Retaining Wall Report

Hwy 270 – Hwy 227 to Ouachita River (Widening) (S)
AHTD Job No. CA0607, Task Order No. C069
Hot Springs, Garland County, Arkansas
January 30, 2017, Revised March 7, 2018
Terracon Project No. 35145118

Prepared for:
Buchart Horn, Inc.
Memphis, Tennessee

Prepared by:
Terracon Consultants, Inc.
Little Rock, Arkansas

January 30, 2017, Revised March 7, 2018

Terracon

Buchart Horn, Inc.
3150 Lenox Park Boulevard, Suite 300
Memphis, Tennessee 38115

Attn: Mr. Andy Pinkley, P.E., CPESC
P: [901] 363 6355

Re: Retaining Wall Report - Final
Hwy 270 – Hwy 227 to Ouachita River (Widening) (S)
AHTD Job No. CA0607, Task Order No. C069
Hot Springs, Garland County, Arkansas
Terracon Report No. 35145118

Dear Mr. Pinkley:

Terracon Consultants, Inc. (Terracon) has completed the geotechnical engineering services for the above-referenced project. This study was performed in general accordance with the scope of services outlined in our Proposal Number P35140348 dated December 2, 2014. The project was authorized per the Master Services Agreement signed December 11, 2014. This report presents results for AHTD Job No. CA0607, Hwy 270 Widening project from Hwy 227 to Ouachita River in Hot Springs, Garland County, Arkansas. This report provides recommendations for designing and constructing retaining walls planned for the project.

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

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

Shaun P. Baker, P.E.
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Arkansas No. 11817

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Senior Staff Engineer

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Licensed in MO and KS

STATE OF ARKANSAS 3/7/2018 LICENSED PROFESSIONAL ENGINEER No.11817 SHAUN P. BAKER

Enclosures
cc: pdf - Addressee

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AHTD JOB NO. CA0607, TASK ORDER NO. C069
HOT SPRINGS, GARLAND COUNTY, ARKANSAS

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1.0 INTRODUCTION

This report presents the results of the geotechnical engineering services completed for the AHTD Job No. CA0607, U.S. Highway 270 widening project from Arkansas Highway 227 to Ouachita River in Hot Springs, Garland County, Arkansas. Twenty-one exploratory borings extending to depths of approximately 9 to 23.6 feet below existing ground surface were drilled in the planned retaining wall areas. The boring logs, site plan and boring location plans are attached.

This report describes the subsurface conditions observed in the borings, presents the laboratory test results, and provides recommendations for designing and constructing retaining walls.

2.0 PROJECT INFORMATION

2.1 Project Description

Item	Description
Site layout	See Appendix A, Exhibits A-2 to A-8, Boring Location Plan
Structures	We understand the project involves widening of about 3 miles of Highway 270. Twelve rigid, cantilever-type retaining walls are planned to retain existing fill, new fill, native soils, and rock. Retaining Wall 1: Station 98+50RT to 99+50RT Approximately 2 to 3 feet high, 100 feet long in cut area Retaining Wall 2: Station 142+10RT to 143+20RT Approximately 1.5 to 4 feet high, 110 feet long in fill area Retaining Wall 3: Station 151+00RT to 152+25RT Approximately 1 to 2 feet high, 125 feet long in cut area

Item	Description
Structures (continued)	Retaining Wall 4: Highway 270 Station 152+99.25RT to 155+00RT Approximately 4 to 5 feet high, 200 feet long in cut area Retaining Wall 5: Highway 270 Station 153+40LT to 154+30LT Approximately 4.5 to 5.5 feet high, 90 feet long in fill area Retaining Wall 6: Highway 270 Station 154+70LT to 156+15LT Approximately 2 to 7.5 feet high, 145 feet long in fill area Retaining Wall 7: Highway 270 Station 159+45LT to 161+26LT Approximately 2 to 12.5 feet high, 181 feet long in fill area Retaining Wall 8: Highway 270 Station 160+75RT to 164+13RT Approximately 2 to 7 feet high, 338 feet long in cut area Retaining Wall 9: Highway 270 Station 163+64LT to 165+45LT Approximately 2 to 3.5 feet high, 181 feet long in fill area Retaining Wall 10: Highway 227 Station 16+50LT to 18+85LT Approximately 2 to 8.5 feet high, 235 feet long in fill area Retaining Wall 11: Highway 270 Station 181+57RT to 182+62RT Approximately 0.5 to 1.6 feet high, 105 feet in cut area Retaining Wall 12: Highway 270 Station 183+72LT to 184+70LT Approximately 1 to 1.5 feet high, 98 feet in fill area

2.2 Site Location and Description

Item	Description
Location	See Appendix A, Exhibit A-1, Site Location Plan U.S. Highway 270 between Arkansas Highway 227 and the Ouachita River in Hot Springs, Garland County, Arkansas Latitude N34.508779°, Longitude W93.177259° (western extent) Latitude N34.503322°, Longitude W93.125961° (eastern extent)
Existing improvements	Highway 270, two-lane highway with three lanes on both the eastern and western ends of the project alignment Highway 227, four-lane highway Asphaltic concrete pavement Some of the properties fronting the Highway 270 are developed residences and commercial properties. Asphalt- and gravel-covered parking lots and drives were present in some of the retaining wall areas
Grading	Cuts up to about 7 feet and fills up to about 12.5 feet

3.0 SUBSURFACE CONDITIONS

3.1 Geology

Formation [1]	Description [2]
Stanley Shale (M_s) **Mississippian Period**	The Stanley Shale is composed of dark-gray shale interbedded with fine-grained sandstone. A thick sandstone member, the Hot Springs Sandstone, is found near the base of the sequence and an equivalent thin conglomerate/breccia occurs at the base of the unit in many other places. Stratigraphically minor amounts of tuff, chert, bedded and vein barite, and conglomerate have also been noted in various parts of the sequence.

1. Interactive Geologic Map of Arkansas and Geological Google Earth files published by the Arkansas Geological Survey, 2015, www.geology.ar.gov
2. "Stratigraphic Summary of Arkansas", published by the Arkansas Geological Commission, 1998, revised 2004.

3.2 Typical Profile

Based on the results of the borings, subsurface conditions at the retaining wall borings can be generalized as follows:

Description	Approximate Depth to Bottom of Stratum (feet)	Material Observed	Consistency/Density
Stratum 1	1 to 10 at all borings Below termination depth of 10 feet at Boring W10-B-2A	Fill: Lean clay, sandy lean clay, gravelly lean clay, sandy gravel	N/A
Stratum 2	2 to 8.5	Native soils: Lean clay, shaley lean clay, and gravelly lean clay	Stiff to hard
Stratum 3	Below termination depths of 8.8 to 23.7 at all borings except Boring W10-B-2A	Shale	Highly weathered / Soft to moderately hard

Conditions and details observed at the boring locations are indicated on the boring logs included in Appendix A. Stratification boundaries on the boring logs represent the approximate location of changes in soil and rock types; in-situ, the transition between materials may be gradual.

Atterberg limits (liquid limit and plastic limit) tests, percent passing the No. 200 sieve (P200), and sieve analysis tests were performed on representative samples of native soils and existing fill to aid in classification. The tested native soils were classified as lean clays (CL) having low to medium plasticity. The laboratory test results are shown on the boring logs in Appendix A. A description of the laboratory testing program is provided in Appendix B.

4.0 RECOMMENDATIONS FOR DESIGN AND CONSTRUCTION

4.1 Geotechnical Considerations

4.1.1 Existing Fill Materials

As previously noted, fill was observed in many of the borings drilled at the site during this study. We do not possess any information regarding how the fill was placed; we have considered fills were placed as specified by AHTD and under the observation of AHTD personnel when the roadway was originally constructed.

The fill at some of the boring locations, specifically Borings W2-B-1, W2-B-2, W3-B-1, W3-B-1A, W8-B-1A, W8, B-2, and W1-B-2A, appears to have low shear strength based on SPT blow counts of 5 or less. The fill consisted of sandy gravel, gravelly lean clay, and lean clay soils. Because the fill appears to have varying composition and SPT blow counts (N-values), it is our opinion the existing fill is not suitable for supporting the retaining walls in its current condition and will require improvement. We recommend thorough testing and evaluation

during construction to identify unsuitable fill materials within the limits of the retaining wall construction.

4.2 Earthwork

Earthwork should be performed as required in the Arkansas State Highway and Transportation Department *"Standard Specifications for Highway Construction,"* 2014 edition. The following presents general recommendations for site preparation, excavation, subgrade preparation and placement of engineered fills on the project. The evaluation of earthwork should include overexcavation operations, observation and testing of engineered fills, subgrade preparation, and other geotechnical conditions exposed during construction of the project.

4.2.1 Site Preparation

Surface vegetation, pavement, topsoil, trees and root systems, and any other existing surface or subsurface structures should be removed from the construction area. Excavations resulting from the removal of any surface or subsurface structures should be cleaned of all loose and disturbed material before placing fill. Soils containing organic matter, debris or deleterious matter should not be used as engineered fill. Areas requiring new fill placement should be initially graded to create a relatively level surface to receive fill and to provide for a relatively uniform thickness of fill beneath the retaining walls. The exposed subgrade should be proofrolled prior to placing fills to confirm there are no unstable areas that could prevent proper compaction of additional fills. If unstable areas are noted, the geotechnical engineer should be notified to provide supplemental recommendations.

The following table provides an estimate of the cuts and fills at the retaining walls and the anticipated retaining wall bearing materials, based on the subsurface conditions observed at the boring locations and the current design plans available at the time of preparing this report.

Retaining Wall / Location	Estimated Cut/Fill	Expected Foundation Bearing Material
Retaining Wall 1 Highway 270 Station 98+50RT to 99+50RT	4 Feet (Cut)	Highly Weathered Shale
Retaining Wall 2 Highway 270 Station 142+10RT to 143+20RT	4 Feet (Fill)	Existing Gravelly Lean Clay Fill
Retaining Wall 3 Highway 270 Station 151+00RT to 152+25RT	3 Feet (Cut)	Lean Clay Fill

Retaining Wall / Location	Estimated Cut/Fill	Expected Foundation Bearing Material
Retaining Wall 4 Highway 270 Station 152+99.25RT to 155+00RT	6 Feet (Cut)	Native Shaley Lean Clay
Retaining Wall 5 Highway 270 Station 153+40LT to 154+30LT	6 Feet (Fill)	Highly Weathered Shale
Retaining Wall 6 Highway 270 Station 154+70LT to 156+15LT	9 Feet (Fill)	Highly Weathered Shale
Retaining Wall 7 Highway 270 Station 159+45LT to 161+26LT	10 Feet (Fill)	Highly Weathered Shale
Retaining Wall 8 Highway 270 Station 160+75RT to 164+13RT	8 Feet (Cut)	Highly Weathered Shale
Retaining Wall 9 Highway 270 Station 163+64LT to 165+45LT	3 Feet (Fill)	Native Lean Clay and Highly Weathered Shale
Retaining Wall 10 Highway 227 Station 16+50LT to 18+85LT	8 Feet (Fill)	Highly Weathered Shale
Retaining Wall 11 Highway 270 Station 181+57RT to 182+62RT	2 Feet (Cut)	Anticipated Highly Weathered Shale
Retaining Wall 12 Highway 270 Station 183+72LT to 184+70LT	2 Feet (Fill)	Anticipated Highly Weathered Shale

All exposed soil subgrade materials, once properly cleared, should be scarified to a maximum depth of 12 inches, conditioned to near optimum moisture content and compacted. Subgrade soils exposed to the elements for an extended period of time should be checked for density and moisture content prior to placing additional fill and/or constructing pavements. Where intact shale and sandstone rock is exposed in the subgrade, shale and sandstone will not require scarification or compaction. The exposed rock surface should be cleaned of loose pieces.

During construction of the subgrade, exposed surfaces should be graded to prevent water from ponding adjacent to the existing roadway pavement and on the exposed subgrade.

It is anticipated excavations for the proposed construction can be accomplished with conventional earthmoving equipment.

The stability of subgrade soils may also be affected by precipitation, repetitive construction traffic or other factors. If unstable conditions are encountered or develop during construction, workability can be improved by overexcavating the unstable zones, scarifying, moisture-conditioning and recompacting the soils or replacing them with imported engineered fill.

4.2.2 Excavation

The existing fill and native lean clay soils can be excavated using conventional backhoes, front-end loaders, and motorized scrapers. However, due to the limited overburden thickness and variable rock depth, our experience indicates that it can be difficult to strip the fill and clay soils off the rock. At many locations, the contractor will likely choose not to strip the soils, but to excavate soil and rock at the same time, unless directed otherwise. This should be taken into consideration when evaluating material quality and quantities.

Shale was observed at depths of about 1 to 8.5 feet below the ground surface at the boring locations. Sandstone beds could be encountered in the shale in other areas away from the boring locations. Auger refusal on shale was observed at depths of about 12.5 to 16 feet below the existing ground surface at Borings W2-B-2, W8-B-2, W9-B-2, and W10-B-2.

Excavation of the shale is expected to be difficult. Typically rock that can be penetrated with our flight augers can sometimes be excavated with large, heavy-duty, track-mounted, excavation equipment such as track-hoes equipped with rock teeth or bulldozers equipped with ripping attachments. We anticipate that the weathering and bedding of the shale will aid in excavation. Pneumatic or hydraulic hammering, and tractor-mounted rock breakers should be expected to excavate rock near and below the depths that we encountered auger refusal. Because of the presence of nearby existing structures and based on the limited rock excavation required for constructing the wall foundations, blasting should not be used unless evaluated by a blasting contractor experienced with restricted blasting techniques for each wall. The final construction plans should note that a blasting plan shall be submitted, reviewed, and approved by the design engineer prior to any blasting.

Excavation of shale with heavy-duty equipment or blasting may result in rock disturbance below the desired depth. Loosened shale pieces should be removed entirely to sound rock.

All excavations should comply with applicable local, state, and federal safety regulations. Construction site safety generally is the sole responsibility of the contractor, who shall also be solely responsible for the means, methods, and sequencing of construction operations. We are providing this information solely as a service to our client. Under no circumstances should the information provided above be interpreted to mean that Terracon is assuming responsibility for

construction site safety or the contractor's activities; such responsibility is not being implied and should not be inferred.

4.2.3 Bedrock Rippability

Field seismic wave (compressive P-wave) velocity is one indicator in assessing rock rippability. Typical seismic wave velocity values for various materials related to this project are listed in the following table. These typical values are cited from U.S. Army Corps of Engineers, Engineer Manual 1110-1-1802, "Geophysical Exploration for Engineering and Environmental Investigations."

Material	Seismic Velocity (ft/second)
Sand	1,500 – 2,950
Clay	2,950 – 5,900
Shale	2,650 – 12,150
Sandstone	7,200 – 13,100

Ripper performance charts published in the Caterpillar Performance Handbook correlate seismic velocity values for various rock types with tractor size. These charts are only a guide; and the actual rippability is dependent upon rock mass discontinuity (joints/fractures/bedding) spacing and orientation.

Several caveats are in order before one makes a final judgment about the suitability and use of equipment for an excavation project. Favorable conditions for rippability include: frequent planes of weakness such as joints, fractures or laminations, weathering, moisture content, stratification, brittleness, and 'lower' shear strength. Unfavorable conditions for rippability include: massive rock with fewer planes of weakness, crystalline rocks, non-brittle energy-absorbing rock matrix, and 'higher' shear strength. Other variables relative tor rippability include: the size of the equipment used, the skill of the operator, inclusions or 'hard spots" in the rock, the condition of the equipment used, and the orientation of any planes of weakness such as fractures or layer bedding.

4.2.4 Import Material Specifications

Fill materials should be free of organic matter and debris. Clean on-site soils or approved imported borrow materials may be used as fill material. While the AHTD has no specific requirements for borrow materials, they do require that the materials must be capable of forming and maintaining a stable embankment when compacted. Therefore, we recommend specifically avoiding silts and elastic silts (ML and MH) and organic soils (OL, OH and PT) when considering materials for use as borrow. Clay soils should exhibit well defined moisture-density relationships.

We suggest that imported soils for borrow (if required) should meet the following material property requirements:

Gradation	Percent finer by weight (ASTM C136)
3”	100
No. 4 Sieve	50-100
No. 200 Sieve	15-50

- Plastic Limit……..20 (max)

4.2.5 Fill Materials and Placement

All fill required to construct the retaining walls should be an approved material that is free of organic matter and debris as outlined in table below.

Fill Type [1]	USCS Classification	Acceptable Location for Placement
Imported borrow [1] per Section 4.2.4 above	SP, SW, SC, SM, SP-SM, GP, GW, GC, GM, GP-GM	Beneath wall foundations and in retained soil zone
Onsite fill and native lean clay and sandy gravel soils [2] (Cohesive Materials with LL ≤ 45 and PI ≤ 20)	CL, GC, GP	Beneath wall foundations Retained soil zone behind retaining wall
Onsite fill and native lean to fat clay soils [2] (Cohesive Materials with 75 > LL > 45 and 50 > PI > 20)	CL-CH and CH	Retained soil zone behind retaining wall
Approved crushed stone (imported borrow) [3]	GP, GW	Directly beneath wall foundations Retaining wall reinforced zone Drainage material behind retaining walls

1. Engineered fill should consist of approved materials that are free of organic matter and debris. Frozen material should not be used, and fill should not be placed on a frozen subgrade. A sample of each material type should be submitted to the testing agency for evaluation before use.
2. We expect that the on-site fill and native soils will be intermixed during site work unless the contractor takes special care to remove and separate the materials. The intermixed soils should be frequently tested, evaluated and approved prior to re-use as engineered fill.
3. Similar to crushed stone aggregate meeting the specifications for AHTD Class 7 aggregate base or granular material such as well graded gravel meeting the specifications for ASTM C33 No. 57 or 67 stone.

We expect sandy gravel, sandy lean clay, gravelly lean clay, and broken shale will be generated from the grading and rock slope excavations. The dimensions of the broken shale could vary significantly depending on the soundness of the rock and the excavation techniques used. We also anticipate that the shale will continue to weather into clay, silt, sand, and smaller shale pieces with time. If it is desired to use the shale for this project, we recommend that the maximum particle size be less than 3 inches. Based on the limited observation of the shale and sandstone beds along the planned alignment, we expect that the size of the broken rock could be reduced by crushing with heavy-duty tracked equipment and mechanical grinders. However, the equipment necessary to crush the rock should be evaluated prior to beginning construction.

We understand that one of the locally available fill materials consists of broken shale. No visual observation or laboratory tests were performed on the shale. Because the excavated shale and imported broken shale fill is likely prone to slaking and decomposition, we recommend that the shale material be broken into gravel-size fragments and properly moisture conditioned and compacted as recommended in the following sections. Fill material should be tested and approved by the geotechnical engineer or his representative prior to use as engineered fill on this site.

4.2.6 Compaction Requirements

Engineered fill should be placed and compacted in horizontal lifts, using equipment and procedures that will produce recommended moisture contents and densities throughout the lift.

Item	Description
Fill maximum lift thickness	10 inches or less in loose thickness
Compaction requirements [1]	95% of the material's standard Proctor maximum dry density (AASHTO T 99)
Moisture content of cohesive material [1]	Within ±2 percentage points of the optimum moisture content value as determined by the material's standard Proctor test (AASHTO T 99) at the time of compaction
Moisture content of granular material [2]	Workable moisture levels

1. We recommend engineered fill be tested for moisture content and compaction during placement (AASHTO T 310 or AHTD Test Method 347 or 348). Should the results of the in-place density tests indicate the specified moisture or compaction limits have not been met, the area represented by the test should be reworked and retested as required until the specified moisture and compaction requirements are achieved.
2. Specifically, moisture levels should be maintained low enough to allow for satisfactory compaction to be achieved without the fill material pumping when proofrolled.

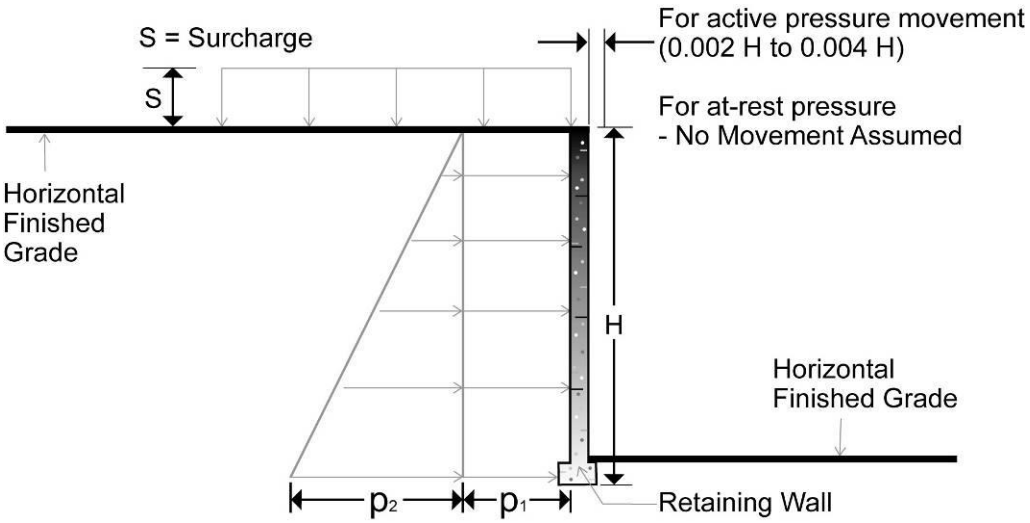
4.3 Retaining Walls

Cross-sections for the retaining walls were provided by Buchart Horn, Inc. Based on these cross-sections, Terracon analyzed eight (8) cast-in-place cantilever retaining walls (Wall 1 through Wall 6, Wall 8 and Wall 10) to evaluate their external stability. Retaining Wall 9 is shown as a 3 foot high, 3H:1V slope in the plans provided to us.

4.3.1 Lateral Earth Pressures for Designing Rigid Retaining Walls

The lateral earth pressure recommendations given in the following paragraphs are applicable to the design of rigid retaining walls subject to slight rotation, such as cantilever, or gravity type concrete walls.

Reinforced concrete walls with unbalanced backfill levels on opposite sides should be designed for earth pressures at least equal to those indicated in the following tables. Earth pressures will be influenced by structural design of the walls, conditions of wall restraint, methods of construction and/or compaction and the strength of the materials being restrained. Two wall restraint conditions are shown. Active earth pressure is commonly used for design of free-standing cantilever retaining walls and assumes wall movement. The "at-rest" condition assumes no wall movement. The recommended design lateral earth pressures do not include a factor of safety and do not provide for possible hydrostatic pressure on the walls.



Earth Pressure Coefficients – Walls 1 and 8

Earth Pressure Conditions	Friction Angle (degree)	Coefficient for Backfill Type	Equivalent Fluid Density (pcf)	Surcharge Pressure, p_1 (psf)	Earth Pressure, p_2 (psf)	Ultimate Coefficient of Friction
Active (Ka)	26	Clay - 0.40	50	(0.40)S	(50)H	-
At-rest (Ko)	26	Clay - 0.55	70	(0.55)S	(70)H	-
Passive (K_p)	24	Weathered Shale – 2.35	300	-	-	0.35

Earth Pressure Coefficients – Walls 3 and 4

Earth Pressure Conditions	Friction Angle (degree)	Coefficient for Backfill Type	Equivalent Fluid Density (pcf)	Surcharge Pressure, p_1 (psf)	Earth Pressure, p_2 (psf)	Ultimate Coefficient of Friction
Active (Ka)	26	Clay - 0.40	50	(0.40)S	(50)H	-
At-rest (Ko)	26	Clay - 0.55	70	(0.55)S	(70)H	-
Passive (K_p)	26	Clay – 2.55	320	-	-	0.35

Earth Pressure Coefficients – Wall 2

Earth Pressure Conditions	Friction Angle (degree)	Coefficient for Backfill Type	Equivalent Fluid Density (pcf)	Surcharge Pressure, p_1 (psf)	Earth Pressure, p_2 (psf)	Ultimate Coefficient of Friction
Active (Ka)	34	Granular - 0.28	35	(0.28)S	(35)H	-
At-rest (Ko)	34	Granular - 0.44	55	(0.44)S	(55)H	-
Passive (K_p)	26	Clay - 2.55	320	-	-	0.35

Earth Pressure Coefficients – Walls 5, 6 and 10

Earth Pressure Conditions	Friction Angle (degree)	Coefficient for Backfill Type	Equivalent Fluid Density (pcf)	Surcharge Pressure, p_1 (psf)	Earth Pressure, p_2 (psf)	Ultimate Coefficient of Friction
Active (Ka)	34	Granular - 0.28	35	(0.28)S	(35)H	-
At-rest (Ko)	34	Granular - 0.44	55	(0.44)S	(55)H	-
Passive (K_p)	24	Weathered Shale - 2.35	300	-	-	0.35

Applicable conditions to the above include:

- For active earth pressure, wall must rotate about base, with top lateral movements of about 0.002 **H** to 0.004 **H**, where **H** is wall height
- Uniform surcharge, where S is surcharge pressure
- Lean clay soils should have a Liquid Limit of less than 45 and Plastic Index less than 20
- Granular backfill weight is a maximum of 125 pcf
- In-situ soil backfill weight is a maximum of 125 pcf
- Horizontal backfill, compacted between 95 and 98 percent of standard Proctor maximum dry density
- Loading from heavy compaction equipment not included
- No hydrostatic pressures acting on wall
- No dynamic loading
- No safety factor included in soil parameters
- Ignore passive pressure in frost zone

Backfill placed against structures should consist of granular soils or low plasticity cohesive soils. For the granular values to be valid, the granular backfill must extend out from the base of the wall at an angle of at least 45 degrees from vertical for the active and at-rest cases, and 60 degrees for the passive case. To calculate the resistance to sliding, a value provided in the tables should be used as the ultimate coefficient of friction between the footing and the underlying native soil/highly weathered shale or engineered fill.

To control hydrostatic pressure behind the wall we recommend that a drain be installed at the foundation wall with a collection pipe leading to a reliable discharge.

- Granular backfill in this case consists of ASTM D 448 No. 57 or 67 stone or equivalent.
- Perforated pipe should be rigid PVC, sized to transport the expected water.
- Exterior ground surface should consist of a 24 inch clay cap sloped to drain from the wall.
- The clay cap can be replaced by a pavement section.

- Weep holes can be considered in lieu of perimeter drains for retaining walls if the water seepage will not impact adjacent structures.

4.3.2 Seismic Hazard Risk

The project site is located approximately 200 miles from the New Madrid Seismic Zone (NMSZ), which is located near the northeastern corner of Arkansas. The New Madrid Fault system extends about 120 miles southward from the area of Charleston, Missouri and Cairo, Illinois, through New Madrid and Caruthersville, generally following Interstate 55 to Blytheville and down to Marked Tree, Arkansas. The fault is active and reportedly averages more than 200 measured events per year (1.0 or more on the Richter scale), or about 20 per month. Tremors large enough to be felt (2.5 to 3.0 on the Richter scale) typically occur annually. The New Madrid fault system was responsible for the major 1811 and 1812 New Madrid Earthquakes that caused severe damage throughout the regional Mississippi Valley. A major earthquake, 7.5 or greater, is predicted to occur in this area about every 200 to 300 years (the last in 1812).

The New Madrid Fault system is considered to be active and particularly affects loose granular soils and soft clays. Granular soils beneath the groundwater level are susceptible to pore water pressure increase during earthquake events. Increases in pore pressure can cause liquefaction, which results in a significant decrease of soil shear strength. Based on the subsurface conditions observed at the boring locations, the existing fill, native soils, and shale are not liquefiable.

Code Used	Site Classification
2012 International Building Code (IBC) [1]	C [2]
Ground Motion Parameter	**Value (g) [3,4]**
S_s	0.258
S_1	0.118
S_{MS}	0.310
S_{M1}	0.199
S_{DS}	0.206
S_{D1}	0.133
Peak Ground Acceleration, PGA	0.126
A_S	**0.152**

1. Site Class defined in general accordance with Chapter 20 of ASCE 7 per 2012 IBC
2. Chapter 20 of ASCE 7 uses a site soil profile determination extending to a depth of 100 feet for seismic site classification. The borings performed for this report extended to a maximum depth of about 23.6 feet, terminating in shale.
3. Latitude 34.506 and Longitude -93.126 degrees

4. The U.S. Seismic Design Maps tool developed by the USGS was utilized to develop these seismic parameters

Based on the review of the seismic design parameters, the project site classifies as **Seismic Zone 1**. Per Section 11.5.4.2 of the AASHTO *LRFD Bridge Design Specifications, 6th Edition, 2012 edition,* a seismic design shall not be considered mandatory for walls located in Seismic Zones 1 through 3, or for walls at sites where the site adjusted peak ground acceleration, A_S, is less than or equal to 0.4g.

4.3.3 External Stability Analysis of Retaining Walls

Our external stability analyses of the wall sections included bearing capacity, direct sliding, overturning, and global stability. Our analyses were performed at wall sections based on the plans, profiles, and cross-sections provided to us by Buchart Horn, Inc. We evaluated the highest wall sections and the sections closest to the existing slopes. Our external stability analyses included the following criteria and considerations:

- Our long term stability analyses for the proposed wall structures were performed based upon drained parameters.
- Direct sliding was evaluated at the base of the walls for the interface between the foundation soils and cast-in-place concrete.
- Wherever applicable, a traffic surcharge load of 240 psf was used for traffic parallel to the wall alignments, in general accordance with AASHTO LRFD.
- In the global stability analyses, the concrete wall was modeled using a cohesion (c') value of 5,000 psf to prevent the failure surface from extending through the wall.
- Our global stability analyses were performed using the Morgenstern-Price method in SLOPE/W (GeoSlope 2007).

Geotechnical parameters used in our analyses and the description of the AASHTO *LRFD Bridge Design Specifications, 6th Edition, 2012* methodology are given in the following sections. Section **4.3.10 Summary of External Stability Analyses under Long Term Conditions** summarizes the results of the Capacity Demand Ratio (CDR) values calculated for select cross-sections under long term conditions.

4.3.4 Design Parameters

Soil and rock strength parameters for our external stability analyses were estimated based on the results of our field exploration, visual classification of soils and rock materials, laboratory test results (soil classification and plasticity tests and Consolidated Undrained Triaxial), literature review, and our experience with similar materials and projects with similar scope.

The following design parameters were used for the external stability analysis of the proposed walls. The shear strength parameters (effective friction angle and cohesion) shown below are based on drained conditions to account for the long-term stability.

Effective Shear Strength Parameters and Soil/Rock Unit Weights for Analysis and Design

Soil Type	Soil Classification	Effective Friction Angle, Φ' (degrees)	Effective Cohesion, c' (psf)	Total Unit Weight, γ (pcf)
Existing and New Fill	Low plasticity fine or granular soils	26	0	100
Lean Clay Fill	Low plasticity fine grained soil	26	0	100
Lean Clay & Shaley Lean Clay	Lean to fat clay soils	26	50	120
Highly Weathered Shale	Shale	24	100	130
Sandy Gravel	Gravel	32	0	120
Bedrock	Shale	0	5,000	135
Granular Backfill	Granular	34	0	125

4.3.5 Load and Resistance Factors

The following load and resistance factors should be applied during the analysis and design of walls, as indicated in the AASHTO *LRFD Bridge Design Specifications, 6th Edition, 2012*.

- Load Factor for vertical earth pressure, EV, from Table 3.4.1-2 and Figures C11.5.6-1 & 2:

  $\gamma_{p\text{-}EV}$ = 1.00 Direct Sliding and Eccentricity
  $\gamma_{p\text{-}EV}$ = 1.35 Bearing Capacity

- Load Factor for dead load from structural components, DC, from Table 3.4.1-2 and Figures C11.5.6-1 & 2:

  $\gamma_{p\text{-}DC}$ = 0.90 Direct Sliding and Eccentricity
  $\gamma_{p\text{-}DC}$ = 1.25 Bearing Capacity

- Load factor for active earth pressure, EH, from Table 3.4.1-2 and Figures C11.5.6-1 & 2:

  $\gamma_{p\text{-}EH}$ = 1.50 Bearing Capacity, Direct Sliding, and Eccentricity

- Load Factor for live load surcharge, LS, from Table 3.4.1-1 and Figure C11.5.6-3:

  $\gamma_{p\text{-}LL}$ = 1.75 Bearing Capacity, Direct Sliding, and Eccentricity

- Resistance factor for bearing resistance of walls from Table 11.5.7-1:

  φ_b = 0.55

- Resistance factor for sliding of walls from Table 11.5.7-1:

  φ_τ = 1.0 Reinforced Soil and Foundation

- Resistance factor for global (overall) stability of walls from Section 11.6.2.3:

  φ = 0.75 for structures that do not support structural elements

  φ = 0.65 for structures that support structural elements (e.g. abutment walls)

  The equivalent minimum factor of safety (FOS) using limit equilibrium methods of analysis (i.e. Allowable Stress Design – ASD) for the above global stability resistance factors correspond to 1.3 and 1.5, respectively)

4.3.6 Foundation Bearing Capacity

The factored bearing resistance (q_R) was evaluated using the following equation:

$$q_R = \varphi_b \, q_n \qquad \text{(Equation 10.6.3.1.1-1)}$$

where: φ_b = resistance factor
q_n = nominal bearing resistance, which is defined as

$$q_n = c \, N_{cm} \, \zeta c + \gamma \, D_f \, N_{qm} \, C_{wq} \, \zeta q + 0.5 \, \gamma \, B' \, N_{\gamma m} \, C_{w\gamma} \, \zeta_\gamma$$

where: c : cohesion
γ : total unit weight
N_{cm}, N_{qm} and $N_{\gamma\mu}$: dimensionless bearing capacity factors
B : effective length of the foundation
C_{wq} and $C_{w\gamma}$: correction factors to account for the location of groundwater table
ζc, ζq, and ζc_γ : correction factors to account for the presence of an infinitely stiff layer at shallow depths

The bearing capacity equations given above are dependent on soil and rock properties, foundation geometry, embedment, loads acting on the wall, load inclination, topography, and groundwater level. A summary of the nominal bearing capacity (ASD) and factored bearing capacity (LRFD) values for each retaining wall are presented in the following table. A summary

of the Capacity Demand Ratio (CDR) values for bearing capacity for the cross-sections analyzed is given in section **4.3.10 Summary of External Stability Analyses under Long Term Conditions**.

Wall No.	Boring	Sta.	H_D (ft.)	B (ft.)	Nominal Bearing Capacity (psf)	Factored Bearing Capacity (psf) (Resistance Factor = 0.55)
1	W1-B-1 W1-B-2	99+00	3.5	5	5,660	3,100
2	W2-B-1 W2-B-2	142+60	3.5	6	6,278	3,400
3	W3-B-1 W3-B-1A W3-B-2	151+28	2.5	4.5	4,240	2,300
4	W4-B-1 W4-B-2	154+00	5.5	6	6,090	3,300
5	W4-B-1 W4-B-2	154+00	8.0	6	8,160	4,500
6	W6-B-2	156+00	11	7	7,500	4,100
8	W8-B-1 W8-B-1A W8-B-2 W8-B-2A	162+00	8.5	8.5	8,110	4,400
9	W9-B-1 W9-B-2	165+00	3.0	--	--	--
10	W10-B-1 W10-B-1A W10-B-2 W10-B-2A	16+50	9.0	6	26,400	14,500

4.3.7 Settlement of Retaining Walls

The retaining walls will likely bear on highly weathered or competent shale. Walls 1, 3, 4, and 8 are cut walls bearing on highly weathered shale. Since no additional fill will be placed to

build these walls, no settlement is expected on these walls. Walls 6 and 8 will bear on competent shale bedrock. We estimate these walls will experience less than ½ inch of total settlement. Walls 2 and 5 are fill walls bearing on highly weathered shale underlain by competent shale. We estimate total settlement of about ½ to 1 inch is expected on these walls.

4.3.8 Direct Sliding

The factored resistance against failure by sliding was determined using the following equation.

$$R_R = \varphi_\tau R_\tau \qquad \text{(Equation 10.6.3.4-1)}$$

where: φ_τ = resistance factor for shear resistance between soil and foundation
R_τ = nominal sliding resistance between soil and foundation

$$R_\tau = V \tan \delta \qquad \text{(Equation 10.6.3.4-2)}$$

where: V = total vertical force
δ = interface friction angle between foundation soil and reinforced zone

We used the assumption that the interface friction angle between the foundation soil and the cast-in-place concrete wall base corresponds to the friction angle of the foundation soil. Thus, we used tan δ = tan ϕ', where ϕ' corresponds to the effective (drained) friction angle of the foundation. A summary of the Capacity Demand Ratio (CDR) values for direct sliding for the cross-sections analyzed is given in section **4.3.10 Summary of External Stability Analyses under Long Term Conditions**.

4.3.9 Eccentricity Limits (Overturning)

According to AASHTO *LRFD Bridge Design Specifications*, retaining wall structures shall be proportioned to satisfy eccentricity. To satisfy overturning, the location of the resultant of the reaction forces shall be within the middle two-thirds of the base width. The following general equation provides for the calculation of eccentricity:

$$e = \frac{(\gamma_{p\text{-}EH})(F_{1H})(H/3) + (\gamma_{p\text{-}LL})(F_2)(H/2) - \sum(\gamma_{p\text{-}EVi})(V_{EVi})(xi) - \sum(\gamma_{p\text{-}DCi)*}V_{DCi})(xi) - (\gamma_{p\text{-}EH})(F_{1V})(B/2)}{\sum(\gamma_{p\text{-}EVi})(V_{EVi}) - \sum(\gamma_{p\text{-}DCi)*}V_{DCi}) - (\gamma_{p\text{-}EH})(F_{1V})(B/2)}$$

where:

$\gamma_{p\text{-}EH}$	=	load factor for horizontal earth pressure (i.e. 1.50)
$\gamma_{p\text{-}LL}$	=	load factor for traffic surcharge load (i.e. 1.75)
$\gamma_{p\text{-}EV}$	=	load factor for dead load of earth fill (i.e. 1.0)
$\gamma_{p\text{-}DC}$	=	load factor for dead load of concrete (i.e. 0.9)
H	=	design height wall
B	=	design width of wall
F_{1H} & F_2	=	horizontal loads due to retained soil and traffic surcharge, respectively
F_{1V}	=	vertical load due to retained soil
V_{EV}	=	vertical load due to the earth backfill
V_{DC}	=	vertical load due to the concrete weight
Xi	=	horizontal moment arm of the earth backfill and concrete weight

A summary of the eccentricity of the walls is given in section **4.3.10 Summary of External Stability Analyses under Long Term Conditions**.

4.3.10 Global Stability

AASHTO *LRFD Bridge Design Specifications, 6th Edition, 2012* recommends that global (overall) stability of the retaining wall, retained slope, and foundation soil be evaluated using limiting equilibrium methods of analysis, in which a single Factor of Safety (FOS) is generated by slope stability program.

The computer program SLOPE/W (GeoSlope 2007) was used to evaluate the global stability of the wall sections. Critical failure surfaces were analyzed using Morgenstern-Price method in SLOPE/W. This stability analysis method requires satisfying equilibrium of forces and moments acting on individual blocks.

A summary of the Factor of Safety (FOS) values for global stability for the cross-sections analyzed is given in section **4.3.10 Summary of External Stability Analyses under Long Term Conditions**. The graphical output from the slope stability analyses are presented in Exhibit E.

4.3.11 Summary of External Stability Analyses under Long Term Conditions

The minimum wall dimensions required to satisfy the external stability of a section corresponds to the dimensions that satisfy Capacity Demand Ratio (CDR) values equal to or greater than 1.0 for bearing capacity (BC), direct sliding (DS) and overturning (OT) and factor of safety (FOS) values for global stability (GS) greater than 1.3 for non-critical structures. Initially the external

and global stability analyses were performed with the geometry of the cast-in-place walls as provided by the Burchart Horn, Inc. The following table shows the summary of the Capacity Demand Ratio (CDR) values for each external stability condition (except eccentricity for overturning and FOS for global stability). For Wall 9, which is shown as a 3H : 1V slope, only global stability factor of safety is reported.

Wall (Exhibit No.)	Boring	Sta.	H_D (ft.)	B (ft.)	CDR_{BC}	CDR_{DS}		e (ft.)	FOS_{GS}	Controlling Case
						With Passive Resistance	Without Passive Resistance			
1 (E-1)	W1-B-1 W1-B-2	99+00	3.5	4.5	9.1	1.3	0.9	0.27	2.4	DS
2 (E-2)	W2-B-1 W2-B-2	142+60	3.5	6	13.4	2.3	1.8	0.53	3.8	--
3 (E-3)	W3-B-1 W3-B-1A W3-B-2	151+28	2.5	4.5	8.9	1.9	1.4	0.35	4.0	--
4 (E-4)	W4-B-1 W4-B-2	154+00	5.5	4.5	5.9	0.9	0.7	0.26	1.8	DS
5 (E-5)	W4-B-1 W4-B-2	154+00	8.0	6	3.3	1.6	1.2	0.75	2.1	--
6 (E-6)	W6-B-2	156+00	11	7	2.1	1.2	1.0	1.24	1.6	--
8[1] (E-7)	W8-B-1 W8-B-1A W8-B-2 W8-B-2A	162+00	8.5	6	4.3	0.5	0.4	1.73	1.4/ 1.9	DS/GS
9[2] (E-8)	W9-B-1 W9-B-2	165+00	3.0	--	--	--	--	--	1.6	--
10 (E-9)	W10-B-1 W10-B-1A W10-B-2 W10-B-2A	16+50	9.0	6	9.2	1.2	1.0	0.95	1.5	--

Notes:

1 For Wall 8, the second value of global stability factor of safety is based on the revised dimension of CIP to satisfy other external stability criteria.

2 Wall 9 is a 3H : 1V slope.

Based on the results of these analyses, Walls 1, 4, and 8 appeared to be insufficient to satisfy external stability requirements (see yellow highlighted). The following table shows our

recommended geometry/dimensions for walls 1, 4, and 8 and the summary of the Capacity Demand Ratio (CDR) values for these walls for each external stability condition:

Wall	Sta.	H_D (ft.)	B (ft.)	F (ft.)	T (ft.)	D_k (ft.)	CDR_{BC}	CDR_{BC}	CDR_{DS}	e (ft.)	Control
1	99+00	3.5	5	--	--	--	10.1	1.3	1.0	0.38	DS
4	154+00	5.5	6	2	3	--	6.5	1.1	1.0	0.18	DS
8	162+00	8.5	8.5	6	1.5	1.5	3.8	1.2	1.0	0.56	DS

The wall dimensions shown in the previous tables are defined as:

H = design height wall
B = design width of wall
F = footing heel width
T = footing toe width
D_k = shear key depth

4.4 General Considerations for Other Retaining Wall Types

Based on our understanding of the project, all of the planned retaining walls can be constructed as reinforced concrete retaining walls. If required due to right-of-way restrictions, alternate types of walls could be considered. Possible types of alternate walls can be cantilevered or tied-back soldier pile walls with permanent fascia or soil nail walls. We can provide design recommendations for these types of walls in those areas if requested.

5.0 GENERAL COMMENTS

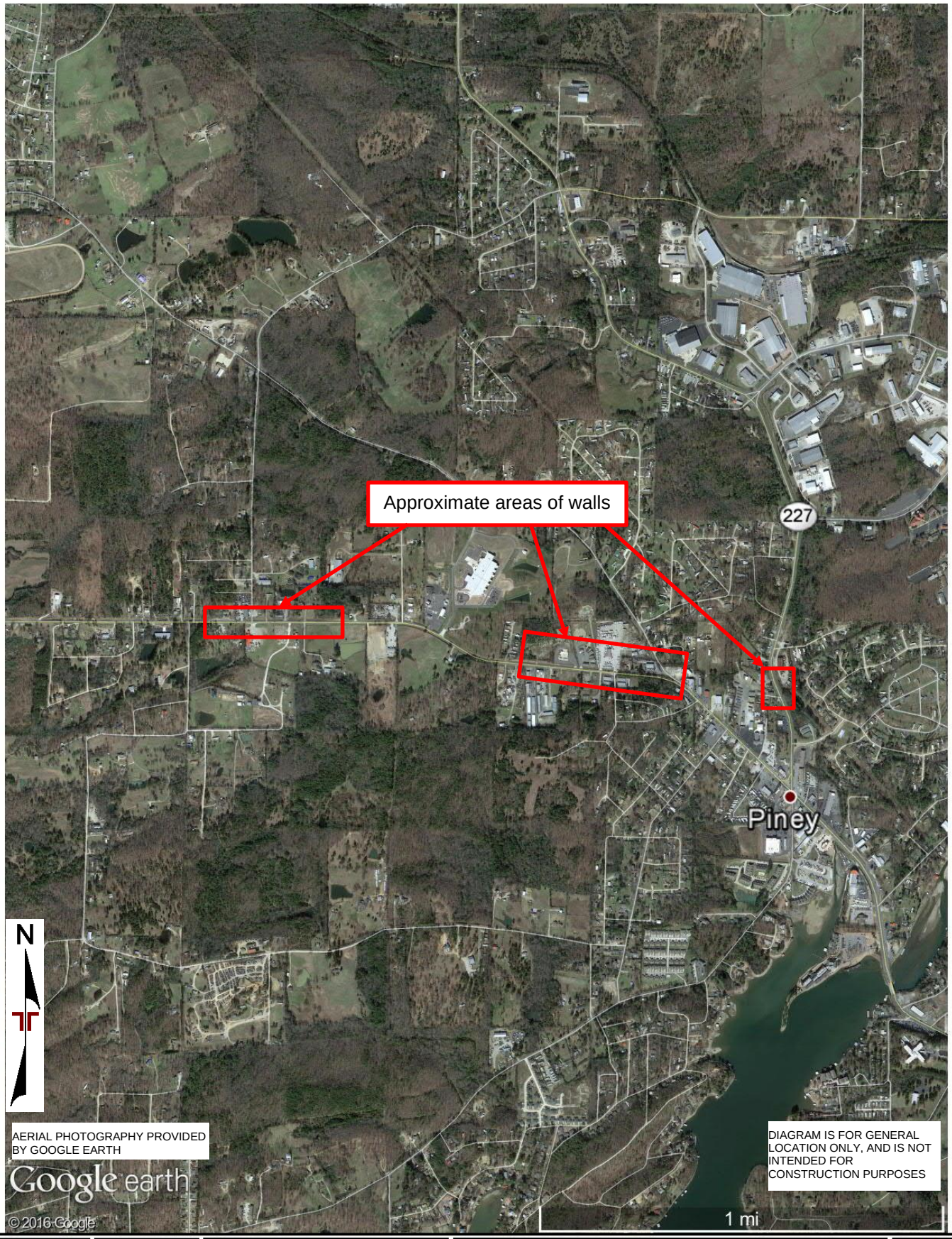
Terracon should be retained to review the final design plans and specifications so comments can be made regarding interpretation and implementation of our geotechnical recommendations in the design and specifications. Terracon also should be retained to provide observation and testing services during grading, excavation, retaining wall construction and other earth-related construction phases of the project.

The analysis and recommendations presented in this report are based upon the data obtained from the borings performed at the indicated locations and from other information discussed in this report. This report does not reflect variations that may occur between borings, across the site, or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. If variations appear, we should be immediately notified so that further evaluation and supplemental recommendations can be provided.

The scope of services for this project does not include either specifically or by implication any environmental assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

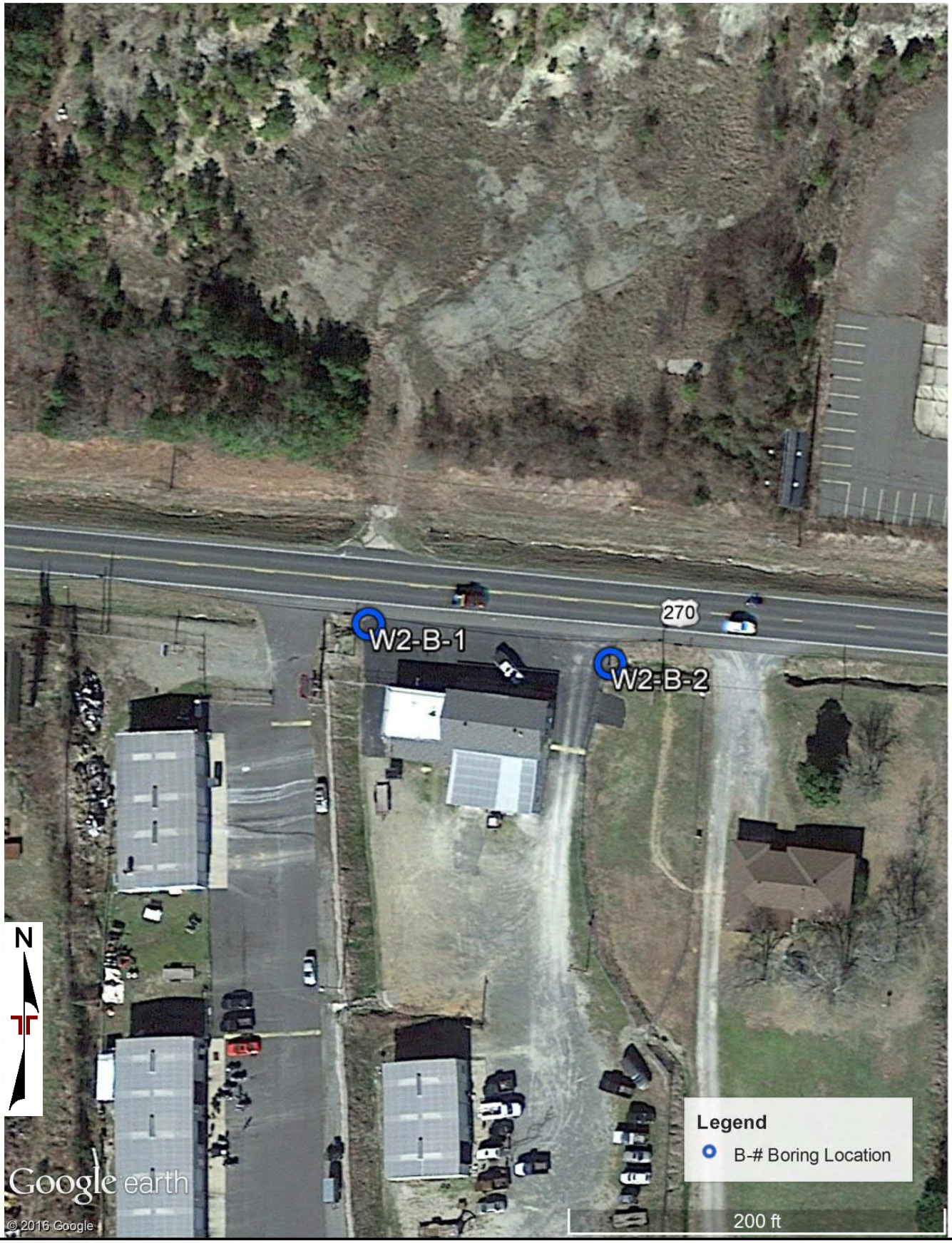
This report has been prepared for the exclusive use of our client for specific application to the project discussed and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, either express or implied, are intended or made. Site safety, excavation support, and dewatering requirements are the responsibility of others. In the event that changes in the nature, design, or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid unless Terracon reviews the changes and either verifies or modifies the conclusions of this report in writing.

APPENDIX A
FIELD EXPLORATION



Project Manager: SPB	Project No. 35145118	Terracon 25809 I 30 Bryant, AR 72022-9313	SITE LOCATION PLAN	Exhibit
Drawn by: RSR	Scale: As Shown		Hwy 270 – Hwy 227 to Ouachita River (Widening) (S) – AHTD Job No. CA0607 Hot Springs, Garland County, Arkansas	A-1
Checked by: SL	File Name: SLP - BLP			
Approved by: SPB	Date: 09/30/2016			

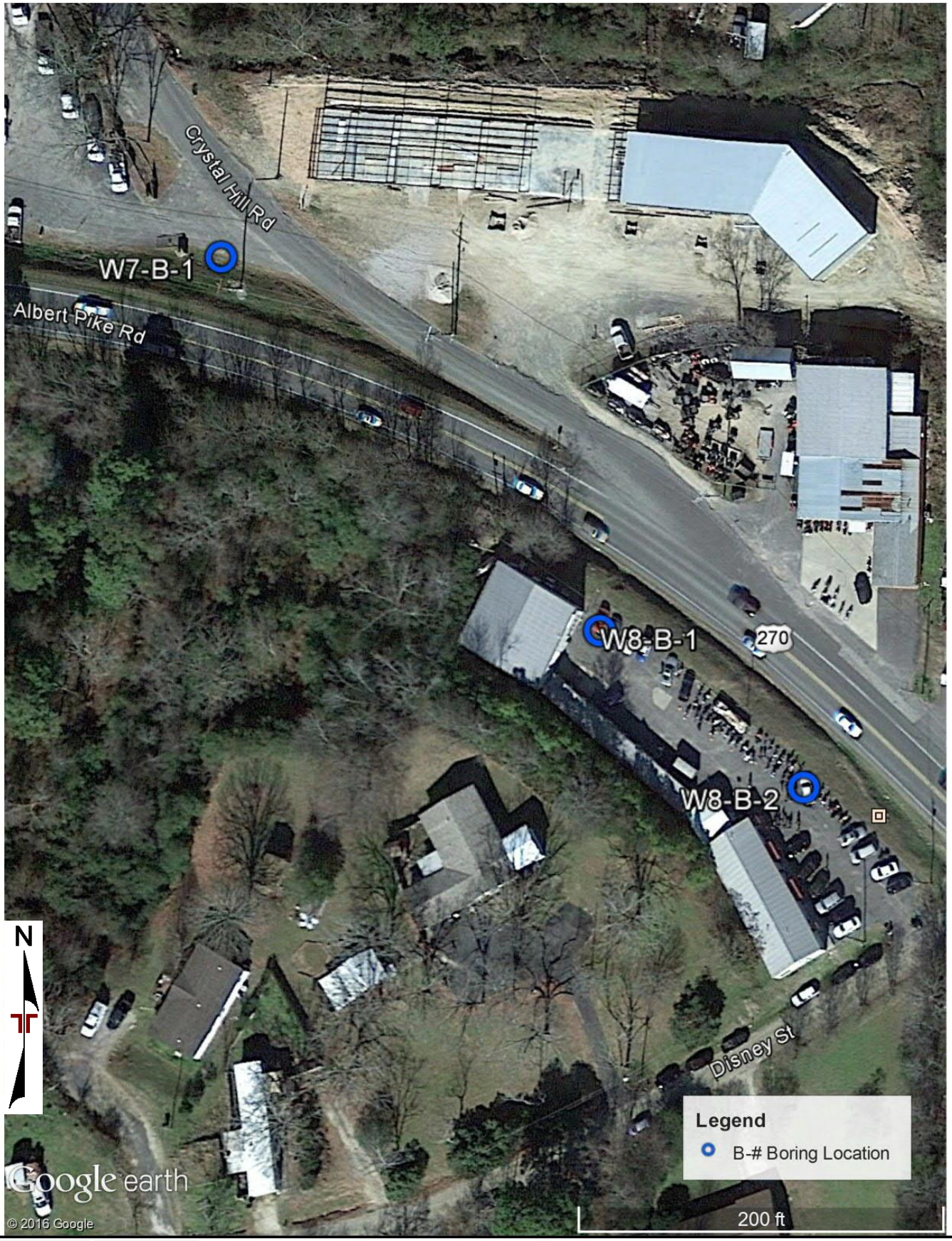
Project Manager: SPB	Project No. 35145118	Terracon 25809 I 30 Bryant, AR 72022-9313	BORING LOCATION PLAN	Exhibit
Drawn by: RSR	Scale: AS SHOWN		Hwy 270 – Hwy 227 to Ouachita River (Widening) (S) – AHTD Job No. CA0607 Hot Springs, Garland County, Arkansas	A-2
Checked by: SL	File Name: SLP-BLP			
Approved by: SPB	Date: 09/30/2016			



Project Manager: SPB	Project No. 35145118	Terracon 25809 I 30 Bryant, AR 72022-9313	BORING LOCATION PLAN	Exhibit
Drawn by: RSR	Scale: AS SHOWN		Hwy 270 – Hwy 227 to Ouachita River (Widening) (S) – AHTD Job No. CA0607 Hot Springs, Garland County, Arkansas	A-3
Checked by: SL	File Name: SLP-BLP			
Approved by: SPB	Date: 09/30/2016			

Project Manager: SPB	Project No. 35145118	Terracon 25809 I 30 Bryant, AR 72022-9313	BORING LOCATION PLAN	Exhibit
Drawn by: RSR	Scale: AS SHOWN		Hwy 270 – Hwy 227 to Ouachita River (Widening) (S) – AHTD Job No. CA0607 Hot Springs, Garland County, Arkansas	A-4
Checked by: SL	File Name: SLP-BLP			
Approved by: SPB	Date: 09/30/2016			

Project Manager: SPB	Project No. 35145118	Terracon 25809 I 30 Bryant, AR 72022-9313	BORING LOCATION PLAN	Exhibit
Drawn by: RSR	Scale: AS SHOWN		Hwy 270 – Hwy 227 to Ouachita River (Widening) (S) – AHTD Job No. CA0607 Hot Springs, Garland County, Arkansas	A-5
Checked by: SL	File Name: SLP-BLP			
Approved by: SPB	Date: 09/30/2016			



Project Manager: SPB	Project No. 35145118	Terracon 25809 I 30 Bryant, AR 72022-9313	BORING LOCATION PLAN	Exhibit
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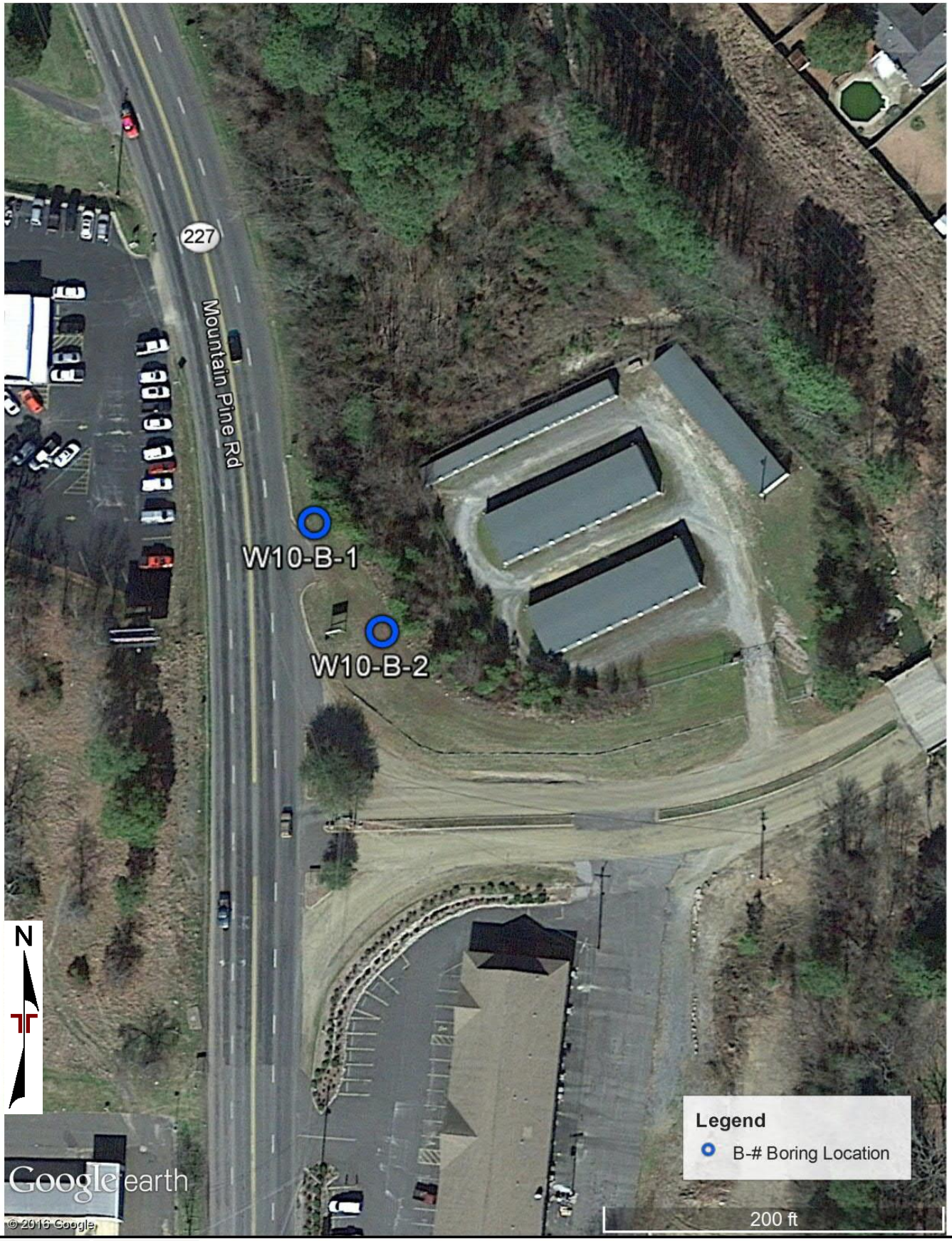
Checked by: SL	File Name: SLP-BLP			
Approved by: SPB	Date: 09/30/2016			

Project Manager: SPB	Project No. 35145118	Terracon 25809 I 30 Bryant, AR 72022-9313	BORING LOCATION PLAN	Exhibit
Drawn by: RSR	Scale: AS SHOWN		Hwy 270 – Hwy 227 to Ouachita River (Widening) (S) – AHTD Job No. CA0607 Hot Springs, Garland County, Arkansas	A-7
Checked by: SL	File Name: SLP-BLP			
Approved by: SPB	Date: 09/30/2016			



Project Manager: SPB	Project No. 35145118	Terracon 25809 I 30 Bryant, AR 72022-9313	BORING LOCATION PLAN	Exhibit
Drawn by: RSR	Scale: AS SHOWN		Hwy 270 – Hwy 227 to Ouachita River (Widening) (S) – AHTD Job No. CA0607 Hot Springs, Garland County, Arkansas	A-8
Checked by: SL	File Name: SLP-BLP			
Approved by: SPB	Date: 09/30/2016			

Field Exploration Description

Sixteen borings were drilled at the site between July 21, 2016 and August 11, 2016. Five additional borings were drilled near the original boring locations, to collect supplemental data. The borings were drilled to depths of about 8.8 to 23.6 feet below the ground surface at the approximate locations shown on the attached Exhibits A-2 through A-8, Boring Location Plans.

Terracon personnel established the borings in the field by using a hand-held GPS to establish the approximate locations shown on the attached Boring Location Plans. The approximate latitude and longitude coordinates were estimated using Google Earth Pro, and then used with the GPS to locate the borings in the field. After completing the field exploration, the boring locations and ground surface elevations were recorded by Harmon Surveying, Inc. The locations and elevations of the borings should be considered accurate only to the degree implied by the methods used to define them.

The boreholes were advanced with a truck-mounted drill rig using 3-1/4" hollow-stem augers and solid-stem flight augers. Samples were obtained using the split-barrel and thin-walled (Shelby) tube sampling procedures. At the completion of the drilling activities, the boreholes were checked for the presence of groundwater and were backfilled with auger cuttings.

In the split-barrel sampling procedure, the number of blows required to advance a standard 2-inch O.D. split-barrel sampler the last 12 inches of the typical total 18-inch penetration by means of a 140-pound standard hammer with a free fall of 30 inches, is the standard penetration resistance value (SPT-N). This value is used to estimate the in-situ consistency of cohesive soils, relative density of granular soils and relative hardness of weathered bedrock.

An automatic SPT hammer was used to advance the split-barrel sampler in the borings performed on this site. A significantly greater efficiency is achieved with the automatic hammer compared to the conventional safety hammer operated with a cathead and rope. This higher efficiency has an appreciable effect on the SPT-N value.

In the thin-walled tube sampling procedure, a thin-walled, seamless steel tube with a sharp cutting edge is pushed hydraulically into the soil to obtain a relatively undisturbed sample.

Two bulk samples were collected in the upper 5 feet, or to rock, at locations W8 and W10. The bulk samples were taken to the laboratory for testing.

The samples were tagged for identification, sealed to reduce moisture loss, and taken to our laboratory for further examination, testing, and classification. Photographs of the soil samples were taken after they were returned to our laboratory. The photographs are included as Exhibits D-1 through D-14.

Field logs were prepared by the drill crew. The logs included visual classifications of the materials encountered during drilling as well as the driller's interpretation of the subsurface conditions between samples. The final boring logs included with this report represent the engineer's interpretation of the subsurface conditions at the boring locations based on field and laboratory data and observation of the samples.

Our exploration services include storing the collected soil samples and making them available for inspection until after construction is completed. The samples will then be discarded unless requested otherwise.

Boring location information and elevations are provided in the following table

Summary of Boring Locations and Elevations					
Boring	**Station (estimated from provided plans)**	**Offset (East facing)**	**Northing**	**Easting**	**Elevation (feet)**
W1-B-1	98+50	30 ft R	1984810.3	965529.4	489.1
W1-B-2	99+50	25 ft R	1984812.4	965616.5	487.5
W2-B-1	142+10	35 ft R	1984216.4	969753.5	477.4
W2-B-2	143+42	25 ft R	1984193.8	969881.9	470.9
W3-B-1	151+10	60 ft R	1984053.9	970623.7	459.3
W3-B-2	152+25	60 ft R	1984073.6	970764.6	458.3
W4-B-1	153+00	60 ft R	1984062.9	970825.9	462.4
W4-B-2	154+95	50 ft R	1984050.6	971044.8	461.1
W6-B-2	155+50	8 ft L	1984108.2	971096.8	453.3
W7-B-1	159+60	50 ft L	1984101.7	971445	440.8
W8-B-1	161+85	50 ft R	1983892.9	971652.9	459.3
W8-B-2	163+30	50 ft R	1983805.5	971763.3	456.5
W9-B-1	163+85	50 ft L	1983840.1	971864.6	446.6
W9-B-2	165+25	65 ft L	1983742.8	971979.4	445.4
W10-B-1	16+50	5 ft L	1983343.1	973148	433.2
W10-B-2	17+40	5 ft L	1983280.8	973186.1	431.9

Survey data provided by Harmon Surveying

Borings W5-B-1, W5-B-2, W6-B-1, W7-B-2, W11-B-1, W11-B-2, W12-B-1, and W12-B-2 could not be drilled because the landowners refused access on their property or did not respond back to our attempts to contact and notify them.

BORING LOG NO. W1-B-1

PROJECT: CA0607 - Hwy 227-Ouachita River (Widening)(S)

CLIENT: Buchart Horn, Inc. Memphis, Tennessee

SITE: Hwy 270 Hot Springs, Garland County, Arkansas

LOCATION See Exhibit A-2

Latitude: 34.509328° Longitude: -93.151189°
Northing: 1984810.3 Easting: 965529.4
Station: 98+50 Offset: 30 ft R

Surface Elev.: 489.1 (Ft.)

DEPTH	ELEVATION (Ft.)		DEPTH (Ft.)	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
1.0	488	**FILL - LEAN CLAY**, with shale gravel, grayish-brown					
		HIGHLY WEATHERED SHALE+, light gray, brown and red, soft			7-8-10 N=18	12	34-19-15
					6-6-6 N=12	12	34-20-14
5.0	484				6-7-9 N=16	14	
		HIGHLY WEATHERED SHALE+, light gray and brown, soft	5		10-17-20 N=37	15	
					9-18-27 N=45	11	
13.5	475.5		10				
		HIGHLY WEATHERED SHALE+, brownish-gray, soft			3-13-18 N=31	10	
18.5	470.5		15				
19.5	469.5	**SHALE+**, dark gray, soft			8-50/6"	6	
		Boring Terminated at 19.5 Feet					

Stratification lines are approximate. In-situ, the transition may be gradual.
+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Hammer Type: Automatic

Advancement Method:
0 to 19.5 ft: Solid-stem auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.
Locations and elevations obtained by survey

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
25809 I 30
Bryant, AR

Boring Started: 8/11/2016 | Boring Completed: 8/11/2016
Drill Rig: CME-75, #837 | Driller: RP
Project No.: 35145118 | Exhibit: A-10

BORING LOG NO. W1-B-2

PROJECT: CA0607 - Hwy 227-Ouachita River (Widening)(S)

CLIENT: Buchart Horn, Inc. Memphis, Tennessee

SITE: Hwy 270 Hot Springs, Garland County, Arkansas

LOCATION See Exhibit A-2

Latitude: 34.509336° Longitude: -93.1509°
Northing: 1984812.4 Easting: 965616.5
Station: 99+50 Offset: 25 ft R

Surface Elev.: 487.5 (Ft.)

DEPTH	ELEVATION (Ft.)		FIELD TEST RESULTS	LABORATORY TORVANE/HP (psf)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
1.5	486	**FILL - SANDY LEAN CLAY**, with shale gravel, reddish-brown	4-5-6 N=11		13		
		HIGHLY WEATHERED SHALE+, light gray, brown and reddish-brown, soft	11-12-13 N=25		16		
4.5	483		10-18-32 N=50		14		
		HIGHLY WEATHERED SHALE+, gray and brown, soft	17-32-45 N=77		12		
			17-18-19 N=37		10		
			4-33-50/3"		8		
18.5	469						
19.3	468	**SHALE+**, dark gray, soft	8-50/4"		7		
		Boring Terminated at 19.3 Feet					

Stratification lines are approximate. In-situ, the transition may be gradual.
+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Hammer Type: Automatic

Advancement Method:
0 to 18.8 ft: Solid-stem auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.
Locations and elevations obtained by survey

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
25809 I 30
Bryant, AR

Boring Started: 8/11/2016 | Boring Completed: 8/11/2016
Drill Rig: CME-75, #837 | Driller: RP
Project No.: 35145118 | Exhibit: A-11

BORING LOG NO. W2-B-1

PROJECT: CA0607 - Hwy 227-Ouachita River (Widening)(S)

CLIENT: Buchart Horn, Inc. Memphis, Tennessee

SITE: Hwy 270 Hot Springs, Garland County, Arkansas

LOCATION See Exhibit A-2

Latitude: 34.507825° Longitude: -93.137144°
Northing: 1984216.4 Easting: 969753.5
Station: 142+10 Offset: 35 ft R

Surface Elev.: 477.4 (Ft.)

DEPTH	ELEVATION (Ft.)	Description	FIELD TEST RESULTS	LABORATORY TORVANE/HP (psf)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
0.0	477.4	**FILL - GRAVELLY LEAN CLAY**, reddish-brown	6-4-4 N=8	9000 (HP)	15		
2.0	475.5	**FILL - SANDY LEAN CLAY**, with gravel, reddish-brown and brown	2-2-2 N=4	9000 (HP)	15	34-18-16	
4.5	473		1-5-8 N=13	5000 (HP)	17		
5.5	472	**LEAN CLAY (CL)**, trace shale pieces, brown, light gray and reddish-brown, stiff	8-25-26 N=51		12		
8.5	469	**HIGHLY WEATHERED SHALE+**, light gray and gray, soft	50/5"		8		
13.7	463.5	**SHALE+**, dark gray, soft to moderately hard	50/2"		2		
		Boring Terminated at 13.7 Feet					

DEPTH (Ft.): 5, 10

Stratification lines are approximate. In-situ, the transition may be gradual.
+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Hammer Type: Automatic

Advancement Method:
0 to 13.7 ft: Solid-stem auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.
Locations and elevations obtained by survey

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
25809 I 30
Bryant, AR

Boring Started: 8/10/2016 | Boring Completed: 8/10/2016
Drill Rig: CME-75, #837 | Driller: RP
Project No.: 35145118 | Exhibit: A-12

BORING LOG NO. W2-B-2

PROJECT: CA0607 - Hwy 227-Ouachita River (Widening)(S)

CLIENT: Buchart Horn, Inc. Memphis, Tennessee

SITE: Hwy 270 Hot Springs, Garland County, Arkansas

LOCATION See Exhibit A-2

Latitude: 34.507767° Longitude: -93.136719°
Northing: 1984193.8 Easting: 969881.9
Station: 143+42 Offset: 25 ft R

Surface Elev.: 470.9 (Ft.)

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	SAMPLE TYPE	FIELD TEST RESULTS	LABORATORY TORVANE/HP (psf)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	FILL - GRAVELLY LEAN CLAY, reddish-brown							
2.0	469			4-5-5 N=10	7000 (HP)	11		
	FILL - SANDY LEAN CLAY, with gravel, reddish-brown			1-2-3 N=5	2000 (HP)	16		
3.5	467.5							
	LEAN CLAY, with shale pieces, light gray and gray, stiff				3500 (HP)			
5.0	466	5		19-50/4"		9		
	HIGHLY WEATHERED SHALE+, light gray and dark gray, soft to moderately hard			42-50/2"		11		
12.5	458.5	10		50/2"				
	Auger refusal at 12.5 Feet							

Stratification lines are approximate. In-situ, the transition may be gradual.
+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Hammer Type: Automatic

Advancement Method:
0 to 12.5 ft: Solid-stem auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.
Locations and elevations obtained by survey

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
25809 I 30
Bryant, AR

Boring Started: 8/10/2016 | Boring Completed: 8/10/2016
Drill Rig: CME-75, #837 | Driller: RP
Project No.: 35145118 | Exhibit: A-13

BORING LOG NO. W3-B-1

PROJECT: CA0607 - Hwy 227-Ouachita River (Widening)(S)

CLIENT: Buchart Horn, Inc. Memphis, Tennessee

SITE: Hwy 270 Hot Springs, Garland County, Arkansas

LOCATION See Exhibit A-2

Latitude: 34.507406° Longitude: -93.13425°
Northing: 1984053.9 Easting: 970623.7
Station: 151+10 Offset: 60 ft R

Surface Elev.: 459.3 (Ft.)

DEPTH	ELEVATION (Ft.)	Description	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	LABORATORY TORVANE/HP (psf)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
		FILL - LEAN CLAY, with rock pieces and sand, reddish-brown and brown				2-3-5 N=8		19		
		- sandy, reddish-brown below about 3.5 feet	5			1-1-1 N=2		18	31-17-14	68
8.5	451									
		HIGHLY WEATHERED SHALE+, olive-gray, gray and red, soft	10			9-13-25 N=38		15		
13.5	446									
		SHALE+, light gray to gray, hard	15			50/1"		6		
18.6	440.5									
		Boring Terminated at 18.6 Feet				50/1"		4		

Stratification lines are approximate. In-situ, the transition may be gradual.
+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Hammer Type: Automatic

Advancement Method:
0 to 18.6 ft: 3-1/4" Hollow-stem auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.
Locations and elevations obtained by survey

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
25809 I 30
Bryant, AR

Boring Started: 7/22/2016 | Boring Completed: 7/22/2016
Drill Rig: CME-75, #837 | Driller: CL
Project No.: 35145118 | Exhibit: A-14

BORING LOG NO. W3-B-1A

PROJECT: CA0607 - Hwy 227-Ouachita River (Widening)(S)

CLIENT: Buchart Horn, Inc. Memphis, Tennessee

SITE: Hwy 270 Hot Springs, Garland County, Arkansas

LOCATION See Exhibit A-2

Latitude: 34.507406° Longitude: -93.13425°
Northing: 1984053.9 Easting: 970623.7
Station: 151+10 Offset: 60 ft R

Surface Elev.: 459.3 (Ft.)

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	LABORATORY TORVANE/HP (psf)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
					4-4-4 N=8	4000 (HP)	17		
					3-3-3 N=6	5000 (HP)	19	40-19-21	69
5.5	454	5			5-9-14 N=23		16		
8.5	451								
					23-33-29 N=62		11		
		10							
14.4	445				34-50/5"		9		

FILL - SANDY LEAN CLAY, with gravel, reddish-brown and brown

SHALEY LEAN CLAY (CL), light brown, brown, and red, very stiff

HIGHLY WEATHERED SHALE+, gray, brown, and red, soft

Boring Terminated at 14.4 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.
+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Hammer Type: Automatic

Advancement Method:
0 to 14.4 ft: Solid-stem auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.
Locations and elevations obtained by survey

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
25809 I 30
Bryant, AR

Boring Started: 8/10/2016 | Boring Completed: 8/10/2016
Drill Rig: CME-75, #837 | Driller: RP
Project No.: 35145118 | Exhibit: A-15

BORING LOG NO. W3-B-2

PROJECT: CA0607 - Hwy 227-Ouachita River (Widening)(S)

CLIENT: Buchart Horn, Inc. Memphis, Tennessee

SITE: Hwy 270 Hot Springs, Garland County, Arkansas

LOCATION See Exhibit A-2

Latitude: 34.507464° Longitude: -93.133783°
Northing: 1984073.6 Easting: 970764.6
Station: 152+25 Offset: 60 ft R

Surface Elev.: 458.3 (Ft.)

DEPTH	ELEVATION (Ft.)	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
FILL - LEAN CLAY, trace rock pieces and sand, reddish-brown				
3.5	455	3-4-3 N=7	17	35-19-16
HIGHLY WEATHERED SHALE+, olive-gray and reddish-brown, soft		15-27-43 N=70	12	
		27-31-50/6"	10	
13.5	445			
SHALE+, gray to dark gray, hard		50/1"	10	
18.6	439.5			
Boring Terminated at 18.6 Feet		50/1"	18	

Stratification lines are approximate. In-situ, the transition may be gradual.
+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Hammer Type: Automatic

Advancement Method:
0 to 18.6 ft: 3-1/4" Hollow-stem auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.
Locations and elevations obtained by survey

Notes:

WATER LEVEL OBSERVATIONS

▽ *13 ft While Sampling*

Terracon
25809 I 30
Bryant, AR

Boring Started: 7/22/2016 | Boring Completed: 7/22/2016
Drill Rig: CME-75, #387 | Driller: CL
Project No.: 35145118 | Exhibit: A-16

BORING LOG NO. W4-B-1

PROJECT: CA0607 - Hwy 227-Ouachita River (Widening)(S)

CLIENT: Buchart Horn, Inc. Memphis, Tennessee

SITE: Hwy 270 Hot Springs, Garland County, Arkansas

LOCATION See Exhibit A-2

Latitude: 34.507436° Longitude: -93.133581°
Northing: 1984062.9 Easting: 970825.9
Station: 153+00 Offset: 60 ft R

Surface Elev.: 462.4 (Ft.)

DEPTH	ELEVATION (Ft.)	Description	DEPTH (Ft.)	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)
0	462.4	**FILL - GRAVELLY LEAN CLAY**, with rock pieces, olive-gray, gray and reddish-brown			11-12-14 N=26	10
3.5	459	**SHALEY LEAN CLAY (CL)**, with sand and shale pieces, reddish-brown and brown, hard	5		11-25-27 N=52	15
8.5	454	**HIGHLY WEATHERED SHALE+**, light gray, olive-gray and reddish-brown, soft	10		27-50/6"	13
		- reddish-brown and dark gray below about 13.5 feet	15		28-44-50/3"	10
18.5	444					
18.9	443.5	**SHALE+**, gray, moderately hard			50/5"	8
		Boring Terminated at 18.9 Feet				

Stratification lines are approximate. In-situ, the transition may be gradual.
+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Hammer Type: Automatic

Advancement Method:
0 to 18.9 ft: 3-1/4" Hollow-stem auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.
Locations and elevations obtained by survey

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
25809 I 30
Bryant, AR

Boring Started: 7/21/2016 | Boring Completed: 7/21/2016
Drill Rig: CME-75, #387 | Driller: CL
Project No.: 35145118 | Exhibit: A-17

BORING LOG NO. W4-B-2

PROJECT: CA0607 - Hwy 227-Ouachita River (Widening)(S)

CLIENT: Buchart Horn, Inc. Memphis, Tennessee

SITE: Hwy 270 Hot Springs, Garland County, Arkansas

LOCATION See Exhibit A-2

Latitude: 34.507411° Longitude: -93.132853°
Northing: 1984050.6 Easting: 971044.8
Station: 154+95 Offset: 50 ft R

Surface Elev.: 461.1 (Ft.)

DEPTH	ELEVATION (Ft.)	Description	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
0	461.1	**FILL - LEAN CLAY**, with rock pieces, reddish-brown and light brown	13-15-15 N=30	13		
4.0	457	**LEAN CLAY (CL)**, trace rootlets, reddish-brown and light brown, very stiff	6-7-19 N=26	18	41-23-18	
8.5	452.5	**HIGHLY WEATHERED SHALE+**, olive-gray and gray, soft	50/6"	10		
13.5	447.5	**SHALE+**, gray to dark gray, hard	50/1"	5		
18.6	442.5	***Boring Terminated at 18.6 Feet***	50/1"	5		

Stratification lines are approximate. In-situ, the transition may be gradual.
+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Hammer Type: Automatic

Advancement Method:
0 to 18.6 ft: 3-1/4" Hollow-stem auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.
Locations and elevations obtained by survey

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
25809 I 30
Bryant, AR

Boring Started: 7/21/2016 | Boring Completed: 7/21/2016
Drill Rig: CME-75, #387 | Driller: CL
Project No.: 35145118 | Exhibit: A-18

BORING LOG NO. W6-B-2

PROJECT: CA0607 - Hwy 227-Ouachita River (Widening)(S)

CLIENT: Buchart Horn, Inc. Memphis, Tennessee

SITE: Hwy 270 Hot Springs, Garland County, Arkansas

LOCATION See Exhibit A-2

Latitude: 34.507569° Longitude: -93.132683°
Northing: 1984108.2 Easting: 971096.8
Station: 155+50 Offset: 8 ft L

Surface Elev.: 453.3 (Ft.)

DEPTH	ELEVATION (Ft.)	
1.0	452.5	**ASPHALT & BASE**
		FILL - LEAN CLAY, with sand and gravel (shale and sandstone pieces), reddish-brown
6.0	447.5	
		SHALE+, gray to dark gray, soft, weathered
18.5	435	
		SHALE+, dark gray, hard
23.6	429.5	
		Boring Terminated at 23.6 Feet

DEPTH (Ft.)	SAMPLE TYPE	FIELD TEST RESULTS	LABORATORY TORVANE/HP (psf)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
		40-28-14 N=42		5		
		4-5-6 N=11	7000 (HP)	14		
5		3-3-3 N=6	9000 (HP)	19		
		3-4-8 N=12		19		
		40-50/4"		9		
10						
		50/6"		6		
15						
		50/1"				
20						
		50/1"		9		

Stratification lines are approximate. In-situ, the transition may be gradual.
+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Hammer Type: Automatic

Advancement Method:
0 to 23.6 ft: 3-1/4" Hollow-stem auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.
Locations and elevations obtained by survey

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
25809 I 30
Bryant, AR

Boring Started: 8/11/2016 Boring Completed: 8/11/2016
Drill Rig: CME-75, #837 Driller: RP
Project No.: 35145118 Exhibit: A-19

BORING LOG NO. W7-B-1

PROJECT: CA0607 - Hwy 227-Ouachita River (Widening)(S)

CLIENT: Buchart Horn, Inc. Memphis, Tennessee

SITE: Hwy 270 Hot Springs, Garland County, Arkansas

LOCATION See Exhibit A-2

Latitude: 34.507564° Longitude: -93.131528°
Northing: 1984101.7 Easting: 971445
Station: 159+60 Offset: 50 ft L

Surface Elev.: 440.8 (Ft.)

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	LABORATORY TORVANE/HP (psf)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	FILL - SANDY SHALE GRAVEL, dark gray								
2.0	439				4-3-4 N=7		9		
	HIGHLY WEATHERED SHALE+, gray to dark gray, soft								
					15-40-50/3"		6		
		5							
8.5	432.5								
	SHALE+, gray to dark gray, hard				50/1"				
		10							
11.1	429.5				50/1"		6		
	Boring Terminated at 11.1 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.
+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Hammer Type: Automatic

Advancement Method:
0 to 11.1 ft: 3-1/4" Hollow-stem auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.
Locations and elevations obtained by survey

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
25809 I 30
Bryant, AR

Boring Started: 7/21/2016 | Boring Completed: 7/21/2016
Drill Rig: CME-75, #387 | Driller: CL
Project No.: 35145118 | Exhibit: A-20

BORING LOG NO. W8-B-1

PROJECT: CA0607 - Hwy 227-Ouachita River (Widening)(S)

CLIENT: Buchart Horn, Inc. Memphis, Tennessee

SITE: Hwy 270 Hot Springs, Garland County, Arkansas

LOCATION See Exhibit A-2

Latitude: 34.506994° Longitude: -93.130831°
Northing: 1983892.9 Easting: 971652.9
Station: 161+85 Offset: 50 ft R

Surface Elev.: 459.3 (Ft.)

DEPTH	ELEVATION (Ft.)	FIELD TEST RESULTS
		FILL - BROKEN SHALE FILL, gray		4-4-3 N=7
				3-4-5 N=9
8.5	451	**HIGHLY WEATHERED SHALE+**, olive-gray to gray, soft		9-18-50/6"
13.5	446	**SHALE+**, dark gray, hard		50/1"
				50/1"
23.7	435.5	***Boring Terminated at 23.7 Feet***		50/2"

DEPTH (Ft.): 5, 10, 15, 20

WATER LEVEL OBSERVATIONS | SAMPLE TYPE | LABORATORY TORVANE/HP (psf) | WATER CONTENT (%) | ATTERBERG LIMITS LL-PL-PI | PERCENT FINES

Stratification lines are approximate. In-situ, the transition may be gradual.
+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Hammer Type: Automatic

Advancement Method:
0 to 23.7 ft: 3-1/4" Hollow-stem auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.
Locations and elevations obtained by survey

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
25809 I 30
Bryant, AR

Boring Started: 7/22/2016 | Boring Completed: 7/22/2016
Drill Rig: CME-75, #387 | Driller: CL
Project No.: 35145118 | Exhibit: A-21

BORING LOG NO. W8-B-1A

PROJECT: CA0607 - Hwy 227-Ouachita River (Widening)(S)

CLIENT: Buchart Horn, Inc. Memphis, Tennessee

SITE: Hwy 270 Hot Springs, Garland County, Arkansas

LOCATION See Exhibit A-2

Latitude: 34.506994° Longitude: -93.130831°
Northing: 1983892.9 Easting: 971652.9
Station: 161+85 Offset: 50 ft R

Surface Elev.: 459.3 (Ft.)

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	LABORATORY TORVANE/HP (psf)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
					3-2-2 N=4		13		
					3-2-3 N=5		10	NP	18
					5-8-12 N=20		9		
		5			6-15-28 N=43		7		
					2-3-32 N=35		6		
		10							

FILL - BROKEN SHALE FILL, gray and reddish-brown

4.0 455.5

HIGHLY WEATHERED SHALE+, trace clay seams, brown and gray

10.0 449.5

Boring Terminated at 10 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.
+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Hammer Type: Automatic

Advancement Method:
0 to 10 ft: Solid-stem auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.
Locations and elevations obtained by survey

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
25809 I 30
Bryant, AR

Boring Started: 8/10/2016 Boring Completed: 8/10/2016

Drill Rig: CME-75, #837 Driller: RP

Project No.: 35145118 Exhibit: A-22

BORING LOG NO. W8-B-2

PROJECT: CA0607 - Hwy 227-Ouachita River (Widening)(S)

CLIENT: Buchart Horn, Inc. Memphis, Tennessee

SITE: Hwy 270 Hot Springs, Garland County, Arkansas

LOCATION See Exhibit A-2

Latitude: 34.506758° Longitude: -93.130458°
Northing: 1983805.5 Easting: 971763.3
Station: 163+30 Offset: 50 ft R

Surface Elev.: 456.5 (Ft.)

DEPTH	ELEVATION (Ft.)	DESCRIPTION	FIELD TEST RESULTS	WATER CONTENT (%)
		FILL - GRAVELLY LEAN CLAY, with sand, reddish-brown	2-2-3 N=5	13
3.5	453			
		HIGHLY WEATHERED SHALE+, with thin sandstone seams, light gray and gray, soft	8-17-34 N=51	7
8.5	448			
		SHALE+, gray, hard	50/1"	3
13.1	443.5			
		Auger refusal at 13.1 Feet	50/1"	3

GRAPHIC LOG | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | FIELD TEST RESULTS | LABORATORY TORVANE/HP (psf) | WATER CONTENT (%) | ATTERBERG LIMITS LL-PL-PI | PERCENT FINES

Stratification lines are approximate. In-situ, the transition may be gradual.
+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Hammer Type: Automatic

Advancement Method:
0 to 13.1 ft: 3-1/4" Hollow-stem auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.
Locations and elevations obtained by survey

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
25809 I 30
Bryant, AR

Boring Started: 7/22/2016 | Boring Completed: 7/22/2016
Drill Rig: CME-75, #387 | Driller: CL
Project No.: 35145118 | Exhibit: A-23

BORING LOG NO. W8-B-2A

PROJECT: CA0607 - Hwy 227-Ouachita River (Widening)(S)

CLIENT: Buchart Horn, Inc. Memphis, Tennessee

SITE: Hwy 270 Hot Springs, Garland County, Arkansas

LOCATION See Exhibit A-2

Latitude: 34.506758° Longitude: -93.130458°
Northing: 1983805.5 Easting: 971763.3
Station: 163+30 Offset: 50 ft R

Surface Elev.: 456.5 (Ft.)

DEPTH	ELEVATION (Ft.)	Description	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	LABORATORY TORVANE/HP (psf)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
		FILL - GRAVELLY LEAN CLAY, reddish-brown to dark brown								
						6-4-5 N=9	3000 (HP)	13		
						2-3-4 N=7	4000 (HP)	17		
5.0	451.5					10-18-32/0"				
		HIGHLY WEATHERED SHALE+	5			13-50/4"		5		
8.8	447.5					50/3"		3		
		Boring Terminated at 8.8 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.
+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Hammer Type: Automatic

Advancement Method:
0 to 8.8 ft: Solid-stem auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.
Locations and elevations obtained by survey

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
25809 I 30
Bryant, AR

Boring Started: 8/10/2016 | Boring Completed: 8/10/2016
Drill Rig: CME-75, #837 | Driller: RP
Project No.: 35145118 | Exhibit: A-24

BORING LOG NO. W9-B-1

PROJECT: CA0607 - Hwy 227-Ouachita River (Widening)(S)

CLIENT: Buchart Horn, Inc. Memphis, Tennessee

SITE: Hwy 270 Hot Springs, Garland County, Arkansas

LOCATION See Exhibit A-2

Latitude: 34.506856° Longitude: -93.130122°
Northing: 1983840.1 Easting: 971864.6
Station: 163+85 Offset: 50 ft L

Surface Elev.: 446.6 (Ft.)

DEPTH	ELEVATION (Ft.)	FIELD TEST RESULTS	WATER CONTENT (%)
		FILL - GRAVELLY LEAN CLAY, reddish-brown	
2.0	444.5	6-15-9 N=24	7
		GRAVELLY LEAN CLAY (CL), with quartz gravel, reddish-brown, very stiff	
		15-17-17 N=34	9
5.0	441.5	15-17-32 N=49	8
		HIGHLY WEATHERED SHALE+, brownish-gray and gray, soft	
		34-50/3"	144
8.5	438		
		SHALE+, dark gray, soft to moderately hard	
		24-50/4"	5
13.8	433		
		Boring Terminated at 13.8 Feet	
		50/3"	4

DEPTH (Ft.): 5, 10

WATER LEVEL OBSERVATIONS | SAMPLE TYPE | LABORATORY TORVANE/HP (psf) | ATTERBERG LIMITS LL-PL-PI | PERCENT FINES

Stratification lines are approximate. In-situ, the transition may be gradual.
+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Hammer Type: Automatic

Advancement Method:
0 to 13.8 ft: Solid-stem auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.
Locations and elevations obtained by survey

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
25809 I 30
Bryant, AR

Boring Started: 8/10/2016 | Boring Completed: 8/10/2016
Drill Rig: CME-75, #837 | Driller: RP
Project No.: 35145118 | Exhibit: A-25

BORING LOG NO. W9-B-2

PROJECT: CA0607 - Hwy 227-Ouachita River (Widening)(S)

CLIENT: Buchart Horn, Inc. Memphis, Tennessee

SITE: Hwy 270 Hot Springs, Garland County, Arkansas

LOCATION See Exhibit A-2

Latitude: 34.506592° Longitude: -93.129739°
Northing: 1983742.8 Easting: 971979.4
Station: 165+25 Offset: 65 ft L

Surface Elev.: 445.4 (Ft.)

DEPTH	ELEVATION (Ft.)	Material	FIELD TEST RESULTS	WATER CONTENT (%)
1.5	444	**FILL - LEAN CLAY**, reddish-brown	3-3-4 N=7	16
3.5	442	**LEAN CLAY (CL)**, with shale pieces, brownish-gray and red, very stiff	6-16-34 N=50	12
8.5	437	**HIGHLY WEATHERED SHALE+**, dark gray, brown, and red, soft	19-50/5"	11
			35-50/3"	5
			50/3"	4
			50/2"	7
16.2	429	**SHALE+**, dark gray, soft to moderately hard	50/2"	
		Auger refusal at 16.2 Feet		

DEPTH (Ft.): 5, 10, 15

WATER LEVEL OBSERVATIONS | SAMPLE TYPE | LABORATORY TORVANE/HP (psf) | ATTERBERG LIMITS LL-PL-PI | PERCENT FINES

Stratification lines are approximate. In-situ, the transition may be gradual.
+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Hammer Type: Automatic

Advancement Method:
0 to 16.2 ft: Solid-stem auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.
Locations and elevations obtained by survey

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
25809 I 30
Bryant, AR

Boring Started: 8/10/2016 | Boring Completed: 8/10/2016
Drill Rig: CME-75, #837 | Driller: RP
Project No.: 35145118 | Exhibit: A-26

BORING LOG NO. W10-B-1

PROJECT: CA0607 - Hwy 227-Ouachita River (Widening)(S)

CLIENT: Buchart Horn, Inc. Memphis, Tennessee

SITE: Hwy 270 Hot Springs, Garland County, Arkansas

LOCATION See Exhibit A-2

Latitude: 34.505531° Longitude: -93.125847°
Northing: 1983343.1 Easting: 973148
Station: 16+50 Offset: 5 ft L

Surface Elev.: 433.2 (Ft.)

DEPTH	ELEVATION (Ft.)	Description	FIELD TEST RESULTS	WATER CONTENT (%)
		FILL - SANDY GRAVEL, brown	7-12-18 N=30	3
		- with asphalt pieces	14-10-11 N=21	8
8.5	424.5			
		HIGHLY WEATHERED SHALE+, olive-gray to olive-brown, soft	14-9-15 N=24	8
13.5	419.5			
		SHALE WITH SANDSTONE SEAMS+, gray, hard	50/2"	1
16.1	417			
		Boring Terminated at 16.1 Feet	50/1"	2

DEPTH (Ft.): 5, 10, 15

WATER LEVEL OBSERVATIONS | SAMPLE TYPE | LABORATORY TORVANE/HP (psf) | ATTERBERG LIMITS LL-PL-PI | PERCENT FINES

Stratification lines are approximate. In-situ, the transition may be gradual.
+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Hammer Type: Automatic

Advancement Method:
0 to 18.6 ft: 3-1/4" Hollow-stem auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.
Locations and elevations obtained by survey

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
25809 I 30
Bryant, AR

Boring Started: 7/21/2016 | Boring Completed: 7/21/2016
Drill Rig: CME-75, #387 | Driller: CL
Project No.: 35145118 | Exhibit: A-27

BORING LOG NO. W10-B-1A

PROJECT: CA0607 - Hwy 227-Ouachita River (Widening)(S)

CLIENT: Buchart Horn, Inc. Memphis, Tennessee

SITE: Hwy 270 Hot Springs, Garland County, Arkansas

LOCATION See Exhibit A-2

Latitude: 34.505531° Longitude: -93.125847°
Northing: 1983343.1 Easting: 973148
Station: 16+50 Offset: 5 ft L

Surface Elev.: 433.2 (Ft.)

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)
FILL - SANDY GRAVEL, brown					
2.0	431			9-8-9 N=17	10
FILL - GRAVELLY LEAN CLAY, with sand, trace asphalt pieces, dark brown and brown				4-9-13 N=22	7
3.5	429.5				
FILL - SANDY GRAVEL, brown				9-9-5 N=14	5
5.0	428	5			
FILL - GRAVELLY LEAN CLAY, brown and grayish-brown				4-4-5 N=9	10
8.5	424.5				
HIGHLY WEATHERED SHALE+, brownish-gray, brown, and red				19-23-20 N=43	9
10.0	423	10			
Boring Terminated at 10 Feet					

ATTERBERG LIMITS: LL-PL-PI

LABORATORY TORVANE/HP (psf)

PERCENT FINES

WATER LEVEL OBSERVATIONS

Stratification lines are approximate. In-situ, the transition may be gradual.
+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Hammer Type: Automatic

Advancement Method:
0 to 10 ft: Solid-stem auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.
Locations and elevations obtained by survey

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
25809 I 30
Bryant, AR

Boring Started: 8/10/2016 Boring Completed: 8/10/2016

Drill Rig: CME-75, #837 Driller: RP

Project No.: 35145118 Exhibit: A-28

BORING LOG NO. W10-B-2

PROJECT: CA0607 - Hwy 227-Ouachita River (Widening)(S)

CLIENT: Buchart Horn, Inc. Memphis, Tennessee

SITE: Hwy 270 Hot Springs, Garland County, Arkansas

LOCATION See Exhibit A-2

Latitude: 34.505358° Longitude: -93.125717°
Northing: 1983280.8 Easting: 973186.1
Station: 17+40 Offset: 5 ft L

Surface Elev.: 431.9 (Ft.)

DEPTH	ELEVATION (Ft.)	Description	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	LABORATORY TORVANE/HP (psf)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
		FILL - SANDY GRAVEL, brown				8-5-5 N=10		8		
						3-3-2 N=5		6		
8.5	423.5		5							
		HIGHLY WEATHERED SHALE WITH SANDSTONE SEAMS+, olive-gray, soft				3-8-10 N=18		7		
13.5	418.5		10							
		SHALE+, gray, hard				50/1"		8		
16.1	416		15			50/1"		5		
		Auger refusal at 16.1 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.
+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Hammer Type: Automatic

Advancement Method:
0 to 16.1 ft: 3-1/4" Hollow-stem auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.
Locations and elevations obtained by survey

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
25809 I 30
Bryant, AR

Boring Started: 7/21/2016 | Boring Completed: 7/21/2016
Drill Rig: CME-75, #387 | Driller: CL
Project No.: 35145118 | Exhibit: A-29

BORING LOG NO. W10-B-2A

PROJECT: CA0607 - Hwy 227-Ouachita River (Widening)(S)

CLIENT: Buchart Horn, Inc. Memphis, Tennessee

SITE: Hwy 270 Hot Springs, Garland County, Arkansas

LOCATION See Exhibit A-2

Latitude: 34.505358° Longitude: -93.125717°
Northing: 1983280.8 Easting: 973186.1
Station: 17+40 Offset: 5 ft L

Surface Elev.: 431.9 (Ft.)

DEPTH	ELEVATION (Ft.)	FIELD TEST RESULTS	WATER CONTENT (%)
		FILL - SANDY GRAVEL, brown	
		12-13-10 N=23	9
		7-6-6 N=12	10
		50/4"	7
5		3-4-4 N=8	9
8.5	423.5		
		FILL - CLAYEY GRAVEL, brown to dark brown	
		4-6-6 N=12	13
10.0	422		
10		***Boring Terminated at 10 Feet***	

GRAPHIC LOG | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | LABORATORY TORVANE/HP (psf) | ATTERBERG LIMITS LL-PL-PI | PERCENT FINES

Stratification lines are approximate. In-situ, the transition may be gradual.
+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Hammer Type: Automatic

Advancement Method:
0 to 10 ft: Solid-stem auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.
Locations and elevations obtained by survey

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
25809 I 30
Bryant, AR

Boring Started: 8/10/2016 | Boring Completed: 8/10/2016
Drill Rig: CME-75, #837 | Driller: RP
Project No.: 35145118 | Exhibit: A-30

APPENDIX B
LABORATORY TESTING

Laboratory Testing Description

Samples retrieved during the field exploration were taken to the laboratory for further observation by the project geotechnical engineer. Descriptive classifications of the soils indicated on the boring log are in accordance with the Explanation of Boring Log Information and the Unified Soil Classification System included in Appendix C. Also shown are estimated Unified Soil Classification Symbols. Rock was described in accordance with Exhibit C-3 General Notes – Sedimentary Rock Classification. All classification was by visual/manual procedures, (ASTM D 2487).

The field descriptions were confirmed or modified as necessary and an applicable laboratory testing program was formulated to determine engineering properties of the subsurface materials. Selected soil samples obtained from the site were tested for the following engineering properties:

- Moisture content (ASTM D2216)
- Atterberg limits (ASTM D4318)
- Hand penetrometer
- Percent fines (percent passing the No. 200 sieve or P200) (ASTM D1140)
- Consolidated Undrained Triaxial Compression Test (ASTM D4767-11)
- Moisture Density Relations of Soils (AASHTO T-99)

The laboratory test results are reported on the boring logs and have been used for the geotechnical engineering analyses, and the development of pavement recommendations. Laboratory tests were performed in general accordance with the applicable ASTM, local or other accepted standards. Procedural standards noted above are for reference to methodology in general. In some cases, variations to methods are applied as a result of local practice or professional judgment.

Laboratory compaction characteristics of soil tests were performed by AASHTO T-99 (standard Proctor) procedures on bulk samples of subgrade soils, designated W8-Bulk 1 and W10-Bulk 1, consisting of silty sand with gravel and clayey sand with gravel, respectively. Results of those two moisture-density relationship tests are presented on Exhibits B-2 and B-3.

Consolidated undrained triaxial tests were performed on two bulk samples W8-Bulk 1 and W10-Bulk 1, and one soil sample from Boring W3-B-1. Results of those three consolidated undrained triaxial tests are presented on Exhibits B-4 through B-6.

Laboratory Compaction Characteristics of Soil

Terracon
13910 West 96th Terrace
Lenexa, Kansas 66215
913-492-7777

Client Name:
Project Name: CA 0607- Highway 227
Location:

Source Material: W8, Bulk, 1.0 to 5.0 feet

Sample Description: Silty Sand with Gravel

Material Designation: SM Sample date:
Test Method: ASTM D698
Test Procedure: Method B
Sample Preparation: Dry Preparation
Rammer: X Mechanical ____ Manual

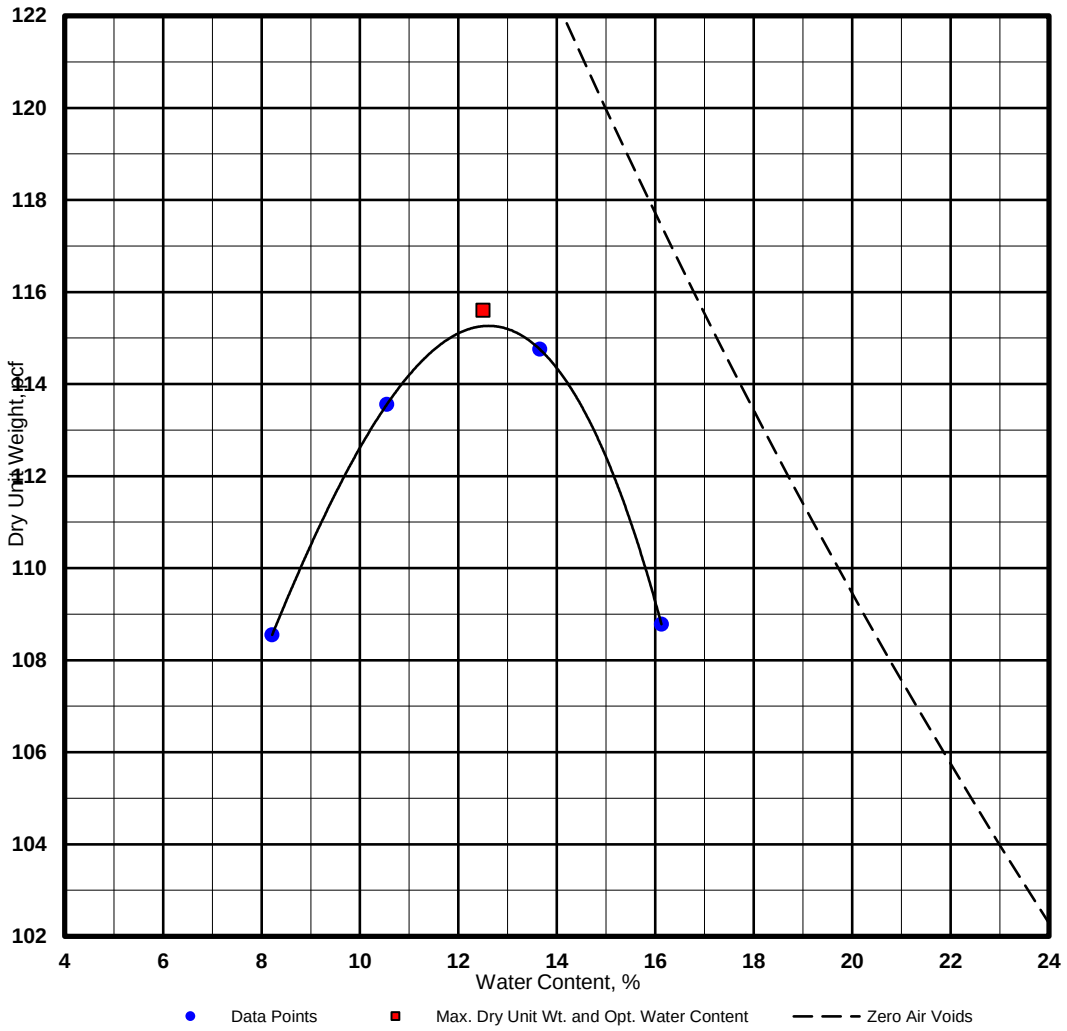
Project No.: 35145118 Date: 8/17/2016

TEST RESULTS

Maximum Dry Unit Wt.:	115.6	pcf
Optimum Water Content:	12.5	%
Rock Correction Values		
Maximum Dry Unit Wt.:	123.8	pcf
Optimum Water Content:	9.8	%

Natural Moisture, %:
% passing # 200 sieve:
Reviewed by:

Zero air voids for specific gravity of 2.70



Laboratory Compaction Characteristics of Soil

13910 West 96th Terrace
Lenexa, Kansas 66215
913-492-7777

Client Name:

Project Name: CA 0607- Highway 227

Location:

Source Material: W10, Bulk, 1.0 to 5.0 feet

Sample Description: CLAYEY SAND WITH GRAVEL

Material Designation: SC Sample date:

Test Method: ASTM D698

Test Procedure: Method B

Sample Preparation: Dry Preparation

Rammer: X Mechanical ____ Manual

Project No.: 35145118 Date: 8/17/2016

TEST RESULTS

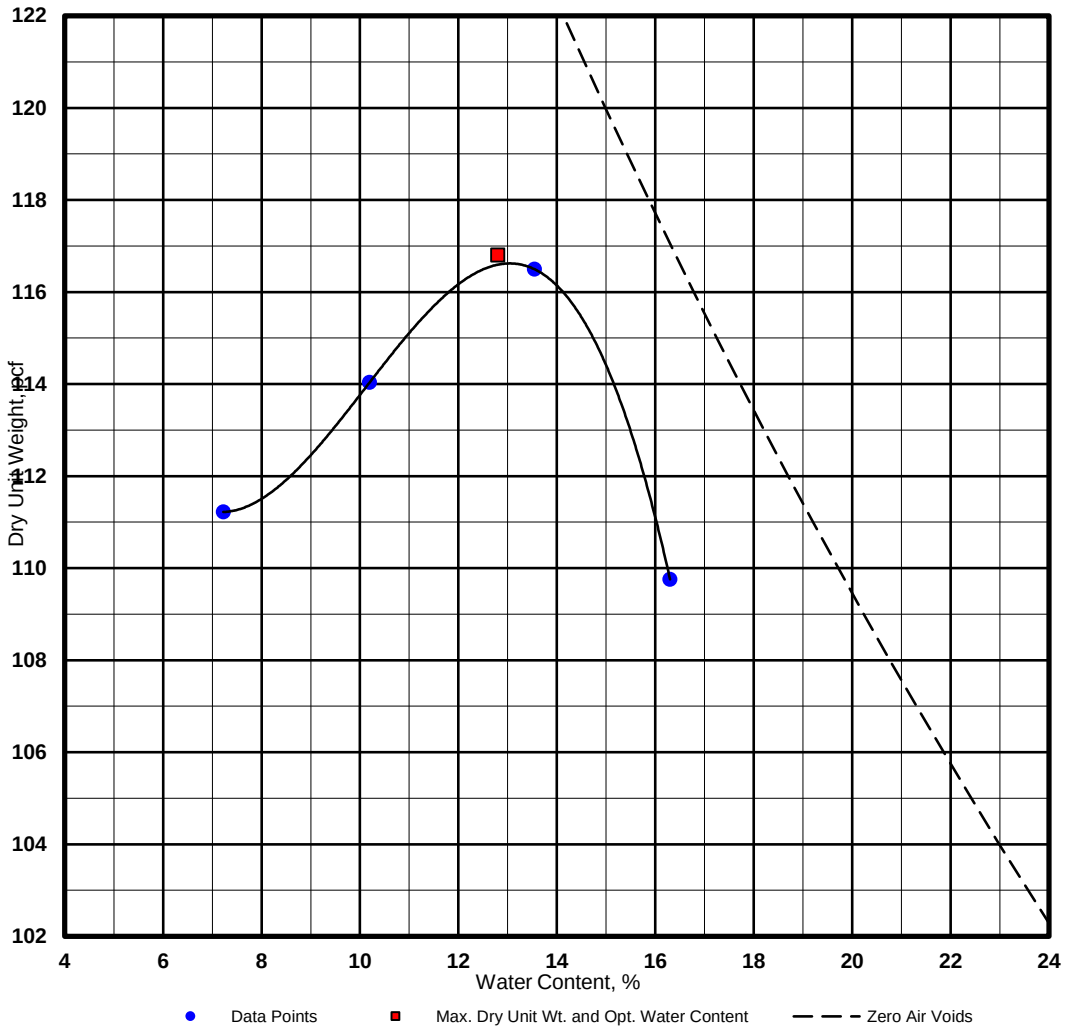
Maximum Dry Unit Wt.:	116.8	pcf
Optimum Water Content:	12.8	%
Rock Correction Values		
Maximum Dry Unit Wt.:	122.8	pcf
Optimum Water Content:	10.9	%

Natural Moisture, %:

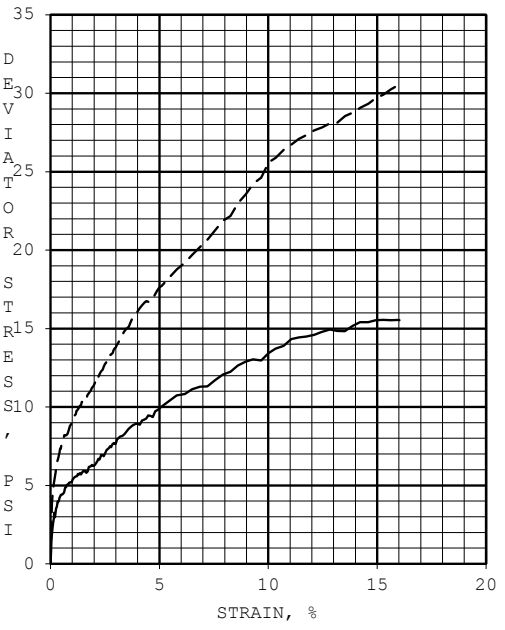
% passing # 200 sieve:

Reviewed by:

Zero air voids for specific gravity of 2.70



	EFFECTIVE STRESS ---	ANGLE OF INTERNAL FRICTION, deg	**35.5**	COHESION, psi	**0.0**
	TOTAL STRESS ——	ANGLE OF INTERNAL FRICTION, deg	**26.4**	COHESION, psi	**0.0**



SPECIMEN ID:		A	B	
INITIAL	WATER CONTENT, %	17.9	18.1	
	DRY DENSITY, pcf	111.1	110.7	
	SATURATION, %	93	94	
	VOID RATIO	0.52	0.52	
BEFORE SHEAR	WATER CONTENT, %	19.3	18.5	
	DRY DENSITY, pcf	110.7	112.3	
	SATURATION (B PARAMETER)	0.97	0.97	
	VOID RATIO	0.52	0.50	
	FINAL BACK PRESSURE, psi	100.8	100.7	
MINOR PRINCIPAL STRESS, psi		4.3	8.9	
EFFECTIVE STRESS PEAK AT % STRAIN		3.0	3.0	
EFF. DEVIATOR STRESS AT PEAK STRAIN, psi		7.6	13.8	
TOTAL STRESS PEAK AT % STRAIN		3.0	3.0	
TOTAL DEVIATOR STRESS AT PEAK STRAIN, psi		7.6	13.8	
ULTIMATE DEVIATOR STRESS (15% STR), psi		15.5	29.7	
TIME TO 50% PRIMARY CONSOLIDATION, min		10.00	1.45	
STRAIN RATE, % / hour		3.99	3.98	
INITIAL DIAMETER, inch		1.364	1.370	
INITIAL HEIGHT, inch		2.793	3.010	
AREA AFTER CONSOLIDATION, inch2		1.473	1.460	

CONTROLLED - STRAIN TEST

SAMPLE TYPE: 3" SHELBY TUBE

DESCRIPTION OF SPECIMENS:
GRAVELLY LEAN CLAY WIH SAND, STRONG BROWN

LL	PL	PI	Gs
31	18	13	2.7 EST.

PROJECT NO. 35145118

LABORATORY: TERRACON - LENEXA

DATE: 8/29/2016

PROJECT: CA0607 - HWY 227 - QUACHITA RIVER (WIDENING)
HOT SPRINGS, ARKANSAS

BORING #: W3-B-1

SAMPLE #: 3

DEPTH, feet: 3.5 - 5.0

PROCEDURE: ASTM D4767, CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST ON COHESIVE SOILS

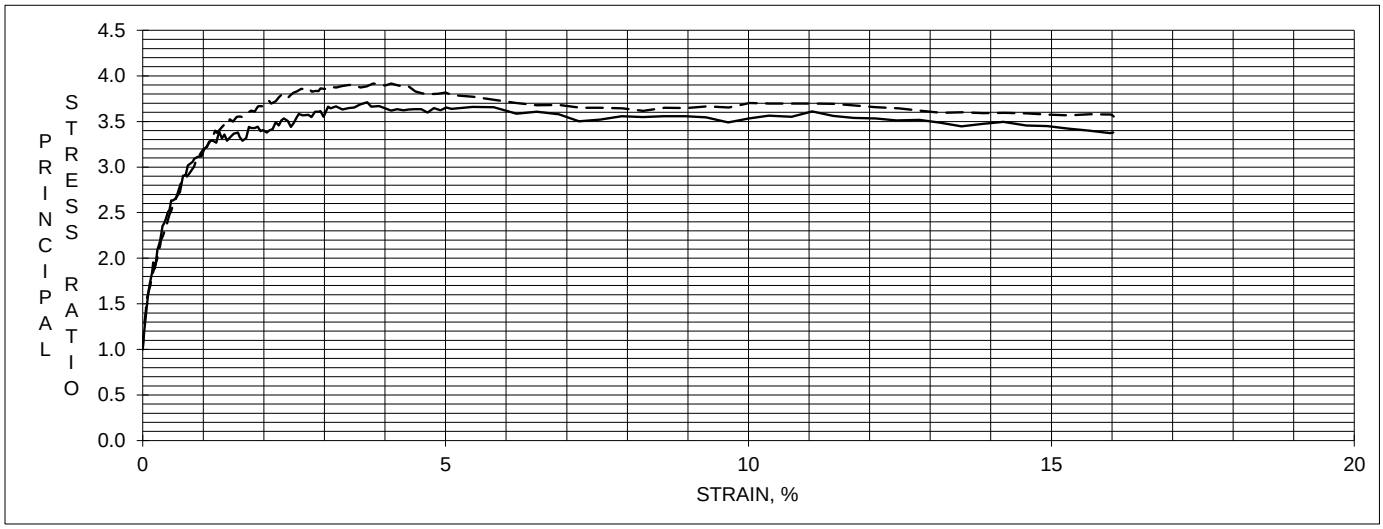
Terracon

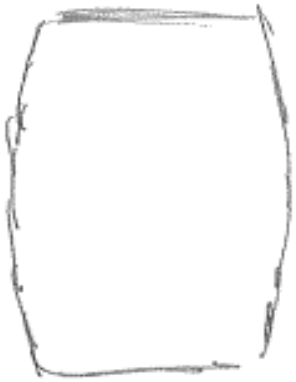
N:\CM\LAB_DATA\00 Projects in Progress\2016 Projects in Progress\35145118 Lab Data\[35145118 Triaxial CU - 3Point W8-BULK-1.0.xlsx]REPORT

Exhibit B-4-a

CA0607 - HWY 227 - QUACHITA RIVER (WIDENING)

35145118 W3-B-1 3 3.5 - 5.0



FAILURE SKETCH	FAILURE SKETCH	FAILURE SKETCH
		
SPECIMEN A	SPECIMEN B	SPECIMEN C

REMARKS:

SPECIMENS SATURATED BY THE WET METHOD.

EFFECTIVE STRESS FAILURE DATA BASED ON 3 % STRAIN.

EFFECTIVE STRESS MOHR'S CIRCLES DRAWN AT 3 % STRAIN.

TOTAL STRESS FAILURE DATA BASED ON 3 % STRAIN.

TOTAL STRESS MOHR'S CIRCLES DRAWN AT 3 % STRAIN.

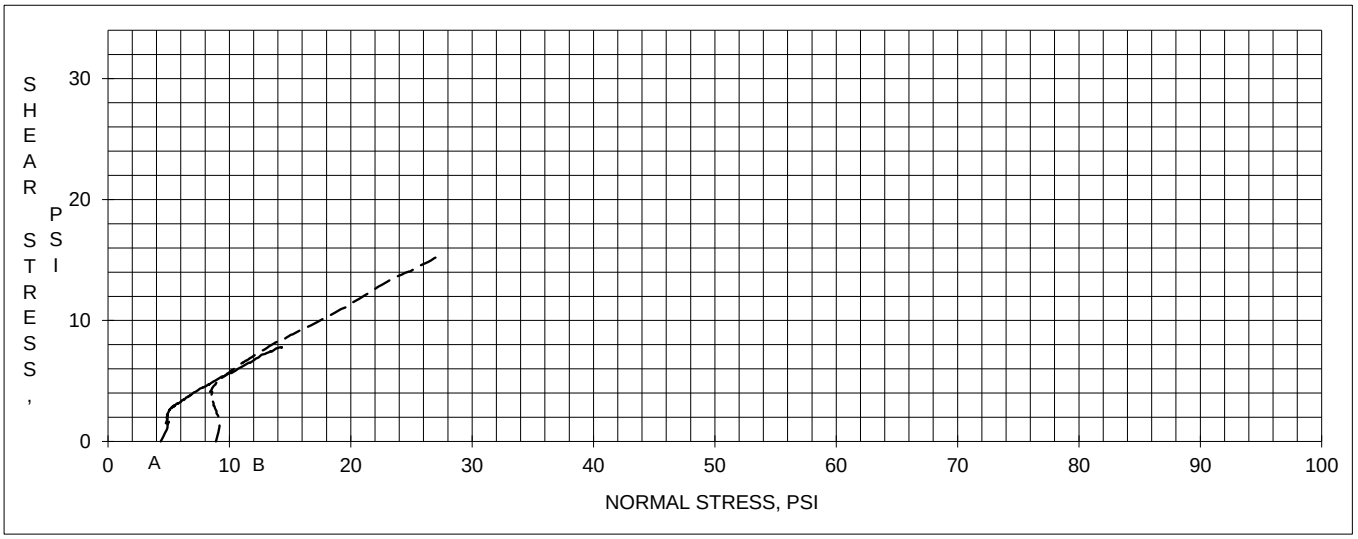
DEVIATOR STRESSES CORRECTED FOR MEMBRANE AND FILTER PAPER EFFECTS.

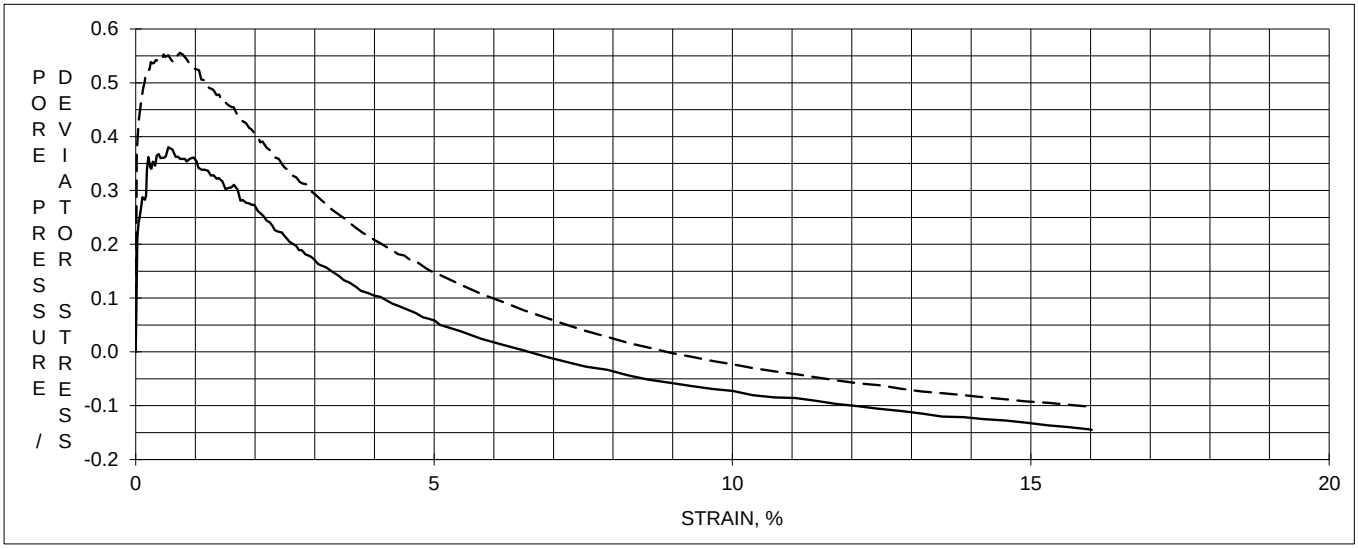
AREA AFTER CONSOLIDATION CALCULATED AS PER SECTION 10.3.2.1 METHOD A

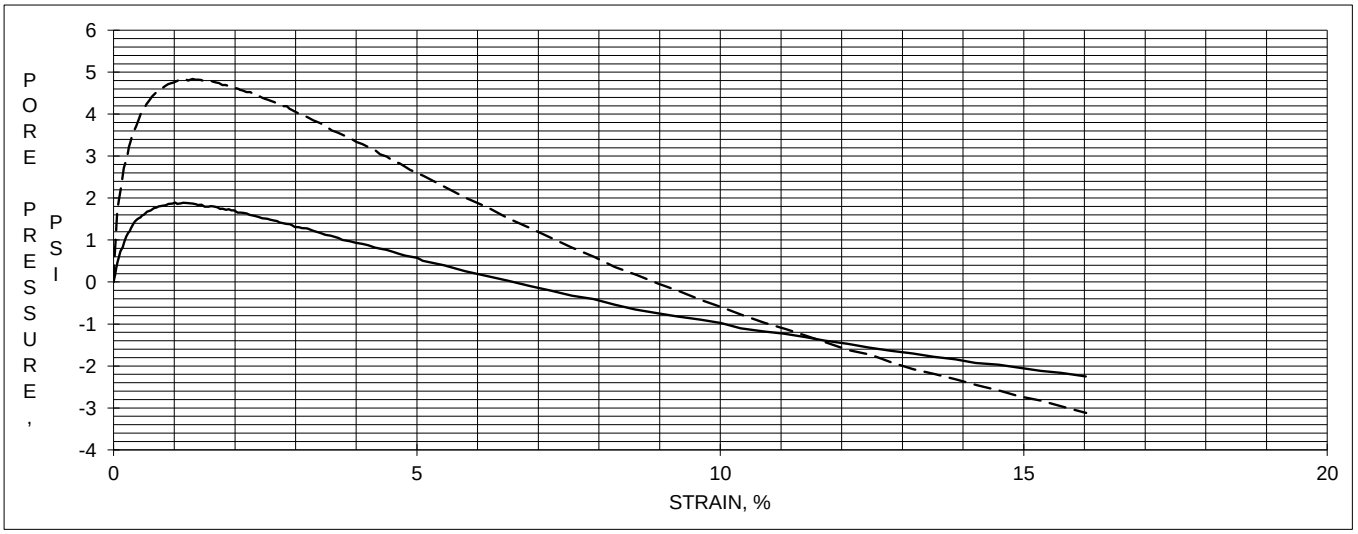
Terracon

CA0607 - HWY 227 - QUACHITA RIVER (WIDENING)

35145118	W3-B-1	3	3.5 - 5.0



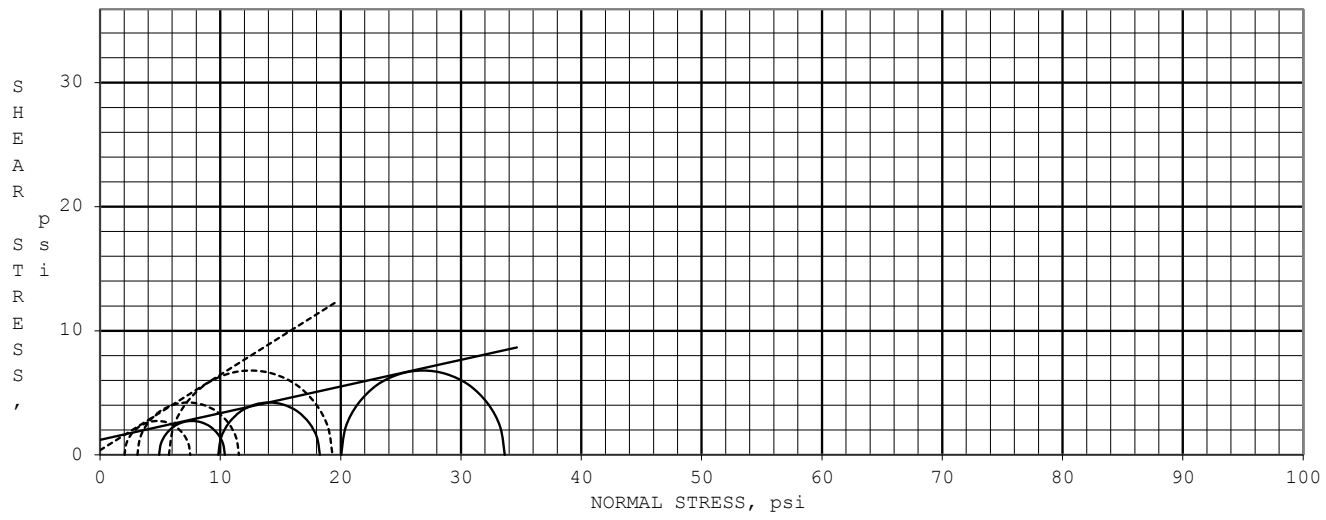




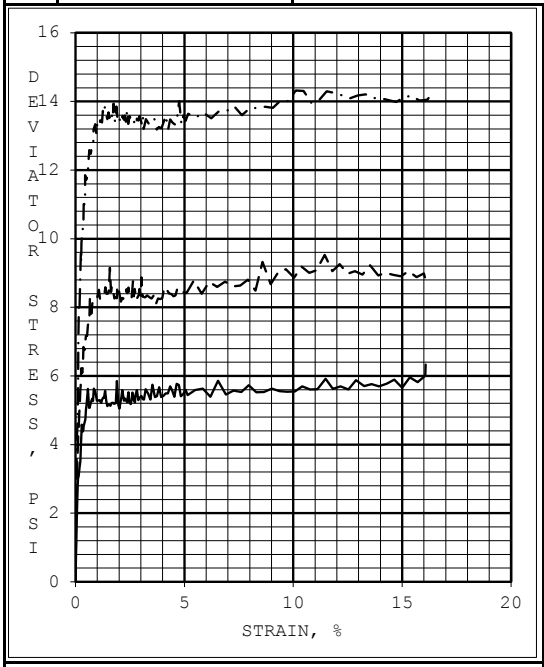
Terracon

N:\CM\LAB_DATA\00 Projects in Progress\2016 Projects in Progress\35145118 Lab Data\[35145118 Triaxial CU - 3Point W8-BULK-1.0.xlsx]REPORT

Exhibit B-4-c



	EFFECTIVE STRESS ---	ANGLE OF INTERNAL FRICTION, deg	**31.3**	COHESION, psi	**0.4**
	TOTAL STRESS ——	ANGLE OF INTERNAL FRICTION, deg	**12.1**	COHESION, psi	**1.2**



	SPECIMEN ID:	A	B	C
INITIAL	WATER CONTENT, %	12.6	12.7	12.6
	DRY DENSITY, pcf	109.1	108.9	108.7
	SATURATION, %	63	63	62
	VOID RATIO	0.55	0.55	0.55
BEFORE SHEAR	WATER CONTENT, %	20.0	19.4	18.8
	DRY DENSITY, pcf	109.4	110.5	111.7
	SATURATION (B PARAMETER)	0.95	0.96	0.96
	VOID RATIO	0.54	0.52	0.51
	FINAL BACK PRESSURE, psi	99.5	99.7	99.1
	MINOR PRINCIPAL STRESS, psi	4.9	9.8	20.0
	EFFECTIVE STRESS PEAK AT % STRAIN	5.0	5.0	5.0
	EFF. DEVIATOR STRESS AT PEAK STRAIN, psi	5.5	8.4	13.6
	TOTAL STRESS PEAK AT % STRAIN	5.0	5.0	5.0
	TOTAL DEVIATOR STRESS AT PEAK STRAIN, psi	5.5	8.4	13.6
	ULTIMATE DEVIATOR STRESS (15% STR), psi	5.7	8.9	14.1
	TIME TO 50% PRIMARY CONSOLIDATION, min	0.84	0.62	0.99
	STRAIN RATE, % / hour	4.07	4.19	4.07
	INITIAL DIAMETER, inch	2.004	2.003	2.002
	INITIAL HEIGHT, inch	4.026	4.033	4.046
	AREA AFTER CONSOLIDATION, inch2	3.154	3.118	3.094

CONTROLLED - STRAIN TEST

SAMPLE TYPE: RE-COMPACTED

DESCRIPTION OF SPECIMENS:
SILTY SAND WITH GRAVEL*

LL	PL	PI	Gs
34	24	10	2.7 EST.

PROJECT NO. 34145118

PROJECT: CA0607 - HWY 227 - QUACHITA RIVER (WIDENING)
HOT SPRINGS, ARKANSAS

BORING #: W8

LABORATORY: TERRACON - LENEXA

SAMPLE #: BULK

DATE: 8/29/2016

DEPTH, feet: 1.0 - 5.0

PROCEDURE: ASTM D4767, CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST ON COHESIVE SOILS

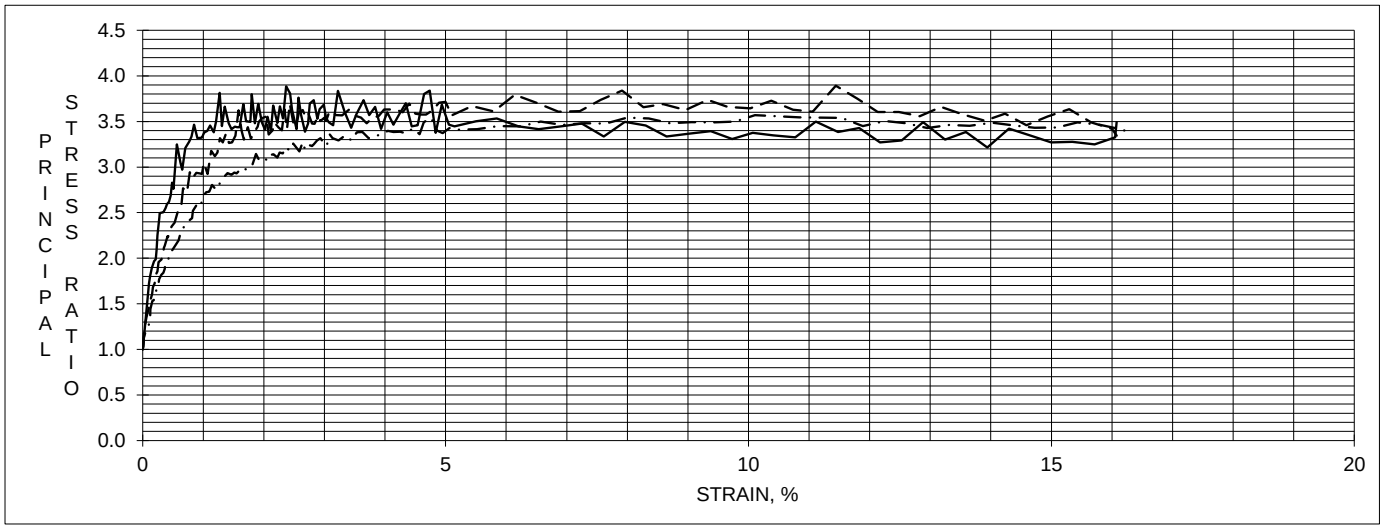
Terracon

N:\CM\LAB_DATA\00 Projects in Progress\2016 Projects in Progress\35145118 Lab Data\[35145118 Triaxial CU - 3Point W8-BULK-1.0.xlsx]REPORT

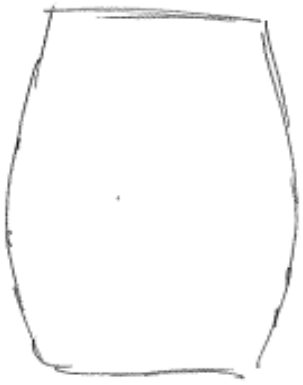
Exhibit B-5-a

CA0607 - HWY 227 - QUACHITA RIVER (WIDENING)

34145118 W8 BULK 1.0 - 5.0



FAILURE SKETCH



SPECIMEN A

FAILURE SKETCH

SPECIMEN B

FAILURE SKETCH

SPECIMEN C

REMARKS:

SPECIMENS SATURATED BY THE WET METHOD.

EFFECTIVE STRESS FAILURE DATA BASED ON 5 % STRAIN.

EFFECTIVE STRESS MOHR'S CIRCLES DRAWN AT 5 % STRAIN.

TOTAL STRESS FAILURE DATA BASED ON 5 % STRAIN.

TOTAL STRESS MOHR'S CIRCLES DRAWN AT 5 % STRAIN.

DEVIATOR STRESSES CORRECTED FOR MEMBRANE AND FILTER PAPER EFFECTS.

AREA AFTER CONSOLIDATION CALCULATED AS PER SECTION 10.3.2.1 METHOD A

* SPECIMENS WERE RE-COMPACTED WITH THE -#10 MATERIAL

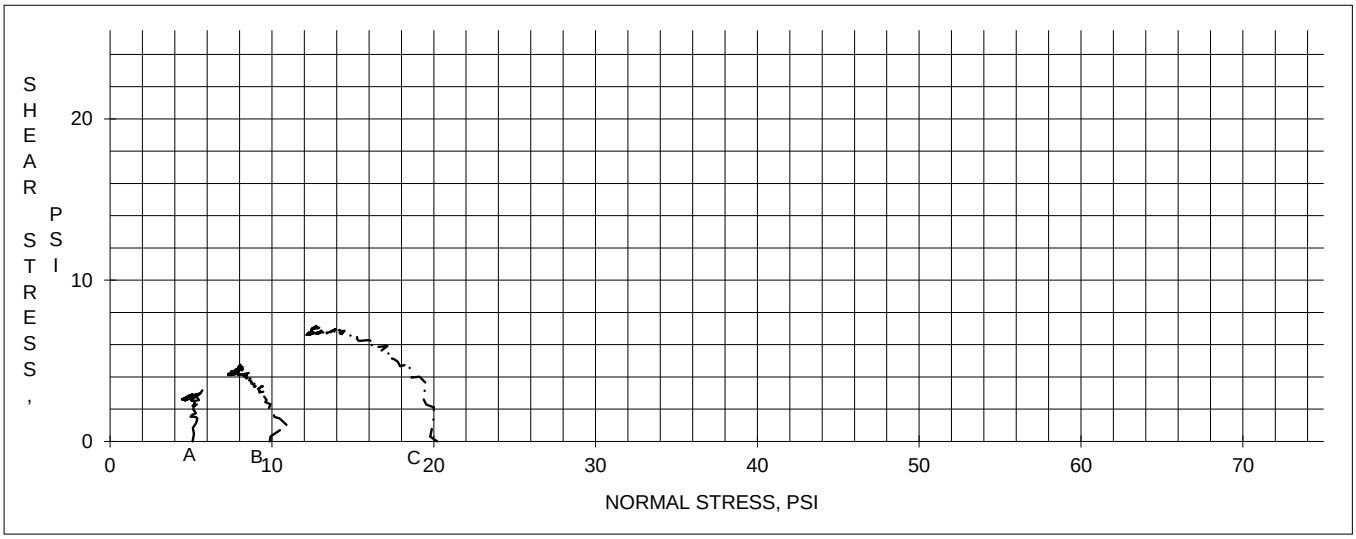
STANDARD PROCTOR = 115.6pcf @ 12.5% MOISTURE

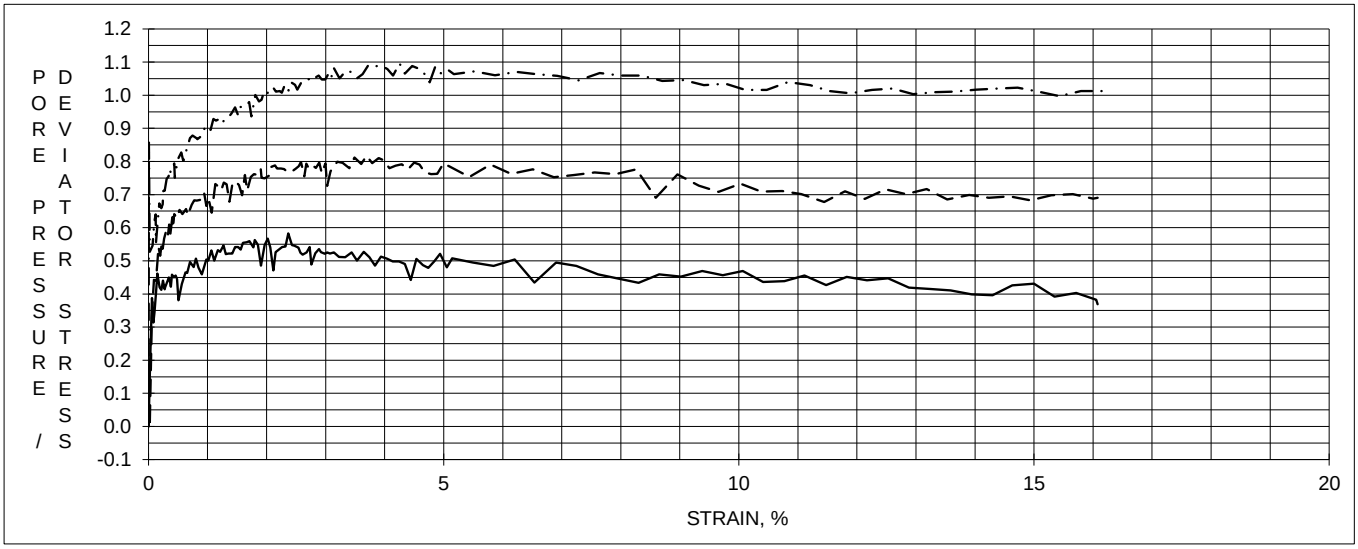
REMOLDED TO 108.9 pcf @ 12.7% MOISTURE REMOLDED TO 94.2% COMPACTION

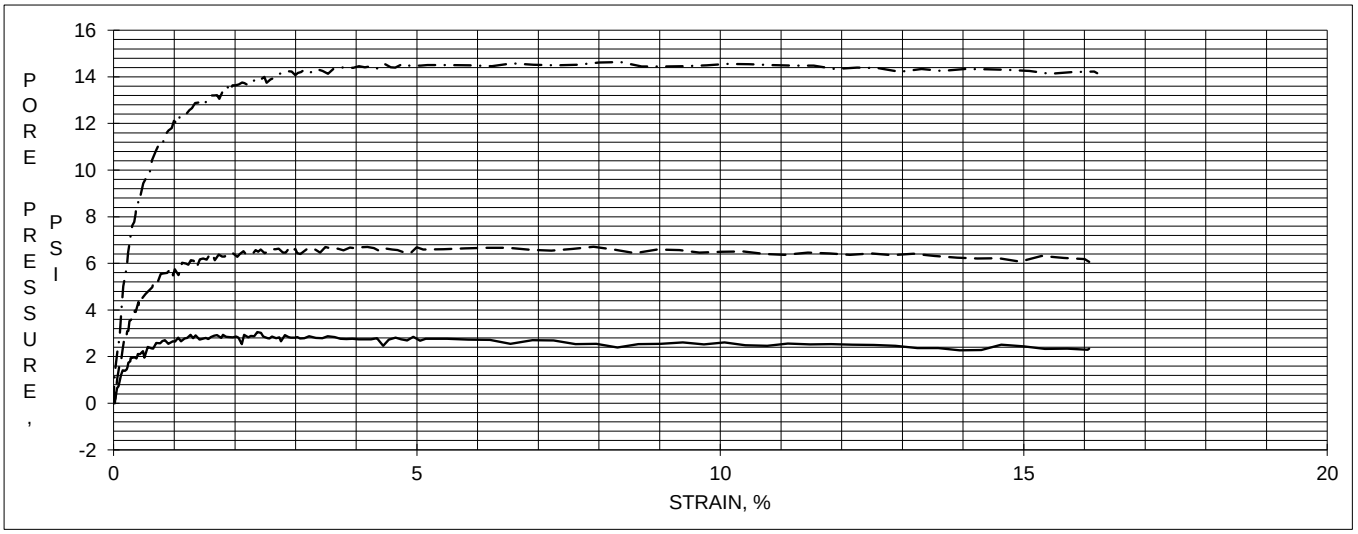
Terracon

CA0607 - HWY 227 - QUACHITA RIVER (WIDENING)

34145118 W8 BULK 1.0 - 5.0







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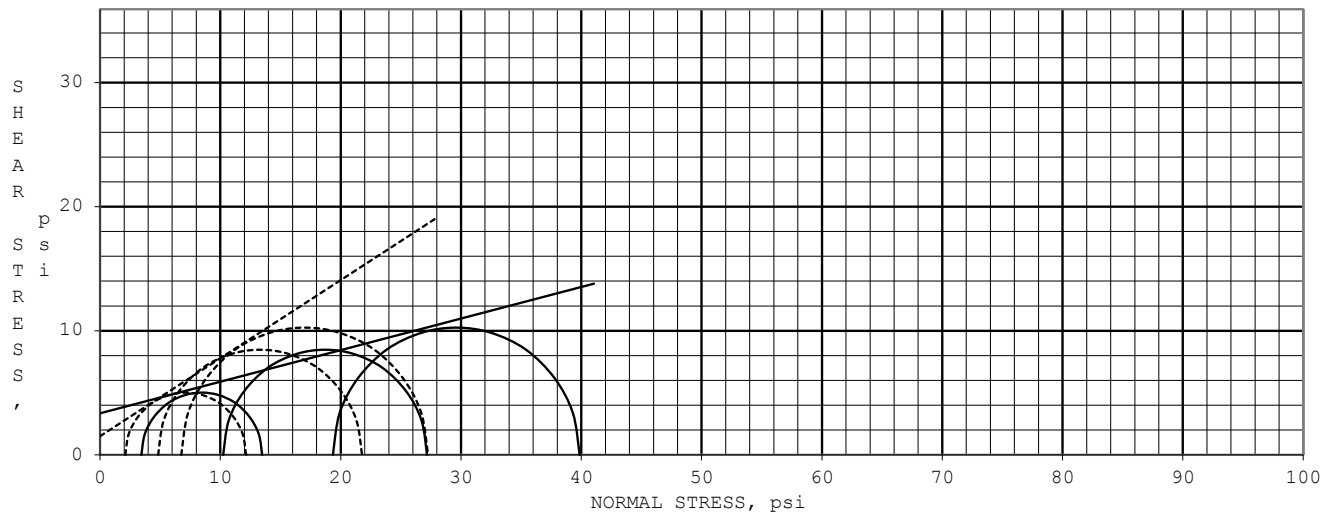
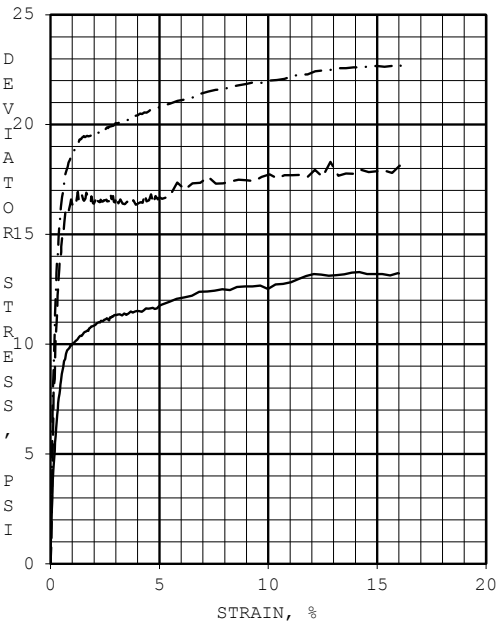


	EFFECTIVE STRESS ---	ANGLE OF INTERNAL FRICTION, deg	**32.2**	COHESION, psi	**1.5**
	TOTAL STRESS ——	ANGLE OF INTERNAL FRICTION, deg	**14.3**	COHESION, psi	**3.3**



	SPECIMEN ID:	A	B	C
INITIAL	WATER CONTENT, %	12.9	12.9	12.8
	DRY DENSITY, pcf	110.4	110.5	110.3
	SATURATION, %	66	66	66
	VOID RATIO	0.53	0.53	0.53
BEFORE SHEAR	WATER CONTENT, %	19.4	19.2	18.7
	DRY DENSITY, pcf	110.5	110.9	112.0
	SATURATION (B PARAMETER)	0.96	0.95	1.00
	VOID RATIO	0.52	0.52	0.50
	FINAL BACK PRESSURE, psi	101.4	99.1	100.5
	MINOR PRINCIPAL STRESS, psi	3.4	10.2	19.4
	EFFECTIVE STRESS PEAK AT % STRAIN	1.0	1.2	4.1
	EFF. DEVIATOR STRESS AT PEAK STRAIN, psi	10.0	16.9	20.5
	TOTAL STRESS PEAK AT % STRAIN	1.0	1.2	4.1
	TOTAL DEVIATOR STRESS AT PEAK STRAIN, psi	10.0	16.9	20.5
	ULTIMATE DEVIATOR STRESS (15% STR), psi	13.2	17.9	22.7
	TIME TO 50% PRIMARY CONSOLIDATION, min	0.33	0.17	0.32
	STRAIN RATE, % / hour	3.84	3.98	4.00
	INITIAL DIAMETER, inch	2.004	2.003	2.005
	INITIAL HEIGHT, inch	4.028	4.030	4.030
	AREA AFTER CONSOLIDATION, inch2	3.152	3.150	3.129

CONTROLLED - STRAIN TEST

SAMPLE TYPE: RE-COMPACTED

DESCRIPTION OF SPECIMENS:
CLAYEY SAND WITH GRAVEL*

LL	PL	PI	Gs
31	22	9	2.7 EST.

PROJECT NO. 34145118

PROJECT: CA0607 - HWY 227 - QUACHITA RIVER (WIDENING)
HOT SPRINGS, ARKANSAS

BORING #: W10

LABORATORY: TERRACON - LENEXA

SAMPLE #: BULK

DATE: 8/29/2016

DEPTH, feet: 1.0 - 5.0

PROCEDURE: ASTM D4767, CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST ON COHESIVE SOILS

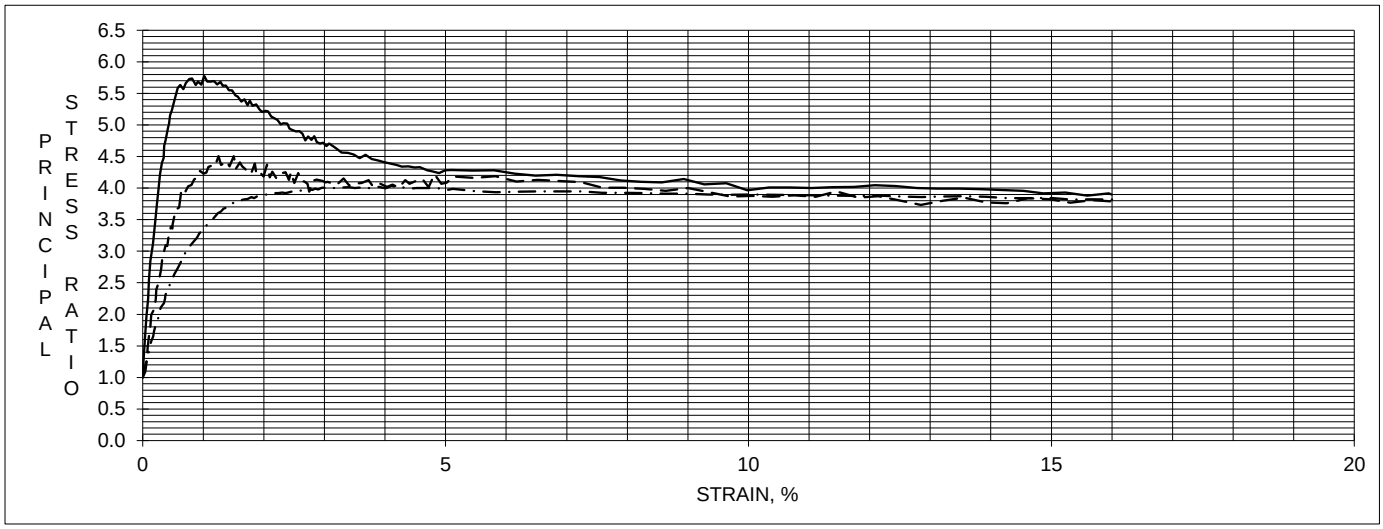
Terracon

N:\CM\LAB_DATA\00 Projects in Progress\2016 Projects in Progress\35145118 Lab Data\[35145118 Triaxial CU - 3Point W8-BULK-1.0.xlsx]REPORT

Exhibit B-6-a

CA0607 - HWY 227 - QUACHITA RIVER (WIDENING)

34145118 W10 BULK 1.0 - 5.0



FAILURE SKETCH

SPECIMEN A

FAILURE SKETCH

SPECIMEN B

FAILURE SKETCH

SPECIMEN C

REMARKS:

SPECIMENS SATURATED BY THE WET METHOD.

EFFECTIVE STRESS FAILURE DATA BASED ON PEAK PRINCIPAL STRESS RATIO % STRAIN.

EFFECTIVE STRESS MOHR'S CIRCLES DRAWN AT PEAK PRINCIPAL STRESS RATIO % STRAIN.

TOTAL STRESS FAILURE DATA BASED ON PEAK PRINCIPAL STRESS RATIO % STRAIN.

TOTAL STRESS MOHR'S CIRCLES DRAWN AT PEAK PRINCIPAL STRESS RATIO % STRAIN.

DEVIATOR STRESSES CORRECTED FOR MEMBRANE AND FILTER PAPER EFFECTS.

AREA AFTER CONSOLIDATION CALCULATED AS PER SECTION 10.3.2.1 METHOD A

* SPECIMENS WERE RE-COMPACTED WITH THE -#10 MATERIAL

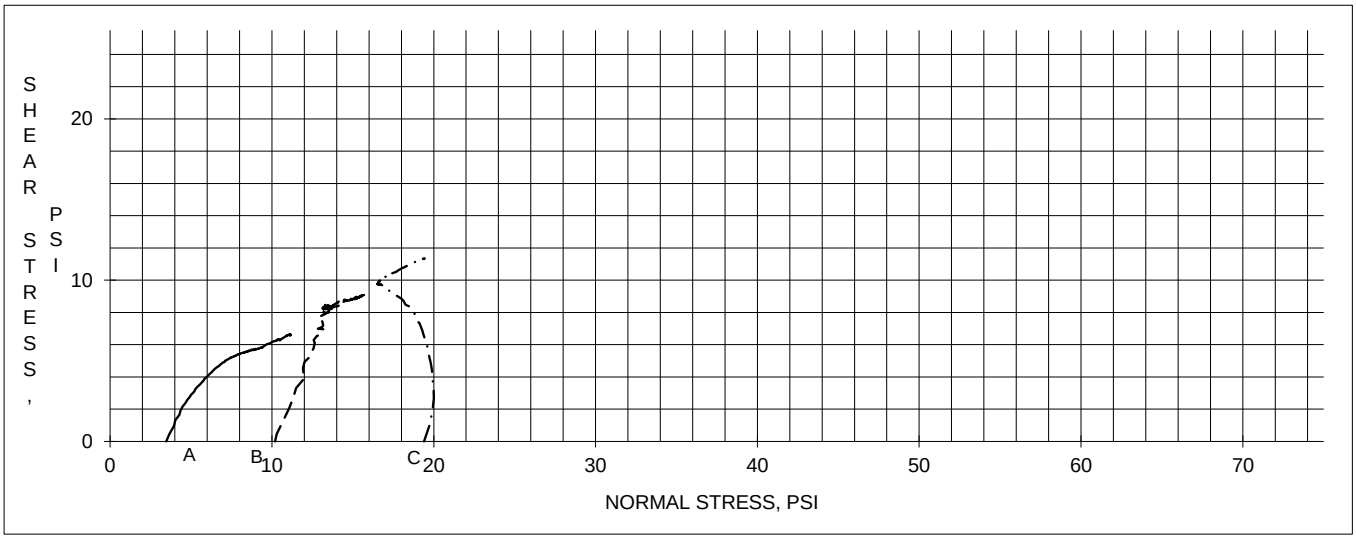
STANDARD PROCTOR = 116.8pcf @ 12.8% MOISTURE

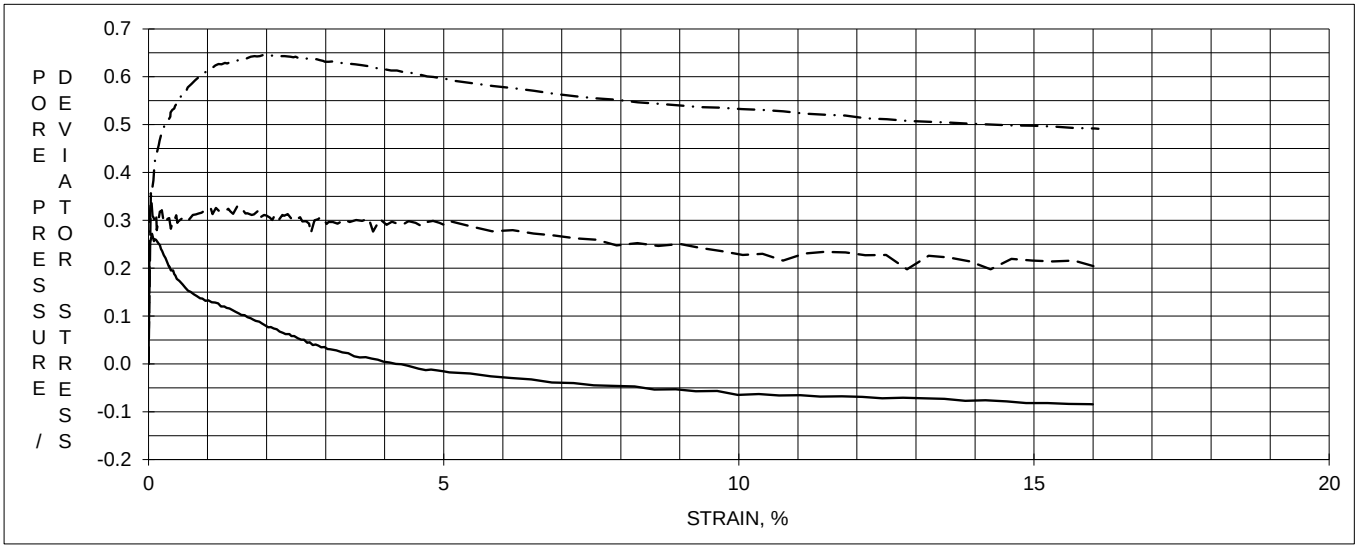
REMOLDED TO 110.4 pcf @ 12.9% MOISTURE REMOLDED TO 94.5% COMPACTION

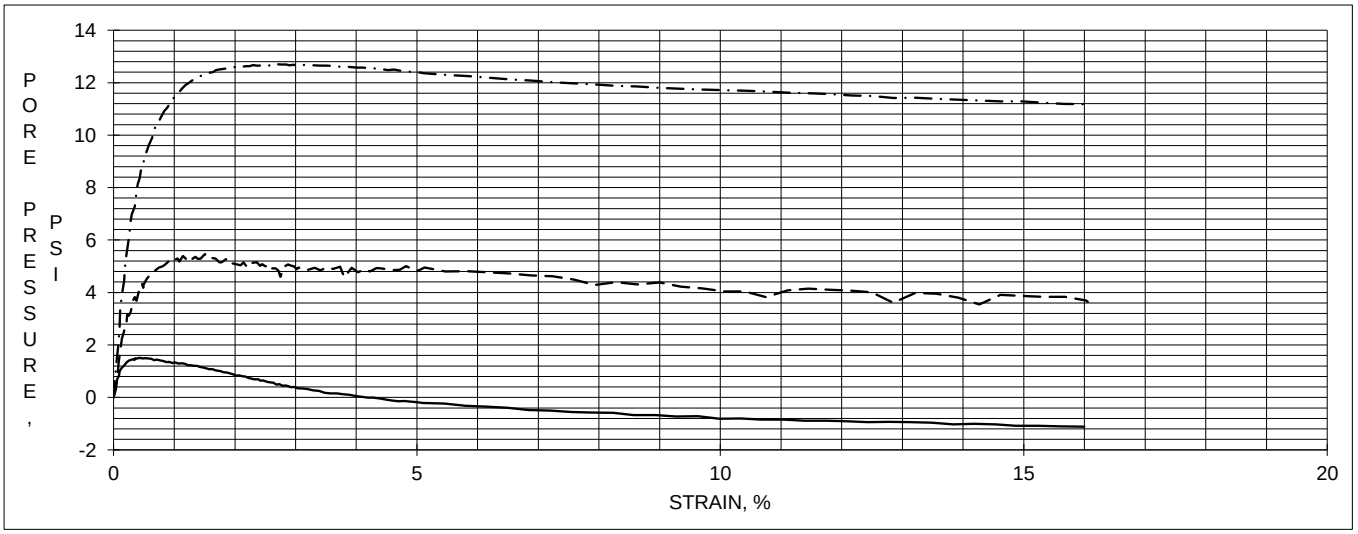
Terracon

CA0607 - HWY 227 - QUACHITA RIVER (WIDENING)

34145118 W10 BULK 1.0 - 5.0







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APPENDIX C
SUPPORTING DOCUMENTS

EXPLANATION OF BORING LOG INFORMATION

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

SAMPLING


Auger


Split Spoon


Shelby Tube


Macro Core


Ring Sampler


Rock Core


Grab Sample


No Recovery

WATER LEVEL


Water Initially Encountered


Water Level After a Specified Period of Time


Water Level After a Specified Period of Time

Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.

FIELD TESTS

(HP)	Hand Penetrometer
(T)	Torvane
(b/f)	Standard Penetration Test (blows per foot)
(PID)	Photo-Ionization Detector
(OVA)	Organic Vapor Analyzer

DESCRIPTIVE SOIL CLASSIFICATION

Soil classification is based on the Unified Soil Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are principally described as clays if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.

LOCATION AND ELEVATION NOTES

Unless otherwise noted, Latitude and Longitude are approximately determined using a hand-held GPS device. The accuracy of such devices is variable. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

STRENGTH TERMS

RELATIVE DENSITY OF COARSE-GRAINED SOILS (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance Includes gravels, sands and silts.			CONSISTENCY OF FINE-GRAINED SOILS (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance			
Descriptive Term (Density)	**Standard Penetration or N-Value Blows/Ft.**	**Ring Sampler Blows/Ft.**	**Descriptive Term (Consistency)**	**Unconfined Compressive Strength, Qu, psf**	**Standard Penetration or N-Value Blows/Ft.**	**Ring Sampler Blows/Ft.**
Very Loose	0 - 3	0 - 6	Very Soft	less than 500	0 - 1	< 3
Loose	4 - 9	7 - 18	Soft	500 to 1,000	2 - 4	3 - 4
Medium Dense	10 - 29	19 - 58	Medium-Stiff	1,000 to 2,000	4 - 8	5 - 9
Dense	30 - 50	59 - 98	Stiff	2,000 to 4,000	8 - 15	10 - 18
Very Dense	> 50	≥ 99	Very Stiff	4,000 to 8,000	15 - 30	19 - 42
			Hard	> 8,000	> 30	> 42

RELATIVE PROPORTIONS OF SAND AND GRAVEL

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 15
With	15 - 29
Modifier	> 30

GRAIN SIZE TERMINOLOGY

Major Component of Sample	Particle Size
Boulders	Over 12 in. (300 mm)
Cobbles	12 in. to 3 in. (300mm to 75mm)
Gravel	3 in. to #4 sieve (75mm to 4.75 mm)
Sand	#4 to #200 sieve (4.75mm to 0.075mm
Silt or Clay	Passing #200 sieve (0.075mm)

RELATIVE PROPORTIONS OF FINES

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 5
With	5 - 12
Modifier	> 12

PLASTICITY DESCRIPTION

Term	Plasticity Index
Non-plastic	0
Low	1 - 10
Medium	11 - 30
High	> 30

UNIFIED SOIL CLASSIFICATION SYSTEM

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

[A] Based on the material passing the 3-inch (75-mm) sieve

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay

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

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

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

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

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

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

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

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

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

[N] PI ≥ 4 and plots on or above "A" line.

[O] PI < 4 or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.

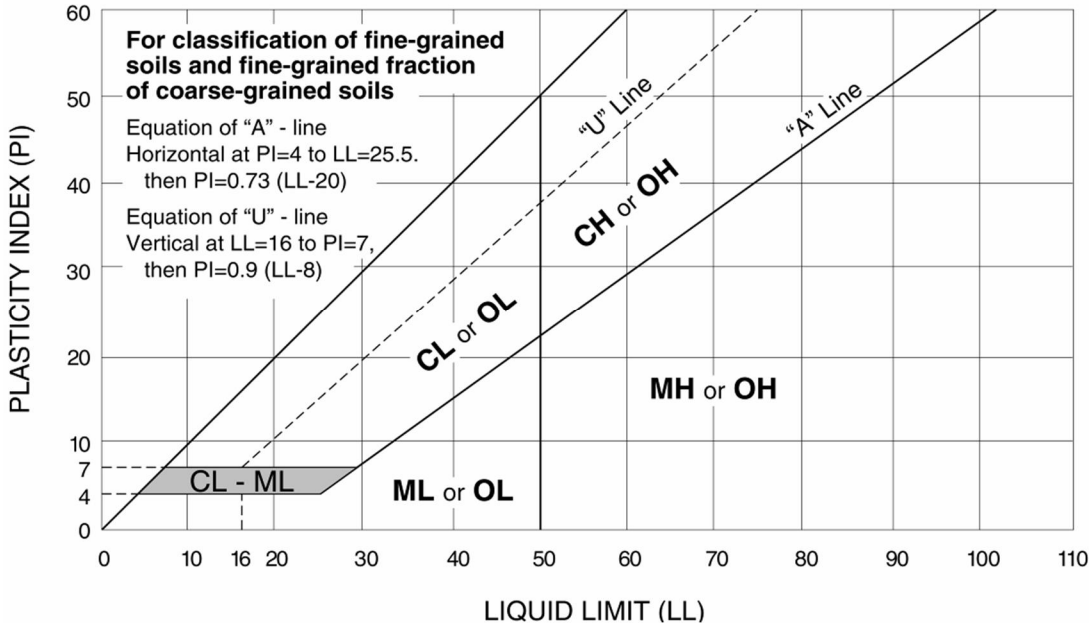

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Exhibit C-2

GENERAL NOTES

Sedimentary Rock Classification

DESCRIPTIVE ROCK CLASSIFICATION:

Sedimentary rocks are composed of cemented clay, silt and sand sized particles. The most common minerals are clay, quartz and calcite. Rock composed primarily of calcite is called limestone; rock of sand size grains is called sandstone, and rock of clay and silt size grains is called mudstone or claystone, siltstone, or shale. Modifiers such as shaly, sandy, dolomitic, calcareous, carbonaceous, etc. are used to describe various constituents. Examples: sandy shale; calcareous sandstone.

LIMESTONE	Light to dark colored, crystalline to fine-grained texture, composed of $CaCo_3$, reacts readily with HCl.
DOLOMITE	Light to dark colored, crystalline to fine-grained texture, composed of $CaMg(CO_3)_2$, harder than limestone, reacts with HCl when powdered.
CHERT	Light to dark colored, very fine-grained texture, composed of micro-crystalline quartz ($Si0_2$), brittle, breaks into angular fragments, will scratch glass.
SHALE	Very fine-grained texture, composed of consolidated silt or clay, bedded in thin layers. The unlaminated equivalent is frequently referred to as siltstone, claystone or mudstone.
SANDSTONE	Usually light colored, coarse to fine texture, composed of cemented sand size grains of quartz, feldspar, etc. Cement usually is silica but may be such minerals as calcite, iron-oxide, or some other carbonate.
CONGLOMERATE	Rounded rock fragments of variable mineralogy varying in size from near sand to boulder size but usually pebble to cobble size (½ inch to 6 inches). Cemented together with various cementing agents. Breccia is similar but composed of angular, fractured rock particles cemented together.

PHYSICAL PROPERTIES:

DEGREE OF WEATHERING

Slight	Slight decomposition of parent material on joints. May be color change.
Moderate	Some decomposition and color change throughout.
High	Rock highly decomposed, may be extremely broken.

HARDNESS AND DEGREE OF CEMENTATION

Limestone and Dolomite:

Hard	Difficult to scratch with knife.
Moderately Hard	Can be scratched easily with knife, cannot be scratched with fingernail.
Soft	Can be scratched with fingernail.

Shale, Siltstone and Claystone

Hard	Can be scratched easily with knife, cannot be scratched with fingernail.
Moderately Hard	Can be scratched with fingernail.
Soft	Can be easily dented but not molded with fingers.

Sandstone and Conglomerate

Well Cemented	Capable of scratching a knife blade.
Cemented	Can be scratched with knife.
Poorly Cemented	Can be broken apart easily with fingers.

BEDDING AND JOINT CHARACTERISTICS

Bed Thickness	Joint Spacing	Dimensions
Very Thick	Very Wide	> 10′
Thick	Wide	3′ - 10′
Medium	Moderately Close	1′ - 3′
Thin	Close	2″ - 1′
Very Thin	Very Close	.4″ - 2″
Laminated	—	.1″ - .4″

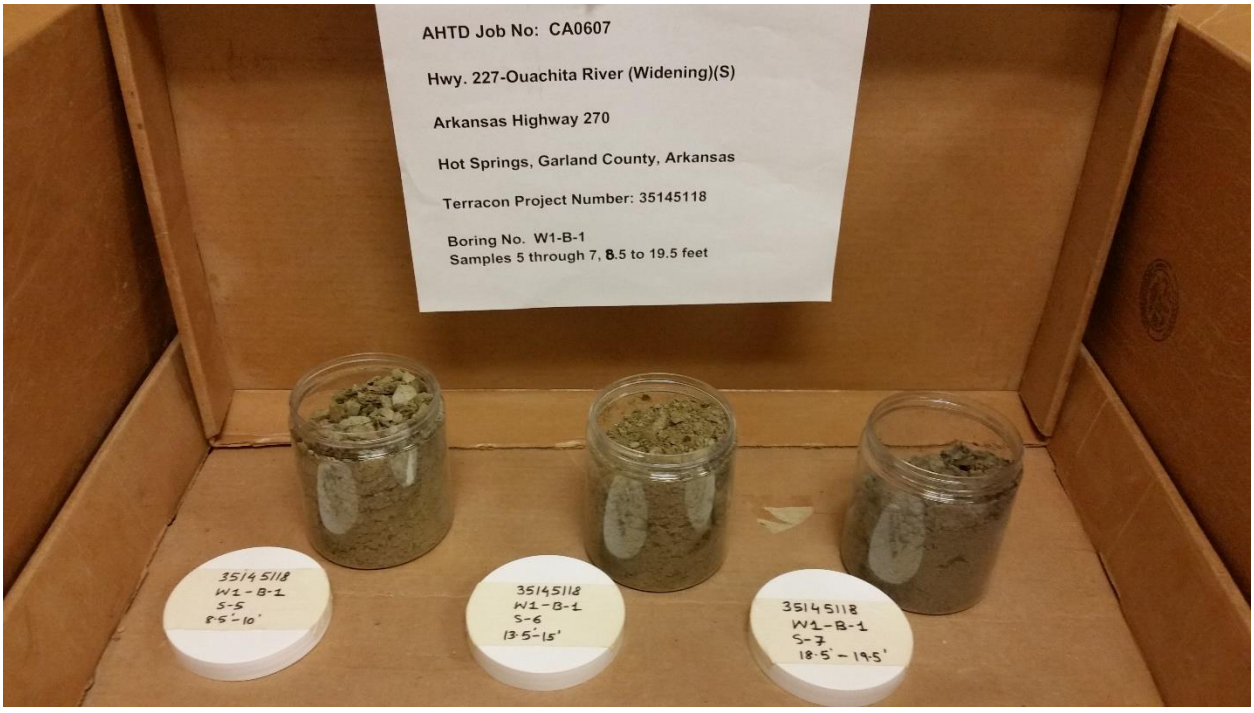
Bedding Plane	A plane dividing sedimentary rocks of the same or different lithology.
Joint	Fracture in rock, generally more or less vertical or transverse to bedding, along which no appreciable movement has occurred.
Seam	Generally applies to bedding plane with an unspecified degree of weathering.

SOLUTION AND VOID CONDITIONS

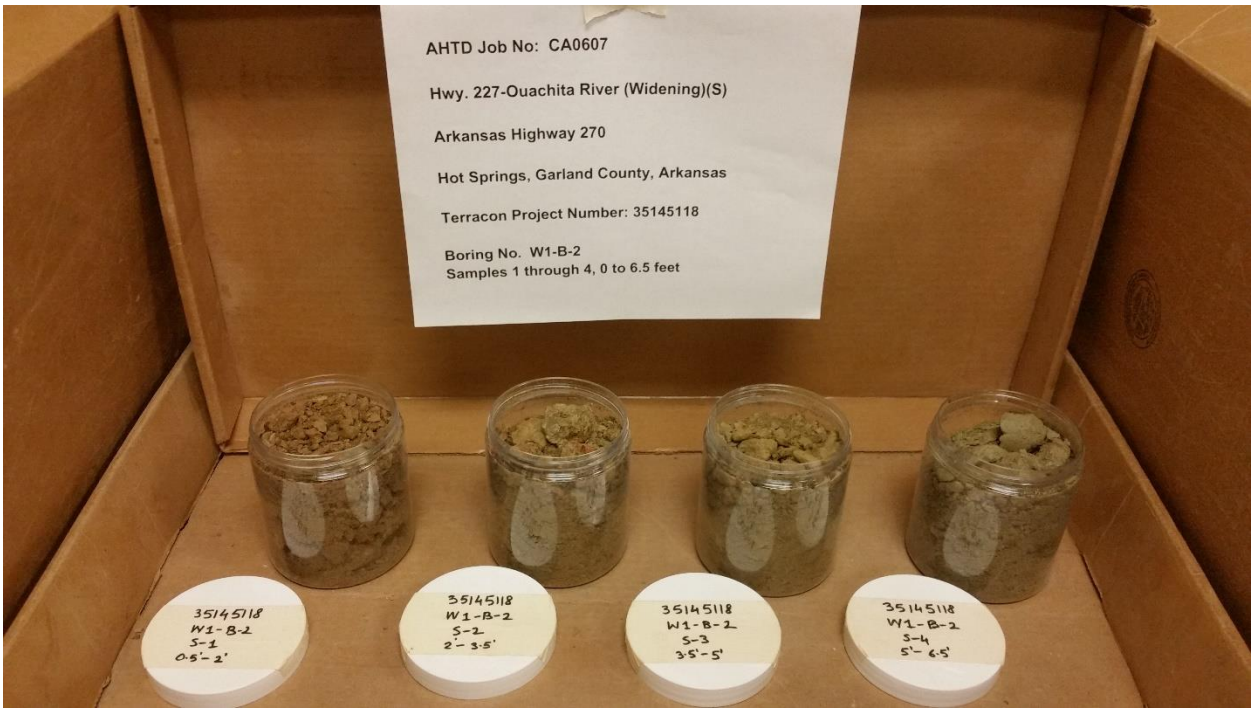
Solid	Contains no voids.
Vuggy (Pitted)	Rock having small solution pits or cavities up to ½ inch diameter, frequently with a mineral lining.
Porous	Containing numerous voids, pores, or other openings, which may or may not interconnect.
Cavernous	Containing cavities or caverns, sometimes quite large.

APPENDIX D
PHOTOGRAPHIC LOG

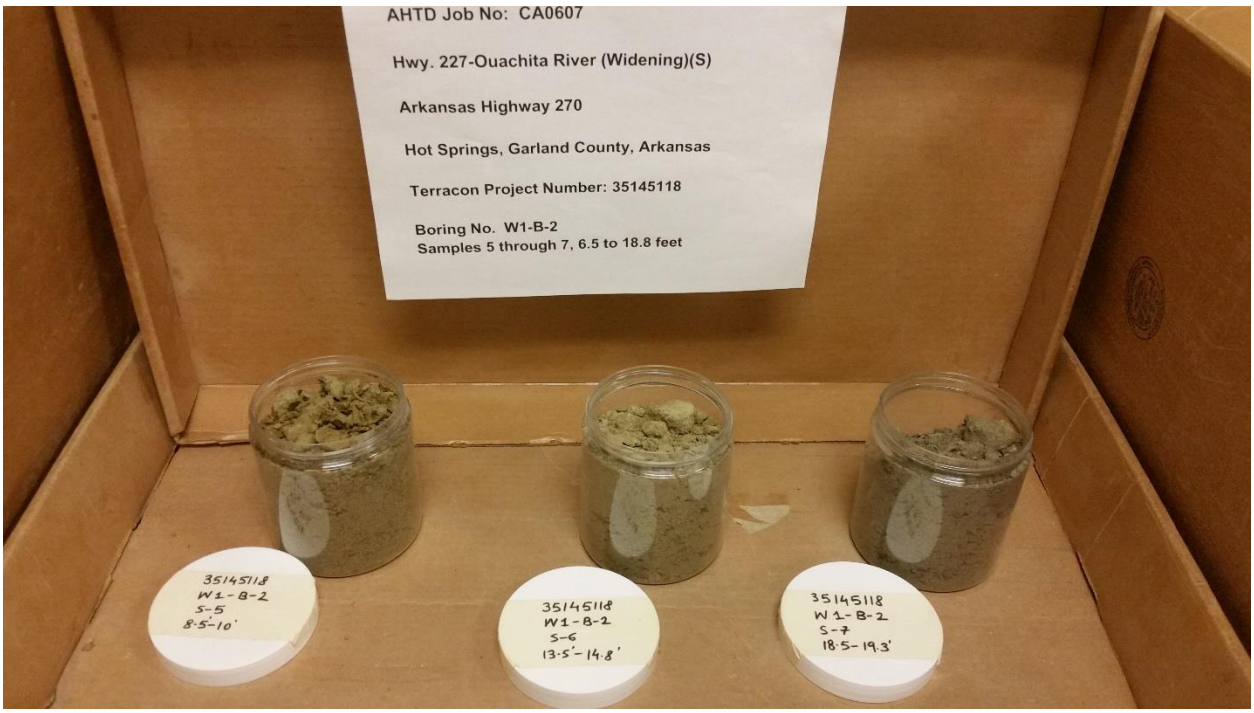
Boring W1-B-1, Samples 1 through 4



Boring W1-B-1, Samples 5 through 7



Boring W1-B-2, Samples 1 through 4



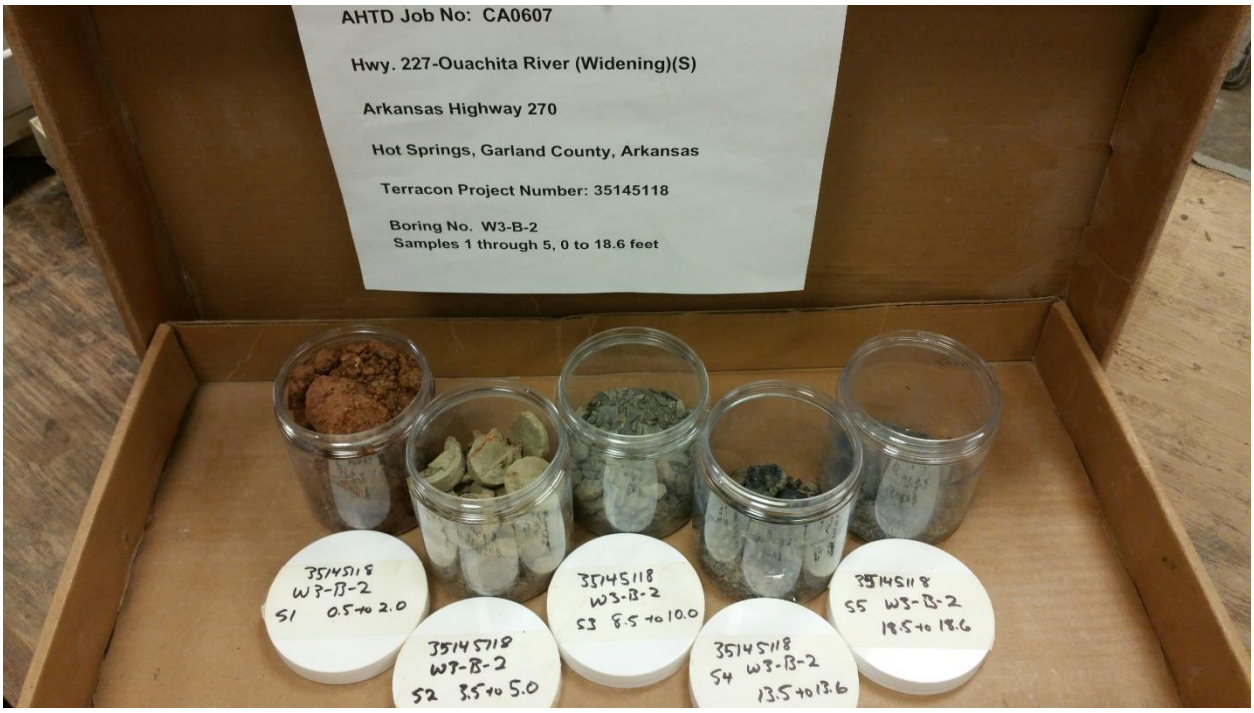
Boring W1-B-2, Samples 5 through 7

Boring W2-B-1, Samples 1 through 6

Boring W2-B-2, Samples 1 through 6

Boring W3-B-1, Samples 1 through 5

Boring W3-B-1A, Samples 1 through 6

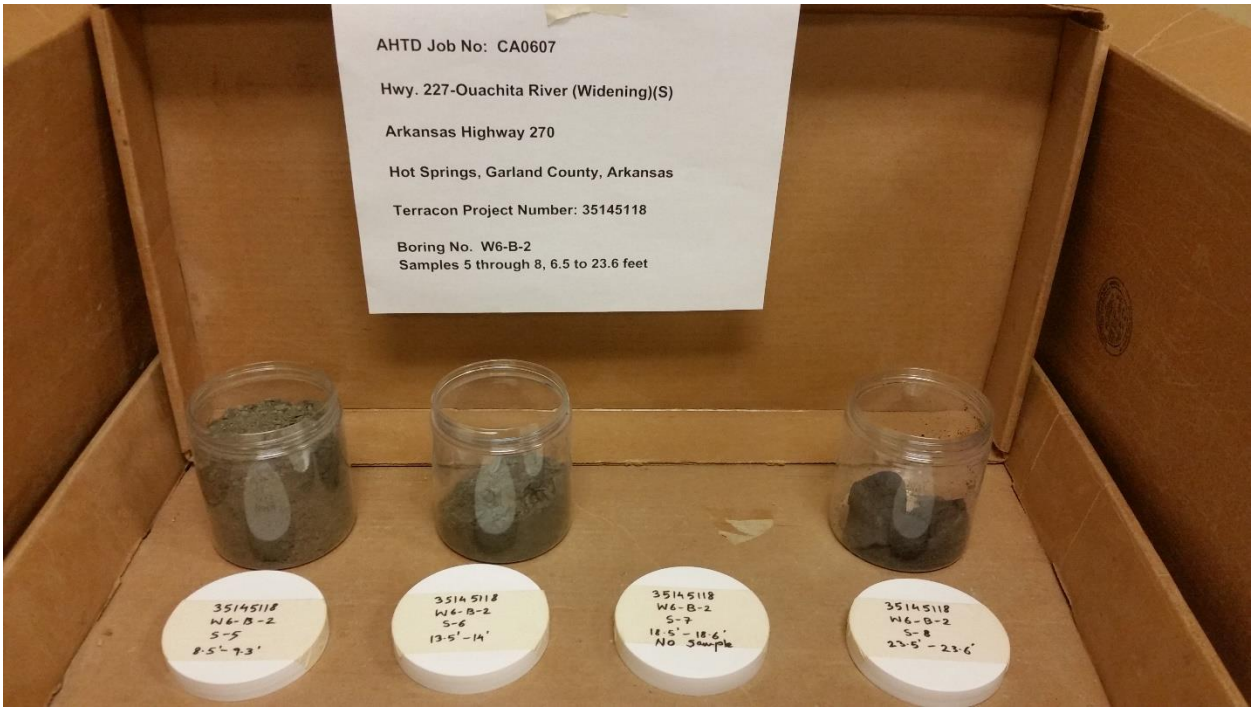


Boring W3-B-2, Samples 1 through 5

Boring W4-B-1, Samples 1 through 5

Boring W4-B-2, Samples 1 through 5

Boring W6-B-2, Samples 1 through 4

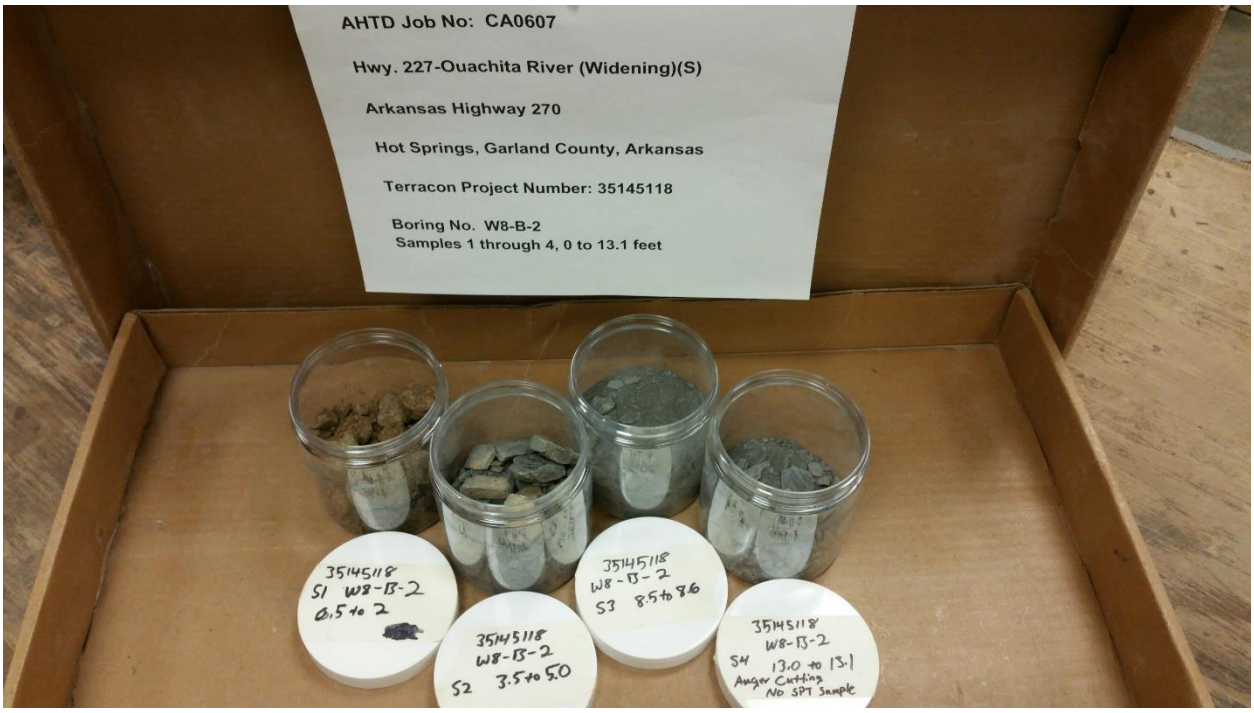


Boring W6-B-2, Samples 5 through 8

Boring W7-B-1, Samples 1 through 4

Boring W8-B-1, Samples 1 through 6

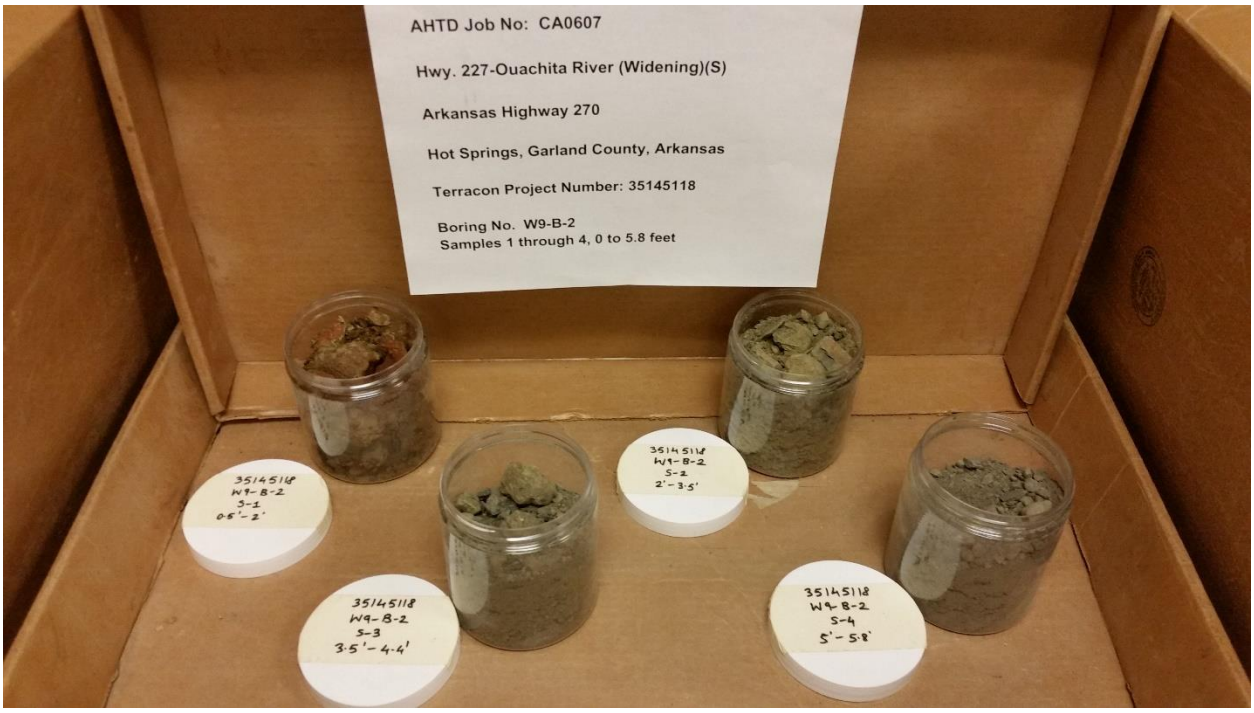
Boring W8-B-1A, Samples 1 through 5



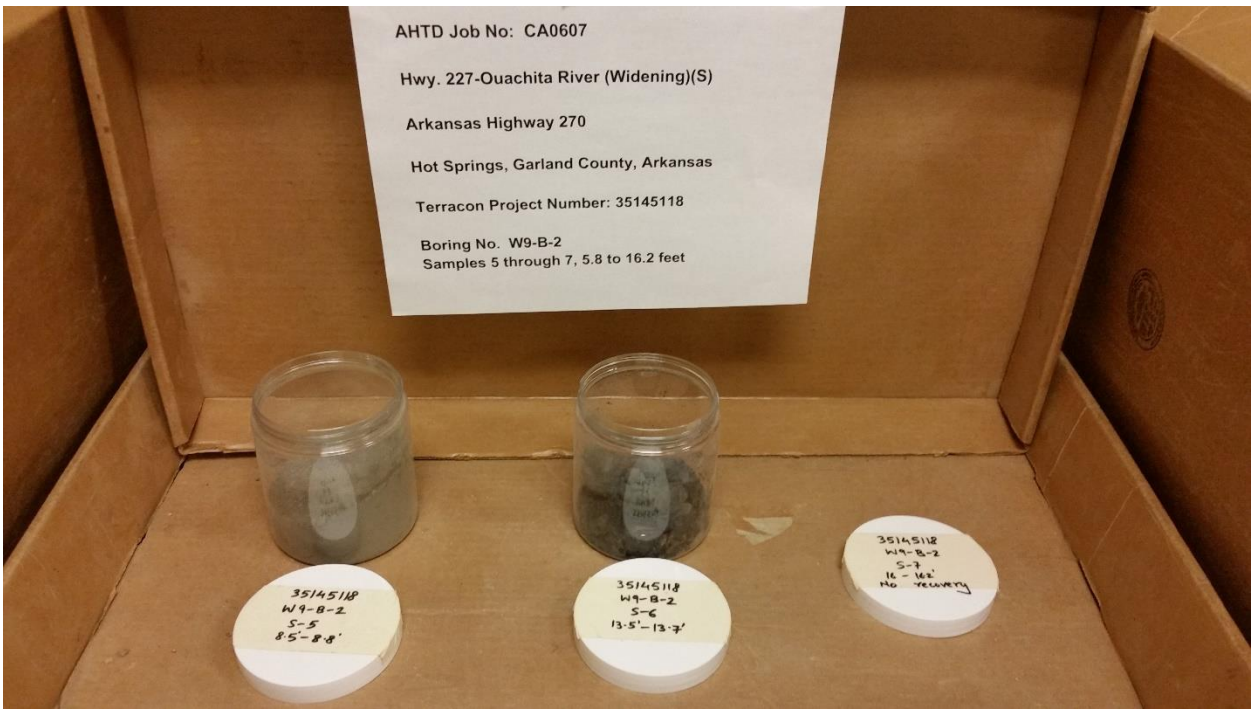
Boring W8-B-2, Samples 1 through 4

Boring W8-B-2A, Samples 1 through 5

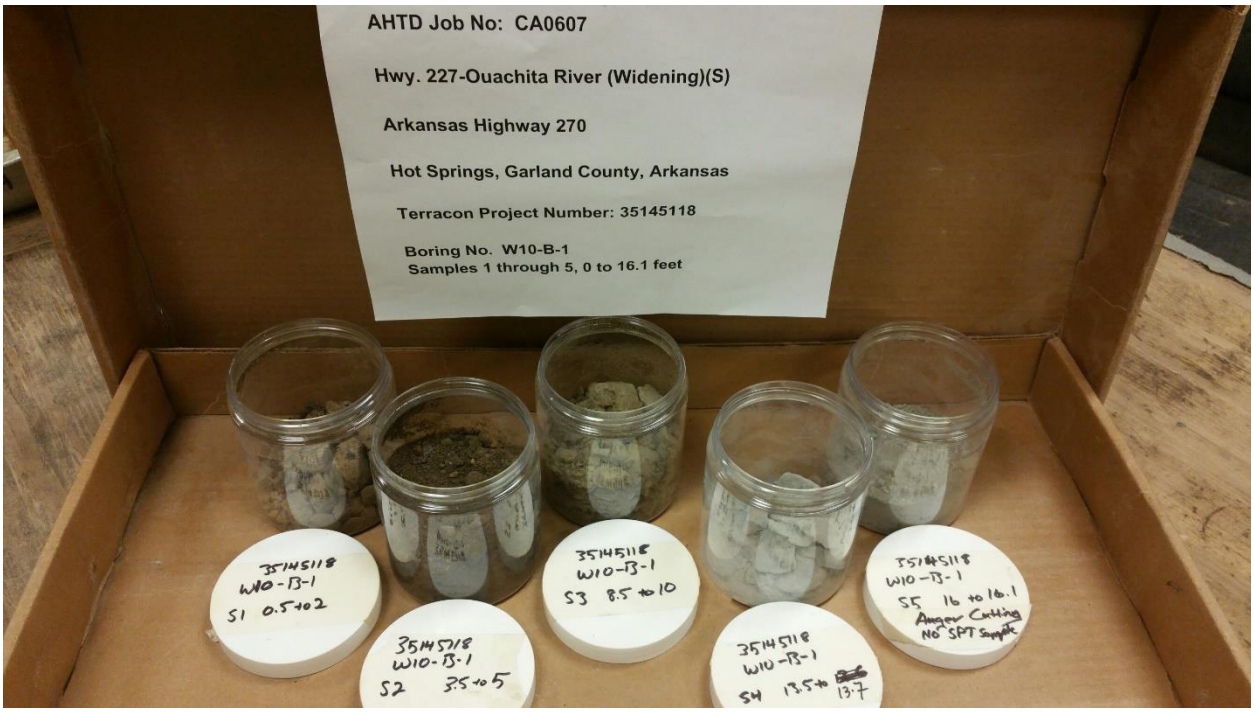
Boring W9-B-1, Samples 1 through 6



Boring W9-B-2, Samples 1 through 4

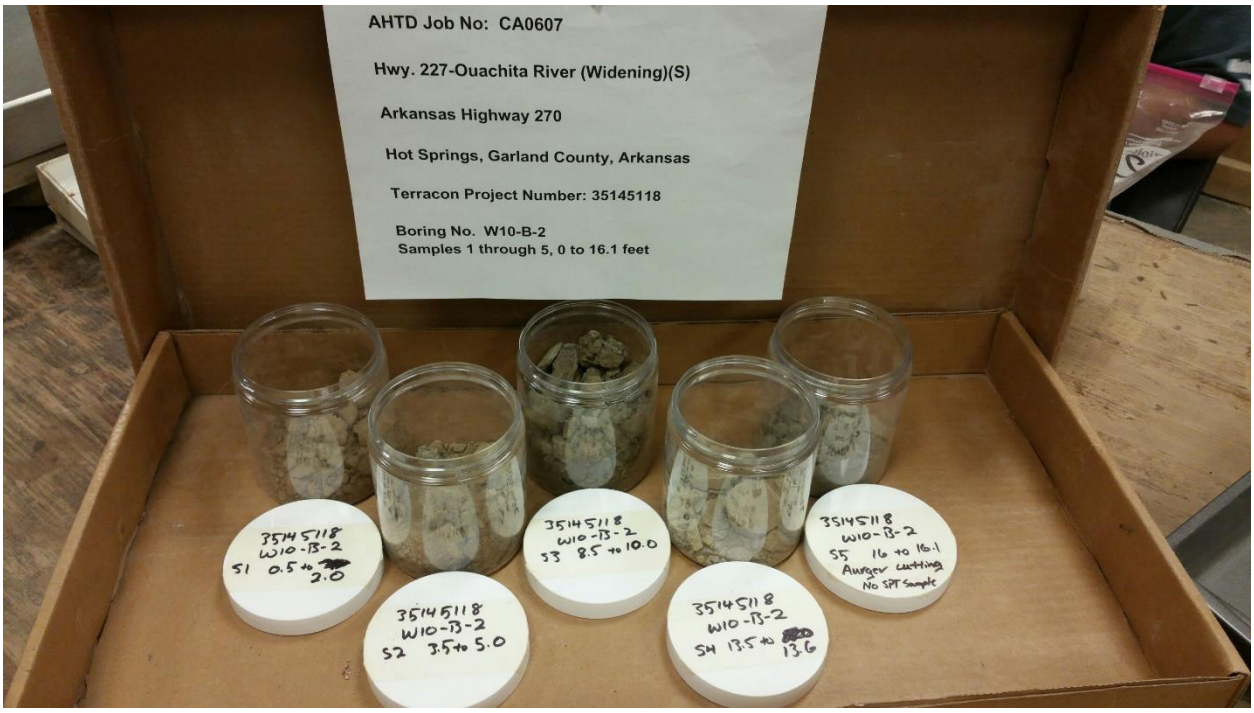


Boring W9-B-2, Samples 5 through 7



Boring W10-B-1, Samples 1 through 5

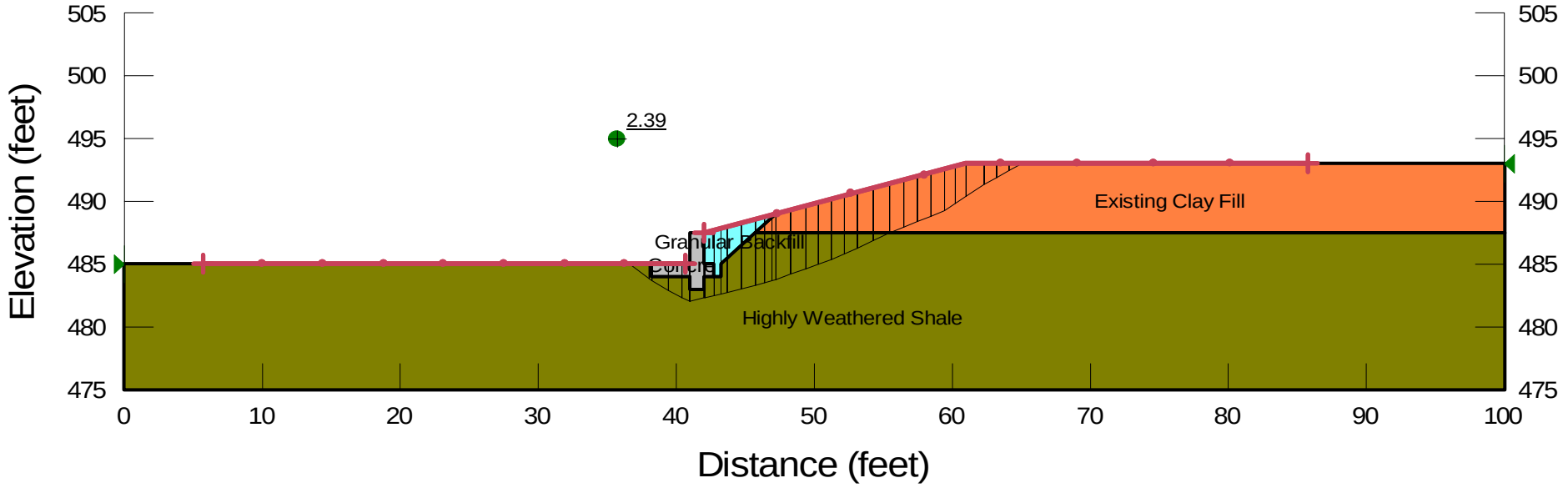
Boring W10-B-1A, Samples 1 through 5



Boring W10-B-2, Samples 1 through 5

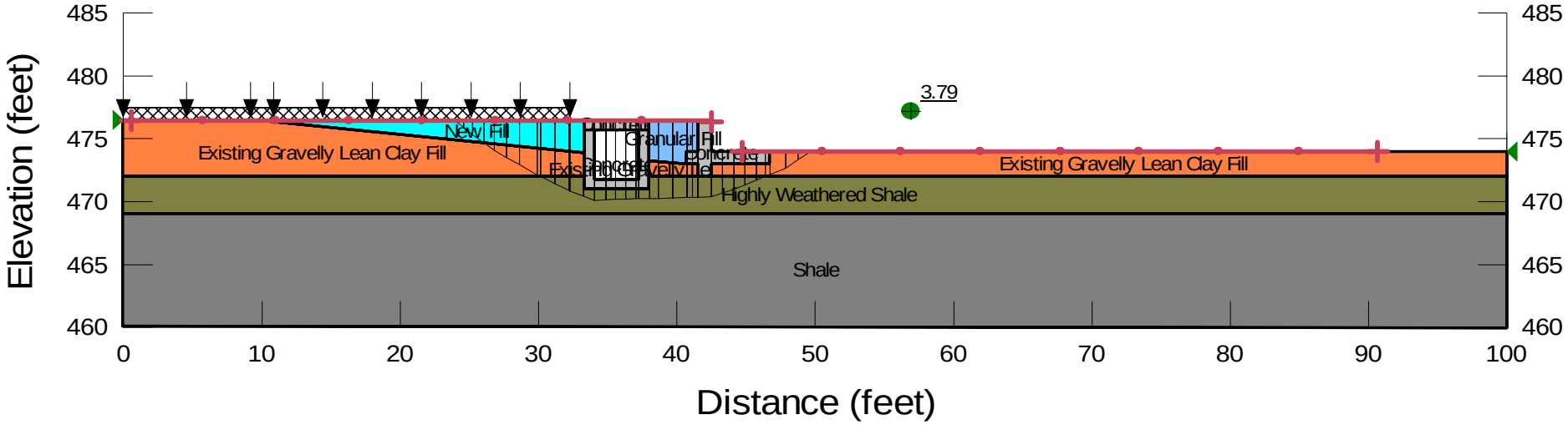
Boring W10-B-2, Samples 1 through 5

APPENDIX E
RETAINING WALLS GLOBAL STABILITY ANALYSES OUTPUTS



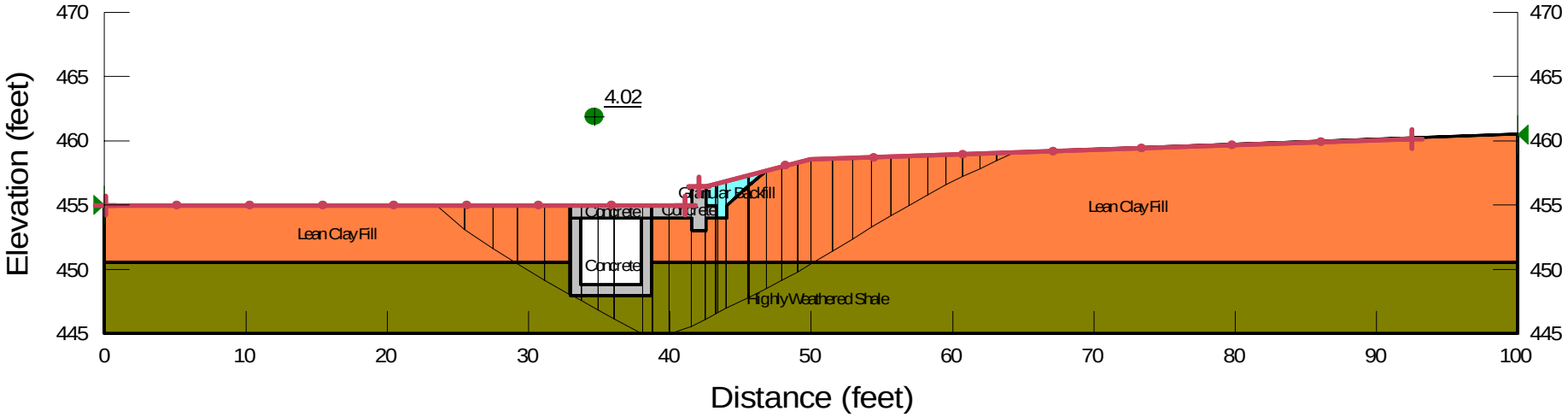
Name: Existing Clay Fill Model: Mohr-Coulomb Unit Weight: 100 pcf Cohesion: 0 psf Phi: 26 °
Name: Highly Weathered Shale Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion: 100 psf Phi: 24 °
Name: Concrete Model: Mohr-Coulomb Unit Weight: 145 pcf Cohesion: 5000 psf Phi: 0 °
Name: Granular Backfill Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 °

Drawn by: DKN	Exhibit: E - 1
Reviewed by: SML	Global Stability Analysis
Scale: As Shown	Retaining Wall No. 1 Wall Station 99+00
Terracon Project No. 35145118	Highway 270 Widening, Little Rock, Arkansas



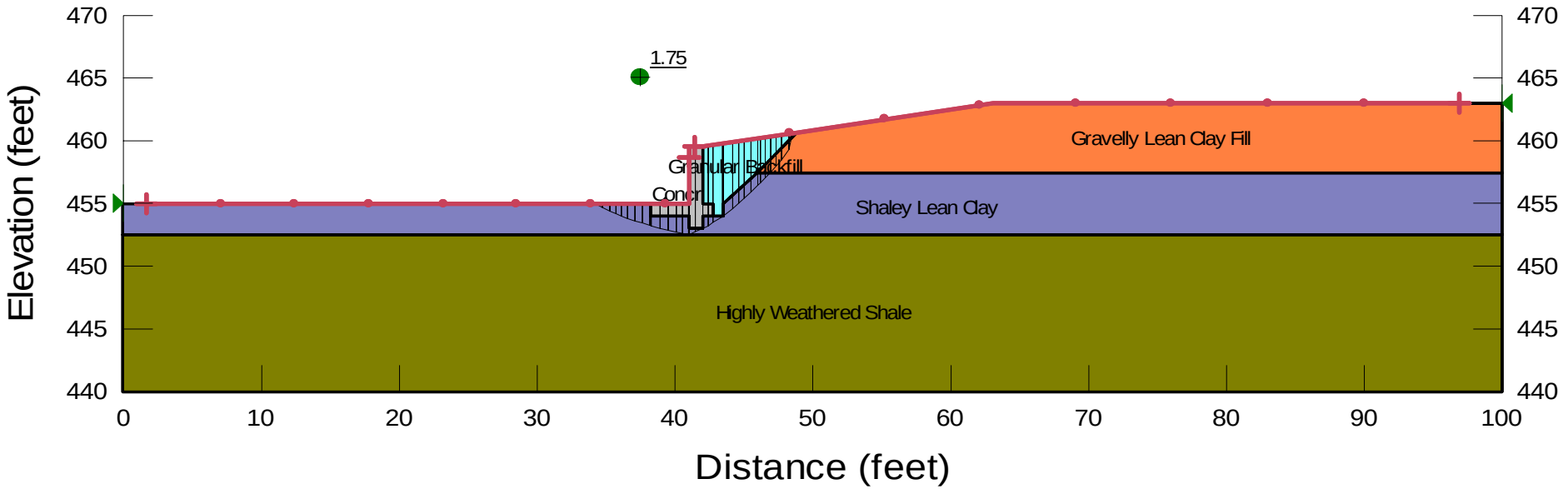
Name: Existing Gravelly Lean Clay Fill Model: Mohr-Coulomb Unit Weight: 100 pcf Cohesion: 0 psf Phi: 26 °
Name: Highly Weathered Shale Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion: 100 psf Phi: 24 °
Name: Concrete Model: Mohr-Coulomb Unit Weight: 145 pcf Cohesion: 5000 psf Phi: 0 °
Name: New Fill Model: Mohr-Coulomb Unit Weight: 100 pcf Cohesion: 0 psf Phi: 26 °
Name: Granular Fill Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 °
Name: Shale Model: Mohr-Coulomb Unit Weight: 135 pcf Cohesion: 5000 psf Phi: 0 °

Drawn by: DKN	Exhibit: E - 2
Reviewed by: SML	Global Stability Analysis
Scale: As Shown	Retaining Wall No. 2 Wall Station 142+60
Terracon Project No. 35145118	Highway 270 Widening, Little Rock, Arkansas



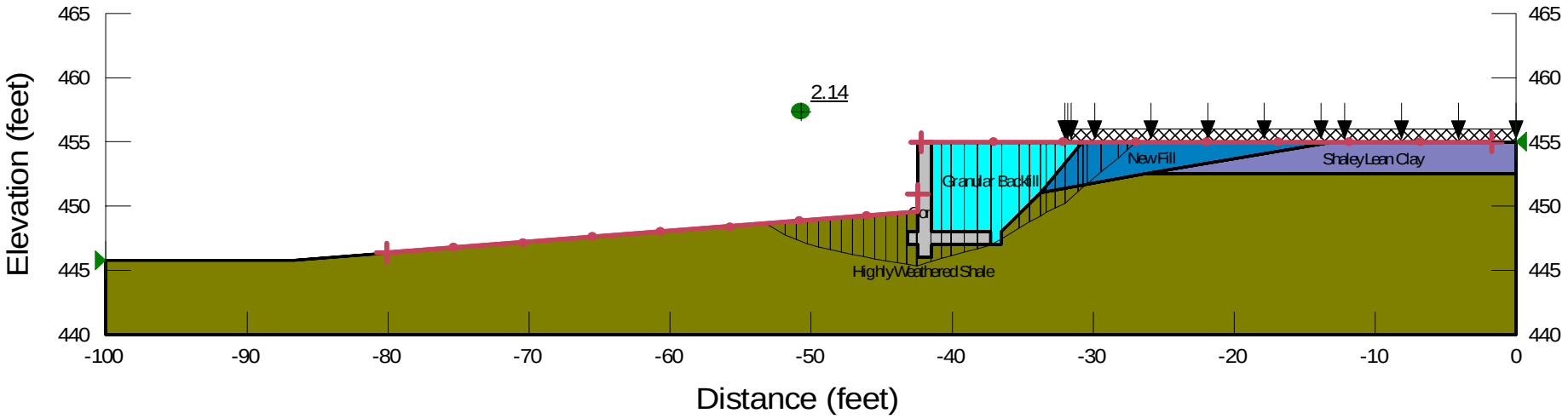
Name: Lean Clay Fill Model: Mohr-Coulomb Unit Weight: 100 pcf Cohesion: 0 psf Phi: 26 °
Name: Highly Weathered Shale Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion: 100 psf Phi: 24 °
Name: Concrete Model: Mohr-Coulomb Unit Weight: 145 pcf Cohesion: 5000 psf Phi: 0 °
Name: Granular Backfill Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 °

Drawn by: DKN	Exhibit: E - 3
Reviewed by: SML	Global Stability Analysis
Scale: As Shown	Retaining Wall No. 3 Wall Station 151+28
Terracon Project No. 35145118	Highway 270 Widening, Little Rock, Arkansas



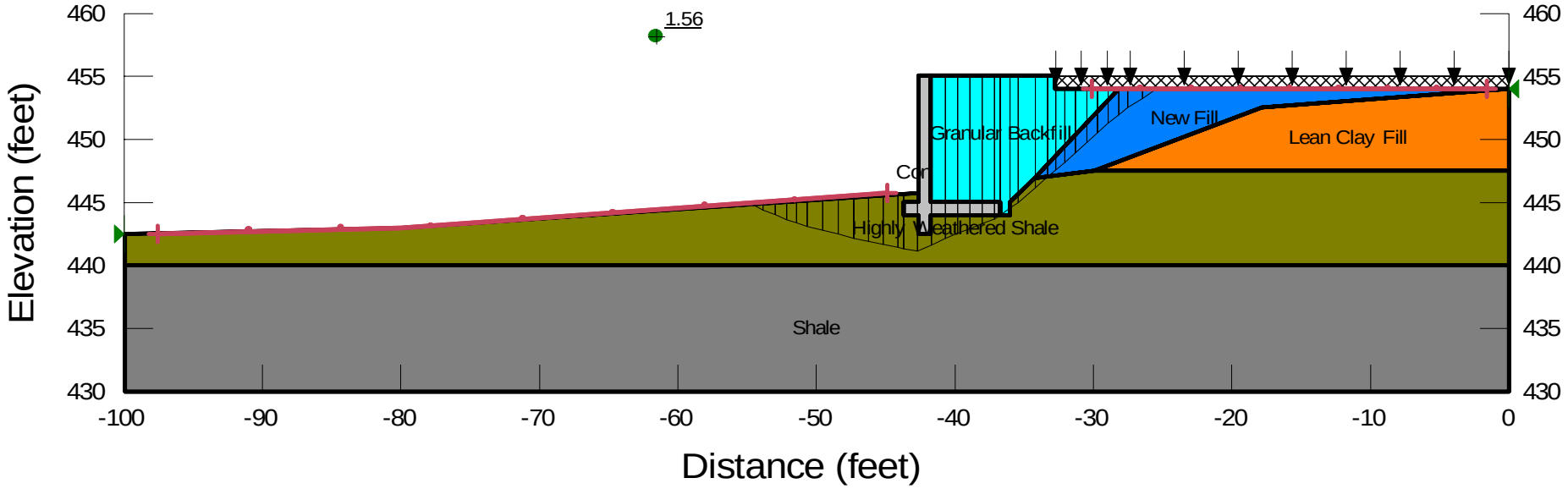
Name: Gravelly Lean Clay Fill Model: Mohr-Coulomb Unit Weight: 100 pcf Cohesion: 0 psf Phi: 26 °
Name: Shaley Lean Clay Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion: 50 psf Phi: 26 °
Name: Highly Weathered Shale Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion: 100 psf Phi: 24 °
Name: Concrete Model: Mohr-Coulomb Unit Weight: 145 pcf Cohesion: 5000 psf Phi: 0 °
Name: Granular Backfill Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 °

Drawn by: DKN	Exhibit: E - 4
Reviewed by: SML	Global Stability Analysis
Scale: As Shown	Retaining Wall No. 4 Wall Station 154+00
Terracon Project No. 35145118	Highway 270 Widening, Little Rock, Arkansas



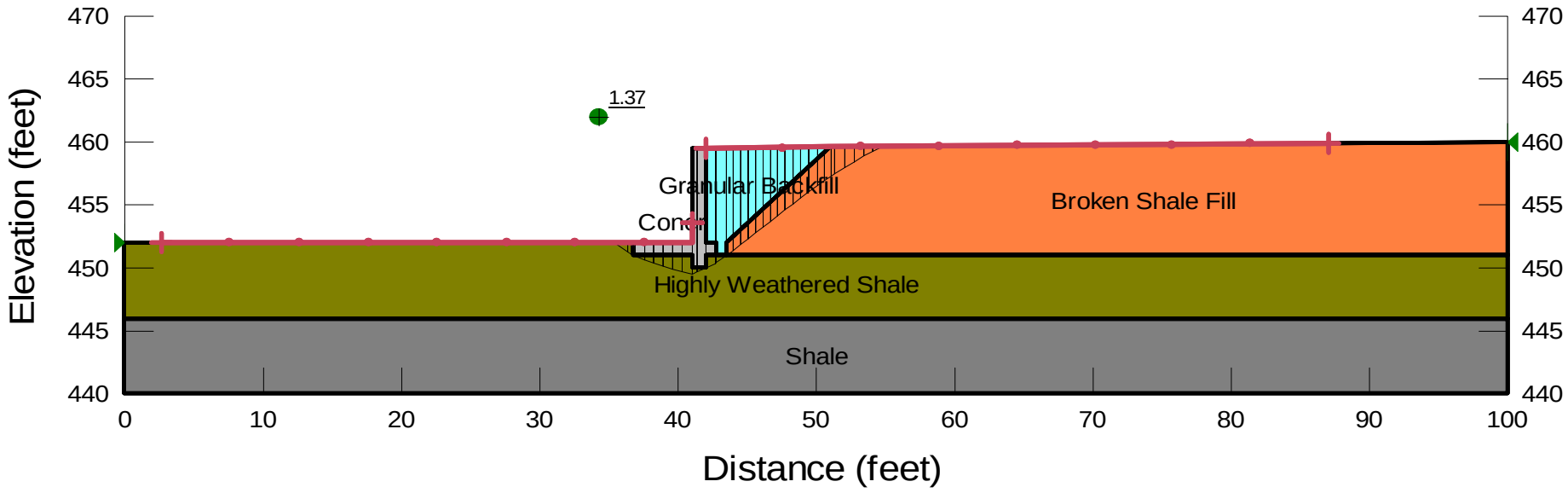
Name: New Fill Model: Mohr-Coulomb Unit Weight: 100 pcf Cohesion: 0 psf Phi: 26 °
Name: Shaley Lean Clay Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion: 50 psf Phi: 26 °
Name: Highly Weathered Shale Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion: 100 psf Phi: 24 °
Name: Concrete Model: Mohr-Coulomb Unit Weight: 145 pcf Cohesion: 5000 psf Phi: 0 °
Name: Granular Backfill Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 °

Drawn by: DKN	Exhibit: E - 5
Reviewed by: SML	Global Stability Analysis
Scale: As Shown	Retaining Wall No. 5 Wall Station 154+00
Terracon Project No. 35145118	Highway 270 Widening, Little Rock, Arkansas



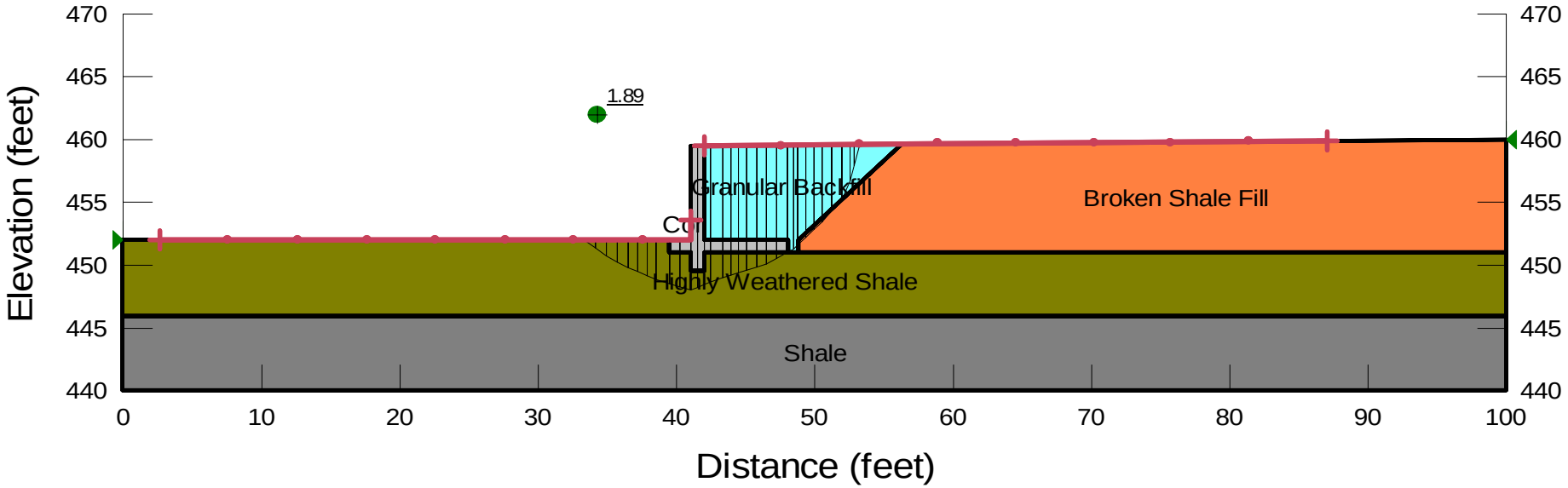
Name: New Fill Model: Mohr-Coulomb Unit Weight: 100 pcf Cohesion: 0 psf Phi: 26 °
Name: Lean Clay Fill Model: Mohr-Coulomb Unit Weight: 100 pcf Cohesion: 0 psf Phi: 26 °
Name: Highly Weathered Shale Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion: 100 psf Phi: 24 °
Name: Concrete Model: Mohr-Coulomb Unit Weight: 145 pcf Cohesion: 5000 psf Phi: 0 °
Name: Shale Model: Mohr-Coulomb Unit Weight: 135 pcf Cohesion: 5000 psf Phi: 0 °
Name: Granular Backfill Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 °

Drawn by: DKN	Exhibit: E - 6
Reviewed by: SML	Global Stability Analysis
Scale: As Shown	Retaining Wall No. 6 Wall Station 156+00
Terracon Project No. 35145118	Highway 270 Widening, Little Rock, Arkansas



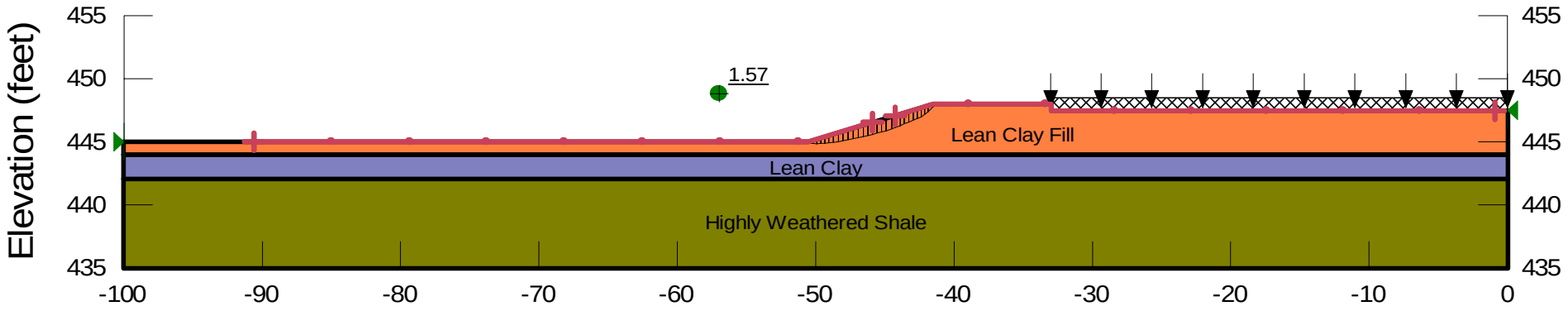
Name: Broken Shale Fill Model: Mohr-Coulomb Unit Weight: 100 pcf Cohesion: 0 psf Phi: 26 °
Name: Highly Weathered Shale Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion: 100 psf Phi: 24 °
Name: Shale Model: Mohr-Coulomb Unit Weight: 135 pcf Cohesion: 5000 psf Phi: 0 °
Name: Concrete Model: Mohr-Coulomb Unit Weight: 145 pcf Cohesion: 5000 psf Phi: 0 °
Name: Granular Backfill Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 °

Drawn by: DKN	Exhibit: E - 7
Reviewed by: SML	Global Stability Analysis
Scale: As Shown	Retaining Wall No. 8 Wall Station 162+00
Terracon Project No. 35145118	Highway 270 Widening, Little Rock, Arkansas



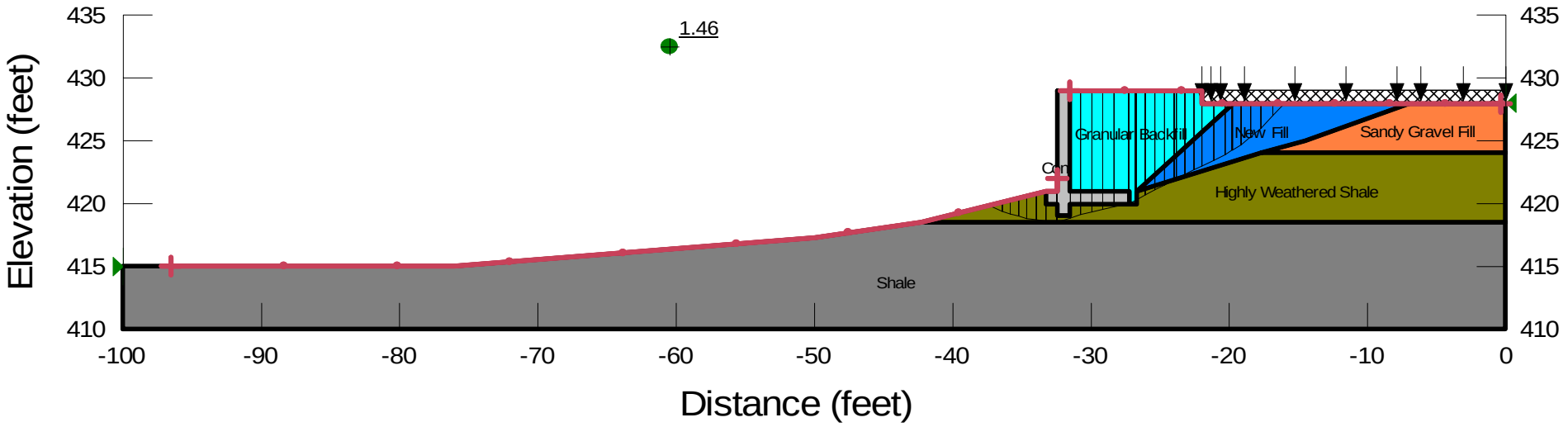
Name: Broken Shale Fill Model: Mohr-Coulomb Unit Weight: 100 pcf Cohesion: 0 psf Phi: 26 °
Name: Highly Weathered Shale Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion: 100 psf Phi: 24 °
Name: Shale Model: Mohr-Coulomb Unit Weight: 135 pcf Cohesion: 5000 psf Phi: 0 °
Name: Concrete Model: Mohr-Coulomb Unit Weight: 145 pcf Cohesion: 5000 psf Phi: 0 °
Name: Granular Backfill Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 °

Drawn by: DKN	Exhibit: E - 7
Reviewed by: SML	Global Stability Analysis
Scale: As Shown	Retaining Wall No. 8 Wall Station 162+00
Terracon Project No. 35145118	Highway 270 Widening, Little Rock, Arkansas



Name: Lean Clay Fill Model: Mohr-Coulomb Unit Weight: 100 pcf Cohesion: 0 psf Phi: 26 °
Name: Lean Clay Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion: 50 psf Phi: 26 °
Name: Highly Weathered Shale Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion: 100 psf Phi: 24 °

Drawn by: DKN	Exhibit: E - 8
Reviewed by: SML	Global Stability Analysis
Scale: As Shown	Retaining Wall No. 9 Wall Station 165+00
Terracon Project No. 35145118	Highway 270 Widening, Little Rock, Arkansas



Name: Sandy Gravel Fill Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion: 0 psf Phi: 32 °
Name: Highly Weathered Shale Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion: 100 psf Phi: 24 °
Name: Shale Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion: 5000 psf Phi: 0 °
Name: Concrete Model: Mohr-Coulomb Unit Weight: 145 pcf Cohesion: 5000 psf Phi: 0 °
Name: New Fill Model: Mohr-Coulomb Unit Weight: 100 pcf Cohesion: 0 psf Phi: 26 °
Name: Granular Backfill Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 °

Drawn by: DKN	Exhibit: E - 9
Reviewed by: SML	Global Stability Analysis
Scale: As Shown	Retaining Wall No. 10 Wall Station 16+50
Terracon Project No. 35145118	Highway 270 Widening, Little Rock, Arkansas