seams below 6 ft	50/6"			•															
		Z		25/0"																		
- 10 -			- auger refusal at 10 ft				•															
			Moderately hard to hard gray cherty limestone, styolitic joints						q <sub>u</sub> = 5	610 p	si, TU	W= 15	9 pcf									
15															100	83						
															100	02						
- 20 -															100	92						
															100	94						
- 25 -															87	85						
				L																		
	DATE: 4-8-22         IN BORING: Dry to 10 ft         DATE: 4/5/2022																					

Grubbs, Hoskyn, Barton & Wyatt, Inc. Consulting Engineers	SYMBOLS AND TERMS USED ON BORING LOGS								
SC	SOIL TYPES SAMPLER TYPES								
(SHOWN IN いてい (SHOWN IN		N)	(SHO	WN ON S		COLUM	N)		
Gravel Sand	Silt	Clay	Shelby		Split		Cutting		
Predomina	nt type shown heavy		lube	Core	Spoon	Recover	У .		
TERM	S DESCRIBING	G CONSISTI	ENCY C	OR CON	IDITION		_		
COARSE GRAINED SO sands, and (2) silty or cla determined by laboratory	ILS (major portion re ayey gravels and sar y tests.	etained on No. 2 nds. Condition i	200 sieve) s rated ac	: Includes cording to	(I) Clean ( relative de	gravels a ensity, a	and S		
DESCRIPT	<b>FIVE TERM</b>	N-VALUE	ſ	RELATIN	/E DEN	SITY			
VERY LOO	SE	0-4			0-15%				
LOOSE MEDIUM D	FNSF	4-10 10-30			15-35% 35-65%				
DENSE		30-50			65-85%				
VERY DEN	SE	50 and a	bove		85-100%				
FINE GRAINED SOILS silts and clays, (2) grav according to shearing s compression tests.	(major portion pass relly, sandy, or silty c strength, as indicated	sing No. 200 sie clays, and (3) cl d by penetrome	ve): Inclue ayey silts. ter reading	des (1) Ino Consisten gs or by ur	rganic and icy is rated nconfined	d organio d	C		
				UNCO	NFINED				
DESCRIP	TIVE TERM		COMF	PRESSIN TON/S	/E STRI SQ. FT.	ENGTH	4		
VER	Y SOFT		l	Less than	0.25				
FIRM	N		(	0.50-1.00					
STIF				1.00-2.00					
HAF	REAL		4	4.00 and h	igher				
NOTE: Slick strengths tha The consiste	NOTE: Slickensided and fissured clays may have lower unconfined compressive strengths than shown above, because of planes of weakness or cracks in the soil. The consistency ratings of such soils are based on penetrometer readings.								
ТЕ	ERMS CHARAC	TERIZING	SOIL S	TRUCTL	JRE				
SLICKENSIDED - ha FISSURED - contain or less	aving inclined planes ling shrinkage cracks s vertical	s of weakness the set of weakness the set of	nat are slid ed with fin	ck and glos e sand or	ssy in app silt; usuall	earance y more			
LAMINATED - comp	osed of thin layers o	f varying color	and textur	e.					
INTERBEDDED - co	mposed of alternate	layers of differ	ent soil typ	onate					
WELL GRADED - ha	aving a wide range in	n grain sizes an	d substan	tial amoun	ts of all in	termedia	ate		
	article sizes.	ne arain size .o	r having a	range of s	izes with	some			
	intermediate sizes	missing.		Tunge et e		001110			
Terms used on this repo are in accordance with t Technical Memorandum	ort for describing soil the UNIFIED SOIL C n No.3-357, Waterwa	ls according to LASSIFICATIC ays Experiment	their textur N SYSTE Station, N	re or grain M, as deso Iarch 1953	size distri cribed in 3	bution			

PLATE 24

Crubbe Hoelvin							
Barton & Wyatt, Consulting Engineers	Inc. BORIN	G LOG TERMS	S – ROCK				
ROCK TYPES (Shown in symbols coli	UMN)	silistone	Coal Shale				
loint	Spacing	Degree of					
Characteristics –	Very Close 0.75 to 2.5 in. Close 2.5 to 8 in. Moderately Close 8 to 24 in. Wide 2 to 6 ft Very Wide 4 toro than 6 ft	Weathering –	Fresh — No visible signs of decomposition or discoloration. Rings under hammer impact. Slighty Wegthered — Slight				
Bedding Characteristics —	Very Thin         0.75 to 2.5 in.           Thin         2.5 to 8 in.           Medium         8 to 24 in.           Thin         2.5 cf.		discoloration inwards from open fractures, otherwise similar to fresh.				
Lithologic Characteristics —	Massive More than 6 ft Clayey Shaly Calcareous (limy) Siliceous		throughout. Weathered — Discoloration throughout. Weatker minerals such as feldspar decomposed. Strength somewhat less than fresh rock, but cores cannot be broken by hand or scraped by knife. Texture preserved.				
Parting –	Sandy (Arenaceous) Silty Plastic Seams Less than 1/16 inch		Highly Weathered — Most minerals somewhat decomposed. Specimens can be broken by hand with effort or shaved with knife. Core stones present in rock mass. Texture				
Seam — Layer — Stratum —	1/16 to 1/2 inch 1/2 to 12 inches Greater than 12 inches		becoming indistinct but fabric				
Hardness-	Soft (S) — Reserved for plastic material alone. Friable (F) — Easily crumbled by hand, pulverized or reduced to powder and is too so to be cut with a pocket knife.	ft	Completely Weathered — Minerals decomposed to soil but fabric and structure preserved (Saprolite). Specimens easily crumbled or penetrated. Residual Soil — Advanced state of decomposition resulting in plastic soils. Rock fabric and structure completely destroyed. Large volume change.				
	Low Hardness (LH) – Can be gouged deeply or carved with a pocket knife.						
	Moderately Hard (MH) — Can be readily scratched by a knife blade; scratch leaves a heavy trace of dust and scratch is readily visible after the powder has been blown away.	Solution and					
	Hard (H) – Can be scratched with difficulty; scratch produces little powder and is often faintly visible; traces of the knife steel may be visible.	Void Conditions –	Solid, contains no voids Vuggy (pitted) Vesicular (igneous) Porous Cavities				
	Very hard (VH) – Cannot be scratched with a pocket knife. Knife steel marks left on surface.	Swelling Properties –	Cavernous Nonswelling Swelling				
Tautura	Fine - Paraly agen with particul and	Slaking Properties —	Nonslaking Slakes slowly on exposure				
lexture –	Medium — Barely seen with naked eye Medium — Barely seen up to 1/8 in. Coarse — 1/8 in. to 1/4 in.	Rock Quality	Slakes readily on exposure				
Structure —	Bedding Flat – 0° – 5° Gently Dipping – 5° – 35° Moderately Dipping – 55° – 85° Steeply Dipping – 55° – 85°	vesignation (KQV) –	Key (rercent)Diagnostic DescriptionGreater than 90Excellent75 - 90Good50 - 75Fair25 - 50PoorLess than 25Very Poor				
	Open Cemented or Tight Fractures, closely spaced Open						
	Cemented or light Brecciated (Sheared and Fragmented) Open Cemented or Tight						
	Faulted Slickensides						

APPENDIX A


x5\_S101\_LO.dgn NEPA\Dra JESkinner 6/29/2023 1:42:31 PM WORKSPACERRDOT Bridge (2019) L:\2017\17017600 - XNA Access - NEPA\

DATE REVISED	DATE REVISED	FED. ROAD DIST. NO.	STATE	JOB NO.	SHEET NO.	TÓTAL SHEETS		
		6	ARK.	090069 \$	\$6N5101\$ \$ST\$			
		\$BN05As	\$	LAYOUT	DN5101\$			



DATE REVISED	DATE REVISED	FED. ROAD DIST. NO.	STATE	JOB NO.	SHEET NO.	TÓTAL SHEETS	
		6	ARK.	090069	6N5102	\$ \$ST\$	
		\$BN05B	5	LAYOUT	\$DN5102\$		

#### **APPENDIX B**

# **B-S27**: Run 1 (10-15 ft)





**<u>ROCK CORE PHOTOS</u>** 090069 XNA Access Road

Benton County, Arkansas

Job No. 19-118

#### **B-S28**: Run 1 (10-15 ft), Run 2 (15-20 ft)



#### **B-S28**: Run 5 (30-35 ft), Run 6 (35-40 ft)



9

8

10 11 12

1

2 3

0

1 2

3

Grubbs, Hoskyn,

**A UES Company** 

Barton & Wyatt, LLC

CONSULTING ENGINEERS

4 5

6 7

**ROCK CORE PHOTOS** 090069 XNA Access Road Benton County, Arkansas

4 5

6

7

Job No. 19-118

10 11

12 in.

2 ft

9

8

### **B-S29**: Run 1 (12-17 ft), Run 2 (17-22 ft)



**B-S29**: Run 3 (22-27 ft), Run 4 (27-32 ft)



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**<u>ROCK CORE PHOTOS</u>** 090069 XNA Access Road Benton County, Arkansas Job No. 19-118

#### **B-S29**: Run 3 (22-27 ft), Run 4 (27-32 ft)





**B-S29**: Run 9 (52-57 ft)

12

1

1

2

3

4

5

6 7

9

8

5 6 7

4

10 11



Grubbs, Hoskyn, Barton & Wyatt, LLC CONSULTING ENGINEERS A UES Company

0

1 2 3

**<u>ROCK CORE PHOTOS</u>** 090069 XNA Access Road Benton County, Arkansas Job No. 19-118

8

9

10

11

12 in.

2 ft

### **B-S30**: Run 1 (8-10 ft), Run 2 (10-15 ft), Run 3 (15-20 ft)



#### **B-S30**: Run 6 (30-35 ft), Run 7 (35-40 ft)



**Benton County, Arkansas** 

**A UES Company** 







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0

**<u>ROCK CORE PHOTOS</u>** 090069 XNA Access Road Benton County, Arkansas Job No. 19-118

2 ft

#### **B-S31**: Run 8 (39-44 ft), Run 9 (44-49 ft)



**A UES Company** 

### **B-S32**: Run 1 (13-14 ft), Run 2 (14-18 ft), Run 3 (18-23 ft)



**A UES Company** 

090069 XNA Access Road **Benton County, Arkansas** 

## **B-S33**: Run 1 (11-15 ft), Run 2 (15-20 ft), Run 3 (20-21 ft)





**<u>ROCK CORE PHOTOS</u>** 090069 XNA Access Road

Benton County, Arkansas

Job No. 19-118

#### **B-S34**: Run 1 (15-20 ft), Run 2 (20-25 ft)



### **B-S34**: Run 5 (35-40 ft), Run 6 (40-45 ft)



**A UES Company** 

**Benton County, Arkansas** 

## **B-S34**: Run 9 (55-59 ft)





# **ROCK CORE PHOTOS**

090069 XNA Access Road **Benton County, Arkansas**  Job No. 19-118

# **B-S35**: Run 1 (11-15 ft), Run 2 (15-20 ft)



#### **B-S35**: Run 5 (30-35 ft), Run 6 (35-40 ft)







# ROCK CORE PHOTOS

090069 XNA Access Road Benton County, Arkansas Job No. 19-118

### **B-S36**: Run 1 (8-10 ft), Run 2 (10-15 ft), Run 3 (15-18 ft)





## **B-S36**: Run 10 (48-53 ft), Run 11 (53-58 ft)





# ROCK CORE PHOTOS

090069 XNA Access Road Benton County, Arkansas Job No. 19-118

#### **B-S37**: Run 1 (8-13 ft), Run 2 (13-14 ft), Run 3 (14-18 ft)



#### **B-S37**: Run 6 (28-33 ft), Run 7 (33-38 ft)



**A UES Company** 

**Benton County, Arkansas** 





**<u>ROCK CORE PHOTOS</u>** 

Job No. 19-118

090069 XNA Access Road Benton County, Arkansas

#### **B-S38**: Run 1 (12-17 ft), Run 2 (17-20 ft)



#### **B-S38**: Run 4 (23-27.5 ft)





# **<u>ROCK CORE PHOTOS</u>**

090069 XNA Access Road Benton County, Arkansas Job No. 19-118

#### **APPENDIX C**

#### SUMMARY of CLASSIFICATION TEST RESULTS PROJECT: 090069 XNA Access Road

PROJECT: 090069 XNA Access Road LOCATION: Benton County, Arkansas GHBW JOB NUMBER: 19-118

BORING SAMPLE		WATER	ATTERBERG LIMITS			SIEVE ANALYSIS						USCS	AASHTO		
		CONTENT	LIQUID PLASTIC PLASTICITY			PERCENT PASSING									
110.	DEI III (II)	(%)	LIMIT	LIMIT	INDEX	2 in.	1 in.	3/4 in.	3/8 in.	#4	#10	#40	#200	CLA55.	CLASS.
S27	4.5-5.5	50	38	32	6					100			63	ML	A-4
S28	4.5-5.5	24	35	22	13					63			35	SC	A-2-6
S30	2.5-3.5	11	34	21	13					91			81	CL	A-6
S31	2.5-3.5	13	28	23	5					51			18	GM	A-1-b
S32	0.5-1.5	17	27	20	7					64			48	GM-GC	A-4
S32	4.5-5.5	13	25	21	4					58			22	GM-GC	A-1-b
S33	6.5-7.5	20	37	21	16					50			28	GC	A-2-6
S34	4.5-5.5	24	43	21	22	100	86	83	64	51	40	26	20	GC	A-2-7
S35	6.5-7.5	12				100	100	80	63	48	32	17	12	GP-GM	A-1-b
S36	4.5-5.5	30	34	24	10					58			24	GM	A-2-4
S37	0.5-1.5	13	29	25	4					43			15	GM	A-1-a
S38	0.5-1.5	25	37	26	11					98			90	ML	A-6





#### SUMMARY of COMPRESSION TEST RESULTS

PROJECT: 090069 XNA Access Road LOCATION: Benton County, Arkansas GHBW JOB NUMBER: 19-118

BORING	SAMPLE	TOTAL UNIT	COMPRESSIVE	DESCRIPTION
No.	DEPTH (ft)	WEIGHT (pcf)	STRENGTH (psi)	DESCRIPTION
S29	15.5-16		7,420	Light gray cherty LIMESTONE
S29	24.5-25	147	10,740	Light gray cherty LIMESTONE
S29	30-30.5	152	3,040	Light gray cherty LIMESTONE
S29	39.5-40	152	10,630	Light gray cherty LIMESTONE
S29	45.5-46	155	7,170	Light gray cherty LIMESTONE
S31	21-21.5	155	10,940	Gray and tan cherty LIMESTONE
S31	29.5-30	152	7,320	Gray and tan cherty LIMESTONE
S31	40-40.5	150	9,010	Gray and tan cherty LIMESTONE
S32	15.5-16	161	9,240	Gray cherty LIMESTONE
S34	21-21.5	156	8,200	Gray cherty LIMESTONE
S34	21.5-22	154	4,810	Gray cherty LIMESTONE
S34	42.5-43	156	6,970	Gray cherty LIMESTONE
S34	51-51.5	160	6,220	Gray cherty LIMESTONE
S36	28-28.5	154	8,090	Light gray w/ gray cherty LIMESTONE
S36	33.5-34	151	7,190	Light gray w/ gray cherty LIMESTONE
S36	39.5-40	147	3,310	Light gray w/ gray cherty LIMESTONE
S36	44.5-45	157	8,120	Light gray w/ gray cherty LIMESTONE
S36	50.5-51	149	7,710	Light gray w/ gray cherty LIMESTONE
S37	22-22.5	150	10,930	Gray and tan cherty LIMESTONE
S37	25.5-26	149	14,180	Gray and tan cherty LIMESTONE
S37	40.3-40.8		8,990	Gray and tan cherty LIMESTONE
S37	45-45.5	141	4,760	Gray and tan cherty LIMESTONE
S37	50.5-51	167	4,160	Gray and tan cherty LIMESTONE
S38	13-13.5	159	5,610	Gray cherty LIMESTONE

#### **APPENDIX D**


**APPENDIX E** 







2. Preboring and grouting required in moderately hard cherty limestone below El 1067 $\pm$ 







# **APPENDIX F**

# Summary of Stability Analysis Results ARDOT 090069 XNA Access Road over Little Osage Creek GHBW Job No. 19-118 Benton County, Arkansas

	Design Loading Condition	Calculated Minimum Factor of Safety
	End of Construction	1.35
South End Slope (Bent 1) (2H:1V)	Long Term	2.33
	Rapid Drawdown from El 1085 to El 1074	2.17
	Seismic ( $k_h = A_S/2 = 0.0245$ )	1.24
	End of Construction	3.55
South Side Slope (Bent 1)	Long Term	3.22
(3H:1V)	Rapid Drawdown from El 1085 to Existing Grade	3.01
	Seismic ( $k_h = A_S/2 = 0.0245$ )	2.80
	End of Construction	2.70
North End Slope (Bent 4)	Long Term	2.39
(2H:1V)	Rapid Drawdown from El 1085 to El 1074	2.16
	Seismic ( $k_h = A_S/2 = 0.0245$ )	2.39
	End of Construction	3.17
North Side Slope (Bent 4) (3H:1V)	Long Term	2.96
	Rapid Drawdown from El 1085 to Existing Grade	2.62
	Seismic ( $k_h = A_S/2 = 0.0245$ )	2.90





Results of Stability Analyses – End of Construction Bent 1 End Slope 2H:1V Slope, H=28 ft ± 19-118 – ARDOT 090069 XNA Access Road over Little Osage Creek





Results of Stability Analyses – Long Term Condition Bent 1 End Slope 2H:1V Slope, H=28 ft ± 19-118 – ARDOT 090069 XNA Access Road over Little Osage Creek





Results of Stability Analyses – Rapid Drawdown Condition from El 1085 to El 1074 Bent 1 End Slope 2H:1V Slope, H=28 ft ± 19-118 – ARDOT 090069 XNA Access Road over Little Osage Creek





 $\begin{array}{c} \mbox{Results of Stability Analyses - Seismic Condition} (k_h = A_S \slashed{A_S} = 0.0245) \\ \mbox{Bent 1 End Slope} \\ \slashed{2H:1V Slope, H=28 ft $\pm$} \\ \mbox{19-118 - ARDOT 090069 XNA Access Road over Little Osage Creek} \\ \end{array}$ 





Results of Stability Analyses – End of Construction Bent 1 Side Slope 3H:1V Slope, H=28 ft ± 19-118 – ARDOT 090069 XNA Access Road over Little Osage Creek





Results of Stability Analyses – Long Term Condition Bent 1 Side Slope 3H:1V Slope, H=28 ft ± 19-118 – ARDOT 090069 XNA Access Road over Little Osage Creek





Results of Stability Analyses – Rapid Drawdown El 1085 to Existing Grade Bent 1 Side Slope 3H:1V Slope, H=28 ft ± 19-118 – ARDOT 090069 XNA Access Road over Little Osage Creek





 $\begin{array}{l} \mbox{Results of Stability Analyses - Seismic Condition} (k_h = A_S / 2 = 0.0245) \\ \mbox{Bent 1 Side Slope} \\ \mbox{3H:1V Slope, H=28 ft } \pm \\ \mbox{19-118 - ArDOT 090069 XNA Access Road over Little Osage Creek} \end{array}$ 





Results of Stability Analyses – End of Construction Bent 4 End Slope 2H:1V Slope, H=34 ft ± 19-118 – ARDOT 090069 XNA Access Road over Little Osage Creek





Results of Stability Analyses – Long Term Condition Bent 4 End Slope 2H:1V Slope, H=34 ft ± 19-118 – ARDOT 090069 XNA Access Road over Little Osage Creek







Results of Stability Analyses – Rapid Drawdown Condition, El 1085 to El 1074 Bent 4 End Slope 2H:1V Slope, H=34 ft ± 19-118 – ARDOT 090069 XNA Access Road over Little Osage Creek





 $\begin{array}{l} \mbox{Results of Stability Analyses - Seismic Condition (k_h = A_S / 2 = 0.0245) \\ \mbox{Bent 4 End Slope} \\ \mbox{2H:1V Slope, H=34 ft } \pm \\ \mbox{19-118 - ArDOT 090069 XNA Access Road over Little Osage Creek} \end{array}$ 





Results of Stability Analyses – End of Construction Bent 4 Side Slope 3H:1V Slope, H=34 ft ± 19-118 – ARDOT 090069 XNA Access Road over Little Osage Creek





Results of Stability Analyses – Long Term Condition Bent 4 Side Slope 3H:1V Slope, H=34 ft ± 19-118 – ARDOT 090069 XNA Access Road over Little Osage Creek





Results of Stability Analyses – Rapid Drawdown Condition, El 1085 to Existing Grade Bent 4 Side Slope 3H:1V Slope, H=34 ft ± 19-118 – ARDOT 090069 XNA Access Road over Little Osage Creek





 $\begin{array}{l} \mbox{Results of Stability Analyses - Seismic Condition} (k_h = A_S / 2 = 0.0245) \\ \mbox{Bent 4 Side Slope} \\ \mbox{3H:1V Slope, H=34 ft } \pm \\ \mbox{19-118 - ArDOT 090069 XNA Access Road over Little Osage Creek} \end{array}$ 



APPENDIX G

# EXAMPLE SPECIAL PROVISION SHOT ROCK FILL JOB 090069

# SHOT ROCK FILL

**Description**: Shot rock shall be highly durable and sound stone such as limestone, dolostone, sandstone, or other inorganic material acceptable to the Engineer. Shale and soft weathered rock shall not be used. All rocks shall be of an angular shape having dimensions similar to that which exists after final blasting at the quarry site and prior to crushing. Typically, neither the width nor thickness of any piece of stone shall be less than one-third  $(\frac{1}{3})$  of the length.

The shot rock shall consist of a well-graded mixture of nominal 3 in. to 18 in. top size durable stone with less than 5 percent by weight passing the No. 200 size sieve. Use of particles finer than about 3 in. should be limited to what is required to fill voids in coarser materials. In general, rock fill borrow should have a maximum percent of wear not greater than 45 based on the Los Angeles Test (AASHTO T 96), a loss not greater than 12 percent when subjected to five (5) cycles of the Sodium Sulfate Soundness Test (AASHTO T 104), and an absorption rate less than 3 percent (AASHTO T 85) unless otherwise modified or accepted by the Engineer.

**Construction Methods**: If widely variable, the shot rock should be graded from coarse in the lower and outer embankment zones to fine in the inner zones and the top of the fill. In general, the lift thickness for rock fills should be limited to about 24 inches. Shot rock fill should be densified using a smooth steel-wheel vibratory roller or other suitable equipment. Shot rock fill must be continuously wetted as required to facilitate compaction/densification. If the surface of the shot rock fill at the subgrade elevation is irregular with exposed voids it should be sealed with a minimum 6 in. of crushed stone aggregate base (ARDOT Standard Specifications Section 303, Class 7) or approved alternate.

In order to evaluate rock fill density and placement methods, including determination of the number of roller passes required to adequately densify the shot rock fill, a test fill section should be utilized. The initial lift of shot rock may be constructed as a test fill. Typically a minimum 50-ft by 100-ft area will be adequate for a test fill, but this can be adjusted based on field conditions. Construction of the test fill should be monitored by the Engineer. Lift thickness must be accurately measured. In-place density of the compacted material can be assessed by observing settlement of the densified fill. Continuous passes of the vibratory roller must continue until no additional settlement of the fill is indicated.

The number of passes by the vibratory roller and lift settlement should be monitored during construction in order to confirm density of the rock fill. If the quality or gradation of the excavated rock fill (i.e., durable limestone, dolostone, or sandstone) changes during construction, additional test fills should be constructed and monitored to evaluate gradation and densification criteria of the variable material.

Acceptance shall be by visual inspection; a written explanation of the manufacturing process shall be provided if requested by the Engineer.

**Basis of Payment**: per ton of approved shot rock



Materials Testing Geotechnical Engineering Environmental Building Sciences & Safety Inspections & Code Compliance Virtual Design Consulting

June 2, 2023 Job No. 19-118

Garver LLC 4701 Northshore Dr North Little Rock, Arkansas 72118

Attn: Mr. Joel Skinner, P.E.

# RESULTS of GEOTECHNICAL INVESTIGATION ARDOT JOB 090069 XNA ACCESS ROAD BRIDGES A and B OVER HADEN ROAD BENTON COUNTY, ARKANSAS

# **INTRODUCTION**

This report provides the results of the geotechnical investigation performed for the XNA Access Road over Haden Road Bridges A and B in Benton County, Arkansas. This project is one facet of the Job 090069 Northwest Arkansas Regional Airport Access (Benton Co) (F). This geotechnical investigation was authorized by the Garver, LCC Subconsultant Agreement for Task Order No. 061 on August 27, 2019. Notice to proceed with the field studies was received on August 30, 2019. Preliminary boring logs were submitted on May 7, 2022.

We understand the new bridges at Haden Road will be continuous W-beam structures with four (4) bents, three (3) spans, and total lengths of approximately 228.5 feet each. We also understand that a foundation system consisting of steel H-piles is planned. Foundation loads of the new bridges are anticipated to be moderate. Simple slopes will be utilized at the bridge ends with end slopes at approximate 2-horizontal to 1-vertical (2H:1V) configurations and side slopes at 3horizontal to 1-vertical (3H:1V) configurations. Preliminary bridge layouts are provided in Appendix A.

The purposes of this study were to explore subsurface conditions in the alignment of the twin bridges and to develop recommendations to guide design and construction of foundations. These purposes have been achieved by a multi-phased study that included the following.

- Drilling sample and core borings to evaluate subsurface conditions at the planned bridge locations and obtain samples of the subgrade and foundation soil and rock.
- Performing laboratory tests to evaluate pertinent engineering properties of the foundation and subgrade strata.
- Analyzing field and laboratory data to develop recommendations for seismic site class, seismic performance zone/seismic design category, foundation and subgrade support, slope stability, and construction considerations.

The relationship of these factors to design and construction of the new bridges has been considered in developing the recommendations and considerations discussed in the following report sections.

# SUBSURFACE EXPLORATION

Subsurface conditions at the Haden Road bridge location were investigated by drilling eight (8) sample and core borings to depths of 27 to 45 feet. The site vicinity is shown on Plate 1. The approximate boring locations are shown on the bridge layout drawing on Plate 2. The subsurface exploration program is summarized in Table 1 below.

Boring No.	Approx Sta	Approx Offset, ft	Approx Surf El, ft	Completion Depth, ft
S39	190+90	60 Lt	1106	33
S40	191+60	60 Lt	1109	32
S41	192+35	60 Lt	1114	27
S42	193+20	60 Lt	1126	45
S43	191+60	60 Rt	1106	30
S44	192+35	60 Rt	1110	33
S45	193+05	60 Rt	1117	43
S46	193+90	60 Rt	1134	33

**Table 1: Summary of Exploration Program** 

The boring logs, presenting descriptions of the soil and rock strata encountered in the borings and the results of the field and laboratory tests, are included as Plates 3 through 12. The centerline station and offset of the boring locations and approximate ground surface elevation, as inferred from the topographic information provided by the Engineer (Garver, LLC) or as inferred from available topographic information, are also shown on the logs. It must be recognized that the surface elevations shown are <u>approximate</u> and actual elevations may vary. Keys to the terms and symbols used on the logs are presented as Plates 13 and 14.

The borings were drilled with a track-mounted CME 850X rotary-drilling rig using a combination of dry-auger and rotary-wash drilling methods. Samples were typically obtained at 2-ft intervals to 10-ft depth and at 5-ft intervals thereafter. Samples were recovered using a 2-in.-diameter split-barrel sampler driven into the strata by blows of a 140-lb automatic hammer with 30-in. drop in accordance with Standard Penetration Test (SPT) procedures. The number of blows required to drive the standard split-barrel sampler the final 12 in. of an 18-in. total drive, or a portion thereof, is defined as the Standard Penetration Number (N). Recorded N-values are shown on the boring logs in the "Blows Per Ft" column.

Representative samples of the cherty limestone bedrock were obtained using a 5-ft-long NQ<sub>WL</sub>-size double-tube core barrel with a diamond bit. For each core run, the percent recovery was determined as the ratio of recovery to total length of core run. Rock Quality Designation (RQD) was also determined for the core run as the sum of intact, sound rock core greater than 4-in. length divided by the total length of the run and expressed in percent. Both these values are presented in the right-hand columns of the log forms, opposite the corresponding core run. Photographs of the recovered rock cores are provided in Appendix B.

All samples were removed from sampling tools in the field, examined and visually classified by the field geologist. Samples were then placed in appropriate containers to prevent moisture loss and/or change in condition during transfer to our laboratory for further examination and testing.

The borings were advanced using dry-auger procedures to the extent possible to facilitate evaluation of shallow groundwater conditions. Observations regarding groundwater levels are noted in the lower-right portion of each log and are discussed in subsequent sections of this report. All boreholes were backfilled after obtaining the final water level readings.

# **LABORATORY TESTING**

Laboratory testing was performed to evaluate subgrade and foundation plasticity and to confirm visual classification. The testing program included natural water content determinations (AASHTO T 265), liquid and plastic (Atterberg) limit determinations (AASHTO T 89 and T 90), and sieve analyses through the No. 200 sieve (AASHTO T 88). Soil shear strength was estimated in the field using SPT results.

A total of 54 natural water content determinations were performed to develop information on *in-situ* soil water content for each boring. Water content results are plotted on the boring log forms in accordance with the scale and symbols shown in the legend located in the upper-right corner of the logs.

To verify field classification and to evaluate soil plasticity, 14 liquid and plastic limit (Atterberg limits) determinations and 14 sieve analyses were performed on selected representative samples. The Atterberg limits are plotted on the logs as pluses inter-connected with a dashed line using the water content scale. The percentage of soil passing through the No. 200 Sieve is noted in the "- No. 200 %" column on the appropriate log forms. Classification test results, along with soil classification by the Unified Soil Classification System and AASHTO designations, are summarized in Appendix C. Grain-size distribution curves are also included in Appendix C.

Unconfined compressive strength of representative core samples of the cherty limestone bedrock was evaluated by compression tests. Results of the laboratory compression tests are shown in lbs per sq in. at the appropriate depth on the boring logs. The total unit weight of intact cores was also measured and these data are also shown on the logs.

#### **GENERAL SITE and SUBSURFACE CONDITIONS**

#### Site Conditions

The alignment of the XNA Access Road extends northwest to southeast. The Haden Road bridges will cross the existing Haden Road alignment approximately 2100 ft southeast of the intersection of Haden Road and Holmes Road. The site locale is a mixture of open agricultural land and occasional trees. Woodlands are present to the northwest. Some scattered houses are present near the bridge location. The site terrain rises steeply to the west of Haden Road. South of Haden Road, the slopes flattens but continues to slope gently to the southeast. Surface drainage is considered good. Site Geology

The project alignment is located in the mapped exposure of the Boone Formation. The early and middle Mississippian Period Boone consists of fine- to coarse-grained limestone interbedded with chert. The chert content can vary widely, both horizontally and vertically, and limestone or chert may be predominant. The Boone Formation is known for dissolutional features such as sinkholes, caves, and enlarged fissures. Typically, the limestone/cherty limestone units of the Boone decompose (weather) to erratic blends of chert fragments and clay/silty clay. The residual soil mantle may extend to significant depths on higher terrain and may contain hard chert seams and/or layers. The thickness of the Boone Formation is reported to be 300 to 350 ft in

northern Arkansas. The Boone is generally disconformable to the underlying Chattanooga Shale and St. Joe Limestone member, with some areas having a conformable contact. Seismic Conditions

In light of the results of the borings, a Seismic Site Class C (very dense soil and soft rock profile) is considered applicable for the site with respect to the criteria of the <u>AASHTO LRFD</u> Bridge Design Specifications Seventh Edition 2014<sup>1</sup>.

Given the location and AASHTO code-based values, the 1.0-sec period spectral acceleration coefficient for Site Class C (S<sub>1</sub>) is 0.051 and the 1.0-sec period spectral acceleration coefficient (S<sub>D1</sub>) value for Site Class C is 0.086. Utilizing these parameters, Table  $3.10.6-1^2$  indicates that a <u>Seismic Performance Zone 1</u> is fitting for the Haden Road bridge site. In reference to the 2011 edition of the AASHTO Guide Specifications, the Peak Ground Acceleration (PGA) having a 7 percent chance of exceedance in 75 years (or mean return period of approximately 1000 years) is predicted to be 0.049 for a Seismic Site Class C for the bridge location. The liquefaction potential is considered low for the predominantly cohesive overburden soils and underlying rock units encountered in the borings drilled for this study.

# Subsurface Conditions

The results of the borings indicate that the subgrade soils in the new bridge alignments typically consist of natural very soft to very stiff brown, reddish brown, tan, reddish tan, and gray clay, silty clay and fine sandy clay with variable, but generally numerous chert fragments to 18- to 27-ft. The subgrade soils typically classify as A-2-4, A-4, A-6, and A-7-6 by the AASHTO classification system. A surficial layer of very soft to soft brown clayey silt is locally present to 2 feet. In general, the natural surface and near-surface soils are relatively strong and will provide fair to good subgrade support for pavement structures. However, some areas will warrant localized undercut for subgrade preparation.

The overburden soils are underlain by moderately hard to very hard light gray cherty limestone. The limestone is flat-bedded with healed fractures. The core sample recovery ranges from 77 to 100 percent and the core sample RQD ranges from 28 to 95 percent in this stratum. The cherty limestone exhibits high strength with laboratory compressive strength values ranging from 3230 to 17,250 lbs per sq inch.

<sup>&</sup>lt;sup>1</sup> <u>AASHTO LRFD Bridge Design Specifications</u>, 7th Edition; AASHTO; 2014

<sup>&</sup>lt;sup>2</sup> AASHTO LRFD Bridge Design Specification, AASHTO; 2012

To aid in visualizing subsurface conditions in the bridge alignment, generalized subsurface profiles are provided in Appendix D. It should be recognized that the stratigraphy illustrated by the profiles has been inferred between discrete boring locations. In view of the natural variations in stratigraphy and subsurface conditions, variations from the stratigraphy illustrated by the profiles should be anticipated. Additionally, the natural transition between strata is generally gradual, and the stratigraphy shown on the profile may vary.

#### Groundwater Conditions

Groundwater was encountered at variable depths ranging from 13.8 ft to 27 ft in April 2022. It has been our experience in the area that localized shallow perched groundwater can be present in the silty overburden soils and fractured zones of the cherty limestone. Groundwater levels will vary, depending on seasonal precipitation, surface runoff and infiltration, and water levels in nearby drainage features.

# **ANALYSES and RECOMMENDATIONS**

#### Foundation Design

Foundations for the new bridges must satisfy two (2) basic and independent design criteria: a) foundations must have an acceptable factor of safety against bearing failure under maximum design loads, and b) foundation movement due to consolidation or swelling of the underlying strata should not exceed tolerable limits for the structures. Construction factors, such as installation of foundations, excavation procedures and surface and groundwater conditions, must also be considered.

Based on the results of the borings performed at the Haden Road bridge site and our understanding of the project, we recommend that foundation loads at the abutments and interior bents be supported on steel piling. Alternatively, the interior bents could be supported on drilled shaft foundations. Recommendations for steel piles are discussed in the following report sections. Recommendations for drilled shafts can be provided upon request.

# **Piling Foundations**

We recommend that the foundation loads of the bridges be supported on steel HP 12x53 or HP 14x73 piles. Other pile sizes or types may be evaluated if desired. Point-bearing steel piles driven to refusal should extend through any new embankment fill, the natural overburden soils, and any zones of highly weathered cherty limestone to develop safe bearing capacity in the competent moderately hard to hard limestone. End-bearing piles should be driven to practical refusal in the moderately hard to hard limestone. We recommend that all steel piles be fitted with rock points.

Steel piles driven to refusal should be designed for the structural capacity of the pile, as per applicable AASHTO Load and Resistance Factor Design (LRFD) procedures<sup>3</sup>. An effective resistance factor ( $\varphi_c$ ) of 0.50 is recommended for structural determination of factored bearing capacities. This effective resistance factor for steel piles has been based on the assumption of severe driving conditions.

For determination of bearing capacities of steel piles driven to refusal we recommend that nominal (ultimate) resistance (P<sub>n</sub>) of HP piles be determined based on the yield strength of steel H piles ( $f_y$ ) and the net end area (A<sub>net</sub>) of the section. It has been our experience that allowable pile capacities of 96 tons for HP12x53 piles and 133 tons for HP14x73 piles are typical for  $f_y = 50$  ksi steel pile sections. These capacities are based on allowable stress design (ASD). However, the appropriate factored bearing capacity should be confirmed by the Engineer. Post-construction settlement of piles driven to refusal will be negligible.

The nominal axial capacities are based on single, isolated foundations. Piles spaced closer than three (3) pile widths may develop lower individual capacity due to group effects. The potential for group capacity reductions should be evaluated for pile spacing closer than three (3) widths (center to center).

Estimated pile tip elevations are summarized below in Table 2.

Bridge	Bent No.	Estimated Pile Tip Elevation, ft	Comments
А	1 (South Bridge End)	1084	Refusal in moderately hard to hard cherty limestone
	2 (Approx Sta 191+61)	1087	Refusal in moderately hard to hard cherty limestone
	3 (Approx Sta 192+43)	1087	Refusal in moderately hard to hard cherty limestone
	4 (North Bridge End)	1096	Refusal in moderately hard to hard cherty limestone
В	1 (South Bridge End)	1088	Refusal in moderately hard to hard cherty limestone
	2 (Approx Sta 192+16)	1087	Refusal in moderately hard to hard cherty limestone

Estimated Tip Elevations of Steel Piles Driven to Refusal

<sup>&</sup>lt;sup>3</sup> Load and Resistance Factor Design (LRFD) for Highway Bridge Substructures, Publication No. FHWA HI-98-032, National Highway Institute, May 2001.

Bridge	Bent No.	Estimated Pile Tip Elevation, ft	Comments
В	3 (Approx Sta 192+98)	1089	Refusal in moderately hard to hard cherty limestone
	4 (North Bridge End)	1111	Refusal in moderately hard to hard cherty limestone

It should be noted that the tip elevations shown in the table above are <u>estimates</u> only based on the results of the relevant borings and the inferred surface elevations at the particular locations. Pile refusal and final depth must be field verified.

Nominal single pile uplift capacity curves for steel HP 14x73 piles are provided in Appendix E. Nominal axial pile capacities for uplift have been developed using static pile capacity formulae, the results of the borings, and the plan pile cap bottom elevations shown on the preliminary bridge layout drawings. We recommend that compression loads be designed for end-bearing alone based on piling driven to refusal, as recommended above.

Based on AASHTO LRFD geotechnical design procedures, a resistance factor ( $\varphi_{up}$ ) of 0.25 is recommended for evaluation of factored uplift capacity. This resistance factor is based on Strength Limit States. For Extreme Events Limit States such as earthquake loading and collision, a resistance factors of 0.8 for uplift is recommended.

Given the anticipated site grading including up to 43 ft of fill, downdrag loads from embankment settlement are anticipated. We recommend a minimum period of 45 days after completion of fill placement before pile driving. Alternatively, piling may be installed prior to the recommended 45 days if piles are pre-bored to the cherty limestone bearing stratum. Downdrag loads on piles constructed as recommended are expected to be negligible. Pre-boring is not expected to be required for pile installation other than installing pile casing.

We recommend a minimum pile penetration of 10 ft below natural grade unless practical refusal is encountered in the moderately hard limestone at shallower depth. We also recommend a minimum pile length of 10 feet.

Piles should be installed in compliance with Standard Specifications for Highway Construction, 2014 Edition, Section 805. However, we recommend a hammer delivering a minimum energy of 22,000 ft-lbs per blow. A specific review and analysis of the pile-hammer system proposed by the Contractor should be performed by the Engineer prior to hammer acceptance and start of driving. We recommend that all piles be fitted with rock points.

As a minimum, safe bearing capacity of piles should be determined by ARDOT Standard Specifications Section 805.09, Method A. Driving records should be available for review by the Engineer during pile installation. Blow counts on steel piles should be limited to about 20 blows per inch. Practical pile refusal may be defined as a penetration of 0.5 in. or less for the final 10 blows. Driving records should be available for review by the Engineer during pile installation. Embankment Slopes

The replacement bridges will include new slope configurations. Plan bridge end embankment configurations are 2-horizontal to 1-vertical (2H:1V) with 3-horizontal to 1-vertical (3H:1V) side slope configurations. The bridge end embankments will have maximum heights of about 42 feet.

To evaluate suitability of the end and side slope plan configurations, slope stability analyses have been performed. A 250 lbs per sq ft uniform surcharge from vehicles was included for the purposes of stability analyses. Stability analyses were performed using the computer program SLOPE/W 2020<sup>4</sup> and utilizing a Morgenstern-Price analysis. For the embankment slopes, three (3) general loading conditions were evaluated, i.e., End of Construction, Long Term, and Seismic Conditions For analysis of the seismic condition, a horizontal seismic acceleration coefficient (k<sub>h</sub>) of one-half the peak acceleration (A<sub>s</sub>) was used, a value of 0.0245.

Stability analyses results are summarized and presented graphically in Appendix F. The results of the stability analyses indicate that plan configurations of the embankment end and side slopes are acceptable with respect to stability of all loading conditions evaluated.

# Subgrade Support

The results of the borings indicate the on-site subgrade soils are somewhat variable, but generally consist of clay and silty clay with chert fragments (AASHTO A-2-4, A-4, A-6, and A-7-6). Given the anticipated new embankment, the approach roadway subgrade is likely to consist of embankment fill. Locally-available borrow, which is likely to be used as unclassified embankment fill, is expected to have similar classification.

We recommend that any soils classifying as A-7-6 and soils with a plasticity index (PI) in excess of 18, if encountered during the work, be excluded from use as subgrade within 18 in. of the plan subgrade elevation. The top 18 in. of subgrade soils should have a maximum plasticity index (PI) of 18. The as-built pavement subgrade should be evaluated by the Engineer. Areas of

<sup>&</sup>lt;sup>4</sup> <u>Slope/W 2020;</u> GEO-SLOPE International; 2020.

unstable or otherwise unsuitable subgrade should be improved by undercut and replacement or treatment with additives approved by the Engineer.

Based on the results of previous laboratory CBR tests on the silty clay with chert fragments subgrade and correlation with the AASHTO classification, we recommend the following parameters for use in design of pavements.

٠	CBR value:	8.3
•	Resilient Modulus (M <sub>R</sub> ):	3260 lbs per sq in.
٠	R value:	13
٠	Modulus of Subgrade Reaction (k):	100 lbs per cu in.

#### Site Grading and Subgrade Preparation

Site grading and site preparation twin bridge location should include necessary clearing and grubbing of trees and underbrush and stripping the organic-containing surface soils in work areas. Where fill depths in excess of 3 ft are planned, stumps may be left after close cutting trees to grade, as per ARDOT criteria. Otherwise, tree stumps must be completely excavated and stumpholes properly backfilled. The zone of organic surface soils should be completely stripped in the embankment footprint areas and at least 5 ft beyond the projected embankment toes. Particular care must be taken to muck out all saturated and/or organic-laden soils in the existing pond or existing drainage features.

Following stripping and grubbing, and prior to fill placement, the extent of weak and unsuitable soils should be determined. Thorough proof-rolling should be performed to verify subgrade stability. Proof-rolling should be performed with a loaded tandem-wheel dump truck or similar equipment. Unstable soils exhibiting a tendency to rut and/or pump should be undercut and replaced with suitable fill. Care should be taken that undercuts, stump holes, and other excavations or low areas resulting from subgrade preparation are properly backfilled with compacted fill.

Based on the results of the borings, the zone of weak surface soils is localized and extends to a depth of about 2 to 4 ft below existing grades, more or less, with some weak zones at depth. Undercuts may be backfilled with unclassified borrow used for embankment fill. Where the weak zone extends in excess of about 3 ft below existing grades, the undercut depth can typically be limited to 3 ft and undercuts backfilled with stone backfill (ARDOT Standard Specifications Section 207).

In lieu of undercutting and replacing unsuitable soils in roadway areas, consideration may be given to using additives to improve soil workability and to stabilize weak areas. Hydrated lime, quick lime, Portland cement, fly ash, or suitable alternate materials may be used as verified by appropriate
testing and approved by the Engineer. Additives can be effective where the depth of unstable soils is relatively shallow. Treatment will be less effective in areas where the zone of unstable soils is deep. The optimum application rate of stabilization additive must be determined by specific laboratory tests performed on the alignment subgrade soils. We recommend a minimum treatment depth of 8 inches.

Subgrade preparation and mass undercuts should extend at least 5 ft beyond the embankment toes to the extent possible. Subgrade preparation in roadway areas should extend at least 3 ft outside pavement shoulder edges to the extent possible.

Fill and backfill may consist of unclassified borrow free of organics and other deleterious materials as per ARDOT Standard Specifications Subsection 210.06. The top 18 in. of subgrade soils should have a maximum plasticity index (PI) of 18. Where A-7-5 or A-7-6 soils are encountered at the subgrade elevation, we recommend that these soils be undercut as required to provide at least 18 in. of low-plasticity subgrade soils, i.e., with a maximum PI of 18. Alternatively, stabilization additives may be utilized to develop a stable subgrade with a PI of 18 or less. Granular soils must be protected from erosion with a minimum 18-in.-thick armor of clayey soil.

Subgrade preparation should comply with ARDOT Standard Specifications Section 212. Embankments should be constructed in accordance with ARDOT criteria (ARDOT Standard Specifications Section 210). Fill and backfill should be placed in nominal 6- to 10-in.-thick loose lifts. All fill and backfill must be placed in horizontal lifts. Where fill is placed against existing slopes, short vertical cuts should be "notched" in the existing slope face to facilitate bonding of horizontal fill lifts. The in-place density and water content should be determined for each lift and should be tested to verify compliance with the specified density and water content prior to placement of subsequent lifts.

### **CONSTRUCTION CONSIDERATIONS**

## Groundwater and Seepage Control

Positive surface drainage should be established at the start of the work, be maintained during construction and following completion of the work to prevent surface water ponding and subsequent saturation of subgrade soils. Density and water content of all earthwork should be maintained until embankments, bridge work, and pavements are completed.

Groundwater was encountered between 13.8 to 27 ft in April 2022. Shallow perched groundwater may be encountered in the near-surface soils, particularly at lower elevations and during

times of high seepage flow. In addition, seasonal surface seeps or springs could develop as infiltrated surface water from areas of higher terrain migrate downgradient.

Seepage into excavations and cuts can typically be controlled by ditching or sump-andpump methods. If seepage infiltration cannot be controlled, construction of drains and/or the use of Select Granular Backfill (AASHTO M 43 No. 57), stone backfill (ARDOT Standard Specifications Section 207), or approved alternates to an elevation above the inflow of seepage will be warranted. In areas of seepage infiltration, the granular fill should be encapsulated with a filter fabric complying with ARDOT Standard Specifications Subsection 625.02, Type 2 and vented to positive discharge. Where surface seeps or springs are encountered during site grading, we recommend the seepage be directed via French drains or blanket drains to positive discharge at daylight or to storm drainage lines.

### **Piling**

Piles should be installed in compliance with ARDOT Standard Specifications, Section 805. Piles should be carefully examined prior to driving and piles with structural defects should be rejected. Any splices in steel piles should develop the full cross-sectional capacity of un-spliced piles. Pile installation should be monitored by qualified personnel to maintain specific and complete driving records and observe pile installation procedures. Safe bearing capacity of production piles should be determined by ARDOT Standard Specifications Section 805.09, Method A. Driving records should be available for review by the Engineer during pile installation. For driving steel piles on this project, we recommend a minimum hammer energy of 22,000 ft-lbs per blow. Blow counts on steel piles should be limited to about 20 blows per inch. Practical pile refusal may be defined as a penetration of 0.5 in. or less for the final 10 blows.

# **CLOSURE**

The Engineer or a designated representative thereof should monitor site preparation, grading work and foundation and pavement construction. Subsurface conditions significantly at variance with those encountered in the borings should be brought to the attention of the Geotechnical Engineer. The conclusions and recommendations of this report should then be reviewed in light of the new information.

### **GRUBBS, HOSKYN, BARTON & WYATT, LLC** Job No. 19-118 – XNA ACCESS ROAD BRIDGE OVER HADEN ROAD

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The following illustrations are attached and complete this final report.

	Plate 1	Site Vicinity
-	Plate 2	Plan of Borings
	Plates 3 through 12	Boring Logs
	Plates 13 and 14	Keys to Terms and Symbols
	Appendix A	Preliminary Bridge Layouts
	Appendix B	Rock Core Photographs
	Appendix C	Laboratory Test Results
	Appendix D	Generalized Subsurface Profiles
	Appendix E	Nominal HP 14x73 Pile Uplift Capacity Curves
	Appendix F	Stability Analyses Results

\* \* \* \*

We appreciate the opportunity to be of service to you on this project. Should you have any questions regarding this report, or if we may be of additional assistance, please call on us.

Sincerely,

# GRUBBS, HOSKYN, BARTON &WYATT, LLC

Velleta M. Scott, P.E. Sr. Project Engineer Mark E. Wyatt, P.E. President

VMS/MEW:jw

Copies Submitted: Garver I Attn: N

Garver LLCAttn:Mr. Joel Skinner, P.E.Attn:Mr. John H. Ruddell, P.E., S.E.Attn:Mr. Adam Wierciak, P.E.

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<u>SITE VICINITY MAP</u> 090069 XNA Access Road over Haden Road Benton County, Arkansas Job No. 19-118

Plate 1



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	Gru Barl <sub>Consul</sub>		s, Hoskyn, & Wyatt, Inc. <sub>Engineers</sub> LOGOF 090069 XNA A Ben	BO cces ton C	<b>RI</b> s Roa Co., Ai	<b>N G</b> ad ov rkans	<b>N (</b> er H sas	<b>D. S</b> aden	<b>39</b> Rd.							
	TYPE	:	HSA to 22 ft /Wash to 23 ft /Core		LOC	CATIC	N: A	pprox :	Sta 19	0+90,	60 ft Li	t				
		S		RFT	ТМТ				SION	, TON/	'SQ FT	-		%	Ž	
PTH, F	YMBOI	MPLE	DESCRIPTION OF MATERIAL	VS PEI	- DRY //CU F	0		0.4 (	).6 ( 	).8 1  TER	.0 1	.2 1.	4 	o. 200	Recove	RQD
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		X	Very soft to soft brown and reddish brown clay w/rootlets	4		1		20	30 4	<u>40 8</u>			0			
		 X	Soft brown, reddish brown and grav silty clay w/chert	5				+•		-				77		
- 5		X	fragments and nodules and ferrous stains	11												
			- with more chert fragments	07												
			below 6 ft Firm to stiff tan and brown silty	21				-								
- 10 -		X	clay w/some chert fragments and nodules	10			-	+	+					90		
			- stiff to very stiff below 13 ft - with numerous chert													
- 15 -		X	fragments at 13 to 18 ft	41			•									
		X	- with more clay and fewer chert fragments below 18 ft	13				•								
- 20 -																
		$\mathbf{T}$	<u>- HSA refusal at 22 ft</u>													
- 25			joints						q <sub>u</sub> =	4670 p	si, TU	W= 15	6 pcf			
			- chert seam at 24 it												97	87
		┨														
- 30 -															89	78
		Ħ													96	83
	<u>_+</u> - -	<b>I</b>			+			-+	+	+						
- 35																
	COMF DATE:	PLE 4	TION DEPTH: 33.0 ft -26-22	DE IN I	PTH T BORIN	O WA G: 19	TER 9.5 ft					DAT	ГЕ: 4/	26/2	022	)
· – – – – – – – – – – – – – – – – – – –																_

	Gru Barl <sup>Consul</sup>	bb tor	s, Hoskyn, <b>&amp; Wyatt, Inc.</b> Engineers Ben	B C acces ton C	<b>) R I</b> s Roa Co., A	<b>N G</b> ad ov rkans	NC er Ha as	<b>). S</b> aden	<b>40</b> Rd.							
	TYPE		HSA to 22 ft /Core		LO	CATIO	N: Ap	prox \$	Sta 19 <sup>.</sup>	1+60,	60 ft Lt	t				
				FT	Ţ			COHE	SION,	TON/	SQ FT	-		, v	/	
Ц Ц	BOL	PLES	DESCRIPTION OF MATERIAL	PER		0	.2 0	.4 0	0.6 0	.8 1	.0 1.	2 1	.4	200 %	cover	B
DEPT	SYN	SAM	SURE EL: 1109+	SMOJE	UNIT D LB/C	PL/ L	ASTIC IMIT <b>+</b>		WA CON	TER TENT		LIQU LIMI	ID T	- No.	% Rec	ж К
	XrX		Very soft brown clayey silt			1	0 2	20 3	30 4	0 5	6 <u>0</u>	0 7	0			
			w/rootlets and occasional	3					•							
		X	Very soft to soft tan and reddish tan clay w/trace fine	4				•								
- 5 -		$\mathbb{X}$	gravel // // // // // // // // // // // // //	8						<b> -</b>				36		
			silty clay w/fine sand, silt pockets, and chert fragments													
			Stiff raddich brown silty alay	0				-								
10		X	w/chert fragments and nodules	20			•									
				21										16		
- 15 -		Δ		21										40		
			- stiff to very stiff, less silty													
- 20 -		X	below 18 ft	50/6"				•								
		$\prod$	- HSA refusal at 22 ft /													
			cherty limestone, flat bedded, stylolitic ioints						q_= 8	770 p	si, TU	W= 16	5 pcf		98	83
25 -			- · <b>,</b> · - · · · · <b>,</b> - · · · ·													
	4 4															
															~~~	05
- 30 -															98	95
		1		<u> </u>				 			 					
- 35 -																
	COMF DATE	PLE : 4	TION DEPTH: 32.0 ft -27-22	DE IN I	PTH T BORIN	O WA <sup>:</sup> G: Dr	TER y to 2	2 ft				DAT	ΓE: 4/	27/2	022	<u>}</u>

	Gru Bar <sub>Consu</sub>	bb tor	s, Hoskyn, & Wyatt, Inc. <sub>Engineers</sub> LOGOF 090069 XNA A Ben	<b>B C</b> acces ton C	<b>R I</b> s Roa co., A	<b>N G</b> ad ove rkans	<b>N O</b> er Ha as	<b>). S</b> aden	<b>41</b> Rd.							
	TYPE		Auger to 27 ft /Wash to 30 ft /Core		LO		<u>N: A</u> p	prox \$	<u>Sta 19</u> 2	2 <u>+35</u> , (	<u>60 ft</u> Lt	t				
L				FT	۲۷.		(		SION	TON/	SQ FT	-		6	Y	
Ξ	1BOL	PLES	DESCRIPTION OF MATERIAL	PER		0.	2 0	.4 (	).6 O	.8 1. I	.0 1.	.2 1.	4	200 %	cover	gg
DEP'	SYN	SAM		SMO	LB/G	PLA LI	STIC		WA CON	TER TENT		LIQU LIMI	ID T	- No.	% Re	% ∃
	mr		SURF. EL: 1114±	B		1(	) 2	20 ;	30 4	0 5	06	0 7	0			
		A,	w/chert fragments and rootlets	6					•							
		X	slightly blocky w/chert fragments	13				•	<u> </u>					66		
- 5 -		X	- very stiff, silty below 4 ft	45			•									
		X	Very stiff reddish brown silty clay w/chert fragments	43			•	- +						55		
			- stiff with ferrous nodules and													
- 10 -		X	stains at 8 to 23 ft	24				•						-		
- 15 -		X		22												
- 20 -		X		22			●									
			- very stiff with numerous													
- 25 -		X	chert fragments below 23 ft	38			●									
		Z	<b>.</b>	25/0"												
		[ ]	- auger refusal in cherty limestone at 27 ft													
- 30 -			Hard light gray cherty													
E			limestone with stylolitic joints						_ 11	130	; <b>т</b> им	V- 161	Prof			
									₁u− । ı,	po ps	n, TUV	v- 102	- poi		87	80
- 35 -																
															100	93
40 -		Щ.		ļ	 											
Ŀ																
	-															
	DATE	'LE : 4	110N DEPTH: 40.0 ft -22-22	DE IN E	BORIN	0 WA G: 27	ER ft					DAT	ΓE: 3/	16/2	022	2

	Gru Bar <sub>Consu</sub>	bb tor	s, Hoskyn, & Wyatt, Inc. Engineers Ben	<b>B C</b> Acces Iton C	<b>) R I</b> s Roa Co., A	<b>N G</b> ad ov rkans	NC er Ha sas	<b>). S</b> aden	<b>42</b> Rd.							
	TYPE		HSA to 30 ft /Core		LO	CATIC	DN: Ap	oprox	Sta 1	93+20,	60 ft l	_t				
				FT	Ļ			COH	ESION		/SQ F	Т				
Е Н	BOL	PLES		PER	RY V U FT	0	.2 (	).4 I	0.6	0.8	1.0	1.2 1	.4	200 %	sovery	B
DEPT	SYM	SAMF	SUBE EL: 1126+	SNOUS	UNIT D LB/C	PL/ L	ASTIC IMIT		W CO	ATER NTENT		Liqu Lim	JID IT	- No.	% Rec	ж К
		$\downarrow$	Stiff brown silty clay w/rootlets			1	0	20	30	40	50	60 7	70			
		Х	and cherty limestone fragments	14				•								
		X	Stiff light brown silty clay w/numerous chert and	21				•	+					36		
			limestone fragments					Ī								
- 5 -		X	ft	27				•						_		
		X	Stiff reddish brown clay	23				•								
			limestone fragments	20												
		X		21				+•				₋⊦₊		52		
- 10 -														_		
			- with discontinuous chert													
		Χ	seams below 13 ft	50/4"			•									
- 15 -																
														_		
			Stiff to very stiff tan and light gray silty clay w/numerous													
- 20 -		X	and chert seams and layers	27												
			limestone)													
			- soft to firm below 22 ft													
25 -		Д		5					-	_				_		
			- with discontinuous chert													
- 30 -		4		25/0"						_				+-		
			Moderately hard to hard light gray w/gray cherty limestone.													
			štylolitičjoints												85	28
		    F	TION DEPTH: 45.0 ft		 РТН Т		 TFR									
	DATE	4	-20-22	INE	BORIN	IG: DI	ry to 3	60 ft				DA	TE: 4	/20/2	022	2

	Gru Bar Consu	bb tor	s, Hoskyn, A & Wyatt, Inc. Engineers Ben	<b>BO</b> acces ton C	<b>) R I</b> s Roa Co., A	<b>N G</b> ad ov rkans	N C er Ha as	<b>). S</b> aden	<b>42</b> Rd.							
	TYPE	:	HSA to 30 ft /Core		LO	CATIC	N: Ap	prox \$	Sta 193	3+20,	60 ft L	t				
		S		2 FT	₽×		(		SION,	TON/	'SQ F	Г		%	≥	
TH, F	MBOI	<b>NPLE</b>	DESCRIPTION OF MATERIAL	S PEI		0	.2 0	.4 (	).6 0	.8 1	.0 1	.2 1.	4	200	ecove	ВQ
DEF	S	SAN	(continued)	BLOW	UNIT LB/	PL/ L	ASTIC IMIT <b>+</b>		WA CON	TER TENT		LIQU LIMI 	ID T	- No	% 8	%
- 40 - - 45 - - 50 - - 55 - - 60 - - 60 - - 65 -			- moderately hard to hard light gray w/gray cherty limestone, stylolitic joints												98	
RECRODN200-2	COMF DATE	PLE : 4	TION DEPTH: 45.0 ft -20-22	DE IN E	PTH T BORIN	O WA G: Dr	TER y to 30	O ft				DAT	Ē: 4/	20/2	022	

	Gru Bar	bb tor	s, Hoskyn, & Wyatt, Inc. Engineers	B O acces	<b>RI</b> s Roa	N G ad ov	N ( er H	<b>D. S</b> aden	<b>43</b> Rd.							
	TYPF		Ben HSA to 20 ft /Core	ton C	0., A	rkans	as N·Δ	nnroy	Sta 10	1+60	60 ft R	t				
				F			<u>'N. A</u>	COHI		TON/	SO FT					
ᄂ	_	ល		L L L L L	×⊢	0	2	04	(		<u> </u>	<b>2</b> 1	٨	%	ery	
Ξ	ABO	ЪГЕ I	DESCRIPTION OF MATERIAL	L L L	NRV CU F	0	.∠	0.4	0.0 C	1.0 I	.0 1.	2 1	.4	200	COVE	l D D
DEP	SYN	SAN		LOWS	LB/	PL/ L	ASTIC IMIT	; 	WA CON	TER TENT		LIQU LIMI	ID T	- No.	% Re	%
			SURF. EL: 1106±			1	0	20	30 4	10 <u>5</u>	60 6	0 7	0			
		X	silty clay w/trace fine gravel	13					•							
			and ferrous stains													
		X	- very sum to mm at 2 to 4 it	26				<b>+</b> +-		+				58		
			- stiff, silty below 4 ft													
- 5 -		Х		17				<b>T</b>								
			Stiff brown, tan and reddish	16					<u> </u>					82		
		Δ	brown silty clay w/silt pockets											02		
			- with chert and limestone													
- 10 -		Х	fragments below 8 ft	23												
			- with discontinuous													
		X	chert seams and inclusions below 13 ft	50/7"			•									
- 15 -																
														-		
			Moderately hard to hard light	50/4"												
- 20 -			joints	50/1					-							
			- with rehealed high-angle													
			shear at 21 ft						$q_u = 8$	3260 p	si, TU	W= 16	1 pcf		98	82
			calcite-filled vugs at 22.5 to													
25 -	44		22.7 ft												_	
															100	
77.5															100	93
<u>5</u> -30-		₽₽		+					+							
и 18																
ECKUL	COMF DATE	'LE : 4	110N DEPTH: 30.0 ft -29-22	DEF In e	PTH T BORIN	0 WA G: 13	FER 8.8 ft					DA	ΓE: 4/	29/2	022	<u>}</u>

<b>—</b>	19-118															
		DDS, HOSKYN, On & Wyatt, Inc. ting Engineers	LOGOF 090069 XNA A Ben	BO acces ton C	s Roa co., A	<b>N G</b> ad ove rkans	N O er Ha as	<b>). S</b> á aden	<b>44</b> Rd.							
	TYPE	: Auger to 20 ft /Wasl	h to 23 ft /Core		LOC		N: Ap	prox S	Sta 193	2+35, (	60 ft R	t				
, FT	OL	В		ER FT	Y WT FT	0.	( 2 0		SION	, TON/	SQ FT	- .2 1.	.4	% 0	very	
DEPTH	SYMB		OF MATERIAL	LOWS F	UNIT DR LB/CU	PLA LI			WA CON	TER TENT			ID T	- No. 20	% Reco	% RC
		J SURF. EL: 1110. J Firm light brown	.0 clav w/rootlets	8	_	1	0 2	20 3	30 4	40 5	60 0	0 7	0			
		and occasional of fragments	chert	9				•								
		- firm to stiff belo - gray and red b	ow 2 ft elow 3 ft	10				•								
- 5 -		Stiff tan, reddish gray silty clay w/ fragments and fo	h brown and /chert errous nodules	12				•								
		and stains and s	6 to 13 ft	29				•								
- 10 -		X		27			●		++					49		
		- stiff below 13 f	t	11												
- 15 -																
		- with discontinu	OUS													
- 20 -		chert seams and layers below 18	d ft	25/0"												
25		Moderately hard	l to hard light stone, flat													
25		bedded, stylolitio	c joints						q_= 6	530 p	si, TU	W= 16	1 pcf		93	87
															100	50
- 30 -															90	50
		L								 						
- 35 -																
	COMP	LETION DEPTH: 33.0 5-10-22	) ft	DEI	) PTH T BORIN	0 WA <sup>-</sup> G: 14	TER						ΓF· 4/	29/2	022	,
		- · •				æ. it						2/1	//			-

	19-118	3														
	Gru Bar <sub>Consu</sub>	bb toi Iting	<b>bs, Hoskyn,</b> <b>h &amp; Wyatt, Inc.</b> <sup>J Engineers</sup> LOGOF 090069 XNA A Ber	<b>BO</b> Acces	<b>RI</b> s Roa co., A	<b>N G</b> ad ov rkans	NO er Ha as	<b>). S</b> aden	<b>45</b> Rd.							
	TYPE	Ξ:	Auger to 28 ft /Core		LO	CATIO	N: Ap	prox	Sta 19	3+05,	60 ft R	t				
F		S		RFT	WT F		(		SION	, TON/	SQ FT	-		%	ry	
νTH, F	MBOI	APLE	DESCRIPTION OF MATERIAL	S PEF		0.	.2 0	.4 (	).6 (	).8 1 I	.0 1	.2 1	.4	. 200	ecove	Rod
DEF	S	SAN		BLOW	UNIT LB/	PLA LI	ASTIC IMIT <b>+</b>		WA CON	TER TENT		LIQU LIM 	IID IT	- No	% R(	%
	111		Soft gravish brown clayey silt	6		1	0 2		30 4	40 <u>(</u>	50 6	0 7	0	13		
			Firm tan, gray and reddish					•						43		
			brown silty clay w/chert fragments	7												
- 5 -		X	Very stiff brown and reddish brown silty clay w/chert	44			•									
		X	and stains	50/7"												
		M	- with discontinuous chert seams and layers below 6.5 ft	50/10												
- 10 -				00/10												
				39				<b>.</b>	+					42		
- 15 -									•							
		X	Firm to stiff reddish brown	10				•								
- 20 -			fragments													
25		X	Very stiff reddish brown fine sandy clay w/numerous chert	50/7"			•									
25			fragments and chert seams and layers													
			limestone at 26 ft													
- 30 -			Hard light gray w/ gray cherty limestone, stylolitic						q <sub>u</sub> = 1	7,250	psi, TL	JW= 1	53 pcf			
			joints												77	49
- 35 -															-	
															78	50
					<u> </u> דע דר											
	DATE	: 4	-22-22	IN E	BORIN	G WA	ft					DA	TE: 3/	16/2	022	<u>}</u>

	19-11	3															
	Gru Bar <sub>Consu</sub>	bb: ton	s, Hoskyn, & Wyatt, Inc. Engineers	LOGOF 090069 XNA A Ber	BC Acces	<b>) R I</b> ss Roa Co., A	<b>N G</b> ad ov rkans	NC er Ha sas	<b>). S</b> é aden	<b>45</b> Rd.							
	TYPE	E: /	Auger to 28 ft /Core			LO	CATIO	N: Ap	oprox \$	Sta 19	3+05,	60 ft I	٦t				
					H-	F			COHE	SION	, TON	/SQ F	Т				
Ţ,	Ы	ы К			ERF	×F	0	.2 0	).4 (	).6 (	0.8	1.0	1.2 1	.4	% 00	very	Q
DEPTH	SYMB	SAMPI	DESCRIPTION O	F MATERIAL	OWS P	NIT DR LB/CU	PL/ L	ASTIC IMIT	1	WA CON			LIQU	JID IT	No. 20	6 Reco	% RG
			(continued)		BL	5	1	+	20 ;	+ 30	● 40	 50		• 70	1	0	
			- hard light gray cherty limestone	w/ gray												93	82
- 45 -																	
	-																
	-																
- 50 -	-																
	-																
	-																
- 55 -	-																
	-																
	-																
60	-																
- 00 -																	
	-																
- 65 -	-																
	-																
	-																
- 70 -	-																
77	-																
	-																
- 75 -	-																
	-																
	-																
	COMF DATE	PLE <sup>-</sup> : 4-	TION DEPTH: 43.01 22-22	ft	DE IN	PTH T BORIN	0 WA IG: 20	TER ) ft	_	_	_	_	DA	TE: 3/	16/2	022	)

	Gru Bar Consu	s bb tor Iting	s, Hoskyn, A & Wyatt, Inc. Engineers D90069 XNA A Ben	<b>BO</b> Acces ton C	9 <b>R I</b> s Roa Co., A	<b>N G</b> ad ov rkans	N O er Ha as	<b>). S</b> aden	<b>46</b> Rd.							
	TYPE	:	HSA to 23 ft /Core		LO		N: Ap	prox S	Sta 19:	3+90, (	60 ft R	t				
.H, FT	BOL	PLES	DESCRIPTION OF MATERIAL	PER FT	RY WT U FT	0.	( 2 0		SION,	TON/	SQ FT	- 2 1.	4	200 %	sovery	gD
DEPT	SYN	SAM		SNOUS	UNIT D LB/C	PL/ Ll	ASTIC MIT <b>+</b>		WA CON	TER TENT		Liqu Limi	ID T	- No. :	% Rec	ж К
		$\overline{\mathbf{A}}$	Stiff reddish brown and brown	21		1	0 2		<u>30 4</u>	10 5	6 6	0 7	0			
			fine sandy clay w/numerous chert and limestone fragments - very stiff at 2 to 8 ft	21			•									
- 5 -		X		50/6"										-		
		X	Euro Euro 0 4 40 ft	50/6"				•								
- 10 -		X	- firm from 8 to 13 ft	8			•	+ +	-					27		
- 15 -		X	- very stiff from 13 to 18 ft	50/5"				•								
- 20 -		X	- soft below 18 ft	5			•									
	$\mathcal{A}$	X		50/3"												
- 25 -			Moderately hard to hard gray w/tan cherty limestone, stylolitic joints - with close rehealed fractures below 24.5 ft						q <sub>u</sub> = 3	3230 p	si, TU	W= 16	2 pcf		100	68
- 30 -			- with high-angle shears at 26.5 to 26.7 ft and 27.7 and 28 ft												100	73
25				+	+		 		·	+						
	COMF DATE	_  PLE : 4·	TION DEPTH: 33.0 ft -28-22	DE IN E	L PTH T BORIN	O WA <sup>:</sup> G: Dr	TER y to 23	 3 ft				DAT	ΓE: 4/	28/2	022	<u></u>

Grubbs, Hoskyn, Barton & Wyatt, Inc. Consulting Engineers	SYMBOLS A	ND TERMS	USED ON	BORING L	OGS
SC (SHOWN IN C C Gravel Sand Predomina	DIL TYPES SYMBOLS COLUMN) Silt nt type shown heavy	Clay She Tu	SAMPLE SHOWN ON SA	ER TYPES MPLES COLUM Split No Spoon Recover	N) Cutting y
TERM COARSE GRAINED SO sands, and (2) silty or cla determined by laborator	S DESCRIBING ILS (major portion reta ayey gravels and sands y tests.	CONSISTENC ined on No. 200 si s. Condition is rate	Y OR CONE eve): Includes (I ed according to re	DITION ) Clean gravels a elative density, as	ind S
DESCRIPT VERY LOO LOOSE MEDIUM D DENSE VERY DEN FINE GRAINED SOILS silts and clays, (2) grav according to shearing s compression tests.	TIVE TERM SE ENSE SE (major portion passing relly, sandy, or silty clay strength, as indicated b	N-VALUE 0-4 4-10 10-30 30-50 50 and above g No. 200 sieve): I ys, and (3) clayey by penetrometer re	RELATIVE ( 1 3 6 6 8 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9	E DENSITY 0-15% 15-35% 35-65% 35-85% 35-100% ganic and organic y is rated confined	5
DESCRIP VEF SOF FIRI STIF VEF HAF NOTE: Slic strengths tha The consiste	TIVE TERM TSOFT T M FF SY STIFF RD kensided and fissured of n shown above, becau ncy ratings of such soil	Cl clays may have lo use of planes of we ls are based on pe	UNCON OMPRESSIVE TON/SO Less than 0. 0.25-0.50 0.50-1.00 1.00-2.00 2.00-4.00 4.00 and hig wer unconfined of eakness or crack	IFINED E STRENGTH Q. FT. .25 gher compressive as in the soil. lings.	1
TE SLICKENSIDED - ha FISSURED - contain or less LAMINATED - comp INTERBEDDED - co CALCAREOUS - con WELL GRADED - ha POORLY GRADED	ERMS CHARACTI aving inclined planes of ing shrinkage cracks, f s vertical. osed of thin layers of v imposed of alternate la ntaining appreciable qu aving a wide range in g particle sizes. - predominantly of one intermediate sizes m	ERIZING SOII f weakness that ar frequently filled with varying color and te yers of different so uantities of calcium rain sizes and sub grain size, or havin issing.	STRUCTUR re slick and gloss th fine sand or si exture. bil types. o carbonate. ostantial amounts ing a range of siz	RE sy in appearance It; usually more s of all intermedia zes with some	ite
Terms used on this repo are in accordance with Technical Memorandun	ort for describing soils a the UNIFIED SOIL CLA n No.3-357, Waterways	according to their f ASSIFICATION SY SExperiment Stati	exture or grain s ′STEM, as descr on, March 1953	ize distribution ibed in	

ſ	Grubbs, Hoskyn,	inc			
	Consulting Engineers	, п.с.	DORIN	G LUG IERM.	
	ROCK TYPES (SHOWN IN SYMBOLS COL	UMN) Sandstor	ne Limestone	Siltstone	Coal Shale
	Joint Characteristics —	<u>Spacing</u> Very Wide Wide Moderately Close Close Vary Close		Degree of Weathering –	Fresh – No visible signs of decomposition or discoloration. Rings under hammer impact.
	Bedding Characteristics —	Very Thin Thin Medium Thiok			discoloration inwards from open fractures, otherwise similar to fresh.
	Lithologic Characteristics —	Massive Clayey Shaly Calcareous (limy) Siliceous			throughout. Weaker minerals such as feldspar decomposed. Strength somewhat less than fresh rock, but cores cannot be broken by hand or scraped by knife. Texture preserved.
	Seam – Layer – Stratum –	Sandy Silty Plastic Seams 1/6 to 1/2 inch 1/2 to 12 inches Greater than 12 inches	Approximate Range of Unique		Highly Weathered — Most minerals somewhat decomposed. Specimens can be broken by hand with effort or shaved with knife. Core stones present in rock mass. Texture becoming indistinct but fabric preserved.
	Hardness and Degree of Cementation –	Very Soft – Can be peeled with a knife Soft – Can just be	Compressive <u>Strength (psi)</u> 140 – 3500		Completely Weathered — Minerals decomposed to soil but fabric and structure preserved (Saprolite). Specimens easily crumbled or penetrated.
		son – Can just be scraped with knife Hard – Can be broken with single moderate blow with pick	5300 - 6900 6900 - 13,900		Residual Soil — Advanced state of decomposition resulting in plastic soils. Rock fabric and structure completely destroyed. Large volume change.
		Very hard – Hand held specimen breaks with hammer end of pick under more than one blow Extremely Hard – Many	13,900 - 28,000	Solution and Void Conditions —	Solid, contains no voids Vuggy (pitted) Vesicular (igneous) Porous
		blows with hammer required to break intact specimen Poorly Cemented		Swelling Properties —	Cavernous Nonswelling Swelling
	Texture -	Cemented Dense		Properties –	Nonslaking Slakes slowly on exposure Slakes radiik on exposure
		Fine Medium Coarse		Rock Quality Designation (RQD) —	RQD (Percent) Diagnostic Description
	Structure —	Bedding Flat Gently Dipping Steeply Dipping Fractures, scattered Open Cemented or Tight Fractures, closely spaced Open			Greater than 90 Excellent 75 – 90 Good 50 – 75 Fair 25 – 50 Poor Less than 25 Very Poor
KEYROCK 5-22-07		Generated (Sheared and Frag Open Cemented or Tight Joints Faulted Slickensides	mented)		

APPENDIX A



BRIDGE ENGINEER

	DATE REVISED	DATE FILMED	DATE REVISED	DATE FILMED	FED. ROAD DIST. NO.	STATE	FED. AID PROJ. NO.	SHEET NO.	TOTAL SHEETS
					6	ARK.			
					JOB N	o <b>.</b>	090069 \$	SN6101	\$ \$ST\$
			0	\$BN06A\$		LAYOUT	\$[	DN6101\$	

(1) Point of Minimum Vertical Clearance



# VERTICAL CURVE DATA

XNA Access Rd. (Profile Grade 14' Right of CL Bridge A)

#### LAYOUT OF BRIDGE A XNA ACCESS RD. OVER HADEN RD. NORTHWEST ARKANSAS NATIONAL AIRPORT ACCESS (F) BENTON COUNTY ROUTE \$RT\$ SEC. \$SC\$ ARKANSAS STATE HIGHWAY COMMISSION

LITTLE ROCK, ARK.

PRELIMINARY NOT FOR CONSTRUCTION

CWT DATE: AUG. 2021 FILENAME: b090069a6\_L1.dgn DRAWN BY: CHECKED BY: JES DATE: SEPT. 2021 SCALE:  $1" = 20^{-0"}$ DESIGNED BY: CSW DATE: AUG. 2021 BRIDGE NO. **\$BN06A\$** DRAWING NO. \$DN6101\$



BRIDGE ENG

DATE REVISED	DATE FILMED	DATE REVISED	DATE FILMED	FED. ROAD DIST. NO.	STATE	FED. AID PROJ. NO.	SHEET NO.	TOTAL SHEETS
				6	ARK.			
				JOB NO.		090069 \$	SN6102	\$ \$ST\$
					\$	LAYOUT	\$[	DN6102\$

1 Point of Minimum Vertical Clearance



# VERTICAL CURVE DATA

XNA Access Rd. (Profile Grade 14' Left of CL Bridge B)

	LAYOUT OF BRIDGE B XNA ACCESS RD. OVER HADEN RD. NORTHWEST ARKANSAS NATIONAL AIRPORT ACCESS (F) BENTON COUNTY
RELIMINARY NOT FOR	ROUTE \$RT\$ SEC. \$SC\$ ARKANSAS STATE HIGHWAY COMMISSION LITTLE ROCK, ARK.
BRIDGE ENGINEER	DRAWN BY:         CWT         DATE:         AUG. 2021         FILENAME:         b090069b6_L1.dgn           CHECKED BY:         JES         DATE:         SEPT. 2021         SCALE:         1" = 20'-0"           DESIGNED BY:         CSW         DATE:         AUG. 2021         SCALE:         1" = 20'-0"           BRIDGE NO.         \$BN06B\$         DRAWING NO.         \$DN6102\$

# **APPENDIX B**



Boring S39 23 – 33 ft 19-118 090069 XNA Access Road over Haden Road





Boring S40 22 – 32 ft 19-118 090069 XNA Access Road over Haden Road





Boring S41 30 – 40 ft 19-118 090069 XNA Access Road over Haden Road





Boring S42 30 – 40 ft 19-118 090069 XNA Access Road over Haden Road





Boring S42 40 – 45 ft 19-118 090069 XNA Access Road over Haden Road





Boring S43 20 – 30 ft 19-118 090069 XNA Access Road over Haden Road





Boring S44 23 – 29 ft 19-118 090069 XNA Access Road over Haden Road





Boring S44 29 – 33 ft 19-118 090069 XNA Access Road over Haden Road





Boring S45 28 – 38 ft 19-118 090069 XNA Access Road over Haden Road





Boring S45 38 – 43 ft 19-118 090069 XNA Access Road over Haden Road





Boring S46 23 – 33 ft 19-118 090069 XNA Access Road over Haden Road



# **APPENDIX C**

# **SUMMARY of CLASSIFICATION TEST RESULTS** PROJECT: 090069 XNA Access Road Bridge over Haden Road

PROJECT: 090069 XNA Access Road Bridge over Haden Road LOCATION: Benton County, Arkansas GHBW JOB NUMBER: 19-118

DODING	CAMDI E	WATER ATTERBERG LIMITS					SIEVE ANALYSIS								
BURING	SAMPLE	CONTENT	LIQUID	PLASTIC	PLASTICITY	PERCENT PASSING								CLASS	AASHIU
110.	DEFTH (II)	(%)	LIMIT	LIMIT	INDEX	2 in.	1 in.	3/4 in.	3/8 in.	#4	#10	#40	#200	CLASS.	CLASS.
S39	2.5-3.5	26	38	22	16					100			77	CL	A-6
S39	9-10	22	32	19	13					98			90	CL	A-6
S40	4.5-5.5	23	40	22	18					92			36	SC	A-6
S40	14-15	17	36	15	21					62			46	GC	A-6
S41	2.5-3.5	21	38	21	17					78			66	CL	A-6
S41	6.5-7.5	17	27	18	9	100	100	92	79	72	66	59	55	CL	A-4
S42	2.5-3.5	20	29	20	9					60			36	GC	A-4
S42	9-10	25	63	21	42					72			52	CH	A-7-6
S43	2.5-3.5	20	42	23	19					94			58	CL	A-7-6
S43	6.5-7.5	21	39	18	21					97			82	CL	A-6
S44	9-10	16	34	18	16					79			49	SC	A-6
S45	0.5-1.5	25	37	28	9					54			43	GM	A-4
S45	14-15	20	32	21	11					63			42	GC	A-6
S46	9-10	17	29	23	6					58			27	GM	A-2-4



# **APPENDIX D**




**APPENDIX E** 









# **APPENDIX** F

## Summary of Stability Analysis Results 090069 XNA Access Road over Haden Road GHBW Job No. 19-118 Benton County, Arkansas

	Design Loading Condition	Calculated Minimum Factor of Safety
South End Slope Bent 1 (2H:1V)	End of Construction	2.2
	Long Term	2.0
	Seismic ( $k_h = A_s/2 = 0.0245$ )	2.0
South Side Slope Bent 1 (3H:1V)	End of Construction	2.4
	Long Term	2.3
	Seismic ( $k_h = A_s/2 = 0.0245$ )	2.2
	End of Construction	2.6
North End Slope Bent 4 (2H:1V)	Long Term	2.1
	Seismic ( $k_h = A_s/2 = 0.0245$ )	2.1
North End Side Slope Bent 4 (3H:1V)	End of Construction	4.9
	Long Term	3.3
	Seismic ( $k_h = A_S/2 = 0.0245$ )	3.2





Results of Stability Analyses – End of Construction Bent 1 South End Slope 2H:1V Slope, H=38 ft ± 19-118 - 090069 XNA Access Road over Haden Road





Results of Stability Analyses – Long Term Condition Bent 1 South End Slope 2H:1V Slope, H=38 ft ± 19-118 - 090069 XNA Access Road over Haden Road





 $\begin{array}{l} \mbox{Results of Stability Analyses - Seismic Condition} (k_h = A_S \ /2 = 0.0245) \\ \mbox{Bent 1 South End Slope} \\ \ 2H: 1V \ Slope, \ H = 38 \ ft \pm \\ 19\text{-}118 \ - \ 090069 \ XNA \ Access \ Road \ over \ Haden \ Road \\ \end{array}$ 





Results of Stability Analyses – End of Construction Bent 1 South Side Slope 3H:1V Slope, H=43 ft ± 19-118 - 090069 XNA Access Road over Haden Road





Results of Stability Analyses – Long Term Condition Bent 1 South Side Slope 3H:1V Slope, H=43 ft ± 19-118 - 090069 XNA Access Road over Haden Road





 $\begin{array}{l} \mbox{Results of Stability Analyses - Seismic Condition} (k_h = A_S \ /2 = 0.0245) \\ \mbox{Bent 1 South Side Slope} \\ \ 3H: 1V \ Slope, \ H=43 \ ft \pm \\ 19\text{-}118 \ - \ 090069 \ XNA \ Access \ Road \ over \ Haden \ Road \\ \end{array}$ 





Results of Stability Analyses – End of Construction Bent 4 North End Slope 2H:1V Slope, H=42 ft ± 19-118 - 090069 XNA Access Road over Haden Road





Results of Stability Analyses – Long Term Condition Bent 4 North End Slope 2H:1V Slope, H=42 ft ± 19-118 - 090069 XNA Access Road over Haden Road





 $\begin{array}{l} \mbox{Results of Stability Analyses - Seismic Condition} (k_h = A_S \ /2 = 0.0245) \\ \mbox{Bent 4 North End Slope} \\ \ 2H: 1V \ Slope, \ H = 42 \ ft \pm \\ 19\text{-}118 \ - \ 090069 \ XNA \ Access \ Road \ over \ Haden \ Road \end{array}$ 





Results of Stability Analyses – End of Construction Bent 4 North Side Slope 3H:1V Slope, H=28 ft ± 19-118 - 090069 XNA Access Road over Haden Road





Results of Stability Analyses – Long Term Condition Bent 4 North Side Slope 3H:1V Slope, H=28 ft ± 19-118 - 090069 XNA Access Road over Haden Road









Materials Testing Geotechnical Engineering Environmental Building Sciences & Safety Inspections & Code Compliance Virtual Design Consulting

September 26, 2023 Job No. 19-118

Garver LLC 4701 Northshore Drive North Little Rock, Arkansas 72118

Attn: Mr. Joel Skinner, P.E.

# RESULTS of GEOTECHNICAL INVESTIGATION ARDOT JOB 090069 XNA ACCESS ROAD OVER HOLMES ROAD BENTON COUNTY, ARKANSAS

# **INTRODUCTION**

This report provides the final results of the geotechnical investigation performed for the XNA Access Road over Holmes Road Bridges A and B in Benton County, Arkansas are provided in this report. The Holmes Road overpass is one facet of ARDOT Job 090069 Northwest Arkansas Regional Airport Access (Benton Co) (F). This geotechnical investigation was authorized by the Garver, LCC Subconsultant Agreement for Task Order No. 061 on August 27, 2019. Notice to proceed with the field studies was received on August 30, 2019. Results and recommendations have been provided throughout the course of this study. An interim report for the bridge was submitted on August 9, 2023, and a preliminary report for the MSE wall planned at the Holmes Road site was submitted on August 12, 2023.

We understand the new Holmes Road bridge will be a continuous plate girder structure with five (5) bents, four (4) spans, and a total length of approximately 323 feet. We also understand that a foundation system consisting of steel piles is planned for all bents. Foundation loads of the new bridge are anticipated to be moderate. The new Holmes Road bridges will include simple slopes with 2-horizontal to 1-vertical (2H:1V) and 3-horizontal to 1-vertical (3H:1V) configurations for the embankment ends and sides, respectively. A MSE retaining wall (Retaining Wall No. 1) is planned northwest of the proposed bridge alignment. Site grading is expected to include up to 60 ft of fill. Preliminary bridge and MSE wall layouts are provided in Appendix A.

The purposes of this study were to explore subsurface conditions in the bridge alignment and to develop recommendations to guide design and construction of foundations. These purposes have been achieved by a multi-phased study that included the following.

- Drilling sample and core borings at the planned bridge location to evaluate subsurface conditions and obtain samples of the subgrade and foundation soil and rock for laboratory testing.
- Performing laboratory tests to evaluate pertinent engineering properties of the foundation and subgrade strata.
- Analyzing field and laboratory data to develop recommendations for seismic site class, seismic performance zone/seismic design category, foundation and subgrade support, MSE walls, slope stability, site grading, and construction considerations.

The relationship of these factors to design and construction of the new bridge has been considered in developing the recommendations and considerations discussed in the following report sections.

# SUBSURFACE EXPLORATION

Subsurface conditions at the Holmes Road bridge location were investigated by drilling 13 sample and core borings to depths of 2.5 to 61 feet. The site vicinity is shown on Plate 1. The approximate bridge boring locations are shown on Plate 2 and MSE wall boring locations are shown on Plate 3. The subsurface exploration program is summarized in Table 1 below.

Boring No.	Approx Sta	Approx Offset, ft	Approx Surf El, ft	Completion Depth, ft
S47A	211+40	45 Lt	1219	2.5*
S47	211+40	40 Lt	1220	61
S48	212+35	55 Lt	1206	51.8
S49	213+50	50 Lt	1191	37
S51	214+80	55 Lt	1182	38.7
S52A	210+55	45 Rt	1229	9*
S52	210+55	50 Rt	1229	10*
S53	211+30	45 Rt	1223	30
S54	212+15	55 Rt	1210	47.4
S56	213+65	55 Rt	1208	42.5
W1	214+90	155 Lt	1182	32
W2	215+90	140 Lt	1201	25
W3	217+10	161 Lt	1214	25

 Table 1: Summary of Exploration Program

\*Note: Boring terminated at practical refusal in hard chert bed or cherty limestone.

The boring logs, presenting descriptions of the soil and rock strata encountered in the borings and the results of the field and laboratory tests, are included as Plates 4 through 17. The centerline station and offset of the boring locations and approximate ground surface elevation, as inferred from the topographic information provided by the Engineer (Garver, LLC) or as inferred from available topographic information, are also shown on the logs. It must be recognized that the surface elevations shown are <u>approximate</u> and actual elevations may vary. Keys to the terms and symbols used on the logs are presented as Plates 18 and 19.

The borings were drilled with a track-mounted CME 55 rotary-drilling rig and a truckmounted CME-55 rotary-drilling rig using a combination of dry-auger and rotary-wash drilling methods. Samples were typically obtained at 2-ft intervals to 10-ft depth and at 5-ft intervals thereafter. Samples were recovered using a 2-in.-diameter split-barrel sampler driven into the strata by blows of a 140-lb automatic hammer with 30-in. drop in accordance with Standard Penetration Test (SPT) procedures. The number of blows required to drive the standard split-barrel sampler the final 12 in. of an 18-in. total drive, or a portion thereof, is defined as the Standard Penetration Number (N). Recorded N-values are shown on the boring logs in the "Blows Per Ft" column.

Representative samples of the cherty limestone/limestone bedrock were obtained using a 5ft-long NQwL- or NQ2-size double-tube core barrel with a diamond bit. For each core run, the percent recovery was determined as the ratio of recovery to total length of core run. Rock Quality Designation (RQD) was also determined for the core run as the sum of intact, sound rock core greater than 4-in. length divided by the total length of the run and expressed in percent. Both these values are presented in the right-hand columns of the log forms, opposite the corresponding core run. Photographs of recovered rock cores are provided in Appendix B.

All samples were removed from sampling tools in the field, examined and visually classified by the field geologist. Samples were then placed in appropriate containers to prevent moisture loss and/or change in condition during transfer to our laboratory for further examination and testing.

The borings were advanced using dry-auger procedures to the extent possible to facilitate evaluation of shallow groundwater conditions. Observations regarding groundwater levels are noted in the lower-right portion of each log and are discussed in subsequent sections of this report. All boreholes were backfilled after obtaining the final water level readings.

## **LABORATORY TESTING**

Laboratory testing was performed to evaluate subgrade and foundation plasticity and to confirm visual classification. The testing program included natural water content determinations (AASHTO T 265), liquid and plastic (Atterberg) limit determinations (AASHTO T 89 and T 90), and sieve analyses through the No. 200 sieve (AASHTO T 88). Soil shear strength was estimated in the field using SPT results.

Natural water content determinations were performed to develop information on *in-situ* soil water content for the borings. Water content results are plotted on the boring log forms in accordance with the scale and symbols shown in the legend located in the upper-right corner of the logs.

To verify field classification and to evaluate soil plasticity, liquid and plastic limit (Atterberg limits) determinations and sieve analyses were performed on selected representative samples. The Atterberg limits are plotted on the logs as pluses inter-connected with a dashed line using the water content scale. The percentage of soil passing through the No. 200 Sieve is noted in the "- No. 200 %" column on the appropriate log forms.

A summary of classification test results and classification by the Unified Soil Classification System and AASHTO Classification System is presented in Appendix C. Grain-size distribution curves are also included in Appendix C.

## **GENERAL SITE and SUBSURFACE CONDITIONS**

#### Site Conditions

The overall alignment of the XNA Access Road extends from the Northwest Arkansas Regional Airport (XNA) about 4 miles southeast to the planned terminus at Highways 70 and 71. The Holmes bridge site crosses Holmes Road approximately 700 ft south of the intersection of Holmes Road and Haden Road. The site locale is presently open pasture land with some mature trees. A drainage ditch with thick underbrush is present in the center of the alignment. Agricultural buildings are located just south of the bridge alignment. The site terrain slopes moderately from the southeast to the northwest and steeply from the northeast to the northwest. Surface drainage is considered good overall, but poor in the area of the drainage feature.

#### Site Geology

The project alignment is located in the mapped exposure of the Boone Formation. The early and middle Mississippian Period Boone consists of fine- to coarse-grained limestone interbedded with chert. The chert content can vary widely, both horizontally and vertically, and limestone or chert may be predominant. The Boone Formation is known for dissolutional features such as sinkholes, caves, and enlarged fissures. Typically, the limestone/cherty limestone units of the Boone decompose (weather) to erratic blends of chert fragments and clay/silty clay. The residual soil mantle may extend to significant depths on higher terrain and may contain hard chert seams and/or layers. The thickness of the Boone Formation is reported to be 300 to 350 ft in northern Arkansas. The Boone is generally disconformable to the underlying Chattanooga Shale and St. Joe Limestone member, with some areas having a conformable contact.

## Seismic Conditions

In light of the results of the borings performed for the Holmes Road bridge, a Seismic Site Class C (very dense soil and soft rock) is considered applicable for the site with respect to the criteria of the <u>AASHTO LRFD Bridge Design Specifications Eighth Edition 2017<sup>1</sup></u>.

Given the location and AASHTO code-based values, the 1.0-sec period spectral acceleration coefficient for Site Class C (S<sub>1</sub>) is 0.049 and the 1.0-sec period spectral acceleration coefficient (S<sub>D1</sub>) value for Site Class C is 0.051. Utilizing these parameters, Table  $3.10.6-1^2$  indicates that a <u>Seismic Performance Zone 1</u> is fitting for the Holmes Road bridge site. In reference to the 2012 edition of the AASHTO Guide Specifications, the Peak Ground Acceleration (PGA) having a 7 percent chance of exceedance in 75 years (or mean return period of approximately 1000 years) is predicted to be 0.049 for a Seismic Site Class C for the bridge location. The liquefaction potential is considered low for the predominantly cohesive overburden soils and underlying rock units encountered in the borings drilled for this study.

## Subsurface Conditions

Based on the results of the borings, the subsurface stratigraphy may be generalized into four (4) primary strata as follows.

<u>Stratum I</u>: The Stratum I soils typically consist of firm to very stiff brown, dark brown, tan, and yellowish tan clayey silt and silty clay and loose to medium dense brown silt and fine sandy silt extending to 1 to 4 feet. This stratum has variable, but generally numerous chert fragments and organics. The silt/fine sandy silt, clayey silt, and silty clay exhibit low plasticity, moderate to high compressibility, and low shear strength. The low-plasticity and silty soils are moisture-sensitive and will lose considerable strength when saturated.

<sup>&</sup>lt;sup>1</sup> AASHTO LRFD Bridge Design Specifications, 8<sup>th</sup> Edition; AASHTO; 2017

<sup>&</sup>lt;sup>2</sup> <u>AASHTO LRFD Bridge Design Specification</u>, AASHTO; 2012

- Stratum II: Below the surficial silty soils is very soft to very stiff red, yellowish red, reddish brown, tan, and light gray clay, silty clay, and fine to coarse sandy clay with variable, but generally numerous chert fragments and low hardness tan, yellowish red, grayish brown, and light gray highly weathered chert and cherty limestone with silty clay seams to 9- to 51-ft depth. This stratum also contains variable amounts of limestone fragments and increasing chert seams and layers with depth. Medium dense brown, gray, and reddish brown fine to coarse clayey sand layers are locally present in this stratum. The subgrade soils typically classify as A-2-6, A-2-7, and A-6 by the AASHTO classification system. In general, the natural surface and near-surface soils are relatively strong and will provide fair to good subgrade support for pavement structures. However, some areas will warrant localized undercut for subgrade preparation.
- Stratum III: The overburden soils are underlain by low hardness to moderately hard gray and light gray highly weathered to fresh cherty limestone. The competence of the limestone increases with depth. The limestone is flat-bedded with healed fractures and some weathered chert seams. The core sample recovery ranges from 13 to 100 percent and the core sample RQD ranges from 0 to 92 percent in this stratum. These RQD values are indicative of variable poor to fair rock quality. Rock quality generally increases with depth.

To aid in visualizing subsurface conditions, generalized subsurface profiles are presented in Appendix D. It should be recognized that the stratigraphy illustrated by the profiles has been inferred between discrete boring locations. In view of the natural variations in stratigraphy and conditions, variations from the stratigraphy illustrated by the profiles should be anticipated. Additionally, the natural transition between strata is generally gradual, and the stratigraphy described in the sections above may vary.

## Groundwater Conditions

Groundwater was not encountered within the exploration range of the borings in March 2022 and January 2023. Perched water may be encountered in the fractured zones of the cherty limestone. Groundwater levels will vary, depending on seasonal precipitation, surface runoff and infiltration, and water levels in nearby drainage features.

## **ANALYSES and RECOMMENDATIONS**

#### Foundation Design

Foundations for the new bridge must satisfy two (2) basic and independent design criteria: a) foundations must have an acceptable factor of safety against bearing failure under maximum design loads, and b) foundation movement due to consolidation or swelling of the underlying strata should not exceed tolerable limits for the structures. Construction factors, such as installation of foundations, excavation procedures and surface and groundwater conditions, must also be considered.

Based on the results of the borings performed at the Holmes Road bridge site and our understanding of the project, we recommend that foundation loads at the abutments and interior bents be supported on steel piling. Recommendations for steel piles are discussed in the following report sections.

#### Pile Foundations

We recommend that the foundation loads of the twin bridges be supported on steel HP12x53 or HP14x73 piles. Other pile sizes or types may be evaluated if desired. Point-bearing steel piles driven to refusal should extend through any new embankment fill, the natural overburden soils, and any zones of highly weathered chert or cherty limestone to develop safe bearing capacity in the competent moderately hard limestone. End-bearing piles should be driven to practical refusal in the moderately hard cherty limestone. We recommend that all steel piles be fitted with rock points.

Steel piles driven to refusal should be designed for the structural capacity of the pile, as per applicable AASHTO Load and Resistance Factor Design (LRFD) procedures<sup>3</sup>. An effective resistance factor ( $\varphi_c$ ) of 0.50 is recommended for structural determination of factored bearing capacities. This effective resistance factor for steel piles has been based on the assumption of severe driving conditions.

For determination of bearing capacities of steel piles driven to refusal we recommend that nominal (ultimate) resistance (P<sub>n</sub>) of HP piles be determined based on the yield strength of steel H piles ( $f_y$ ) and the net end area (A<sub>net</sub>) of the section. It has been our experience that allowable pile capacities of 96 tons for HP12x53 piles and 133 tons for HP14x73 piles are typical for  $f_y = 50$  ksi steel pile sections. These capacities are based on allowable stress design (ASD). However, the appropriate factored bearing capacity should be confirmed by the Engineer. Post-construction settlement of piles driven to refusal will be negligible.

The nominal axial capacities are based on single, isolated foundations. Piles spaced closer than three (3) pile widths may develop lower individual capacity due to group effects. The potential

<sup>&</sup>lt;sup>3</sup> Load and Resistance Factor Design (LRFD) for Highway Bridge Substructures, Publication No. FHWA HI-98-032, National Highway Institute, May 2001.

#### **GRUBBS, HOSKYN, BARTON & WYATT, LLC** Job No. 19-118 – XNA ACCESS ROAD OVER HOLMES ROAD

for group capacity reductions should be evaluated for pile spacing closer than three (3) widths (center to center).

Estimated pile tip elevations are summarized in Table 1 below.

Bridge	Bent No.	Estimated Pile Tip Elevation, ft	Comments
А	1A (South Bridge End)	1169	Refusal in moderately hard cherty limestone
	2A	1167	Refusal in moderately hard weathered cherty limestone
	3A	1168	Refusal in moderately hard slightly weathered cherty limestone
	4A	1162	Refusal in moderately hard slightly weathered cherty limestone
	5A (North Bridge End)	1154	Refusal in moderately hard slightly weathered cherty limestone
В	1B (South Bridge End)	1219	Refusal in hard cherty limestone or chert
	2B	1212	Refusal in moderately hard weathered cherty limestone
	3B	1174	Refusal in moderately hard cherty limestone
	4B	1175	Refusal in moderately hard cherty limestone
	5B (North Bridge End)	1177	Refusal in moderately hard to hard cherty limestone

Table 1: Estimated Tip Elevations of Steel Piles Driven to Refusal

It should be noted that the tip elevations shown in the table above are <u>estimates</u> only based on the results of the relevant borings and the inferred surface elevations at the particular locations. Pile refusal and final depth must be field verified. Given the variable topography and depth to competent limestone, variation from these estimated tip elevations should be anticipated.

Some steel piles may be subjected to uplift loads. Nominal single pile uplift capacity curves for steel HP piles are provided in Appendix E. Where preboring is expected for pile installation, calculated uplift capacities are based upon a prebored section. Nominal axial pile uplift capacities have been developed using static pile capacity formulae, the results of the borings, and the plan pile cap elevations shown on the preliminary bridge layout drawings.

Based on AASHTO LRFD geotechnical design procedures, a resistance factor ( $\varphi_{up}$ ) of 0.25 is recommended for evaluation of factored uplift capacity. This resistance factor is based on

Strength Limit States. For Extreme Events Limit States such as earthquake loading and collision, a resistance factors of 0.8 for uplift is recommended.

Given the anticipated site grading on the north embankment, including up to 60 ft of fill, downdrag loads from settlement of embankment soils and the embankment foundation soils could occur. We recommend deferring pile driving for a minimum period of 45 days after completion of embankment fill placement. Alternatively, piling may be installed prior to the recommended waiting period if piles are pre-bored to the cherty limestone bearing stratum. Downdrag loads on piles constructed utilizing prebores are expected to be negligible.

We understand that the 45-day waiting period for embankment and foundation settlement may not be possible at Bent 4A due to the planned construction sequence. If fill is placed after pile installation at Bent 4A, downdrag loads of 26 tons have been calculated for an HP14x73 steel pile. Due to the lesser amount of fill at the southern embankment, with maximum fill heights of about 12 ft at Bent 1, a waiting period is not considered to be needed after embankment construction and before pile installation.

Pre-boring through more resistant chert layers may be required for pile installation. Following pile acceptance, the annulus around the installed piles in prebores should be expeditiously backfilled with grout as per ARDOT Standard Specifications Section 805. The grout should have a minimum compressive strength pf 4000 psi, as per ARDOT Section 501 or an alternate approved by the Engineer.

We recommend a minimum pile penetration of 10 ft below natural grade unless practical refusal is encountered in the moderately hard to hard cherty limestone at shallower depth. We also recommend a minimum pile length of 10 feet. Pre-boring is anticipated to develop minimum pile lengths of 10 ft for Bents 1B and 2B.

Piles should be installed in compliance with Standard Specifications for Highway Construction, 2014 Edition, Section 805. However, we recommend a hammer delivering a minimum energy of 22,000 ft-lbs per blow. A specific review and analysis of the pile-hammer system proposed by the Contractor should be performed by the Engineer prior to hammer acceptance and start of driving. We recommend that all piles be fitted with rock points.

As a minimum, safe bearing capacity of piles should be determined by ARDOT Standard Specifications Section 805.09, Method A. Driving records should be available for review by the Engineer during pile installation. Blow counts on steel piles should be limited to about 20 blows per inch. Practical pile refusal may be defined as a penetration of 0.5 in. or less for the final 10 blows. Driving records should be available for review by the Engineer during pile installation. MSE Walls

The project includes a mechanically stabilized earth (MSE) retaining wall to the northwest of the proposed bridge. Wall height varies from a nominal 5 ft to 18 ft, with the maximum height of the walls at the eastern section of the wall alignment (approximately Sta 1+70) and the height tapering out away on both ends. Design of MSE walls must include consideration of both internal and external stability. Design with respect to internal stability must be performed by the specific wall designer based on final plans and configurations. Analyses have been performed to verify external (global) stability and bearing capacity.

#### MSE Wall Bearing

The natural subgrade and foundation soils in the wall alignment generally consist of medium dense fine sandy silt with chert fragments, very soft to very stiff silty clay with numerous chert fragments, and low hardness highly weathered cherty limestone. These soils and weathered rock exhibit variable low to moderate shear strength and moderate to low compressibility. Depending on final grading plans, some undercut and replacement will be required to improve bearing capacity and to limit settlement. The wall north of approximately Sta 0+85 will be supported in embankment fill. Subgrade preparation, including undercut of unstable or otherwise unsuitable soils, should include the complete wall alignment, including areas where the wall is supported in embankment fill. All subgrade improvements should extend at least 5 ft outside wall face and reinforced zone limits.

MSE wall subgrade/foundation preparation and bearing recommendations are summarized below.

- 1. The leveling pad and reinforced zone should be embedded at least 2 ft below final grade. The embedded depth must be such that the embedment grade is equal to or below the elevation of the foreslope at a distance from the wall face which is equal to the width of the reinforced zone.
- 2. The wall subgrade/bearing stratum should be observed by the Engineer and thoroughly proof-rolled to verify stability and suitable bearing.
- 3. The results of the borings indicate that mass undercuts on the order of 2 ft, more or less, will likely be required to develop a stable subgrade. Depending on seasonal site conditions, deeper undercuts could be required in some areas. Undercuts should extend to the stiff to very stiff reddish brown silty clay or the low hardness pale red highly weathered limestone.

- 4. All undercuts should be backfilled with ARDOT Standard Specifications Section 303, Class 7 crushed stone aggregate base, or Select Granular Backfill (AASHTO M43 No. 57).
- 5. Nominal bearing on compacted undercut backfill over stiff to very stiff silty clay: 10.0 kips per sq ft
- 6. Resistance factor  $(\phi_b)$  for bearing resistance: 0.65
- 7. Nominal resistance to sliding: 0.35
- 8. Resistance factor for sliding resistance ( $\varphi_{\tau}$ ): 1.0

The MSE wall leveling pad and reinforced zones should bear as recommended above and at a minimum depth of 2 ft below lowest adjacent grade. A minimum wall reinforcement length of 0.7H or 8 ft, whichever is greater, is recommended. Subgrade and foundation preparation in the wall locations and under all embankments must include stripping all organics and thorough proof-rolling.

The suitability of the MSE wall bearing stratum must be field verified by the Engineer or Department at the time of construction. Where undercuts are warranted, these should extend a minimum horizontal distance determined by a 1-horizontal to 1 -vertical (1H:1V) projection or at least 5 ft, whichever is greater, beyond the reinforced zone to the undercut bottom.

Where seepage into undercuts is apparent or positive drainage cannot be assured, Select Granular Backfill should be used for backfill. The crushed stone should be fully encapsulated in a filter fabric geotextile complying with ARDOT Standard Specifications Subsection 625.02, Type 2. Granular backfill should be vented to positive discharge for the relief of infiltrated surface water and/or groundwater.

## MSE Wall Global Stability

Stability analyses were performed to verify global stability of the MSE wall. A 250 lbs per sq ft uniform surcharge from vehicles was included for the purposes of stability analyses. Stability analyses were performed using the computer program SLOPE/W  $2021^4$  and a Morgenstern-Price analysis. Three (3) general loading conditions were evaluated, i.e., End of Construction, Long Term, and Seismic Conditions. For analysis of the seismic condition, a horizontal seismic acceleration coefficient (k<sub>h</sub>) of one-half the peak acceleration (A<sub>s</sub>) was used, a value of 0.0245.

For the purposes of the stability analyses, unclassified embankment as per Standard Specifications for Highway Construction, 2014 Edition, Subsection 210.06 was assumed for

<sup>&</sup>lt;sup>4</sup> <u>Slope/W 2021;</u> GEOSLOPE Ltd.

embankment fill. Accordingly, an undrained shear strength value of 1500 lbs per sq ft has been assumed for the embankment fill. Depending on the specific borrow utilized for embankments, verification of stability could be warranted.

Stability analyses results for the MSE wall are summarized and presented graphically in Appendix F. The results of the stability analyses indicate that global stability of plan configurations of the MSE wall is acceptable with respect to stability of all loading conditions evaluated.

## Embankment Slopes

The project scope includes new embankments at each bridge end. Plan bridge end embankment configurations are 2-horizontal to 1-vertical (2H:1V) with 3-horizontal to 1-vertical (3H:1V) side slope configurations. The embankment heights are expected to be a maximum of 60 feet.

To evaluate suitability of the plan configurations, slope stability analyses have been performed. A 250 lbs per sq ft uniform surcharge from vehicles was included for the stability analyses. Stability analyses were performed using the computer program SLOPE/W 2021<sup>5</sup> and a Morgenstern-Price analysis. For the embankment slopes, three (3) general loading conditions were evaluated, i.e., End of Construction, Long Term, and Seismic. For analysis of the seismic condition, a horizontal seismic acceleration coefficient (k<sub>h</sub>) of one-half the peak acceleration (A<sub>s</sub>) was used, a value of 0.0245.

Stability analyses results are summarized and presented graphically in Appendix F. The results of the stability analyses indicate that plan configurations of the embankment end and side slopes are acceptable with respect to stability of all loading conditions evaluated.

## Subgrade Support

The results of the borings indicate the on-site subgrade soils generally consist of silt, clay and silty clay with chert fragments (AASHTO A-2-6 and A-2-7). Given the anticipated new embankment, the approach roadway subgrade is likely to consist of embankment fill. Locallyavailable borrow, which is likely to be used as unclassified embankment fill, is expected to have similar classification.

We recommend that any soils classifying as A-7-5 or A-7-6 soils be excluded from use as subgrade within 18 in. of the plan subgrade elevation. The top 18 in. of subgrade soils should have a maximum plasticity index (PI) of 18. The as-built pavement subgrade should be evaluated by the

<sup>&</sup>lt;sup>5</sup> <u>Slope/W 2021;</u> GEOSLOPE Ltd.

Engineer. Areas of unstable or otherwise unsuitable subgrade should be improved by undercut and replacement or treatment with additives approved by the Engineer.

Based on the results of previous laboratory CBR tests on the silty clay with chert fragments subgrade and correlation with the AASHTO classification, we recommend the following parameters for use in design of pavements.

٠	CBR:	8.3
•	Resilient Modulus (M <sub>R</sub> ):	3260 lbs per sq in.
٠	R value:	13
٠	Modulus of Subgrade Reaction (k):	100 lbs per cu in.

#### Site Grading and Subgrade Preparation

As noted, the silty surface soils are moisture-sensitive. Though presently stable, at elevated water contents the silt and clayey silt subgrade is likely to be soft and unstable. Consequently, <u>site</u> <u>grading operations will be significantly easier to perform during dry seasons of the year</u>.

Site preparation will require localized clearing and grubbing and stripping the zone of organic-containing soils. The depth of stripping will be variable, with deeper stripping depths in wooded areas, and less stripping required in open land. In general, the stripping depth is estimated to be about 6 to 9 inches in clear areas but may be 18 to 24 in. or more where trees and thick underbrush are present. The zone of organic surface soils should be completely stripped in the embankment footprint areas and at least 5 ft beyond the projected embankment toes and outside the reinforced zone of MSE walls. Particular care must be taken to muck out all saturated and/or organic-laden soils in the existing drainage feature.

Following stripping and prior to fill placement, the extent of weak and unsuitable soils should be determined. Thorough proof-rolling should be performed to verify subgrade stability. Proof-rolling should be performed with a loaded tandem-wheel dump truck or similar equipment. Unstable soils exhibiting a tendency to rut and/or pump should be undercut and replaced with suitable fill. Care should be taken that undercuts, stump holes, and other excavations or low areas resulting from subgrade preparation are properly backfilled with compacted fill.

Depending on seasonal conditions, undercuts of about 2 to 4 ft below existing grades, more or less, could be required. Deeper undercuts may be required in wet seasons. General undercuts for site grading may be backfilled with unclassified borrow used for embankment fill. Undercuts under MSE wall foundations should be backfilled with ARDOT Standard Specifications Section 303, Class 7 crushed stone aggregate base or Select Granular Backfill (AASHTO M43 No. 57).

In lieu of undercutting and replacing unsuitable soils in approach road alignments, consideration may be given to using additives to improve soil workability and to stabilize weak areas. Hydrated lime, quick lime, Portland cement, fly ash, or suitable alternate materials may be used as verified by appropriate testing and approved by the Engineer. Additives can be effective where the depth of unstable soils is relatively shallow. Treatment will be less effective in areas where the zone of unstable soils is deep. The optimum application rate of stabilization additive must be determined by specific laboratory tests performed on the alignment subgrade soils. We recommend a minimum treatment depth of 8 inches.

Subgrade preparation and mass undercuts should extend at least 5 ft beyond the embankment toes and outside the reinforced zone of MSE walls to the extent possible. Subgrade preparation for the approach roads should extend at least 3 ft outside pavement shoulder edges to the extent possible.

Fill and backfill may consist of unclassified borrow free of organics and other deleterious materials as per ARDOT Standard Specifications Subsection 210.06. Where A-7-5 or A-7-6 soils are encountered at the subgrade elevation, we recommend that these soils be undercut as required to provide at least 18 in. of suitable low-plasticity subgrade soils, i.e., with a maximum PI of 18, or approved "hillside" cherty clay with a maximum of 35 percent passing the No. 200 sieve. Alternatively, stabilization additives may be utilized to develop a stable subgrade with a PI of 18 or less. Granular soils must be protected from erosion with a minimum 18-in.-thick armor of clayey soil.

Subgrade preparation should comply with ARDOT Standard Specifications Section 212. Embankments should be constructed in accordance with ARDOT criteria (ARDOT Standard Specifications Section 210). Fill and backfill should be placed in nominal 6- to 10-in.-thick loose lifts. All fill and backfill must be placed in horizontal lifts. The in-place density and water content should be determined for each lift and should be tested to verify compliance with the specified density and water content prior to placement of subsequent lifts.

## **CONSTRUCTION CONSIDERATIONS**

## Groundwater and Seepage Control

Positive surface drainage should be established at the start of the work, be maintained during construction and following completion of the work to prevent surface water ponding and subsequent

saturation of subgrade soils. Density and water content of all earthwork should be maintained until embankments, bridge work, and pavements are completed.

Shallow groundwater was not encountered in the borings in March 2022 and January 2023. Shallow perched groundwater may be encountered in the near-surface soils, particularly during wet seasons. Seepage into excavations and cuts can typically be controlled by ditching or sump-and-pump methods. If seepage infiltration cannot be controlled, construction of drains and/or the use of Select Granular Backfill (AASHTO M 43 No. 57), stone backfill (ARDOT Standard Specifications Section 207), or approved alternates to an elevation above the inflow of seepage will be warranted. In areas of seepage infiltration, the granular fill should be encapsulated with a filter fabric complying with ARDOT Standard Specifications Subsection 625.02, Type 2 and vented to positive discharge. Where surface seeps or springs are encountered during site grading, we recommend the seepage be directed via French drains or blanket drains to positive discharge at daylight or to storm drainage lines.

Site preparation should also include construction of blanket drains in all existing drainage features which will be covered by fill. All loose and/or organic materials should be excavated from drainage features prior to drain construction. Blanket drains should consist of at least 8 to 12 in. of select granular backfill (AASHTO M 43 No. 57) fully encapsulated by a filter fabric. A fabric complying with ARDOT Standard Specifications Subsection 625.02, Type 2 is recommended. Drains should direct water to positive discharge at daylight or into storm drain lines. Piling

Piles should be installed in compliance with ARDOT Standard Specifications, Section 805. Piles should be carefully examined prior to driving and piles with structural defects should be rejected. Any splices in steel piles should develop the full cross-sectional capacity of un-spliced piles. Preboring should be anticipated for pile installation. Some rock drilling could be required for prebores. Where piles are prebored to develop uplift resistance, the annulus between the steel piles and the prebore should be expeditiously backfilled with approved grout or concrete.

Pile installation should be monitored by qualified personnel to maintain specific and complete driving records and observe pile installation procedures. Safe bearing capacity of production piles should be determined by ARDOT Standard Specifications Section 805.09, Method A. Driving records should be available for review by the Engineer during pile installation. For driving steel piles on this project, we recommend a minimum hammer energy of 34,000 ft-lbs
per blow. Blow counts on steel piles should be limited to about 20 blows per inch. Practical pile refusal may be defined as a penetration of 0.5 in. or less for the final 10 blows.

#### **CLOSURE**

The Engineer or Department or a designated representative thereof should monitor site preparation, grading work and foundation and pavement construction. Subsurface conditions significantly at variance with those encountered in the borings should be brought to the attention of the Geotechnical Engineer. The conclusions and recommendations of this report should then be reviewed in light of the new information.

The following illustrations are attached and complete this final report.

Plate 1	Site Vicinity
Plates 2 and 3	Plans of Borings
Plates 4 through 17	Boring Logs
Plates 18 and 19	Keys to Terms and Symbols
Appendix A	Preliminary Bridge and MSE Wall Layouts
Appendix B	Selected Rock Core Photographs
Appendix C	Classification Test Results
Appendix D	Generalized Subsurface Profiles
Appendix E	Nominal Uplift Pile Capacity Curves
Appendix F	Stability Analyses Results

\* \* \* \* \*

We appreciate the opportunity to be of service to you on this project. Should you have any

questions regarding this report, or if we may be of additional assistance, please call on us.

Sincerely,

GRUBBS, HOSKYN, BARTON &WYATT, LLC

Vellet M. Sutt

Velleta M. Scott, P.E. Sr. Project Engineer PROFESSIONAL Mark E. Wyatt, P.E. No. 7791 President

VMS/MEW:jw

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Copies Submitted:	Garve	r LLC	
	Attn:	Mr. Joel Skinner, P.E.	(1-email)
	Attn:	Mr. Lawren Wilcox, P.E.	(1-email)
	Attn:	Mr. Adam Wierciak, P.E.	(1-email)









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		tor	<b>&amp; Wyatt, Inc.</b> Engineers LOGOF 090069 XNA A	B O ccess	<b>RI</b> Roa	N G d ove	<b>N O</b> er Hol	<b>. S</b> Imes	<b>53</b> Rd.							
			Ben	ton C	Co., A	rkans	as									
	TYPE	:	Auger to 6.5 ft /Wash to 11 ft /Core		LOC	CATIO	N: Ap	prox S	Sta 21 <sup>.</sup>	1+30, 4	45 ft R	t		1		
		S		보	T V T		(		SION,	TON/	SQ F1	Γ		%	≥	
отн, F	MBOI	MPLE	DESCRIPTION OF MATERIAL	S PEI	DRY CU F	0.	.2 0.	.4 0	.6 0	.8 1	.0 1	.2 1.	.4	. 200	ecove	RQD
DEF	S	SA		BLOW	UNIT LB/	PLA LI	ASTIC IMIT <b>+</b>		CON			LIQU LIMI	ID T	۹ ۱	% R	%
	<b>H</b>		Firm tan and brown clayey silt	8		1	0 2	03	0 4	0 5	io 6	i0 7	0			
			w/numerous chert fragments Stiff reddish brown and tan	50/7"												
			and discontinuous chert	50/7				<b></b>	<b>#</b>					24		
- 5 -		X		50/10 <sup>-</sup> 25/0"	,		•		- •							
			- auger refusal in chert at 6.5 ft													
10 -																
			Moderately hard light yellowish													
			tan weathered limestone, highly fractured w/chert												20	0
- 15 -			and close soil-filled fractures													
20															22	0
20																
															13	0
- 25 -														-		
															25	0
- 30 -		<b>] I</b>		+	+											
- 35 -																
40 -														-		
		LE	TION DEPTH: 30.0 ft -15-22			O WA G: Dr	TER v to 1 <sup>2</sup>	1 ft	1	1	I		F: 3/	15/2	 022	,
			=			J. DI	,					2/1				

	<u>19-118</u> Gru	<u>3</u> bb	s, Hoskyn,					<u> </u>	<b>E</b> 4							
	Bar	<b>toi</b> Iting	<b>&amp; Wyatt, Inc.</b> Engineers Ben	ccess ton C	s Roa Co., A	n G d ove rkans	er Ho as	olmes	<b>54</b> Rd.							
	TYPE	:	HSA to 36 ft /Wash		LO		N: Ap	orrox S	Sta 212	<u>2</u> +15, \$	55 ft F	٦t				
				Ŀ	Ч			COHE	SION	, TON	/SQ F	T				
L L	BOL	LES		PER	RY ∧ U FT	0	.2 0	).4 (	).6 C	).8 1	.0	1.2 1	.4	00 %	over)	B
DEPT	SYM	SAMF	DESCRIPTION OF MATERIAL	SMOJ	UNIT DI LB/CI	PL/ L			WA CON	TER TENT		LIQU LIM	JID IT	- No. 2	% Rec	% R
	82823		Medium dense brown fine	<u>ш</u>		1	0 2	<u>20 ;</u>	30 4	10 t	50	60	70			
		X	sandy silt w/organics and numerous chert and limestone	13												
- 5 -			fragments (topsoil) - loose to medium dense	10												
			below 2 ft Firm to stiff red silty clay	41												
		X	w/numerous chert hodules and fragments	50/5"												
- 10 -			- stiff to very stiff below 6 π - chert layer at 8 ft													
				21												
- 15 -				31												
			- more red clay below 18 ft													
- 20 -		X		31												
- 25 -		X	Stiff yellowish red fine to	17												
	A		chert nodules and fragments													
- 30 -			limestone)	51												
			and reddish tan highly weathered chert w/limestone													
			fragments and silty clay													
- 35 -			- auger refusal at 36 ft												58	
			cherty limestone, fractured												00	
- 40 -														-	20	0
- 45 -														-	45	0
3		1		+						+						
- 50 -																
55														1		
	COMF	LL PLE	TION DEPTH: 47.4 ft	DE	 PTH T	O WA	TER	I	1	1			I	<u> </u>		
L.	DATE	: 7	-29-23	IN E	BORIN	G: Dr	y to 3	6 ft				DA	IE: 7	/29/2	023	•

<u> </u>	19-118	}													_
	Gru Bar <sub>Consu</sub>	bbs, Hoskyn, con & Wyatt, Inc. ting Engineers LOGOF 090069 XNA A Ben	BC ccess ton C	<b>) R I</b> s Roa Co., A	N G Id ove rkans	N ( er Ho sas	<b>D. S</b> olme	<b>356</b> s Rd.							
	TYPE	: HSA to 31.5 ft /Wash		LO	CATIO	N: A	pprox	: Sta 21	3+65,	55 ft R	łt				
			FT	Τ			СО⊦	IESION	I, TON/	SQ F1	<b>-</b>				
	ğ	LES	DER	NFT NFT	0	.2	0.4	0.6	0.8 1	.0 1	.2 1	.4	% 00	very	R
DEPTI	SYME		LOWS	JNIT DF LB/CU	PL/ L	ASTIC IMIT	;				LIQU LIM	ID IT	- No. 2	% Rec	% R(
		SURF. EL: 1208±	<u> </u>	<b>–</b>	1	0	20	30	<u>40 5</u>	60 E	60 7	0			
		w/chert nodules and fragments /	20												
<u> </u>		Stiff to very stiff red clay	28												
- 5 -		w/numerous chert nodules and fragments	60										-		
		Medium dense to dense reddish brown and light gray	35										-		
10		w/numerous chert nodules and	16												
		fragments													
		Stiff to very stiff reddish brown											-		
- 15		and light gray fine to medium	50												
		nodules and fragments													
	ZZ														
- 20 -	KX)	X	19												
-		- with highly weathered cherty													
- 25 -		limestone seams and layers below 23 ft	17												
		- moist below 26 ft													
	$\mathcal{A}$	chert layer at 28 ft													
- 30			50/5												
		Moderately hard to hard grav						q.=	5930 p	si, TU'	W= 16	6 pcf		-	
		cherty liméstone												73	65
- 35															
		† †												100	100
40														91	67
		Щ	+	<u> </u>											
15	_														
40	-														
	COMF DATE	2LETION DEPTH: 42.5 ft 7-31-23	DE IN I	PTH T BORIN	O WA <sup>:</sup> IG: Dr	TER y to 3	31.5 f	t			DA	TE: 7/	31/2	023	}

	TYPE	:	HSA to 25.5 ft /Wash	1	LO		DN: Ap	prox	Sta 2	14+90	, 155	ft Lt				
	-	ŝ		R FT	T ∨ T		(				I/SQ I	FT	1 4	%	ery	
ОЕРТН,	SYMBC	SAMPLE	DESCRIPTION OF MATERIAL	DWS PE	VIT DRY LB/CU F	PL	ASTIC	.4	U.0 W/ COI	ATER	1.0	LIQ		No. 200	6 Recove	% RQD
			SURF. EL: 1182±	BLO	5	1	+ 10 2	- — — 0	30	•	 50	60	<b>-</b> 70	'	%	
		X,	Medium dense brown fine sandy silt w/chert nodules and fragments	14												
			Stiff reddish brown silty clay w/numerous chert fragments	15												
- 5 -		X		50/5"										_		
		X		45												
- 10 -		X		19												
45		X		24												
- 15 -																
			- very soft,red below 17.5 ft													
- 20 -		X		4										_		
- 25 -		X	Very soft reddish tan and yellowish brown silty clay, çalcareous w/chert nodules	3										_		
			(completely weathered chert limestone													
			Moderately hard gray and light gray cherty limestone													
- 30 -															71	69
		-		+		+ — — ·	+ +	L	-		+	+	+			
- 35 -														-		
l																

	19-11	8												
	Gru Bar <sub>Consu</sub>	bb toi	s, Hoskyn, & Wyatt, Inc. Engineers Benton (	<b>D R</b> I is Roa Co., <i>P</i>	l <b>N G</b> ad ov Arkan	<b>N</b> er H sas	<b>O.</b> olme	<b>W2</b> es Ro	d.					
	TYPE	:	HSA	LC	CATIO	ON:	Appr	ox St	a 215+	90, 14	) ft Lt			
		S		R FT	T V			COF	HESION		I/SQ F	Г		%
PTH, F	MBOI	MPLE	DESCRIPTION OF MATERIAL	S PEI	DRY /CU F	(	0.2	0.4	0.6	0.8	1.0 1	.2 1.	.4	. 200
DEF	S	SAI	SUPE EL 1201+	BLOW	UNIT			; 		ATER NTENT		LIQU LIMI <b>+</b>	ID T	- No
	8282	$\left  \right $	Loose to modium donse brown fine				10	20	30	40	50 6	<u>60 7</u>	0	
		X	sandy silt w/chert nodules and fragments and trace organics	10										
		X	Stiff to very stiff reddish brown silty clay w/numerous chert nodules and fragments	12										
- 5 -		X		33										
		X	- with discontinuous chert seams below 6 ft	50/4"										
- 10 -		X		33										
- 15		X		21										
		X		50/5"										
- 20 -														
-			with more chart below 22.5 ft											
25 - 25		X		10										
RD.GPJ														
IOLMES F														
19-118_H														
GBNEW	COMP DATE	PLE : 7	TION DEPTH: 25.0 ft DE -26-23 IN	PTH BORI	TO WANG: D	ATER Pry					DA	TE: 7	/26/20	23

	19-118												
	Grub Barto Consulti	bs, Hoskyn, on & Wyatt, Inc. <sub>ng Engineers</sub> LOGOFE 090069 XNA Acc Bento	<b>B O R I</b> æss Roa n Co., <i>A</i>	<b>N G</b> ad ov vrkan	<b>i N (</b> er Ho sas	<b>D. V</b> olmes	<b>V3</b> s Ro	1.					
	TYPE:	HSA	LC	CATIO	ON:	Appro	x Sta	a 217+	10, 16	61 ft Lt			
			ET	F			СОН	IESION		N/SQ F	T		
H, FT	30L		PER	ZY √ J FT	0	.2 0	.4	0.6	0.8	1.0	1.2	1.4	% 00
DEPT	SYM		SMOUS	UNIT DI LB/CI	PL/ L	ASTIC IMIT			ATER NTENT	r	Liqi Liv	JID IIT	- No. 2
		Medium dense light brown silt			1	0 2	20	30	40	50	60	70	
		w/chert and limestone fragments	14										
		Low hardness pale red highly weathered limestone w/chert nodules and fragments and discontinuous chert seams	25										
- 5 -			50/3"										
		with red charts day accurs and	50/4"										
- 10 -		layers below 8 ft	46										
- 15 -			50/2"										
- 20 -			30										
		Very stiff reddish brown silty clay w/numerous chert nodules and fragments											
25 - 25			25					_					
IES RD.GPJ													
9-118_HOLM													
LGBNEW 1	COMPL DATE:	ETION DEPTH: 25.0 ft 7-25-23	DEPTH <sup>-</sup> IN BORII	I FO WA NG: D	ATER Pry	l				D	ATE: 7	7/25/20	)23

Grubbs, Hoskyn, Barton & Wyatt, Inc. Consulting Engineers	SYMBOLS A	ND TERM	S USED O	N BORING	LOGS
SC (SHOWN IN C C Gravel Sand Predomina	DIL TYPES SYMBOLS COLUMN) Silt nt type shown heavy	Clay S	SAMP (SHOWN ON S helby Rock ube Core	LER TYPES SAMPLES COLI Split No Spoon Reco	UMN) o Cutting very
TERM COARSE GRAINED SO sands, and (2) silty or cla determined by laborator	S DESCRIBING ILS (major portion reta ayey gravels and sand y tests.	CONSISTEN nined on No. 200 s. Condition is ra	CY OR COI sieve): Includes ated according to	NDITION (I) Clean grave relative density	ls and ⁄, as
DESCRIPT VERY LOO LOOSE MEDIUM D DENSE VERY DEN FINE GRAINED SOILS silts and clays, (2) grav according to shearing s compression tests.	TIVE TERM SE ENSE SE (major portion passin velly, sandy, or silty cla strength, as indicated b	N-VALUE 0-4 4-10 10-30 30-50 50 and abov g No. 200 sieve) ys, and (3) claye by penetrometer	RELATI re Includes (1) In y silts. Consiste readings or by u	VE DENSITY 0-15% 15-35% 35-65% 65-85% 85-100% organic and organicy is rated inconfined	anic
DESCRIP VEF SOF FIRI STIF VEF HAF NOTE: Slic strengths tha The consiste	TIVE TERM SOFT T ST ST ST STIFF SD kensided and fissured an shown above, becau ancy ratings of such soi	clays may have use of planes of ils are based on	UNCC COMPRESSI TON/ Less than 0.25-0.50 0.50-1.00 1.00-2.00 2.00-4.00 4.00 and lower unconfine weakness or cra penetrometer re	NFINED VE STRENG SQ. FT. 0.25 higher d compressive icks in the soil. adings.	iTH
TE SLICKENSIDED - ha FISSURED - contain or less LAMINATED - comp INTERBEDDED - co CALCAREOUS - col WELL GRADED - ha POORLY GRADED	ERMS CHARACT aving inclined planes of ing shrinkage cracks, s vertical. bosed of thin layers of w omposed of alternate la ntaining appreciable qu aving a wide range in g particle sizes. - predominantly of one intermediate sizes m	ERIZING SC of weakness that frequently filled v varying color and ayers of different uantities of calcin grain sizes and s e grain size, or ha hissing.	DIL STRUCT are slick and glo with fine sand or l texture. soil types. um carbonate. ubstantial amou aving a range of	URE ossy in appearar silt; usually mor nts of all interme sizes with some	nce. re ediate
Terms used on this repo are in accordance with Technical Memorandun	ort for describing soils the UNIFIED SOIL CL/ n No.3-357, Waterways	according to the ASSIFICATION s s Experiment Sta	ir texture or grain SYSTEM, as des ation, March 195	n size distributio scribed in 3	n

PLATE 18

Grubbs, Hoskyn,	las I			
Barton & Wyatt, Consulting Engineers	INC.	BOKIN	J LUG IERMS	
ROCK TYPES (SHOWN IN SYMBOLS COLU	IMN)	Sandstone	Siltstone	Coal Shale
Joint Characteristics —	<u>Spacing</u> Very Close Close Moderately Close Wide Very Wide	0.75 to 2.5 in. 2.5 to 8 in. 8 to 24 in. 2 to 6 ft More than 6 ft	Degree of Weathering –	Fresh — No visible signs of decomposition or discoloration. Rings under hammer impact. Slighty Weathered — Slight
Bedding Characteristics — Lithologic Characteristics —	Very Thin Thin Medium Thick Massive Clayey Shaly Calcareous (limy) Siliceous Sandy (Arenaceous) Silty	0.75 to 2.5 in. 2.5 to 8 in. 8 to 24 in. 2 to 6 ft More than 6 ft		discoloration inwards from open fractures, otherwise similar to fresh. Moderately Weathered — Discoloration throughout. Weaker minerals such as feldspar decomposed. Strength somewhat less than fresh rock, but cores cannot be broken by hand or scraped by knife. Texture preserved. Highly Weathered — Most minerals somewhat decomposed. Specimens oran be broken by hand with effort
Parting – Seam – Layer – Stratum –	Plastic Seams Less than 1/1 6incl 1/1 fo 1 /2inch 1/2 to 1 2inches Greater than 1 2inc	h		can be broken by nand with effort or shaved with knife. Core stones present in rock mass. Texture becoming indistinct but fabric
Hardness-	Soft (S) - Reserved Friable (F) - Easily pulverized or reduce to be cut with a po	l for plastic material alone. crumbled by hand, ad to powder and is too sof ocket knife. — Can be gouged deeply	ł	Completely Weathered — Minerals decomposed to soil but fabric and structure preserved (Saprolite). Specimens easily crumbled or penetrated. Residual Soil — Advanced state
	Moderately Hard (MH scratched by a knif heavy trace of dust visible after the pow Hard (H) - Can be scratch produces lif faintly visible; traces be visible.	<ul> <li>d) - Can be readily</li> <li>e blade; scratch leaves a</li> <li>and scratch is readily</li> <li>wder has been blown away.</li> <li>scratched with difficulty;</li> <li>tle powder and is often</li> <li>s of the knife steel may</li> </ul>	Solution and Void Conditions —	of decomposition resulting in plastic soils. Rock fabric and structure completely destroyed. Large volume change. Solid, contains no voids Vuggy (pitted) Vesicular (igneous) Porous Cavities
	Very hard (VH) — C a pocket knife. Knit surface.	Cannot be scratched with fe steel marks left on	Swelling Properties – Slaking Properties –	Cavernous Nonswelling Swelling
Texture –	Fine — Barely seen Medium — Barely se Coarse — 1/8 in. te	with naked eye een up to 1/8 in. o 1/4 in.	Rock Quality	Slakes slowly on exposure Slakes readily on exposure
Structure -	Bedding Flat - 0° - 5° Gently Dipping - Moderately Dippi Steeply Dipping Fractures, scattered Open Cemented Fractures, closely sp Open Cemented Brecciated (Sheared	- 5° – 35° ng – 55° – 85° – 55° – 85° or Tight paced or Tight and Fragmented)	Designation (RQD) –	RQD (Percent) Greater than 90Diagnostic Description Excellent75 - 90Good50 - 75Fair25 - 50PoorLess than 25Very Poor
ETROCK FHWA	Open Cemented Joints Faulted Slickenside	or Tight es		

APPENDIX A



(7 S101 LO.dgn NEPA\Dra JESkinner 8/3/2023 9:30:14 AM WORKSPACERRDOT Bridge (2019) L:\2017\17017600 - XNA Access - NEPA\L

DATE REVISED	DATE REVISED	FED. ROAD DIST. NO.	STATE	JOB NO.	SHEET NO.	TÓTAL SHEETS
		6	ARK.	090069 \$	SN7101	\$ \$ST\$
		\$BN07As	þ	LAYOUT	\$C	DN7101\$

NOTES:

Use Type F Approach Slab at each end of bridge. See Std. Dwg. No. 55040F1.

Use Type F Approach Gutters at each end of bridge. See Std. Dwg. No. 55030F.

# EXISTING UTILITIES LEGEND

FOC = Fiber Optic Cable OHE = Overhead Electric

NOTE:

Utilities shown are based on locations at time of survey and do not reflect any potential utility relocations prior to construction.

#### HORIZONTAL CURVE DATA

XNA Access Rd. Mediar PI = 224 + 12.04 $\Delta = 55^{\circ}35'22''$  Rt.  $D = 2^{\circ}00'00''$ T = 1510.09' L = 2779.47'

- e = 0.07 Ft./Ft.
- R = 2864.79

NOTES: For "PROJECT GENERAL NOTES", see Dwg. No. \$DN0201\$.

For "LOCATION SKETCH" and "GENERAL NOTES", see Dwg. No. \$DN7103\$.

For "ELEVATION OF SOIL BORINGS - BRIDGE A", "BORING LEGEND" and "N-VALUES", see Dwg. No. \$DN7104\$.

CL Construction is on a 2°00'00" curve right. CL Girders and the longitudinal lines of the bridge and approach slabs and gutters shall be constructed on curves concentric with CL Construction.

(3) Existing gravel roadway width varies

 $(\underbrace{4}$  Angle measured at point of intersection between line tangent to CL XNA Access Rd. Median and line tangent to CL Holmes Rd.

(5) For Bents 1A & 5A: Measured from CL Joint to a line radial to CL Bridge A at CL Joint.

Measured from CL Bent to a line radial to CL Bridge A at CL Bent.

(6) Point of Minimum Vertical Clearance

(7) For Retaining Wall Details, see Dwg. Nos. \$DNXXXX\$-\$DNXXXX\$.

+0.53%

+5.00%

VERTICAL CURVE DATA

XNA Access Rd. (Profile Grade 11' Right of CL Bridge A)

# 07-20-2023

SHEET 1 OF 4 LAYOUT OF BRIDGES XNA ACCESS RD. OVER HOLMES RD. NORTHWEST ARKANSAS NATIONAL AIRPORT ACCESS (F) **BENTON COUNTY** ROUTE \$RT\$SEC. \$SC\$

PRELIMINARY NOT FOR CONSTRUCTION

CSW DATE: AUG. 2021 FILENAME: b090069x7\_L1.dgn DRAWN BY: DATE: AUG. 2022 ABH CHECKED BY: SCALE: <u>1" = 30'-0"</u> CSW DATE: AUG. 2021 DESIGNED BY: BRIDGE NO. **\$BN07A\$** DRAWING NO. \$DN7101\$

ARKANSAS STATE HIGHWAY COMMISSION

LITTLE ROCK, ARK.

BRIDGE ENGINEER



(7\_S102\_LO.dgn NEPA/Dra 8/3/2023 9:30:16 AM RDOT Bridge (2019) 7600 - XNA Access - NEPANE JESkinner WORKSPA L \2017\1:

DATE REVISED	DATE REVISED	FED. ROAD DIST. NO.	STATE	JOB NO.	SHEET NO.	TÓTAL SHEETS
	REVISED	6	ARK.	090069 \$	SN7102	\$ \$ST\$
		\$BN07B	\$	LAYOUT	\$[	DN7102\$

NOTES

Use Type F Approach Slab at each end of bridge. See Std. Dwg. No. 55040F1.

Use Type F Approach Gutters at each end of bridge. See Std. Dwg. No. 55030F.

#### EXISTING UTILITIES LEGEND

FOC = Fiber Optic Cable OHE = Overhead Electric

#### HORIZONTAL CURVE DATA

XNA Access Rd. Mediar

- PI = 224+12.04 $\Delta$  =  $55^{\circ}35'22''$  Rt.
- $D = 2^{\circ}00'00''$
- $T = 1510.09^{\circ}$
- L = 2779.47 = 0.07 Ft./Ft.
- R = 2864.79'

NOTES:

For "PROJECT GENERAL NOTES", see Dwg. No. \$DN0201\$.

For "LOCATION SKETCH" and "GENERAL NOTES", see Dwg. No. \$DN7103\$.

For "ELEVATION OF SOIL BORINGS", "BORING LEGEND" and "N-VALUES", see Dwg. No.  $\prescript{solution}$ 

CL Construction is on a 2°00'00" curve right. CL Girders and the longitudinal lines of both the bridge and approach slabs and gutters shall be constructed on curves concentric with CL Construction. CL Joints of Bents 1 & 5 and CL Bents of Bents 2 thru 4 shall be constructed on radial lines to CL Construction.

PVI Sta. 209+50.00 Elev. 1238.56 V.C. = 1110'

+0.53%

+5.00%

#### VERTICAL CURVE DATA

XNA Access Rd. (Profile Grade 15' Left of CL Bridge B)

## 07-20-2023

SHEET 2 OF 4 LAYOUT OF BRIDGES XNA ACCESS RD. OVER HOLMES RD. NORTHWEST ARKANSAS NATIONAL AIRPORT ACCESS (F) **BENTON COUNTY** ROUTE \$RT\$SEC. \$SC\$ ARKANSAS STATE HIGHWAY COMMISSION LITTLE ROCK, ARK.

PRELIMINARY NOT FOR CONSTRUCTION

CSW DATE: AUG. 2021 FILENAME: b090069x7\_L2.dgn DRAWN BY: DATE: AUG. 2022 ABH CHECKED BY: SCALE: <u>1" = 30'-0"</u> CSW DATE: AUG. 2021 DESIGNED BY: DRAWING NO. \$DN7102\$ BRIDGE NO. **\$BN07B\$** 



<u>PLAN</u> Scale: 1" = 20'-0"



x9 S101 RW CSWylie 7/20/2023 12:58:50 PM WORKSPACBARDOT Bridge (2019) L:\2017\17017600 - XNA Access - NEPA\DrawIngs\b0

dgn

DATE REVISED	DATE REVISED	FED. ROAD DIST. NO.	STATE	JOB NO.	SHEET NO.	TÓTAL SHEETS
		6	ARK.	090069 \$	SN9101	\$ \$ST\$
		\$BN0XX	\$	RETAINING WALLS	5 \$D	N9101\$



# 07-20-2023

SHEET 1 OF X RETAINING WALL DETAILS ROUTE SEC.

PRELIMINARY NOT FOR CONSTRUCTION

ARKANSAS STATE HIGHWAY COMMISSION LITTLE ROCK, ARK. 
 DRAWN BY:
 HEW
 DATE:
 MAY 2023
 FILENAME:
 b090069\_rw1.dgn

 CHECKED BY:
 \$CHKBY\$
 DATE:
 \$DTCHK\$
 SCALE:
 As Shown

 DESIGNED BY:
 CSW
 DATE:
 MAY 2023
 SCALE:
 As Shown

BRIDGE ENGINEER

DRAWING NO. \$DN9101\$

BRIDGE NO. \$BNXX\$



	DATE REVISED	DATE REVISED	FED. ROAD DIST. NO.	STATE	JOB NO.	SHEET NO.	TOTAL SHEETS
E			6	ARK.	090069	SNXXX	\$ \$ST\$
ŀ			\$BN0XX	5	RETAINING WALLS	5 \$E	DNXXX\$

# 07-20-2023

SHEET 1 OF X RETAINING WALL DETAILS ROUTE SEC.

ARKANSAS STATE HIGHWAY COMMISSION LITTLE ROCK, ARK.



 
 DRAWN BY:
 CSW
 DATE:
 MAY 2023
 FILENAME:
 b090069\_rw1.dgn

 CHECKED BY:
 \$CHKBY\$
 DATE:
 \$DTCHK\$
 SCALE:
 As Shown

 DESIGNED BY:
 CSW
 DATE:
 MAY 2023
 SCALE:
 As Shown
 BRIDGE NO. \$BNXX\$ DRAWING NO. **\$DNXXX\$** 

BRIDGE ENGINEER

# **APPENDIX B**



B-S48: Run 1 (37.5-39.5 ft), Run 2 (39.5-42.7 ft), Run 3 (42.7-47.7 ft)





A UES Company

## **ROCK CORE PHOTOS** 090069 XNA Access Road

090069 XNA Access Road Benton County, Arkansas Job No. 19-118

B-S49: Run 1 (22-27 ft), Run (27-32 ft)



Grubbs, Hoskyn, Barton & Wyatt, LLC CONSULTING ENGINEERS A UES Company

**ROCK CORE PHOTOS** 090069 XNA Access Road Benton County, Arkansas Job No. 19-118

# **B-S50**: Run 1 (21-22.25 ft), Run 2 (22.25-27.25 ft), Run 3 (27.25-31 ft)





A UES Company

### **<u>ROCK CORE PHOTOS</u>** 090069 XNA Access Road

090069 XNA Access Road Benton County, Arkansas Job No. 19-118

**B-S51**: Run 1 (28-31.7 ft), Run 2 (31.7-36.7 ft)



**B-S51**: Run 3 (36.7-38.7 ft)



# **B-S53**: Run 1 (11-16 ft), Run 2 (16-21 ft)



B-S54: Run 1 (36-37.5 ft), Run 2 (37.5-42.5 ft), Run 3 (42.5-47.5 ft)





**ROCK CORE PHOTOS** 090069 XNA Access Road

Benton County, Arkansas

Job No. 19-118

# B-S55: Run 1 (34-37.25 ft), Run 2 (37.25-39.25 ft), Run 3 (39.42-41.92 ft)





A UES Company

### **ROCK CORE PHOTOS** 090069 XNA Access Road

090069 XNA Access Road Benton County, Arkansas Job No. 19-118

# B-S56: Run 1 (31.5-36.5 ft), Run 2 (36.5-37.5 ft), Run 3 (37.5-42.5 ft)





A UES Company

## **ROCK CORE PHOTOS** 090069 XNA Access Road

**Benton County, Arkansas** 

Job No. 19-118
# **APPENDIX C**

# SUMMARY of CLASSIFICATION TEST RESULTS

PROJECT: 090069 XNA Access Road

LOCATION: Benton County, Arkansas

GHBW JOB NUMBER: 19-118

PODINC	SAMPLE DEPTH (ft)	WATER CONTENT (%)	ATTERBERG LIMITS			SIEVE ANALYSIS						USCS			
DUKING			LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	PERCENT PASSING						CLASS	AASHTU		
110.						2 in.	1 in.	3/4 in.	3/8 in.	#4	#10	#40	#200		
S52A	2.5-3.5	18	45	29	16					52			31	GM	A-2-7
S53	4.5-5.5	11	38	22	16	100	100	85	63	48	36	28	24	GC	A-2-6



# **APPENDIX D**





**APPENDIX E** 















2. Pile penetration limited in moderately hard weathered limestone below El.  $1154\pm$ 











### ULTIMATE SINGLE PILE CAPACITY, TONS

Note: 1. Piles driven from cap bottom elevation

2. Pile penetration limited in moderately hard weathered limestone below El. 1177±

Benton County, Arkansas

# **APPENDIX F**

#### Summary of Stability Analysis Results ARDOT 090069 XNA Access Road over Holmes Road GHBW Job No. 19-118 Benton County, Arkansas

	Design Loading Condition	Calculated Minimum Factor of Safety
	End of Construction	2.08
MSE Wall No. 1 (H=18 ft)	Long Term	2.15
	Seismic ( $k_h = A_S/2 = 0.0245$ )	1.82





Results of Stability Analyses – End of Construction MSE Wall No. 1 3H:1V Slope, Wall Height=18 ft ± 19-118 – ARDOT Job No.090069 – XNA Access Road over Holmes Road





Results of Stability Analyses – Long Term Condition MSE Wall No. 1 3H:1V Slope, Wall Height=18 ft ± 19-118 – ARDOT Job No.090069 – XNA Access Road over Holmes Road





 $\begin{array}{l} \mbox{Results of Stability Analyses - Seismic Condition} (k_h = A_S \ /2 = 0.0245) \\ \mbox{MSE Wall No. 1} \\ \mbox{3H:1V Slope, Wall Height=18 ft $\pm$} \\ \mbox{19-118 - ArDOT Job No.090069 - XNA Access Road over Holmes Road} \end{array}$ 



#### Summary of Stability Analysis Results ARDOT 090069 XNA Access Road over Holmes Road GHBW Job No. 19-118 Benton County, Arkansas

	Design Loading Condition	Calculated Minimum Factor of Safety
	End of Construction	2.69
South End Slope (Bent 1) (2H:1V)	Long Term	2.26
	Seismic ( $k_h = A_S/2 = 0.0245$ )	2.53
	End of Construction	3.71
South Side Slope (Bent 1) (3H:1V)	Long Term	3.19
	Seismic ( $k_h = A_S/2 = 0.0245$ )	3.37
	End of Construction	2.13
North End Slope (Bent 5) (2H:1V)	Long Term	1.87
	Seismic ( $k_h = A_S/2 = 0.0245$ )	1.98
	End of Construction	2.11
North Side Slope (Bent 5) (3H:1V)	Long Term	2.32
、 /	Seismic ( $k_h = A_S/2 = 0.0245$ )	1.93





Results of Stability Analyses – End of Construction Bent 1 End Slope 2H:1V Slope, H=47 ft ± 19-118 – ARDOT Job No.090069 – XNA Access Road over Holmes Road





Results of Stability Analyses – Long Term Condition Bent 1 End Slope 2H:1V Slope, H=47 ft ± 19-118 – ARDOT Job No.090069 – XNA Access Road over Holmes Road





 $\begin{array}{l} \mbox{Results of Stability Analyses - Seismic Condition} (k_h = A_S \ /2 = 0.0245) \\ \mbox{Bent 1 End Slope} \\ \ 2H:1V \ Slope, \ H = 47 \ ft \pm \\ 19\text{-}118 - \ ARDOT \ Job \ No.090069 - XNA \ Access \ Road \ over \ Holmes \ Road \\ \end{array}$ 





Results of Stability Analyses – End of Construction Bent 1 Side Slope 3H:1V Slope, H=47 ft ± 19-118 – ARDOT Job No.090069 – XNA Access Road over Holmes Road





Results of Stability Analyses – Long Term Condition Bent 1 Side Slope 3H:1V Slope, H=47 ft ± 19-118 – ARDOT Job No.090069 – XNA Access Road over Holmes Road

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Results of Stability Analyses – End of Construction Bent 5 End Slope 2H:1V Slope, H=60 ft ± 19-118 – ARDOT Job No.090069 – XNA Access Road over Holmes Road





Results of Stability Analyses – Long Term Condition Bent 5 End Slope 2H:1V Slope, H=60 ft ± 19-118 – ARDOT Job No.090069 – XNA Access Road over Holmes Road





 $\begin{array}{l} \mbox{Results of Stability Analyses - Seismic Condition (k_h = A_S / 2 = 0.0245) \\ \mbox{Bent 5 End Slope} \\ \mbox{2H:1V Slope, H=60 ft $\pm$} \\ \mbox{19-118 - ARDOT Job No.090069 - XNA Access Road over Holmes Road} \end{array}$ 





Results of Stability Analyses – End of Construction Bent 5 Side Slope 3H:1V Slope, H=60 ft ± 19-118 – ARDOT Job No.090069 – XNA Access Road over Holmes Road





Results of Stability Analyses – Long Term Condition Bent 5 Side Slope 3H:1V Slope, H=60 ft ± 19-118 – ARDOT Job No.090069 – XNA Access Road over Holmes Road









Materials Testing Geotechnical Engineering Environmental Building Sciences & Safety Inspections & Code Compliance Virtual Design Consulting

September 28, 2023 Job No. 19-118

Garver LLC 4701 Northshore Drive North Little Rock, Arkansas 72118

Attn: Mr. Joel Skinner, P.E.

### FINAL RESULTS of GEOTECHNICAL INVESTIGATION ARDOT JOB 090069 MALONE LANE BRIDGE OVER XNA ACCESS ROAD BENTON COUNTY, ARKANSAS

### **INTRODUCTION**

This report provides the final results of the geotechnical investigation performed for the Malone Lane over the XNA Access Road in Benton County, Arkansas are provided in this report. The Malone Lane overpass is one facet of ARDOT Job 090069 Northwest Arkansas Regional Airport Access (Benton Co) (F). This geotechnical investigation was authorized by the Garver, LCC Subconsultant Agreement for Task Order No. 061 on August 27, 2019. Notice to proceed with the field studies was received on August 30, 2019. This final report includes additional recommendations for pile foundation uplift resistance and supersedes the submittal of June 3, 2023.

We understand the new Malone Lane bridge will be a continuous plate girder structure with three (3) bents, two (2) spans, and a total length of approximately 218 feet. We also understand that a foundation system consisting of steel piles is planned for all bents. Foundation loads of the new bridge are anticipated to be moderate. The bridge end embankments will utilize MSE walls at bridge abutments and simple slopes at 3-horizontal to 1-vertical (3H:1V) configurations at the embankment sides. Site grading is expected to include up to 29 ft of embankment fill. A preliminary bridge layout is provided in Appendix A.

The purposes of this study were to explore subsurface conditions in the bridge alignment and to develop recommendations to guide design and construction of foundations. These purposes have been achieved by a multi-phased study that included the following.
- Drilling sample and core borings at the planned bridge location to evaluate subsurface conditions and obtain samples of the subgrade and foundation soil and rock for laboratory testing.
- Performing laboratory tests to evaluate pertinent engineering properties of the foundation and subgrade strata.
- Analyzing field and laboratory data to develop recommendations for seismic site class, seismic performance zone/seismic design category, foundation and subgrade support, MSE walls, slope stability, site grading, and construction considerations.

The relationship of these factors to design and construction of the new bridge has been considered in developing the recommendations and considerations discussed in the following report sections.

# SUBSURFACE EXPLORATION

Subsurface conditions at the Malone Lane bridge location were investigated by drilling 11 sample and core borings to depths of 9.5 to 68 feet. The site vicinity is shown on Plate 1. The approximate boring locations are shown on the bridge layout drawing on Plate 2. The subsurface exploration program is summarized in Table 1 below.

Boring No.	Approx Sta	Approx Offset, ft	Approx Surf El, ft	Completion Depth, ft
S57	22+36	CL	1241	62
S58	23+50	CL	1242	68
S59	24+57	CL	1243	55
S60	22+04	74 L	1240	15*
S61	22+35	40 L	1240	25
S62	22+44	34 Rt	1242	14.5*
S63	22+09	67 Rt	1242	14.5*
S64	24+78	60 L	1244	10*
S65	22+10	67 R	1244	9.5*
S66	24+58	38 Rt	1242	10*
S67	24+90	78 Rt	1242	11.5*

**Table 1: Summary of Exploration Program** 

\*Note: Boring terminated at practical refusal in hard chert bed or cherty limestone.

The boring logs, presenting descriptions of the soil and rock strata encountered in the borings and the results of the field and laboratory tests, are included as Plates 3 through 16. The centerline station and offset of the boring locations and approximate ground surface elevation, as inferred from the topographic information provided by the Engineer (Garver, LLC) or as inferred from available topographic information, are also shown on the logs. It must be recognized that the surface elevations shown are <u>approximate</u> and actual elevations may vary. Keys to the terms and symbols used on the logs are presented as Plates 17 and 18.

The borings were drilled with a track-mounted CME 55 rotary-drilling rig using a combination of dry-auger and rotary-wash drilling methods. Samples were typically obtained at 2-ft intervals to 10-ft depth and at 5-ft intervals thereafter. Samples were recovered using a 2-in.-diameter split-barrel sampler driven into the strata by blows of a 140-lb automatic hammer with 30-in. drop in accordance with Standard Penetration Test (SPT) procedures. The number of blows required to drive the standard split-barrel sampler the final 12 in. of an 18-in. total drive, or a portion thereof, is defined as the Standard Penetration Number (N). Recorded N-values are shown on the boring logs in the "Blows Per Ft" column.

Representative samples of the limestone bedrock were obtained using a 5-ft-long NQwL-size double-tube core barrel with a diamond bit. For each core run, the percent recovery was determined as the ratio of recovery to total length of core run. Rock Quality Designation (RQD) was also determined for the core run as the sum of intact, sound rock core greater than 4-in. length divided by the total length of the run and expressed in percent. Both these values are presented in the right-hand columns of the log forms, opposite the corresponding core run. Selected photographs of the recovered rock cores are provided in Appendix B.

All samples were removed from sampling tools in the field, examined and visually classified by the field geologist. Samples were then placed in appropriate containers to prevent moisture loss and/or change in condition during transfer to our laboratory for further examination and testing.

The borings were advanced using dry-auger procedures to the extent possible to facilitate evaluation of shallow groundwater conditions. Observations regarding groundwater levels are noted in the lower-right portion of each log and are discussed in subsequent sections of this report. All boreholes were backfilled after obtaining the final water level readings.

## **LABORATORY TESTING**

Laboratory testing was performed to evaluate subgrade and foundation plasticity and to confirm visual classification. The testing program included natural water content determinations (AASHTO T 265), liquid and plastic (Atterberg) limit determinations (AASHTO T 89 and T 90),

and sieve analyses through the No. 200 sieve (AASHTO T 88). Soil shear strength was estimated in the field using SPT results.

A total of 44 natural water content determinations were performed to develop information on *in-situ* soil water content for each boring. Water content results are plotted on the boring log forms in accordance with the scale and symbols shown in the legend located in the upper-right corner of the logs.

To verify field classification and to evaluate soil plasticity, 10 liquid and plastic limit (Atterberg limits) determinations and 12 sieve analyses were performed on selected representative samples. The Atterberg limits are plotted on the logs as pluses inter-connected with a dashed line using the water content scale. The percentage of soil passing through the No. 200 Sieve is noted in the "- No. 200 %" column on the appropriate log forms. Classification test results, along with soil classification by the Unified Soil Classification System and AASHTO designations, are summarized in Appendix C.

#### **GENERAL SITE and SUBSURFACE CONDITIONS**

#### Site Conditions

The overall alignment of the XNA Access Road extends from the Northwest Arkansas Airport (XNA) about 4 miles southeast to the planned terminus at Highways 70 and 71. The Malone bridge site crosses Malone Lane approximately 1250 ft west of the intersection of Malone Lane and Haden Road. The site locale is presently open agricultural/pasture land with scattered mature trees. A drainage area with shallow standing water and thick underbrush is present in the center of the alignment near the plan Bent 2 location. The site terrain slopes gently from the south to the north. Surface drainage is considered fair overall, but poor in the area of the drainage feature and localized low areas.

#### Site Geology

The project alignment is located in the mapped exposure of the Boone Formation. The early and middle Mississippian Period Boone consists of fine- to coarse-grained limestone interbedded with chert. The chert content can vary widely, both horizontally and vertically, and limestone or chert may be predominant. The Boone Formation is known for dissolutional features such as sinkholes, caves, and enlarged fissures. Typically, the limestone/cherty limestone units of the Boone decompose (weather) to erratic blends of chert fragments and clay/silty clay. The residual soil mantle may extend to significant depths on higher terrain and may contain hard chert

seams and/or layers. The thickness of the Boone Formation is reported to be 300 to 350 ft in northern Arkansas. The Boone is generally disconformable to the underlying Chattanooga Shale and St. Joe Limestone member, with some areas having a conformable contact.

# Seismic Conditions

In light of the results of the borings, a Seismic Site Class C (very dense soil and soft rock profile) is considered applicable for the site with respect to the criteria of the <u>AASHTO LRFD</u> <u>Bridge Design Specifications Seventh Edition 2014<sup>1</sup></u>.

Given the location and AASHTO code-based values, the 1.0-sec period spectral acceleration coefficient for Site Class C (S<sub>1</sub>) is 0.051 and the 1.0-sec period spectral acceleration coefficient (S<sub>D1</sub>) value for Site Class C is 0.086. Utilizing these parameters, Table  $3.10.6-1^2$  indicates that a <u>Seismic Performance Zone 1</u> is fitting for the Malone Lane bridge site. In reference to the 2011 edition of the AASHTO Guide Specifications, the Peak Ground Acceleration (PGA) having a 7 percent chance of exceedance in 75 years (or mean return period of approximately 1000 years) is predicted to be 0.049 for a Seismic Site Class C for the bridge location. The liquefaction potential is considered low for the predominantly cohesive overburden soils and underlying rock units encountered in the borings drilled for this study.

# Subsurface Conditions

Based on the results of the borings, the subsurface stratigraphy may be generalized into four (4) primary strata as follows.

- Stratum I: The Stratum I soils extend to depths of 2 to 4 ft and are comprised of loose to medium dense brown, reddish brown, and tan silt and fine sandy silt with subordinate units of soft to stiff brown, reddish brown, and reddish tan clayey silt and silty clay. These surface and near-surface soils contain a variable content of chert fragments and nodules. The silt/fine sandy silt, clayey silt, and silty clay exhibit low plasticity, moderate to high compressibility, and low shear strength. The low-plasticity and silty soils are moisture-sensitive and will lose considerable strength when saturated.
- Stratum II: Below the predominantly weak surface and near-surface soils of Stratum I and extending to 6- to 15-ft depth are stiff to very stiff red, reddish brown, tan, and gray clay and silty clay with numerous chert fragments and discontinuous chert seams and layers. The clay and silty clay are residual in origin and have weathered from the underlying cherty limestone bedrock. The Stratum II clay and silty clay have low to moderate plasticity, low to moderate shear strength, and low compressibility. The potential for volume change with

<sup>&</sup>lt;sup>1</sup> <u>AASHTO LRFD Bridge Design Specifications</u>, 7th Edition; AASHTO; 2014

<sup>&</sup>lt;sup>2</sup> <u>AASHTO LRFD Bridge Design Specification</u>, AASHTO; 2012

changes in water content is considered low due to the relatively high content of limestone and chert fragments.

- Stratum III: The overburden soils are underlain to 50- to 63-ft depth by low hardness to moderately hard gray and light gray weathered cherty limestone with numerous reddish brown cherty clay seams and layers. The weathered cherty limestone exhibits differential weathering with frequent reddish brown clay seams, laminations, and layers, which represent zones of completely weathered limestone. SPT refusal in the frequent The weathered limestone has very poor rock quality.
- <u>Stratum IV</u>: The basal stratum encountered in the borings is moderately hard gray and light gray cherty limestone. The cherty limestone is flat bedded. Rock core recovery values range from 33 to 100 percent and rock quality designation (RQD) values range from 0 to 100 percent. These RQD values are indicative of variable poor to fair rock quality. Rock quality generally increases with depth.

To aid in visualizing subsurface conditions, a generalized subsurface profile is presented in Appendix D. It should be recognized that the stratigraphy illustrated by the profile has been inferred between discrete boring locations. In view of the natural variations in stratigraphy and conditions, variations from the stratigraphy illustrated by the profile should be anticipated. Additionally, the natural transition between strata is generally gradual, and the stratigraphy described in the sections above may vary.

## Groundwater Conditions

Groundwater was locally encountered at 12 ft in January 2023. This represents perched water over the fractured zones of the cherty limestone. Groundwater levels will vary, depending on seasonal precipitation, surface runoff and infiltration, and water levels in nearby drainage features.

## **ANALYSES and RECOMMENDATIONS**

## Foundation Design

Foundations for the new bridge must satisfy two (2) basic and independent design criteria: a) foundations must have an acceptable factor of safety against bearing failure under maximum design loads, and b) foundation movement due to consolidation or swelling of the underlying strata should not exceed tolerable limits for the structures. Construction factors, such as installation of foundations, excavation procedures and surface and groundwater conditions, must also be considered.

Based on the results of the borings performed at the Malone Lane bridge site and our understanding of the project, we recommend that foundation loads at the abutments and interior bents be supported on steel piling. Recommendations for steel piles are discussed in the following report sections.

## Piling Foundations

We recommend that the foundation loads of the bridge be supported on steel piles. Steel piles should be driven to refusal in the moderately hard cherty limestone. Highly variable chert beds, seams and layers extend to depths of 45 to 63 ft below existing grades at the Malone bridge site. Preboring will likely be required for pile installation through the interbedded chert zones. Prebores must extend to <u>competent</u> moderately hard cherty limestone and steel piles driven to refusal to mobilize the structural capacity of the pile section.

Steel piles driven to refusal should be designed for the structural capacity of the pile, as per applicable AASHTO Load and Resistance Factor Design (LRFD) procedures<sup>3</sup>. An effective resistance factor ( $\varphi_c$ ) of 0.50 is recommended for structural determination of factored bearing capacities. This effective resistance factor for steel piles has been based on the assumption of severe driving conditions.

For determination of bearing capacities of steel piles driven to refusal, we recommend that nominal (ultimate) resistance (P<sub>n</sub>) of HP piles be determined based on the yield strength of steel H piles ( $f_y$ ) and the net end area (A<sub>net</sub>) of the section. It has been our experience that allowable pile capacities of 133 tons for HP14x73 piles are typical for  $f_y = 50$  ksi steel pile sections. These capacities are based on allowable stress design (ASD). However, the appropriate factored bearing capacity should be confirmed by the Engineer. Post-construction settlement of piles driven to refusal will be negligible.

The nominal axial capacities are based on single, isolated foundations. Piles spaced closer than three (3) pile widths may develop lower individual capacity due to group effects. The potential for group capacity reductions should be evaluated for pile spacing closer than three (3) widths (center to center).

Consideration may be given to driving a heavy HP14x73 or greater pile through the interbedded chert zones. If the Contractor elects to forgo preboring and drive through the interbedded chert zones to the recommended limestone bearing stratum, it is opined that the heavier pile sections, i.e., HP14x73 or heavier, will be required along with a high energy hammer

<sup>&</sup>lt;sup>3</sup> Load and Resistance Factor Design (LRFD) for Highway Bridge Substructures, Publication No. FHWA HI-98-032, National Highway Institute, May 2001.

to achieve the anticipated depth. There will be a risk that the required pile bearing elevation cannot be attained without unacceptable damage to piles. Where piles are prebored to the competent moderately hard cherty limestone, as shown in Table 2 below, HP12x53 steel piles will be suitable.

End-bearing piles must be driven to practical refusal. All steel piles should be fitted with rock points. Hard driving or deep preboring should be anticipated.

Estimated prebore depths and pile tip elevations are summarized below in Table 2.

Bent No.	Estimated Prebore depth, ft (below existing grade)	Estimated Pile Tip Elevation, ft	Comments
1 (West Bridge End)	48	1194	Refusal in moderately hard cherty limestone (Stratum IV)
2 (Approx Sta 23+53)	63	1179	Refusal in moderately hard cherty limestone (Stratum IV)
3 (East Bridge End)	45	1198	Refusal in moderately hard cherty limestone (Stratum IV)

 Table 2: Estimated Tip Elevations of Steel Piles Driven to Refusal

It should be noted that the prebore depths and tip elevations shown in the table above are <u>estimates</u> only based on the results of the relevant borings and the inferred surface elevations at the particular locations. Pile refusal and final depth must be field verified.

Steel piles at the end bents (Bents 1, 2, and 3) may be subjected to uplift loads. Nominal single pile uplift capacity curves for steel HP14x73 piles are provided in Appendix E. Nominal axial pile capacities have been developed using static pile capacity formulae, the results of the borings, and the plan MSE wall subgrade elevations shown on the preliminary bridge layout drawings. Prebored and grouted piles have been assumed for calculation of the uplift resistance.

Based on AASHTO LRFD geotechnical design procedures, a resistance factor ( $\varphi_{up}$ ) of 0.25 is recommended for evaluation of factored uplift capacity. This resistance factor is based on Strength Limit States. For Extreme Events Limit States such as earthquake loading and collision, a resistance factor of 0.8 for uplift is recommended.

Piles should be installed in compliance with Standard Specifications for Highway Construction, 2014 Edition, Section 805. We recommend a hammer delivering a minimum energy of 34,000 ft-lbs per blow. A higher energy hammer may be required where the Contractor plans to drive a heavier steel pile section through the interbedded chert zones. A specific review and analysis of the pile-hammer system proposed by the Contractor should be performed by the

Engineer prior to hammer acceptance and start of driving. We recommend that all piles be fitted with rock points.

A minimum pile length of 10 ft is recommended. As noted, preboring is expected for pile installation to facilitate installation through the more resistant chert seams, layers, and beds. encountered at shallow depth. Rock drilling methods could be required for prebores extending through thicker intervals of chert or weathered limestone. Following pile acceptance, the annulus around installed piles in prebores should be expeditiously backfilled as per ARDOT Standard Specifications Section 805. The grout should have a minimum compressive strength of 4000 lbs per sq in., as per ARDOT Section 501 or an alternate approved by the Engineer.

As a minimum, safe bearing capacity of piles should be determined by ARDOT Standard Specifications Section 805.09, Method A. Driving records should be available for review by the Engineer during pile installation. Blow counts on steel piles should be limited to about 20 blows per inch. Practical pile refusal may be defined as a penetration of 0.5 in. or less for the final 10 blows. Driving records should be available for review by the Engineer during pile installation. MSE Walls

The project includes mechanically stabilized earth (MSE) retaining walls on both bridge ends. Wall height varies from a nominal 2 ft to 27 ft, with the maximum height of the walls near the center of the wall alignment and the height tapering out away from the bridge ends and parallel to the roadway. Design of MSE walls must include consideration of both internal and external stability. Design with respect to internal stability must be performed by the specific wall designer based on final plans and configurations. Analyses have been performed to verify external (global) stability and bearing capacity. Conclusions and recommendations regarding wall bearing and global stability are discussed in the following report sections.

## MSE Wall Bearing

The subgrade and foundation soils in the wall alignment generally consist of stiff to very stiff clay and silty clay with numerous chert fragments. These soils exhibit moderate shear strength and low compressibility. Depending on final grading plans, some undercut and replacement may be required to improve bearing capacity and to limit settlement. MSE wall bearing recommendations are summarized below.

- 1. Bent 1 West bridge end
  - a. Undercut the leveling pad and reinforced zone subgrade as needed to encounter the <u>very stiff</u> clay and silty clay with chert fragments (Stratum II). The undercut should extend at least 5 ft beyond the reinforced zone limits to the extent possible.
    - i. Mass undercut on the order of 4 ft, more or less, could be required to develop suitable bearing.
    - ii. Backfill any undercut with ARDOT Standard Specifications Section 303, Class 7 crushed stone aggregate base or Select Granular Backfill (AASHTO M43 No. 57).
    - iii. Nominal bearing on very stiff clay: 16,000 lbs per sq ft
- 2. Bent 3 East bridge end
  - a. Undercut the leveling pad and reinforced zone subgrade as needed to encounter the very stiff clay and silty clay with chert fragments (Stratum II). The undercut should extend at least 5 ft beyond the reinforced zone limits to the extent possible.
    - i. Mass undercut on the order of 2 ft, more or less, should be anticipated to develop suitable bearing.
    - ii. Backfill all undercuts with ARDOT Standard Specifications Section 303, Class 7 crushed stone aggregate base or Select Granular Backfill (AASHTO M43 No. 57).
    - iii. Nominal bearing on very stiff clay: 16,000 lbs per sq ft
- 3. Resistance factor ( $\varphi_b$ ) for bearing resistance: 0.65
- 4. Nominal resistance to sliding: 0.35
- 5. Resistance factor for sliding resistance ( $\varphi_{\tau}$ ): 1.0

The MSE wall leveling pads and reinforced zones should bear as recommended above and at a minimum depth of 2 ft below lowest adjacent grade. A minimum wall embedment of 2 ft and a minimum reinforcement length of 0.7H or 8 ft, whichever is greater, is recommended. Subgrade and foundation preparation in the wall locations and under all embankments must include stripping all organics and thorough proof-rolling.

The suitability of the MSE wall bearing stratum must be field verified by the Engineer or Department at the time of construction. Where undercuts are warranted, these should extend a minimum horizontal distance determined by a 1-horizontal to 1 -vertical (1H:1V) projection or at least 5 ft, whichever is greater, beyond the reinforced zone to the undercut bottom.

Where seepage into undercuts is apparent or positive drainage cannot be assured, Select Granular Backfill should be used for backfill. The crushed stone should be fully encapsulated in a filter fabric geotextile complying with ARDOT Standard Specifications Subsection 625.02, Type 2. Granular backfill should be vented to positive discharge for the relief of infiltrated surface water and/or groundwater.

## MSE Wall Global Stability

Stability analyses were performed to verify global stability of the MSE walls at both the bridge abutments. A 250 lbs per sq ft uniform surcharge from vehicles was included for the purposes of stability analyses. Stability analyses were performed using the computer program SLOPE/W 2020<sup>4</sup> and a Morgenstern-Price analysis. Three (3) general loading conditions were evaluated, i.e., End of Construction, Long Term, and Seismic Conditions. For analysis of the seismic condition, a horizontal seismic acceleration coefficient ( $k_h$ ) of one-half the peak acceleration ( $A_s$ ) was used, a value of 0.0245.

Stability analyses results for the MSE walls are summarized and presented graphically in Appendix F. The results of the stability analyses indicate that global stability of plan configurations of the MSE walls is acceptable with respect to stability of all loading conditions evaluated.

## Embankment Slopes

The bridge end embankments will utilize MSE walls at the bridge abutments and simple slopes at 3-horizontal to 1-vertical (3H:1V) configurations on the embankment sides. The bridge embankments will have maximum heights of about 28 feet.

To evaluate suitability of the side slope plan configurations, slope stability analyses were performed using the computer program SLOPE/W 2020<sup>5</sup> and utilizing a Morgenstern-Price analysis. A 250 lbs per sq ft uniform surcharge from vehicles was included for the purposes of stability analyses. Stability analyses For the embankment slopes, End of Construction, Long Term, and Seismic Conditions were evaluated. For analysis of the seismic condition, a horizontal seismic acceleration coefficient ( $k_h$ ) of one-half the peak acceleration ( $A_s$ ) was used, a value of 0.0245.

The stability analyses results summarized in Appendix F include the results of evaluation of side slopes. The results of the stability analyses indicate that plan configurations of the side slopes are acceptable with respect to stability of all loading conditions evaluated.

<sup>&</sup>lt;sup>4</sup> <u>Slope/W 2020;</u> GEO-SLOPE International; 2020.

#### Subgrade Support

The results of the borings indicate the on-site subgrade soils generally consist of silt, clay and silty clay with chert fragments (AASHTO A-2-6, A-4, A-6, and A-7-5). Given the anticipated new embankment, the approach roadway subgrade is likely to consist of embankment fill. Locallyavailable borrow, which is likely to be used as unclassified embankment fill, is expected to have similar classification.

We recommend that any soils classifying as A-7-5 or A-7-6 soils be excluded from use as subgrade within 18 in. of the plan subgrade elevation. The top 18 in. of subgrade soils should have a maximum plasticity index (PI) of 18. The as-built pavement subgrade should be evaluated by the Engineer. Areas of unstable or otherwise unsuitable subgrade should be improved by undercut and replacement or treatment with additives approved by the Engineer.

Based on the results of previous laboratory CBR tests on the silty clay with chert fragments subgrade and correlation with the AASHTO classification, we recommend the following parameters for use in design of pavements.

•	CBR:	8.3
•	Resilient Modulus (M <sub>R</sub> ):	3260 lbs per sq in.
•	R value:	13
•	Modulus of Subgrade Reaction (k):	100 lbs per cu in.

## Site Grading and Subgrade Preparation

As noted, the surface soils are silty, poorly graded, and moisture-sensitive. Though presently stable, at elevated water contents the silt and clayey silt subgrade is likely to be soft and unstable. Consequently, <u>site grading operations will be significantly easier to perform during dry seasons of the year</u>.

Site preparation will require localized clearing and grubbing and stripping the zone of organic-containing soils. The depth of stripping will be variable, with deeper stripping depths in wooded areas, and less stripping required in open land. In general, the stripping depth is estimated to be about 6 to 9 inches in clear areas but may be 18 to 24 in. or more in the localized areas where trees and thick underbrush are present. The zone of organic surface soils should be completely stripped in the embankment footprint areas and at least 5 ft beyond the projected embankment toes and outside the reinforced zone of MSE walls. Particular care must be taken to muck out all saturated and/or organic-laden soils in the existing drainage features.

Following stripping and prior to fill placement, the extent of weak and unsuitable soils should be determined. Thorough proof-rolling should be performed to verify subgrade stability.

Proof-rolling should be performed with a loaded tandem-wheel dump truck or similar equipment. Unstable soils exhibiting a tendency to rut and/or pump should be undercut and replaced with suitable fill. Care should be taken that undercuts, stump holes, and other excavations or low areas resulting from subgrade preparation are properly backfilled with compacted fill.

Depending on seasonal conditions, undercuts of about 2 to 4 ft below existing grades, more or less, could be required. Deeper undercuts may be required in wet seasons. General undercuts for site grading may be backfilled with unclassified borrow used for embankment fill. Undercuts under MSE wall foundations should be backfilled with ARDOT Standard Specifications Section 303, Class 7 crushed stone aggregate base or Select Granular Backfill (AASHTO M43 No. 57).

In lieu of undercutting and replacing unsuitable soils in approach road alignments, consideration may be given to using additives to improve soil workability and to stabilize weak areas. Hydrated lime, quick lime, Portland cement, fly ash, or suitable alternate materials may be used as verified by appropriate testing and approved by the Engineer. Additives can be effective where the depth of unstable soils is relatively shallow. Treatment will be less effective in areas where the zone of unstable soils is deep. The optimum application rate of stabilization additive must be determined by specific laboratory tests performed on the alignment subgrade soils. We recommend a minimum treatment depth of 8 inches.

Subgrade preparation and mass undercuts should extend at least 5 ft beyond the embankment toes and outside the reinforced zone of MSE walls to the extent possible. Subgrade preparation for the approach roads should extend at least 3 ft outside pavement shoulder edges to the extent possible.

Fill and backfill may consist of unclassified borrow free of organics and other deleterious materials as per ARDOT Standard Specifications Subsection 210.06. Where A-7-5 or A-7-6 soils are encountered at the subgrade elevation, we recommend that these soils be undercut as required to provide at least 18 in. of suitable low-plasticity subgrade soils, i.e., with a maximum PI of 18, or approved "hillside" cherty clay with a maximum of 35 percent passing the No. 200 sieve. Alternatively, stabilization additives may be utilized to develop a stable subgrade with a PI of 18 or less. Granular soils must be protected from erosion with a minimum 18-in.-thick armor of clayey soil.

Subgrade preparation should comply with ARDOT Standard Specifications Section 212. Embankments should be constructed in accordance with ARDOT criteria (ARDOT Standard Specifications Section 210). Fill and backfill should be placed in nominal 6- to 10-in.-thick loose lifts. All fill and backfill must be placed in horizontal lifts. The in-place density and water content should be determined for each lift and should be tested to verify compliance with the specified density and water content prior to placement of subsequent lifts.

## **CONSTRUCTION CONSIDERATIONS**

#### Groundwater and Seepage Control

Positive surface drainage should be established at the start of the work, be maintained during construction and following completion of the work to prevent surface water ponding and subsequent saturation of subgrade soils. Density and water content of all earthwork should be maintained until embankments, bridge work, and pavements are completed.

Localized perched groundwater was encountered in the borings in January 2023. Shallow perched groundwater may be encountered in the near-surface soils, particularly during wet seasons. Seepage into excavations and cuts can typically be controlled by ditching or sump-and-pump methods. If seepage infiltration cannot be controlled, construction of drains and/or the use of Select Granular Backfill (AASHTO M 43 No. 57), stone backfill (ARDOT Standard Specifications Section 207), or approved alternates to an elevation above the inflow of seepage will be warranted. In areas of seepage infiltration, the granular fill should be encapsulated with a filter fabric complying with ARDOT Standard Specifications Subsection 625.02, Type 2 and vented to positive discharge. Where surface seeps or springs are encountered during site grading, we recommend the seepage be directed via French drains or blanket drains to positive discharge at daylight or to storm drainage lines. Piling

Piles should be installed in compliance with ARDOT Standard Specifications, Section 805. Piles should be carefully examined prior to driving and piles with structural defects should be rejected. Any splices in steel piles should develop the full cross-sectional capacity of un-spliced piles. Preboring should be anticipated for pile installation. Some rock drilling could be required for prebores. Where piles are prebored to develop uplift resistance, the annulus between the steel piles and the prebore should be expeditiously backfilled with approved grout or concrete.

Pile installation should be monitored by qualified personnel to maintain specific and complete driving records and observe pile installation procedures. Safe bearing capacity of production piles should be determined by ARDOT Standard Specifications Section 805.09, Method A. Driving records should be available for review by the Engineer during pile installation. For driving steel piles on this project, we recommend a minimum hammer energy of 34,000 ft-lbs

per blow. Blow counts on steel piles should be limited to about 20 blows per inch. Practical pile refusal may be defined as a penetration of 0.5 in. or less for the final 10 blows.

## **CLOSURE**

The Engineer or Department or a designated representative thereof should monitor site preparation, grading work and foundation and pavement construction. Subsurface conditions significantly at variance with those encountered in the borings should be brought to the attention of the Geotechnical Engineer. The conclusions and recommendations of this report should then be reviewed in light of the new information.

The following illustrations are attached and complete this final report.

Plate 1	Site Vicinity
Plate 2	Plan of Borings
Plates 3 through 16	Boring Logs
Plates 17 and 18	Keys to Terms and Symbols
Appendix A	Preliminary Bridge Layout
Appendix B	Selected Rock Core Photographs
Appendix C	Classification Test Results
Appendix D	Generalized Subsurface Profile
Appendix E	Nominal HP14x73 Uplift Pile Capacity Curves
Appendix F	Stability Analyses Results

We appreciate the opportunity to be of service to you on this project. Should you have any questions regarding this report, or if we may be of additional assistance, please call on us.

Sincerely,

# GRUBBS, HOSKYN, BARTON &WYATT, LLC

ellet M. Sc Velleta M. Sco Sr. Project En Mark E. Wyatt President

VMS/MEW:jw

Copies Submitted:	Garve	r LLC	
	Attn:	Mr. Joel Skinner, P.E.	(1-email)
	Attn:	Mr. Lawren Wilcox, P.E.	(1-email)
	Attn:	Mr. Adam Wierciak, P.E.	(1-email)



**A UES Company** 

090069 Malone Lane over XNA Access Road **Benton County, Arkansas** 

Plate 1



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Grubbs, Hoskyn, Inc.     Grubbs, Hoskyn,		19-11	8														
TYPE:         Auger to 15 ft Wash         LOCATION: Approx Sta 22+36, CL           Li         DESCRIPTION OF MATERIAL         Super Lot 15 ft Wash         COMESION, TON/SQ FT         Super Lot 15 ft Wash           SURF. EL:         12412         DESCRIPTION OF MATERIAL         Super Lot 15 ft Wash         Comesion, TON/SQ FT         Super Lot 15 ft Wash           SURF. EL:         12412         Tot 15 ft Wash         DESCRIPTION OF MATERIAL         Super Lot 12 tot 15 ft         DESCRIPTION OF MATERIAL         Super Lot 12 tot 15 ft         Super Lot 12 tot 12		Gru Bar Consi	ibk toi	os, Hoskyn, n & Wyatt, Inc. g Engineers Ber	BC Land	<b>) R I</b> e ove Co., A	<b>N G</b> r XNA ırkans	N C A Acc sas	<b>). S</b> æss l	<b>57</b> Road							
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5         Woderately hard very light gray weathered cherty limestone wivery close reddish brown cherty clay seams and layers and discontinuous chert beds         50/5"         0			. 🛛		15			•			-NOM	I-PLA	STIC-		39		
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W/very close reddish brown cherty close seams and layers and discontinuous chert beds         50/5"           10         50/3"           115         50/3"           20         25/0"           20         25/0"           20         25/0"           25/0"         25/0"           20         25/0"           21         25/0"           25/0"         25/0"           25/0"         25/0"           25/0"         25/0"           25/0"         25/0"           25/0"         25/0"           25/0"         25/0"           25/0"         25/0"           25/0"         25/0"           25/0"         25/0"           25/0"         25/0"           25/0"         25/0"				Moderately hard very light gray weathered cherty limestone	50/5'												
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- 65 -													-		

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- 50 -			25/0"											
- 55 -			25/0"											
- 60 -			25/0"											
- 65 -		Moderately hard gray cherty limestone, flat bedded						q <sub>u</sub> = 2	830 p	si, TU	N= 14	7 pcf		100 67
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- 5 -		X	Stiff to very stiff reddish brown	50/7"					•							
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- 45 -		Moderately hard light gray and	25/0	,	1		20	30	40 5	50	60	70			_
- 50 -		gray slightly weathered cherty limestone, flat bedded	•											87	70
- 55 -														97	55
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- 70 -													-		
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		Gru Bar Consu	ibk toi	n & Wyatt, Inc. g Engineers Benton	<b>ORI</b> ne ove Co., A	<b>N G</b> er XN Arkan	A Aco sas	<b>D. S</b> cess	60 Road	ł					
		TYPI	Ξ:	Auger	LC	CATIO	ON:	Appro	x Sta	22+04	I, 74 ft	Lt			
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			X	Loose brown and tan fine sandy silt, slightly clayey	4			•							
			X	Stiff to very stiff reddish brown clay w/chert nodules and fragments	32				• -	••	₽ ₽				23
	5 -		X	- with discontinuous chert seams and layers below 4 ft	50/7'					•					
•			X		50/3'	,			•						
			X		50/4'	'n			•						
	10 -														
	15 -			- with more chert fragments below 14 ft	25/0'	,									
				Note: Practical refusal in											
		-		hard chert bed or cherty limestone											
	20 -														
-2-23															
IE RD.GPJ 6	25 -	-													
9-118_MALON															
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19-11	3								
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TYPE	: Auger	LC	CATIO	ON: Appro	ox Sta 22	2+35, 40 ft	Lt		
DEPTH, FT SYMBOL	DESCRIPTION OF MATERIAL	SLOWS PER FT	UNIT DRY WT LB/CU FT	0.2 PLASTIC LIMIT	COHES 0.4 0.6		/SQ FT	LIQUID LIMIT	- No. 200 %
	Medium dense dark brown silt w/ chert nodules and trace organics	12		10	20 30	40 5	50 60	70	76
	Stiff red and reddish brown clay w/chert nodules and fragments	19		•					
- 5 -	- stiff to very stiff with discontinuous chert seams and layers below 4 ft	50/6"		•					
	X	50/4"							
10	X	50/6"			•				_
	X	50/4"			•				_
	X	50/3"		•					_
		25/0"							_
	PLETION DEPTH: 25.0 ft : 1-19-23	DEPTH T	FO WANG: D	ATER Iry			DAT	E: 1/19/2	023

Г		19-11	8									
(		Gru Bar Consu	to Iting	os, Hoskyn, n & Wyatt, Inc. g Engineers D90069 Malone Lan Benton 0	<b>) R I</b> e ove Co., <i>P</i>	<b>NG</b> er XN/ Arkan:	NO. A Acces sas	<b>S62</b> ss Roa	d			
		TYPI	Ξ:	Auger	LC	CATIO	DN: Ap	prox Sta	1 22+44, 34	ft Rt		
	⊢				Ē	Ę.		COH	ESION, TO	N/SQ F1	Γ	8
	щ	BOL	2LEO		PER	RY V U FT	0.2	0.4	0.6 0.8	1.0 1	.2 1.4	500 %
	DEPT	SYM	SAMI		LOWS	UNIT D LB/C	PLAST LIMI	TIC T		Г	LIQUII LIMIT	No.
╞		****	-	SURF. EL: 1242±	m	<b>–</b>	10	20	30 40	50 6	<u>60 70</u>	
			X	nodules	3			•				
			X	Stiff to very stiff tan and gray silty clay w/ numerous chert nodules and fragments	31		•	<b>+</b> -				33
	5 -		X	- reddish brown with discontinuous chert seams and layers below 4 ft	50/7"			•				
			X		50/5"			•				
	10 -				25/0"							
F			4	;	25/0"							
	15 -			Note: Practical refusal in hard chert bed or cherty limestone								
	20 -											
NE RD.GPJ 5-23-2	25 -											
19-118_MALOI												
LGBNEW		COMI DATE	PLE : 1	-20-23 IN	PTH T BORII	ro Wa NG: D	TER ry			DA	TE: 1/2	20/2023

	19-118	3												
	Gru Bar <sub>Consu</sub>	bb toi Iting	<b>bs, Hoskyn,</b> <b>a Wyatt, Inc.</b> Engineers Engineers LOGOFB 090069 Malone Lar Benton	<b>D R I</b> ne ove Co., <i>I</i>	<b>NG</b> er XN/ Arkan:	N C A Acc sas	<b>). S</b> cess	<b>63</b> Road	1					
	TYPE	Ξ:	Auger	LC	CATIO	DN:	Appro	ox Sta	22+09	, 67 ft	Rt			
		0		۴T	۲۷-			COHE	SION	, TON/	SQ FT			%
TH, F	MBOL	<b>APLES</b>	DESCRIPTION OF MATERIAL	S PEF	DRY / CU FI	0	.2 (	0.4 (	0.6 0	).8 1 I	.0 1.	2 1.	4	200
DEP	SYI	SAN		NOU	UNIT LB/	PLA LI	ASTIC IMIT		WA CON	TER TENT		Liqu Limi	ID T	NON -
		$\left  \right $	l oose tan fine sandy silt w/ chert			1	0	20	30 4	40 5	6 6	0 7	0	
		X	nodules	4				•						87
			Very stiff tan and gray clayey silt w/chert nodules and fragments	50			•	+ -	+					36
- 5 -		X	Stiff to very stiff reddish brown and gray clay w/chert nodules and fragments and discontinuous chert seams and layers	50/9"			•							
		X		50/4"		•								
- 10 -		X		50/6"										
15		Ħ,		2 <u>5/0"</u>										
	-		Note: Practical refusal in hard chert bed or cherty limestone											
	-													
- 20 -	-													
	-													
	-													
25 -	-													
	1 - - -													
	COMF	PLE	TION DEPTH: 14.5 ft D	EPTH		TER	1	1	1	1			100/05	
	DATE	: 1	-20-23 IN	I BORII	NG: D	ry					DA	TE: 1/	/20/20	23

	19-118												
	Grub Barto Consulting	os, Hoskyn, n & Wyatt, Inc. g Engineers LOGOFBO 090069 Malone Lan Benton	<b>D R I</b> le ove Co., A	<b>NG</b> er XN Arkan	N C A Acc sas	<b>). S</b> cess	64 Road	ł					
	TYPE:	Auger	LC	CATIO	DN:	Appro	ox Sta	24+78	, 60 ft L	.t			
			F	5			COHE	ESION,		SQ FT			<b>`</b> 0
Ц Ц Ц	IBOL PLES	DESCRIPTION OF MATERIAL	PER	NY V U FT	0.	.2 (	).4	0.6 0	.8 1.0	) 1.: I	2 1.	4	200 %
DEP1	SYN SAM		-OWS	UNIT D	PLA LI	ASTIC IMIT		WA CON	TER TENT			ID T	- No.
		SURF. EL: 1244±			1	<b>T</b>	20	<u>30</u> 4	0 50	) 60	) 7(	)	
		- with discontinueous chert seams	31			•	+-						37
		and layers below 2.5 ft	50/7'										
- 5 -			50/6"					•					
			50/3"			•							
- 10 -			25/0"			•							
		Note: Practical refusal in hard chert bed or cherty limestone											
15													
GUNE	DATE: 1	- IION DEPTH: 10.0 tt DE I-19-23 IN	BORI	NG: D	NIER ry					DA	ΓE: 1/	19/20	23

<b>—</b>	19-118	8												
	Gru Bar <sub>Consu</sub>	bb Or ting	s, Hoskyn, & Wyatt, Inc. <sub>Engineers</sub> LOGOFBO 090069 Malone Lan Benton	<b>D R I</b> le ove Co., <i>F</i>	<b>NG</b> er XN Arkan	<b>N</b> A Ac sas	O. S	<b>S65</b> s Ro	ad					
	TYPE		Auger	LC	CATIO	ON:	Аррі	rox S	ta 22+1	0, 67 ft	Rt			
			<u> </u>	Ŀ	F			СО	HESION		/SQ FT	-		
Ξ.	BOL	PLES		PER	RY √		0.2	0.4	0.6	0.8	1.0 1	.2 1	.4	200 %
DEPT	SYM	SAMI	DESCRIPTION OF WATERIAE	-OWS	UNIT D	PL		С	W COI			LIQU LIM	ID IT	- No.
	88554		SURF. EL: 1244±	B			10	20	30	40	50 6	60 7	0	
			w/ chert nodules and trace organics											
		X	Soft reddish tan silty clay w/ chert	5				-						
			nodules											
			Very stiff reddish brown silty clay w/numerous chert nodules and											
		V	fragments and discontinuous chert seams and lavers	50/4"										
		Д	,											
		$\overline{\mathbf{M}}$							₽└──					27
- 5 -		Ň		50/9"					·	•				
		M		50/3"		•	•							
		Δ						_						
		X		50/5'										
- 10 -		ļ	/											
	-		Note: Practical refusal in											
	-		hard chert bed or cherty limestone											
	-													
3														
2-62-6														
19. 	-													
	-													
	-													
° <mark>  15</mark> _	COMF	PLE	TION DEPTH: 9.5 ft DE	EPTH <sup>-</sup>	I TO WA									
	DATE	1	-19-23 IN	BORI	NG: D	ry					DA	TE: 1	/19/20	23

<b></b>	19-118													
	Grul Bart Consul	bb: on	s, Hoskyn, & Wyatt, Inc. Engineers Bent	<b>B O R I</b> Lane ove on Co., <i>I</i>	<b>NG</b> er XN/ Arkan:	NC A Acc sas	). S æss	<b>66</b> Roa	d					
	TYPE	: /	Auger	LC	CATIO	DN: /	Appro	ox Sta	24+58	3, 38 ft	Rt			
│⊢		~		E	۲Ľ			СОН	ESION	, <b>TON</b> /	SQ FT	-		%
TH, F	MBOL	1PLES	DESCRIPTION OF MATERIAL	S PEF		0.	2 (	0.4	0.6	0.8 1	.0 1	.2 1	.4	200
DEP	SYI	SAN		LOW:	UNIT LB/	PLA LI			WATER CONTENT			LIQUID LIMIT		- No.
			SURF. EL: 1242±	8	-	10	0 2	20	30	<u>40 5</u>	50 E	0 7	0	
			clayey w/ chert nodules											
		X		5				T						
		_												
			Stiff to very stiff tan silty clay w/chert nodules and											
		∬ ¹	fragments				•							
		1		27										
		,	Very stiff reddish brown and tan											
			silty clay w/numerous chert nodules and fragments and					<b>↓</b> +		·  •	T			29
- 5 -		Ŵ	discontinuous chert seams and lavers	50/11										
		X		50/7"				•						
		$\overline{\mathbf{X}}$		50/4"										
- 10 -		4.		25/0"										-
			Note: Practical refusal in hard chert bed or cherty											
			limestone											
3														
2-02-0														
15		LE.	TION DEPTH: 10.0 ft	DEPTH									100.100	
	DATE:	1-	20-23	IN ROKI	NG: D	чy					DA	i⊨: 1	120/20	23

	19-118	}													
	Gru Bar <sub>Consu</sub>	bb Or ting	s, Hoskyn, <b>&amp; Wyatt, Inc.</b> Engineers Engineers LOGOFI 090069 Malone I Bento	BORI ₋ane ove on Co., /	<b>NG</b> er XN Arkan	A Acosas	<b>D.</b> ces:	<b>S67</b> s Ro	, ad						
	TYPE	:	Auger	LC	CATIO	ON:	Арр	rox S	ta 24+	90,	78 ft	Rt			
			5	Ŀ	E			СО	HESIC	DN, '	TON/	SQ F1	<b>-</b>		
H, FT	30L	LES		PER	U FT	C	).2	0.4	0.6	 8.0 	) 3 1.	.0 1	.2 1	.4	% 00
DEPTI	SYME	SAMP		STOWS I	UNIT DI LB/CI	PL. L	ASTI IMIT	c 	/ 		TER LIQUID ITENT LIMIT ●+			JID IT	- No. 2
			Loose tan silt_slightly sandy w/	ш			10	20	30	40	5	06	60 T	70	
		X	chert nodules	4				•							79
		X	Stiff to very stiff reddish brown an tan silty clay w/chert nodules and fragments	d 48			•								-
- 5 -		X	- with discontinuous chert seams and layers below 4 ft	50/3'	E.										-
		X		50/7'	T										-
- 10 -				50/5											-
				25/0'			 								
15	-		Note: Practical refusal in hard chert bed or cherty limestone	<b>_</b> _											-
	COMF DATE	LE	TION DEPTH: 11.5 ft -20-23	DEPTH IN BORI	TO WA NG: 1	ATER 2 ft						DA	TE: 1	/20/20	23



Technical Memorandum No.3-357, Waterways Experiment Station, March 1953

Grubbs, Hoskyn, Barton & Wyatt, Consulting Engineers	Inc.	BORIN	G LOG TERMS	S – ROCK
ROCK TYPES (SHOWN IN SYMBOLS COLU	JMN)	Sandstone Limestone	Siltstone	Coal Shale
Joint Characteristics —	<u>Spacing</u> Very Close Close Moderately Close Wide	0.75 to 2.5 in. 2.5 to 8 in. 8 to 24 in.	Degree of Weathering —	Fresh — No visible signs of decomposition or discoloration. Rings under hammer impact.
Bedding Characteristics —	Very Wide Very Thin Thin Medium Thick	2 to 6 tf More than 6 ft 0.75 to 2.5 in. 2.5 to 8 in. 8 to 24 in. 2 to 6 ft		Slighty Weathered — Slight discoloration inwards from open fractures, otherwise similar to fresh. Moderately Weathered — Discoloration
Lithologic Characteristics —	Massive Clayey Shaly Calcareous (limy) Siliceous	More than 6 ft		throughout. Weaker minerals such as feldspar decomposed. Strength somewhat less than fresh rock, but cores cannot be broken by hand or scraped by knife. Texture preserved.
Parting — Seam — Layer —	Sandy (Arenaceous) Silty Plastic Seams Less than 1/1 6inc 1 /1 6o 1 /2inch 1 /2to 1 2inches	h		Highly Weathered — Most minerals somewhat decomposed. Specimens can be broken by hand with effort or shaved with knife. Core stones present in rock mass. Texture becoming indistinct but fabric
Stratum – Hardness–	Greater than 1 2inc Soft (S) - Reserved Friable (F) - Easily pulverized or reduce to be cut with a po	thes I for plastic material alone. crumbled by hand, ed to powder and is too sof ocket knife.	ł	Completely Weathered — Minerals decomposed to soil but fabric and structure preserved (Saprolite). Specimens easily crumbled or penetrated.
	Low Hardness (LH) or carved with a po Moderately Hard (Mi scratched by a knif heavy trace of dust	<ul> <li>Can be gouged deeply ocket knife.</li> <li>Can be readily</li> <li>blade; scratch leaves a and scratch is readily</li> </ul>		Residual Soil – Advanced state of decomposition resulting in plastic soils. Rock fabric and structure completely destroyed. Large volume change.
	visible after the pov Hard (H) – Can be scratch produces lit faintly visible; traces be visible.	wder has been blown away. scratched with difficulty; tle powder and is often s of the knife steel may	Solution and Void Conditions –	Solid, contains no voids Vuggy (pitted) Vesicular (igneous) Porous Cavities
	Very hard (VH) – C a pocket knife. Knit surface.	Cannot be scratched with fe steel marks left on	Swelling Properties —	Nonswelling Swelling
Texture —	Fine — Barely seen Medium — Barely se Coarse — 1 /8in. †	with naked eye een up to 1/8 in. o 1 /4 in.	Properties – Rock Quality	Nonslaking Slakes slowly on exposure Slakes readily on exposure
Structure -	Bedding Flat - 0° - 5' Gently Dipping - Moderately Dippi Steeply Dipping Fractures, scattered Open	- 5° – 35° ng – 55° – 85° – 55° – 85°	Designation (RQD) –	RQD (Percent)Diagnostic DescriptionGreater than 90Excellent75 - 90Good50 - 75Fair25 - 50PoorLess than 25Very Poor
	Fractures, closely sy Open Cemented Brecciated (Sheared Open Cemented	or Tight or Tight and Fragmented) or Tight		
	Faulted Slickenside	85		

APPENDIX A



DATE REVISED	DATE FILMED	DATE REVISED	DATE FILMED	FED. ROAD DIST. NO.	STATE	FED. AID PROJ. NO.	SHEET NO.	TOTAL SHEETS
				6	ARK.			
				JOB N	o <b>.</b>	090069 \$	SN8101	\$ \$ST\$
			()	\$BN08\$		LAYOUT	\$[	DN8101\$



#### VERTICAL CURVE DATA

Malone Ln. (Theoretical Grade Along CL Construction)

NOTES: For "PROJECT GENERAL NOTES", see Dwg. No. \$DN0201\$.

For "ELEVATION OF SOIL BORINGS", "N-VALUES", "BORING LEGEND", and "GENERAL NOTES", see Dwg. No. \$DN8102\$.

Use Type F Approach Gutters at each end of bridge. See Std. Dwg. No. 55030F.

Stations shown are along CL Construction. Elevations shown are theoretical working point elevations at CL Bridge. Any vertical dimension referenced to CL Deck Is based on theoretical working point elevation at CL Bridge. See "Rounding Detail" on Standard Drawing No. 55007 for additional information.

SOIL BORINGS NOT AVAILABLE AT TIME OF PRINTING

SHEET 1 OF 2 LAYOUT OF BRIDGE MALONE LN. OVER XNA ACCESS RD. NORTHWEST ARKANSAS NATIONAL AIRPORT ACCESS (F) BENTON COUNTY ROUTE \$RT\$ SEC. \$SC\$

PRELIMINARY NOT FOR CONSTRUCTION ARKANSAS STATE HIGHWAY COMMISSION

LITTLE ROCK, ARK.

HEW DATE: JULY 2022 FILENAME: b090069x8\_L1.dgn DRAWN BY JES DATE: SEPT. 2022 CHECKED BY: SCALE: 1" = 20"-0" DESIGNED BY: MAS DATE: JULY 2022 BRIDGE NO. \$BN08\$ DRAWING NO. \$DN8101\$

BRIDGE ENGINEER

# **APPENDIX B**






# **APPENDIX C**

# SUMMARY of CLASSIFICATION TEST RESULTS

PROJECT: 090069 XNA Access Road over Malone Lane LOCATION: Benton County, Arkansas GHBW JOB NUMBER: 19-118

BORING	SAMPLE	WATER	ATTERBERG LIMITS			SIEVE ANALYSIS							USCE		
		CONTENT	LIQUID	PLASTIC	PLASTICITY	PERCENT PASSING							CLASS	CLASS	
110.	DEI III (II)	(%)	LIMIT	LIMIT	INDEX	2 in.	1 in.	3/4 in.	3/8 in.	#4	#10	#40	#200	CLASS.	CLASS.
S57	2.5-3.5	15	1	NON-PLASTI	С								39	GM	A-4
S58	0.5-1.5	13	1	NON-PLASTI	C								41	GM	A-4
S59	6.5-7.5	19	56	32	24								36	GC	A-7-5
S60	2.5-3.5	22	39	28	11					77			23	SC	A-2-6
S61	0.5-1.5	25	1	NON-PLASTI	C					97			76	ML	A-4
S63	0.5-1.5	22								96			87	ML	A-4
S63	2.5-3.5	12	31	22	9					80			36	SC	A-4
S64	0.5-1.5	17	35	23	12					63			37	SC	A-6
S65	4.5-5.5	15	45	26	19					47			27	GC	A-2-7
S66	4.5-5.5	20	49	26	23					73			29	SC	A-2-7
S67	0.5-1.5	19								89			79	ML	A-4

# **APPENDIX D**



# **APPENDIX E**







# **APPENDIX** F

### Summary of Stability Analysis Results 090069 XNA Access Road – Malone Lane over XNA Access Road GHBW Job No. 19-118 Benton County, Arkansas

	Design Loading Condition	Calculated Minimum Factor of Safety			
	End of Construction	3.90			
West MSE Wall Bent 1	Long Term	3.01			
	Seismic ( $k_h = A_S/2 = 0.0245$ )	3.19			
	End of Construction	3.98			
West Side Slope Bent 1 (3H:1V)	Long Term	3.26			
	Seismic ( $k_h = A_S/2 = 0.0245$ )	3.67			
	End of Construction	2.98			
East MSE Wall Bent 3	Long Term	2.41			
	Seismic ( $k_h = A_S/2 = 0.0245$ )	2.72			
	End of Construction	4.35			
East Side Slope Bent 3 (3H:1V)	Long Term	3.21			
× /	Seismic ( $k_h = A_s/2 = 0.0245$ )	4.01			





Results of Stability Analyses – End of Construction Bent 1 - West MSE Wall H=27 ft  $\pm$ 19-118 - 090069 Malone Lane over XNA Access Road





Results of Stability Analyses – Long Term Condition Bent 1 -West MSE Wall H=27 ft  $\pm$ 19-118 - 090069 Malone Lane over XNA Access Road





Results of Stability Analyses – Seismic Condition ( $k_h = A_S / 2 = 0.0245$ ) Bent 1 – West MSE Wall H=27 ft ± 19-118 - 090069 Malone Lane over XNA Access Road





Results of Stability Analyses – End of Construction Bent 1 - West Side Slope 3H:1V Slope, H=29 ft ± 19-118 - 090069 Malone Lane over XNA Access Road





Results of Stability Analyses – Long Term Condition Bent 1 - West Side Slope 3H:1V Slope, H=29 ft ± 1919-118 - 090069 Malone Lane over XNA Access Road





 $\begin{array}{l} \mbox{Results of Stability Analyses - Seismic Condition} (k_h = A_S \slashed{A_S} = 0.0245) \\ \mbox{Bent 1 - West Side Slope} \\ \slashed{3H:1V Slope, H=28 ft $\pm$} \\ \mbox{19-118 - 090069 Malone Lane over XNA Access Road} \end{array}$ 





Results of Stability Analyses – End of Construction Bent 3 – East MSE Wall H=23 ft  $\pm$ 19-118 - 090069 Malone Lane over XNA Access Road





Results of Stability Analyses – Long Term Condition Bent 3 – East MSE Wall H=23 ft  $\pm$ 19-118 - 090069 Malone Lane over XNA Access Road





Results of Stability Analyses – Seismic Condition ( $k_h = A_S / 2 = 0.0245$ ) Bent 3 – East MSE Wall H=23 ft ± 19-118 - 090069 Malone Lane over XNA Access Road





Results of Stability Analyses – End of Construction Bent 3 – East Side Slope 3H:1V Slope, H=26 ft ± 19-118 - 090069 Malone Lane over XNA Access Road





Results of Stability Analyses – Long Term Condition Bent 3 - East Side Slope 3H:1V Slope, H=26 ft ± 19-118 - 090069 Malone Lane over XNA Access Road





 $\begin{array}{l} \mbox{Results of Stability Analyses - Seismic Condition} (k_h = A_S \ /2 = 0.0245) \\ \mbox{Bent 3 - East Side Slope} \\ \ 3H: 1V \ Slope, \ H = 26 \ ft \pm \\ 19-118 \ - \ 090069 \ Malone \ Lane \ over \ XNA \ Access \ Road \end{array}$ 

