ARKANSAS DEPARTMENT OF TRANSPORTATION

SUBSURFACE INVESTIGATION

STATE JOB NO. 030501

FEDERAL AID PROJECT NO. NHPP-0076(152)

SALINE & CADDO RIVERS STRS. & APPRS. (S)

STATE HIGHWAY 70 & 278 **SECTION** 2, 3, 5 & 2

IN HOWARD, PIKE, & SEVIER **COUNTY**

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

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GEOTECHNICAL INVESTIGATION
ARDOT JOB 030501 SALINE & CADDO RIVERS STRS. & APPRS. (S)
BRIDGE 03602 – HWY. 278 OVER SALINE RIVER
HOWARD COUNTY, ARKANSAS

INTRODUCTION

This report provides the final results of the geotechnical investigation performed for ARDOT Job 030501 Saline & Caddo Rivers Strs. & Apprs. (S). Specifically, this is the report of the geotechnical investigation phase for Bridge 03602, Hwy. 278 over the Saline River in Dierks, Howard County, Arkansas. This geotechnical investigation was authorized on behalf of Michael Baker International by the subconsultant agreement of March 27, 2018. This study has been performed in general accordance with our submittal of March 1, 2018 (GHBW Proposal No. 18-044). Results of this study have been provided to Michael Baker International as data were developed. Recommendations for subgrade support parameters were provided on August 23, 2018. Foundations recommendations were provided on October 25, 2018.

We understand the replacement bridge will be continuous composite plate girder units with six (6) bents, five (5) spans, and a total length of approximately 382 feet. We also understand that a foundation system consisting of steel piles is planned at the bridge ends (Bents 1 and 6) and drilled shaft foundations are planned at the interior bents (Bents 2, 3, 4, and 5). Foundation loads of the new bridge are anticipated to be moderate. Simple slopes will be utilized at the bridge end embankments. A preliminary bridge layout is provided in Attachment 1.

The results of the subsurface exploration program and laboratory test results are included in the attachments. Recommendations for seismic site classification and bridge foundations for the planned bridge are discussed in the following report sections. Additionally, stability analyses have

been performed for the planned simple slopes at the bridge ends and subgrade parameters have been provided for pavement design.

SUBSURFACE EXPLORATION

Subsurface conditions at the replacement bridge location were investigated by drilling nine (9) sample and core borings to depths of 4.5 to 45 ft and excavating one (1) test pit to 2-ft depth. Borings S6, S7, S7B, S8, and S9 were drilled to 25- to 40-ft depth in or near the plan bridge alignment. Borings P5, P6, P7, and P8 were drilled in plan pavement areas. The site vicinity is shown on Plate 1 of Attachment 2. The approximate boring locations at the new bridge and pavement locations are shown on Plates 2a and 2b. The subsurface exploration program is summarized on Plate 3 of Attachment 2. Keys to the terms and symbols used on the boring logs are presented as Plates 4 and 5 of Attachment 2.

The boring logs for the replacement bridge structure are presented in Attachment 3. A generalized subsurface profile in the bridge alignment is provided on Plate 6 of Attachment 3. Photographs of rock cores recovered from the structure borings are provided in Attachment 4. The boring logs from the pavement borings are provided in Attachment 5. The centerline station and offset of the boring locations and the inferred ground surface elevation are noted on the logs. The approximate boring surface elevation was inferred from the topographic information provided by the Engineer (Michael Baker International). It must be recognized that the elevations shown are approximate and actual elevations may vary.

A generalized subsurface profile is shown on Plate 6 of Attachment 3 is provided to aid in visualizing subsurface conditions in the bridge alignment. It should be recognized that the stratigraphy illustrated by the profile has been inferred between discrete boring locations. In view of the natural variations in stratigraphy and conditions, variations from the stratigraphy illustrated by the profiles should be anticipated. Additionally, the natural transition between strata is generally gradual, and the stratigraphy shown on the profile and described elsewhere in this report may vary.

The borings were drilled with a truck-mounted SIMCO 2400 rotary-drilling rig and a track-mounted CME 850 rotary-drilling rig using a combination of dry-auger and rotary-wash drilling procedures. Soil and weathered rock samples were typically obtained using a 2-in.-diameter split-barrel sampler driven into the strata by blows of a 140-lb hammer dropped 30 inches, in accordance with Standard Penetration Test (SPT) procedures. For the SPTs, a safety hammer was

utilized with the SIMCO 2400 drill rig and an automatic hammer was utilized with the CME 850. The number of blows required to drive the standard split-barrel sampler the final 12 in. of an 18-in. total drive, or a portion thereof is defined as the N-value. Recorded N-values are shown on the boring logs in the "Blows Per Ft" column. Where rock hardness precluded obtaining samples via the SPT, cuttings were obtained for use in visual classification.

Representative samples of the shale and sandstone bedrock were obtained using a 5-ft-long NQ_{WL}-size double-tube core barrel with a diamond or carbide bit. For each core run, the percent recovery was determined as the ratio of recovery to total length of core run. Rock Quality Designation (RQD) was also determined for the core run as the sum of intact, sound rock core greater than 4-in. length divided by the total length of the run and expressed in percent. Both these values are presented in the right hand columns of the log forms, opposite the corresponding core run. Where rock was not cored cuttings were collected for visual examination. Photographs of the recovered rock cores are provided in Attachment 3.

All samples were extruded or otherwise removed from samplers in the field. Samples were visually classified and placed in appropriate containers to prevent moisture loss and/or disturbance during transfer to our laboratory for further examination and testing.

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

LABORATORY TESTING

To evaluate pertinent soil and rock properties, laboratory tests consisting of classification tests, natural water content determinations, and uniaxial compressive strength of rock cores were performed.

A total of 21 natural water content determinations were performed to develop a soil water content profile for each boring. Water content results are plotted on the boring log forms in accordance with the scale and symbols shown in the legend located in the upper-right corner of the logs.

To verify field classification and to evaluate soil plasticity, 13 liquid and plastic limit (Atterberg limits) determinations and 11 sieve analyses were performed on selected representative samples. The Atterberg limits are plotted on the log as pluses inter-connected with

a dashed line using the water content scale. The percentage of soil passing through the No. 200 Sieve is noted in the "- No. 200 %" column on the appropriate log forms. Classification test results, along with soil classification by the Unified Soil Classification System and AASHTO designations, are summarized in Attachment 6.

Selected rock core samples were tested for unit weight and compressive strength. The test results are indicated on the boring logs, in lbs per sq in., at the appropriate depth. The total unit weight (TUW) is also noted on the logs.

One (1) laboratory moisture-density relationship (Proctor) test was performed on a representative bulk soil sample obtained in the approach road alignment to evaluate the moisture-density relationship of on-site subgrade soils. The Proctor test and bulk sample classification test results are provided in Attachment 7. Pavement subgrade support properties of the potential subgrade soils were evaluated by performing one (1) California Bearing Ratio (CBR) test on the collected bulk sample. The CBR results are also provided in Attachment 7.

GENERAL SITE and SUBSURFACE CONDITIONS

Site Conditions

Bridge 03602 over the Saline River is planned at Hwy 278 Sta 2999+99 to Sta 3003+81 in Howard County, Arkansas. The new bridge will replace the existing bridge currently spanning the Saline River. The replacement bridge will have an approximate 382-ft length. At this location, the channel is split into a main channel on the north side of the river and a relief channel on the south side. A floodplain divides the north and south sides of the river. The channel slopes are thickly wooded. Sand and gravel bars are common throughout the channel. The existing Hwy. 278 bridge deck is Portland cement concrete is visually in poor condition. The roadway is a two-lane highway bordered by shallow ditches from apparent prior site grading. Surface drainage of the existing roadway is good and drainage of the surrounding terrain varies from poor to fair.

Site Geology

The bridge site is located in the Arkansas Valley and Ouachita Mountains physiographic region and in the mapped outcrop of the Mississippian Period Stanley Shale formation. The Stanley Shale mainly consists of dark gray shale interbedded with fine-grained sandstone. Minor amounts of tuff, chert, barite and conglomerate occur within the formation at varying depths. The formation is reported to be from 3500 to 10,000 feet in thickness. The Stanley Shale rests disconformably on the early Mississippian Arkansas Novaculite.

Seismic Conditions

Based on the site geology, the average soil and rock conditions revealed by the borings, and our experience in the area, a Seismic Site Class C (very dense soil and soft rock profile) is considered fitting for the Bridge 03602 structure site with respect to the criteria of the AASHTO LRFD Bridge Design Specifications Seventh Edition 2014[1]. The liquefaction potential is considered minor for the predominantly cohesive and coarse granular overburden soils and underlying rock units encountered in the borings.

Given the location and AASHTO code-based values, the 1.0-sec period spectral acceleration coefficient for Site Class C (S_1) is 0.051 and the 1.0-sec period spectral acceleration coefficient (S_{D1}) value for Site Class C is 0.087. Utilizing these parameters, Table 3.10.6-1[2] indicates that a Seismic Performance Zone 1 is fitting for the Bridge 03062 site. In reference to the 2011 edition of the AASHTO Guide Specifications, the Peak Ground Acceleration (PGA) having a 7 percent chance of exceedance in 75 years (or mean return period of approximately 1000 years) is predicted to be 0.054 for a Seismic Site Class C for the bridge location.

Subsurface Conditions

Based on the results of the borings, the subsurface stratigraphy may be generalized into several primary strata as follows.

Stratum I: The on-site embankment fill is comprised of loose to dense tan fine to coarse gravel, fine to medium sand, clayey fine sand, and stiff reddish tan fine sandy clay. The predominantly coarse granular on-site fill contain varying amounts of silt and sand. The fill extends to depths ranging from 4 to 8 ft in the bridge alignment and to depths of 2 to 7.5 ft where encountered at the pavement boring locations. The fill exhibits high to low compressibility and variable poor to good compaction. The embankment fill soils typically classify as A-1-a, A-1-b, A-2-4, A-4, and A-6 by the AASHTO classification system (AASHTO M 145), which correlates with poor to excellent subgrade support for pavement structures.

Stratum II: The natural surface and near-surface overburden soils are loose to medium dense brown silty fine to coarse sand, sandy fine to coarse gravel, fine sandy silt and stiff reddish tan and tan fine sandy clay. The natural overburden soils extend to depths of 5 to 12 feet. The fine sandy clay has low plasticity, moderate shear strength, and moderate compressibility. The granular soils have low to medium relative density and high to moderate compressibility.

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1 AASHTO LRFD Bridge Design Specifications, 7th Edition; AASHTO; 2014.

2 AASHTO LRFD Bridge Design Specification, AASHTO; 2012

The natural overburden soils typically classify as A-2-4 and A-4 by the AASHTO classification system (AASHTO M 145), correlating with poor to good subgrade support for pavement structures.

Stratum III: The basal stratum encountered in the borings is moderately hard dark gray weathered shale. The basal shale is weathered to fresh and thinly bedded. The shale contains sandstone, calcite, and siltstone partings and seams. Localized strata of sandstone and argillaceous siltstone were also present on site. Rock competence and hardness vary widely with depth. Rock bedding is typically flatly to moderately dipping with bedding planes inclined from 5 to 30 degrees. Core recovery in the basal shale ranged from 33 to 93 percent, with an average recovery of 70 percent. RQD values ranged from 0 to 67 percent and averaged about 23 percent. These values are indicative of poor rock quality. A laboratory measurement of the compressive strength (q_u) performed on one (1) specimen indicate a measured strength of 6640 lbs per sq inch. The basal shale contains numerous fractures, including low angle to high-angle shears, slickensides, and ferrous stains and concretions.

Groundwater Conditions

Groundwater was encountered at 2- to 13-ft depth at the bridge location in May 2018. Seasonal seeps and springs could be locally present as infiltrated surface water migrates from areas of higher terrain through the overburden soils and upper fractured zones of the shale. Perched water could also occur locally at shallow depths within the fill-soil-rock interface. Groundwater levels will vary, depending upon seasonal precipitation, surface runoff and infiltration, and water levels in the nearby Saline River and other surface water features.

ANALYSES and RECOMMENDATIONS

Foundation Design for Bridges

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

In light of the results of the borings performed for this study, the anticipated moderate bridge foundation loads, and our understanding of the project, we recommend that foundation loads be supported on steel piling at the bridge ends (Bents 1 and 6) and on drilled shafts at the interior bents (Bents 2, 3, 4, and 5). Recommendations for foundations are discussed in the following report sections.

Bridge Ends (Bent 1 and Bent 6): Pile Foundations

We recommend that the foundation loads at the bridge ends be supported on steel piles. Steel HP12x53 or HP14x73 piles, or heavier sections, are recommended. Other pile sizes or types may be evaluated if desired. Piles should extend through all embankment fill and overburden soils to bear in the moderately hard weathered dark gray shale, dark gray shale, or tan weathered sandstone. Piles should be driven to practical refusal. All steel piles should be fitted with rock points.

Bearing capacities of piles driven to refusal must be determined using the AASHTO Load and Resistance Factor Design (LRFD) structural design procedure. We recommend that nominal resistance (P_n) of steel piles be determined based on the yield strength of steel H piles (f_y) and the net end area (A_{net}) of the section. Given that the piles will be driven to refusal in hard rock with the potential for driving damage, we recommend a maximum allowable stress (σ_{all}) of 0.25 f_y. An effective resistance factor (φ_b) of 0.50 is recommended for end bearing piles. This effective resistance factor for steel piles has been based on the assumption of difficult driving.

It has been our experience that allowable pile capacities of 96 tons for HP12x53 piles and 133 tons for HP14x73 piles are common for f_y 50 ksi steel. These capacities are based on allowable stress design (ASD). However, the appropriate factored bearing capacity must be determined by the Engineer. We recommend a minimum pile embedment of 10 ft below natural grade unless practical refusal is encountered in the moderately hard to hard shale or sandstone at shallower depth.

Post-construction settlement of piles driven to refusal will be negligible. The preliminary layout indicates that piles will extend through 3 to 5 ft of new embankment fill. Given an anticipated construction sequence with embankment fill placement in excess of 30 days prior to pile driving, downdrag loads on piles are expected to be negligible. Preboring is not expected to be required for pile installation. However, some large rock fragments might be encountered in on-site embankment fill that could mandate preboring in some instances. In the event that preboring is required, the prebore diameter should be large enough to prevent pile damage during driving. We also recommend that the prebore annulus around piles be backfilled with grout, lean concrete, or an approved alternate.

Battered piles may be utilized to resist lateral loads. The geotechnical axial capacity of battered piles may be taken as equivalent to that of a vertical pile with the same tip elevation and

embedment. Special driving equipment is typically required where pile batter exceeds about 1-horizontal to 4-vertical.

Estimated pile tip elevations for steel pipes at bridge ends, as based on the results of the borings, are summarized in the table below.

Estimated Tip Elevations of Steel Piles Driven to Refusal

Bent No.	Estimated Pile Tip Elevation, ft
Bent 1	562
Bent 6	569

It should be noted that the tip elevations shown in the tables above are estimates only based on the results of the borings and the inferred surface elevations at the particular locations. Pile capacity and as-built depth must be field verified.

Drilled Shaft Foundations – Bents 2, 3, 4, and 5

Drilled straight-shafts are recommended for support of foundation loads at the interior bents, i.e., Bents 2, 3, 4, and 5. Drilled shafts should be founded with a minimum embedment of 8 ft or two (2) shaft diameters, whichever is greater, into the moderately hard to hard shale, siltstone, or hard weathered fine-grained sandstone and sandstone. Drilled shafts founded as recommended may be sized using a maximum nominal end-bearing pressure (R_n) of 120 kips per sq foot. This bearing capacity for compression is based on end bearing resistance only. A resistance factor (φ) of 0.50 is recommended for drilled shaft end bearing. Total and differential settlement of properly installed drilled shafts founded in the competent shale as described is expected to be negligible. We also recommend that drilled shafts be sized for axial compression loads based on end bearing alone.

Resistance to uplift will be provided by the weight of the foundations and circumferential shaft friction. For calculation of uplift capacity, a maximum nominal skin resistance (R_n) value of 10 kips per sq ft may be used for shaft penetration into the competent moderately hard to hard shale, siltstone, or hard weathered fine-grained sandstone and sandstone. For the calculation of uplift capacity, the penetration within the overburden soil, the top 3 ft of weathered shale, or any cased intervals, whichever length is greater, should be neglected. A resistance factor (φ) of 0.40 is recommended for evaluation of drilled shaft uplift capacity.

A minimum embedment length of either 8 ft or two (2) shaft diameters into moderately hard to hard siltstone, shale, or hard weathered fine-grained sandstone and sandstone, whichever is greater, a minimum shaft length of 10 ft, and a minimum shaft diameter of 30 in. are

recommended for drilled shafts. Drilled shaft excavations should be observed by the Engineer or Department to verify suitable bearing and adequate shaft penetration. Depending on the degree and extent of weathering and rock quality, localized deepening or shortening of shaft depths could be warranted.

End Slopes – Bents 1 and 6

The project scope includes new bridge end embankments at each side of the bridge. The proposed embankment on the east side has an approximate 2.4-horizontal to 1-vertical (2.4H:1V) slope. The east embankment height is expected to be a maximum of 13 feet. The west end embankment slope configuration is expected to be configured on 2.H:1V slope. The west abutment will have a maximum height of about 14 feet.

To evaluate suitability of the plan configurations, slope stability analyses have been performed. A 250 lbs per sq ft uniform surcharge from vehicles was included for the stability analyses. Stability analyses were performed using the computer program SLOPE/W 2007[3] and a Morgenstern-Price analysis. For the embankment slopes, four (4) general loading conditions were evaluated, i.e., End of Construction, Long Term, Rapid Drawdown, and Seismic Conditions. For analysis of the seismic condition, a horizontal seismic acceleration coefficient (k_h) of one-half the peak acceleration (A_s) was used, a value of 0.032. For evaluating the rapid drawdown condition, a water surface elevation drop from El 585 to channel bottom grade was assumed. The sections used for the analyses are shown in the graphical results provided in Attachment 8.

The results of the stability analyses indicate that stability of the end slope configurations is acceptable with respect to all loading conditions evaluated. Consequently, it is our conclusion that the end slope configurations are suitable with respect to slope stability.

The results of the stability analyses of the end slopes are summarized in the tables below.

Stability Analysis Results – Bent 1, 2.4H:1V, H = 13 ft

Design Load Condition	Calculated Minimum Factor of Safety
End of Construction	2.4
Long Term	2.1
Rapid Drawdown from El 585 to Existing Grade	1.9
Seismic ($k_h = A_s/2 = 0.032$)	2.2

[3] Slope/W 2007; GEO-SLOPE International; 2008.

Stability Analysis Results – Bent 6, 2H:1V, H = 14 ft

Design Load Condition	Calculated Minimum Factor of Safety
End of Construction	2.6
Long Term	2.2
Rapid Drawdown from El 541 to Existing Grade	2.3
Seismic ($k_h = A_s/2 = 0.032$)	2.4

Subgrade Support

Based on the results of the borings and laboratory tests, the on-site subgrade soils are expected to be comprised primarily of embankment fill. These predominantly granular soils are variable and include AASHTO classifications of A-1-a, A-1-b, A-2-4, and A-5. These classifications correlate with excellent to fair subgrade support. It is opined that the classification of locally available borrow for use as unclassified embankment fill will vary from A-1-a to A-6. We recommend that any soils classifying as A-7-6 and soils with a plasticity index (PI) in excess of 18 be excluded from use as subgrade within 18 in. of the plan subgrade elevation. The as-built pavement subgrade should be evaluated by the Engineer. Areas of unstable or otherwise unsuitable subgrade should be improved by undercut and replacement or treatment with additives approved by the Engineer.

Based on the results of the borings and laboratory CBR tests and correlation with the AASHTO classification of the anticipated subgrade soils, subgrade support is expected to be poor. The following parameters are recommended for use in pavement design for a subgrade of the on-site sandy gravel to clayey sand.

- Resilient Modulus (M_R): 3100 lbs per sq inch
- R value: 10

Site Grading and Subgrade Preparation

Site grading/site preparation in the bridge alignment should include necessary clearing and grubbing of trees and underbrush and stripping the organic-containing surface soils in work areas. Where fill depths in excess of 3 ft are planned, stumps may be left after close cutting trees to grade, as per ARDOT criteria. Otherwise, tree stumps must be completely excavated and stumpholes properly backfilled.

The depth of stripping will be variable, with deeper stripping depths in wooded areas, and less stripping required in the areas of higher terrain. In general, the stripping depth is estimated to

be about 6 to 9 in. in cleared areas, but may be 18 to 24 in. or more in the localized wooded areas and areas with thick underbrush. The zone of organic surface soils should be completely stripped in the embankment footprint areas and at least 5 ft beyond the projected embankment toe.

Where existing pavements are to be demolished, consideration may be given to utilizing the processed asphalt concrete and aggregate base for embankment fill. In this case, the demolished materials should be thoroughly blended and processed to a reasonably well-graded mixture with a maximum particle size of 2 in. as per Standard Specifications for Highway Construction, 2014 Edition, Section 212. If abandoned pavements are within 3 ft of the plan subgrade elevation, the existing pavement surface should be scarified to a minimum depth of 6 inches. The scarified material should be recompacted to a stable condition.

Following required pavement demolition, clearing and grubbing, and stripping, and prior to fill placement or otherwise continuing with subgrade preparation, the extent of weak and unsuitable soils should be determined. Thorough proof-rolling should be performed to verify subgrade stability. Proof-rolling should be performed with a loaded tandem-wheel dump truck or similar equipment. Unstable soils exhibiting a tendency to rut and/or pump should be undercut and replaced with suitable fill. Care should be taken that undercuts, stump holes, and other excavations or low areas resulting from subgrade preparation are properly backfilled with compacted fill. Based on the results of the borings, localized undercutting could be required to develop subgrade stability. Potential undercut depths are estimated to be on the order of 1 ft, more or less.

In areas of deep fills, the potential exists for use of thick initial lifts ("bridging"), as per ARDOT criteria. Bridge lifts will be subject to some consolidation. Settlement of a primarily granular fill suitable for use in bridging would be expected to be relatively rapid and long-term post-construction settlement would not be expected to be a significant concern. Where clayey soils are placed in thick lifts, long term settlement will be more significant. Consequently, we recommend that the use of "bridging" techniques be limited to granular borrow soils, i.e., sand or gravel. Where fill amounts are limited to less than about 3 ft, bridging will be less effective and the potential for undercut or stabilization will increase. Use of bridging techniques and fill lift thickness must be specifically approved by the Engineer or Department.

Subgrade preparation and mass undercuts should extend at least 10 ft beyond the embankment toes to the extent possible. Subgrade preparation in roadway areas should extend at least 3 ft outside pavement shoulder edges to the extent possible. The existing drainage features

should be completely mucked out and all loose and/or organic soils removed prior to fill placement.

Fill and backfill may consist of unclassified borrow free of organics and other deleterious materials as per Standard Specifications for Highway Construction, 2014 Edition, Subsection 210.06. Granular soils must be protected from erosion with a minimum 18-in.-thick armor of clayey soil. The on-site silty clay and sandy clay are typically suitable for this use.

Subgrade preparation should comply with Standard Specifications for Highway Construction, 2014 Edition, Section 212. Embankments should be constructed in accordance with Standard Specifications for Highway Construction, 2014 Edition, Section 210. Fill and backfill should be placed in nominal 6- to 10-in.-thick loose lifts. All fill and backfill must be placed in horizontal lifts. Where fill is placed against existing slopes, short vertical cuts should be "notched" in the existing slope face to facilitate bonding of horizontal fill lifts. The in-place density and water content should be determined for each lift and should be tested to verify compliance with the specified density and water content prior to placement of subsequent lifts.

CONSTRUCTION CONSIDERATIONS

Groundwater and Seepage Control

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

Subgrade soils or foundation strata that become saturated by ponding water or runoff should be excavated to undisturbed soil or rock. The embankment subgrade should be evaluated by the Engineer during subgrade preparation.

Shallow perched groundwater could be encountered in the near-surface soils. The volume of groundwater produced can be highly variable depending on the condition of the soils in the immediate vicinity of the excavation. In addition, seasonal surface seeps or springs could develop.

Seepage into excavations and cuts can typically be controlled by ditching or sump-and-pump methods. If seepage into excavations becomes a problem, backfill should consist of select granular backfill (AASHTO M43, No. 57), stone backfill (Standard Specifications for Highway Construction, 2014 Edition, Section 207), or clean aggregate (Standard Specifications for Highway Construction, 2014 Edition, Subsections 403.01 and 403.02 Class 3 mineral aggregate)

up to an elevation above the inflow of seepage. In areas of seepage infiltration, the granular fill should be encapsulated with a filter fabric complying with Standard Specifications for Highway Construction, 2014 Edition, Subsection 625.02, Type 2 and vented to positive discharge. Where surface seeps or springs are encountered during site grading, we recommend the seepage be directed via French drains or blanket drains to positive discharge at daylight or to storm drainage lines.

Piling

Piles should be installed in compliance with Standard Specifications for Highway Construction, 2014 Edition, Section 805. Pre-boring to achieve the minimum pile length is not generally anticipated, but could be warranted where large rock fragments are encountered in the on-site fill. Based on local experience, we recommend a hammer system capable of delivering at least 22,000 ft-lbs per blow for the steel piles at the bridge ends. A specific review and analysis of the pile-hammer system proposed by the Contractor should be performed by the Engineer or Department prior to hammer acceptance and start of pile installation.

As a minimum, safe bearing capacity of production piles should be determined by Standard Specifications for Highway Construction, 2014 Edition, Section 805.09, Method A. Driving records should be available for review by the Engineer during pile installation. Piles should be carefully examined prior to driving and piles with structural defects should be rejected. Any splices in steel piles should develop the full cross-sectional capacity of un-spliced piles. Pile installation should be monitored by qualified personnel to maintain specific and complete driving records and to observe pile installation procedures. Blow counts on steel piles should be limited to about 20 blows per inch. We recommend that practical pile refusal be defined as a penetration of 0.5 in. or less for the final 10 blows.

Drilled Shafts

Groundwater could be encountered in drilled shaft excavations. Limited seepage into drilled shaft excavations can probably be controlled by close coordination of drilling, cleanup and concrete placement. We recommend that casing be on site in the event it is needed to control seepage and/or caving into shaft excavations. Drilled shaft excavations should essentially be dry at the time of concrete placement. Where more than about 3 in. of water is present in shaft excavations, the excavation should be dewatered prior to concrete placement. Where shaft excavations cannot be dewatered, underwater concrete placement should be performed with a

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

Some hard drilling could be experienced when advancing drilled shafts into the more resistant units of the moderately hard weathered shale, shale, siltstone, moderately hard to hard sandstone, and sandstone. Heavy-duty drilling equipment and rock drilling tools will be required to advance shaft excavations to the recommended minimum penetration in these more resistant units. Coring or other rock excavation methods is likely to be required to achieve the recommended penetration into the shale and sandstone bearing strata. All drilled shaft excavations should be observed by the Engineer to verify suitable bearing and adequate penetration.

CLOSURE

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

The following illustrations are attached and complete this submittal.

Attachment 1	Preliminary Bridge Layout
Attachment 2	Site Vicinity Map, Plans of Borings, Summary of Subsurface Exploration, Keys to Terms and Symbols
Attachment 3	Structure Boring Logs
Attachment 4	Rock Core Photographs
Attachment 5	Pavement Boring Logs
Attachment 6	Classification Test Results
Attachment 7	Subgrade Support Laboratory Test Results
Attachment 8	End Slope Stability Analyses Results

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

Sincerely,

GRUBBS, HOSKYN,
BARTON &WYATT, INC.

Ben Davis, E.I.
Staff Engineer

Mark E. Wyatt, P.E.
President

STATE OF ARKANSAS
REGISTERED PROFESSIONAL ENGINEER
No. 7791
MARK E. WYATT

BJD/MEW:jw

Copies Submitted: Michael Baker International
Attn: Mr. Scott P. Thornsberry, P.E. (1-email)

ATTACHMENT 1

DATE	DATE FILMED	DATE REVISED	DATE FILMED	FED.RD. DIST.NO.	STATE	FED.AID PROJ.NO.	SHEET NO.	TOTAL SHEETS
				3	ARK.			
				JOB NO.		030501	$PAGE$	$TOTAL$
				(1) XXXXX - LAYOUT - XXXXX				

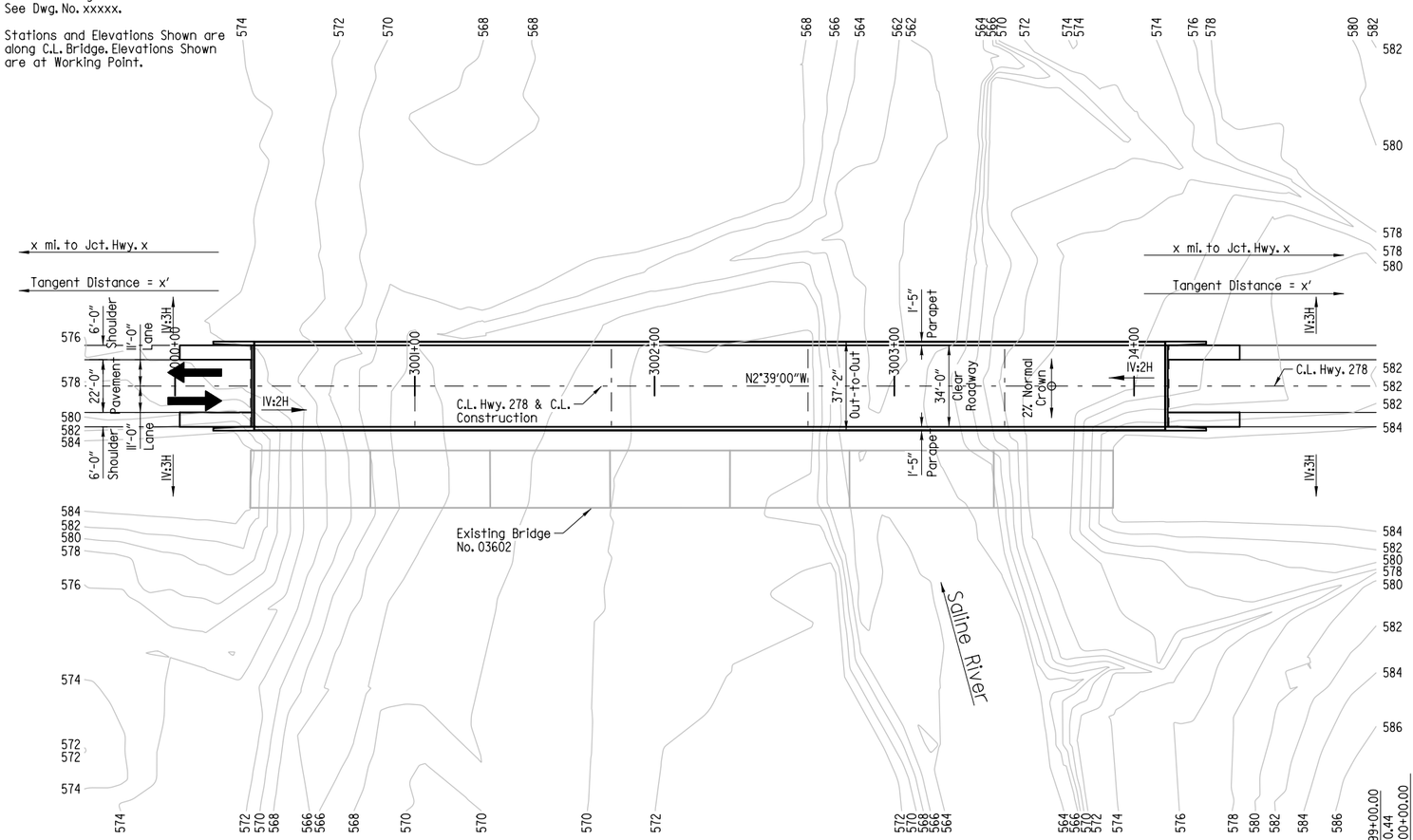
(1) Measured to Working Point. See "Rounding Detail" on Dwg. No. xxxxx.

Note:
Use Type CI Approach Slab ("w" = 24'-0") at both ends of bridge, See Std. Dwg. No. 55030C.

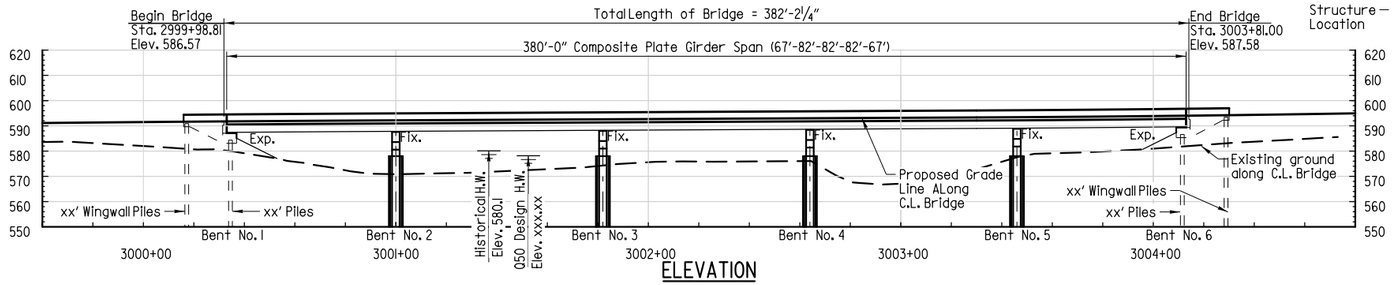
Notes:
For Soil Borings
See Dwg. No. xxxxx.

Stations and Elevations Shown are along C.L. Bridge. Elevations Shown are at Working Point.

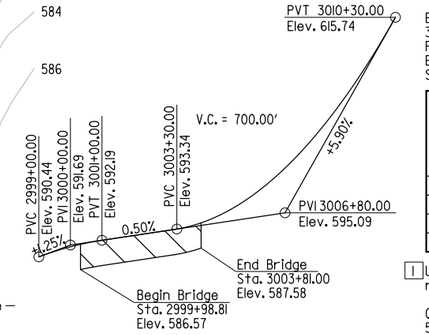
For R/W Data and Guard Rail Details, See Roadway Plans.



PLAN



ELEVATION



VERTICAL CURVE DATA

(Stations and Elevations are along C.L. Bridge)

GENERAL NOTES

BENCH MARK: Vertical Control Data are shown on the Survey Control Data Sheets.

CONSTRUCTION SPECIFICATIONS: Arkansas State Highway and Transportation Department Standard Specifications for Highway Construction (2014 Edition) with applicable Supplemental Specifications and Special Provisions. Unless otherwise noted, Section and Subsection refer to the Standard Construction Specifications.

DESIGN SPECIFICATIONS: AASHTO LRFD Bridge Design Specifications, Sixth Edition (2012) with current Interim Specifications.

LIVE LOADING: HL-93

SEISMIC ZONE: x SDI =0.xx SITE CLASS = x

MATERIALS AND STRENGTHS:

Class S(AE) Concrete (superstructure)	f'c = 4,000 psi
Class S Concrete (substructure)	f'c = 3,500 psi
Reinforcing Steel (AASHTO M 31 or M 322, Type A, Gr, 60)	fy = 60,000 psi
Structural Steel (AASHTO M 270, Gr. HPS 70W)	Fy = 70,000 psi
Structural Steel (AASHTO M 270, Gr. 50)	Fy = 50,000 psi
Structural Steel (AASHTO M 270, Gr. 36)	Fy = 36,000 psi

BORING LOGS: Boring logs may be obtained from the Construction Contract Procurement Section of the Program Management Division.

PILING:

TEXTURED COATING FINISH: Class 3 Textured Coating Finish shall be applied to bridge surfaces as specified in Special Provision Job No. 100942 "Textured Coating Finish" and in accordance with Subsection 802.19(b)(3). Class 1 Protective Surface Treatment shall not be applied on surfaces where Class 3 Textured Coating Finish is specified.

BRIDGE DECK: The concrete bridge deck shall be given a tine finish as specified for final finishing in Subsection 802.19 for Class 5 Tined Bridge Roadway Surface Finish. Shared Use Path shall be given a Class 6 Broomed Finish.

PROTECTIVE SURFACE TREATMENT: Class 1 Protective Surface Treatment shall be applied to the roadway surface and top of end bent backwalls. Class 1 Protective Surface Treatment shall meet the requirements of Section 803.

PAINT: All Structural Steel except galvanized members and some surfaces in contact with concrete shall be cleaned in accordance with Subsection 807.84(b) and painted as specified in Subsection 807.75. Unless noted otherwise the color of the paint shall be Red and shall match Federal Standard 595B, Color Chip No. 31350. The color of the Steel Fence, Posts, and Type H-2 Metal Rail shall be Black and shall match Fed. Std. 595B Color Chip No. 27038.

DETAIL DRAWINGS	DRAWING NOS.
End Bents	XXXXX-XXXXX
380'-0" Cont. Comp. Plate Girder Span	XXXXX-XXXXX
Poured Silicone Joint	XXXXX-XXXXX
Elastomeric Bearings	XXXXX
Standard General Notes	XXXXX

FLOOD DESCRIPTION	FREQUENCY	DISCHARGE	(1) NATURAL WATER SURFACE ELEVATION	WATER SURFACE ELEV. WITH BACKWATER
	YEARS	CFS	FEET	FEET
Design	50	17900	583.68	584.22
Base	100	21000	584.34	585.03
Extreme	500	28900	585.80	586.78
Overtopping	>500	>500	>500	>500

(1) Unconstricted water surface without structure or roadway approaches.

Q100 backwater elevation for existing structure = 580.06 feet.

Proposed Low Bridge Chord Elevation = 585.12 feet.

Drainage area = 57.1 square miles.

Historical H.W. Elev. = 580.1 Feet (from 1961 Construction plans)

PRELIMINARY SUBJECT TO REVISION

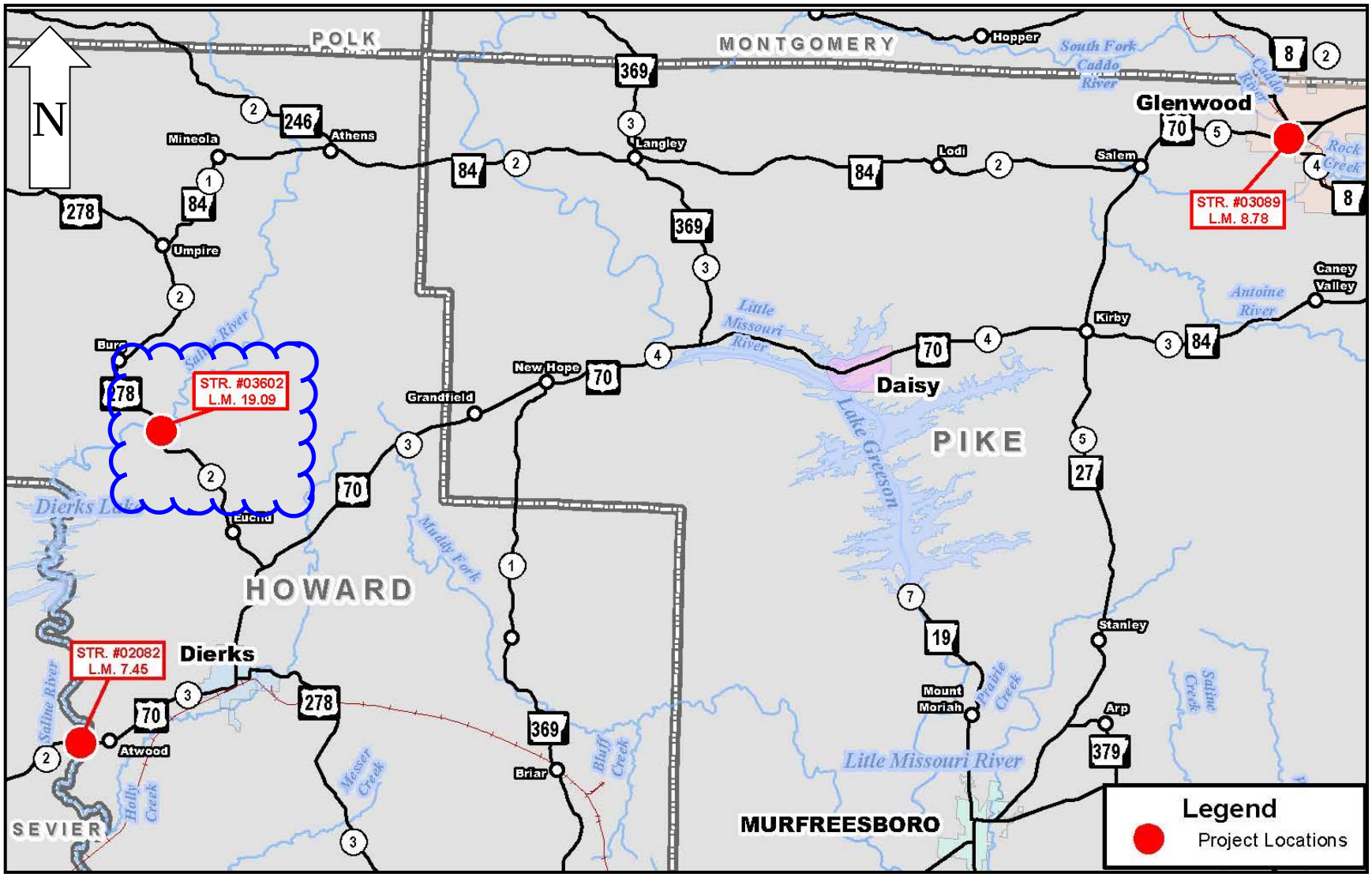
BRIDGE ENGINEER
PRINT DATE: 6/13/2018

SHEET 1 OF X
LAYOUT OF BRIDGE OVER SALINE RIVER
SALINE AND CADDO RIVERS
STRS. & APPRS. (S)
HOWARD COUNTY
ROUTE 278 SECTION 2
ARKANSAS STATE HIGHWAY COMMISSION
LITTLE ROCK, ARKANSAS

DRAWN BY: JPC DATE: 03/2018 FILENAME: B030501X3_LX1.dgn
CHECKED BY: xxx DATE: xx/xx/xxxx
DESIGNED BY: xxx DATE: xx/xx/xxxx SCALE: 1" = 30'
BRIDGE NO. xxxxx DRAWING NO. xxx

Justin.carney 6/13/2018 11:10:53 AM
WORKSPACE: AHTD_Bridge
Y:\Projects\ArDOT_166131_030501_Caddo & Saline River Bridges\Design\BRIDGE\Drawings\B030501X3_LX1.dgn
REVISED DATE:

ATTACHMENT 2

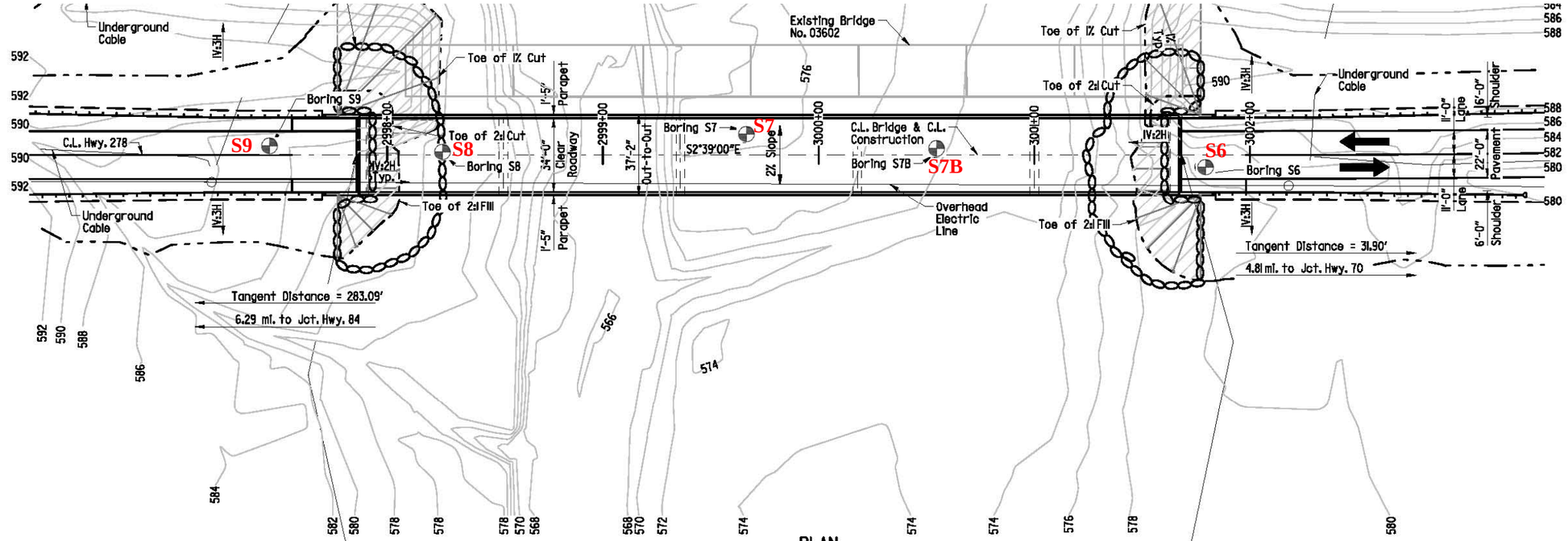


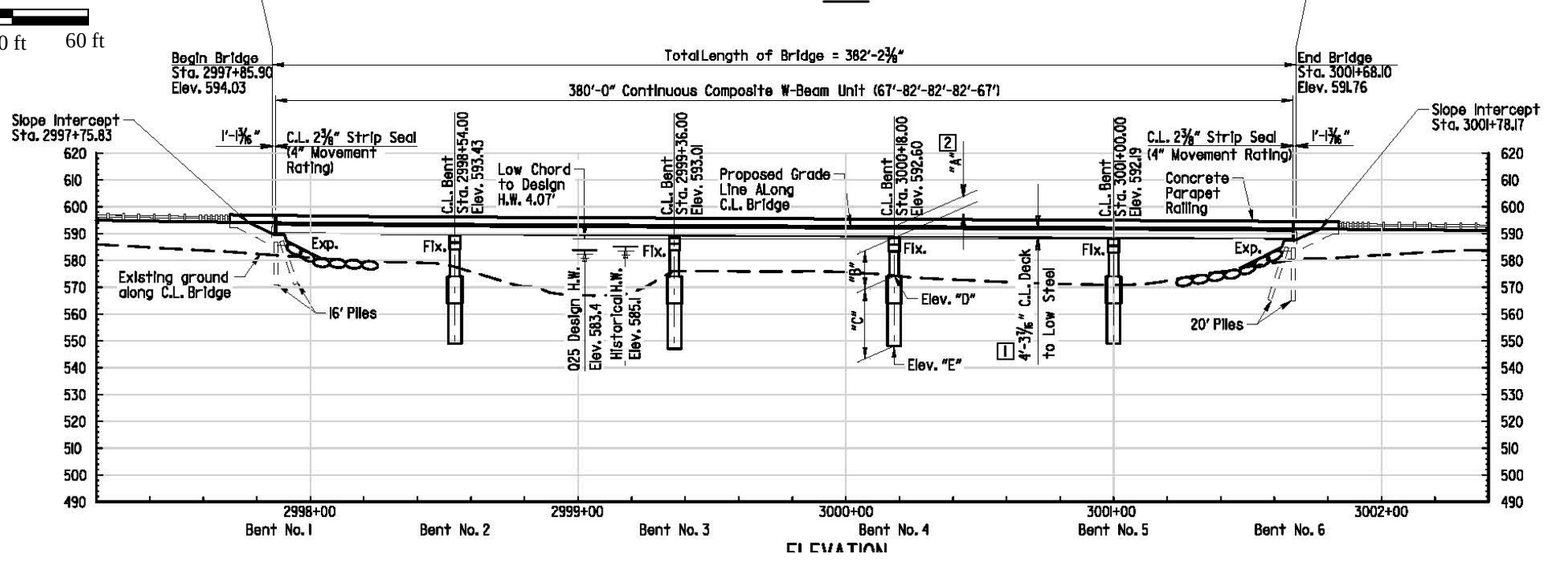
Grubbs, Hoskyn, Barton & Wyatt, INC.
CONSULTING ENGINEERS

Site Vicinity Map
ARDOT 030501
Pike and Howard Counties, Arkansas

Job No. 18-040

Plate 1





30 ft 0 30 ft 60 ft

ontractor shall
e the embankment
e existing bridge
as shown using IV:2H

HYDRAULIC DATA

FLOOD DESCRIPTION	FREQUENCY	DISCHARGE	[1] NATURAL WATER SURFACE ELEVATION
	YEARS	CFS	FEET
Design	25	15000	582.89
Base	100	21000	584.34
Extreme	500	28900	585.80
Overtopping	>500	>500	>500

[1] Unconstricted water surface without struc roadway approaches.

Q100 backwater elevation for existing struc 585.12 feet.

Proposed Bridge Low Chord Elevation = 587.4

Drainage area = 57.1 square miles.

Historical H.W. Elev. = 585.1 Feet (from 1961 Cons

TABLE OF VARIABLES

Location	"A"	"B"	"C"	"D"	"E"
Bent No. 2	4'-9⅞"	14'-7¾"	25'-0"	574.00	549.00
Bent No. 3	4'-9⅞"	14'-2⅛"	27'-0"	574.00	547.00
Bent No. 4	4'-9⅞"	13'-9¾"	26'-0"	574.00	548.00
Bent No. 5	4'-9⅞"	13'-4⅛"	25'-0"	574.00	549.00

[1] Measured to Working Point. See "Rounding Detail" on Dwg. No. xxxxx.

[2] Dimensions are taken from Centerline top of deck @ Centerline Bent to low seat of cap.

PRELIMINARY SUBJECT TO REVISION

SHEET 1 OF 2
LAYOUT OF BRIDGE
HWY 278 OVER SALINE
SALINE AND CADDO RI
STRS. & APPRS. (S
HOWARD COUNTY
ROUTE 278 SECTION 2
ARKANSAS STATE HIGHWAY C
LITTLE ROCK, ARKANSAS

Grubbs, Hoskyn, Barton & Wyatt, INC.
CONSULTING ENGINEERS

PLAN OF BORINGS
ARDOT 030501 – Bridge 03602
Howard County, Arkansas

Scale: As Shown

Date: December 2018

Job No. 18-040

PLATE 2A

Grubbs, Hoskyn, Barton & Wyatt, INC.
CONSULTING ENGINEERS

PLAN OF BORINGS

ARDOT 030501 – BRIDGE 03602 over SALINE RIVER
Howard County, Arkansas

Scale: As Shown

Job No. 18-040

Plate No. 2B

SUMMARY of SUBSURFACE EXPLORATION

PROJECT: ArDOT 030501 - Bridge 03602

LOCATION: Howard County, Arkansas

GHBW JOB No.: 18-040

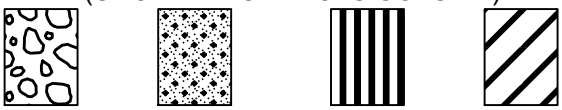
Boring No.	Station Reference	Approx Sta	Approx Offset, ft	Approx Surf El, ft	Completion Depth, ft
S6	Hwy 278	3000+00	20 Lt	574	25
S7	Hwy 278	3002+35	CL	570	40
S7B	Hwy 278	3001+00	CL	566	38
S8	Hwy 278	3003+60	CL	574	45
S9	Hwy 278	3004+40	5 Lt	579	25
P5	±230 South of Bridge End			--	5
P6	±525 South of Bridge End			--	8
P7	±195 North of Bridge End			--	8
P8	±560 North of Bridge End			--	5

Grubbs, Hoskyn, Barton & Wyatt, Inc.
Consulting Engineers

SYMBOLS AND TERMS USED ON BORING LOGS

SOIL TYPES

(SHOWN IN SYMBOLS COLUMN)

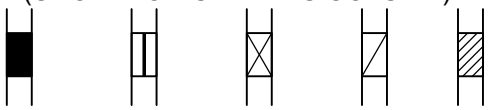


Gravel Sand Silt Clay

Predominant type shown heavy

SAMPLER TYPES

(SHOWN ON SAMPLES COLUMN)



Shelby Tube | Rock Core | Split Spoon | No Recovery | Cutting

TERMS DESCRIBING CONSISTENCY OR CONDITION

COARSE GRAINED SOILS (major portion retained on No. 200 sieve): Includes (I) Clean gravels and sands, and (2) silty or clayey gravels and sands. Condition is rated according to relative density, as determined by laboratory tests.

DESCRIPTIVE TERM	N-VALUE	RELATIVE DENSITY
VERY LOOSE	0-4	0-15%
LOOSE	4-10	15-35%
MEDIUM DENSE	10-30	35-65%
DENSE	30-50	65-85%
VERY DENSE	50 and above	85-100%

FINE GRAINED SOILS (major portion passing No. 200 sieve): Includes (1) Inorganic and organic silts and clays, (2) gravelly, sandy, or silty clays, and (3) clayey silts. Consistency is rated according to shearing strength, as indicated by penetrometer readings or by unconfined compression tests.

DESCRIPTIVE TERM	UNCONFINED COMPRESSIVE STRENGTH TON/SQ. FT.
VERY SOFT	Less than 0.25
SOFT	0.25-0.50
FIRM	0.50-1.00
STIFF	1.00-2.00
VERY STIFF	2.00-4.00
HARD	4.00 and higher

NOTE: Slickensided and fissured clays may have lower unconfined compressive strengths than shown above, because of planes of weakness or cracks in the soil. The consistency ratings of such soils are based on penetrometer readings.

TERMS CHARACTERIZING SOIL STRUCTURE

SLICKENSIDED - having inclined planes of weakness that are slick and glossy in appearance.
FISSURED - containing shrinkage cracks, frequently filled with fine sand or silt; usually more or less vertical.
LAMINATED - composed of thin layers of varying color and texture.
INTERBEDDED - composed of alternate layers of different soil types.
CALCAREOUS - containing appreciable quantities of calcium carbonate.
WELL GRADED - having a wide range in grain sizes and substantial amounts of all intermediate particle sizes.
POORLY GRADED - predominantly of one grain size, or having a range of sizes with some intermediate sizes missing.

Terms used on this report for describing soils according to their texture or grain size distribution are in accordance with the UNIFIED SOIL CLASSIFICATION SYSTEM, as described in Technical Memorandum No.3-357, Waterways Experiment Station, March 1953

KEY 5-18-18

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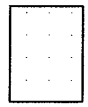
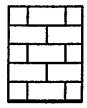
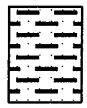
Consulting Engineers

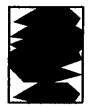
BORING LOG TERMS – ROCK

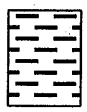
ROCK TYPES
(SHOWN IN SYMBOLS COLUMN)


Sandstone


Limestone


Siltstone


Coal


Shale

Joint Characteristics – Spacing
- Very Wide
- Wide
- Moderately Close
- Close
- Very Close

Bedding Characteristics –
- Very Thin
- Thin
- Medium
- Thick
- Massive

Lithologic Characteristics –
- Clayey
- Shaly
- Calcareous (limy)
- Siliceous
- Sandy
- Silty
- Plastic Seams

Seam – 1/6 to 1/2 inch
Layer – 1/2 to 12 inches
Stratum – Greater than 12 inches

Hardness and Degree of Cementation –

	Approximate Range of Uniaxial Compressive Strength (psi)
Very Soft – Can be peeled with a knife	140 – 3500
Soft – Can just be scraped with knife	3500 – 6900
Hard – Can be broken with single moderate blow with pick	6900 – 13,900
Very hard – Hand held specimen breaks with hammer end of pick under more than one blow	13,900 – 28,000
Extremely Hard – Many blows with hammer required to break intact specimen	More than 28,000

- Poorly Cemented
- Cemented

Texture –
- Dense
- Fine
- Medium
- Coarse

Structure –
- Bedding
  - Flat
  - Gently Dipping
  - Steeply Dipping
- Fractures, scattered
  - Open
  - Cemented or Tight
- Fractures, closely spaced
  - Open
  - Cemented or Tight
- Brecciated (Sheared and Fragmented)
  - Open
  - Cemented or Tight
- Joints
- Faulted
- Slickensides

Degree of Weathering –

Fresh – No visible signs of decomposition or discoloration. Rings under hammer impact.

Slighty Weathered – Slight discoloration inwards from open fractures, otherwise similar to fresh.

Moderately Weathered – Discoloration throughout. Weaker minerals such as feldspar decomposed. Strength somewhat less than fresh rock, but cores cannot be broken by hand or scraped by knife. Texture preserved.

Highly Weathered – Most minerals somewhat decomposed. Specimens can be broken by hand with effort or shaved with knife. Core stones present in rock mass. Texture becoming indistinct but fabric preserved.

Completely Weathered – Minerals decomposed to soil but fabric and structure preserved (Saprolite). Specimens easily crumbled or penetrated.

Residual Soil – Advanced state of decomposition resulting in plastic soils. Rock fabric and structure completely destroyed. Large volume change.

Solution and Void Conditions –
- Solid, contains no voids
- Vuggy (pitted)
- Vesicular (igneous)
- Porous
- Cavities
- Cavernous

Swelling Properties –
- Nonswelling
- Swelling

Slaking Properties –
- Nonslaking
- Slakes slowly on exposure
- Slakes readily on exposure

Rock Quality Designation (RQD) –

RQD (Percent)	Diagnostic Description
Greater than 90	Excellent
75 – 90	Good
50 – 75	Fair
25 – 50	Poor
Less than 25	Very Poor

KEYROCK 5-22-07

ATTACHMENT 3

18-040

Grubbs, Hoskyn, Barton & Wyatt, Inc.
Consulting Engineers

LOG OF BORING NO. S6

ARDOT 030501 - Bridge 03602
Howard County, Arkansas

TYPE: Auger to 12 ft /Wash

LOCATION: Approx Sta 3001+78, 5 ft Rt

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	COHESION, TON/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) / PLASTIC LIMIT / WATER CONTENT / LIQUID LIMIT (10 20 30 40 50 60 70)	- No. 200 %	% Recovery	% RQD
			SURF. EL: 581.0±						
			Dense tan silty fine to coarse gravel w/some fine to coarse sand (fill)	41		-NON-PLASTIC-	22		
			- medium dense below 2 ft	20					
5			- with more fine to coarse gravel below 4 ft	25/0"					
			Loose to medium dense brown silty fine to coarse sand, slightly clayey w/some cobbles				42		
10			- water at 10 ft						
			Moderately hard dark gray shale, apparent dip 30° ± w/closely spaced gray calcareous siltstone partings and very thin calcite veins						
15			- with close slickensides below 16 ft					72	23
			- with moderately close sandstone seams below 17.5 ft						
20			- with very close calcareous siltstone inclusions below 21 ft					41	25
25									

COMPLETION DEPTH: 25.0 ft
DATE: 5-16-18

DEPTH TO WATER IN BORING: 10 ft

DATE: 5/16/2018

RECRQDN200-2 18-040_BRIDGE 03602.GPJ 12-7-18

PLATE 1

Grubbs, Hoskyn, Barton & Wyatt, Inc.
Consulting Engineers

LOG OF BORING NO. S7

ARDOT 030501 - Bridge 03602
Howard County, Arkansas

TYPE: Auger to 8.5 ft /Wash

LOCATION: Approx Sta 2999+66, 9 ft Lt

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	COHESION, TON/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) / PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT (10 20 30 40 50 60 70)	- No. 200 %	% Recovery	% RQD
			SURF. EL: 576.7±						
			Medium dense brown fine to medium sand, slightly silty w/some fine to coarse gravel (fill)	12		-NON-PLASTIC-	8		
				14					
5			- loose below 4 ft	9					
			Moderately hard dark gray argillaceous siltstone, slightly weathered, apparent dip 30°±	25/0"					
10						q_u = 6640 psi, TUW = 157 pcf		87	57
			Moderately hard dark gray shale, apparent dip 30°± w/closely spaced calcareous siltstone partings and very thin calcite veins						
15			- with slickensides below 15 ft					80	33
20			- argillaceous siltstone layer at 21.2 - 22 ft					90	67
			- near vertical calcite vein and fracture at 23.2 ft						
25								88	25
			- with very close shears and slickensides from 28 - 29.5 ft, 31 - 32.8 ft and 34 - 35 ft						
30								93	23
35								52	18
40									

COMPLETION DEPTH: 40.0 ft
DATE: 5-15-18

DEPTH TO WATER IN BORING: 8 ft

DATE: 5/14/2018

RECRQDN200-2 18-040_BRIDGE 03602.GPJ 12-7-18

Grubbs, Hoskyn, Barton & Wyatt, Inc.
Consulting Engineers

LOG OF BORING NO. S7B

ARDOT 030501 - Bridge 03602
Howard County, Arkansas

TYPE: Auger to 7 ft /Wash

LOCATION: Approx Sta 3000+54, 2 ft Lt

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	COHESION, TON/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) / PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT (10 20 30 40 50 60 70)	- No. 200 %	% Recovery	% RQD
			SURF. EL: 572.4±						
			Medium dense brown sandy fine to coarse gravel w/numerous cobbles - water at 2 ft	19		-NON-PLASTIC-			
5			Moderately hard dark gray, gray and tan weathered shale, apparent dip ±5° w/very thin moderately close fine-grained sandstone partings	25/0"					
10			Moderately hard to hard dark gray shale, flat bedded w/very close sandstone partings and seams - with very close slickensides below 10 ft - frequent mechanical fractures below 10.5 ft					72	28
15								67	0
20			- with very close fractures and shears below 20 ft - with very close, very thin quartz veins below 20 ft					77	0
25								63	0
30			- with very close sandstone partings and seams below 30 ft - frequent slickensides from 31 - 34 ft					80	13
35			Moderately hard dark gray shale w/very close fine-grained sandstone partings			q_u = 11,370 psi, TUW = 167 pcf		82	82
40			Hard gray fine-grained sandstone - with near-vertical calcite vein with pyrite precipitant from 36 - 37 ft - dark gray shale seam at 37.2 ft - with very close thin shale seams below 37.7 ft						
45									

COMPLETION DEPTH: 38.0 ft
DATE: 5-10-18

DEPTH TO WATER IN BORING: 2 ft
DATE: 5/10/2018

RECRQDN200-2 18-040_BRIDGE 03602.GPJ 12-7-18

Grubbs, Hoskyn, Barton & Wyatt, Inc.
Consulting Engineers

LOG OF BORING NO. S8

ARDOT 030501 - Bridge 03602
Howard County, Arkansas

TYPE: Auger to 12 ft /Wash

LOCATION: Approx Sta 2998+26, 1 ft Lt

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	COHESION, TON/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) / PLASTIC LIMIT / WATER CONTENT / LIQUID LIMIT (10 20 30 40 50 60 70)	- No. 200 %	% Recovery	% RQD
			SURF. EL: 579.8±						
			Medium dense brown silty fine to medium sand w/a little fine to coarse gravel (fill)	16 30		-NON-PLASTIC-	21		
5			- loose to medium dense below 4 ft	10					
			Loose reddish tan and tan fine sandy silt, slightly clayey w/ferrous nodules and stains	8			60		
			- with sandstone fragments below 8.5 ft	25/0"					
10			Low hardness dark gray and brown weathered shale - water at 10 ft						
			Moderately hard dark gray shale, apparent dip 30°± w/moderately close calcite veins and calcareous siltstone partings and seams - with close slickensides below 15 ft					53	15
15									
20			- interbedded shale and calcareous siltstone below 16 ft					92	45
25			- predominately shale below 25.5 ft					67	23
			- with close calcite seams at 28.3 ft, 32 ft, 33.5 ft and 42 ft					82	22
30									
35			- with close shears below 37 ft					87	37
40								52	17
45									

COMPLETION DEPTH: 45.0 ft
DATE: 5-17-18

DEPTH TO WATER IN BORING: 10 ft
DATE: 5/17/2018

RECRQDN200-2 18-040_BRIDGE 03602.GPJ 12-7-18

18-040

Grubbs, Hoskyn, Barton & Wyatt, Inc.
Consulting Engineers

LOG OF BORING NO. S9

ARDOT 030501 - Bridge 03602
Howard County, Arkansas

TYPE: Auger to 15 ft /Wash

LOCATION: Approx Sta 2997+45, 3 ft Lt

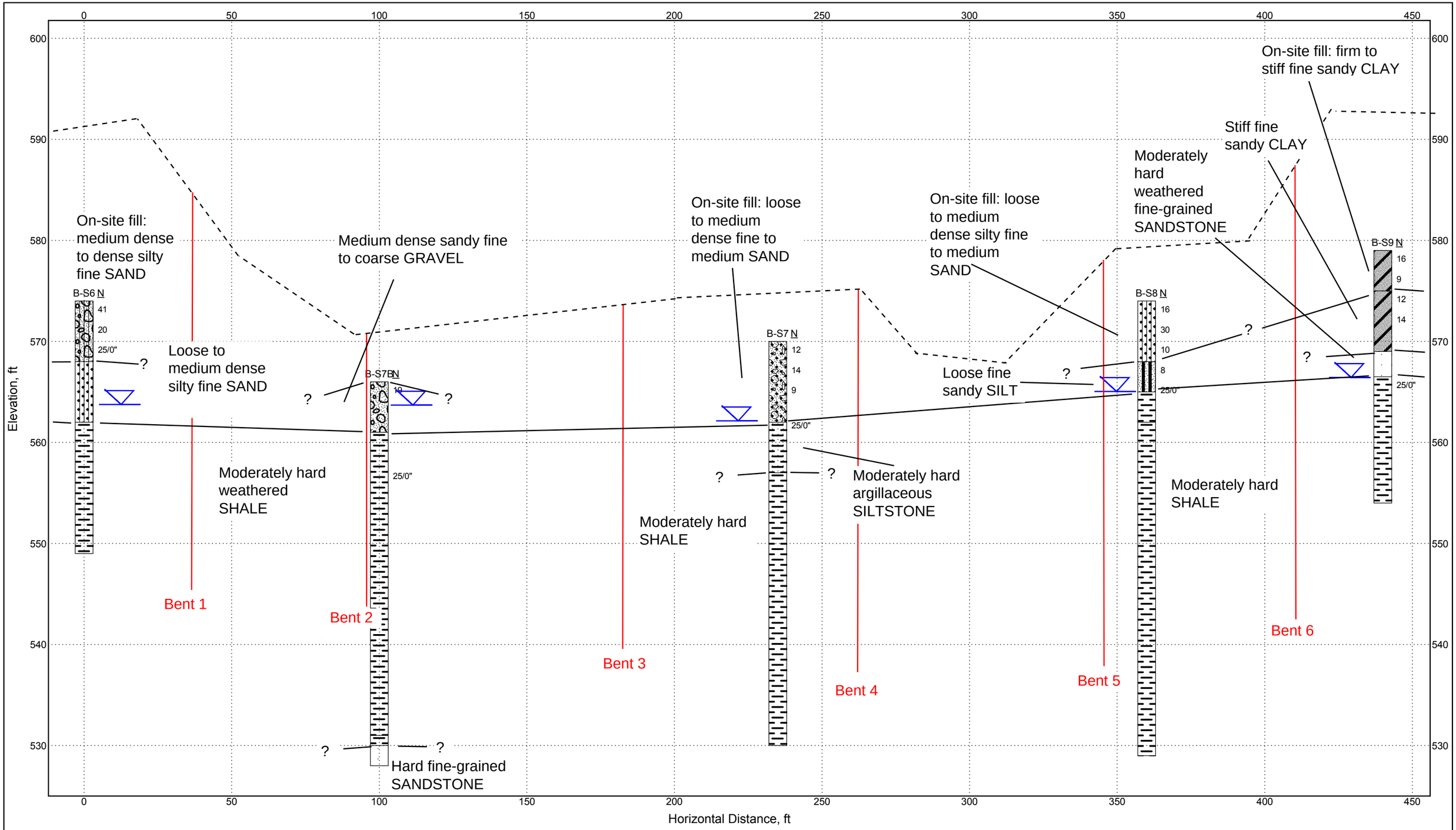
DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	COHESION, TON/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) / PLASTIC LIMIT / WATER CONTENT / LIQUID LIMIT (10 20 30 40 50 60 70)	- No. 200 %	% Recovery	% RQD
			SURF. EL: 584.8±						
			Stiff reddish tan fine sandy clay (fill)	16			57		
			- firm with some fine to coarse gravel at below 2 - 4 ft	9					
5			Stiff reddish tan and tan fine sandy clay w/ferrous nodules and stains	12			60		
				14					
			- with sandstone fragments below 8 ft						
10			Moderately hard tan weathered fine-grained sandstone, fractured w/some silty clay seams						
			Moderately hard dark gray shale w/moderately close calcareous siltstone seams and partings and calcite veins	25/0"				34	0
15									
20								33	0
25									

COMPLETION DEPTH: 25.0 ft
DATE: 5-22-18

DEPTH TO WATER IN BORING: 13 ft
DATE: 5/22/2018

RECRQDN200-2 18-040_BRIDGE 03602.GPJ 12-7-18

PLATE 5



Grubbs, Hoskyn, Barton & Wyatt, Inc.

NOTES:
1. Subsurface conditions have been inferred between discrete boring locations. Actual conditions may vary.
2. Ground surface approximate.

Generalized Subsurface Profile
ARDOT 030501 - Bridge 03602
Howard County, Arkansas

Project Number: 18-040

Plate 6

ATTACHMENT 4


1804D 03062
5-6
5>6+7
18-040
B-6
15-25'
Grubbs, Hoskyn, Barton & Wyatt INC.
CONSULTING ENGINEERS
RUN1. 15'-20'
RUN2. 20'-25'


Buddy Salmon Run
5-7
5-6+7
Dmc, Ck, Gubbs
Box 1
20'
N TOP
hole PRODUCTS
hole PRODUCTS.com
18-040
B-7
10'-20'
Grubbs, Hoskyn, Barton & Wyatt INC.
CONSULTING ENGINEERS
RUN 1. 10'- 15'
RUN 2. 15'- 20'
N DIVIDER


18040
5-7
+ 8+9
B-040
B-S7
20'- 30'
Grubbs, Hoskyn, Barton & Wyatt INC
CONSULTING ENGINEERS
RUN1. 20'-25'
RUN2. 25'-30'


5-7
5-10+11
18-040
B-7
30-40'
Grubbs, Hoskyn, Barton & Wyatt INC
CONSULTING ENGINEERS
RUN1. 30'-35'
RUN2. 35'-40'


18-040
B-7B
10'-20'
Grubbs, Hoskyn, Barton & Wyatt INC
CONSULTING ENGINEERS


18-040
B-7B
20' - 30'
Grubbs, Hoskyn, Barton & Wyatt INC.
CONSULTING ENGINEERS


18-040
B-7B
30-38'
Grubbs, Hoskyn, Barton & Wyatt
RUN 1. 30'-35'
RUN 2. 35'-38'
Bridge Soaking Raise
B-7B
5-10-11
Box 3 of 3
hole PRODUCTS
www.hole PRODUCTS.com
N TOP


18040 03062
5-8
5+6+7
B-040
B-S8
15'-25'
Grubbs, Hoskyn, Barton & Wyatt, INC.
CONSULTING ENGINEERS
RUN1. 15'-20'
RUN2. 20'-25'


18-040
B-S8
25'-35'
Grubbs, Hoskyn, Barton & Wyatt, INC.
CONSULTING ENGINEERS
RUN1. 25'-30'
RUN2. 30'-35'


18-040
B-S8
35'-45'
Grubbs, Hoskyn, Barton & Wyatt
RUN 1. 35'-40'
RUN 2. 40-45'


18-040
B-59
15'-25'
Grubbs, Hoskyn, Barton & Wyatt INC.
CONSULTING ENGINEERS
RUN 1. 15'-20'
RUN 2. 20'-25'

ATTACHMENT 5

Grubbs, Hoskyn, Barton & Wyatt, Inc.
Consulting Engineers

LOG OF BORING NO. P5

ARDOT 030501 - Bridge 03602
Howard County, Arkansas

TYPE: Auger

LOCATION: Pavement - ±230 ft S of S Bridge End, Rt

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	COHESION, TON/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) / PLASTIC LIMIT / WATER CONTENT / LIQUID LIMIT (10 20 30 40 50 60 70)	- No. 200 %
			SURF. EL:				
			Medium dense to dense brown sandy fine to coarse gravel, slightly silty (fill)				
1				25/0"			
2				25/0"			
3						●	11
4				25/0"			
			- auger refusal in cobbles at 4.5 ft				
5							
6							
7							
8							
9							

COMPLETION DEPTH: 4.5 ft
DATE: 5-14-18

DEPTH TO WATER IN BORING: Dry

DATE: 5/14/2018

LGBNEW 18-040_BRIDGE 03602.GPJ 10-17-18

Grubbs, Hoskyn, Barton & Wyatt, Inc.
Consulting Engineers

LOG OF BORING NO. P6

ARDOT 030501 - Bridge 03602
Howard County, Arkansas

TYPE: Auger

LOCATION: Pavement - ±525 ft S of S Bridge End, Lt

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	COHESION, TON/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) / PLASTIC LIMIT / WATER CONTENT / LIQUID LIMIT (10 20 30 40 50 60 70)	- No. 200 %
			SURF. EL:				
1			Medium dense to dense brown silty fine gravel, sandy (fill)	50			
2			- with shale fragments below 2 ft				
3				17		+ ● +	18
4							
5				14			
6							
7				22		●	
8			Low hardness brownish gray and tan highly weathered shale - auger refusal in shale at 8 ft				
9							

COMPLETION DEPTH: 8.0 ft
DATE: 5-14-18

DEPTH TO WATER IN BORING: Dry

DATE: 5/14/2018

LGBNEW 18-040_BRIDGE 03602.GPJ 10-17-18

Grubbs, Hoskyn, Barton & Wyatt, Inc.
Consulting Engineers

LOG OF BORING NO. P7

ARDOT 030501 - Bridge 03602
Howard County, Arkansas

TYPE: Auger

LOCATION: Pavement - ±195 ft N of N Bridge End, Rt

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	COHESION, TON/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) / PLASTIC LIMIT / WATER CONTENT / LIQUID LIMIT (10 20 30 40 50 60 70)	- No. 200 %
			SURF. EL:				
1			Dense to very dense brown and reddish brown clayey fine to coarse gravel, sandy w/sandstone fragments	50/10"			
2							42
3				50/11"			
4			Friable brownish yellow and reddish tan highly weathered fine-grained sandstone, weakly cemented	50/7"			
5							
6			- moderately hard below 6 ft	50/2"			
7							
8			- auger refusal in sandstone at 8 ft				
9							

COMPLETION DEPTH: 8.0 ft
DATE: 5-14-18

DEPTH TO WATER IN BORING: Dry

DATE: 5/14/2018

LGBNEW 18-040_BRIDGE 03602.GPJ 10-17-18

Grubbs, Hoskyn, Barton & Wyatt, Inc.
Consulting Engineers

LOG OF BORING NO. P8

ARDOT 030501 - Bridge 03602
Howard County, Arkansas

TYPE: Auger

LOCATION: Pavement - ±560 ft N of N Bridge End, Lt

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	COHESION, TON/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) / PLASTIC LIMIT / WATER CONTENT / LIQUID LIMIT (10 20 30 40 50 60 70)	- No. 200 %
			SURF. EL:				
1			Medium dense grayish brown and reddish brown clayey fine sand w/sandstone fragments (fill)	18			44
2			Friable yellowish brown and tan highly weathered fine-grained sandstone, weakly cemented	50/1"			
3							
4				25/0"			
5			- auger refusal in cobbles and sandstone at 5 ft				
6							
7							
8							
9							

COMPLETION DEPTH: 5.0 ft
DATE: 5-14-18

DEPTH TO WATER IN BORING: Dry

DATE: 5/14/2018

LGBNEW 18-040_BRIDGE 03602.GPJ 10-17-18

ATTACHMENT 6

SUMMARY of CLASSIFICATION TEST RESULTS

PROJECT: ARDOT 030501, Bridge 03062
LOCATION: Howard County
JOB NUMBER: 18-040

BORING NO.	SAMPLE DEPTH (ft)	WATER CONTENT (%)	ATTERBERG LIMITS			SIEVE ANALYSIS PERCENT PASSING							UNIFIED CLASS.	AASHTO CLASS.
			LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	1 in.	3/4 in.	3/8 in.	#4	#10	#40	#200		
S6	0.5-1.5	6	NONPLASTIC			100	80	67	60	52	45	22	GM	A-1-b
S6	6.5-7.5	21	18	16	2	-----	-----	-----	94	-----	-----	42	SM	A-4
S7	0.5-1.5	8	NONPLASTIC			100	95	82	72	67	49	8	SP	A-1-b
S7B	0.5-1.5	-----	NONPLASTIC			-----	-----	-----	-----	-----	-----	-----	GM	A-2-4
S7B	6.5-7.5	14	24	14	10	-----	-----	-----	-----	-----	-----	-----	SHALE	
S8	0.5-1.5	8	NONPLASTIC			100	93	91	85	78	64	21	SM	A-2-4
S8	6.5-7.5	17	19	16	3	-----	-----	-----	100	-----	-----	60	ML	A-4
S9	0.5-1.5	12	25	15	10	100	100	97	96	93	87	57	CL	A-4
S9	4.5-5.5	17	27	17	10	100	100	100	98	95	90	60	CL	A-4
P5	2-2.5	4	-----	-----	-----	100	79	46	35	28	22	11	GP	A-1-a
P6	2.5-3.5	10	26	17	9	100	100	78	56	39	29	18	SC	A-2-4

GRUBBS, HOSKYN, BARTON & WYATT, INC.
Consulting Engineers

SUMMARY of CLASSIFICATION TEST RESULTS

PROJECT: ARDOT 030501, Bridge 03062
LOCATION: Howard County
JOB NUMBER: 18-040

BORING NO.	SAMPLE DEPTH (ft)	WATER CONTENT (%)	ATTERBERG LIMITS			SIEVE ANALYSIS PERCENT PASSING							UNIFIED CLASS.	AASHTO CLASS.
			LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	1 in.	3/4 in.	3/8 in.	#4	#10	#40	#200		
P7	2-3	10	32	16	16	100	84	76	70	67	62	42	SC	A-6
P8	0.5-1.5	13	33	18	15	100	88	77	72	68	62	44	SC	A-6

18-040-Bridge 03602

GRAIN SIZE CURVE

Grubbs, Hoskyn, Barton & Wyatt, INC.
CONSULTING ENGINEERS

GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

Sample: S6, 0.5-1.5 ft; NONPLASTIC

Description: Tan silty fine to coarse GRAVELwith some fine to coarse sand (fill) **USCS = GM AASHTO = A-1-b**

18-040-Bridge 03602

GRAIN SIZE CURVE

Grubbs, Hoskyn, Barton & Wyatt, INC.
CONSULTING ENGINEERS

GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

Sample: S7, 0.5-1.5 ft; NONPLASTIC
Description: Brown fine to medium SAND, slightly silty with some fine to coarse gravel (fill)

USCS = SP AASHTO = A-1-b

18-040-Bridge 03602

GRAIN SIZE CURVE

Grubbs, Hoskyn, Barton & Wyatt, INC.
CONSULTING ENGINEERS

GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

Sample: S8, 0.5-1.5 ft; NONPLASTIC
Description: Brown silty fine to medium SAND with a little fine to coarse gravel (fill)

USCS = SM AASHTO = A-2-4

18-040-Bridge 03602

GRAIN SIZE CURVE

Grubbs, Hoskyn, Barton & Wyatt, INC.
CONSULTING ENGINEERS

GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

Sample: S9, 0.5-1.5 ft; LL = 25, PL = 15, PI = 10
Description: Reddish tan fine sandy CLAY (fill)

USCS = CL AASHTO = A-4

18-040-Bridge 03602

GRAIN SIZE CURVE

Grubbs, Hoskyn, Barton & Wyatt, INC.
CONSULTING ENGINEERS

GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

Sample: P-5, 2-2.5 ft;
Description: Brown sandy fine to coarse GRAVEL, slightly silty (fill)

USCS = GP AASHTO = A-1-a

18-040-Bridge 03602

GRAIN SIZE CURVE

Grubbs, Hoskyn, Barton & Wyatt, INC.
CONSULTING ENGINEERS

GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

Sample: P-6, 2.5-3.5 ft; LL = 26, PL = 17, PI = 9
Description: Brown silty fine GRAVEL, sandy (fill)

USCS = SC AASHTO = A-2-4

18-040-Bridge 03602

GRAIN SIZE CURVE

Grubbs, Hoskyn, Barton & Wyatt, INC.
CONSULTING ENGINEERS

GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

Sample: P-7, 2-3 ft; LL = 32, PL = 16, PI = 16
Description: Brown and reddish brown clayey fine to coarse GRAVEL, sandy with sandstone fragments (fill)

USCS = GC AASHTO = A-6

18-040-Bridge 03602

GRAIN SIZE CURVE

Grubbs, Hoskyn, Barton & Wyatt, INC.
CONSULTING ENGINEERS

GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

Sample: P-8, 0.5-1.5 ft; LL = 33, PL = 18, PI = 15
Description: Grayish brown and reddish brown clayey fine to coarse SAND withsandstone fragments (fill)

USCS = SC AASHTO = A-6

ATTACHMENT 7

Grubbs, Hoskyn, Barton & Wyatt, INC.
CONSULTING ENGINEERS

P.O. Box 30970
Little Rock, Arkansas 72260-0970
#1 Trigon Place 72209
(501) 455-2536
FAX (501) 455-4137

REPORT OF MODIFIED PROCTOR TEST
(AASHTO T-180 METHOD D)

Project: ARDOT 030501 - Bridge 03602 over Saline River Job No: 18-18-040

Material Description: Brown sandy fine to coarse gravel (fill)

Location Sampled/Source: 5/21A
Sample Depth, ft: 0.5-2
Date Sampled: 5/21/2018
Date Tested: 6/14/2018
Tested By: LLC
Report Date: 6/21/2018

LAB COMPACTION PROCEDURE: AASHTO T-180 Method: D	
Maximum Unit Dry Wt. (pcf):	135.4
Optimum Water Content (%):	8.0

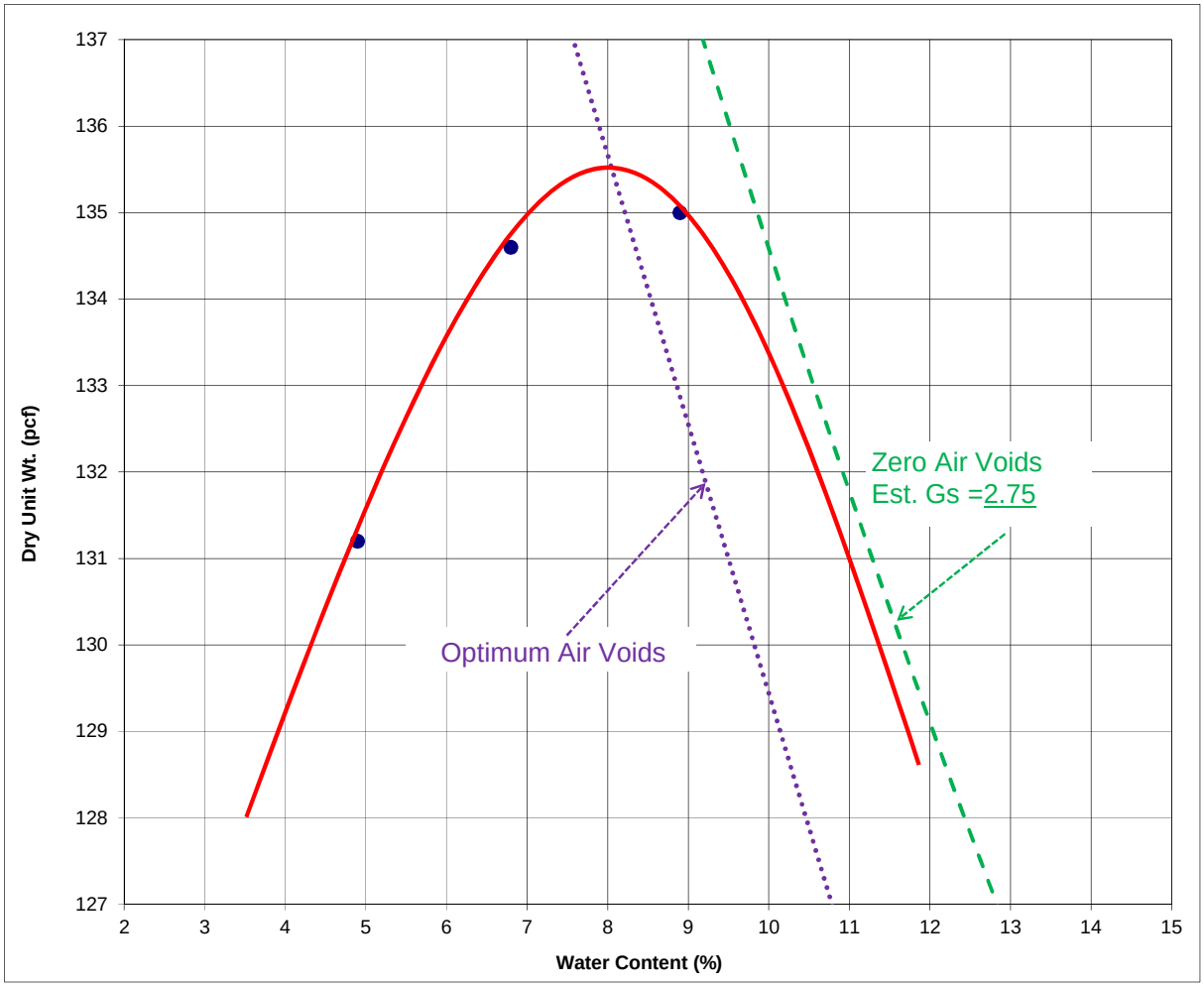
As Processed Water Content: 3.4 %

ATTERBERG LIMITS AASHTO T-89 & T-90
Liquid Limit: NP
Plastic Limit: NP
Plasticity Index: NP

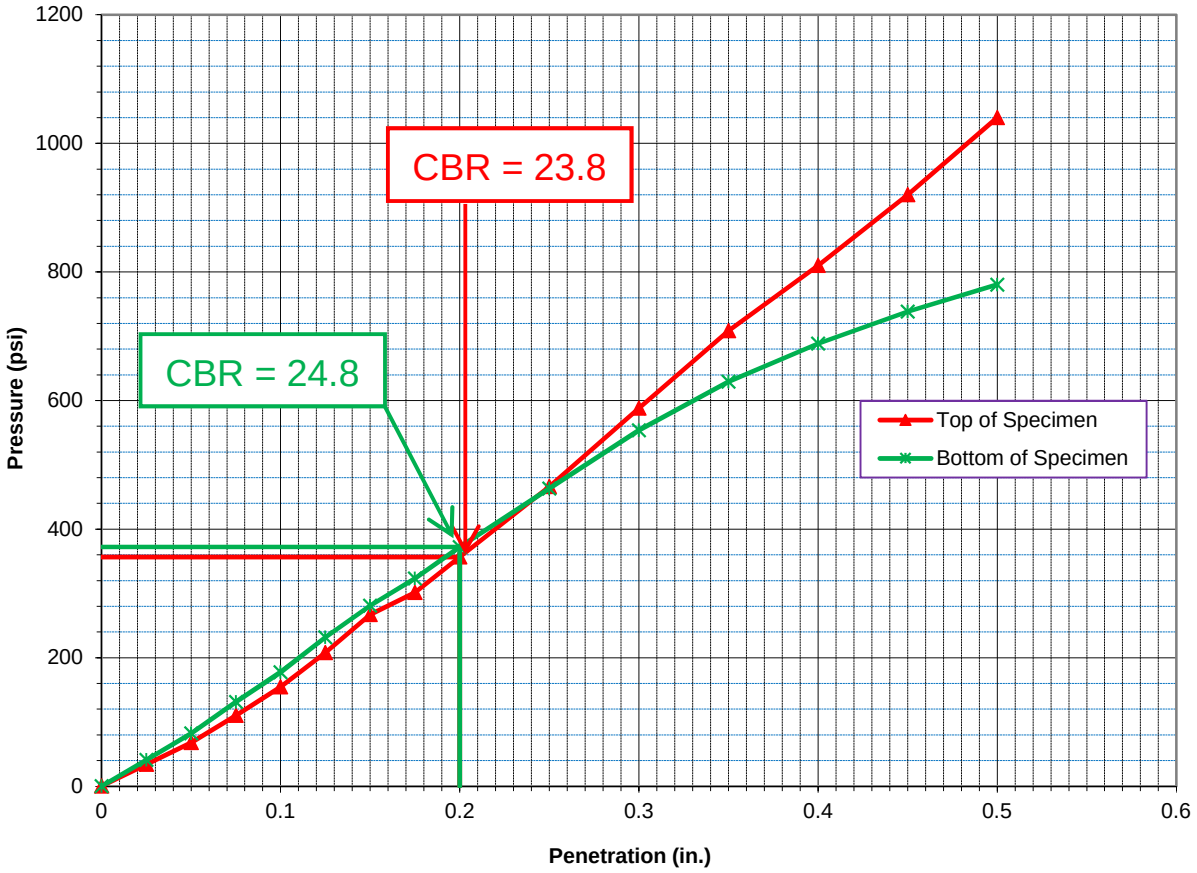
AASHTO Classification:
GM

USCS Classification:
A-1-b

GRADATION AASHTO T-88	
Sieve Number	Percent Passing
2 in.	100
1 in.	80
3/4 in.	72
3/8 in.	61
#4	53
#10	46
#40	36
#200	13



Laboratory CBR Test Report
(AASHTO T-193)



Sample/Depth, ft	Classification		Natural Moisture Content, %	Assumed Specific Gravity	Liquid Limit, %	Plastic Limit, %	% Passing No.4	% Passing No.200
	USCS	AASHTO						
5/21A/0.5-2	GM	A-1-b	3.4	2.75	NP	NP	53	13

PROCTOR TEST RESULTS (AASHTO T-180 D)	MATERIAL DESCRIPTION
Optimum Moisture Content = 8.0% Maximum Dry Density = 135.4 pcf	Brown sandy fine to coarse gravel (fill)

Remarks:

As molded: Dry Unit Weight, γ_d = 130.8 pcf; Moisture Content, w = 7.5%

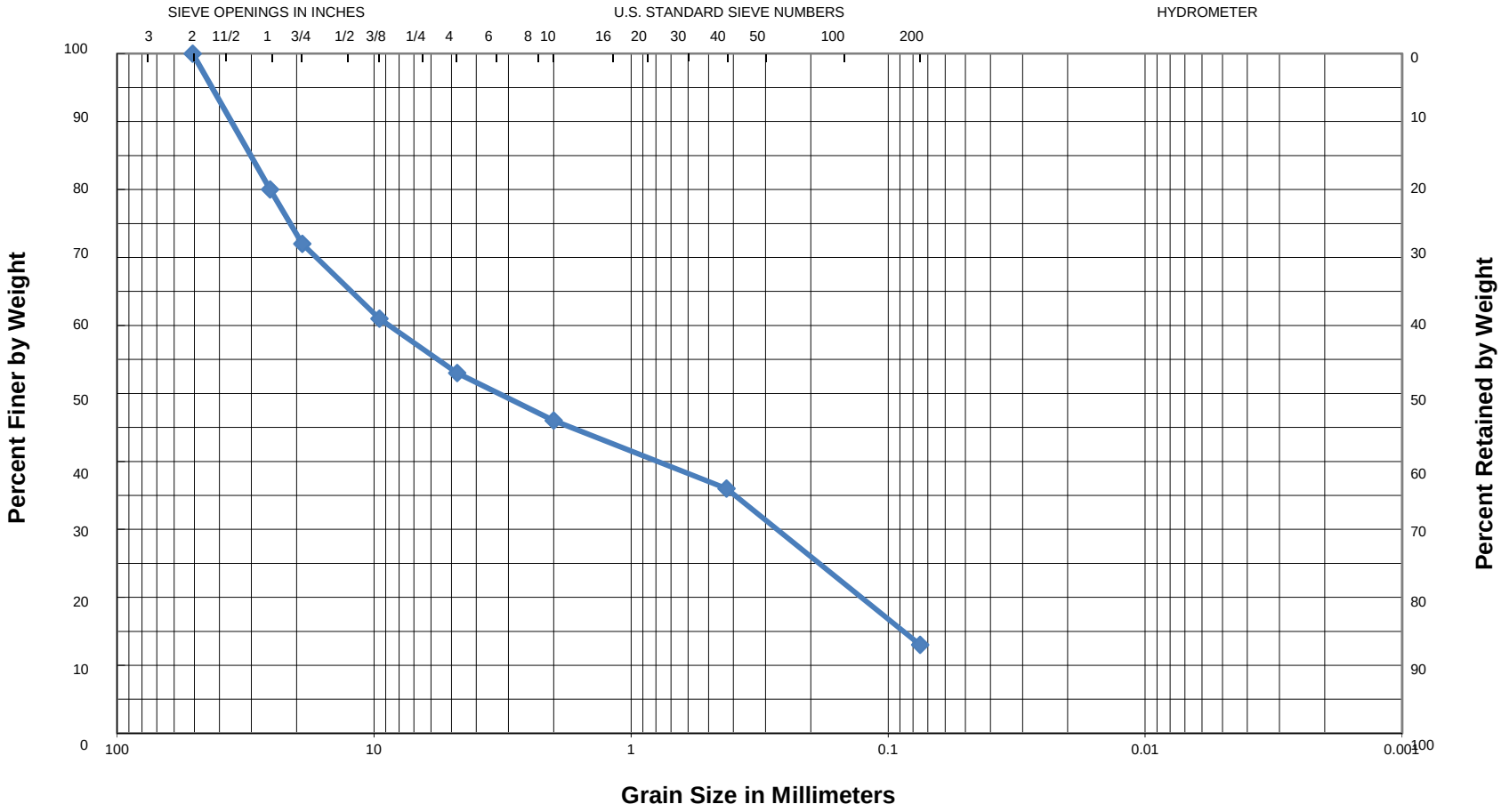
Grubbs, Hoskyn, Barton & Wyatt, INC.
CONSULTING ENGINEERS

Project: ARDOT 030501 - Bridge 03602
GHBW Project No.: 18-040
Location: Howard Co., Arkansas
Sample Date: 05-21-18
Test Date: 06-14-18

18-040-Bridge 03602

GRAIN SIZE CURVE

Grubbs, Hoskyn, Barton & Wyatt, INC.
CONSULTING ENGINEERS



GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

Sample: 5/21A, 0.5-2 ft
Atterberg Limits: Non Plastic

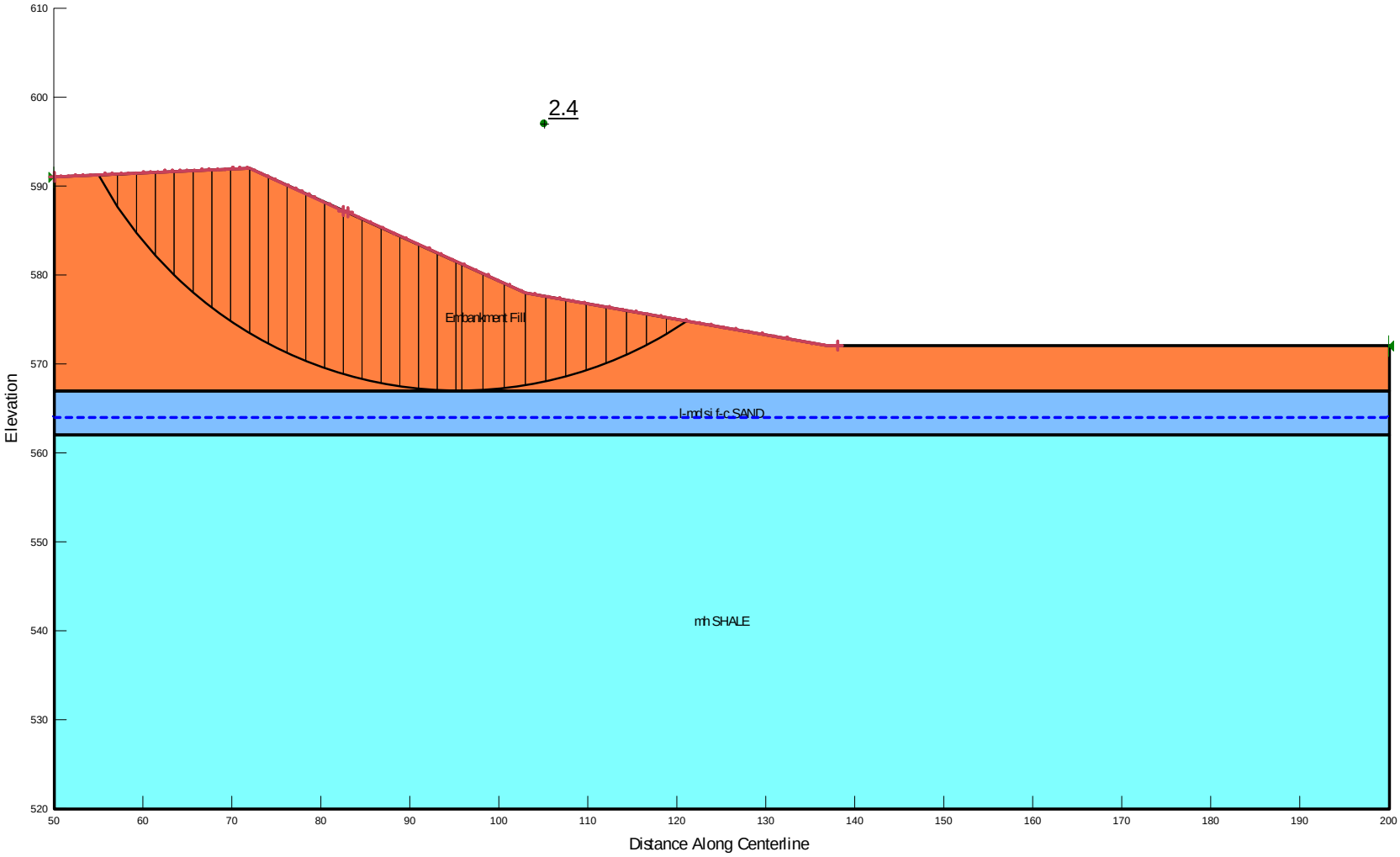
Description: Brown sandy fine to coarse gravel

Classification: **USCS = GM; AASHTO = A-1-b**

ATTACHMENT 8

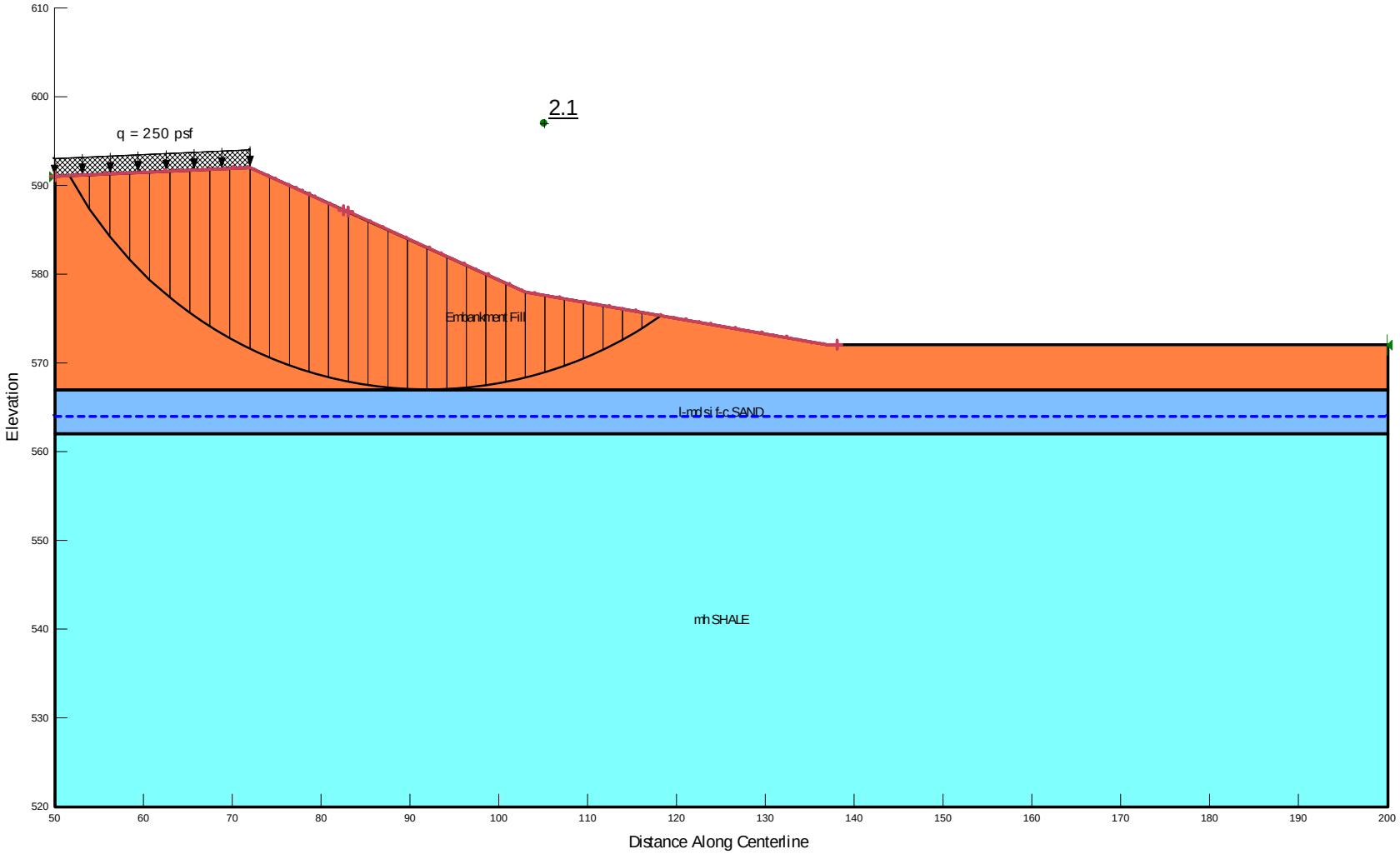
Summary of Stability Analysis Results
ARDOT Job No. 030501 Saline & Caddo Rivers Strs. & Apprs. (S)
Bridge 03602 Over Saline River
GHBW Job No. 18-040
Howard County, Arkansas

Bridge End	Design Loading Condition	Calculated Minimum Factor of Safety
Bent 1 End Slope	End of Construction	2.4
	Long Term	2.1
	Rapid Drawdown from El 585 to Existing Grade	1.9
	Seismic ($k_h = A_S/2 = 0.032$)	2.2
Bent 6 End Slope	End of Construction	2.6
	Long Term	2.2
	Rapid Drawdown from El 585 to Existing Grade	2.3
	Seismic ($k_h = A_S/2 = 0.032$)	2.4

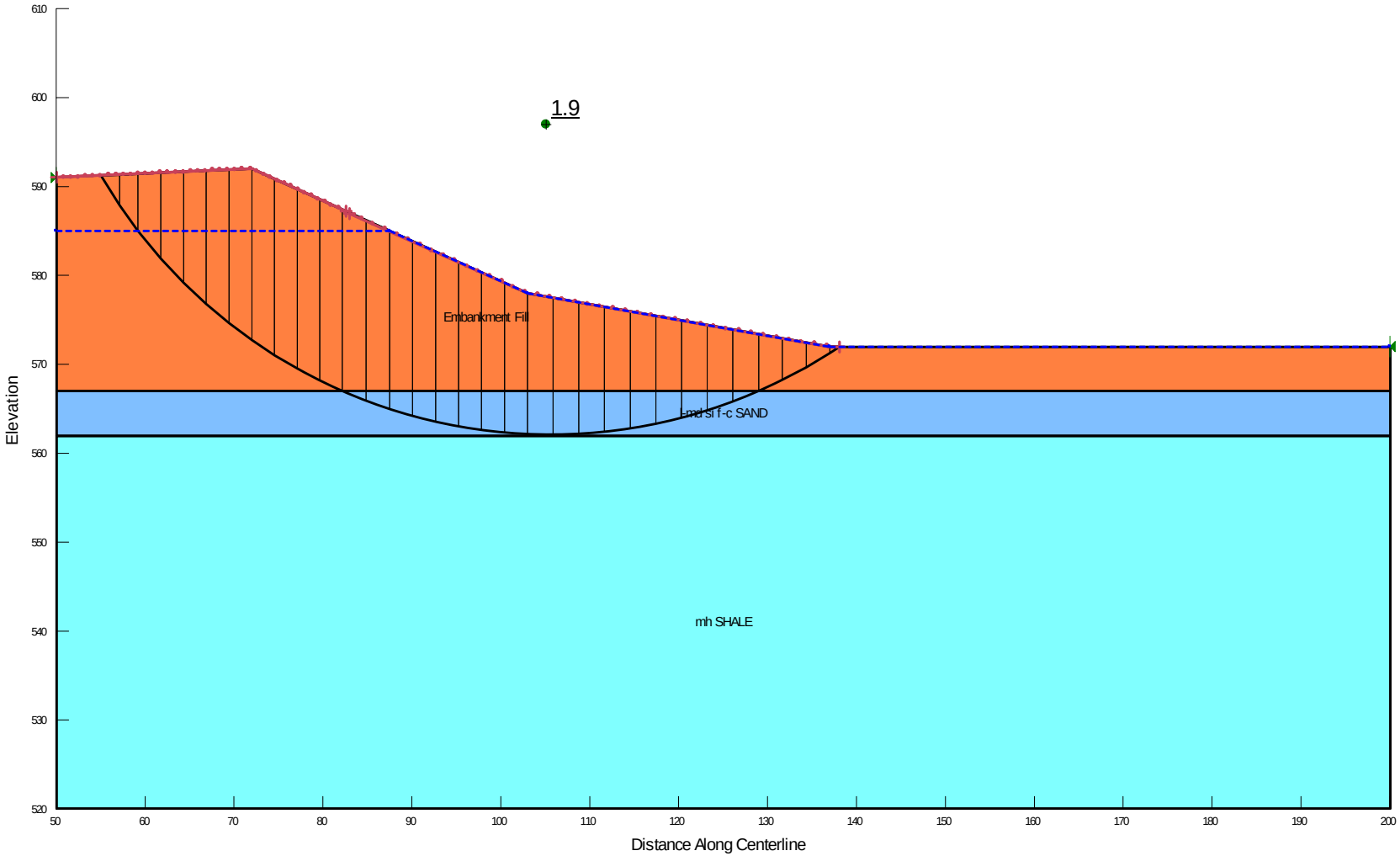


Results of Stability Analyses – End of Construction
Bent 1 End Slope
ARDOT Job No. 030501 Saline & Caddo Rivers Strs. & Apprs. (S)
Bridge 03602 Over Saline River
GHBW Job No. 18-040
Howard County, Arkansas

GRUBBS, HOSKYN, BARTON & WYATT, INC.
Consulting Engineers

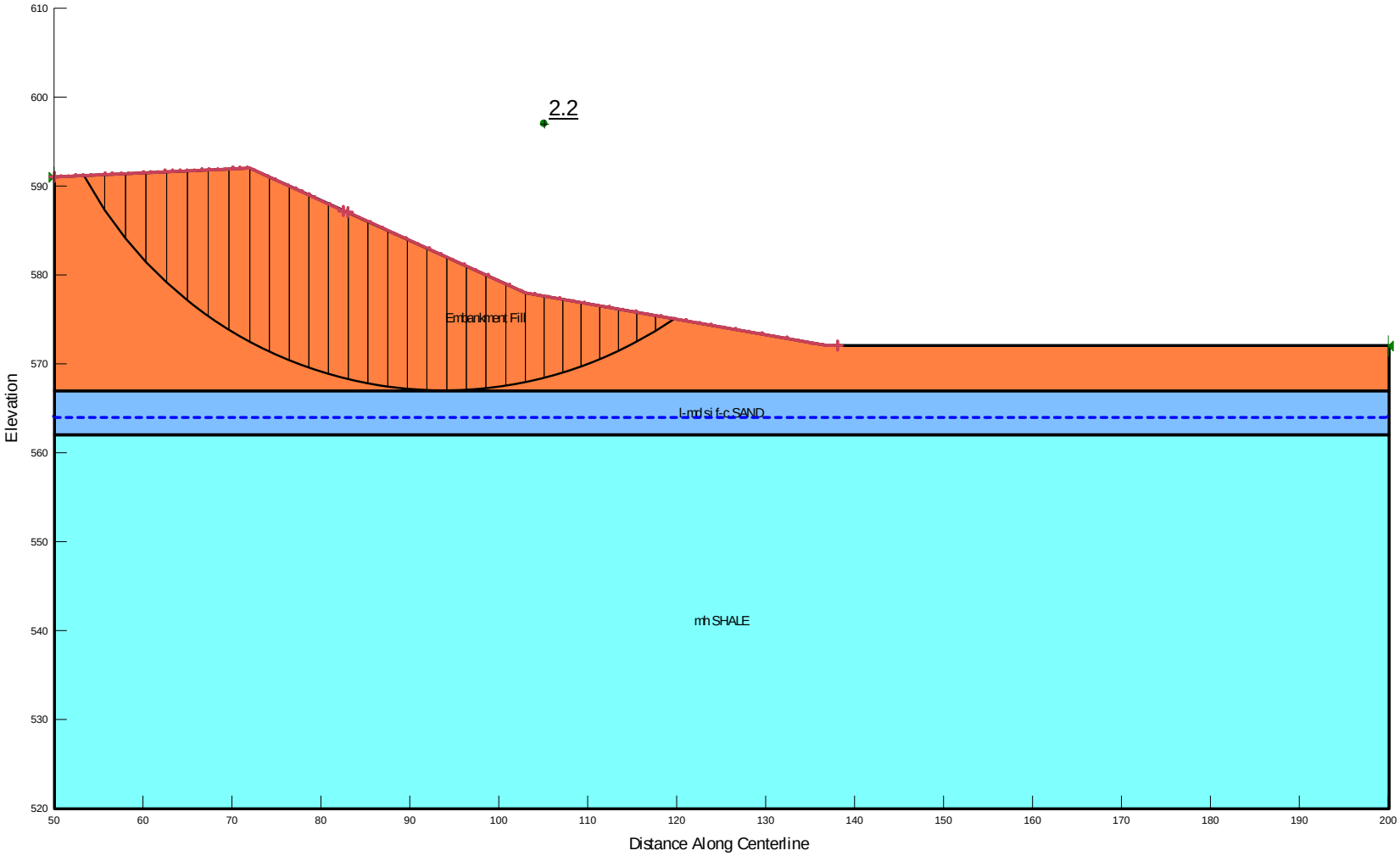


Results of Stability Analyses – Long Term Condition
Bent 1 End Slope
ARDOT Job No. 030501 Saline & Caddo Rivers Strs. & Apprs. (S)
Bridge 03602 Over Saline River
GHBW Job No. 18-040
Howard County, Arkansas

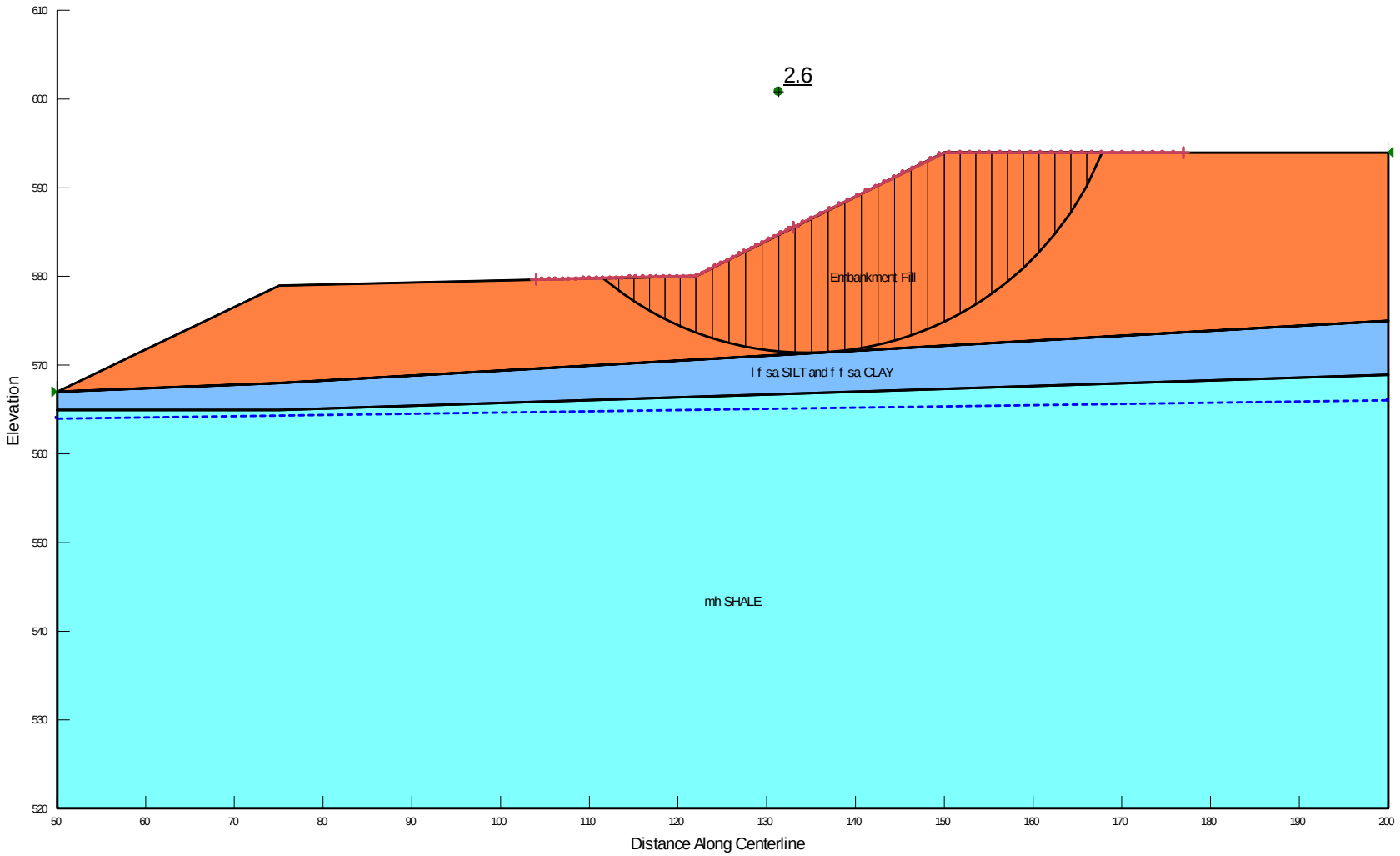


Results of Stability Analyses – Rapid Drawdown Condition, EI 585 to Existing Grade
Bent 1 End Slope
ARDOT Job No. 030501 Saline & Caddo Rivers Strs. & Apprs. (S)
Bridge 03602 Over Saline River
GHBW Job No. 18-040
Howard County, Arkansas

GRUBBS, HOSKYN, BARTON & WYATT, INC.
Consulting Engineers

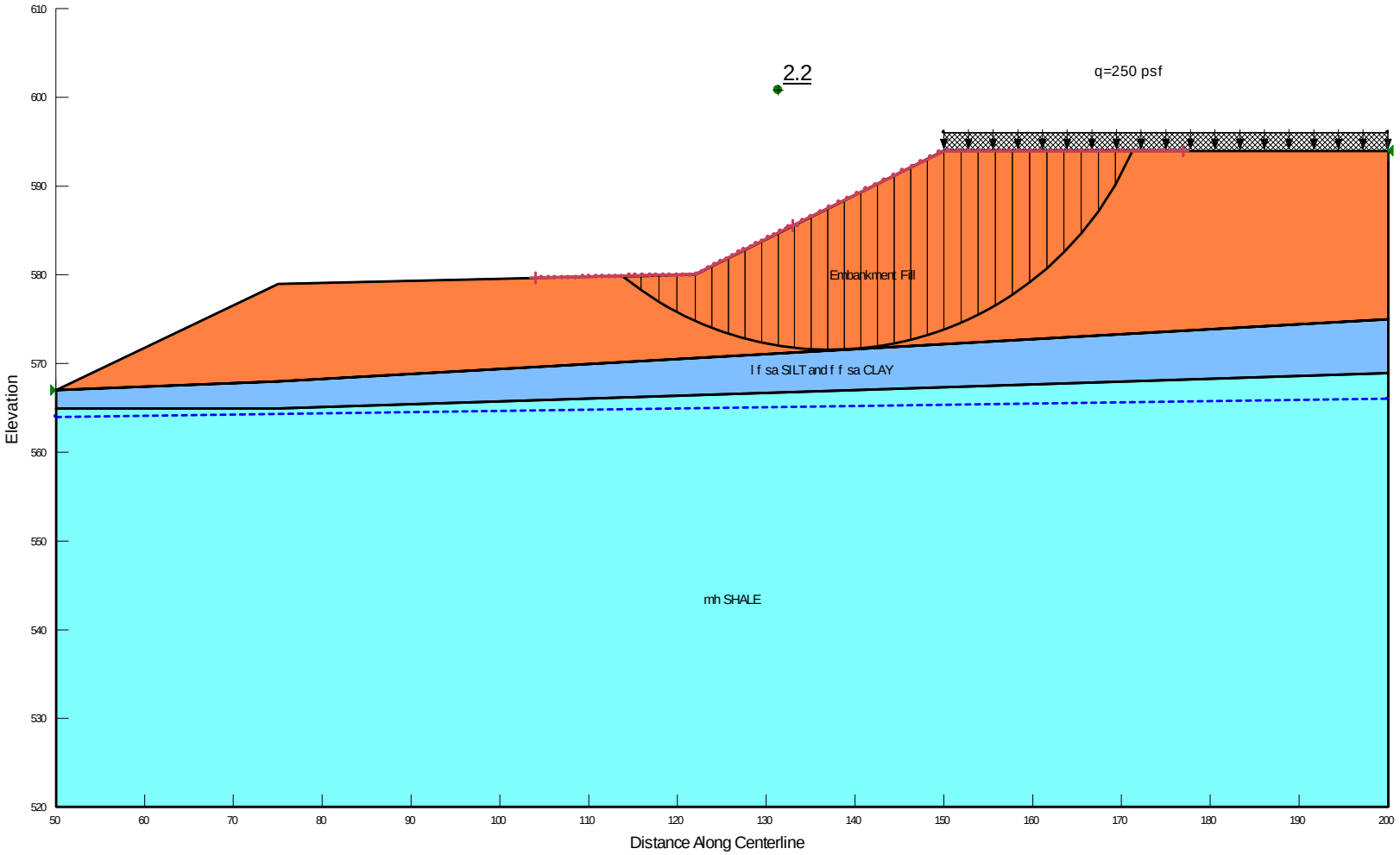


Results of Stability Analyses – Seismic Condition ($k_h = A_S /2 = 0.032$)
Bent 1 End Slope
ARDOT Job No. 030501 Saline & Caddo Rivers Strs. & Apprs. (S)
Bridge 03602 Over Saline River
GHBW Job No. 18-040
Howard County, Arkansas

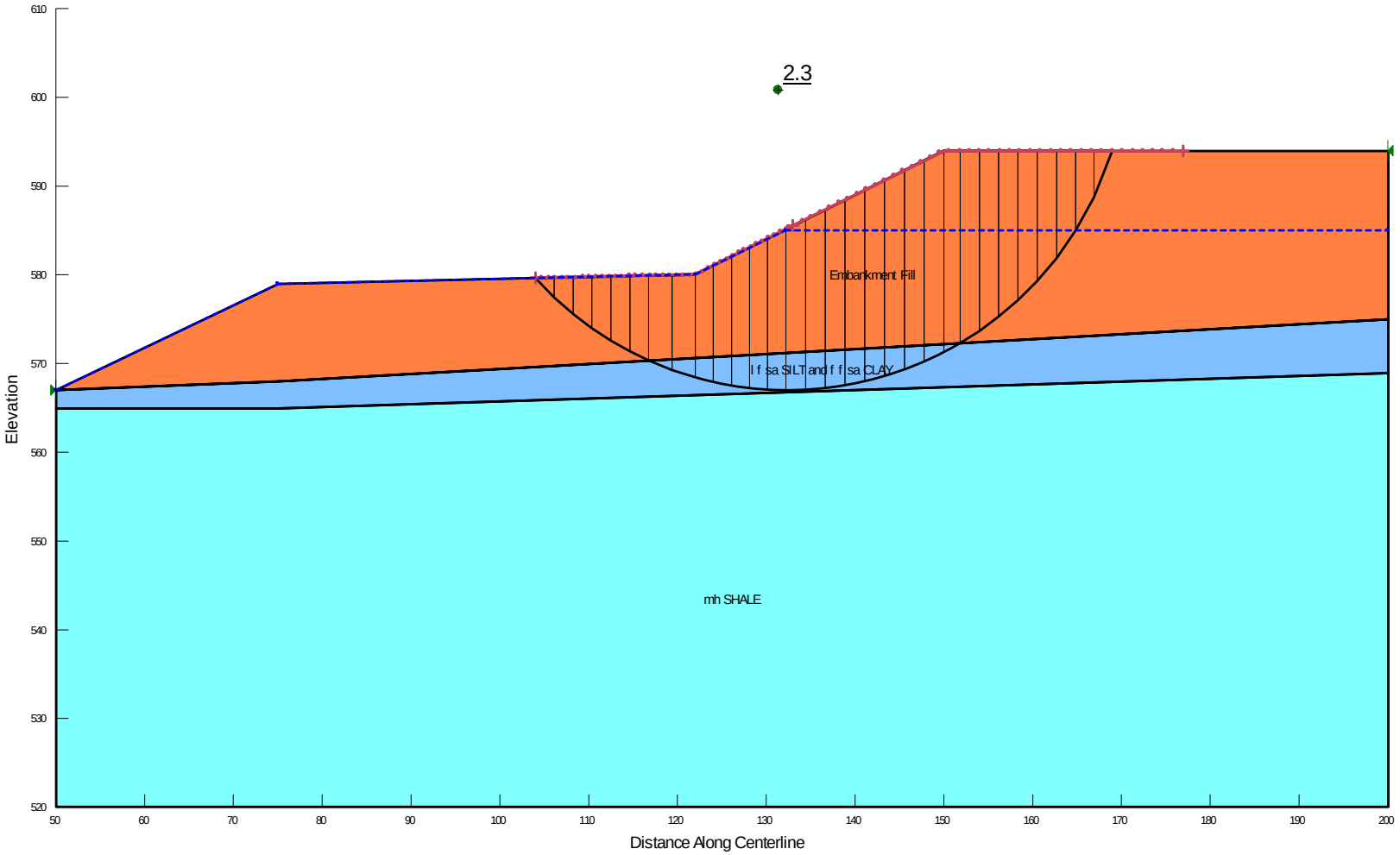


Results of Stability Analyses – End of Construction
Bent 6 End Slope
ARDOT Job No. 030501 Saline & Caddo Rivers Strs. & Apprs. (S)
Bridge 03602 Over Saline River
GHBW Job No. 18-040
Howard County, Arkansas

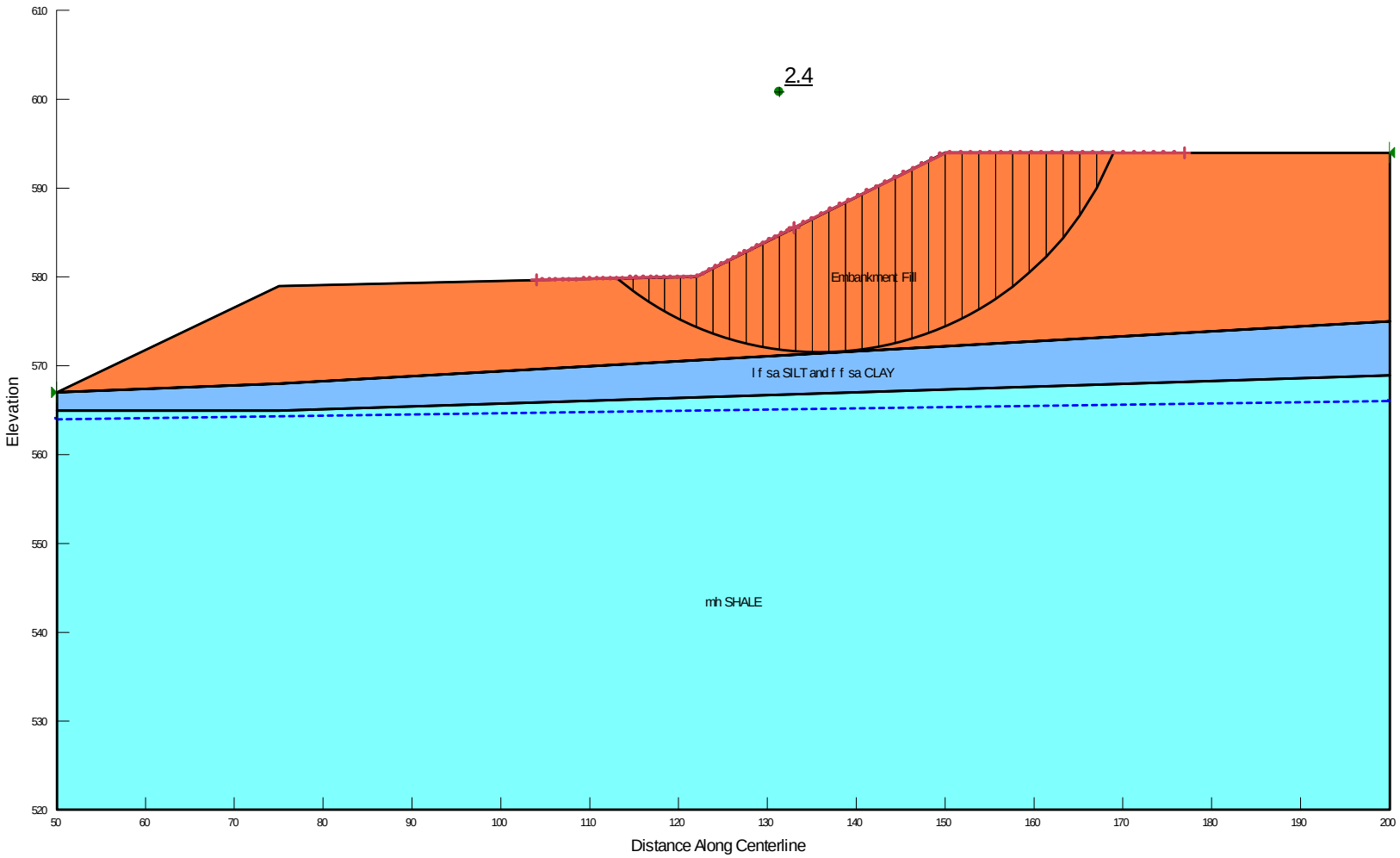
GRUBBS, HOSKYN, BARTON & WYATT, INC.
Consulting Engineers



Results of Stability Analyses – Long Term Condition
Bent 6 End Slope
ARDOT Job No. 030501 Saline & Caddo Rivers Strs. & Apprs. (S)
Bridge 03602 Over Saline River
GHBW Job No. 18-040
Howard County, Arkansas



Results of Stability Analyses – Rapid Drawdown Condition, EI 585 to Existing Grade
Bent 6 End Slope
ARDOT Job No. 030501 Saline & Caddo Rivers Strs. & Apprs. (S)
Bridge 03602 Over Saline River
GHBW Job No. 18-040
Howard County, Arkansas



Results of Stability Analyses – Seismic Condition ($k_h = A_S /2 = 0.032$)
Bent 6 End Slope
ARDOT Job No. 030501 Saline & Caddo Rivers Strs. & Apprs. (S)
Bridge 03602 Over Saline River
GHBW Job No. 18-040
Howard County, Arkansas

Grubbs, Hoskyn, Barton & Wyatt, INC.
CONSULTING ENGINEERS

P.O. Box 30970
Little Rock, Arkansas 72260-0970
#1 Trigon Place 72209
(501) 455-2536
FAX (501) 455-4137

May 10, 2019
Job No. 18-040

Michael Baker International
Union Station
1400 West Markham, Suite 204
Little Rock, Arkansas 72201

Attn: Mr. Scott P. Thornsberry, P.E.
Project Manager - Transportation

GEOTECHNICAL INVESTIGATION
ARDOT JOB 030501 SALINE & CADDO RIVERS STRS. & APPRS. (S)
BRIDGE 02082 – HWY. 70 OVER SALINE RIVER
ATWOOD, HOWARD and SEVIER COUNTY, ARKANSAS

INTRODUCTION

This report provides the final results of the geotechnical investigation performed for ARDOT Job 030501 Saline & Caddo Rivers Strs. & Apprs. (S). Specifically. This report provides results and recommendations relevant to Bridge 02082, Hwy. 70 over the Saline River near Atwood, in both Howard and Sevier County, Arkansas. This geotechnical investigation was authorized on behalf of Michael Baker International by the subconsultant agreement of March 27, 2018. This study has been performed in general accordance with our submittal of March 1, 2018 (GHBW Proposal No. 18-044). Results of this study have been provided to Michael Baker International as data were developed. Interim recommendations for were provided on August 23, 2018 and October 24, 2018.

We understand the replacement bridge will be a continuous composite plate girder units structure with six (6) bents, five (5) spans, and a total length of approximately 467 feet. We also understand that a foundation system consisting of steel piles is planned at both the bridge ends and interior bents. Foundation loads of the new bridge are anticipated to be moderate. Simple slopes will be utilized for embankments at the bridge ends. A preliminary bridge layout is included in Attachment 1.

The results of the subsurface exploration program and laboratory test results are included in the attachments. Recommendations for seismic site classification and bridge foundations for the planned bridge are discussed in the following report sections. Additionally, stability analyses have

been performed for the planned simple slopes at the bridge ends and subgrade parameters have been developed for use in pavement design.

SUBSURFACE EXPLORATION

Subsurface conditions at the replacement bridge location were investigated by drilling nine (9) sample borings to depths of 7 to 75 ft and excavating one (1) test pit to 2-ft depth. The site vicinity is shown on Plate 1 of Attachment 2. The approximate boring locations at the new bridge and pavement locations are shown on Plates 2a and 2b. The subsurface exploration program is summarized on Plate 3 of Attachment 2. Keys to the terms and symbols used on the boring logs are presented as Plates 4 and 5 of Attachment 2.

The boring logs for the replacement bridge structure are presented in Attachment 3. A generalized subsurface profile in the bridge alignment is provided on Plate 11 of Attachment 3. The boring logs from the pavement borings are provided in Attachment 4. The centerline station and offset of the boring locations and the inferred ground surface elevation are noted on the logs. The approximate boring surface elevation was inferred from the topographic information provided by the Engineer (Michael Baker International). It must be recognized that the elevations shown are approximate and actual elevations may vary.

A generalized subsurface profile is shown on Plate 11 of Attachment 3 is provided to aid in visualizing subsurface conditions in the bridge alignment. It should be recognized that the stratigraphy illustrated by the profile has been inferred between discrete boring locations. In view of the natural variations in stratigraphy and conditions, variations from the stratigraphy illustrated by the profiles should be anticipated. Additionally, the natural transition between strata is generally gradual, and the stratigraphy shown on the profile and described elsewhere in this report may vary.

The borings were drilled with truck-mounted SIMCO 2400 and SIMCO 2800 rotary-drilling rigs. Samples were typically obtained at 2-ft intervals to 10-ft depth and at 5-ft intervals thereafter. Samples were recovered using a 2-in.-diameter split-barrel sampler driven into the strata by blows of a 140-lb hammer with 30-in. drop in accordance with Standard Penetration Test (SPT) procedures. A safety hammer was used with the SIMCO 2400 (used on road borings) and the SIMCO 2800 (used for bridge borings) utilized an automatic hammer. The number of blows required to drive the standard split-barrel sampler the final 12 in. of an 18-in. total drive, or a portion thereof, is defined as the Standard Penetration Number (N). Recorded N-values are shown on the

boring logs in the "Blows Per Ft" column. Where rock hardness precluded recovery with the split-spoon, cuttings were recovered for use in visual classification. The predominance of caving, granular soils precluded coring the shale and sandstone bedrock.

All samples were extruded or otherwise removed from samplers in the field. Samples were visually classified and placed in appropriate containers to prevent moisture loss and/or disturbance during transfer to our laboratory for further examination and testing.

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

LABORATORY TESTING

To evaluate pertinent soil and rock properties, laboratory tests consisting of classification tests and natural water content determinations were performed. A total of 63 natural water content determinations were performed to develop information on *in-situ* soil water content. Water content results are plotted on the boring log forms in accordance with the scale and symbols shown in the legend located in the upper-right corner of the logs.

To verify field classification and to evaluate soil plasticity, 16 liquid and plastic limit (Atterberg limits) determinations and 33 sieve analyses were performed on selected representative samples. The Atterberg limits are plotted on the log as pluses inter-connected with a dashed line using the water content scale. The percentage of soil passing through the No. 200 Sieve is noted in the "- No. 200 %" column on the appropriate log forms. Classification test results, along with soil classification by the Unified Soil Classification System and AASHTO designations and grain size curves, are presented in Attachment 5.

One (1) laboratory moisture-density relationship (Proctor) test was performed on a representative bulk soil sample obtained in the approach road alignment to evaluate the moisture-density relationship of on-site subgrade soils. The Proctor test and bulk sample classification test results are provided in Attachment 6. Pavement subgrade support properties of the potential subgrade soils were evaluated by performing one (1) California Bearing Ratio (CBR) test on the collected bulk sample. The CBR results are also provided in Attachment 6.

GENERAL SITE and SUBSURFACE CONDITIONS

Site Conditions

Bridge 02082 is planned at Hwy 70 Sta 999+99 to Sta 1004+66 on the border of Howard and Sevier County, Arkansas. The new bridge will replace the existing bridge currently spanning the Saline River. The replacement bridge will have an approximate 467-ft length. The bridge replacement will span the Saline River, which flows south into the Ouachita River. Surface drainage of this area is considered poor to fair. The Saline River's channel slopes visually appear to be stable with thickly established vegetation. The slope intercept of the creek bank is lined with medium to large trees and underbrush. Overhead electrical power lines cross the Saline River north of the existing bridge.

The existing Hwy. 70 roadway is a two-lane highway bordered by both shallow ditches and gentle hillsides from apparent prior site grading. Surface drainage of the existing roadway is good and drainage of the surrounding terrain varies from poor to fair.

Site Geology

Geologically, the project locale is in the mapped exposure of Recent Alluvium. The alluvium in this area is reported to be underlain by the Paleozoic rocks of the Pennsylvanian Period Jackfork Sandstone Formation. The alluvial deposits are associated with the Saline River floodplain. The alluvium is comprised of variable sand, silt, gravel, and clay units, and mixtures of any or all of these clastic materials. Typically, the alluvial soils grade from fine-grained at shallow depths to increasing coarse soils at depth. It is not unusual for gravel, cobbles, and boulders to overlie the more consolidated sediments of Pennsylvanian age. The results of the borings performed for this study did encounter variable amounts of cobbles and possible boulders.

The Jackfork Sandstone consists of thin to massive quartzitic sandstone and silty sandstone with shale units. The subordinate sandstone units in the Jackfork are locally discontinuous but may occur as localized and discontinuous beds or may be massive in some locations. The Jackfork is conformable on the underlying Stanley Shale and is reported to have a thickness varying from 3500 to 6000 feet.

Seismic Conditions

Based on the site geology, the average soil and rock conditions revealed by the borings, and our experience in the area, a Seismic Site Class D (stiff soil profile) is considered fitting for the Bridge 02082 structure site with respect to the criteria of the AASHTO LRFD Bridge Design

Specifications Seventh Edition 2014[1]. The liquefaction potential is considered minor for the predominantly coarse granular overburden soils and underlying rock units encountered in the borings.

Given the location and AASHTO code-based values, the 1.0-sec period spectral acceleration coefficient for Site Class D (S_1) is 0.050 and the 1.0-sec period spectral acceleration coefficient (S_{D1}) value for Site Class D is 0.120. Utilizing these parameters, Table 3.10.6-1[2] indicates that a Seismic Performance Zone 1 is fitting for the Bridge 02082 site. In reference to the 2011 edition of the AASHTO Guide Specifications, the Peak Ground Acceleration (PGA) having a 7 percent chance of exceedance in 75 years (or mean return period of approximately 1000 years) is predicted to be 0.053 for a Seismic Site Class D for the bridge location.

Subsurface Conditions

Subsurface conditions revealed by the borings performed for the bridge replacement can be summarized into general subsurface conditions which are summarized below.

The on-site embankment fill is variable but generally consists of loose to medium dense reddish tan and tan clayey fine to coarse gravel, silty fine sand, clayey fine sand, fine sandy silt, and silty fine to coarse sand. These soils typically classify as A-1-a, A-1-b, A-2-4, and A-4 by the AASHTO classification system (AASHTO M 145), which correlates with excellent to poor subgrade support for pavement structures. The fill extends to 2- to 7-ft depth.

Below 2- to 7-ft depth is loose to dense reddish tan and tan fine to coarse gravel with variable amounts of silt, sand, and cobbles. Additionally, loose to dense silty fine to medium sand, medium to coarse sand, fine to coarse sand and fine sand units are present in the overburden soil. The natural granular soils exhibit variable and typically increasing low to high relative density and decreasing compressibility with depth. The overburden soils also includes localized strata of very stiff to hard bluish gray fine sandy clay, soft brown and gray fine sandy clay, and dense to very dense silt. These granular units typically extend to depths of 50 to 58 ft below existing grades (EI 508 to EI 521).

The basal stratum encountered in the borings is moderately hard weathered yellowish brown, maroon, gray and tan weathered shale. The basal shale has a steep dip, approximately 80°, and is thin bedded. Rock quality is fair to good and the competence and hardness increases with depth. The weathered shale contains variable amounts of silty clay laminations. Locally (see

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1 AASHTO LRFD Bridge Design Specifications, 7th Edition; AASHTO; 2014.
2 AASHTO LRFD Bridge Design Specification, AASHTO; 2012

Boring 13), moderately hard to hard tan and gray fine-grained sandstone was encountered below 73-ft depth. Rock quality in the weathered sandstone unit is typically good.

Groundwater Conditions

Groundwater was encountered at 4- to 8-ft depth at the bridge location in April 2018. Seasonal seeps and springs could be locally present as infiltrated surface water migrates from areas of higher terrain through the overburden soils. Groundwater levels will vary, depending upon seasonal precipitation, surface runoff and infiltration, and water levels in the nearby Saline River and other surface water features.

ANALYSES and RECOMMENDATIONS

Bridge Foundation Design

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

In light of the results of the borings performed for this study, the anticipated moderate bridge foundation loads, and for constructability, we recommend that foundation loads be supported on piling at both the bridge ends (Bents 1 and 6) and at the interior bents (Bents 2, 3, 4, and 5). Given the relatively deep, granular overburden soils, low-displacement steel piles are recommended. Recommendations for foundations are discussed in the following paragraphs.

Pile Foundations

We recommend that the foundation loads at the bridge ends be supported on steel piles. Steel HP12x53 or HP14x73 piles, or heavier sections, are recommended. Other pile sizes or types may be evaluated if desired. Piles should extend through all embankment fill and overburden soils to bear in the moderately hard yellowish brown, maroon, gray and tan weathered shale. Piles should be driven to practical refusal unless otherwise directed by the Engineer. All steel piles should be fitted with rock points.

Nominal single pile capacity curves are provided for steel HP12x53 and HP14x73 piles in Attachments 7 and 8, respectively, for each bent. Bearing capacities of piles driven to refusal must be determined for the structural section using the AASHTO Load and Resistance Factor

Design (LRFD) structural design procedure. Pile capacity above the refusal elevation will be based on the geotechnical capacity of the pile. The capacity curves shown in Attachments 7 and 8 show the geotechnical pile capacity to the anticipated depth of refusal. The geotechnical capacity includes nominal capacity for both compression and uplift. No information has been provided on anticipated scour depth for piling. Consequently, the upper 10 to 15 ft of pile embedment has been neglected in developing the capacity curves for geotechnical pile capacity. At the anticipated refusal depth, the structural capacity is indicated. At the depth of pile refusal, pile capacity should be taken as the structural capacity of the pile section.

For the structural capacity, we recommend that nominal resistance (P_n) of steel piles be determined based on the yield strength of steel H piles (f_y) and the net end area (A_{net}) of the section. Given that the piles will be driven to refusal in hard rock with the potential for driving damage, we recommend a maximum allowable stress (σ_{all}) of 0.25 f_y. An effective resistance factor (φ_b) of 0.50 is recommended for end bearing piles. This effective resistance factor for steel piles has been based on the assumption of difficult driving.

It has been our experience that allowable pile capacities of 96 tons for HP12x53 piles and 133 tons for HP14x73 piles are common for f_y 50 ksi steel. These capacities are based on allowable stress design (ASD). However, the appropriate factored bearing capacity must be determined by the Engineer.

Post-construction settlement of piles driven to refusal will be negligible. The preliminary layout indicates that piles at the bridge ends will extend through 1 to 9 ft of new embankment fill. Given an anticipated construction sequence with embankment fill placement in excess of 30 days prior to pile driving, and the predominantly granular overburden soils, downdrag loads on piles are expected to be negligible. Where pile foundation design is based on geotechnical capacity, piles should have a minimum spacing of three (3) pile widths to limit capacity reductions due to group effects. Point bearing piles bearing on rock will not require a group reduction.

Preboring is not expected to be required for pile installation. However, some cobbles or boulders could be encountered in the overburden soils that would mandate preboring in some instances. In the event that preboring is required to advance piles through obstructions, we recommend the prebore diameter should be large enough to prevent pile damage during driving. We also recommend that the prebore annulus around piles be backfilled with grout, lean concrete, or an approved alternate.

Battered piles may be utilized to resist lateral loads. The geotechnical axial capacity of battered piles may be taken as equivalent to that of a vertical pile with the same tip elevation and embedment. Special driving equipment is typically required where pile batter exceeds about 1-horizontal to 4-vertical.

Estimated pile tip elevations for steel pipes at bridge ends, as based on the results of the borings, are summarized in the table below.

Estimated Tip Elevations of Steel Piles Driven to Refusal

Bent No.	Estimated Pile Tip Elevation, ft
Bent 1	316
Bent 2	311
Bent 3	309
Bent 4	309
Bent 5	307
Bent 6	307

It should be noted that the tip elevations shown in the tables above are estimates only based on the results of the borings and the inferred surface elevations at the particular locations. Pile capacity and as-built depth must be field verified.

End Slope Stability – Bents 1 and 6

The replacement bridge will have simple slopes at the abutment embankments. The new bridge end embankment on the west side of the river (Bent 1) has a plan nominal 2.5-horizontal to 1-vertical (2.5H:1V) slope configuration and a maximum height on the order of 20 feet. The east bridge end (Bent 6) embankment configuration is planned at 3.1H:1V with a maximum height of about 8 ft above existing grade.

To evaluate suitability of the plan configurations, slope stability analyses have been performed. A 250 lbs per sq ft uniform surcharge from vehicles was included for the purposes of stability analyses. Stability analyses were performed using the computer program SLOPE/W 2007[3] and a Morgenstern-Price analysis. For the embankment slopes, four (4) general loading conditions were evaluated, i.e., End of Construction, Long Term, Rapid Drawdown, and Seismic Conditions. For analysis of the seismic condition, a horizontal seismic acceleration coefficient (k_h) of one-half the peak acceleration (A_s) was used, a value of 0.044. For evaluating the rapid drawdown condition, a water surface elevation drop from El 374 to channel bottom grade was

[3] Slope/W 2007; GEO-SLOPE International; 2008.

assumed. The sections used for the analyses are shown in the graphical results provided in Attachment 9.

The results of the stability analyses of the end slopes are summarized in the tables below.

Stability Analysis Results – Bent 1, 2.5H:1V, H = 20 ft

Design Load Condition	Calculated Minimum Factor of Safety
End of Construction	3.0
Long Term	2.8
Rapid Drawdown from El 374 to EI 358	2.0
Seismic ($k_h = A_s/2 = 0.044$)	2.6

Stability Analysis Results – Bent 6, 3.1H:1V, H = 8 ft

Design Load Condition	Calculated Minimum Factor of Safety
End of Construction	3.4
Long Term	2.8
Rapid Drawdown from El 374 to Existing Grade	2.7
Seismic ($k_h = A_s/2 = 0.044$)	3.0

The results of the stability analyses indicate that stability of the end slope configurations is acceptable with respect to all loading conditions evaluated. Consequently, it is our conclusion that the plan end slope configurations are suitable with respect to slope stability.

The toes of embankment slopes should be protected from scour. Typically dumped riprap is adequate for slope scour protection. Where the new embankments are constructed of granular soils, the face of slopes should be armored with the low-plasticity soils, i.e., with a plasticity index between 5 and 18, to limit surface erosion and skin slides

Subgrade Support

Based on the results of the borings and laboratory tests, the on-site subgrade soils are expected to be comprised primarily of embankment fill which includes A-1-a, A-1-b, and A-2-4 soils as per AASHTO classification. These classifications correlate with excellent to good subgrade support. Locally available borrow for use as unclassified embankment fill may not compare with these classifications, and could provide lower subgrade support parameters.

The as-built pavement subgrade should be evaluated by the Engineer. Areas of unstable or otherwise unsuitable subgrade should be improved by undercut and replacement or treatment with additives approved by the Engineer.

Based on the results of the borings and laboratory CBR tests and correlation with the AASHTO classification of the anticipated subgrade soils, subgrade support is expected to be poor. The following parameters are recommended for use in pavement design for a subgrade of the on-site sandy gravel. These values have been reduced for environmental factors.

On-site sandy gravel subgrade (A-1-a, A-1-b, and A-2-4)

- Resilient Modulus (M_R): 6200 lbs per sq inch
- R value: 30

In the event that the subgrade will be unclassified embankment fill, AASHTO classifications of A-4 and A-6 could be obtained. We recommend that any soils classifying as A-7-6 and soils with a plasticity index (PI) in excess of 18 be excluded from use as subgrade within 18 in. of the plan subgrade elevation. The top 18 in. of subgrade soils should have a maximum plasticity index (PI) of 18. For unclassified embankment fill subgrade, we recommend the following parameters for use in pavement design.

Unclassified Borrow Embankment Fill (A-4 or A-6)

- Resilient Modulus (M_R): 3100 lbs per sq inch
- R value: 10

Site Grading and Subgrade Preparation

Site grading/site preparation in the bridge alignment should include necessary clearing and grubbing of trees and underbrush and stripping the organic-containing surface soils in work areas. Where fill depths in excess of 3 ft are planned, stumps may be left after close cutting trees to grade, as per ARDOT criteria. Otherwise, tree stumps must be completely excavated and stumpholes properly backfilled.

The depth of stripping will be variable, with deeper stripping depths in wooded areas, and less stripping required in the areas of higher terrain. In general, the stripping depth is estimated to be about 6 to 9 in. in cleared areas, but may be 18 to 24 in. or more in the localized wooded areas and areas with thick underbrush. The zone of organic surface soils should be completely stripped in the embankment footprint areas and at least 5 ft beyond the projected embankment toe.

Where existing pavements are to be demolished, consideration may be given to utilizing the processed asphalt concrete and aggregate base for embankment fill. In this case, the demolished materials should be thoroughly blended and processed to a reasonably well-graded mixture with a maximum particle size of 2 in. as per Standard Specifications for Highway Construction, 2014 Edition, Section 212. If abandoned pavements are within 3 ft of the plan

subgrade elevation, the existing pavement surface should be scarified to a minimum depth of 6 inches. The scarified material should be recompacted to a stable condition.

Following required pavement demolition, clearing and grubbing, and stripping, and prior to fill placement or otherwise continuing with subgrade preparation, the extent of weak and unsuitable soils should be determined. Thorough proof-rolling should be performed to verify subgrade stability. Proof-rolling should be performed with a loaded tandem-wheel dump truck or similar equipment. Unstable soils exhibiting a tendency to rut and/or pump should be undercut and replaced with suitable fill. Care should be taken that undercuts, stump holes, and other excavations or low areas resulting from subgrade preparation are properly backfilled with compacted fill. Based on the results of the borings, localized undercutting could be required to develop subgrade stability. Potential undercut depths are estimated to be on the order of 1 ft, more or less.

In areas of deep fills, the potential exists for use of thick initial lifts ("bridging"), as per ARDOT criteria. Bridge lifts will be subject to some consolidation. Settlement of a primarily granular fill suitable for use in bridging would be expected to be relatively rapid and long-term post-construction settlement would not be expected to be a significant concern. Where clayey soils are placed in thick lifts, long term settlement will be more significant. Consequently, we recommend that the use of "bridging" techniques be limited to granular borrow soils, i.e., sand or gravel. Where fill amounts are limited to less than about 3 ft, bridging will be less effective and the potential for undercut or stabilization will increase. Use of bridging techniques and fill lift thickness must be specifically approved by the Engineer or Department.

Subgrade preparation and mass undercuts should extend at least 10 ft beyond the embankment toes to the extent possible. Subgrade preparation in roadway areas should extend at least 3 ft outside pavement shoulder edges to the extent possible. The existing drainage features should be completely mucked out and all loose and/or organic soils removed prior to fill placement.

Fill and backfill may consist of unclassified borrow free of organics and other deleterious materials as per Standard Specifications for Highway Construction, 2014 Edition, Subsection 210.06. Granular soils must be protected from erosion with a minimum 18-in.-thick armor of clayey soil. The on-site silty clay and sandy clay are typically suitable for this use.

Subgrade preparation should comply with Standard Specifications for Highway Construction, 2014 Edition, Section 212. Embankments should be constructed in accordance with

Standard Specifications for Highway Construction, 2014 Edition, Section 210. Fill and backfill should be placed in nominal 6- to 10-in.-thick loose lifts. All fill and backfill must be placed in horizontal lifts. Where fill is placed against existing slopes, short vertical cuts should be "notched" in the existing slope face to facilitate bonding of horizontal fill lifts. The in-place density and water content should be determined for each lift and should be tested to verify compliance with the specified density and water content prior to placement of subsequent lifts.

CONSTRUCTION CONSIDERATIONS

Groundwater and Seepage Control

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

Subgrade soils or foundation strata that become saturated by ponding water or runoff should be excavated to undisturbed soil. The embankment subgrade should be evaluated by the Engineer during subgrade preparation.

Shallow perched groundwater could be encountered in the near-surface soils. The volume of groundwater produced can be highly variable depending on the condition of the soils in the immediate vicinity of the excavation. In addition, seasonal surface seeps or springs could develop.

Seepage into excavations and cuts can typically be controlled by ditching or sump-and-pump methods. If seepage into excavations becomes a problem, backfill should consist of select granular backfill (AASHTO M43, No. 57), stone backfill (Standard Specifications for Highway Construction, 2014 Edition, Section 207), or clean aggregate (Standard Specifications for Highway Construction, 2014 Edition, Subsections 403.01 and 403.02 Class 3 mineral aggregate) up to an elevation above the inflow of seepage. In areas of seepage infiltration, the granular fill should be encapsulated with a filter fabric complying with Standard Specifications for Highway Construction, 2014 Edition, Subsection 625.02, Type 2 and vented to positive discharge. Where surface seeps or springs are encountered during site grading, we recommend the seepage be directed via French drains or blanket drains to positive discharge at daylight or to storm drainage lines.

Piling

Piles should be installed in compliance with Standard Specifications for Highway Construction, 2014 Edition, Section 805. Pre-boring to achieve the minimum pile length is not generally anticipated, but could be warranted where large rock fragments are encountered. Based on local experience, we recommend a hammer system capable of delivering at least 22,000 per blow for the steel piles at the bridge ends and interior bents. A specific review and analysis of the pile-hammer system proposed by the Contractor should be performed by the Engineer or Department prior to hammer acceptance and start of pile installation.

The density of the predominantly granular overburden soils increases with depth. As a result, difficult driving could be experienced. Use of a higher energy hammer could be warranted. Installing piles using a vibratory hammer or jetting could also be required. Use of vibrating or jetting for pile installation should be approved by the Engineer or Department. If piles are installed by jetting, the geotechnical capacity of piles should be re-evaluated if these values are utilized in design.

Where piles are advanced by approved vibrating or jetting, we recommend that the final 5 ft of penetration, or driving to refusal, be achieved with an impact hammer. Blow counts on steel piles should be limited to about 20 blows per inch. We recommend that practical pile refusal be defined as a penetration of 0.5 in. or less for the final 10 blows.

As a minimum, safe bearing capacity of production piles should be determined by Standard Specifications for Highway Construction, 2014 Edition, Section 805.09, Method A. Driving records should be available for review by the Engineer during pile installation. Piles should be carefully examined prior to driving and piles with structural defects should be rejected. Any splices in steel piles should develop the full cross-sectional capacity of un-spliced piles. Pile installation should be monitored by qualified personnel to maintain specific and complete driving records and to observe pile installation procedures. Blow counts on steel piles should be limited to about 20 blows per inch. We recommend that practical pile refusal be defined as a penetration of 0.5 in. or less for the final 10 blows.

CLOSURE

The Engineer or Department or a designated representative thereof should monitor site preparation, grading work and foundation and pavement construction. Subsurface conditions significantly at variance with those encountered in the borings and test pits should be brought to

the attention of the Geotechnical Engineer. The conclusions and recommendations of this report should then be reviewed in light of the new information.

The following illustrations are attached and complete this report.

Attachment 1	Preliminary Bridge Layout
Attachment 2	Site Vicinity Map, Plans of Borings, Summary of Subsurface Exploration, Keys to Terms and Symbols
Attachment 3	Structure Boring Logs
Attachment 4	Pavement Boring Logs
Attachment 5	Classification Test Results
Attachment 6	Subgrade Test Results
Attachment 7	Nominal Single Pile Capacity Curves – HP12x53
Attachment 8	Nominal Single Pile Capacity Curves – HP14x73
Attachment 9	End Slope Stability Analyses Results

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

Sincerely,

GRUBBS, HOSKYN,
BARTON &WYATT, INC.

Ben Davis, E.I.
Staff Engineer

Mark E. Wyatt, P.E.
President

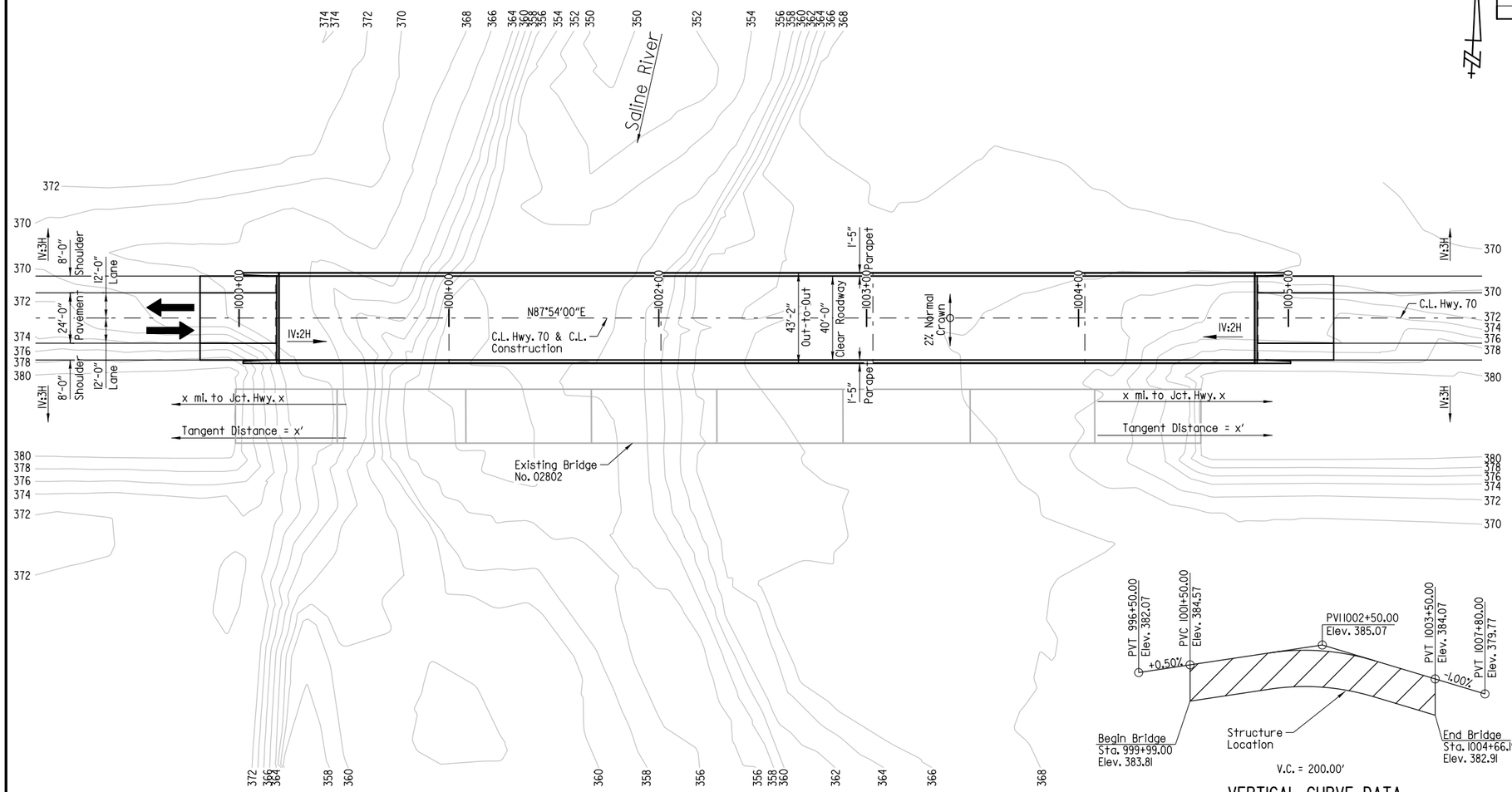
STATE OF ARKANSAS
REGISTERED PROFESSIONAL ENGINEER
No. 7791
MARK E. WYATT

BJD/MEW:jw

Copies Submitted: Michael Baker International
Attn: Mr. Scott P. Thornsberry, P.E. (1-email)

ATTACHMENT 1

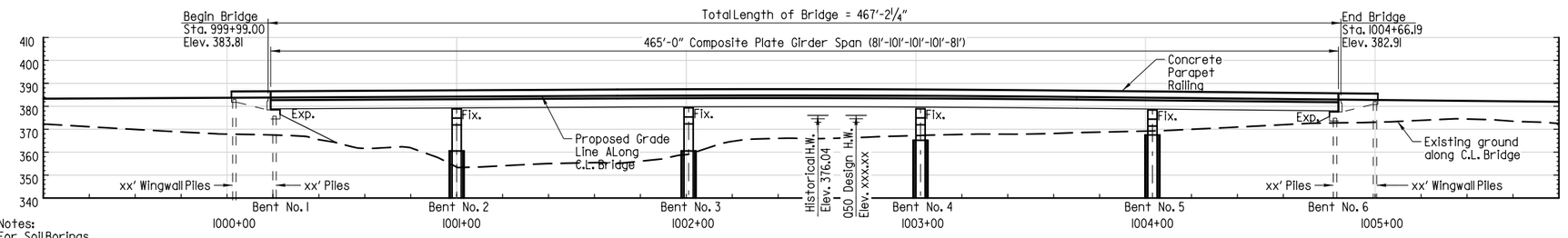
For R/W Data and Guard Rail Details, See Roadway Plans.



PLAN

VERTICAL CURVE DATA

(Stations and Elevations are along C.L. Bridge)



ELEVATION

Notes:
For Soil Borings
See Dwg. No. xxxxx.

Stations and Elevations Shown are along C.L. Bridge.
Elevations Shown are at Working Point.

[1] Measured to Working Point.
See "Rounding Detail" on
Dwg. No. xxxxx.

Note:
Use Type CI Approach Slab
("w" = 24'-0") and Type C Approach
Gutters ("w" = 8'-0") at both ends of
bridge, See Std. Dwg. Nos. 55040CI
and 55030C.

DATE	DATE FILMED	DATE REVISED	DATE FILMED

FED.RD. DIST.NO.	STATE	FED.AID PROJ.NO.	SHEET NO.	TOTAL SHEETS
3	ARK.			
JOB NO.		030501	$PAGE$	$TOTAL$

XXXXX - LAYOUT - XXXXX

GENERAL NOTES

BENCH MARK: Vertical Control Data are shown on the Survey Control Data Sheets.

CONSTRUCTION SPECIFICATIONS: Arkansas State Highway and Transportation Department Standard Specifications for Highway Construction (2014 Edition) with applicable Supplemental Specifications and Special Provisions. Unless otherwise noted, Section and Subsection refer to the Standard Construction Specifications.

DESIGN SPECIFICATIONS: AASHTO LRFD Bridge Design Specifications, Sixth Edition (2012) with current Interim Specifications.

LIVE LOADING: HL-93

SEISMIC ZONE: x SDI =0.xx SITE CLASS = x

MATERIALS AND STRENGTHS:

Class S(AE) Concrete (superstructure)	f'c = 4,000 psi
Class S Concrete (substructure)	f'c = 3,500 psi
Reinforcing Steel (AASHTO M 31 or M 322, Type A, Gr, 60)	fy = 60,000 psi
Structural Steel (AASHTO M 270, Gr. HPS 70W)	Fy = 70,000 psi
Structural Steel (AASHTO M 270, Gr. 50)	Fy = 50,000 psi
Structural Steel (AASHTO M 270, Gr. 36)	Fy = 36,000 psi

BORING LOGS: Boring logs may be obtained from the Construction Contract Procurement Section of the Program Management Division.

PILING:

TEXTURED COATING FINISH: Class 3 Textured Coating Finish shall be applied to bridge surfaces as specified in Special Provision Job No. 100942 "Textured Coating Finish" and in accordance with Subsection 802.19(b)(3). Class 1 Protective Surface Treatment shall not be applied on surfaces where Class 3 Textured Coating Finish is specified.

BRIDGE DECK: The concrete bridge deck shall be given a tine finish as specified for final finishing in Subsection 802.19 for Class S Tined Bridge Roadway Surface Finish. Shared Use Path shall be given a Class 6 Broomed Finish.

PROTECTIVE SURFACE TREATMENT: Class 1 Protective Surface Treatment shall be applied to the roadway surface and top of end bent backwalls. Class 1 Protective Surface Treatment shall meet the requirements of Section 803.

PAINT: All Structural Steel except galvanized members and some surfaces in contact with concrete shall be cleaned in accordance with Subsection 807.84(b) and painted as specified in Subsection 807.75. Unless noted otherwise the color of the paint shall be Red and shall match Federal Standard 595B, Color Chip No. 31350. The color of the Steel Fence, Posts, and Type H-2 Metal Rail shall be Black and shall match Fed. Std. 595B Color Chip No. 27038.

DETAIL DRAWINGS	DRAWING NOS.
End Bents	XXXXX-XXXXX
465'-0" Cont. Comp. Plate Girder Span	XXXXX-XXXXX
Poured Silicone Joint	XXXXX-XXXXX
Elastomeric Bearings	XXXXX
Standard General Notes	XXXXX

FLOOD DESCRIPTION	FREQUENCY	DISCHARGE	[1] NATURAL WATER SURFACE ELEVATION	WATER SURFACE ELEV. WITH BACKWATER
	YEARS	CFS	FEET	FEET
Design	50	25400	373.33	373.62
Base	100	29500	374.28	374.46
Extreme	500	40200	375.38	376.38
Overtopping	>500	>500	>500	>500

[1] Unconstricted water surface without structure or roadway approaches.

Q100 backwater elevation for existing structure = 374.48 feet.

Proposed Low Bridge Chord Elevation = 578.00 feet.

Drainage area = 120 square miles.

Historical H.W. Elev. = 376.04 Feet (from USGS stream gage 07341000 on May 13, 1968 with a Stream-flow of 59,200 cfs)

PRELIMINARY
SUBJECT TO REVISION

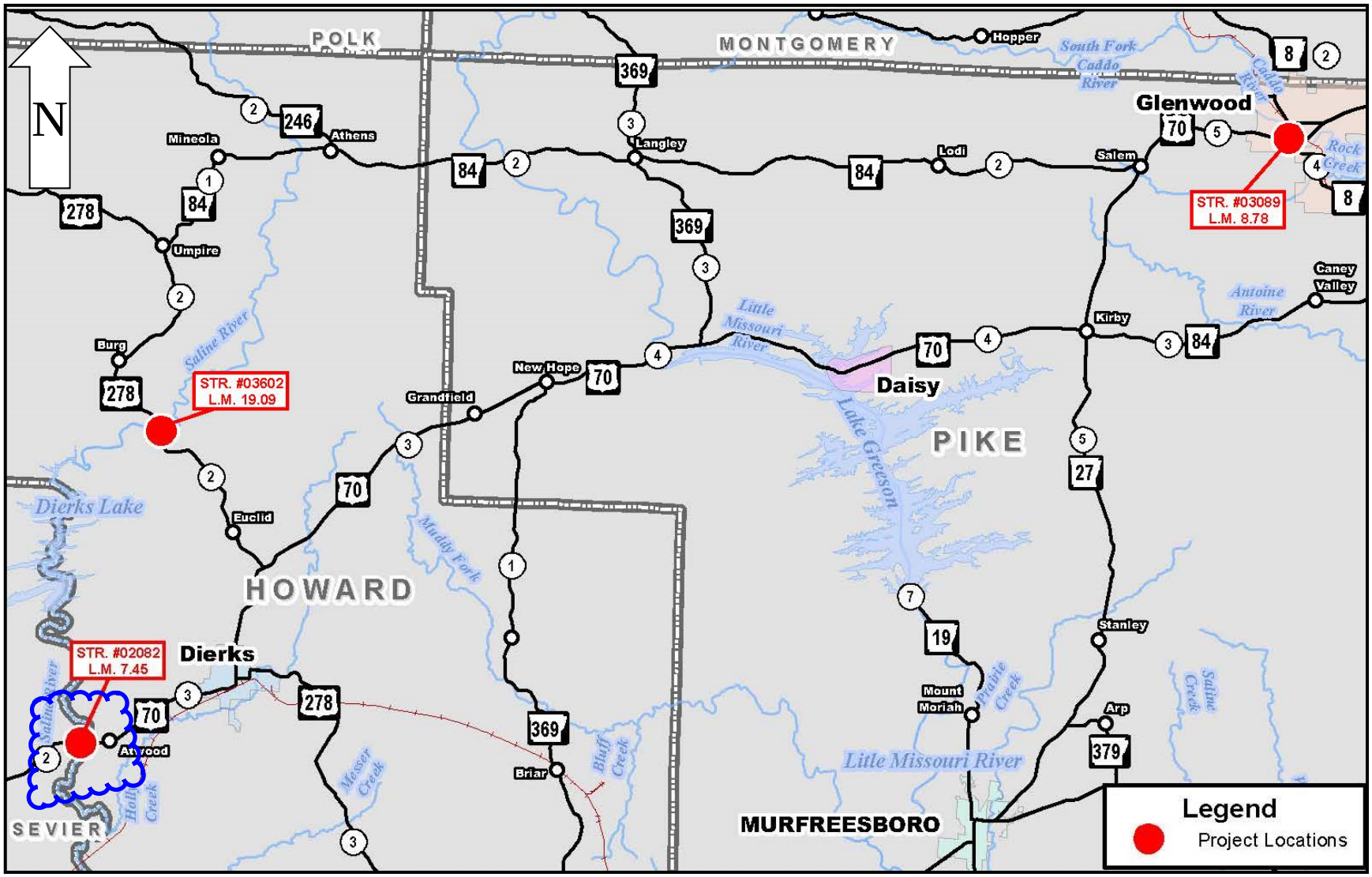
BRIDGE ENGINEER
PRINT DATE: 6/13/2018

SHEET 1 OF X
LAYOUT OF BRIDGE OVER SALINE RIVER
SALINE AND CADDO RIVERS
STRS. & APPRS. (S)
SEVIER AND HOWARD COUNTIES
ROUTE 70 SECTION 2
ARKANSAS STATE HIGHWAY COMMISSION
LITTLE ROCK, ARKANSAS

DRAWN BY: JPC DATE: 03/2018 FILENAME: B030501XL_LXI.dgn
CHECKED BY: xxx DATE: xx/xx/xxxx
DESIGNED BY: xxx DATE: xx/xx/xxxx SCALE: 1" = 30'
BRIDGE NO. xxxxx DRAWING NO. xxx

Justin.carney 6/13/2018 11:10:33 AM
WORKSPACE: AHTD_Bridge
Y:\Projects\ArDOT_166131_030501_Caddo & Saline River Bridges\Design\BRIDGE\Drawings\B030501XL_LXI.dgn
REVISED DATE:

ATTACHMENT 2

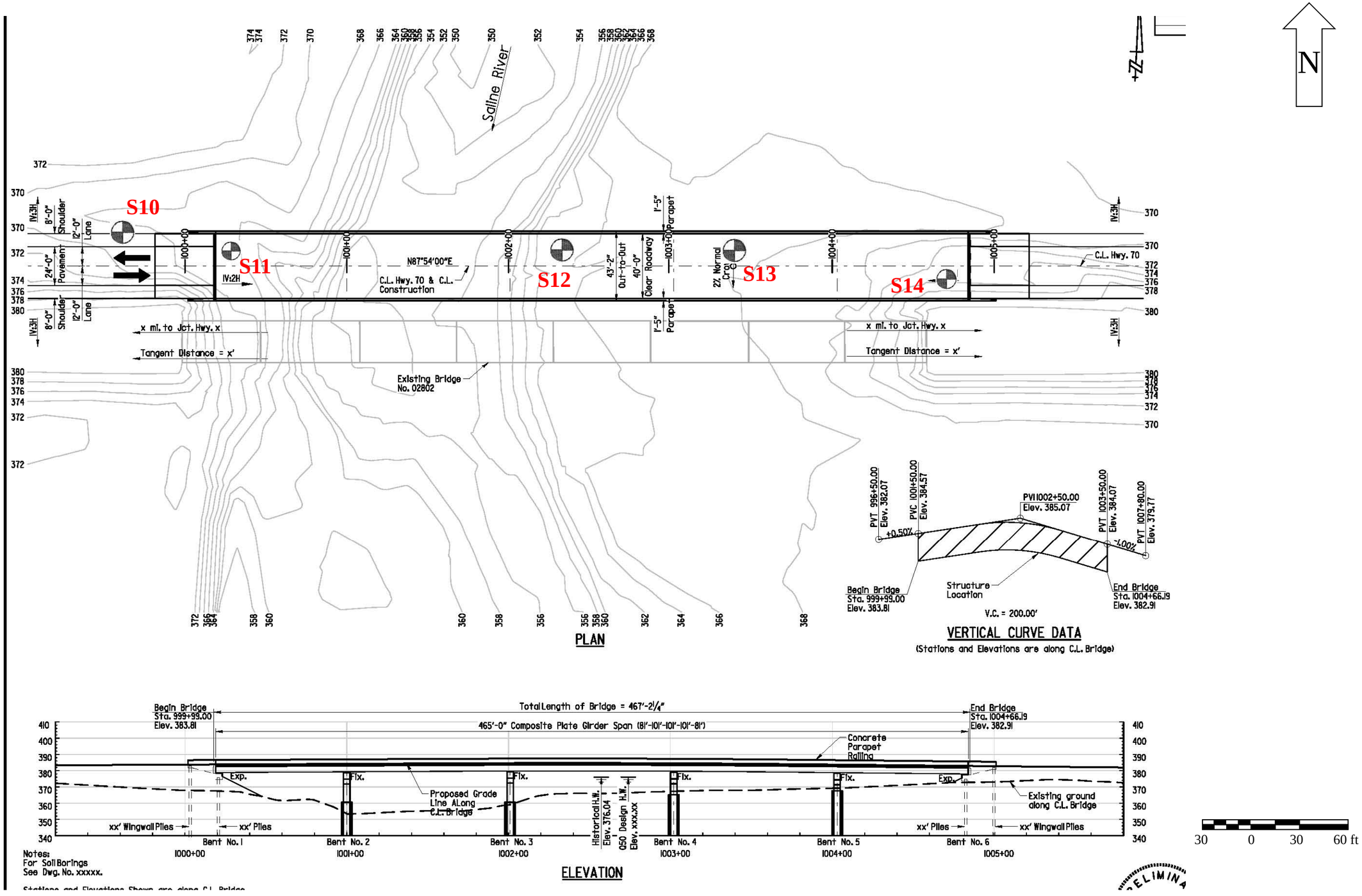


Grubbs, Hoskyn, Barton & Wyatt, INC.
CONSULTING ENGINEERS

Site Vicinity Map
ARDOT 030501
Sevier and Howard County, Arkansas

Job No. 18-040

Plate 1



Grubbs, Hoskyn, Barton & Wyatt, INC. CONSULTING ENGINEERS	**PLAN OF BORINGS** **ARDOT 030501 – BRIDGE 02082 OVER SALINE RIVER** **HOWARD COUNTY, ARKANSAS**	**Scale: As shown**	**Job No. 18-040**	**PLATE 2A**

Grubbs, Hoskyn, Barton & Wyatt, INC.
CONSULTING ENGINEERS

PLAN OF BORINGS

ARDOT 030501 Bridge 02082 over Saline River
Howard County, Arkansas

Scale: N.T.S.

Job No. 18-040

Plate 2B

SUMMARY of SUBSURFACE EXPLORATION

PROJECT: ArDOT 030501 - Bridge 02062

LOCATION: Atwood, Howard County, Arkansas

GHBW JOB No.: 18-040

Boring No.	Station Reference	Approx Sta	Approx Offset, ft	Approx Surf El, ft	Completion Depth, ft
S10	Hwy 70	999+75	CL	379	75
S11	Hwy 70	1000+48	15 Lt	364	75
S12	Hwy 70	1002+45	7 Rt	362	75
S13	Hwy 70	1003+75	CL	365	75
S14	Hwy 70	1005+28	9 Rt	368	75
P9	±565 West of Bridge End			380	7
P10	±150 West of Bridge End			380	7
P11	±180 East of Bridge End			380	10
P12	±815 East of Bridge End			380	10

Grubbs, Hoskyn, Barton & Wyatt, Inc.
Consulting Engineers

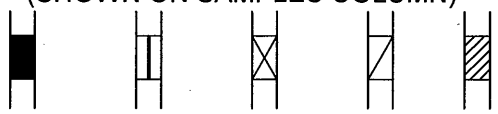
SYMBOLS AND TERMS USED ON BORING LOGS

SOIL TYPES
(SHOWN IN SYMBOLS COLUMN)

Gravel Sand Silt Clay

Predominant type shown heavy

SAMPLER TYPES
(SHOWN ON SAMPLES COLUMN)



Shelby Tube | Rock Core | Split Spoon | No Recovery | Cutting

TERMS DESCRIBING CONSISTENCY OR CONDITION

COARSE GRAINED SOILS (major portion retained on No. 200 sieve): Includes (I) Clean gravels and sands, and (2) silty or clayey gravels and sands. Condition is rated according to relative density, as determined by laboratory tests.

DESCRIPTIVE TERM	N-VALUE	RELATIVE DENSITY
VERY LOOSE	0-4	0-15%
LOOSE	4-10	15-35%
MEDIUM DENSE	10-30	35-65%
DENSE	30-50	65-85%
VERY DENSE	50 and above	85-100%

FINE GRAINED SOILS (major portion passing No. 200 sieve): Includes (1) Inorganic and organic silts and clays, (2) gravelly, sandy, or silty clays, and (3) clayey silts. Consistency is rated according to shearing strength, as indicated by penetrometer readings or by unconfined compression tests.

DESCRIPTIVE TERM	UNCONFINED COMPRESSIVE STRENGTH TON/SQ. FT.
VERY SOFT	Less than 0.25
SOFT	0.25-0.50
FIRM	0.50-1.00
STIFF	1.00-2.00
VERY STIFF	2.00-4.00
HARD	4.00 and higher

NOTE: Slickensided and fissured clays may have lower unconfined compressive strengths than shown above, because of planes of weakness or cracks in the soil. The consistency ratings of such soils are based on penetrometer readings.

TERMS CHARACTERIZING SOIL STRUCTURE

SLICKENSIDED - having inclined planes of weakness that are slick and glossy in appearance.
FISSURED - containing shrinkage cracks, frequently filled with fine sand or silt; usually more or less vertical.
LAMINATED - composed of thin layers of varying color and texture.
INTERBEDDED - composed of alternate layers of different soil types.
CALCAREOUS - containing appreciable quantities of calcium carbonate.
WELL GRADED - having a wide range in grain sizes and substantial amounts of all intermediate particle sizes.
POORLY GRADED - predominantly of one grain size, or having a range of sizes with some intermediate sizes missing.

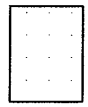
Terms used on this report for describing soils according to their texture or grain size distribution are in accordance with the UNIFIED SOIL CLASSIFICATION SYSTEM, as described in Technical Memorandum No.3-357, Waterways Experiment Station, March 1953

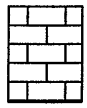
KEY 7-28-11

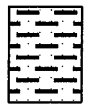
Grubbs, Hoskyn, Barton & Wyatt, Inc.
Consulting Engineers

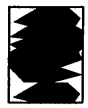
BORING LOG TERMS – ROCK

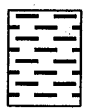
ROCK TYPES
(SHOWN IN SYMBOLS COLUMN)


Sandstone


Limestone


Siltstone


Coal


Shale

Joint Characteristics – Spacing
- Very Wide
- Wide
- Moderately Close
- Close
- Very Close

Bedding Characteristics –
- Very Thin
- Thin
- Medium
- Thick
- Massive

Lithologic Characteristics –
- Clayey
- Shaly
- Calcareous (limy)
- Siliceous
- Sandy
- Silty
- Plastic Seams

Seam – 1/6 to 1/2 inch
Layer – 1/2 to 12 inches
Stratum – Greater than 12 inches

Hardness and Degree of Cementation –

	Approximate Range of Uniaxial Compressive Strength (psi)
Very Soft – Can be peeled with a knife	140 – 3500
Soft – Can just be scraped with knife	3500 – 6900
Hard – Can be broken with single moderate blow with pick	6900 – 13,900
Very hard – Hand held specimen breaks with hammer end of pick under more than one blow	13,900 – 28,000
Extremely Hard – Many blows with hammer required to break intact specimen	More than 28,000

- Poorly Cemented
- Cemented

Texture –
- Dense
- Fine
- Medium
- Coarse

Structure –
- Bedding
  - Flat
  - Gently Dipping
  - Steeply Dipping
- Fractures, scattered
  - Open
  - Cemented or Tight
- Fractures, closely spaced
  - Open
  - Cemented or Tight
- Brecciated (Sheared and Fragmented)
  - Open
  - Cemented or Tight
- Joints
- Faulted
- Slickensides

Degree of Weathering –

Fresh – No visible signs of decomposition or discoloration. Rings under hammer impact.

Slighty Weathered – Slight discoloration inwards from open fractures, otherwise similar to fresh.

Moderately Weathered – Discoloration throughout. Weaker minerals such as feldspar decomposed. Strength somewhat less than fresh rock, but cores cannot be broken by hand or scraped by knife. Texture preserved.

Highly Weathered – Most minerals somewhat decomposed. Specimens can be broken by hand with effort or shaved with knife. Core stones present in rock mass. Texture becoming indistinct but fabric preserved.

Completely Weathered – Minerals decomposed to soil but fabric and structure preserved (Saprolite). Specimens easily crumbled or penetrated.

Residual Soil – Advanced state of decomposition resulting in plastic soils. Rock fabric and structure completely destroyed. Large volume change.

Solution and Void Conditions –
- Solid, contains no voids
- Vuggy (pitted)
- Vesicular (igneous)
- Porous
- Cavities
- Cavernous

Swelling Properties –
- Nonswelling
- Swelling

Slaking Properties –
- Nonslaking
- Slakes slowly on exposure
- Slakes readily on exposure

Rock Quality Designation (RQD) –

RQD (Percent)	Diagnostic Description
Greater than 90	Excellent
75 – 90	Good
50 – 75	Fair
25 – 50	Poor
Less than 25	Very Poor

KEYROCK 5-22-07

ATTACHMENT 3

Grubbs, Hoskyn, Barton & Wyatt, Inc.
Consulting Engineers

LOG OF BORING NO. S10

ARDOT 030501 - Bridge 02082 over Saline River
Howard County, Arkansas

TYPE: Auger to 20 ft /Wash

LOCATION: Bridge, Approx Sta 999+60, 19 ft Lt

SURF. EL: 368.8±

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	COHESION, TON/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) / PLASTIC LIMIT / WATER CONTENT / LIQUID LIMIT (10 20 30 40 50 60 70)	- No. 200 %
0			Loose to medium dense reddish tan and tan clayey fine to coarse gravel w/silt and fine to coarse sand (fill)	7			
				50/8"			8
5				50/10"			
			- water at 6 ft	25/0"			
			Dense to very dense reddish tan and tan sandy fine to coarse gravel w/some cobbles	25/0"			
10							
				25/0"			2
15							
				25/0"			
20							
			- slightly silty at 23 to 28 ft	50/10"			7
25							
				25/0"			
30							
				50/2"			
35							
				50/3"			
40							
				25/0"			

COMPLETION DEPTH: 75.0 ft
DATE: 4-30-18

DEPTH TO WATER IN BORING: 6 ft

DATE: 4/30/2018

LGBNEW 18-040_BRIDGE 02082.GPJ 12-7-18

18-040

Grubbs, Hoskyn, Barton & Wyatt, Inc.
Consulting Engineers

LOG OF BORING NO. S10

ARDOT 030501 - Bridge 02082 over Saline River
Howard County, Arkansas

TYPE: Auger to 20 ft /Wash

LOCATION: Bridge, Approx Sta 999+60, 19 ft Lt

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	COHESION, TON/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) / PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT (10 20 30 40 50 60 70)	- No. 200 %
			(continued)				
50				25/0"			
			Dense to very dense gray silt, slightly sandy w/a little fine gravel	50/6"			88
55							
			Moderately hard maroon, tan and gray weathered shale, apparent dip ±80° w/ferrous stains and occasional silty clay laminations	50/8"			
60							
				70/4"			
65							
			- maroon and tan below 68 ft	70/5"			
70							
75				70/3"			
80							
85							

COMPLETION DEPTH: 75.0 ft
DATE: 4-30-18

DEPTH TO WATER IN BORING: 6 ft

DATE: 4/30/2018

LGBNEW 18-040_BRIDGE 02082.GPJ 12-7-18

PLATE 2

Grubbs, Hoskyn, Barton & Wyatt, Inc.
Consulting Engineers

LOG OF BORING NO. S11

ARDOT 030501 - Bridge 02082 over Saline River
Howard County, Arkansas

TYPE: Auger to 20 ft /Wash

LOCATION: Bridge, Approx Sta 1000+25, 7 ft Lt

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	COHESION, TON/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) / PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT (10 20 30 40 50 60 70)	- No. 200 %
			SURF. EL: 367.3±				
			Medium dense reddish tan silty fine sand w/occasional clay pockets (fill)	12			
			Loose tan clayey fine sand (fill)	6			
5			Dense crushed sandstone fragments w/fine sand (fill)	50/10"			
			Medium dense brown silty fine to coarse gravel, sandy - water at 6 ft	25/0"			14
10				27			
			- with some cobbles below 13 ft	25/0"			
15							
			Very stiff to hard bluish gray fine sandy clay, silty	50/5"			70
20							
			- with a little fine to coarse gravel and occasional organic inclusions below 23 ft	50/6"			
25							
			Dense to very dense brown sandy fine to coarse gravel	25/0"			3
30							
				50/5"			
35							
				50/5"			
40			Dense to very dense bluish gray silty fine gravel, sandy	50/3"			15

COMPLETION DEPTH: 75.0 ft
DATE: 4-26-18

DEPTH TO WATER IN BORING: 6 ft

DATE: 4/26/2018

LGBNEW 18-040_BRIDGE 02082.GPJ 12-7-18

PLATE 3

Grubbs, Hoskyn, Barton & Wyatt, Inc.
Consulting Engineers

LOG OF BORING NO. S11

ARDOT 030501 - Bridge 02082 over Saline River
Howard County, Arkansas

TYPE: Auger to 20 ft /Wash

LOCATION: Bridge, Approx Sta 1000+25, 7 ft Lt

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	COHESION, TON/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) / PLASTIC LIMIT / WATER CONTENT / LIQUID LIMIT (10 20 30 40 50 60 70)	- No. 200 %
			(continued)				
				50/4"			
50			Moderately hard to hard yellowish brown, tan and gray weathered shale, steeply bedded				
				25/0"		●	
55							
				25/0"			
60							
				25/0"		+ +	
65							
				25/0"			
70							
				25/0"			
75							
80							
85							

COMPLETION DEPTH: 75.0 ft
DATE: 4-26-18

DEPTH TO WATER IN BORING: 6 ft

DATE: 4/26/2018

LGBNEW 18-040_BRIDGE 02082.GPJ 12-7-18

Grubbs, Hoskyn, Barton & Wyatt, Inc.
Consulting Engineers

LOG OF BORING NO. S12

ARDOT 030501 - Bridge 02082 over Saline River
Howard County, Arkansas

TYPE: Auger to 46 ft /Wash

LOCATION: Bridge, Approx Sta 1002+32, 12 ft Lt

SURF. EL: 365.7±

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	COHESION, TON/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) / PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT (10 20 30 40 50 60 70)	- No. 200 %
			Medium dense dark brown silty fine sand (possible fill)	12			
			- loose below 2 ft	7		-NON-PLASTIC-	47
5			- water at 4 ft	6			
			Soft brown and gray fine sandy clay, silty	6			51
10			Dense brown silty fine to medium sand w/trace fine to coarse gravel	30			22
15				50/8"			
20				25/0"			
25				25/0"			24
30				25/0"			
35			Dense reddish tan and tan medium to coarse sand w/a little fine gravel	25/0"			3
40				25/0"			
				25/0"			

COMPLETION DEPTH: 75.0 ft
DATE: 5-1-18

DEPTH TO WATER IN BORING: 4 ft

DATE: 5/1/2018

LGBNEW 18-040_BRIDGE 02082.GPJ 12-7-18

Grubbs, Hoskyn, Barton & Wyatt, Inc.
Consulting Engineers

LOG OF BORING NO. S12

ARDOT 030501 - Bridge 02082 over Saline River
Howard County, Arkansas

TYPE: Auger to 46 ft /Wash

LOCATION: Bridge, Approx Sta 1002+32, 12 ft Lt

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	COHESION, TON/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) / PLASTIC LIMIT / WATER CONTENT / LIQUID LIMIT (10 20 30 40 50 60 70)	- No. 200 %
			(continued)				
50			- slightly silty below 48 ft	25/0"		-NON-PLASTIC-	10
55			Moderately hard maroon and tan weathered shale, apparent dip ±80° w/ferrous stains	50/5"			
60				70/5"			
65				70/6"			
70				70/6"			
75				70/6"			
80							
85							

COMPLETION DEPTH: 75.0 ft
DATE: 5-1-18

DEPTH TO WATER IN BORING: 4 ft

DATE: 5/1/2018

LGBNEW 18-040_BRIDGE 02082.GPJ 12-7-18

Grubbs, Hoskyn, Barton & Wyatt, Inc.
Consulting Engineers

LOG OF BORING NO. S13

ARDOT 030501 - Bridge 02082 over Saline River
Howard County, Arkansas

TYPE: Auger to 26 ft /Wash

LOCATION: Bridge, Approx Sta 1003+36, 9 ft Lt

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	COHESION, TON/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) / PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT (10 20 30 40 50 60 70)	- No. 200 %
			SURF. EL: 367.6±				
			Medium dense dark brown silty fine sand (fill)	12		-NON-PLASTIC-	33
			Loose tan silty fine sand	6		-NON-PLASTIC-	24
5				5			
			Medium dense tan and brown clayey fine sand	10			
			Loose brown silty fine to coarse sand w/a little fine gravel - water at 8 ft	7			14
10							
			- medium dense below 13 ft	20			
15							
			Dense reddish tan and tan sandy fine to coarse gravel w/occasional cobbles				4
20							
25							
30							
35							
40							

COMPLETION DEPTH: 75.0 ft
DATE: 5-2-18

DEPTH TO WATER IN BORING: 8 ft

DATE: 5/2/2018

LGBNEW 18-040_BRIDGE 02082.GPJ 12-7-18

Grubbs, Hoskyn, Barton & Wyatt, Inc.
Consulting Engineers

LOG OF BORING NO. S13

ARDOT 030501 - Bridge 02082 over Saline River
Howard County, Arkansas

TYPE: Auger to 26 ft /Wash

LOCATION: Bridge, Approx Sta 1003+36, 9 ft Lt

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	COHESION, TON/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) / PLASTIC LIMIT / WATER CONTENT / LIQUID LIMIT (10 20 30 40 50 60 70)	- No. 200 %
			(continued)				
50							
55				25/0"			
60			Moderately hard maroon and tan weathered shale, apparent dip ±80° w/ferrous stains and occasional silty clay laminations	70/6"			
65				70/6"			
70				80/4"			
75			Moderately hard to hard tan and gray fine-grained sandstone	80/3"			
80							
85							

COMPLETION DEPTH: 75.0 ft
DATE: 5-2-18

DEPTH TO WATER IN BORING: 8 ft

DATE: 5/2/2018

LGBNEW 18-040_BRIDGE 02082.GPJ 12-7-18

Grubbs, Hoskyn, Barton & Wyatt, Inc.
Consulting Engineers

LOG OF BORING NO. S14

ARDOT 030501 - Bridge 02082 over Saline River
Howard County, Arkansas

TYPE: Auger to 20 ft /Wash

LOCATION: Bridge, Approx Sta 1004+72, 2 ft Rt

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	COHESION, TON/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) / PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT (10 20 30 40 50 60 70)	- No. 200 %
			SURF. EL: 372.7±				
			Medium dense dark brown fine sandy silt w/fine to coarse gravel (fill)	17			
			Loose brown silty fine sand w/trace fine gravel	11			
5				8		-NON-PLASTIC-	40
			- water at 6 ft	5			
10				6			
15			Medium dense brown sandy fine to coarse gravel, slightly silty	28			11
20			Dense brown silty fine to coarse sand w/some fine to coarse gravel	34			26
			- auger refusal at 20 ft in gravel and cobbles				
25			Dense brown fine sand, slightly silty	34			9
30			- dense to very dense below 28 ft	50/10"			
35			Dense to very dense reddish tan and tan medium to coarse sand w/some fine gravel	50/8"			3
				25/0"			
40				25/0"			

COMPLETION DEPTH: 75.0 ft
DATE: 5-2-18

DEPTH TO WATER IN BORING: 6 ft

DATE: 5/2/2018

LGBNEW 18-040_BRIDGE 02082.GPJ 12-7-18

Grubbs, Hoskyn, Barton & Wyatt, Inc.
Consulting Engineers

LOG OF BORING NO. S14

ARDOT 030501 - Bridge 02082 over Saline River
Howard County, Arkansas

TYPE: Auger to 20 ft /Wash

LOCATION: Bridge, Approx Sta 1004+72, 2 ft Rt

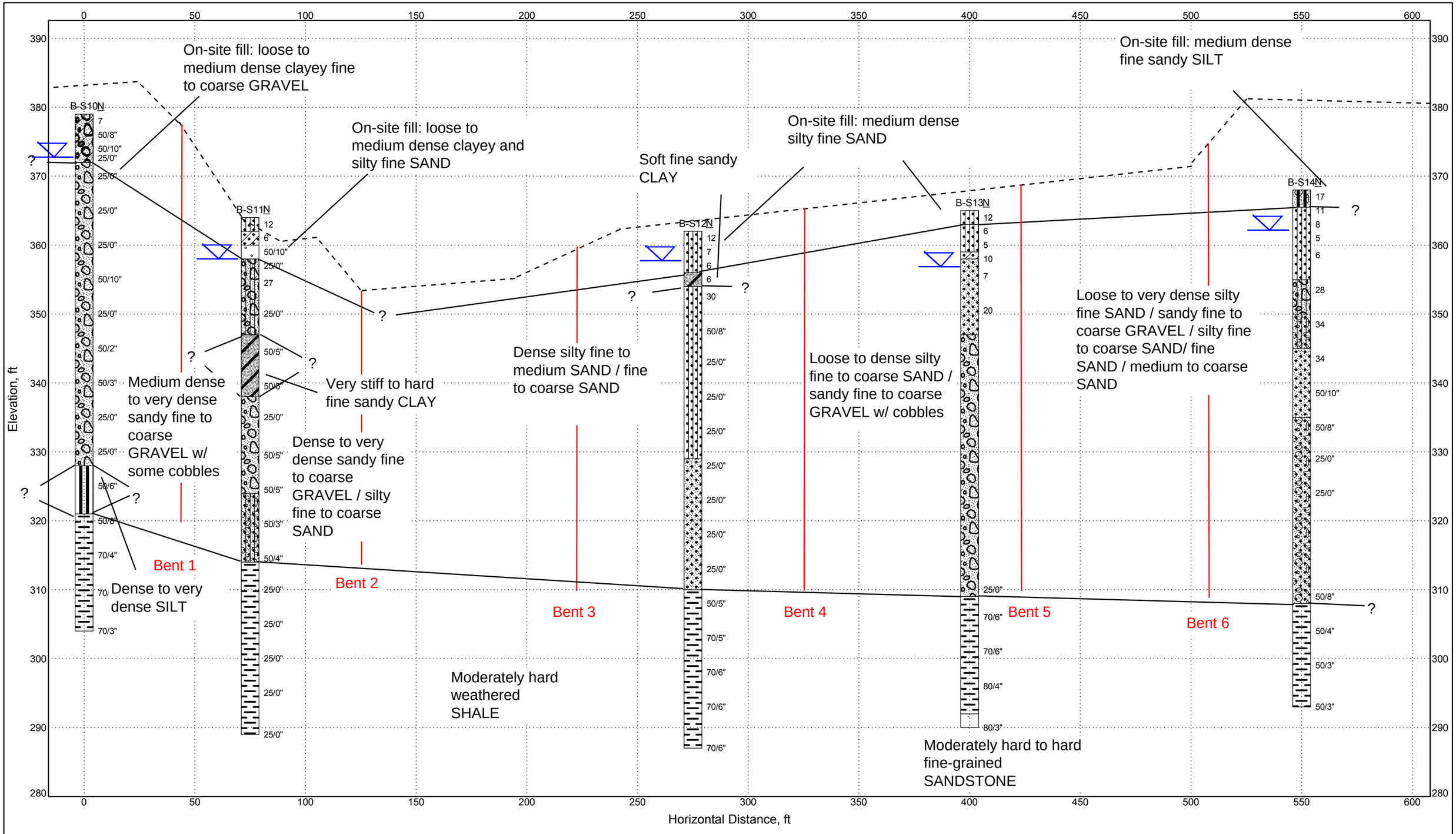
DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	COHESION, TON/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) / PLASTIC LIMIT / WATER CONTENT / LIQUID LIMIT (10 20 30 40 50 60 70)	- No. 200 %
			(continued)				
50							
55							
				50/8"			
60			Moderately hard maroon, gray and tan weathered shale, apparent dip ±80° w/occasional silty clay laminations				
				50/4"			
65							
				50/3"			
70							
				50/3"			
75							
80							
85							

COMPLETION DEPTH: 75.0 ft
DATE: 5-2-18

DEPTH TO WATER IN BORING: 6 ft

DATE: 5/2/2018

LGBNEW 18-040_BRIDGE 02082.GPJ 12-7-18



Grubbs, Hoskyn, Barton & Wyatt, Inc.

NOTES:
1. Subsurface conditions have been inferred between discrete boring locations. Actual conditions may vary.
2. Ground surface approximate.

Generalized Subsurface Profile
ARDOT 030501 - Bridge 02082 over Saline River
Howard County, Arkansas
Project Number: 18-040

Plate 11

ATTACHMENT 4

Grubbs, Hoskyn, Barton & Wyatt, Inc.
Consulting Engineers

LOG OF BORING NO. P9

ARDOT 030501 - Bridge 02082 over Saline River
Howard County, Arkansas

TYPE: Auger LOCATION: Pavements, ±565 ft West of Bridge End

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	COHESION, TON/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) / PLASTIC LIMIT / WATER CONTENT / LIQUID LIMIT (10 20 30 40 50 60 70)	- No. 200 %
			SURF. EL: 380±				
			3 inches: Asphalt Concrete				
			Medium dense tan and reddish brown silty fine to coarse sand w/some fine to coarse gravel (fill)	26		-NON-PLASTIC-	19
			- dense with more gravel below 2 ft	35			
			(Note: auger refusal at 3 ft, offset Boring 3 ft east)				
			Dense tan and gray silty fine to coarse gravel, sandy	50/6"		-NON-PLASTIC-	20
5				40			
			- auger refusal at 7 ft in apparent sandstone				
10							
15							

COMPLETION DEPTH: 7.0 ft
DATE: 4-18-18

DEPTH TO WATER IN BORING: Dry

DATE: 4/18/2018

LGBNEW 18-040_BRIDGE 02082.GPJ 10-9-18

18-040

Grubbs, Hoskyn, Barton & Wyatt, Inc.
Consulting Engineers

LOG OF BORING NO. P10

ARDOT 030501 - Bridge 02082 over Saline River
Howard County, Arkansas

TYPE: Auger

LOCATION: Pavements, ±150 ft West of Bridge End

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	COHESION, TON/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) / PLASTIC LIMIT / WATER CONTENT / LIQUID LIMIT (10 20 30 40 50 60 70)	- No. 200 %
			SURF. EL: 380±				
			3 inches: Asphalt Concrete				
			Medium dense tan and reddish brown silty fine to coarse sand w/fine to coarse gravel (fill)	24		-NON-PLASTIC-	23
			Dense gray and tan clayey fine sand w/some fine to coarse gravel (fill)	41			
5			Dense tan and gray clayey fine sand w/a little fine to coarse gravel	38			
				50/4"			
			- auger refusal in apparent sandstone at 7 ft				
10							
15							

COMPLETION DEPTH: 7.0 ft
DATE: 4-20-18

DEPTH TO WATER IN BORING: Dry

DATE: 4/20/2018

LGBNEW 18-040_BRIDGE 02082.GPJ 10-9-18

PLATE 2

Grubbs, Hoskyn, Barton & Wyatt, Inc.
Consulting Engineers

LOG OF BORING NO. P11

ARDOT 030501 - Bridge 02082 over Saline River
Howard County, Arkansas

TYPE: Auger

LOCATION: Pavements, ±180 ft East of Bridge End

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	COHESION, TON/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) / PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT (10 20 30 40 50 60 70)	- No. 200 %
			SURF. EL: 380±				
			2 inches: Asphalt Concrete				
			Medium dense tan and reddish brown sandy fine to coarse gravel, slightly silty (fill)	28			9
			Stiff brown clayey silt, sandy w/fine to coarse gravel (fill)	11			
5			Medium dense tan and brown clayey fine sand w/fine sandy clay seams	16			
			- with more fine sandy clay seams below 6 ft	21			
			Very stiff gray fine sandy clay	35			
10							
15							

COMPLETION DEPTH: 9.5 ft
DATE: 4-20-18

DEPTH TO WATER IN BORING: Dry

DATE: 4/20/2018

LGBNEW 18-040_BRIDGE 02082.GPJ 10-9-18

Grubbs, Hoskyn, Barton & Wyatt, Inc.
Consulting Engineers

LOG OF BORING NO. P12

ARDOT 030501 - Bridge 02082 over Saline River
Howard County, Arkansas

TYPE: Auger

LOCATION: Pavements, ±815 ft East of Bridge End

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	COHESION, TON/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) / PLASTIC LIMIT / WATER CONTENT / LIQUID LIMIT (10 20 30 40 50 60 70)	- No. 200 %
			SURF. EL: 380±				
			3 inches: Asphalt Concrete				
			Medium dense tan and reddish brown sandy fine to coarse gravel, silty (fill)	27			13
			Very stiff brown fine sandy clay, silty (fill)	35			67
5				35			
			Medium dense tan fine sandy silt	19			
			Loose reddish tan silty fine sand, slightly clayey	8			
10							
15							

COMPLETION DEPTH: 9.5 ft
DATE: 4-20-18

DEPTH TO WATER IN BORING: Dry

DATE: 4/20/2018

LGBNEW 18-040_BRIDGE 02082.GPJ 10-9-18

ATTACHMENT 5

SUMMARY of CLASSIFICATION TEST RESULTS

PROJECT: ARDOT 030501, Bridge 02082 over Saline River
LOCATION: Sevier and Howard Co, AR
GHBW JOB NUMBER: 18-040

BORING NO.	SAMPLE DEPTH (ft)	WATER CONTENT (%)	ATTERBERG LIMITS			SIEVE ANALYSIS PERCENT PASSING								UNIFIED CLASS.	AASHTO CLASS.
			LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	2 in.	1 in.	3/4 in.	3/8 in.	#4	#10	#40	#200		
S10	2.5-3.5	4	20	14	6	100	56	51	35	28	23	15	8	GM-GC	A-1-a
S10	13.5-14	16	-----	-----	-----	100	100	97	62	37	19	4	1	GP	A-1-a
S10	23.5-24.5	12	-----	-----	-----	100	78	71	49	38	27	17	7	GW-GM	A-1-a
S10	53.5-54.5	15	-----	-----	-----	100	100	100	100	100	98	95	88	ML	A-4
S10	58.5-59	15	37	21	16	--	--	--	--	--	--	--	--	SHALE	
S11	6-6.5	14	-----	-----	-----	100	100	83	48	37	34	28	14	GM	A-1-a
S11	18.5-19	12	18	13	5	--	--	--	--	--	--	--	70	CL-ML	A-4
S11	28.5-29	25	-----	-----	-----	100	96	96	67	36	13	5	3	GP	A-1-a
S11	43.5-44	33	-----	-----	-----	100	100	100	74	53	37	22	15	GM	A-1-a
S11	53.5-54	11	-----	-----	-----	--	--	--	--	--	--	--	--	SHALE	
S11	63.5-65	39	23	16	7	--	--	--	--	--	--	--	--	SHALE	
S12	2.5-3.5	14	NON-PLASTIC			100	100	100	100	100	100	100	47	SM	A-4
S12	6.5-7.5	18	22	14	8	100	100	100	100	100	100	97	51	CL	A-4
S12	9-10	-----	-----	-----	-----	100	100	88	84	81	77	67	22	SM	A-2-4

SUMMARY of CLASSIFICATION TEST RESULTS

PROJECT: ARDOT 030501, Bridge 02082 over Saline River
LOCATION: Sevier and Howard Co, AR
GHBW JOB NUMBER: 18-040

BORING NO.	SAMPLE DEPTH (ft)	WATER CONTENT (%)	ATTERBERG LIMITS			SIEVE ANALYSIS PERCENT PASSING								UNIFIED CLASS.	AASHTO CLASS.
			LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	2 in.	1 in.	3/4 in.	3/8 in.	#4	#10	#40	#200		
S12	24-25	-----	-----	-----	-----	100	100	100	100	95	87	73	24	SM	A-2-4
S12	34.5-35	16	-----	-----	-----	100	100	100	100	80	24	6	3	SW	A-1-a
S12	49.5-50	-----	-----	-----	-----	100	100	100	95	84	51	16	10	SP-SM	A-1-b
S12	53.5-54	15	39	21	18	--	--	--	--	--	--	--	--	SHALE	
S13	0.5-1.5	10	NON-PLASTIC			100	100	100	100	100	99	95	33	SM	A-2-4
S13	2.5-3.5	11	NON-PLASTIC			100	100	100	100	100	100	98	24	SM	A-2-4
S13	9-10	16	-----	-----	-----	100	100	100	86	75	65	49	14	SM	A-1-b
S13	19-20	16	-----	-----	-----	100	100	100	60	33	16	6	4	GP	A-1-a
S14	2.5-3.5	14	-----	-----	-----	100	100	100	95	92	91	87	34	SM	A-2-4
S14	4.5-5.5	17	NON-PLASTIC			100	100	100	100	100	100	99	40	SM	A-4
S14	14-15	11	-----	-----	-----	100	100	93	72	53	37	26	11	GW-GM	A-1-a
S14	19-20	15	-----	-----	-----	100	100	88	73	66	61	54	26	SM	A-2-4
S14	24-25	24	-----	-----	-----	100	100	100	100	100	100	99	9	SP-SM	A-3
S14	34-35	14	-----	-----	-----	100	100	100	90	65	24	5	3	SP	A-1-a

SUMMARY of CLASSIFICATION TEST RESULTS

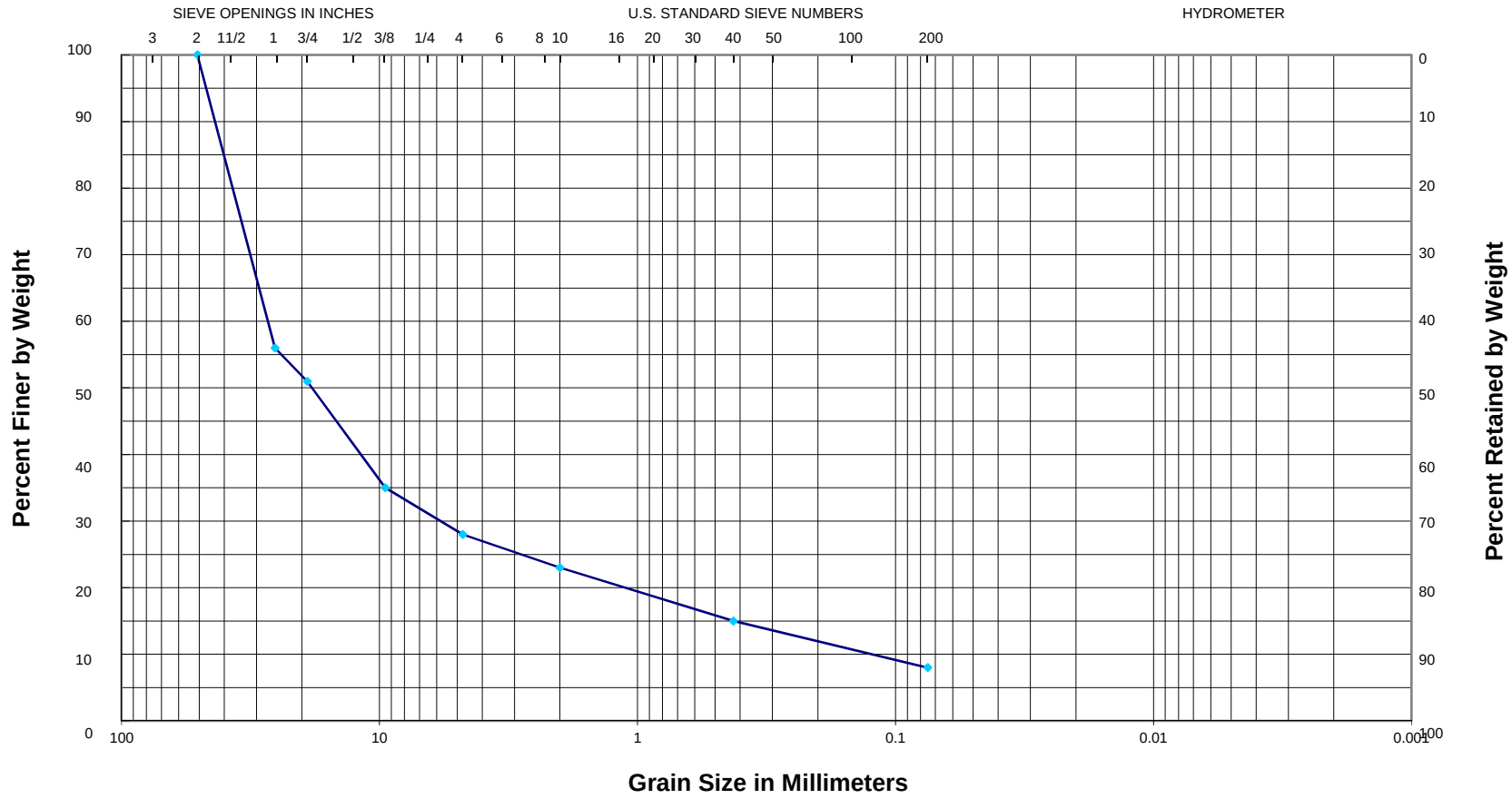
PROJECT: ARDOT 030501, Bridge 02082 over Saline River
LOCATION: Sevier and Howard Co, AR
GHBW JOB NUMBER: 18-040

BORING NO.	SAMPLE DEPTH (ft)	WATER CONTENT (%)	ATTERBERG LIMITS			SIEVE ANALYSIS PERCENT PASSING								UNIFIED CLASS.	AASHTO CLASS.
			LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	2 in.	1 in.	3/4 in.	3/8 in.	#4	#10	#40	#200		
P9	1-2	7	NON-PLASTIC			100	100	89	78	69	58	48	19	SM	A-1-b
P9	4.5-5	7	NON-PLASTIC			100	87	81	62	58	52	43	20	GM	A-1-b
P10	1-2	9	NON-PLASTIC			100	100	100	94	82	69	58	23	SM	A-2-4
P11	0.5-1.5	5	NON-PLASTIC			100	100	94	72	51	38	26	9	GP-GM	A-1-a
P12	1-2	7	-----	-----	-----	100	100	87	65	51	37	26	13	GM	A-1-a
P12	2.5-3.5	12	22	15	7	--	--	--	--	96	--	--	67	CL-ML	A-4

18-040-Bridge 02082

GRAIN SIZE CURVE

Grubbs, Hoskyn, Barton & Wyatt, INC.
CONSULTING ENGINEERS



GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

Sample: Boring S10, 2.5-3.5 ft; LL = 20, PL = 14, PI = 6
Description: Reddish tan and tan clayey fine GRAVEl, sandy (fill)

USCS = GM-GC AASHTO = A-1-a

18-040-Bridge 02082

GRAIN SIZE CURVE

Grubbs, Hoskyn, Barton & Wyatt, INC.
CONSULTING ENGINEERS

GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

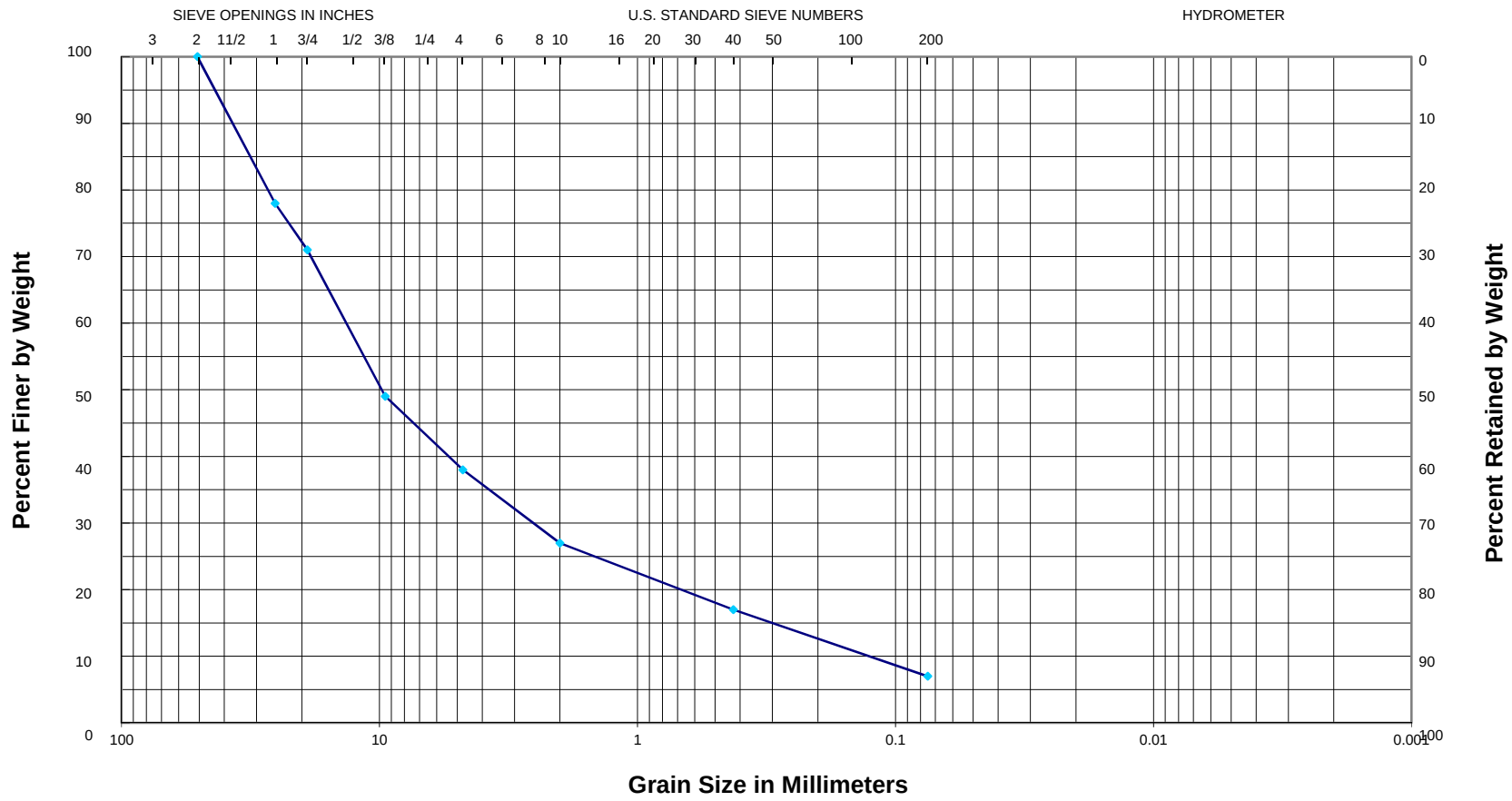
Sample: Boring S10, 13.5-14 ft;
Description: Reddish tan and tan sandy fine to coarse GRAVEL
with some cobbles

USCS = GP AASHTO = A-1-a

18-040-Bridge 02082

GRAIN SIZE CURVE

Grubbs, Hoskyn, Barton & Wyatt, INC.
CONSULTING ENGINEERS



GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

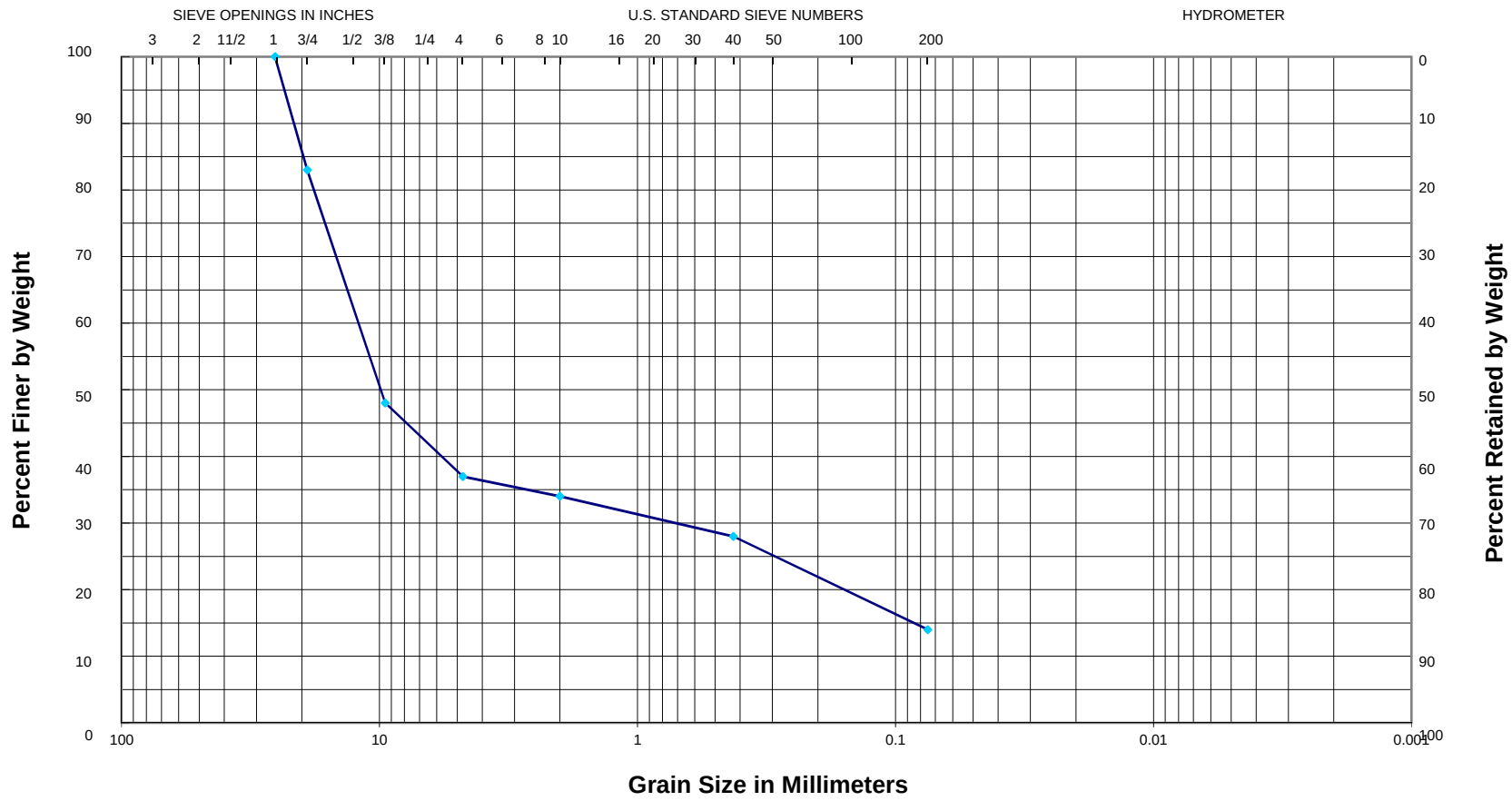
Sample: Boring S10, 23.5-24.5 ft;
Description: Reddish tan and tan sandy fine to coarse GRAVEL with some cobbles

USCS = GW-GM AASHTO = A-1-a

18-040-Bridge 02082

GRAIN SIZE CURVE

Grubbs, Hoskyn, Barton & Wyatt, INC.
CONSULTING ENGINEERS



GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

Sample: Boring S11, 6-6.5 ft;
Description: Brown silty fine to coarse GRAVEL, sandy

USCS = GM **AASHTO = A-1-a**

18-040-Bridge 02082

GRAIN SIZE CURVE

Grubbs, Hoskyn, Barton & Wyatt, INC.
CONSULTING ENGINEERS

GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

Sample: Boring S11, 28.5-29 ft;
Description: Brown sandy fine to coarse GRAVEL

USCS = GP AASHTO = A-1-a

18-040-Bridge 02082

GRAIN SIZE CURVE

Grubbs, Hoskyn, Barton & Wyatt, INC.
CONSULTING ENGINEERS

GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

Sample: Boring S11, 43.5-44 ft;
Description: Bluish gray silty fine GRAVEL, sandy

USCS = GM **AASHTO = A-1-a**

18-040-Bridge 02082

GRAIN SIZE CURVE

Grubbs, Hoskyn, Barton & Wyatt, INC.
CONSULTING ENGINEERS

GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

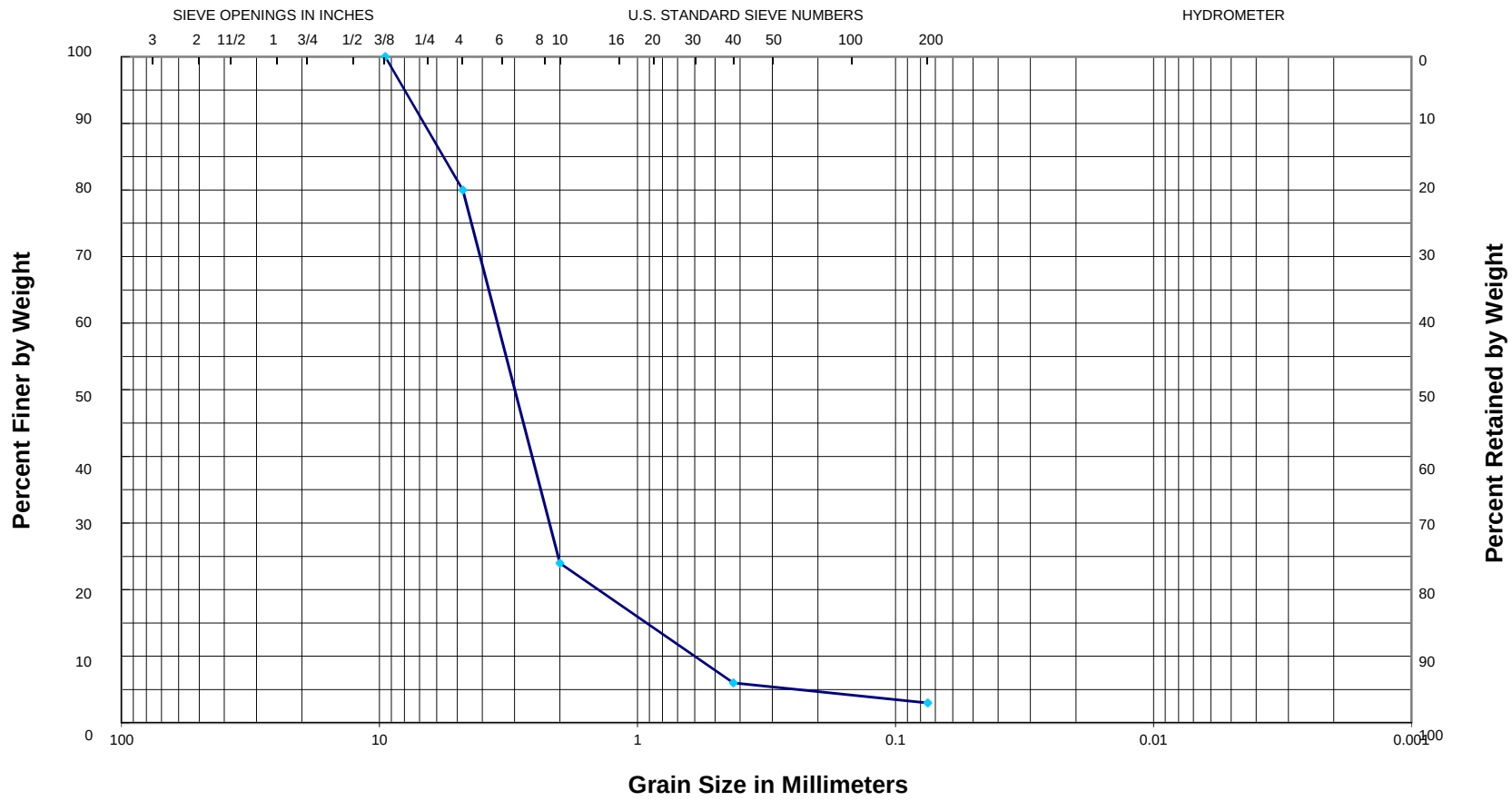
Sample: Boring S12, 9-10 ft;
Description: Brown silty fine to medium SAND with trace fine to coarse gravel

USCS = SM AASHTO = A-2-4

18-040-Bridge 02082

GRAIN SIZE CURVE

Grubbs, Hoskyn, Barton & Wyatt, INC.
CONSULTING ENGINEERS



GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

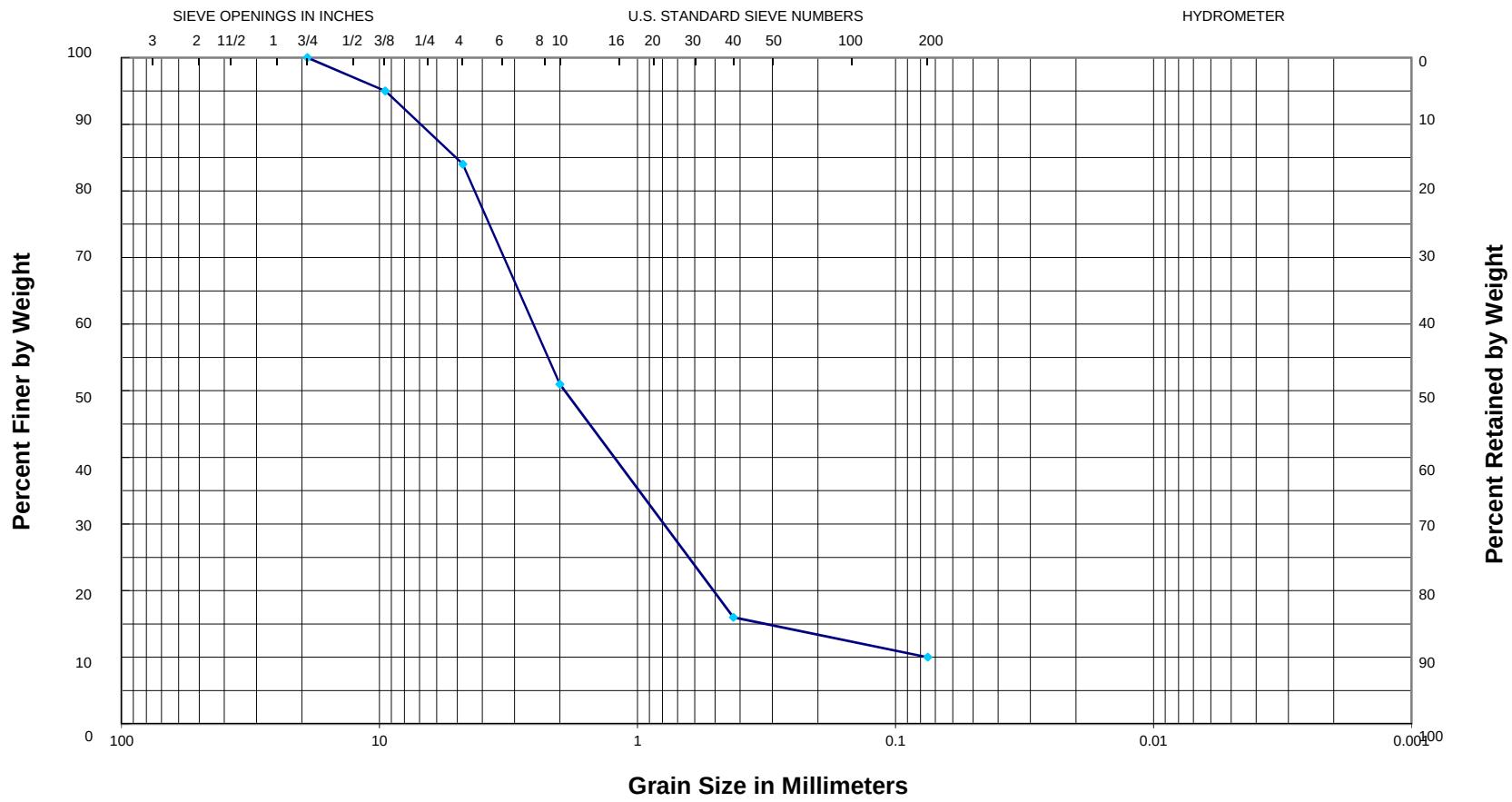
Sample: Boring S12, 34.5-35 ft;
Description: Reddish tan and tan medium to coarse SAND with a little fine gravel

USCS = SW AASHTO = A-1-a

18-040-Bridge 02082

GRAIN SIZE CURVE

Grubbs, Hoskyn, Barton & Wyatt, INC.
CONSULTING ENGINEERS



GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

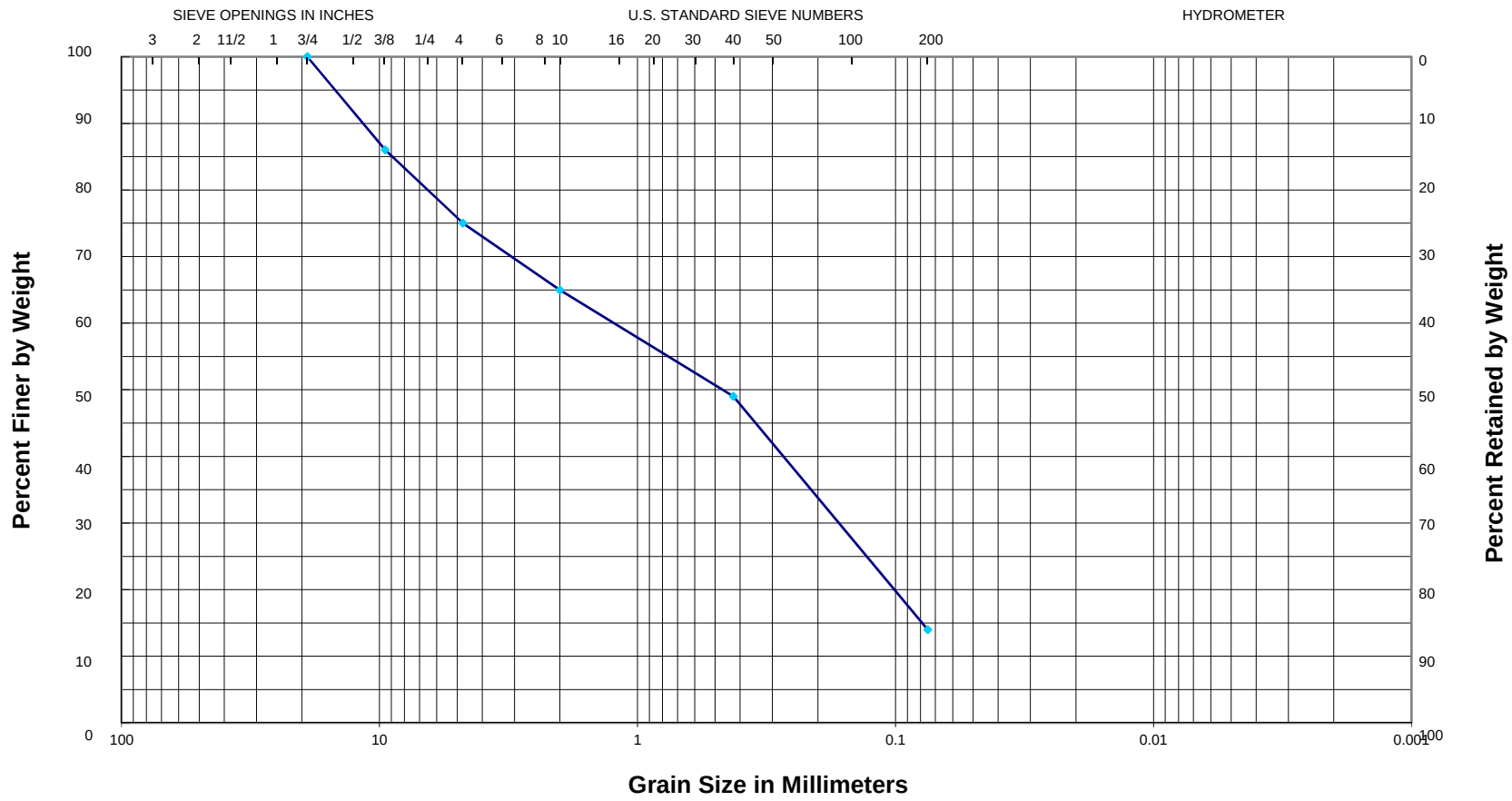
Sample: Boring S12, 49.5-50 ft;
Description: Reddish tan and tan fine to medium SAND,
slightly silty with a little fine to coarse gravel

USCS = SP-SM AASHTO = A-1-b

18-040-Bridge 02082

GRAIN SIZE CURVE

Grubbs, Hoskyn, Barton & Wyatt, INC.
CONSULTING ENGINEERS



GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

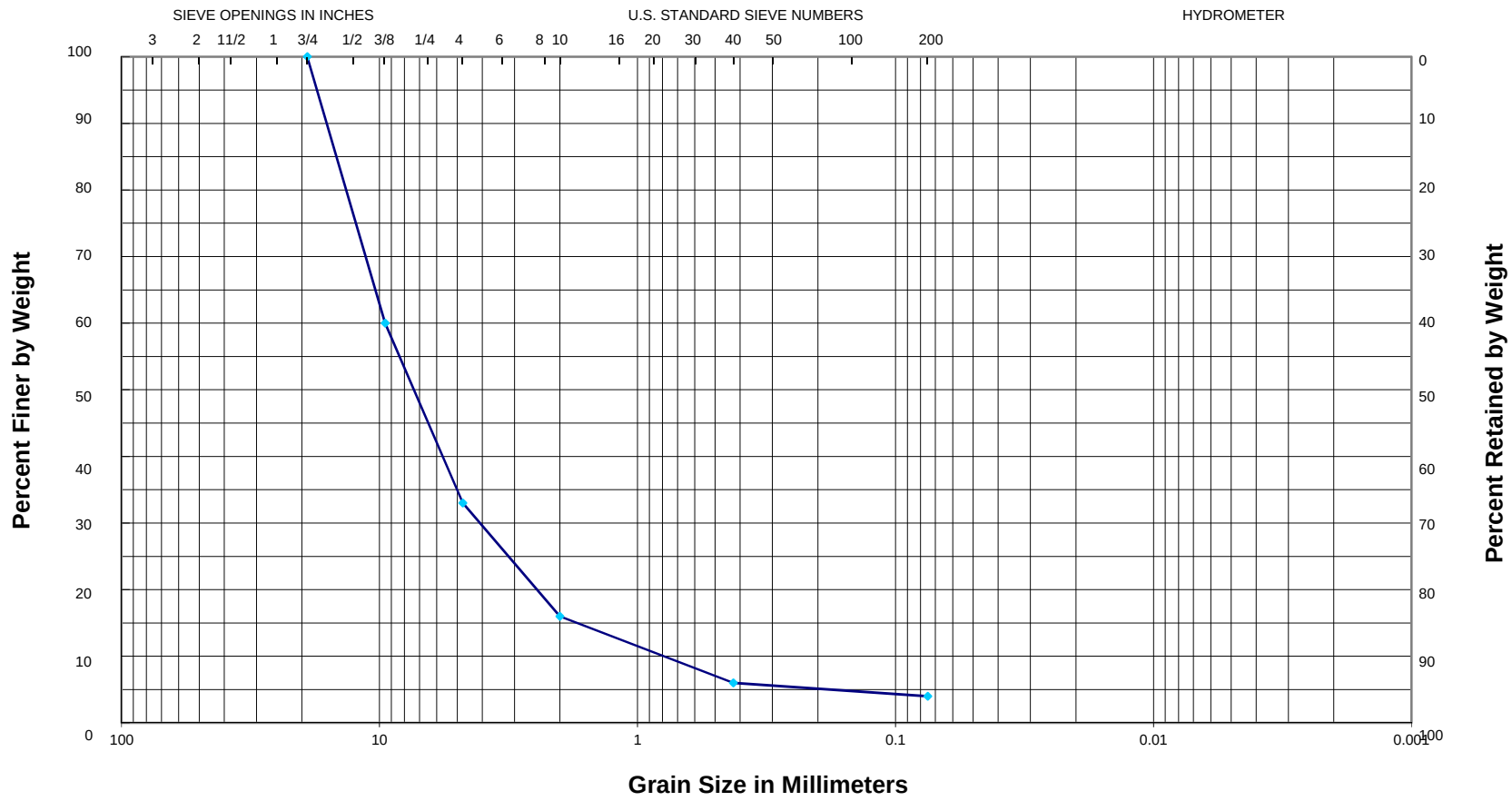
Sample: Boring S13, 9-10 ft;
Description: Brown silty fine to coarse SAND with some fine gravel

USCS = SM **AASHTO = A-1-b**

18-040-Bridge 02082

GRAIN SIZE CURVE

Grubbs, Hoskyn, Barton & Wyatt, INC.
CONSULTING ENGINEERS



GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

Sample: Boring S13, 19-20 ft;
Description: Reddish tan and tan sandy fine GRAVEL with occasional cobbles

USCS = GP AASHTO = A-1-a

18-040-Bridge 02082

GRAIN SIZE CURVE

Grubbs, Hoskyn, Barton & Wyatt, INC.
CONSULTING ENGINEERS

GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

Sample: Boring S14, 2.5-3.5 ft;
Description: Brown silty fine SAND with trace fine gravel

USCS = SM AASHTO = A-2-4

18-040-Bridge 02082

GRAIN SIZE CURVE

Grubbs, Hoskyn, Barton & Wyatt, INC.
CONSULTING ENGINEERS

GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

Sample: Boring S14, 14-15 ft;
Description: Brown sadny fine to coarse GRAVEL, slightly silty **USCS = GW-GM** **AASHTO = A-1-a**

18-040-Bridge 02082

GRAIN SIZE CURVE

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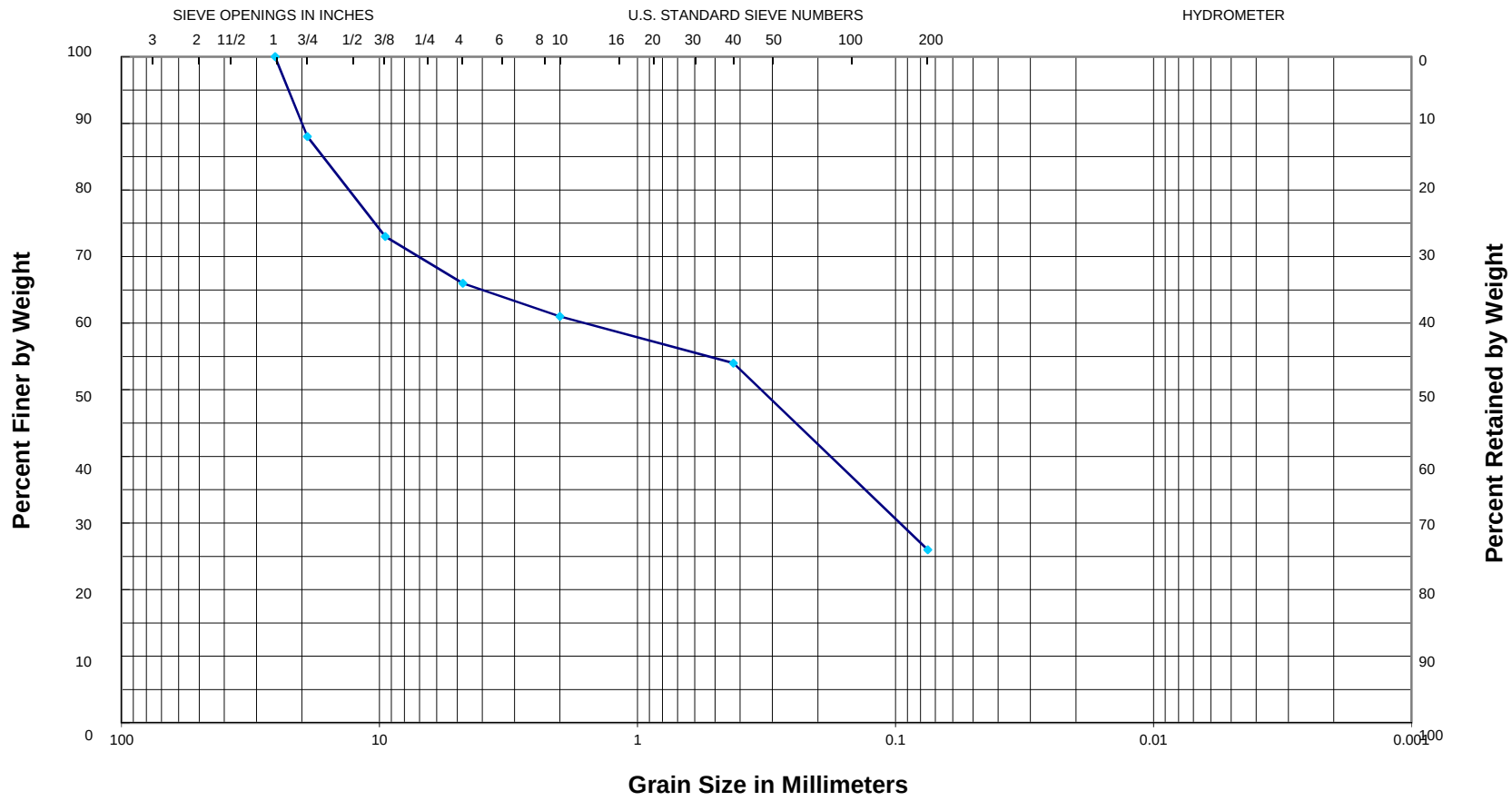
CONSULTING ENGINEERS



GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

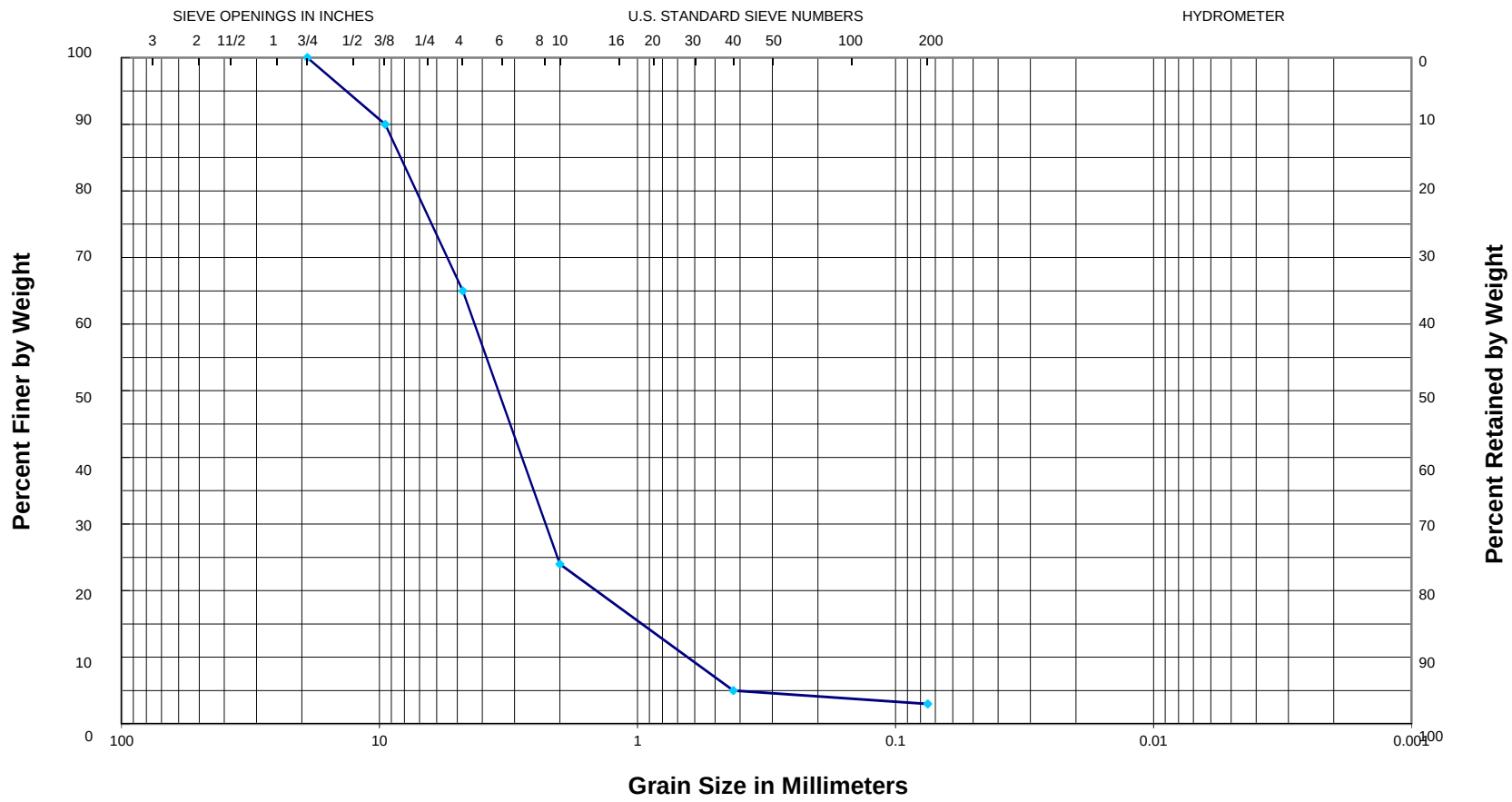
Sample: Boring S14, 19-20 ft;
Description: Brown silty fine to coarse SAND with fine to coarse gravel

USCS = SM AASHTO = A-2-4

18-040-Bridge 02082

GRAIN SIZE CURVE

Grubbs, Hoskyn, Barton & Wyatt, INC.
CONSULTING ENGINEERS



GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

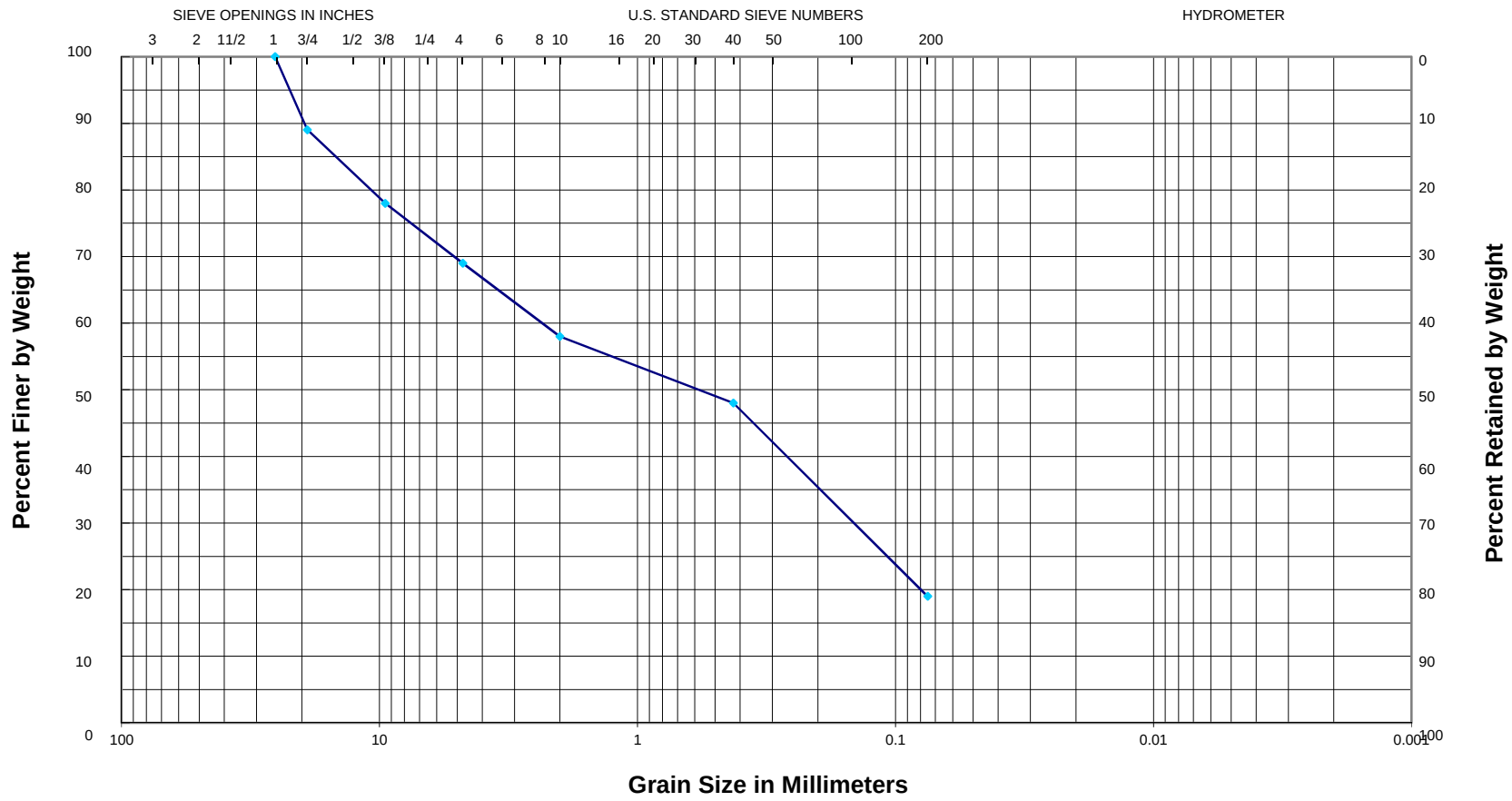
Sample: Boring S14, 34-35 ft;
Description: Reddish tan and tan medium to coarse SAND with some fine gravel

USCS = SP AASHTO = A-1-a

18-040-Bridge 02082

GRAIN SIZE CURVE

Grubbs, Hoskyn, Barton & Wyatt, INC.
CONSULTING ENGINEERS



GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

Sample: Boring P9, 1-2 ft; NON-PLASTIC
Description: Tan and reddish brown silty fine to coarse SAND with some fine to coarse gravel (fill)

USCS = SM **AASHTO = A-1-b**

18-040-Bridge 02082

GRAIN SIZE CURVE

Grubbs, Hoskyn, Barton & Wyatt, INC.
CONSULTING ENGINEERS

GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

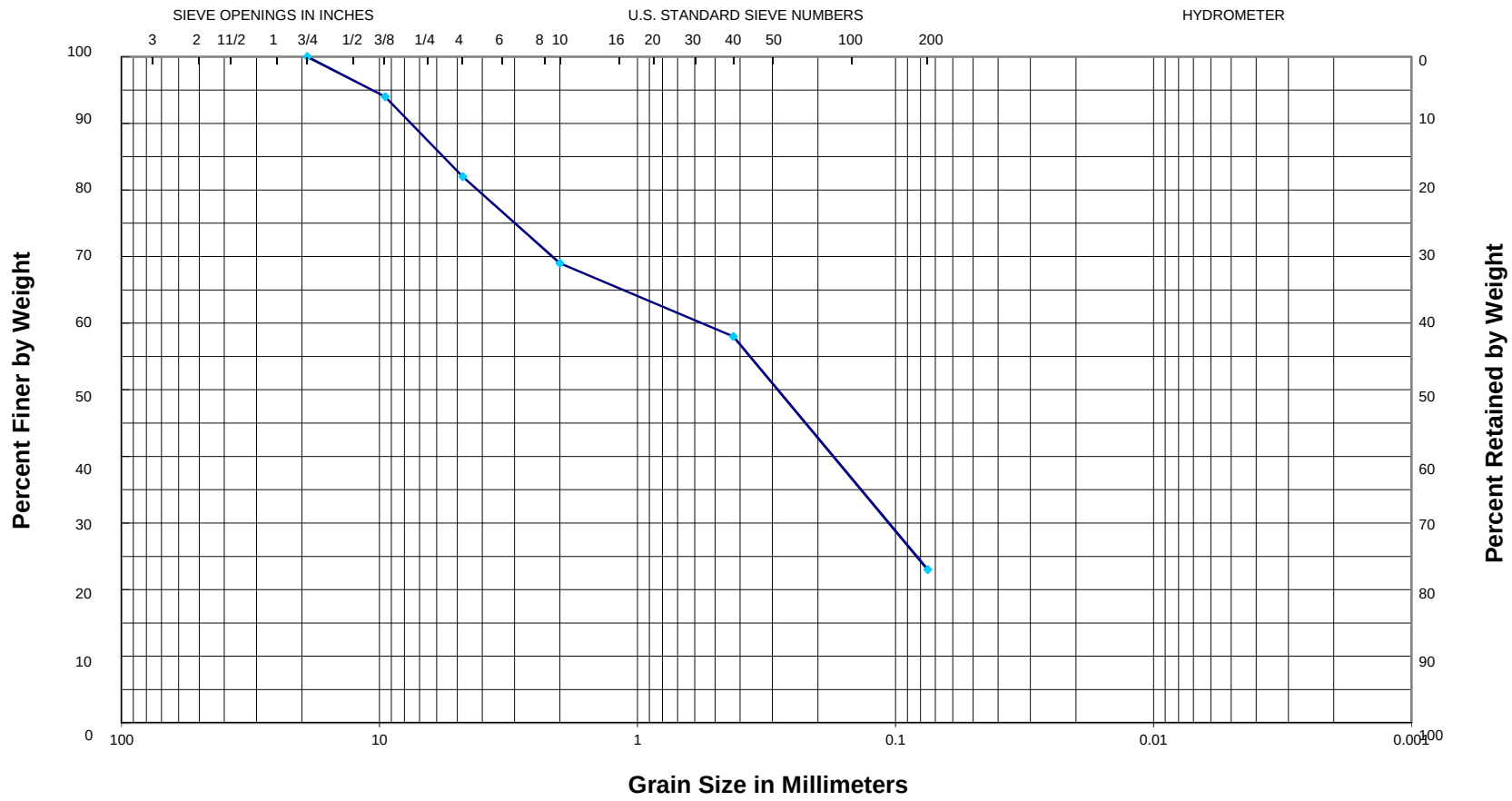
Sample: Boring P9, 4.5-5 ft; NON-PLASTIC

Description: Tan and gray silty fine to coarse GRAVEL, sandy **USCS = GM** **AASHTO = A-1-b**

18-040-Bridge 02082

GRAIN SIZE CURVE

Grubbs, Hoskyn, Barton & Wyatt, INC.
CONSULTING ENGINEERS



GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

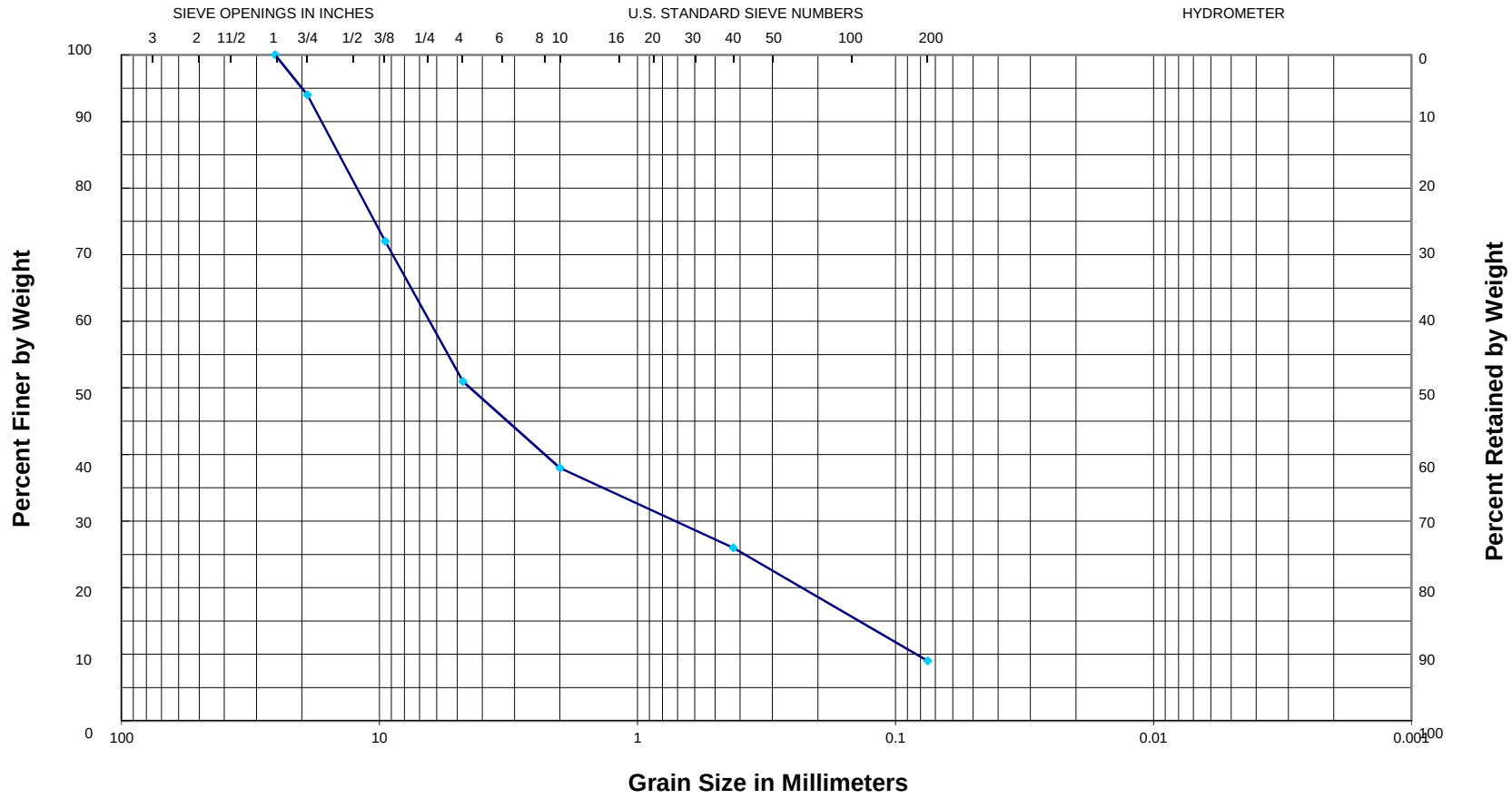
Sample: Boring P10, 1-2 ft; NON-PLASTIC
Description: Tan and reddish brown sandy fine to coarse SAND with a little fine gravel(fill)

USCS = SM AASHTO = A-2-4

18-040-Bridge 02082

GRAIN SIZE CURVE

Grubbs, Hoskyn, Barton & Wyatt, INC.
CONSULTING ENGINEERS



GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

Sample: Boring P11, 0.5-1.5 ft; NON-PLASTIC

Description: Tan and reddish brown sandy fine to coarse GRAVEL slightly silty (fill) **USCS = GP-GM** **AASHTO = A-1-a**

18-040-Bridge 02082

GRAIN SIZE CURVE

Grubbs, Hoskyn, Barton & Wyatt, INC.
CONSULTING ENGINEERS

GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

Sample: Boring P12, 1-2 ft;
Description: Tan and reddish brown silty fine to coarse GRAVEL, sandy (fill)

USCS = GM AASHTO = A-1-a

ATTACHMENT 6

Grubbs, Hoskyn, Barton & Wyatt, INC.
CONSULTING ENGINEERS

P.O. Box 30970
Little Rock, Arkansas 72260-0970
#1 Trigon Place 72209
(501) 455-2536
FAX (501) 455-4137

REPORT OF MODIFIED PROCTOR TEST
(AASHTO T-180 METHOD D)

Project: ARDOT 030501 - Bridge 02082 over Saline River Job No: 18-040

Material Description: Tan and reddish brown sandy fine to coarse gravel

Location Sampled/Source: 5/10A
Sample Depth, ft: 0.5-2
Date Sampled: 5/10/2018
Date Tested: 5/29/2018
Tested By: LLC
Report Date: 6/12/2018

LAB COMPACTION PROCEDURE: AASHTO T-180 Method: D	
Maximum Unit Dry Wt. (pcf):	132.7
Optimum Water Content (%):	5.5

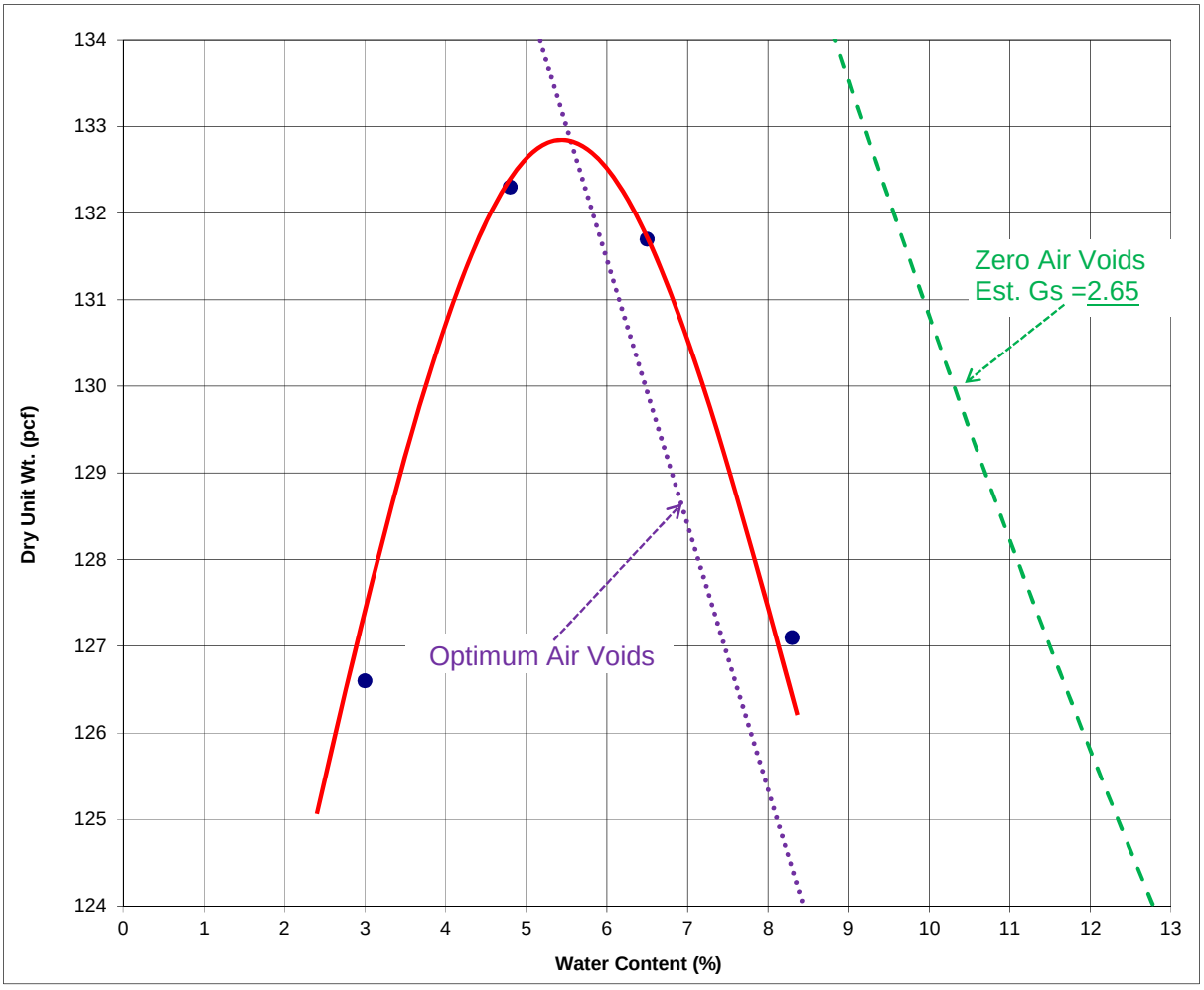
As Processed Water Content: 4.3 %

ATTERBERG LIMITS AASHTO T-89 & T-90
Liquid Limit: NP
Plastic Limit: NP
Plasticity Index: NP

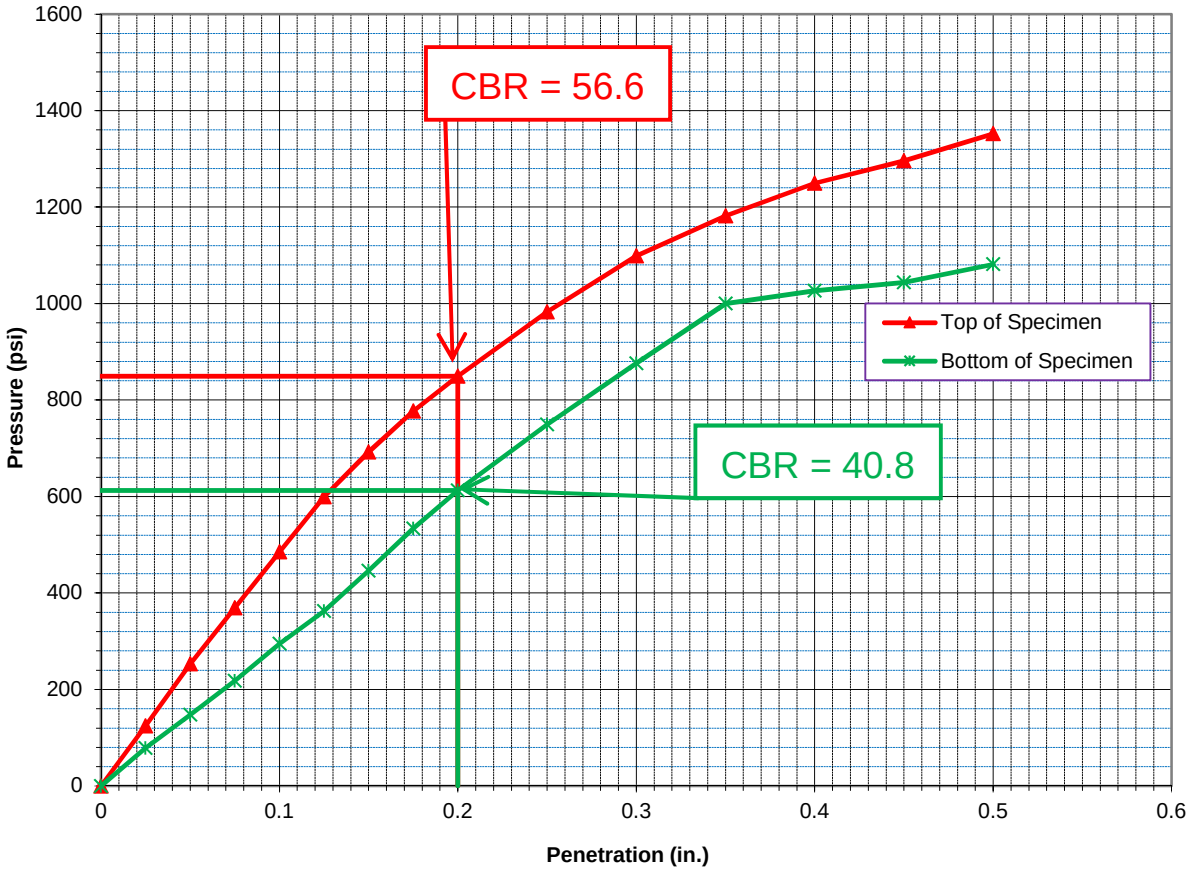
AASHTO Classification:
GM-GP

USCS Classification:
A-1-b

GRADATION AASHTO T-88	
Sieve Number	Percent Passing
3 in.	100
2 in.	100
3/4 in.	97
3/8 in.	79
#4	56
#10	41
#40	31
#200	8



Laboratory CBR Test Report
(AASHTO T-193)



Sample/Depth, ft	Classification		Natural Moisture Content, %	Assumed Specific Gravity	Liquid Limit, %	Plastic Limit, %	% Passing No.4	% Passing No.200
	USCS	AASHTO						
5/10A/0.5-2	GM-GP	A-1-b	4.3	2.65	NP	NP	56	8

PROCTOR TEST RESULTS (AASHTO T-180 D)	MATERIAL DESCRIPTION
Optimum Moisture Content = 4.3% Maximum Dry Density = 132.8 pcf	Tan and reddish brown sandy fine to coarse gravel

Remarks:

As molded: Dry Unit Weight, γ_d = 127.6 pcf; Moisture Content, w = 4.9%

Grubbs, Hoskyn, Barton & Wyatt, INC.
CONSULTING ENGINEERS

Project: ARDOT 030501 - Bridge 02082
GHBW Project No.: 18-040
Location: Howard Co., Arkansas
Sample Date: 05-10-18
Test Date: 5-31-18

18-040-Bridge 02082

GRAIN SIZE CURVE

Grubbs, Hoskyn, Barton & Wyatt, INC.
CONSULTING ENGINEERS

GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

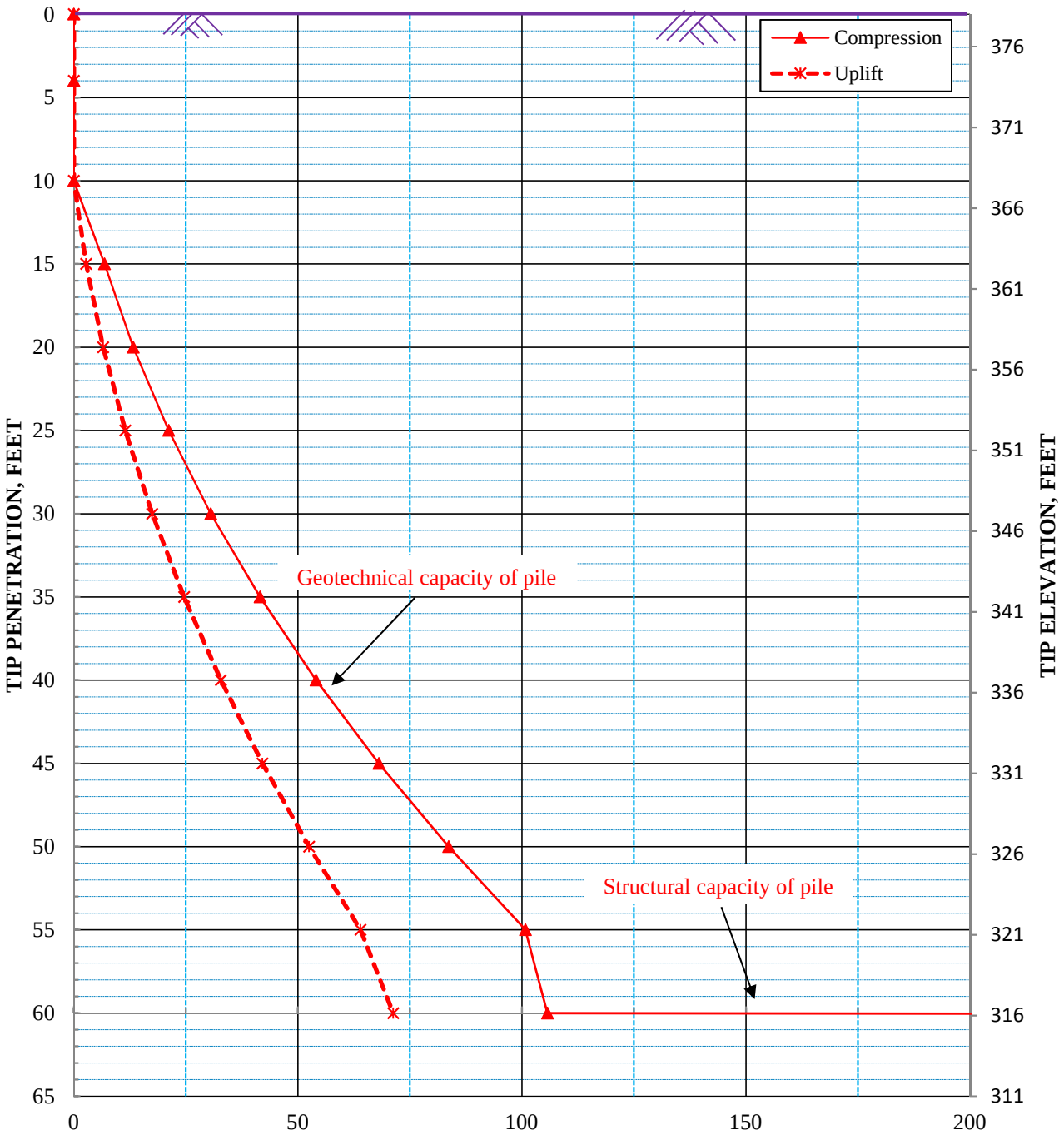
Sample: 5/10A, 0.5-2 ft
Atterberg Limits: Non Plastic

Description: Tan and reddish brown sandy fine to coarse gravel

Classification: **USCS = GM-GP; AASHTO = A-1-b**

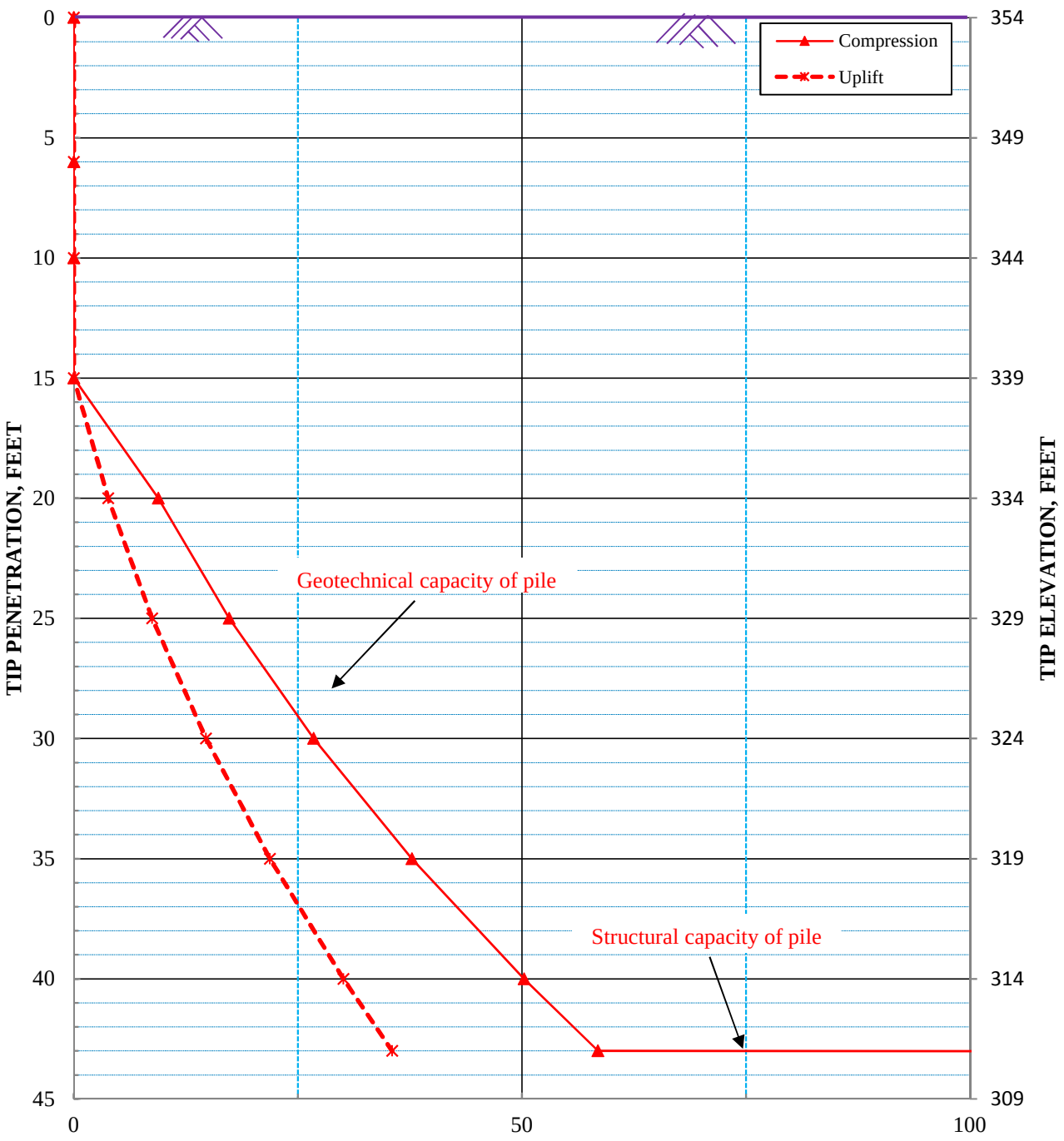
ATTACHMENT 7

NOMINAL SINGLE PILE CAPACITY, TONS



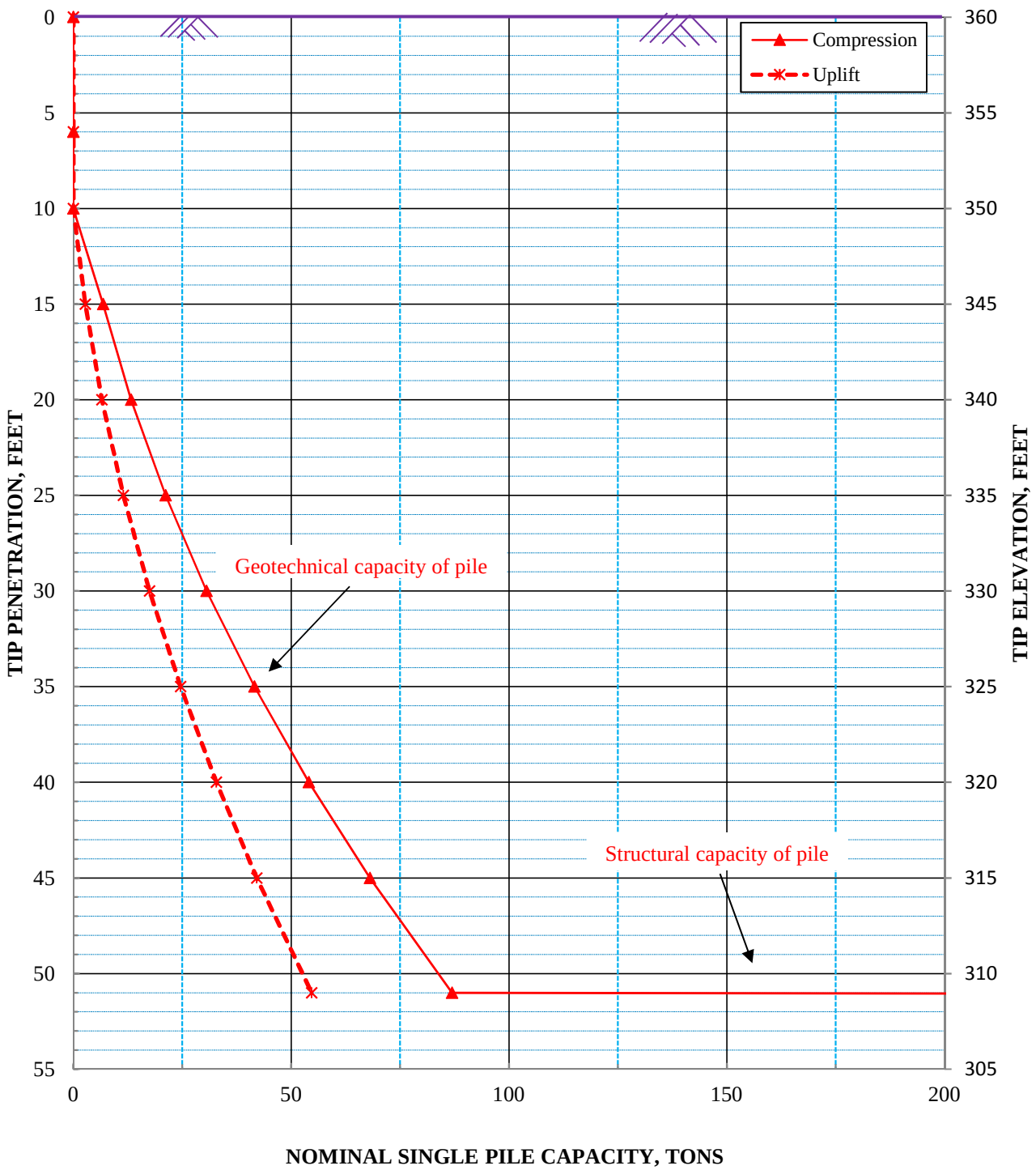
Bent 1 Steel Piles - HP12x53
ARDOT 030501 - Bridge 02082 over Saline River
Sevier County, Arkansas

Note: Piles driven from pile cap bottom elevation



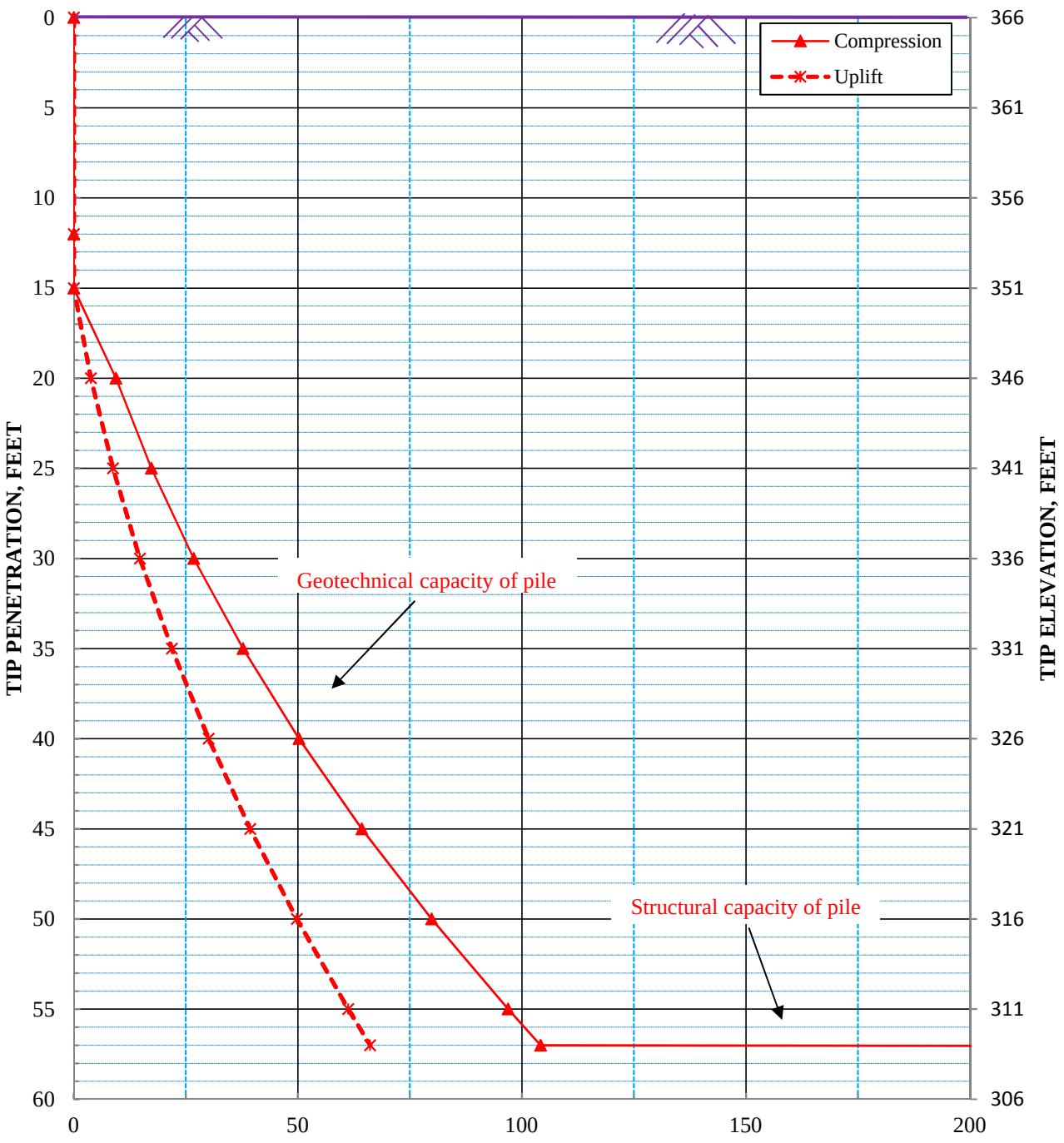
Bent 2 Steel Piles - HP12x53
ARDOT 030501 - Bridge 02082 over Saline River
Sevier County, Arkansas

Note: Piles driven from pile cap bottom elevation



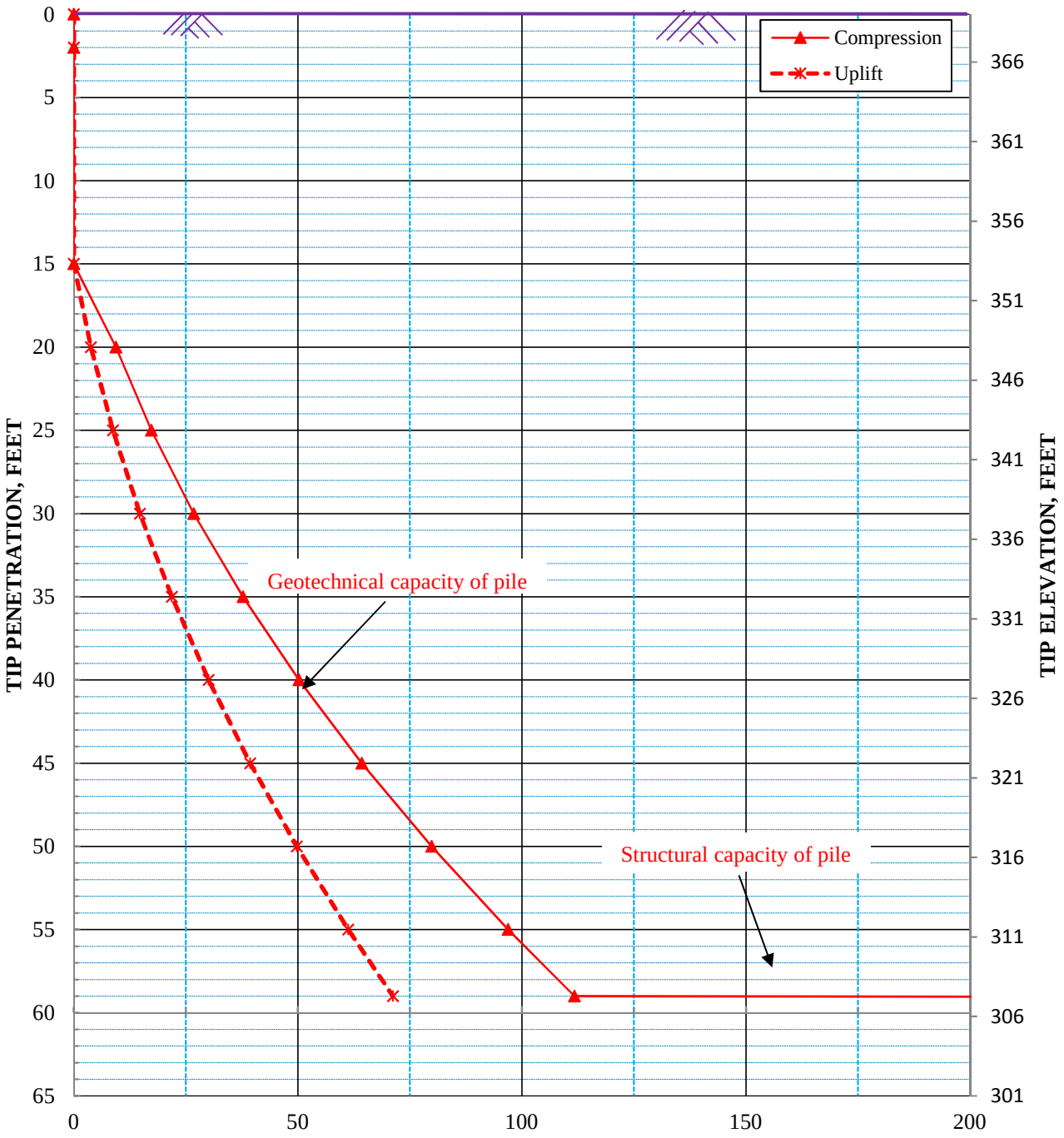
Bent 3 Steel Piles - HP12x53
ARDOT 030501 - Bridge 02082 over Saline River
Sevier County, Arkansas

Note: Piles driven from pile cap bottom elevation



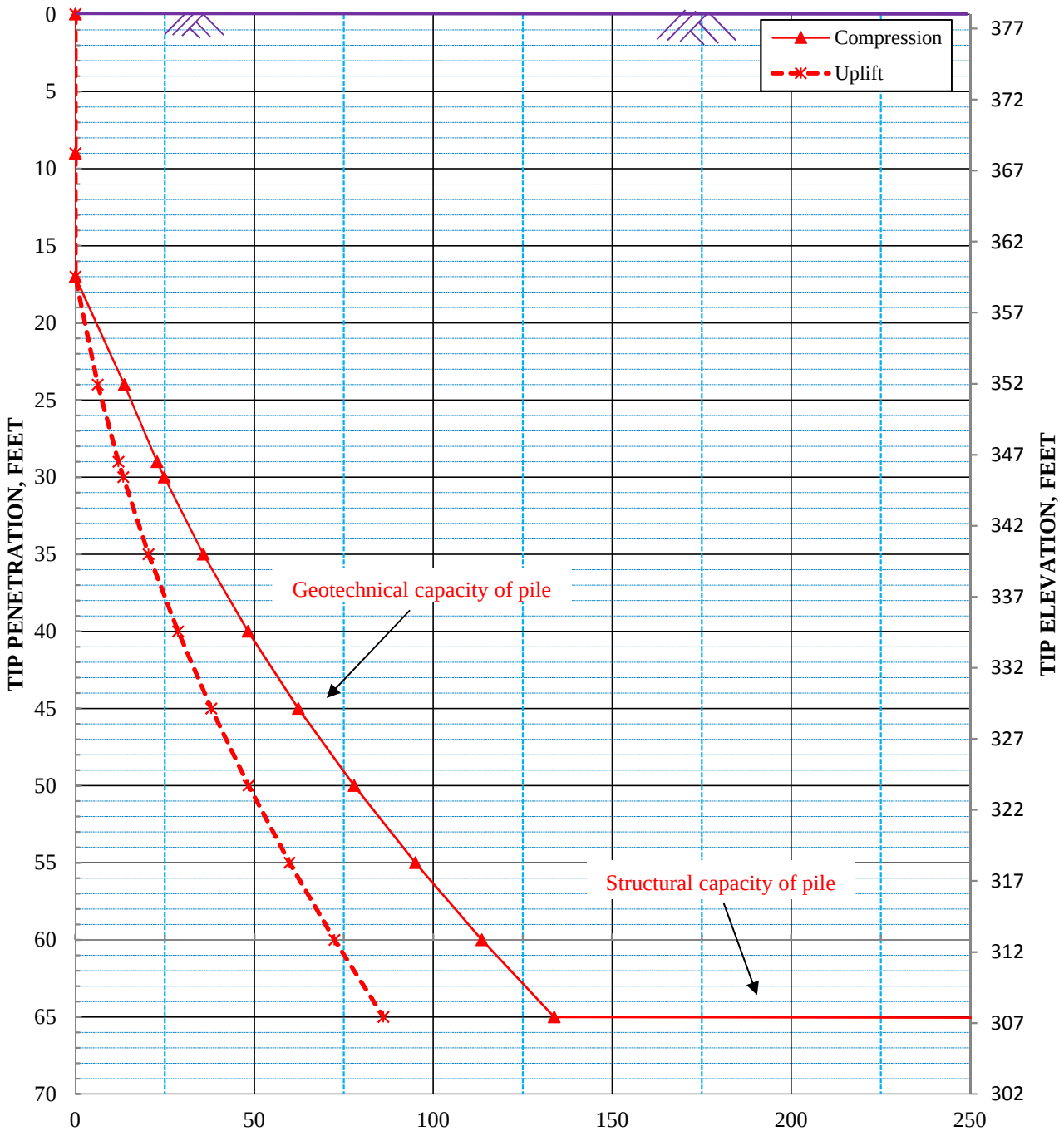
Bent 4 Steel Piles - HP12x53
ARDOT 030501 - Bridge 02082 over Saline River
Sevier County, Arkansas

Note: Piles driven from pile cap bottom elevation



Bent 5 Steel Piles - HP12x53
ARDOT 030501 - Bridge 02082 over Saline River
Sevier County, Arkansas

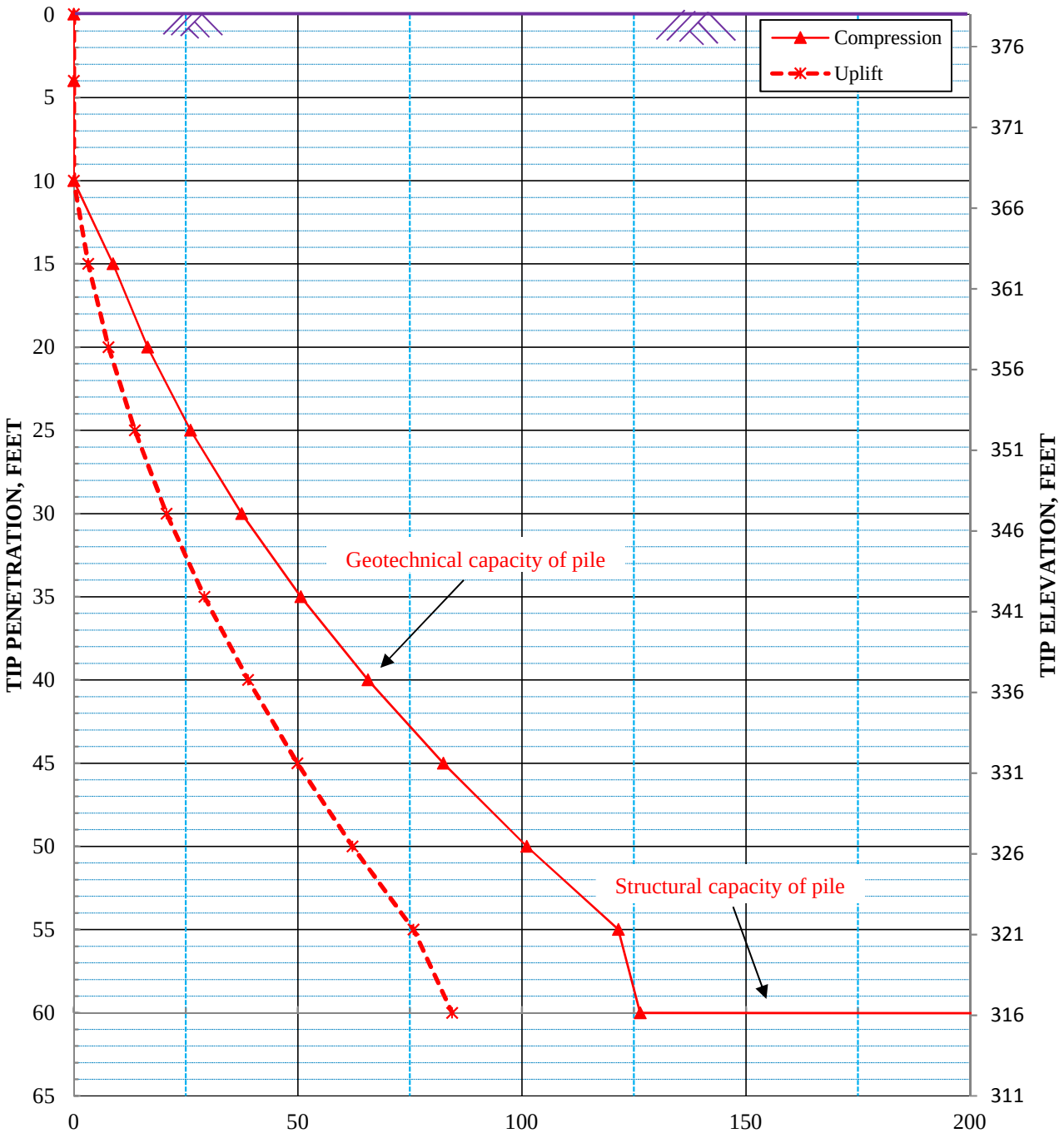
Note: Piles driven from pile cap bottom elevation



Bent 6 Steel Piles - HP12x53
ARDOT 030501 - Bridge 02082 over Saline River
Sevier County, Arkansas

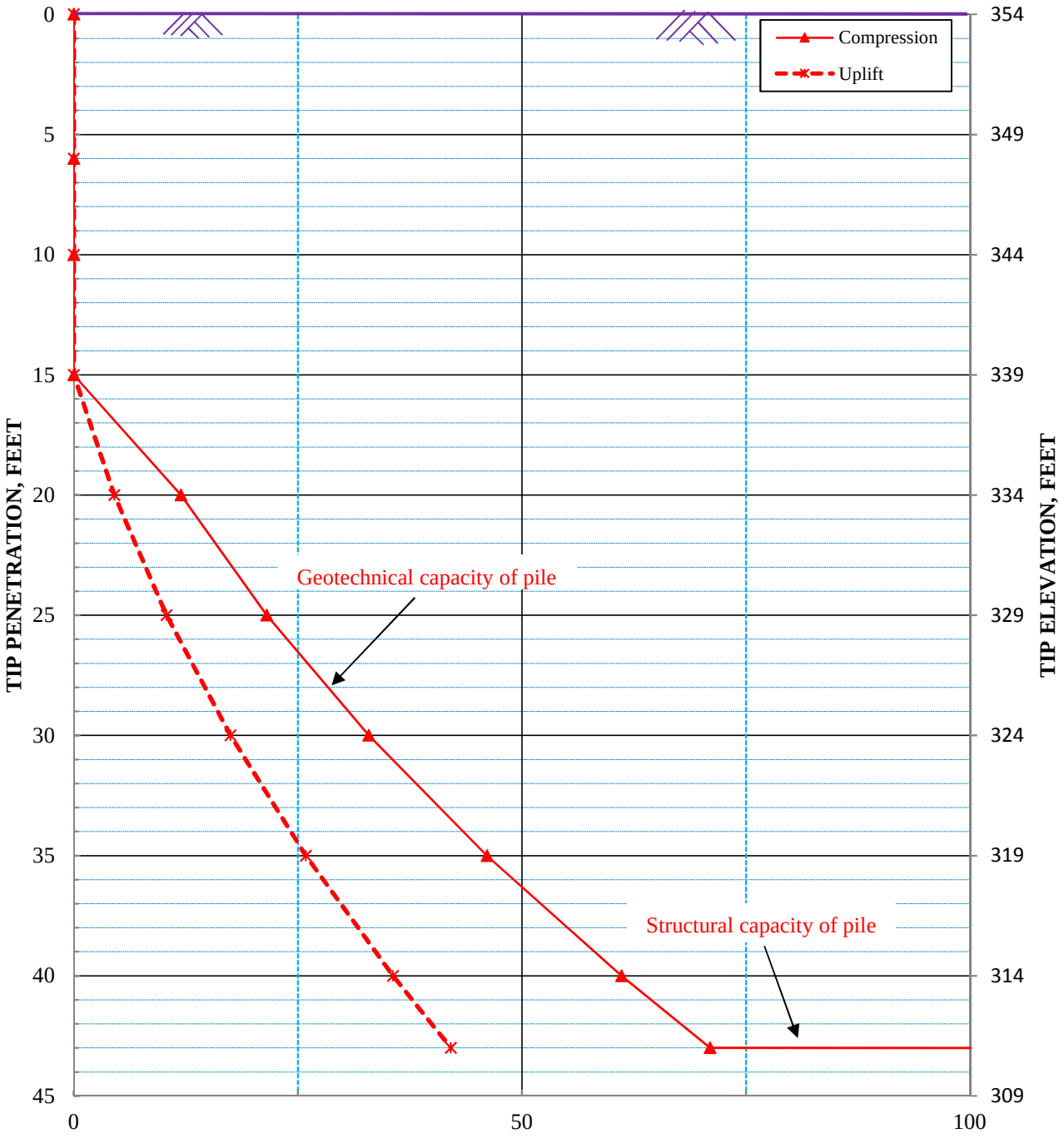
Note: Piles driven from pile cap bottom elevation

ATTACHMENT 8



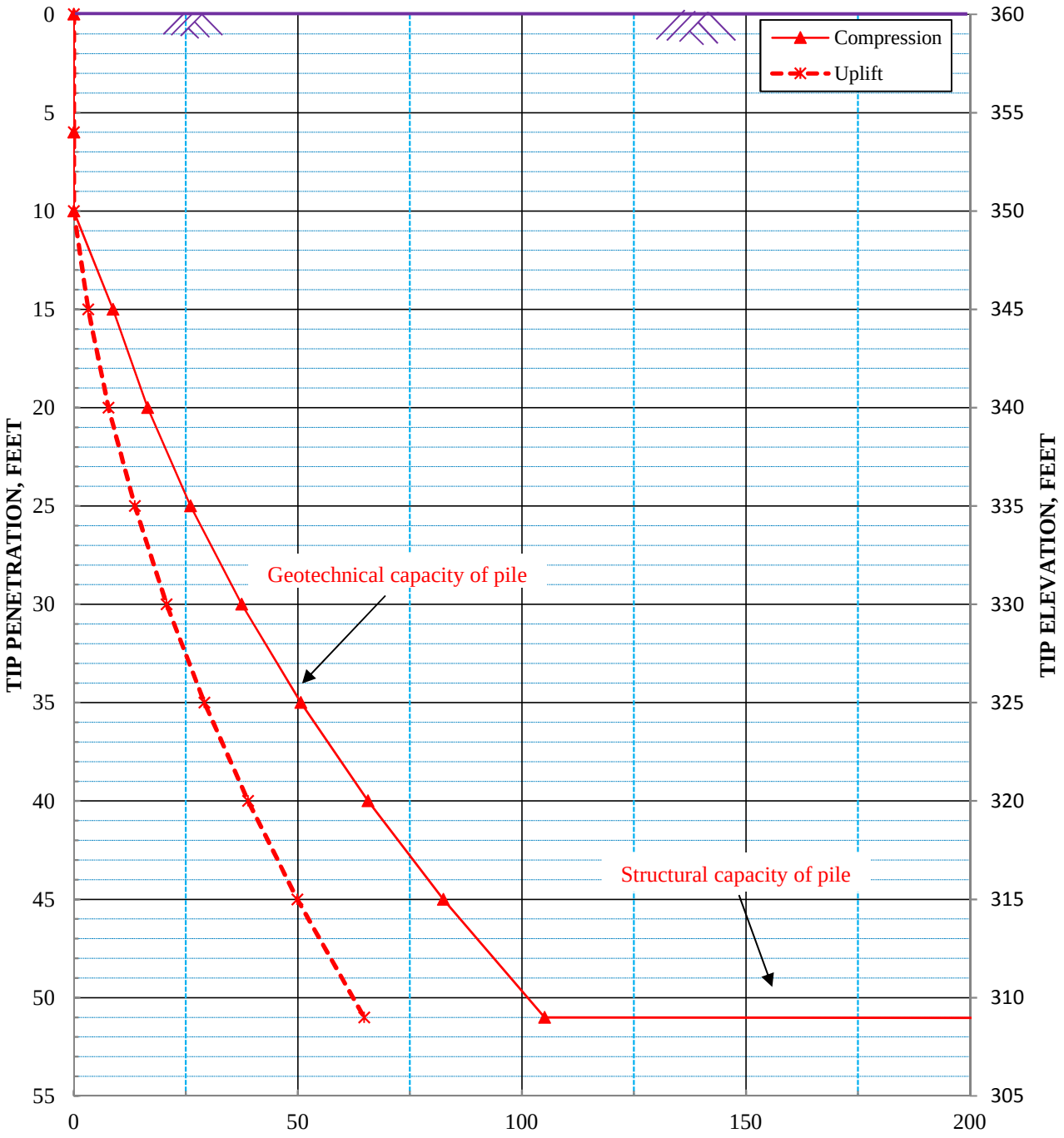
Bent 1 Steel Piles - HP14x73
ARDOT 030501 - Bridge 02082 over Saline River
Sevier County, Arkansas

Note: Piles driven from pile cap bottom elevation



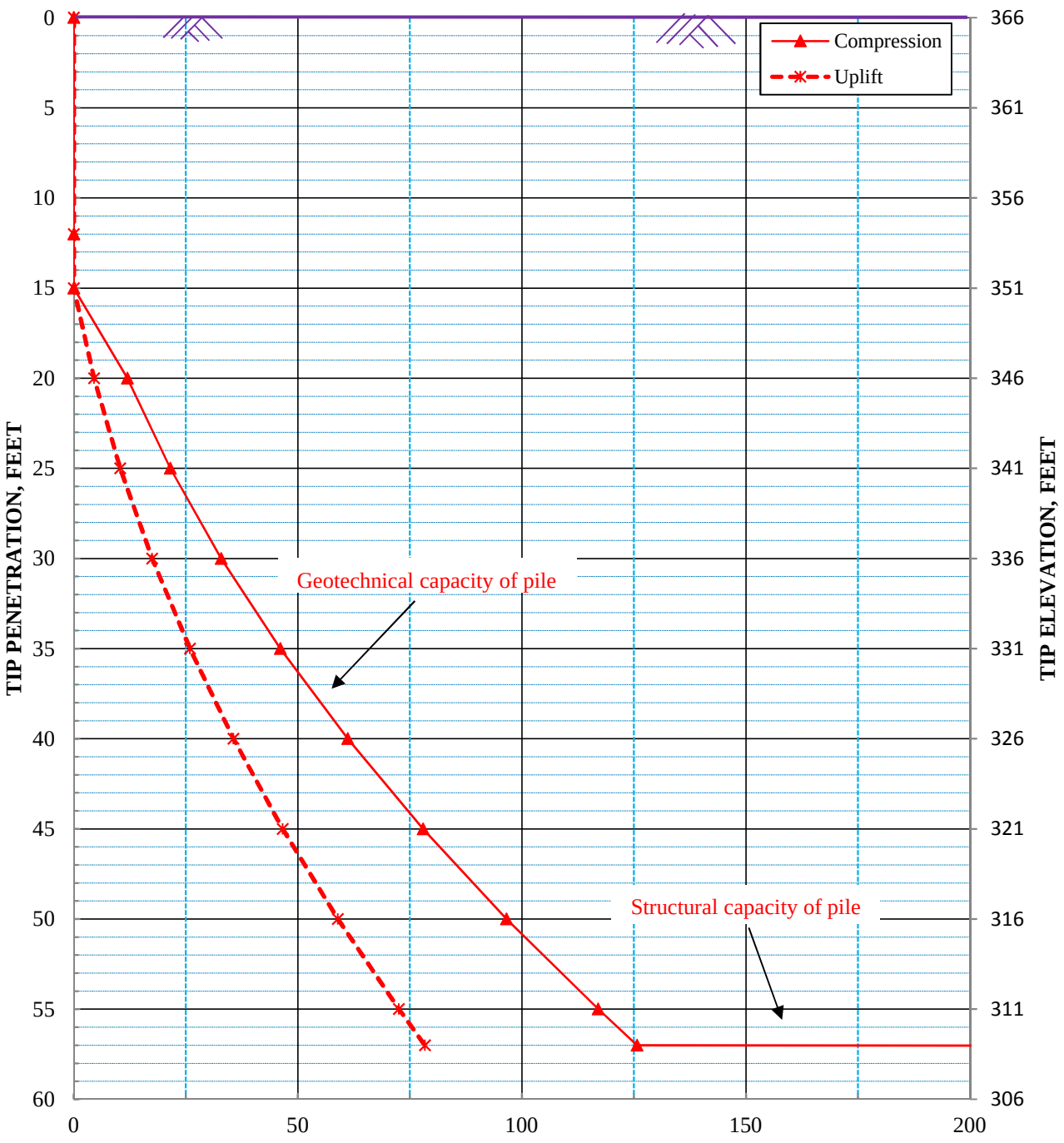
Bent 2 Steel Piles - HP14x73
ARDOT 030501 - Bridge 02082 over Saline River
Sevier County, Arkansas

Note: Piles driven from pile cap bottom elevation



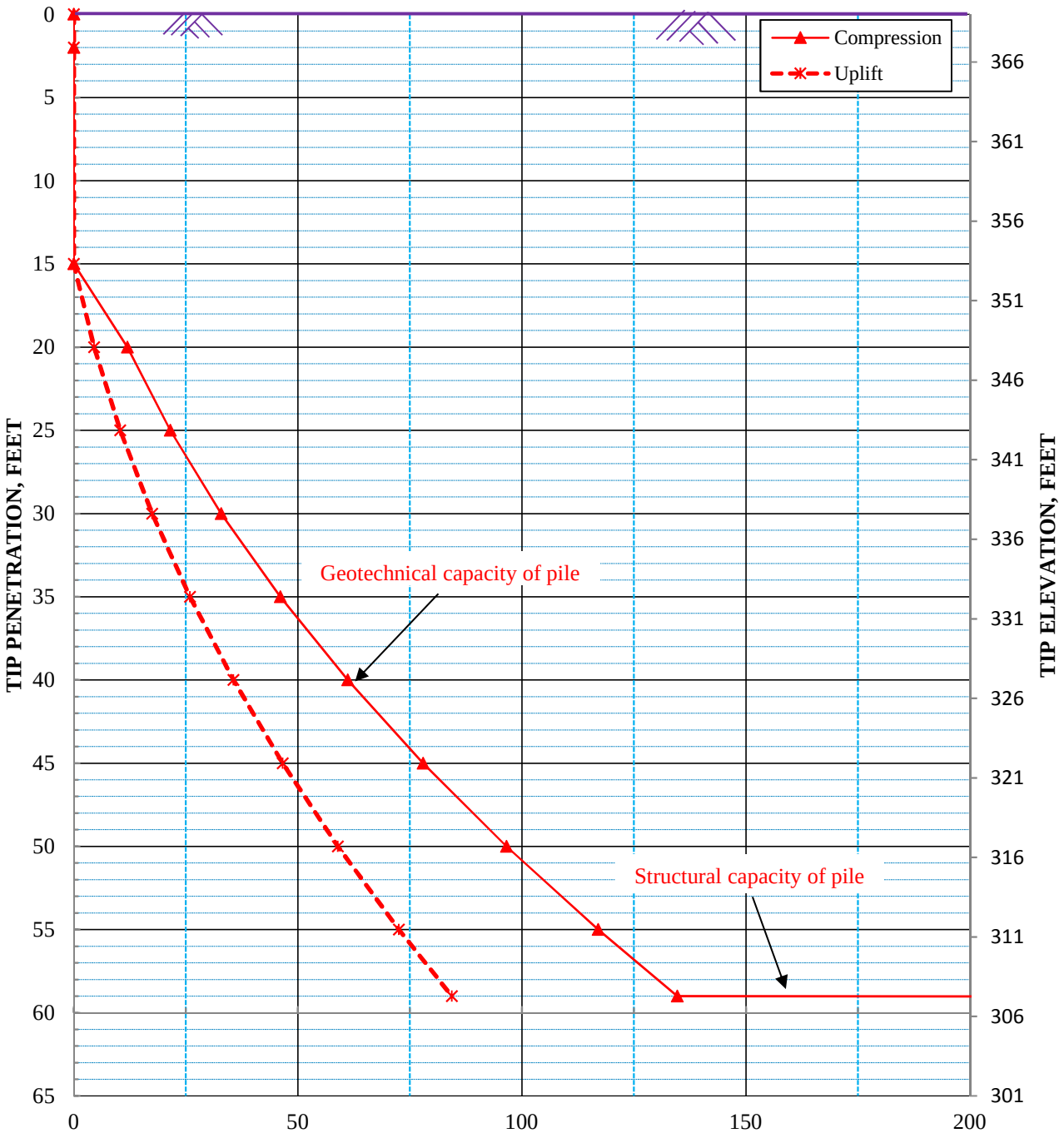
Bent 3 Steel Piles - HP14x73
ARDOT 030501 - Bridge 02082 over Saline River
Sevier County, Arkansas

Note: Piles driven from pile cap bottom elevation



Bent 4 Steel Piles - HP14x73
ARDOT 030501 - Bridge 02082 over Saline River
Sevier County, Arkansas

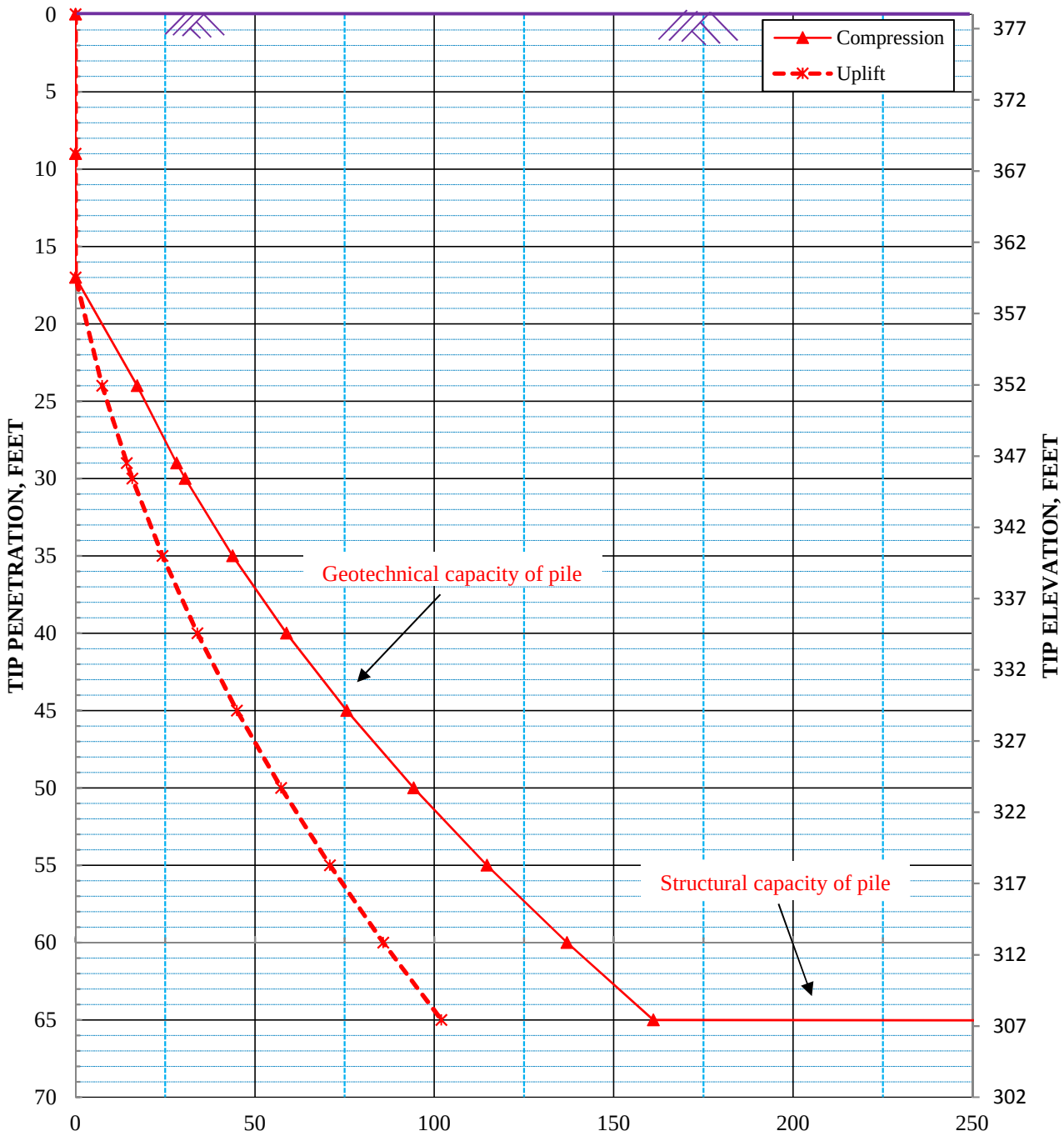
Note: Piles driven from pile cap bottom elevation



Bent 5 Steel Piles - HP14x73
ARDOT 030501 - Bridge 02082 over Saline River
Sevier County, Arkansas

Note: Piles driven from pile cap bottom elevation

NOMINAL SINGLE PILE CAPACITY, TONS



NOMINAL SINGLE PILE CAPACITY, TONS

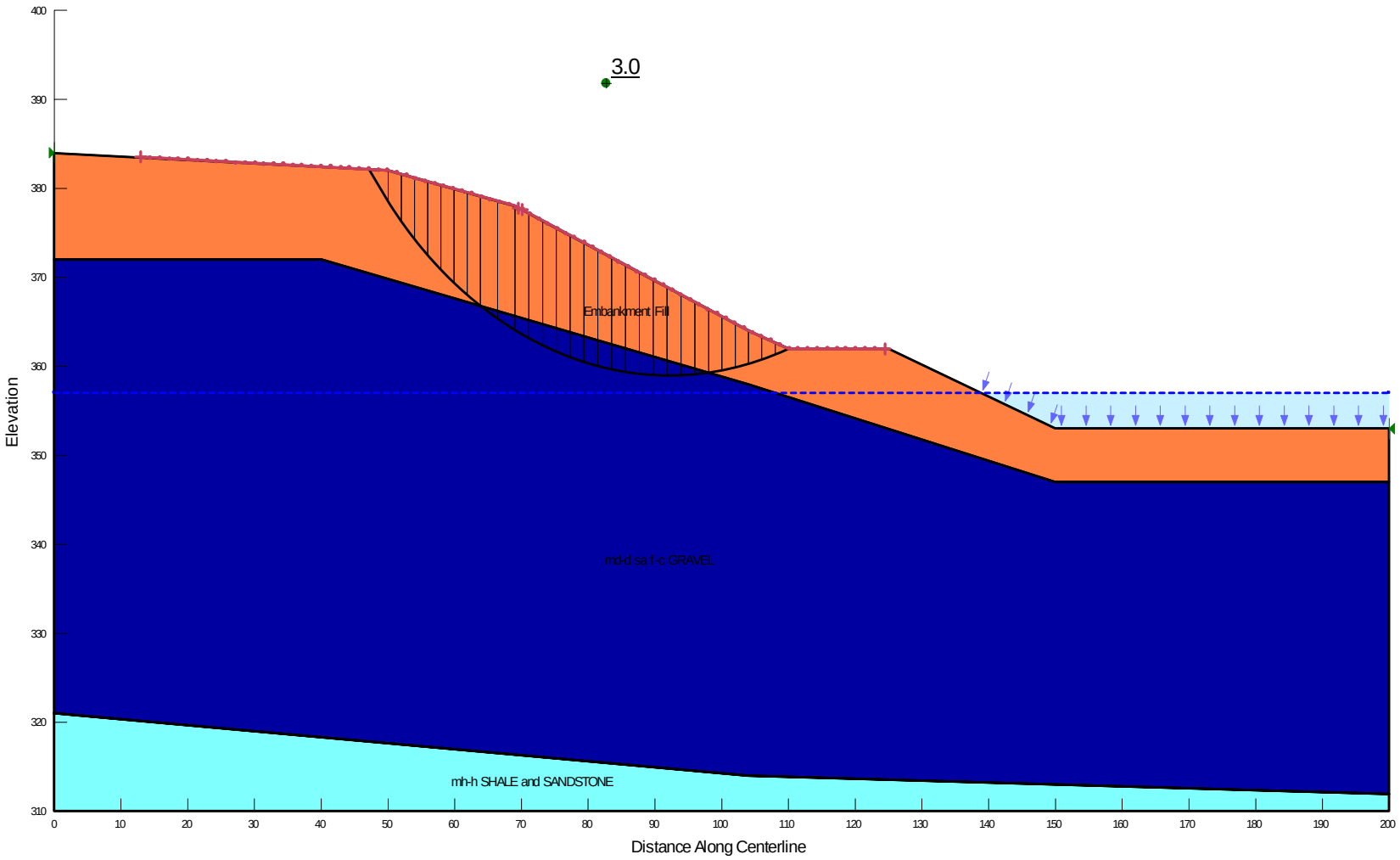
Bent 6 Steel Piles - HP14x73
ARDOT 030501 - Bridge 02082 over Saline River
Sevier County, Arkansas

Note: Piles driven from pile cap bottom elevation

ATTACHMENT 9

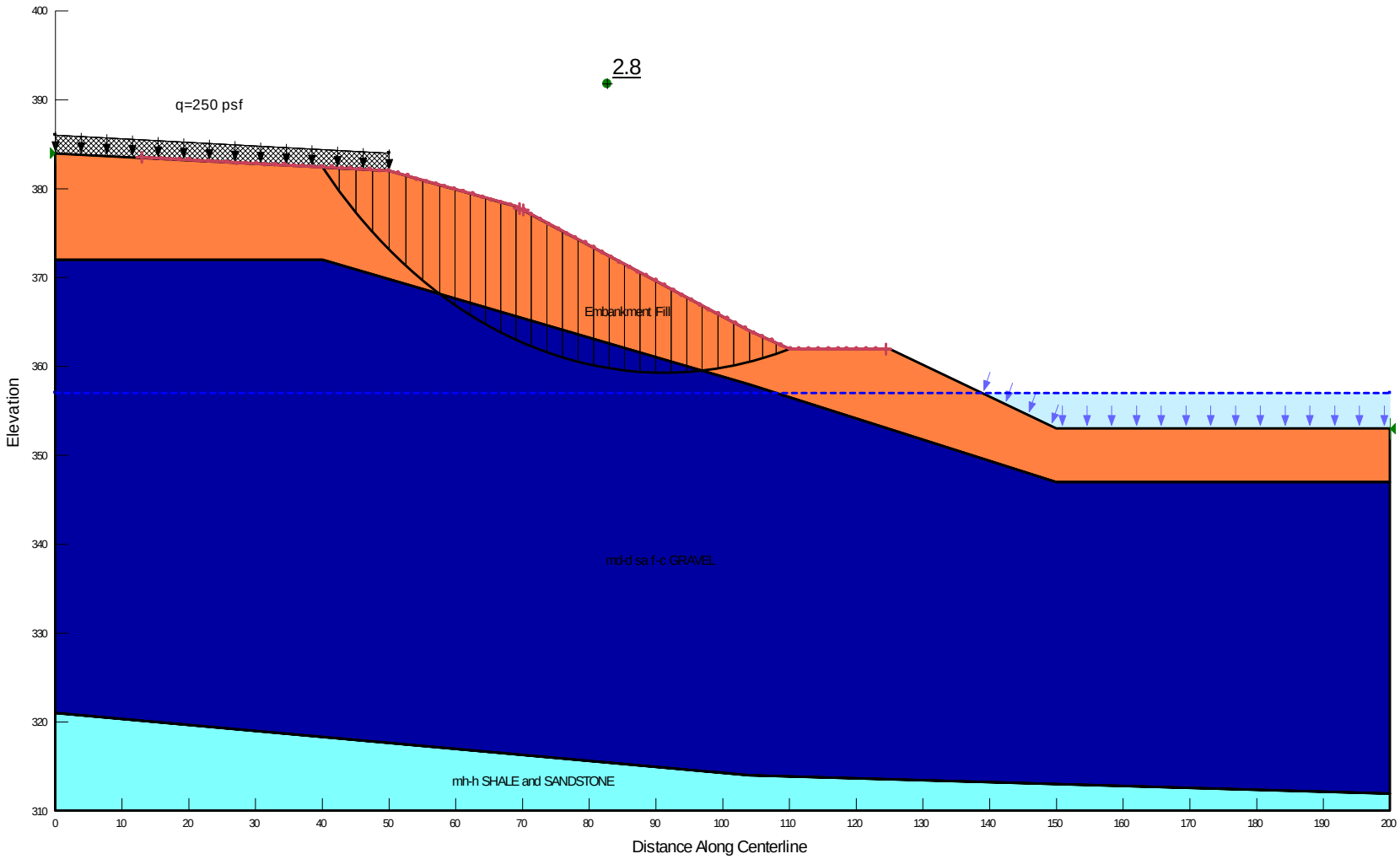
Summary of Stability Analysis Results
ARDOT Job No. 030501 Saline & Caddo Rivers Strs. & Apprs. (S)
Bridge 02082 Over Saline River
GHBW Job No. 18-040
Sevier and Howard County, Arkansas

Bridge End	Design Loading Condition	Calculated Minimum Factor of Safety
Bent 1 End Slope	End of Construction	3.0
	Long Term	2.8
	Rapid Drawdown from El 374 to Existing Grade	2.0
	Seismic ($k_h = A_S/2 = 0.044$)	2.6
Bent 6 End Slope	End of Construction	3.4
	Long Term	2.8
	Rapid Drawdown from El 374 to Existing Grade	2.7
	Seismic ($k_h = A_S/2 = 0.044$)	3.0

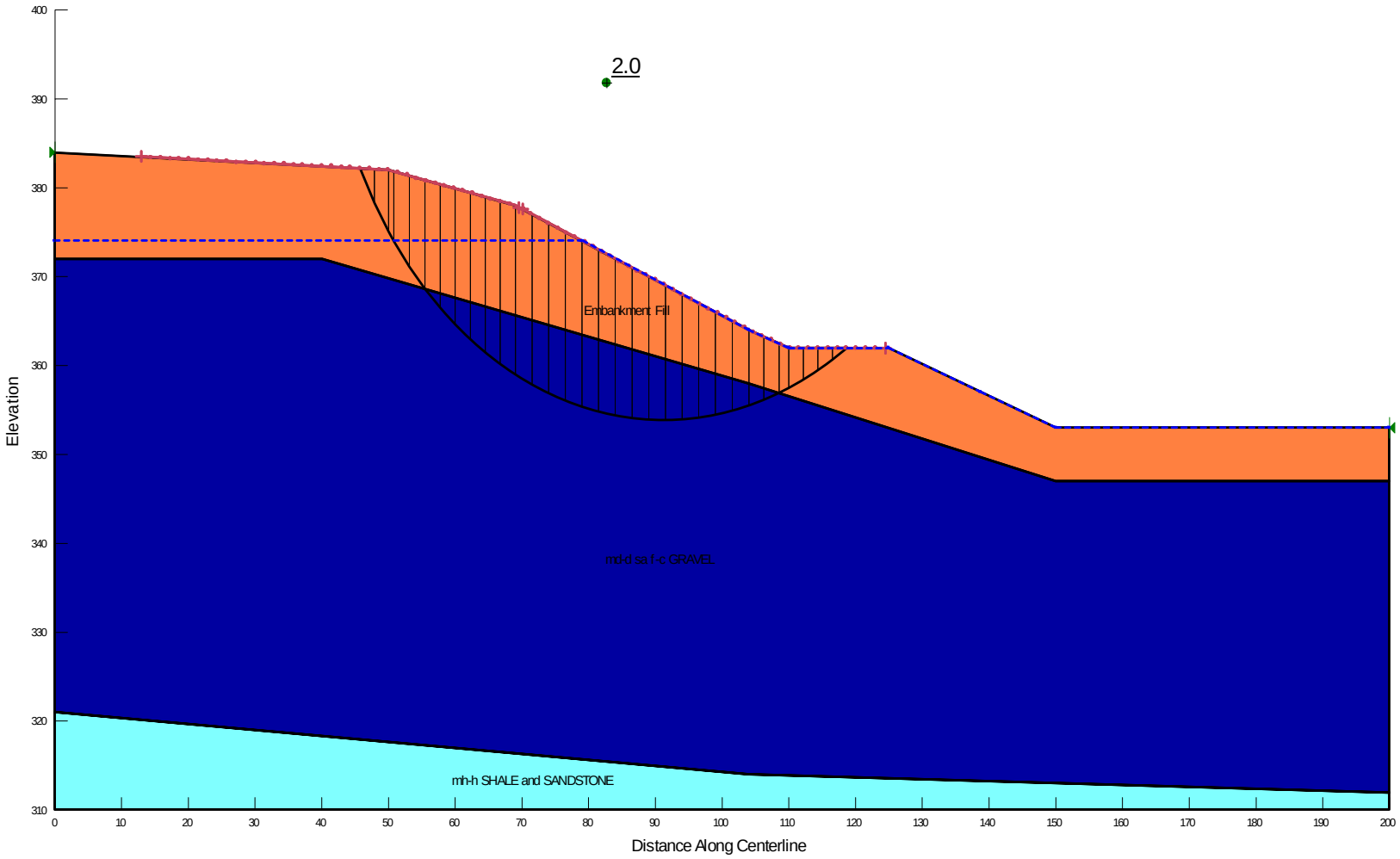


Results of Stability Analyses – End of Construction
Bent 1 End Slope
ARDOT Job No. 030501 Saline & Caddo Rivers Strs. & Apprs. (S)
Bridge 02082 Over Saline River
GHBW Job No. 18-040
Sevier and Howard County, Arkansas

GRUBBS, HOSKYN, BARTON & WYATT, INC.
Consulting Engineers

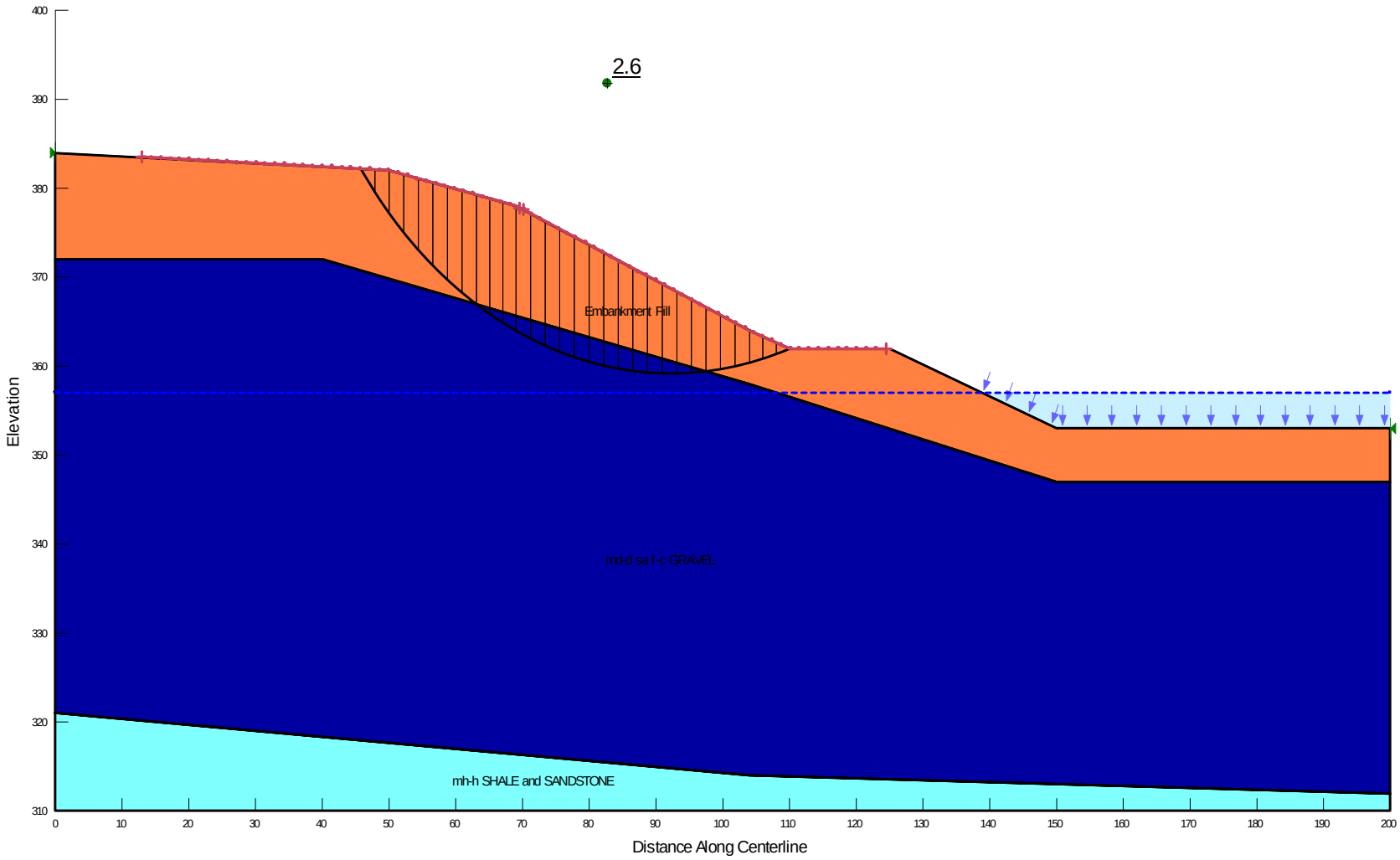


Results of Stability Analyses – Long Term Condition
Bent 1 End Slope
ARDOT Job No. 030501 Saline & Caddo Rivers Strs. & Apprs. (S)
Bridge 02082 Over Saline River
GHBW Job No. 18-040
Sevier and Howard County, Arkansas



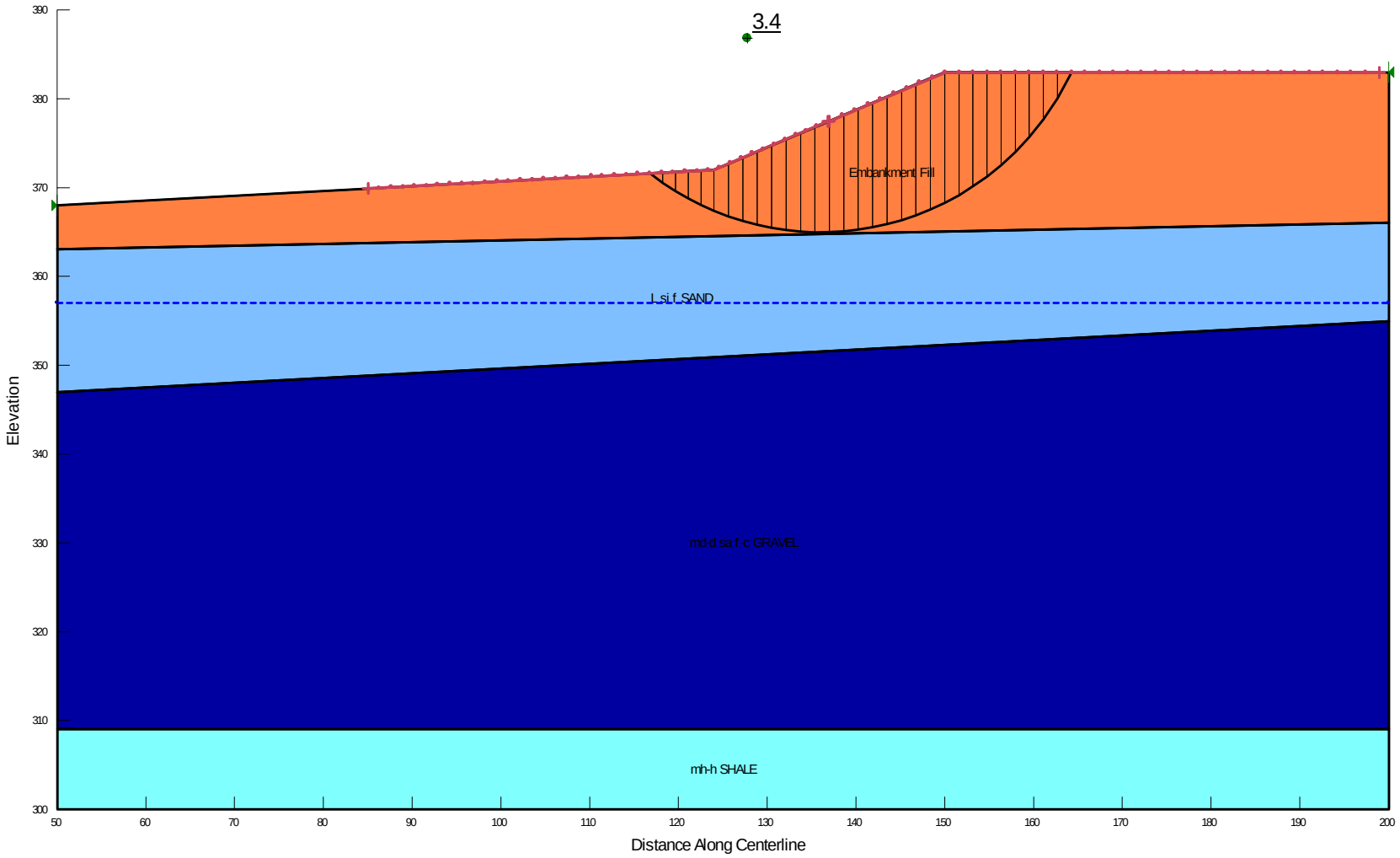
Results of Stability Analyses – Rapid Drawdown Condition, EI 374 to Exisitng Grade
Bent 1 End Slope
ARDOT Job No. 030501 Saline & Caddo Rivers Strs. & Apprs. (S)
Bridge 02082 Over Saline River
GHBW Job No. 18-040
Sevier and Howard County, Arkansas

GRUBBS, HOSKYN, BARTON & WYATT, INC.
Consulting Engineers



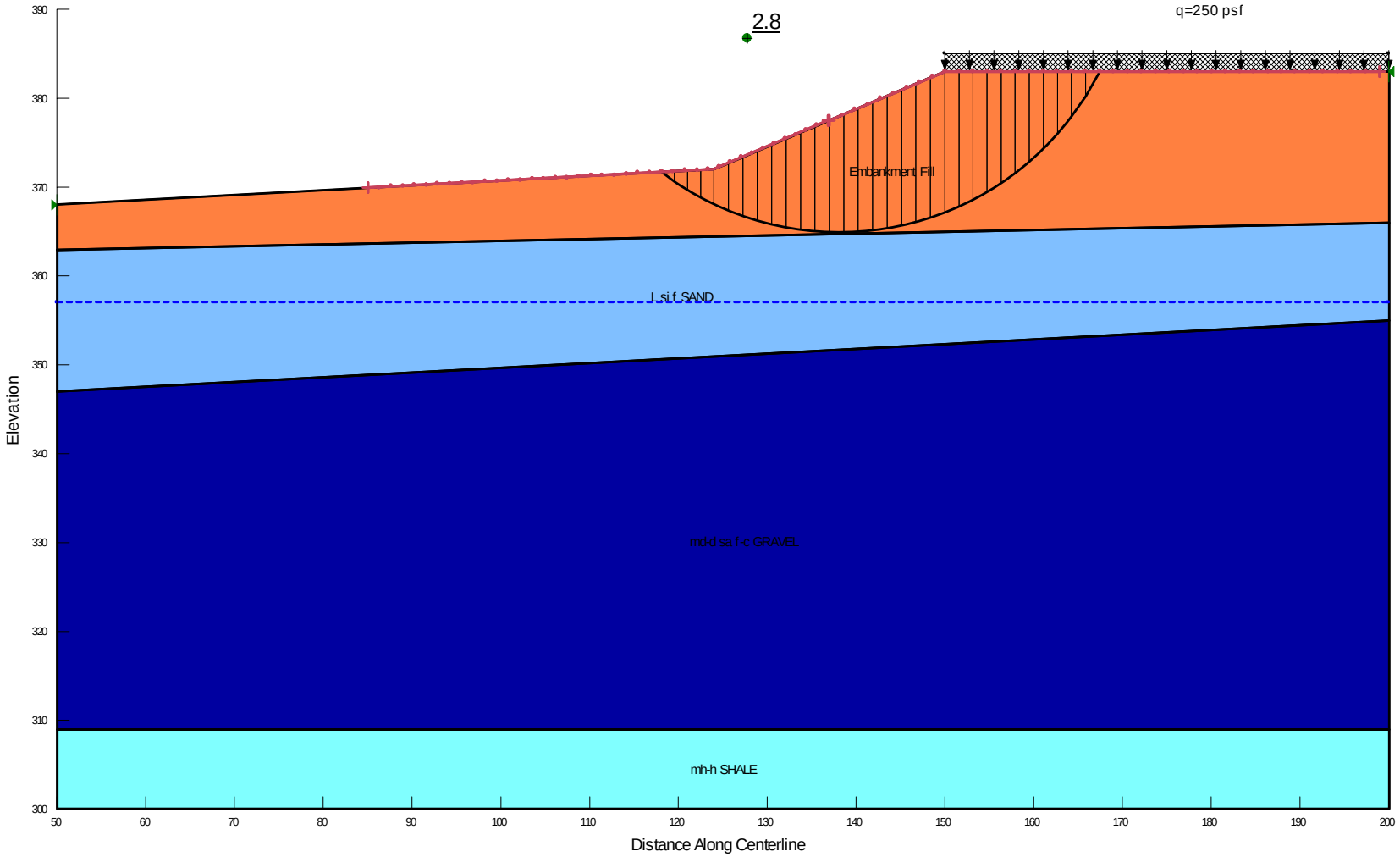
Results of Stability Analyses – Seismic Condition ($k_h = A_S /2 = 0.044$)
Bent 1 End Slope
ARDOT Job No. 030501 Saline & Caddo Rivers Strs. & Apprs. (S)
Bridge 02082 Over Saline River
GHBW Job No. 18-040
Sevier and Howard County, Arkansas

GRUBBS, HOSKYN, BARTON & WYATT, INC.
Consulting Engineers



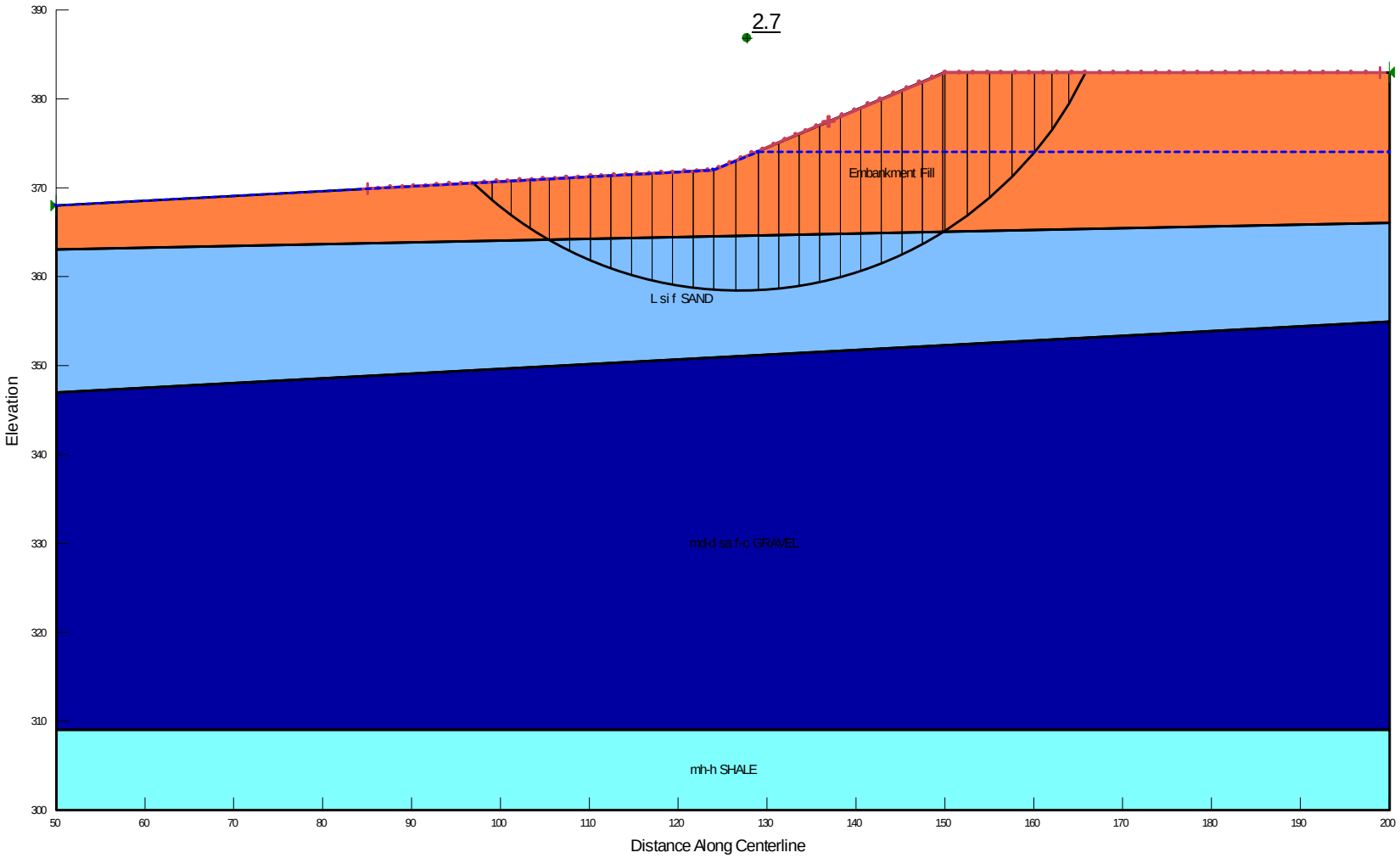
Results of Stability Analyses – End of Construction
Bent 6 End Slope
ARDOT Job No. 030501 Saline & Caddo Rivers Strs. & Apprs. (S)
Bridge 02082 Over Saline River
GHBW Job No. 18-040
Sevier and Howard County, Arkansas

GRUBBS, HOSKYN, BARTON & WYATT, INC.
Consulting Engineers



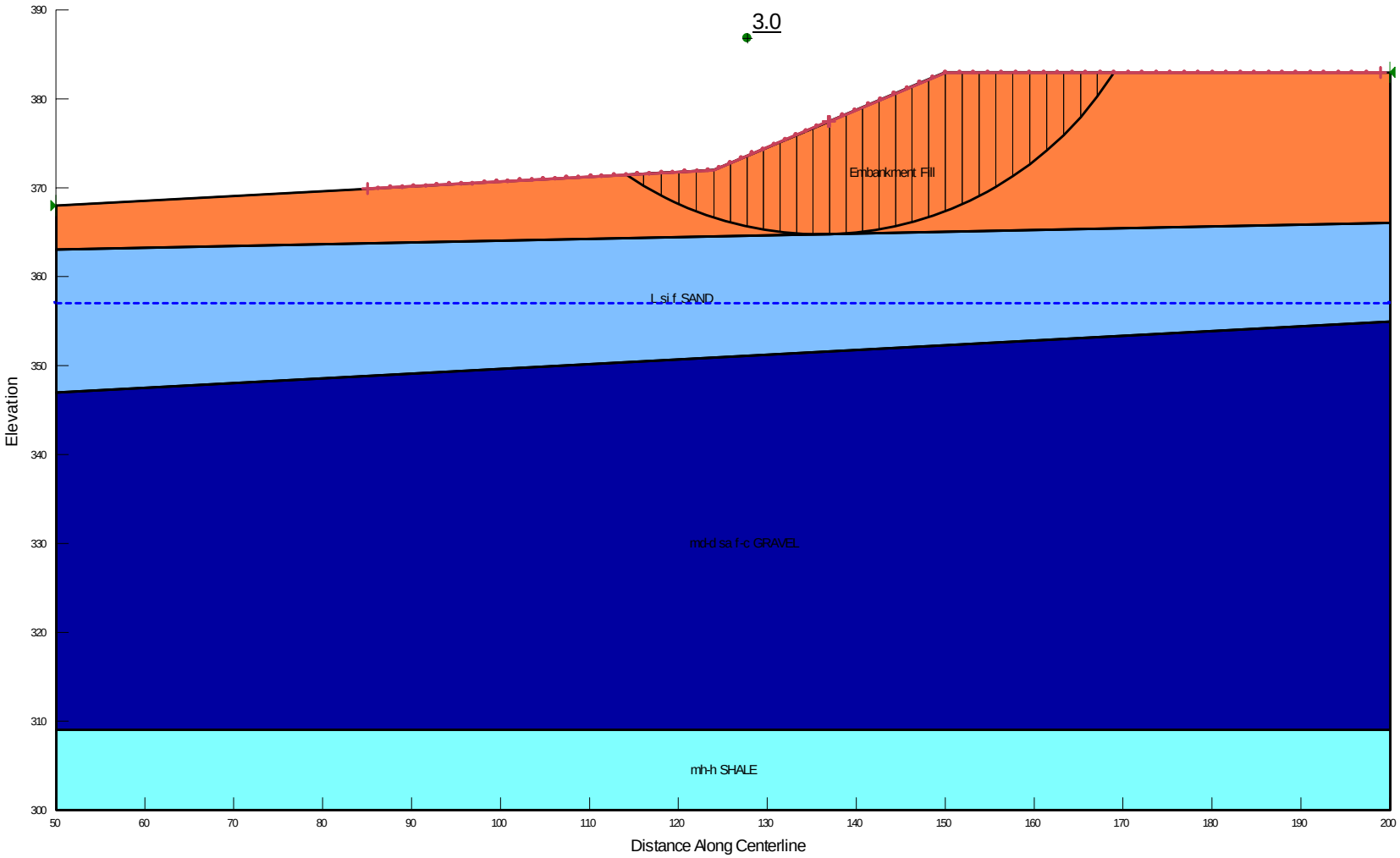
Results of Stability Analyses – Long Term Condition
Bent 6 End Slope
ARDOT Job No. 030501 Saline & Caddo Rivers Strs. & Apprs. (S)
Bridge 02082 Over Saline River
GHBW Job No. 18-040
Sevier and Howard County, Arkansas

GRUBBS, HOSKYN, BARTON & WYATT, INC.
Consulting Engineers



Results of Stability Analyses – Rapid Drawdown Condition, EI 374 to Existing Grade
Bent 6 End Slope
ARDOT Job No. 030501 Saline & Caddo Rivers Strs. & Apprs. (S)
Bridge 02082 Over Saline River
GHBW Job No. 18-040
Sevier and Howard County, Arkansas

GRUBBS, HOSKYN, BARTON & WYATT, INC.
Consulting Engineers



Results of Stability Analyses – Seismic Condition ($k_h = A_S /2 = 0.04$)
Bent 6 End Slope
ARDOT Job No. 030501 Saline & Caddo Rivers Strs. & Apprs. (S)
Bridge 02082 Over Saline River
GHBW Job No. 18-040
Sevier and Howard County, Arkansas

GRUBBS, HOSKYN, BARTON & WYATT, INC.
Consulting Engineers

Grubbs, Hoskyn, Barton & Wyatt, INC.
CONSULTING ENGINEERS

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(501) 455-2536
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October 2, 2018
Job No. 18-040

Michael Baker International
Union Station
1400 West Markham, Suite 204
Little Rock, Arkansas 72201

Attn: Mr. Scott P. Thornsberry, P.E.
Project Manager - Transportation

GEOTECHNICAL INVESTIGATION
ARDOT JOB 030501 SALINE & CADDO RIVERS STRS. & APPRS. (S)
BRIDGE 03089 – HWY. 70 OVER CADDO RIVER
PIKE COUNTY, ARKANSAS

INTRODUCTION

Submitted herein are the final results of the geotechnical investigation performed for ARDOT Job 030501 Saline & Caddo Rivers Strs. & Apprs. (S). Specifically, these recommendations are for Bridge 03089, Hwy. 70 over the Caddo River in Glenwood, Pike County, Arkansas. This geotechnical investigation was authorized on behalf of Michael Baker International by the subconsultant agreement of March 27, 2018. This study has been performed in general accordance with our submittal of March 1, 2018 (GHBW Proposal No. 18-044). Results of this study have been provided to Michael Baker International as data were developed. Interim recommendations for subgrade support parameters were provided on August 23, 2018.

We understand the replacement bridge will be continuous composite plate girder units with six (6) bents, five (5) spans, and a total length of approximately 602 feet. We also understand that a foundation system consisting of steel piles is planned at the bridge ends (Bents 1 and 6) and drilled shaft foundations are planned at the interior bents (Bents 2, 3, 4, and 5). Foundation loads of the new bridge are anticipated to be moderate. Simple slopes will be utilized at the bridge ends. A preliminary bridge layout is provided in Attachment 1.

Recommendations for seismic site classification and bridge foundations for the planned bridge are discussed in the following report sections. Additionally, stability analyses have been performed for the planned simple slopes at the bridge ends and subgrade parameters have been

provided for pavement design. The results of the subsurface exploration program and laboratory test results are included in the attachments.

SUBSURFACE EXPLORATION

Subsurface conditions at the replacement bridge location were investigated by drilling seven (7) sample and core borings to depths of 36 to 50 ft and excavating one (1) test pit to 2-ft depth. The site vicinity is shown on Plate 1 of Attachment 2. The approximate boring locations at the new bridge and pavement locations are shown on Plates 2a and 2b. The subsurface exploration program is summarized on Plate 3 of Attachment 2. Keys to the terms and symbols used on the boring logs are presented as Plates 4 and 5 of Attachment 2.

The boring logs for the replacement bridge structure are presented in Attachment 3. A generalized subsurface profile in the bridge alignment is provided on Plate 8 of Attachment 3. Photographs of rock cores recovered from the structure borings are provided in Attachment 4. The boring logs from the pavement borings are provided in Attachment 5. The centerline station and offset of the boring locations and the inferred ground surface elevation are noted on the logs. The approximate boring surface elevation was inferred from the topographic information provided by the Engineer (Michael Baker International). It must be recognized that the elevations shown are approximate and actual elevations may vary.

A generalized subsurface profile is shown on Plate 8 of Attachment 3 is provided to aid in visualizing subsurface conditions in the bridge alignment. It should be recognized that the stratigraphy illustrated by the profile has been inferred between discrete boring locations. In view of the natural variations in stratigraphy and conditions, variations from the stratigraphy illustrated by the profiles should be anticipated. Additionally, the natural transition between strata is generally gradual, and the stratigraphy shown on the profile and described elsewhere in this report may vary.

The borings were drilled with truck-mounted SIMCO 2400 and SIMCO 2800 rotary-drilling rigs. Samples were typically obtained at 2-ft intervals to 10-ft depth and at 5-ft intervals thereafter. Samples were recovered using a 2-in.-diameter split-barrel sampler driven into the strata by blows of a 140-lb hammer with 30-in. drop in accordance with Standard Penetration Test (SPT) procedures. A safety hammer was used with the SIMCO 2400 and the SIMCO 2800 utilized an automatic hammer. The number of blows required to drive the standard split-barrel sampler the final 12 in. of an 18-in. total drive, or a portion thereof, is defined as the Standard Penetration Number

(N). Recorded N-values are shown on the boring logs in the "Blows Per Ft" column. Where rock hardness precluded recovery with the split-spoon, cuttings were recovered for use in visual classification.

Representative samples of the shale and sandstone bedrock were obtained using a 5-ft-long NQ_{WL}-size double-tube core barrel with a diamond or carbide bit. For each core run, the percent recovery was determined as the ratio of recovery to total length of core run. Rock Quality Designation (RQD) was also determined for the core run as the sum of intact, sound rock core greater than 4-in. length divided by the total length of the run and expressed in percent. Both these values are presented in the right hand columns of the log forms, opposite the corresponding core run. Where rock was not cored cuttings were collected for visual examination. Photographs of the recovered rock cores are provided in Attachment 3.

All samples were extruded or otherwise removed from samplers in the field. Samples were visually classified and placed in appropriate containers to prevent moisture loss and/or disturbance during transfer to our laboratory for further examination and testing.

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

LABORATORY TESTING

To evaluate pertinent soil and rock properties, laboratory tests consisting of classification tests, natural water content determinations, and uniaxial compressive strength of rock cores were performed.

A total of 51 natural water content determinations were performed to develop a soil water content profile for each boring. Water content results are plotted on the boring log forms in accordance with the scale and symbols shown in the legend located in the upper-right corner of the logs.

To verify field classification and to evaluate soil plasticity, 14 liquid and plastic limit (Atterberg limits) determinations and 15 sieve analyses were performed on selected representative samples. The Atterberg limits are plotted on the log as pluses inter-connected with a dashed line using the water content scale. The percentage of soil passing through the No. 200 Sieve is noted in the "- No. 200 %" column on the appropriate log forms. Classification test

results, along with soil classification by the Unified Soil Classification System and AASHTO designations, are summarized in Attachment 6.

Selected rock core samples were tested for unit weight and compressive strength. The test results are indicated on the boring logs, in lbs per sq in., at the appropriate depth. The total unit weight (TUW) is also noted on the logs.

One (1) laboratory moisture-density relationship (Proctor) test was performed on a representative bulk soil sample obtained in the approach road alignment to evaluate the moisture-density relationship of on-site subgrade soils. The Proctor test and bulk sample classification test results are provided in Attachment 7. Pavement subgrade support properties of the potential subgrade soils were evaluated by performing one (1) California Bearing Ratio (CBR) test on the collected bulk sample. The CBR results are also provided in Attachment 7.

GENERAL SITE and SUBSURFACE CONDITIONS

Site Conditions

Bridge 03089 over the Caddo River is planned at Hwy 70 Sta 1999+94 to Sta 2005+96 in Pike County, Arkansas. The new bridge will replace the existing bridge currently spanning the Caddo River. The replacement bridge will have an approximate 602-ft length, spanning the relatively large river channel. At this location, the channel is relatively broad and well formed. The east bank slopes down to the channel, while the west bank is steeper. Sand and gravel bars are common the channel. The flood plain around the channel is primarily open with a short grass cover. The existing Hwy. 70 roadway is a two-lane highway bordered by both shallow ditches and steep hillsides from apparent prior site grading. Surface drainage of the existing roadway is good and drainage of the surrounding terrain varies from poor to fair.

Site Geology

The bridge site is located in the Arkansas Valley and Ouachita Mountains physiographic region and in the mapped outcrop of the Mississippian Period Stanley Shale formation. The Stanley Shale mainly consists of dark gray shale interbedded with fine-grained sandstone. Minor amounts of tuff, chert, barite and conglomerate occur within the formation at varying depths. The formation is reported to be from 3500 to 10,000 feet in thickness. The Stanley Shale rests disconformably on the early Mississippian Arkansas Novaculite.

Seismic Conditions

Based on the site geology, the average soil and rock conditions revealed by the borings, and our experience in the area, a Seismic Site Class C (very dense soil and soft rock profile) is considered fitting for the Bridge 03089 structure site with respect to the criteria of the AASHTO LRFD Bridge Design Specifications Seventh Edition 2014[1]. The liquefaction potential is considered minor for the predominantly cohesive and coarse granular overburden soils and underlying rock units encountered in the borings.

Given the location and AASHTO code-based values, the 1.0-sec period spectral acceleration coefficient for Site Class C (S_1) is 0.058 and the 1.0-sec period spectral acceleration coefficient (S_{D1}) value for Site Class C is 0.099. Utilizing these parameters, Table 3.10.6-1[2] indicates that a Seismic Performance Zone 1 is fitting for the Bridge 03089 site. In reference to the 2011 edition of the AASHTO Guide Specifications, the Peak Ground Acceleration (PGA) having a 7 percent chance of exceedance in 75 years (or mean return period of approximately 1000 years) is predicted to be 0.067 for a Seismic Site Class C for the bridge location.

Subsurface Conditions

Based on the results of the borings, the subsurface stratigraphy may be generalized into several primary strata as follows.

Stratum I: The on-site embankment fill is comprised of soft to very stiff reddish brown fine sandy clay and silty clay with fine to coarse gravel and varying amounts of sandstone fragments and medium dense brown fine sandy silt. The fill extends to depths ranging from 2 to 8.5 ft in the bridge alignment and to depths of 9 to 12 ft where encountered at the pavement boring locations. The fill exhibits low plasticity and variable poor to good compaction. The embankment fill soils typically classify as A-1-b, A-2-4, A-4, and A-6 by the AASHTO classification system (AASHTO M 145), which correlates with poor to good subgrade support for pavement structures.

Stratum II: The natural surface and near-surface overburden soils are stiff dark brown and brown fine sandy clay and silty clay with varying amounts of fine to coarse gravel and medium dense to dense reddish tan, tan, and brown sandy fine to coarse gravel. The natural overburden soils extend to depths of 3 to 18 feet. The fine sandy clay and silty clay have low plasticity and moderate shear strength. The fine to coarse gravel has medium to high relative density and moderate to low compressibility.

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1 AASHTO LRFD Bridge Design Specifications, 7th Edition; AASHTO; 2014.

2 AASHTO LRFD Bridge Design Specification, AASHTO; 2012

The natural overburden soils typically classify as A-2-4, A-4, and A-6 by the AASHTO classification system (AASHTO M 145), correlating with poor to good subgrade support for pavement structures.

Stratum III: The basal stratum encountered in the borings is moderately hard tan and dark gray arenaceous weathered shale, shale, tan and dark gray argillaceous weathered fine-grained sandstone and sandstone. The shale and sandstone are often interbedded. The upper weathered shale units may contain silty clay and/or clay laminations, seams and layers in weathered units while the sandstone may contain calcite inclusions and pyrite partings. The shale and sandstone have variable degrees of weathering within the upper 5 to 10 feet. However, weathering generally decreases and rock quality increases with depth. Rock bedding is typically steeply dipping with bedding planes inclined greater than 50 degrees.

Groundwater Conditions

Groundwater was encountered at 2- to 14-ft depth at the bridge location in April and June 2018. Seasonal seeps and springs could be locally present as infiltrated surface water migrates from areas of higher terrain through the overburden soils and upper fractured zones of the shale. Perched water could also occur locally at shallow depths within the fill-soil-rock interface. Groundwater levels will vary, depending upon seasonal precipitation, surface runoff and infiltration, and water levels in the nearby Caddo River and other surface water features.

ANALYSES and RECOMMENDATIONS

Foundation Design for Bridges

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

In light of the results of the borings performed for this study, the anticipated moderate bridge foundation loads, and our understanding of the project, we recommend that foundation loads be supported on steel piling at the bridge ends (Bents 1 and 6) and on drilled shafts at the interior bents (Bents 2, 3, 4, and 5). Recommendations for foundations are discussed in the following report sections.

Bridge Ends (Bent 1 and Bent 6): Pile Foundations

We recommend that the foundation loads at the bridge ends be supported on steel piles. Steel HP12x53 or HP14x73 piles, or heavier sections, are recommended. Other pile sizes or types may be evaluated if desired. Piles should extend through all embankment fill and overburden soils to bear in the moderately hard weathered tan and dark gray shale, dark gray shale, tan weathered sandstone, or dark gray sandstone. Piles should be driven to practical refusal. All steel piles should be fitted with rock points.

Bearing capacities of piles driven to refusal must be determined using the AASHTO Load and Resistance Factor Design (LRFD) structural design procedure. We recommend that nominal resistance (P_n) of steel piles be determined based on the yield strength of steel H piles (f_y) and the net end area (A_{net}) of the section. Given that the piles will be driven to refusal in hard rock with the potential for driving damage, we recommend a maximum allowable stress (σ_{all}) of 0.25 f_y. An effective resistance factor (φ_b) of 0.50 is recommended for end bearing piles. This effective resistance factor for steel piles has been based on the assumption of difficult driving.

It has been our experience that allowable pile capacities of 96 tons for HP12x53 piles and 133 tons for HP14x73 piles are common for f_y 50 ksi steel. These capacities are based on allowable stress design (ASD). However, the appropriate factored bearing capacity must be determined by the Engineer.

We recommend a minimum pile penetration of 10 ft below natural grade unless practical refusal is encountered in the moderately hard to hard shale or sandstone at shallower depth. We recommend a minimum pile length of 12 feet.

Post-construction settlement of piles driven to refusal will be negligible. The preliminary layout indicates that piles will extend through 8 to 10 ft of new embankment fill. Given an anticipated construction sequence with embankment fill placement in excess of 30 days prior to pile driving, downdrag loads on piles are expected to be negligible. Preboring is not expected to be required for pile installation. However, some large rock fragments might be encountered in on-site embankment fill that could mandate preboring in some instances. In the event that preboring is required, the prebore diameter should be large enough to prevent pile damage during driving. We also recommend that the prebore annulus around piles be backfilled with grout, lean concrete, or an approved alternate.

Estimated pile tip elevations for steel pipes at bridge ends, as based on the results of the borings, are summarized in the table below.

Estimated Tip Elevations of Steel Piles Driven to Refusal

Bent No.	Estimated Pile Tip Elevation, ft
Bent 1	513
Bent 6	528

It should be noted that the tip elevations shown in the tables above are estimates only based on the results of the borings and the inferred surface elevations at the particular locations. Pile capacity and as-built depth must be field verified.

Drilled Shaft Foundations – Bents 2, 3, 4, and 5

Drilled straight-shafts are recommended for support of foundation loads at the interior bents, i.e., Bents 2, 3, 4, and 5. Drilled shafts should be founded with a minimum embedment of 10 ft or two (2) shaft diameters, whichever is greater, into the moderately hard to hard weathered shale, shale, or hard weathered fine-grained sandstone and sandstone. Drilled shafts founded as recommended may be sized using a maximum nominal end-bearing pressure (R_n) of 150 kips per sq foot. This bearing capacity for compression is based on end bearing resistance only. A resistance factor (φ) of 0.50 is recommended for drilled shaft end bearing. Total and differential settlement of properly installed drilled shafts founded in the competent shale as described is expected to be negligible. We also recommend that drilled shafts be sized for axial compression loads based on end bearing alone.

Resistance to uplift will be provided by the weight of the foundations and circumferential shaft friction. For calculation of uplift capacity, a maximum nominal skin resistance (R_n) value of 11.5 kips per sq ft may be used for shaft penetration into the competent moderately hard to hard weathered shale, shale, or hard weathered fine-grained sandstone and sandstone. For the calculation of uplift capacity, the penetration within the overburden soil, the top 3 ft of weathered shale, or any cased intervals, whichever length is greater, should be neglected. A resistance factor (φ) of 0.40 is recommended for evaluation of drilled shaft uplift capacity.

A minimum embedment length of either 10 ft or two (2) shaft diameters into moderately hard to hard weathered shale, shale, or hard weathered fine-grained sandstone and sandstone, whichever is greater, a minimum shaft length of 10 ft, and a minimum shaft diameter of 30 in. are recommended for drilled shafts. Drilled shaft excavations should be observed by the Engineer or Department to verify suitable bearing and adequate shaft penetration. Depending on the degree and extent of weathering and rock quality, localized deepening or shortening of shaft depths could be warranted.

End Slopes – Bents 1 and 6

The project scope includes new end slope configurations on the east and west ends of the bridge. The proposed embankment on the east side has an approximate 2.8-horizontal to 1-vertical (2.8H:1V) slope. The east embankment height is expected to be a maximum of 25 feet. The west end embankment slope configuration is expected to be configured on 2.5H:1V slope. The west abutment will have a maximum height of about 21 feet.

To evaluate suitability of the plan configurations, slope stability analyses have been performed. A 250 lbs per sq ft uniform surcharge from vehicles was included for the stability analyses. Stability analyses were performed using the computer program SLOPE/W 2007[3] and a Morgenstern-Price analysis. For the embankment slopes, four (4) general loading conditions were evaluated, i.e., End of Construction, Long Term, Rapid Drawdown, and Seismic Conditions. For analysis of the seismic condition, a horizontal seismic acceleration coefficient (k_h) of one-half the peak acceleration (A_s) was used, a value of 0.04. For evaluating the rapid drawdown condition, a water surface elevation drop from El 541 to channel bottom grade was assumed. The sections used for the analyses are shown in the graphical results provided in Attachment 7.

The results of the stability analyses indicate that stability of the end slope configurations is acceptable with respect to all loading conditions evaluated. Consequently, it is our conclusion that the end slope configurations are suitable with respect to slope stability.

The results of the stability analyses of the end slopes are summarized in the tables below.

Stability Analysis Results – Bent 1, 2.5H:1V, H = 21 ft

Design Load Condition	Calculated Minimum Factor of Safety
End of Construction	2.3
Long Term	2.1
Rapid Drawdown from El 541 to Existing Grade	1.8
Seismic ($k_h = A_s/2 = 0.04$)	2.1

[3] Slope/W 2007; GEO-SLOPE International; 2008.

Stability Analysis Results – Bent 6, 2.8H:1V, H = 25 ft

Design Load Condition	Calculated Minimum Factor of Safety
End of Construction	3.9
Long Term	2.2
Rapid Drawdown from El 541 to Existing Grade	2.1
Seismic ($k_h = A_s/2 = 0.07$)	2.1

In light of the results of the stability analyses, the plan configurations shown on the layout drawings are considered suitable for all conditions evaluated.

Subgrade Support

Based on the results of the borings and laboratory tests, the on-site subgrade soils are expected to be comprised primarily of embankment fill, including sandy silt to fine sandy clay. The AASHTO classification of the subgrade soils is expected to predominantly consist of A-2-4 and A-6 soils. Locally available borrow for use as unclassified embankment fill is expected to be comprised of similar soils.

The as-built pavement subgrade should be evaluated by the Engineer. Areas of unstable or otherwise unsuitable subgrade should be improved by undercut and replacement or treatment with additives approved by the Engineer.

Based on the results of the borings and laboratory CBR tests and correlation with the AASHTO classification of the anticipated subgrade soils, subgrade support is expected to be poor. The following parameters are recommended for use in pavement design.

- Resilient Modulus (M_R): 3100 lbs per sq inch
- R value: 10

Site Grading and Subgrade Preparation

Site grading/site preparation in the bridge alignment should include necessary clearing and grubbing of trees and underbrush and stripping the organic-containing surface soils in work areas. Where fill depths in excess of 3 ft are planned, stumps may be left after close cutting trees to grade, as per ARDOT criteria. Otherwise, tree stumps must be completely excavated and stumpholes properly backfilled.

The depth of stripping will be variable, with deeper stripping depths in wooded areas, and less stripping required in the areas of higher terrain. In general, the stripping depth is estimated to be about 6 to 9 in. in cleared areas, but may be 18 to 24 in. or more in the localized wooded areas

and areas with thick underbrush. The zone of organic surface soils should be completely stripped in the embankment footprint areas and at least 5 ft beyond the projected embankment toe.

Where existing pavements are to be demolished, consideration may be given to utilizing the processed asphalt concrete and aggregate base for embankment fill. In this case, the demolished materials should be thoroughly blended and processed to a reasonably well-graded mixture with a maximum particle size of 2 in. as per Standard Specifications for Highway Construction, 2014 Edition, Section 212. If abandoned pavements are within 3 ft of the plan subgrade elevation, the existing pavement surface should be scarified to a minimum depth of 6 inches. The scarified material should be recompacted to a stable condition.

Following required pavement demolition, clearing and grubbing, and stripping, and prior to fill placement or otherwise continuing with subgrade preparation, the extent of weak and unsuitable soils should be determined. Thorough proof-rolling should be performed to verify subgrade stability. Proof-rolling should be performed with a loaded tandem-wheel dump truck or similar equipment. Unstable soils exhibiting a tendency to rut and/or pump should be undercut and replaced with suitable fill. Care should be taken that undercuts, stump holes, and other excavations or low areas resulting from subgrade preparation are properly backfilled with compacted fill. Based on the results of the borings, localized undercutting could be required to develop subgrade stability. Potential undercut depths are estimated to be on the order of 1 ft, more or less.

In areas of deep fills, the potential exists for use of thick initial lifts ("bridging"), as per ARDOT criteria. Bridge lifts will be subject to some consolidation. Settlement of a primarily granular fill suitable for use in bridging would be expected to be relatively rapid and long-term post-construction settlement would not be expected to be a significant concern. Where clayey soils are placed in thick lifts, long term settlement will be more significant. Consequently, we recommend that the use of "bridging" techniques be limited to granular borrow soils, i.e., sand or gravel. Where fill amounts are limited to less than about 3 ft, bridging will be less effective and the potential for undercut or stabilization will increase. Use of bridging techniques and fill lift thickness must be specifically approved by the Engineer or Department.

Subgrade preparation and mass undercuts should extend at least 10 ft beyond the embankment toes to the extent possible. Subgrade preparation in roadway areas should extend at least 3 ft outside pavement shoulder edges to the extent possible. The existing drainage features

should be completely mucked out and all loose and/or organic soils removed prior to fill placement.

Fill and backfill may consist of unclassified borrow free of organics and other deleterious materials as per Standard Specifications for Highway Construction, 2014 Edition, Subsection 210.06. Granular soils must be protected from erosion with a minimum 18-in.-thick armor of clayey soil. The on-site silty clay and sandy clay are typically suitable for this use.

Subgrade preparation should comply with Standard Specifications for Highway Construction, 2014 Edition, Section 212. Embankments should be constructed in accordance with Standard Specifications for Highway Construction, 2014 Edition, Section 210. Fill and backfill should be placed in nominal 6- to 10-in.-thick loose lifts. All fill and backfill must be placed in horizontal lifts. Where fill is placed against existing slopes, short vertical cuts should be "notched" in the existing slope face to facilitate bonding of horizontal fill lifts. The in-place density and water content should be determined for each lift and should be tested to verify compliance with the specified density and water content prior to placement of subsequent lifts.

CONSTRUCTION CONSIDERATIONS

Groundwater and Seepage Control

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

Subgrade soils or foundation strata that become saturated by ponding water or runoff should be excavated to undisturbed soil or rock. The embankment subgrade should be evaluated by the Engineer during subgrade preparation.

Shallow perched groundwater could be encountered in the near-surface soils. The volume of groundwater produced can be highly variable depending on the condition of the soils in the immediate vicinity of the excavation. In addition, seasonal surface seeps or springs could develop.

Seepage into excavations and cuts can typically be controlled by ditching or sump-and-pump methods. If seepage into excavations becomes a problem, backfill should consist of select granular backfill (AASHTO M43, No. 57), stone backfill (Standard Specifications for Highway Construction, 2014 Edition, Section 207), or clean aggregate (Standard Specifications for Highway Construction, 2014 Edition, Subsections 403.01 and 403.02 Class 3 mineral aggregate)

up to an elevation above the inflow of seepage. In areas of seepage infiltration, the granular fill should be encapsulated with a filter fabric complying with Standard Specifications for Highway Construction, 2014 Edition, Subsection 625.02, Type 2 and vented to positive discharge. Where surface seeps or springs are encountered during site grading, we recommend the seepage be directed via French drains or blanket drains to positive discharge at daylight or to storm drainage lines.

Piling

Piles should be installed in compliance with Standard Specifications for Highway Construction, 2014 Edition, Section 805. Pre-boring to achieve the minimum pile length is not generally anticipated, but could be warranted where large rock fragments are encountered in the on-site fill. Based on local experience, we recommend a hammer system capable of delivering at least 22,000 per blow for the steel piles at the bridge ends. A specific review and analysis of the pile-hammer system proposed by the Contractor should be performed by the Engineer or Department prior to hammer acceptance and start of pile installation.

As a minimum, safe bearing capacity of production piles should be determined by Standard Specifications for Highway Construction, 2014 Edition, Section 805.09, Method A. Driving records should be available for review by the Engineer during pile installation. Piles should be carefully examined prior to driving and piles with structural defects should be rejected. Any splices in steel piles should develop the full cross-sectional capacity of un-spliced piles. Pile installation should be monitored by qualified personnel to maintain specific and complete driving records and to observe pile installation procedures. Blow counts on steel piles should be limited to about 20 blows per inch. We recommend that practical pile refusal be defined as a penetration of 0.5 in. or less for the final 10 blows.

Drilled Shafts

Groundwater could be encountered in drilled shaft excavations. Limited seepage into drilled shaft excavations can probably be controlled by close coordination of drilling, cleanup and concrete placement. We recommend that casing be on site in the event it is needed to control seepage and/or caving into shaft excavations. Drilled shaft excavations should essentially be dry at the time of concrete placement. Where more than about 3 in. of water is present in shaft excavations, the excavation should be dewatered prior to concrete placement. Where shaft excavations cannot be dewatered, underwater concrete placement should be performed with a

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

Some hard drilling could be experienced when advancing drilled shafts into the more resistant units of the moderately hard weathered shale, shale, moderately hard to hard sandstone, and sandstone. Heavy-duty drilling equipment and rock drilling tools will be required to advance shaft excavations to the recommended minimum penetration in these more resistant units. Coring or other rock excavation methods is likely to be required to achieve the recommended penetration into the shale and sandstone bearing strata. All drilled shaft excavations should be observed by the Engineer to verify suitable bearing and adequate penetration.

CLOSURE

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

The following illustrations are attached and complete this submittal.

Attachment 1	Preliminary Bridge Layout
Attachment 2	Site Vicinity Map, Plans of Borings, Summary of Subsurface Exploration, Keys to Terms and Symbols
Attachment 3	Structure Boring Logs
Attachment 4	Rock Core Photographs
Attachment 5	Pavement Boring Logs
Attachment 6	Classification Test Results
Attachment 7	Subgrade Test Results
Attachment 8	End Slope Stability Results

* * * * *

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

Sincerely,

GRUBBS, HOSKYN,
BARTON &WYATT, INC.

Ben Davis, E.I.
Staff Engineer

Mark E. Wyatt, P.E.
President

BJD/MEW:jw

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Attn:	Mr. Fred Harper, P.E.	(1-email)
Attn:	Mr. Byron Lawrence, P.E.	(1-email)
Attn:	Ms. Caroline Fox, E.I.	(1-email)

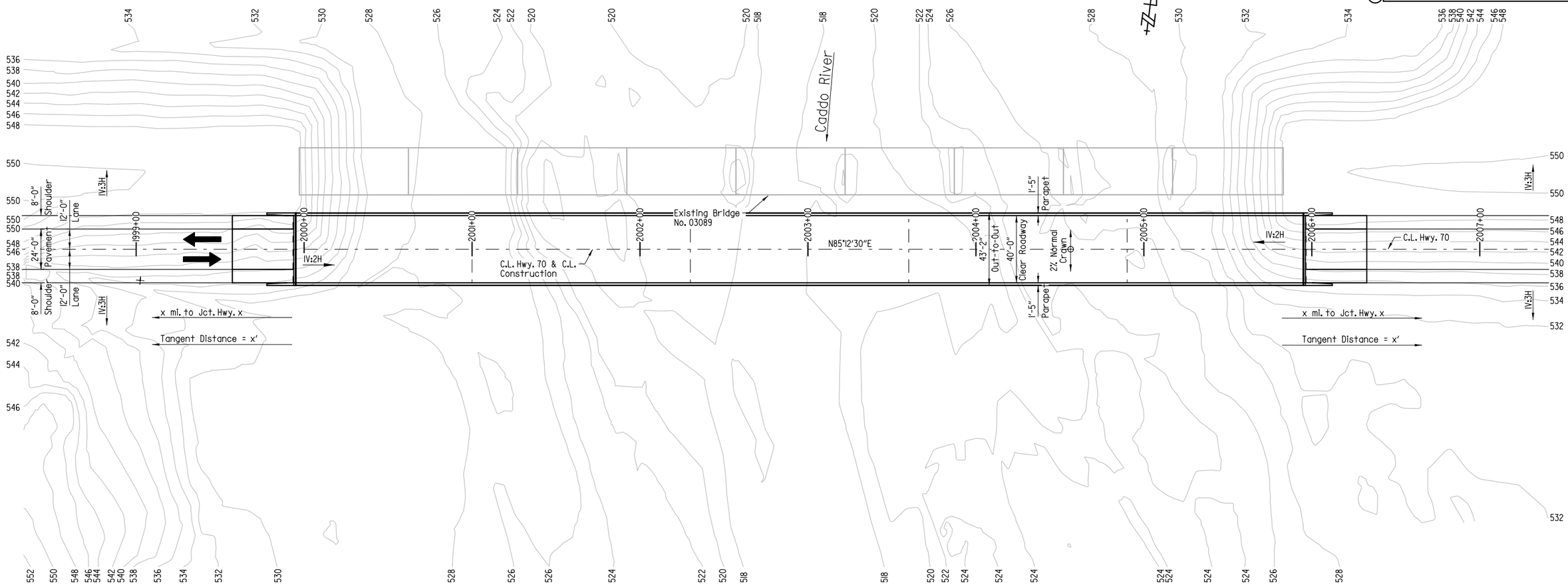
ATTACHMENT 1

For R/W Data and Guard Rail Details, See Roadway Plans.

DATE	DATE FILMED	DATE REVISED	DATE FILMED

FED.RD. DIST.NO.	STATE	FED.AID PROJ.NO.	SHEET NO.	TOTAL SHEETS
3	ARK.			
JOB NO.		030501	$PAGE$	$TOTAL$

(1) XXXXX - LAYOUT - XXXXX



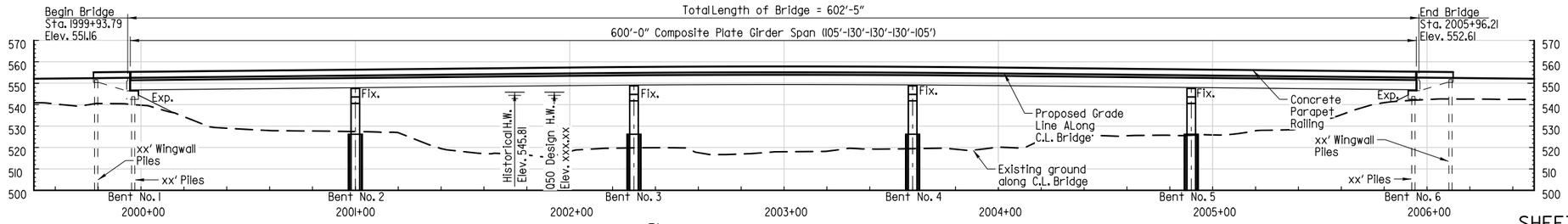
PLAN

(1) Measured to Working Point. See "Rounding Detail" on Dwg. No. xxxxx.

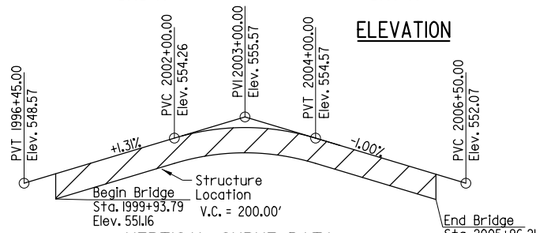
Note:
Use Type C1 Approach Slab ("w" = 24'-0") and Type C Approach Gutters ("w" = 8'-0") at both ends of bridge, See Std. Dwg. Nos. 550401 and 55030C.

Notes:
For General Notes and Soil Borings See Dwg. No. xxxxx.

Stations and Elevations Shown are along C.L. Bridge. Elevations Shown are at Working Point.



ELEVATION



VERTICAL CURVE DATA

(Stations and Elevations are along C.L. Bridge)

FLOOD DESCRIPTION	FREQUENCY	DISCHARGE	(1) NATURAL WATER SURFACE ELEVATION	WATER SURFACE ELEV. WITH BACKWATER
	YEARS	CFS	FEET	FEET
Design	50	58500	539.77	541.28
Base	100	67600	541.68	543.17
Extreme	500	90200	546.01	547.44
Overtopping	>500	>500	>500	>500

(1) Unconstricted water surface without structure or roadway approaches.

Q100 backwater elevation for existing structure = 543.24 feet.

Proposed Low Bridge Chord Elevation = 546.84 feet.

Drainage area = 202 square miles.

Historical H.W. Elev. = 545.81 Feet (from USGS stream gage 07359700 on May 13, 1968 with a Stream-flow of 88,000 cfs)

PRELIMINARY SUBJECT TO REVISION

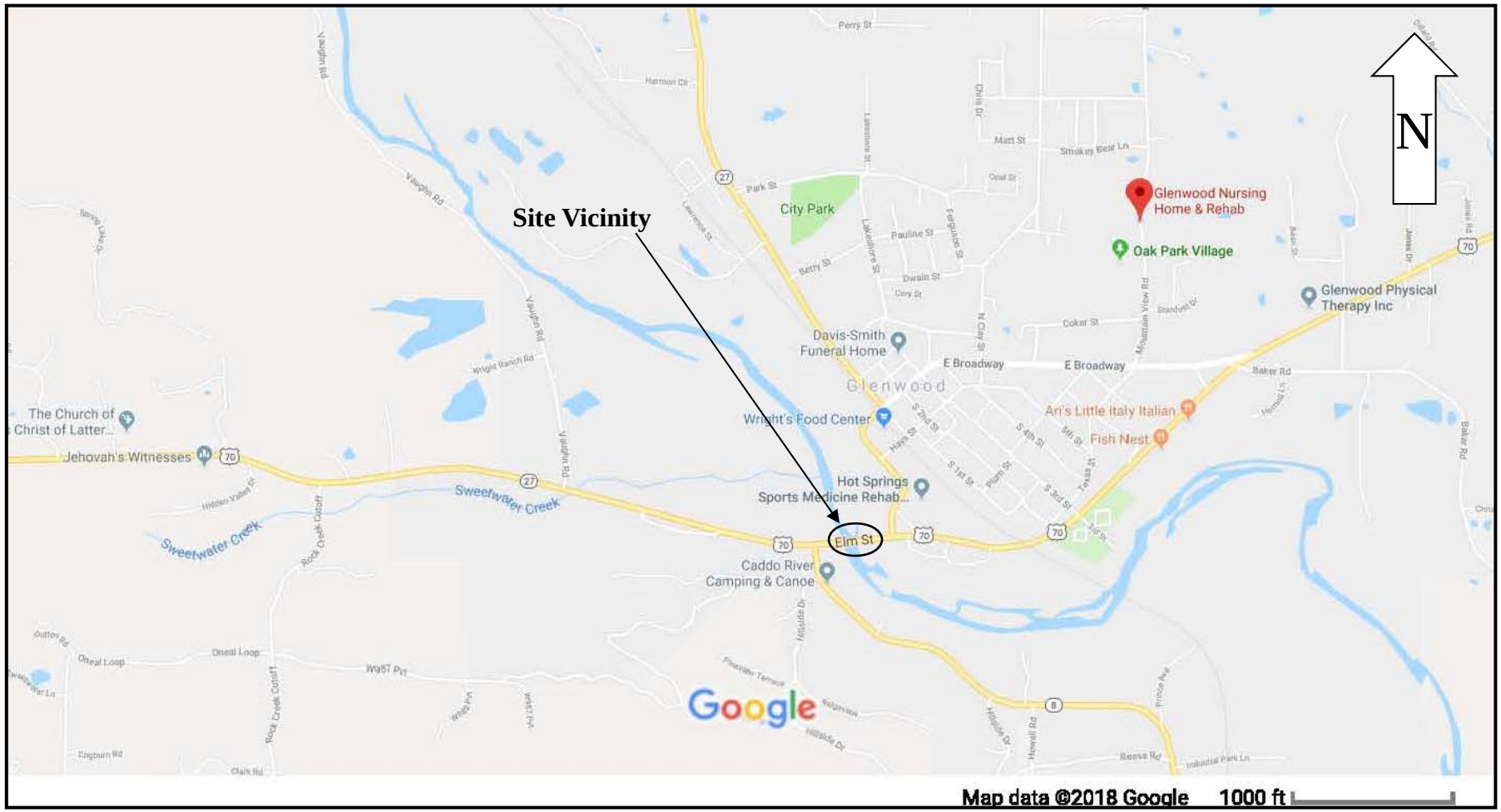
BRIDGE ENGINEER
PRINT DATE: 5/21/2018

SHEET 1 OF X
LAYOUT OF BRIDGE OVER CADDO RIVER
SALINE AND CADDO RIVERS
STRS. & APPRS. (S)
PIKE COUNTY
ROUTE 70 SECTION 5
ARKANSAS STATE HIGHWAY COMMISSION
LITTLE ROCK, ARKANSAS

DRAWN BY: JPC DATE: 03/2018 FILENAME: B030501X2_LXI.dgn
CHECKED BY: xxx DATE: xx/xx/xxxx
DESIGNED BY: xxx DATE: xx/xx/xxxx SCALE: 1" = 30'
BRIDGE NO. xxxxx DRAWING NO. xxx

Justin.carney 5/21/2018 7:26:36 AM
WORKSPACE: AHTD_Bridge
Y:\Projects\ArDOT_166\3_03050_Caddo & Saline River Bridges\Design\BRIDGE\Drawings\B030501X2_LXI.dgn
REVISED DATE:

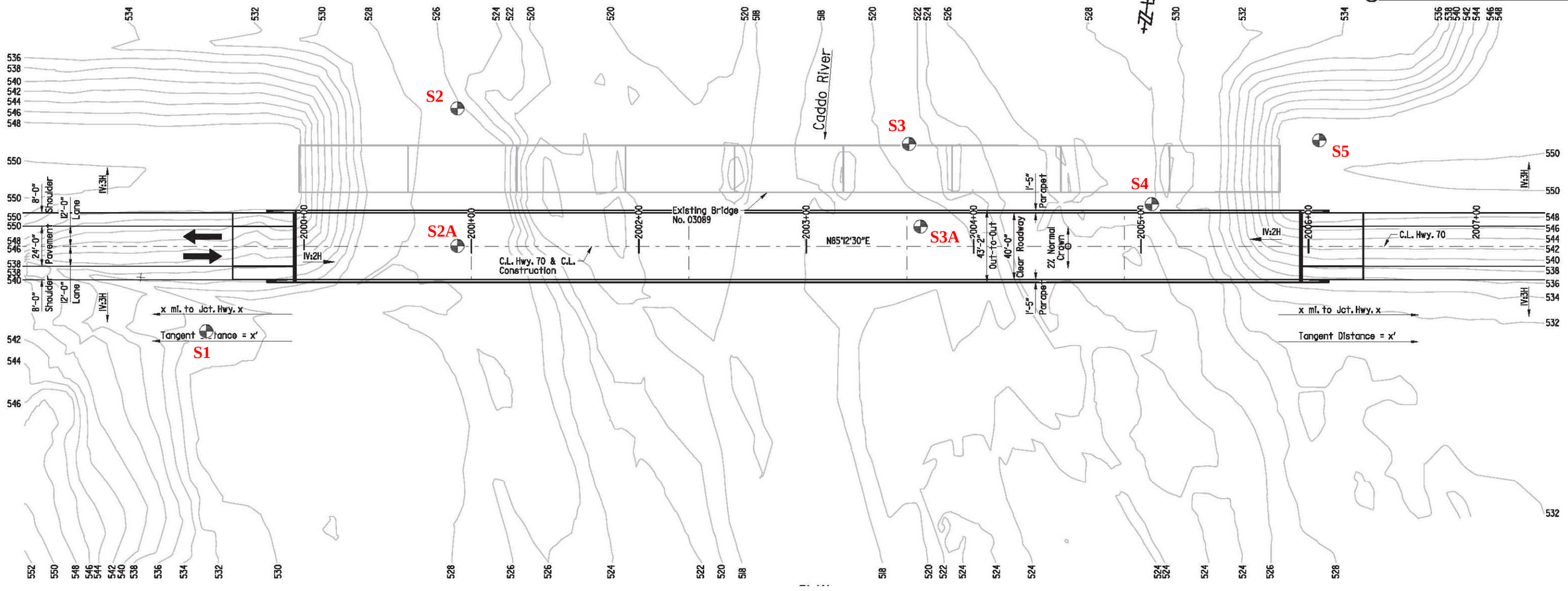
ATTACHMENT 2



Grubbs, Hoskyn, Barton & Wyatt, INC. CONSULTING ENGINEERS	**Site Vicinity Map** **ARDot 030501 – Bridge 03089** **Over Caddo River** **Glenwood, Pike County, Arkansas**	**Job No. 18-040**	**Plate 1**

For R/W Data and Guard Rail Details, See Roadway Plans.

DATE	DATE FILMED	DATE REVISED	DATE FILMED	FEDERAL DIST.NO.	STATE	FED.AID PROJ.NO.	PROJ. NO.	SH.
				3	ARK.			
				JOB NO.	030501	◆PAGE◆	◆TO	
				XXXXX - LAYOUT - XXXXX				



Grubbs, Hoskyn, Barton & Wyatt, INC. CONSULTING ENGINEERS	**PLAN OF BORINGS** **ARDOT 030501 – Bridge 03089** **Glenwood, Pike County, Arkansas**	**Scale: As Shown** **Date: April 2018**	**Job No. 18-040**	**PLATE 2A**

Grubbs, Hoskyn, Barton & Wyatt, INC.
CONSULTING ENGINEERS

PLAN OF BORINGS

ARDOT 030501 – BRIDGE 03089 over CADDO RIVER
Glenwood, Pike County, Arkansas
CONWAY, ARKANSAS

Scale: As Shown

Job No. 18-040

Plate No. 2B

SUMMARY of SUBSURFACE EXPLORATION

PROJECT: ArDOT 030501 - Bridge 03089

LOCATION: Glenwood, Pike County, Arkansas

GHBW JOB No.: 18-040

Boring No.	Station Reference	Approx Sta	Approx Offset, ft	Approx Surf El, ft	Completion Depth, ft
S1	Hwy 70	1999+45	75 Rt	530	38
S2	Hwy 70	2000+95	80 Lt	526	36
S2A	Hwy 71	2000+95	CL	527	45
S3	Hwy 72	2003+50	65 Lt	521	35
S3A	Hwy 74	2003+50	CL	519	36
S4	Hwy 75	2005+07	25 Lt	528	35
S5	Hwy 76	2006+10	65 Lt	549	50
P1	±405 West of Bridge End			557	10
P2	±165 West of Bridge End			552	15
P3	±125 East of Bridge End			553	9
P4	±375 East of Bridge End			555	10

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Consulting Engineers

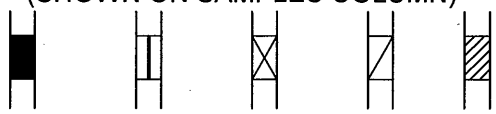
SYMBOLS AND TERMS USED ON BORING LOGS

SOIL TYPES
(SHOWN IN SYMBOLS COLUMN)

Gravel Sand Silt Clay

Predominant type shown heavy

SAMPLER TYPES
(SHOWN ON SAMPLES COLUMN)



Shelby Tube | Rock Core | Split Spoon | No Recovery | Cutting

TERMS DESCRIBING CONSISTENCY OR CONDITION

COARSE GRAINED SOILS (major portion retained on No. 200 sieve): Includes (I) Clean gravels and sands, and (2) silty or clayey gravels and sands. Condition is rated according to relative density, as determined by laboratory tests.

DESCRIPTIVE TERM	N-VALUE	RELATIVE DENSITY
VERY LOOSE	0-4	0-15%
LOOSE	4-10	15-35%
MEDIUM DENSE	10-30	35-65%
DENSE	30-50	65-85%
VERY DENSE	50 and above	85-100%

FINE GRAINED SOILS (major portion passing No. 200 sieve): Includes (1) Inorganic and organic silts and clays, (2) gravelly, sandy, or silty clays, and (3) clayey silts. Consistency is rated according to shearing strength, as indicated by penetrometer readings or by unconfined compression tests.

DESCRIPTIVE TERM	UNCONFINED COMPRESSIVE STRENGTH TON/SQ. FT.
VERY SOFT	Less than 0.25
SOFT	0.25-0.50
FIRM	0.50-1.00
STIFF	1.00-2.00
VERY STIFF	2.00-4.00
HARD	4.00 and higher

NOTE: Slickensided and fissured clays may have lower unconfined compressive strengths than shown above, because of planes of weakness or cracks in the soil. The consistency ratings of such soils are based on penetrometer readings.

TERMS CHARACTERIZING SOIL STRUCTURE

SLICKENSIDED - having inclined planes of weakness that are slick and glossy in appearance.
FISSURED - containing shrinkage cracks, frequently filled with fine sand or silt; usually more or less vertical.
LAMINATED - composed of thin layers of varying color and texture.
INTERBEDDED - composed of alternate layers of different soil types.
CALCAREOUS - containing appreciable quantities of calcium carbonate.
WELL GRADED - having a wide range in grain sizes and substantial amounts of all intermediate particle sizes.
POORLY GRADED - predominantly of one grain size, or having a range of sizes with some intermediate sizes missing.

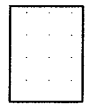
Terms used on this report for describing soils according to their texture or grain size distribution are in accordance with the UNIFIED SOIL CLASSIFICATION SYSTEM, as described in Technical Memorandum No.3-357, Waterways Experiment Station, March 1953

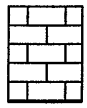
KEY 7-28-11

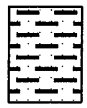
Grubbs, Hoskyn, Barton & Wyatt, Inc.
Consulting Engineers

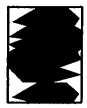
BORING LOG TERMS – ROCK

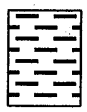
ROCK TYPES
(SHOWN IN SYMBOLS COLUMN)


Sandstone


Limestone


Siltstone


Coal


Shale

Joint Characteristics –
Spacing
Very Wide
Wide
Moderately Close
Close
Very Close

Bedding Characteristics –
Very Thin
Thin
Medium
Thick
Massive

Lithologic Characteristics –
Clayey
Shaly
Calcareous (limy)
Siliceous
Sandy
Silty
Plastic Seams

Seam –
1/6 to 1/2 inch
Layer –
1/2 to 12 inches
Stratum –
Greater than 12 inches

Hardness and Degree of Cementation –

	Approximate Range of Uniaxial Compressive Strength (psi)
Very Soft – Can be peeled with a knife	140 – 3500
Soft – Can just be scraped with knife	3500 – 6900
Hard – Can be broken with single moderate blow with pick	6900 – 13,900
Very hard – Hand held specimen breaks with hammer end of pick under more than one blow	13,900 – 28,000
Extremely Hard – Many blows with hammer required to break intact specimen	More than 28,000

Poorly Cemented

Cemented

Texture –
Dense
Fine
Medium
Coarse

Structure –
Bedding
  Flat
  Gently Dipping
  Steeply Dipping
Fractures, scattered
  Open
  Cemented or Tight
Fractures, closely spaced
  Open
  Cemented or Tight
Brecciated (Sheared and Fragmented)
  Open
  Cemented or Tight
Joints
Faulted
Slickensides

Degree of Weathering –

Fresh – No visible signs of decomposition or discoloration. Rings under hammer impact.

Slighty Weathered – Slight discoloration inwards from open fractures, otherwise similar to fresh.

Moderately Weathered – Discoloration throughout. Weaker minerals such as feldspar decomposed. Strength somewhat less than fresh rock, but cores cannot be broken by hand or scraped by knife. Texture preserved.

Highly Weathered – Most minerals somewhat decomposed. Specimens can be broken by hand with effort or shaved with knife. Core stones present in rock mass. Texture becoming indistinct but fabric preserved.

Completely Weathered – Minerals decomposed to soil but fabric and structure preserved (Saprolite). Specimens easily crumbled or penetrated.

Residual Soil – Advanced state of decomposition resulting in plastic soils. Rock fabric and structure completely destroyed. Large volume change.

Solution and Void Conditions –
Solid, contains no voids
Vuggy (pitted)
Vesicular (igneous)
Porous
Cavities
Cavernous

Swelling Properties –
Nonswelling
Swelling

Slaking Properties –
Nonslaking
Slakes slowly on exposure
Slakes readily on exposure

Rock Quality Designation (RQD) –

RQD (Percent)	Diagnostic Description
Greater than 90	Excellent
75 – 90	Good
50 – 75	Fair
25 – 50	Poor
Less than 25	Very Poor

KEYROCK 5-22-07

ATTACHMENT 3

18-040

Grubbs, Hoskyn, Barton & Wyatt, Inc.
Consulting Engineers

LOG OF BORING NO. S1

ARDOT 030501 - Bridge 03089 over Caddo River
Glenwood, Pike County, Arkansas

TYPE: Auger to 20 ft /Wash

LOCATION: Bridge, Approx Sta 1999+45, 75 ft Rt

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	COHESION, TON/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) / PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT (10 20 30 40 50 60 70)	- No. 200 %	% Recovery	% RQD
			SURF. EL: 530±						
			Stiff reddish brown fine sandy clay w/some fine to coarse gravel (fill)	20			34		
			Firm to stiff dark brown fine sandy clay	10			59		
5			- stiff at 4 - 6 ft	11					
			- with some fine to coarse gravel below 4 ft						
			- firm to stiff with less gravel below 6 ft	10					
			Medium dense brown sandy fine to coarse gravel	21					
10									
			- water at 13 ft						
			- dense below 13 ft	32					
15									
			- auger refusal at 17 ft on sandstone						
			Moderately hard to hard tan weathered fine-grained sandstone w/ferrous stains					20	0
20			Moderately hard dark gray weathered arenaceous shale, apparent dip 85°, highly fractured			q_u = 1830 psi, TUW = 169 pcf			
			Moderately hard dark gray arenaceous shale, apparent dip 85°± w/thinly interbedded calcareous siltstone seams and occasional slickensides on bedding planes					100	50
25						q_u = 1860 psi, TUW = 170 pcf			
30								98	98
						q_u = 1920 psi, TUW = 169 pcf			
35								100	100
40									

COMPLETION DEPTH: 38.0 ft
DATE: 4-18-18

DEPTH TO WATER IN BORING: 13 ft

DATE: 4/18/2018

RECRQDN200-2 18-040_BRIDGE 03089.GPJ 9-17-18

PLATE 1

18-040

Grubbs, Hoskyn, Barton & Wyatt, Inc.
Consulting Engineers

LOG OF BORING NO. S2

ARDOT 030501 - Bridge 03089 over Caddo River
Glenwood, Pike County, Arkansas

TYPE: Auger to 15 ft /Wash

LOCATION: Bridge, Approx Sta 2000+95, 80 ft Lt

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	COHESION, TON/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) / PLASTIC LIMIT / WATER CONTENT / LIQUID LIMIT (10 20 30 40 50 60 70)	- No. 200 %	% Recovery	% RQD
			SURF. EL: 526±						
			Stiff brownish tan and reddish tan fine sandy clay, silty w/fine gravel (fill)	23			53		
			- with some cobbles below 1 ft	25/0"			48		
5			Medium dense to dense reddish tan and tan sandy fine to coarse gravel	25/0"					
10									
			- with some silty clay seams below 13,5 ft						
15			- water at 14 ft						
			Hard dark gray argillaceous fine-grained sandstone, dip ± 55° w/close shale seams and quartz veins			q_u = 2800 psi, TUW = 166 pcf		80	80
20						q_u = 2150 psi, TUW = 167 pcf		77	77
25						q_u = 2250 psi, TUW = 161 pcf		100	80
30								93	93
			- dark gray shale layer at 33.5 to 34.5 ft						
35									
40									

COMPLETION DEPTH: 36.0 ft
DATE: 4-17-18

DEPTH TO WATER IN BORING: 14 ft
DATE: 4/17/2018

RECRQDN200-2 18-040_BRIDGE 03089.GPJ 9-17-18

PLATE 2

Grubbs, Hoskyn, Barton & Wyatt, Inc.
Consulting Engineers

LOG OF BORING NO. S2A

ARDOT 030501 - Bridge 03089 over Caddo River
Glenwood, Pike County, Arkansas

TYPE: Auger to 20 ft /Wash

LOCATION: Bridge, Approx Sta 2000+95, CL

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	COHESION, TON/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) / PLASTIC LIMIT / WATER CONTENT / LIQUID LIMIT (10 20 30 40 50 60 70)	- No. 200 %	% Recovery	% RQD
			SURF. EL: 527±						
			Medium dense to dense brown sandy fine to coarse gravel w/some cobbles	50/8"					
5									
			Medium dense to dense brown clayey gravel w/some sand						
10									
15			- clay seam at 15 ft						
			Medium dense to dense brown sandy fine to coarse gravel w/cobbles						
20			Moderately hard to hard dark gray arenaceous shale w/occasional calcareous siltstone partings, apparent dip ~50°±			q_u = 7640 psi, TUW = 161 pcf		100	63
25						q_u = 4820 psi, TUW = 164 pcf		100	75
30			Moderately hard dark gray shale w/some slickensides and fractures, apparent dip ~ 50°± - with occasional calcite veins below 31 ft					58	10
35			- numerous fractures and slickensides below 35 ft					48	0
40								55	12
45									

COMPLETION DEPTH: 45.0 ft
DATE: 6-15-18

DEPTH TO WATER IN BORING: 14 ft
DATE: 6/15/2018

RECRQDN200-2 18-040_BRIDGE 03089.GPJ 9-17-18

Grubbs, Hoskyn, Barton & Wyatt, Inc.
Consulting Engineers

LOG OF BORING NO. S3

ARDOT 030501 - Bridge 03089 over Caddo River
Glenwood, Pike County, Arkansas

TYPE: Auger to 5 ft /Wash

LOCATION: Bridge, Approx Sta 2003+50, 65 ft Lt

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	COHESION, TON/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) / PLASTIC LIMIT / WATER CONTENT / LIQUID LIMIT (10 20 30 40 50 60 70)	- No. 200 %	% Recovery	% RQD
			SURF. EL: 521±						
			Medium dense brown fine sandy silt w/some fine to coarse gravel (fill)	21					
			Stiff brown silty clay w/shale fragments	16			50		
5			Moderately hard gray and tan weathered shale w/silty clay laminations and seams and ferrous stains - water at 5 ft	50/7"				100	17
10			Hard gray weathered fine-grained sandstone, dip ±50°, fractured w/ferrous stains in fractures and occasional silty clay seams - with close dark gray arenaceous shale seams below 10 ft			q_u = 7070 psi, TUW = 165 pcf		87	28
15			Moderately hard dark gray slightly weathered arenaceous shale w/very close fine-grained sandstone seams			q_u = 6120 psi, TUW = 166 pcf		100	53
20			Hard gray and dark gray fine-grained sandstone, apparent dip ~ 50° w/some slickensides on bedding planes					58	0
25			Moderately hard dark gray slightly weathered shale, apparent dip ~ 50° w/some ferrous stained bedding planes and occasional slickensides on bedding planes - with moderately close thin sandstone seams below 20 ft			q_u = 11430 psi, TUW = 163 pcf		100	100
30			Hard dark gray fine-grained sandstone, apparent dip ~ 50° - with very close thin dark gray shale seams below 28 ft			q_u = 1740 psi, TUW = 157 pcf q_u = 5960 psi, TUW = 163 pcf		100	100
35			Moderately hard dark gray arenaceous shale, apparent dip ~ 50° w/close thin fine-grained sandstone seams						
40			Hard dark gray fine-grained sandstone, apparent dip ~ 50° w/moderately close dark gray shale seams						

COMPLETION DEPTH: 35.0 ft
DATE: 4-16-18

DEPTH TO WATER IN BORING: 5 ft

DATE: 4/16/2018

RECRQDN200-2 18-040_BRIDGE 03089.GPJ 9-17-18

Grubbs, Hoskyn, Barton & Wyatt, Inc.
Consulting Engineers

LOG OF BORING NO. S3A

ARDOT 030501 - Bridge 03089 over Caddo River
Glenwood, Pike County, Arkansas

TYPE: Auger to 16 ft /Wash

LOCATION: Bridge, Approx Sta 2003+50, CL

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	COHESION, TON/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) / PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT (10 20 30 40 50 60 70)	- No. 200 %	% Recovery	% RQD
			SURF. EL: 519±						
			Dense brown fine to coarse gravel w/some cobbles	34			0		
5			Moderately hard dark gray shale, arenaceous, apparent dip ~ 65°±					75	22
10			Hard dark gray argillaceous sandstone, apparent dip ~ 65°±			q_u = 7040 psi, TUW = 174 pcf		95	95
15			- with some shale partings below 12.5 ft - shale seams at 13 and 15 ft					88	88
20			- with calcareous siltstone inclusions below 16.5 ft			q_u = 8870 psi, TUW = 182 pcf		98	92
25			- with close calcareous siltstone inclusions and seams below 24.5 ft			q_u = 6870 psi, TUW = 176 pcf		98	98
30			- slickensided and fractured below 32 ft					75	13
35									
40									

COMPLETION DEPTH: 36.0 ft
DATE: 6-18-18

DEPTH TO WATER IN BORING: 2 ft
DATE: 6/18/2018

RECRQDN200-2 18-040_BRIDGE 03089.GPJ 9-17-18

18-040

Grubbs, Hoskyn, Barton & Wyatt, Inc.
Consulting Engineers

LOG OF BORING NO. S4

ARDOT 030501 - Bridge 03089 over Caddo River
Glenwood, Pike County, Arkansas

TYPE: Auger to 9 ft /Wash

LOCATION: Bridge, Approx Sta 2005+07, 25 ft Lt

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	COHESION, TON/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) / PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT (10 20 30 40 50 60 70)	- No. 200 %	% Recovery	% RQD
			SURF. EL: 528±						
			Medium dense brown clayey fine sand, silty	13			50		
			Moderately hard tan and dark gray weathered shale	50/7" 50/4"					
5			- moderately hard to hard below 6 ft	25/0" 25/0"					
10			Hard light gray and gray weathered fine-grained sandstone, apparent dip ~ 50°, w/occasional calcite veins and calcite crystal filled fractures			q_u = 6520 psi, TUW = 161 pcf		85	17
15			- with some dark gray shale partings below 14 ft - dark gray shale layer at 15 - 15.5 ft - with occasional pyrite inclusions below 16 ft - near vertical joint with calcite crystals from 16.5 - 17.5 ft			q_u = 3680 psi, TUW = 167 pcf		100	43
20			Hard dark gray arenaceous shale, apparent dip ~ 50° w/calcite veins - slickensided bedding planes and apparent fault scarp at 21 - 22 ft, 24.8 - 25.5 ft, 26.5 - 27.5 ft, and 28.5 - 29 ft					100	68
25								72	23
30			- with fewer slickensides below 29.5 ft					50	48
35									
40									

COMPLETION DEPTH: 35.0 ft
DATE: 4-23-18

DEPTH TO WATER IN BORING: Dry to 9 ft

DATE: 4/23/2018

RECRQDN200-2 18-040_BRIDGE 03089.GPJ 9-17-18

PLATE 6

Grubbs, Hoskyn, Barton & Wyatt, Inc.
Consulting Engineers

LOG OF BORING NO. S5

ARDOT 030501 - Bridge 03089 over Caddo River
Glenwood, Pike County, Arkansas

TYPE: Auger to 18 ft /Wash

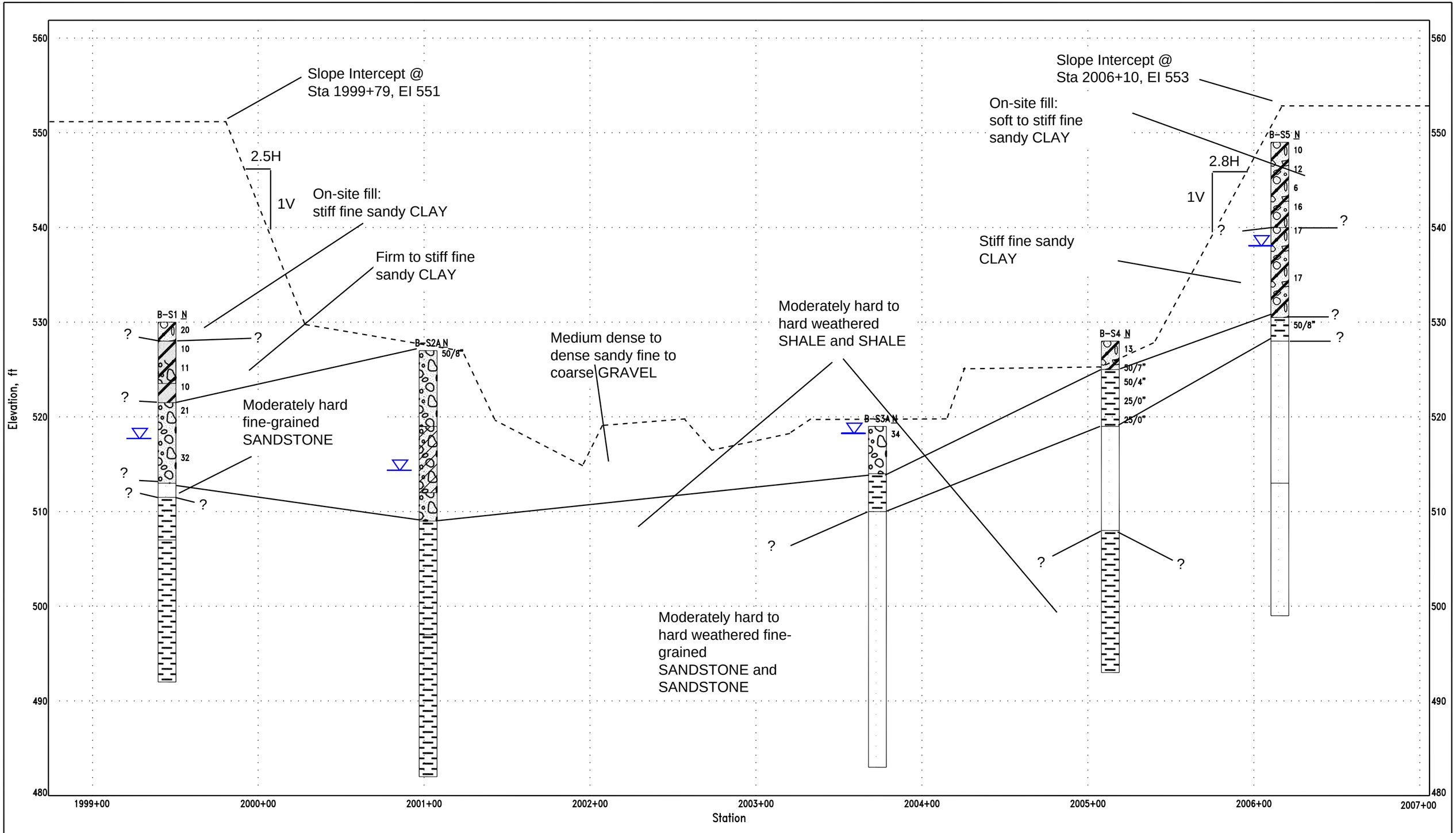
LOCATION: Bridge, Approx Sta 2006+10, 65 ft Lt

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	COHESION, TON/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) / PLASTIC LIMIT / WATER CONTENT / LIQUID LIMIT (10 20 30 40 50 60 70)	- No. 200 %	% Recovery	% RQD
			SURF. EL: 549±						
			Firm to stiff reddish brown fine sandy clay w/numerous crushed sandstone fragments (fill)	10			45		
				12					
5			- stiff at 2 - 4 ft	6					
			- with brown fine sandy silt seams below 2 ft	16					
			- soft at 4 to 6 ft						
10			- stiff, reddish brown, gray and brown below 6 ft	17			20		
			Stiff tan and gray fine sandy clay w/numerous shale fragments						
15			- water at 12 ft	17					
20			Moderately hard tan and dark gray weathered shale w/silty clay seams and ferrous stains	50/8"					
			Hard gray and dark gray slightly weathered fine-grained sandstone, argillaceous, apparent dip ~ 50° w/some near vertical fractures and occasional very thin quartz veins						
25									
						q_u = 3370 psi, TUW = 168 pcf		93	78
30									
						q_u = 8930 psi, TUW = 163 pcf		97	85
35									
			Hard gray fine-grained sandstone, apparent dip 50°± w/very thin, very close dark gray shale partings and occasional calcareous veins			q_u = 1960 psi, TUW = 165 pcf		85	85
40									
			- with thicker sandstone bedding below 40 ft			q_u = 4290 psi, TUW = 165 pcf		92	88
45									
			- with some pyrite crystals on bedding planes below 46 ft			q_u = 6130 psi, TUW = 158 pcf		54	54
50									
55									

COMPLETION DEPTH: 50.0 ft
DATE: 4-24-18

DEPTH TO WATER IN BORING: 12 ft
DATE: 4/24/2018

RECRQDN200-2 18-040_BRIDGE 03089.GPJ 9-17-18



Grubbs, Hoskyn,
Barton & Wyatt, Inc.

NOTES:
1. Subsurface conditions have been inferred between discrete boring locations. Actual conditions may vary.
2. Ground surface approximate.

Generalized Subsurface Profile
ARDOT 030501 – Bridge 03089 over Caddo River
Glenwood, Pike County, Arkansas
Project Number: 18-040

Plate 8

ATTACHMENT 4


18040
S3A
18-040
B-S3A
16'-26'
Grubbs, Hoskyn, Barton & Wyatt, INC.
CONSULTING ENGINEERS
RUN 1. 16'-21'
RUN 2. 21'-26'


18040
S-3A
18-040
B-S3A
26'-36'
Grubbs, Hoskyn,
Barton & Wyatt INC.
CONSULTING ENGINEERS
RUN1, 26'-31'
RUN2, 31'-36'


10'
18040
Bridge Cobb Run
5.4
5-6+7
Drg Ws, Cuttings
18-040
B-84
10'-20'
Grubbs, Hoskyn, Barton & Wyatt, INC.
CONSULTING ENGINEERS
RUN1. 10'-15'
RUN2. 15'-20'
hole PRODUCTS
www.hole PRODUCTS.com
N TOP


Bridge Caddo River
S-4
8&9
Doc, WS, Grubbs
18-040
B-84
20'-30'
Grubbs, Hoskyn, Barton & Wyatt INC
CONSULTING ENGINEERS
RUN1. 20'-25'
RUN2. 25'-30'
hole PRODUCTS
www.hole PRODUCTS.com
N TOP


18-040
B-S4
30'-35'
Grubbs, Hoskyn, Barton & Wyatt INC
CONSULTING ENGINEERS
5-4
5-10
hole PRODUCTS
www.hole PRODUCTS.com
N TOP
35'


18040
Bridge Cobbs River
S-S
S-9 + 10
Dwg. WS. Gubbs
hole PRODUCTS
www.hole PRODUCTS.com
N TOP
36'
18-040
B-S5
26'-36'
Grubbs, Hoskyn, Barton & Wyatt INC.
CONSULTING ENGINEERS
RUN 1. 26'-31'
RUN 2. 31'-36'


18-040
B-S5
36'-46'
Grubbs, Hoskyn, Barton & Wyatt, INC
CONSULTING ENGINEERS
RUN1. 36'-41'
RUN2. 41'-46'


18-040
B-S5
46'-50'
Grubbs, Hoskyn, Barton & Wyatt INC
CONSULTING ENGINEERS
DEPTH FROM
TO
OF
BOXES


hole PRODUCTS
www.hole PRODUCTS.com
N TOP
18-040
B-S1
18'-28'
Grubbs, Hoskyn, Barton & Wyatt INC
CONSULTING ENGINEERS
RUN1. 18'-23'
RUN2. 23'-28'
N DIVIDER


18-040
B-S1
28'-38'
Grubbs, Hoskyn, Barton & Wyatt INC
CONSULTING ENGINEERS
RUN1. 28'-33'
RUN2. 33'-38'


18040
5.2
7.8
18-040
B-82
16' - 26'
Grubbs, Hoskyn, Barton & Wyatt, INC.
CONSULTING ENGINEERS
RUN1. 16'-21'
RUN2. 21' - 26'


18-040
B-S2
26'-36'
Grubbs, Hoskyn, Barton & Wyatt INC
CONSULTING ENGINEERS
RUN 1. 26-31'
RUN 2. 31-36'
DEPTH FROM
TO
BOXES
B2


180'-0"
S.3A
S-3
B-040
B-S2A
6'-16'
Grubbs, Hoskyn, Barton & Wyatt, INC.
CONSULTING ENGINEERS
RUN 1. 6'-11'
RUN 2. 11'-16'


18-040
B-82A
20'-30'
Grubbs, Hoskyn, Barton & Wyatt INC
CONSULTING ENGINEERS
RUN1. 20'-25'
RUN2. 25'-30'


18040
5-2A
5. 10+11
18-040
B-S2A
30'-40'
Grubbs, Hoskyn, Barton & Wyatt, INC.
CONSULTING ENGINEERS
RUN1. 30'-35'
RUN2. 35'-40'


18-040
B-S2A
40'-45'
Grubbs, Hoskyn,
Barton & Wyatt INC.
CONSULTING ENGINEERS


hole PRODUCTS
www.hole PRODUCTS.com
18-040
B-33
6'- 15'
Grubbs, Hoskyn, Barton & Wyatt INC
CONSULTING ENGINEERS
RUN1.) 6- 9'
RUN2.) 10'- 15'
COMPANY
PROPERTY
HOLE NO.
BOX NO.
FROM
TO


18-040
B-83
15'-25'
Grubbs, Hoskyn, Barton & Wyatt INC.
CONSULTING ENGINEERS
RUN 1.) 15'-20'
RUN 2.) 20'-25'
COMPANY
PROPERTY
HOLE NO.
BOX NO.
FROM
TO
hole PRODUCTS


18-040
B-83
25'-35'
Grubbs, Hoskyn, Barton & Wyatt, INC.
CONSULTING ENGINEERS
RUN 1. 25'-30'
RUN 2. 30'-35'
hole PRODUCTS
N TOP
COMPANY
PROPERTY
HOLE NO.
BOX NO.
FROM
TO


18-040
B-S3A
6'-16'
Grubbs, Hoskyn, Barton & Wyatt
RUN 1. 6-11'
RUN 2. 11'-16'

ATTACHMENT 5

Grubbs, Hoskyn, Barton & Wyatt, Inc.
Consulting Engineers

LOG OF BORING NO. P1

ARDOT 030501 - Bridge 03089 over Caddo River
Glenwood, Pike County, Arkansas

TYPE: Auger

LOCATION: Pavements, ±405 ft West of Bridge End

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	COHESION, TON/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) / PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT (10 20 30 40 50 60 70)	- No. 200 %
			SURF. EL: 557±				
			3 inches: Asphalt Concrete				
			Medium dense to dense dark brown fine sandy silt w/crushed stone fragments (fill)	48			
			Stiff tan and reddish tan silty clay, slightly sandy (fill)	14			80
5				13			
				10			
			Stiff gray fine sandy clay w/sandstone fragments	15			
10							
15							

COMPLETION DEPTH: 10.0 ft
DATE: 4-17-18

DEPTH TO WATER IN BORING: Dry

DATE: 4/17/2018

LGBNEW 18-040_BRIDGE 03089.GPJ 9-17-18

Grubbs, Hoskyn, Barton & Wyatt, Inc.
Consulting Engineers

LOG OF BORING NO. P2

ARDOT 030501 - Bridge 03089 over Caddo River
Glenwood, Pike County, Arkansas

TYPE: Auger

LOCATION: Pavements, ±165 ft West of Bridge End

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	COHESION, TON/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) / PLASTIC LIMIT / WATER CONTENT / LIQUID LIMIT (10 20 30 40 50 60 70)	- No. 200 %
			SURF. EL: 552±				
			2.3 inches: Asphalt Concrete				
			Stiff to very stiff dark brown fine sandy clay w/crushed stone (fill)	39			20
			Stiff brown silty clay w/numerous shale fragments (fill)	12			28
5			- with numerous sandstone fragments below 4 ft (NOTE: refusal on sandstone cobbles and boulders at 4.5 ft, offset boring 3 ft west)	24			
			Medium dense crushed sandstone fragments and shale fragments w/some silty clay (fill)	18			
10			Stiff tan silty clay w/crushed sandstone fragments (fill)	14			
			Moderately hard tan and dark brown weathered shale w/ferrous stains	50/9"			
15							
20							
25							

COMPLETION DEPTH: 15.0 ft
DATE: 4-17-18

DEPTH TO WATER IN BORING: Dry

DATE: 4/17/2018

LGBNEW 18-040_BRIDGE 03089.GPJ 9-17-18

Grubbs, Hoskyn, Barton & Wyatt, Inc.
Consulting Engineers

LOG OF BORING NO. P3

ARDOT 030501 - Bridge 03089 over Caddo River
Glenwood, Pike County, Arkansas

TYPE: Auger

LOCATION: Pavements, ±125 ft East of Bridge End

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	COHESION, TON/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) / PLASTIC LIMIT / WATER CONTENT / LIQUID LIMIT (10 20 30 40 50 60 70)	- No. 200 %
			SURF. EL: 553±				
			4.8 inches: Asphalt Concrete				
			Medium dense brown fine sandy clay w/crushed sandstone and shale fragments (fill)	14			39
			Firm to stiff brown silty clay (fill)	10			
5			- with crushed sandstone fragments and shale fragments below 4 ft	19			
				12			
			Loose dark gray fine sandy silt, clayey w/shale fragments (possible fill)	9			
10							
15							

COMPLETION DEPTH: 9.0 ft
DATE: 4-17-18

DEPTH TO WATER IN BORING: Dry

DATE: 4/17/2018

LGBNEW 18-040_BRIDGE 03089.GPJ 9-17-18

Grubbs, Hoskyn, Barton & Wyatt, Inc.
Consulting Engineers

LOG OF BORING NO. P4

ARDOT 030501 - Bridge 03089 over Caddo River
Glenwood, Pike County, Arkansas

TYPE: Auger LOCATION: Pavements, ±375 ft East of Bridge End

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	COHESION, TON/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) / PLASTIC LIMIT / WATER CONTENT / LIQUID LIMIT (10 20 30 40 50 60 70)	- No. 200 %
			SURF. EL: 555±				
			1.8 inches: Asphalt Concrete				
			Medium dense to dense dark brown silty fine sand w/crushed stone fragments and silty clay pockets (fill)	37			14
			Stiff to very stiff brown silty clay w/shale and sandstone fragments (fill)	34			30
			- reddish brown and dark gray below 4 ft				
5				20			
				11			
			Stiff tan silty clay	15			
10							
15							

COMPLETION DEPTH: 10.0 ft
DATE: 4-17-18

DEPTH TO WATER IN BORING: Dry

DATE: 4/17/2018

LGBNEW 18-040_BRIDGE 03089.GPJ 9-17-18

ATTACHMENT 6

SUMMARY OF CLASSIFICATION TEST RESULTS

PROJECT: ARDOT Job #030501 - Bridge 03089 over Caddo River
LOCATION: Glenwood, Arkansas
JOB NUMBER: 18-040

BORING NO.	SAMPLE DEPTH (ft)	WATER CONTENT (%)	ATTERBERG LIMITS			SIEVE ANALYSIS PERCENT PASSING								UNIFIED CLASS.	AASHTO CLASS.
			LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	2 in.	1 in.	3/4 in.	3/8 in.	#4	#10	#40	#200		
S1	0.5-1.5	16	34	24	10	100	100	100	82	75	65	49	34	SC	A-2-4
S1	2.5-3.5	19	---	---	---	---	---	---	---	---	---	---	59	CL	A-4
S2	0.5-1.5	15	27	17	10	---	---	---	---	89	---	---	53	CL	A-4
S2	2.5-3.5	17	---	---	---	100	100	100	96	86	79	68	48	SM	A-4
S3	2.5-3.5	18	24	19	5	100	100	100	89	84	79	72	50	CL-ML	A-4
S3	4-5	7	27	19	8	---	---	---	---	---	---	---	---	SHALE	
S3A	2.5-3.5	4	---	---	---	100	46	29	4	1	1	0	0	GP	A-2-4
S4	0.5-1.5	15	24	17	7	---	---	---	---	93	---	---	50	CL-ML	A-4
S4	2.5-3.5	9	26	17	9	---	---	---	---	---	---	---	---	SHALE	
S5	0.5-1.5	14	29	19	10	100	100	93	86	81	75	67	45	SC	A-4
S5	9-10	14	32	19	13	---	---	---	---	60	---	---	20	GC	A-2-6
P1	2.5-3.5	17	35	19	16	---	---	---	---	99	---	---	80	CL	A-6
						---	---	---	---						
P2	0.5-1.5	9	23	16	7	100	100	100	91	79	63	41	20	SC	A-2-6
P2	2.5-3.5	13	30	19	11	---	---	---	---	78	---	---	28	SC	A-2-6
P3	1-2	17	35	21	14	---	---	---	---	87	---	---	39	SC	A-6
P4	1-2	8	21	17	4	100	100	100	86	65	49	31	14	SC-SM	A-1-b
P4	2.5-3.5	11	24	17	7	---	---	---	---	76	---	---	30	SC-SM	A-2-4

18-040

GRAIN SIZE CURVE

GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

Sample: S1, 0.5-1.5 ft; LL=34, PL=24, PI=10

Description: Reddish brown fine sandy CLAY with some fine to coarse gravel (fill) **USCS = SC; AASHTO = A-2-4**

18-040

GRAIN SIZE CURVE

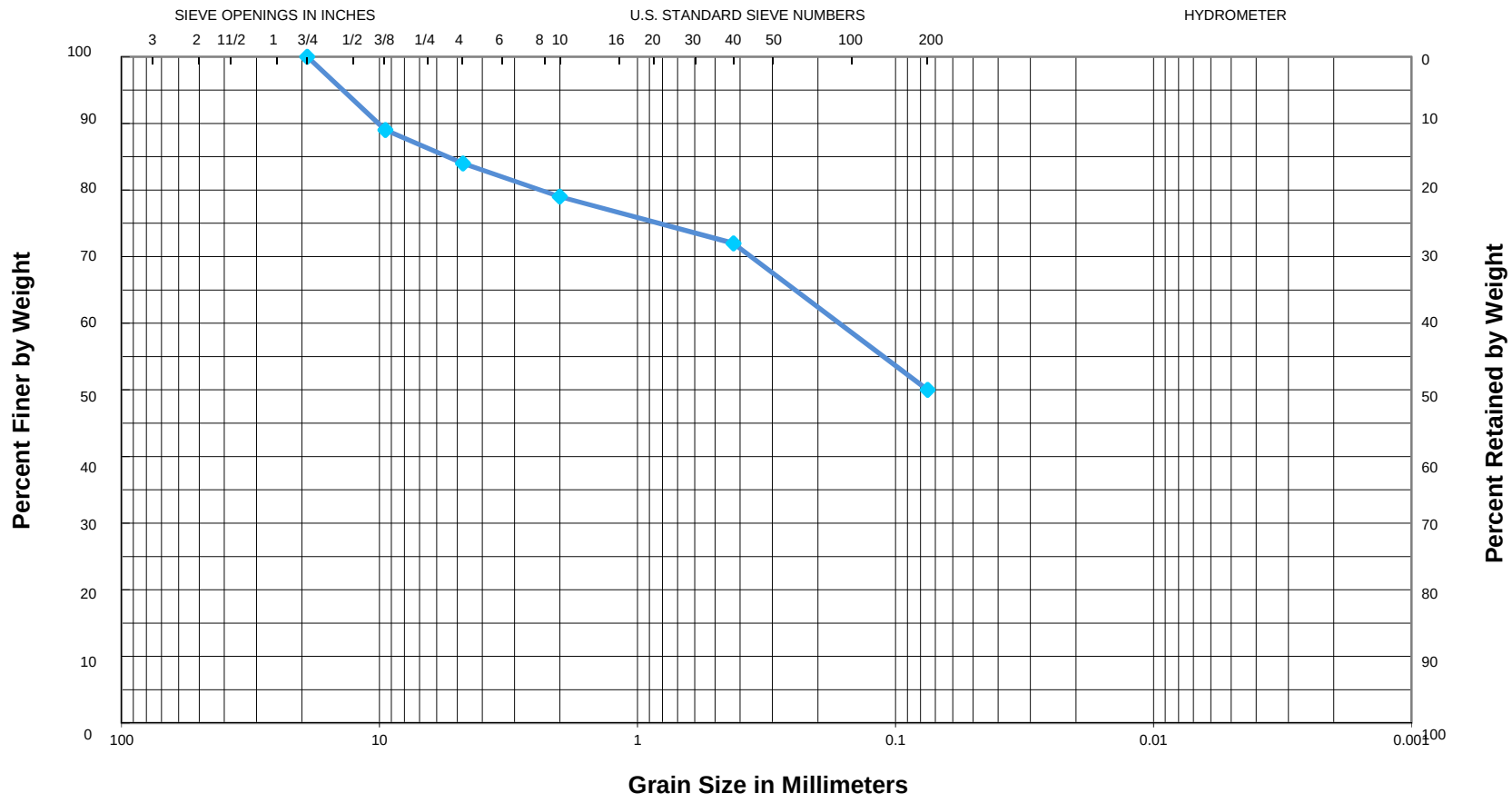
GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

Sample: S2, 2.5-3.5 ft

Description: Brownish tan and reddish tan silty CLAY with some fine gravel (fill) **USCS = SM; AASHTO = A-4**

18-040

GRAIN SIZE CURVE



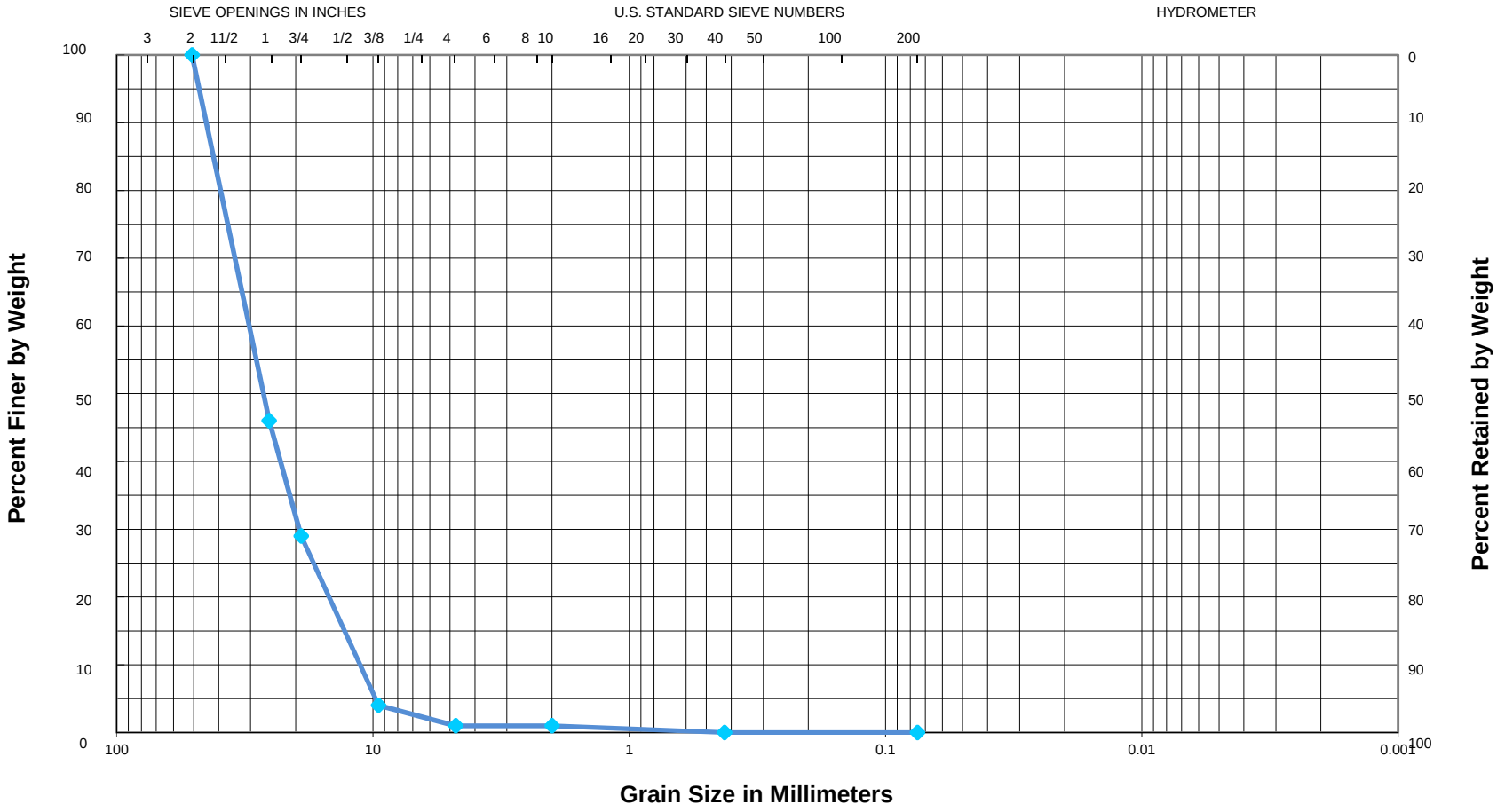
GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

Sample: S3, 2.5-3.5 ft; LL=24, PL=19, PI=5
Description: Brown silty CLAY with shale fragments

USCS = CL-ML; AASHTO = A-4

18-040

GRAIN SIZE CURVE



GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

Sample: S3A, 2.5-3.5 ft;
Description: Brown fine to coarse GRAVEL with some cobbles **USCS = GP; AASHTO = A-2-4**

18-040

GRAIN SIZE CURVE

GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

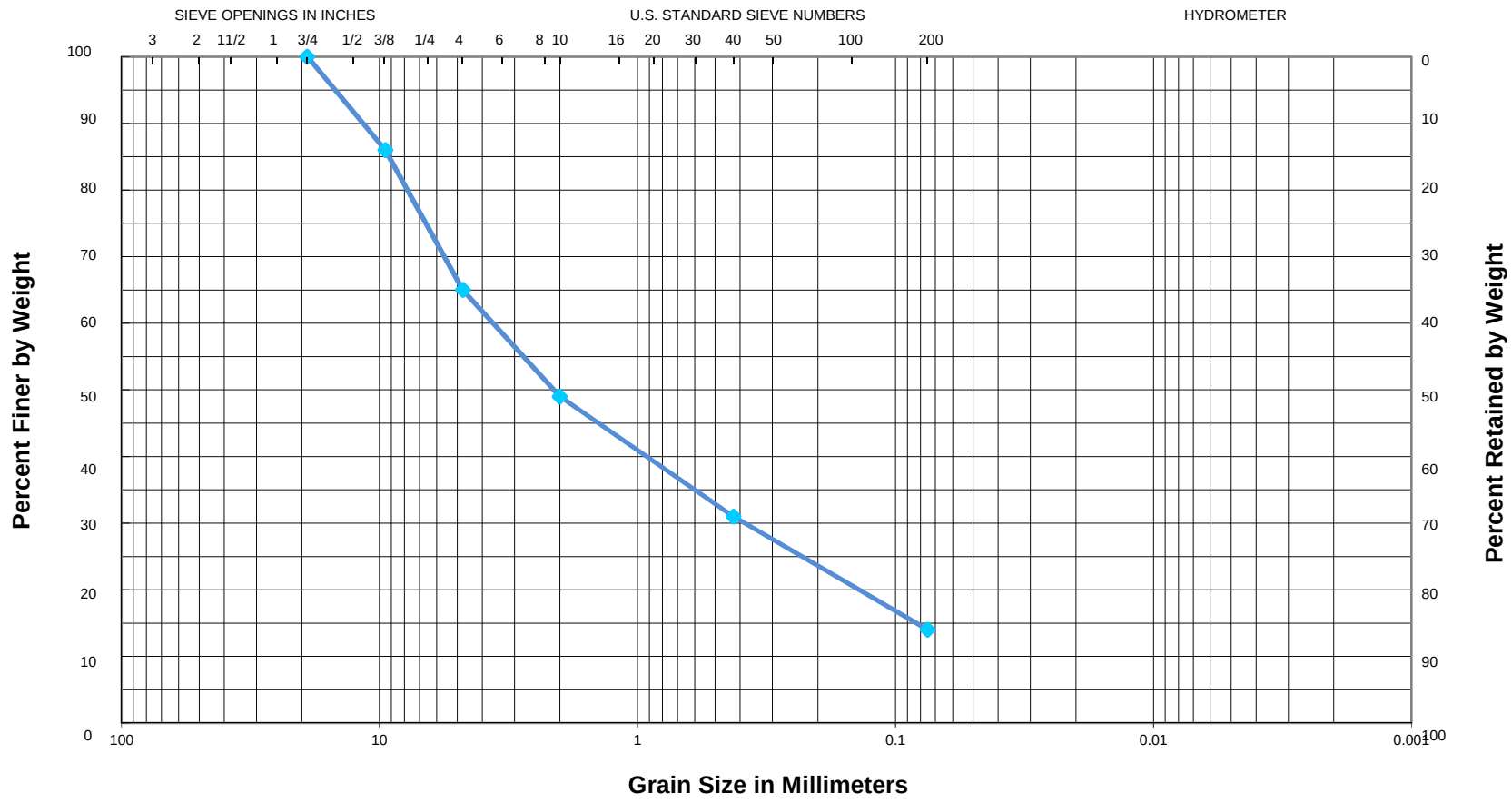
Sample: P2, 0.5-1.5 ft; LL=23, PL=16, PI=7

Description: Dark brown fine sandy CLAY with some crushed stone (fill)

USCS = SC; AASHTO = A-2-6

18-040

GRAIN SIZE CURVE



GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

Sample: P4, 1-2 ft; LL=21, PL=17, PI=4

Description: Dark brown fine sandy CLAY with some crushed stone (fill) **USCS = SC-SM; AASHTO = A-1-b**

ATTACHMENT 7

Grubbs, Hoskyn, Barton & Wyatt, INC.
CONSULTING ENGINEERS

P.O. Box 30970
Little Rock, Arkansas 72260-0970
#1 Trigon Place 72209
(501) 455-2536
FAX (501) 455-4137

REPORT OF STANDARD PROCTOR TEST
(AASHTO T-99 METHOD C)

Project: ARDOT 030501 - Bridge 03089 over Caddo River Job No: 18-040

Material Description: Tan and reddish brown silty fine to medium SAND with trace fine to coarse gravel

Location Sampled/Source: 5/10B
Sample Depth, ft: 0.5-2
Date Sampled: 5/14/2018
Date Tested: 5/18/2018
Tested By: LLC
Report Date: 6/14/2018

LAB COMPACTION PROCEDURE: AASHTO T-99 Method: C	
Maximum Unit Dry Wt. (pcf):	109
Optimum Water Content (%):	13.3

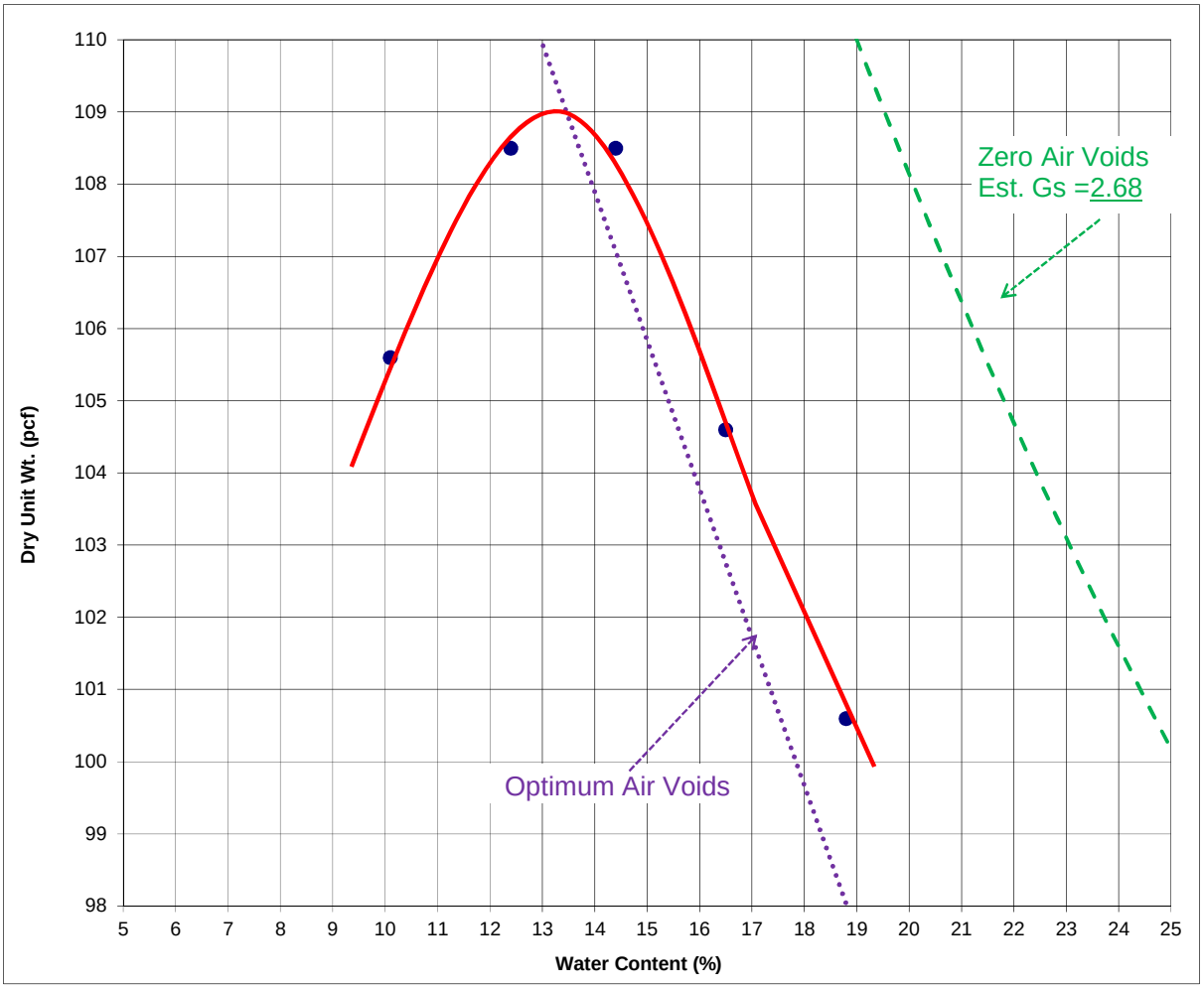
As Processed Water Content: 8.8 %

ATTERBERG LIMITS AASHTO T-89 & T-90
Liquid Limit: NP
Plastic Limit: NP
Plasticity Index: NP

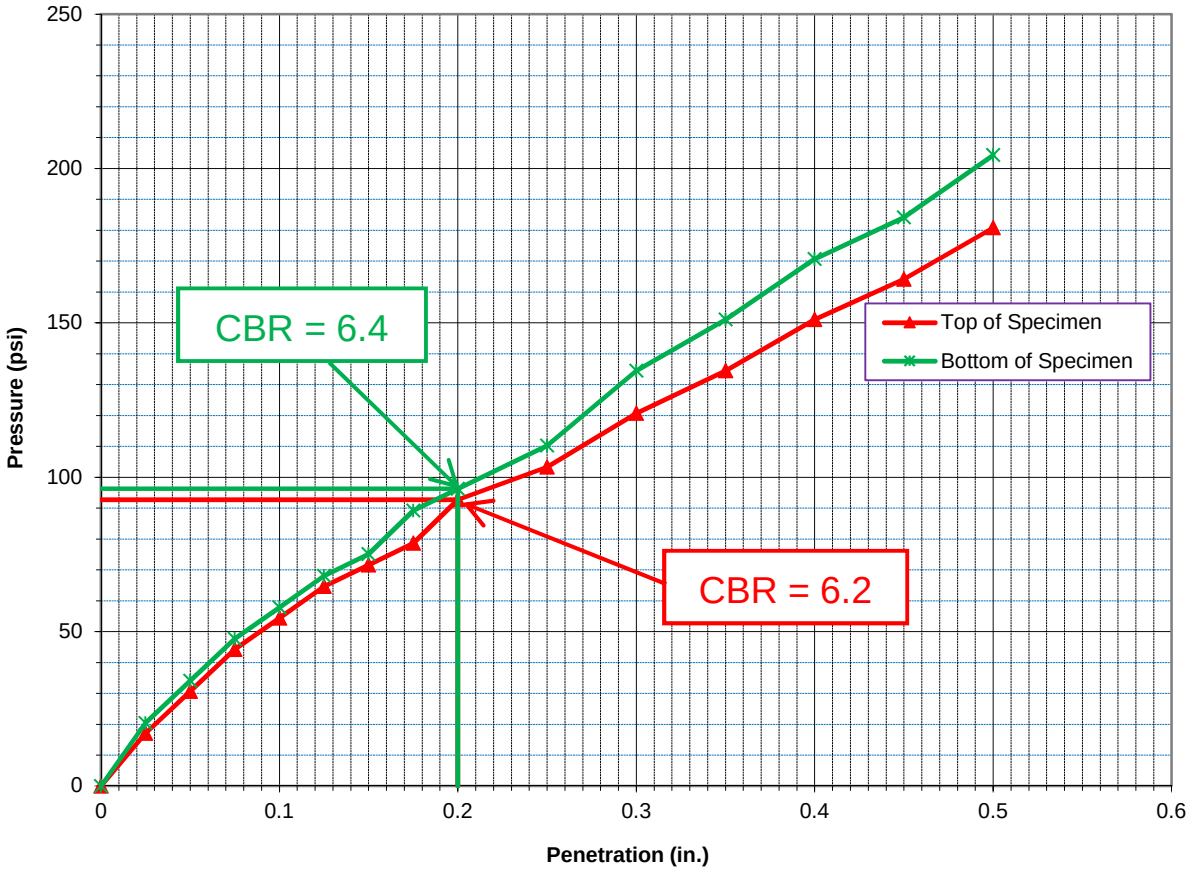
AASHTO Classification:
SM

USCS Classification:
A-2-4

GRADATION AASHTO T-88	
Sieve Number	Percent Passing
3 in.	100
2 in.	100
3/4 in.	93
3/8 in.	90
#4	83
#10	74
#40	51
#200	25



Laboratory CBR Test Report
(AASHTO T-193)



Sample/Depth, ft	Classification		Natural Moisture Content, %	Assumed Specific Gravity	Liquid Limit, %	Plastic Limit, %	% Passing No.4	% Passing No.200
	USCS	AASHTO						
5/10B/0.5-2	SM	A-2-4	8.8	2.65	NP	NP	83	25

PROCTOR TEST RESULTS (AASHTO T-99 C)	MATERIAL DESCRIPTION
Optimum Moisture Content = 13.3% Maximum Dry Density = 109 pcf	Tan and reddish brown silty fine to medium SAND with trace fine to coarse gravel

Remarks:

As molded: Dry Unit Weight, γ_d = 102.7 pcf; Moisture Content, w = 13.3%

Grubbs, Hoskyn, Barton & Wyatt, INC.
CONSULTING ENGINEERS

Project: ARDOT 030501 - Bridge 02082
GHBW Project No.: 18-040
Location: Howard Co., Arkansas
Sample Date: 05-14-18
Test Date: 5-18-18

18-040-Bridge 03089

GRAIN SIZE CURVE

Grubbs, Hoskyn, Barton & Wyatt, INC.
CONSULTING ENGINEERS

GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

Sample: 5/10B, 0.5-2 ft
Atterberg Limits: Non Plastic

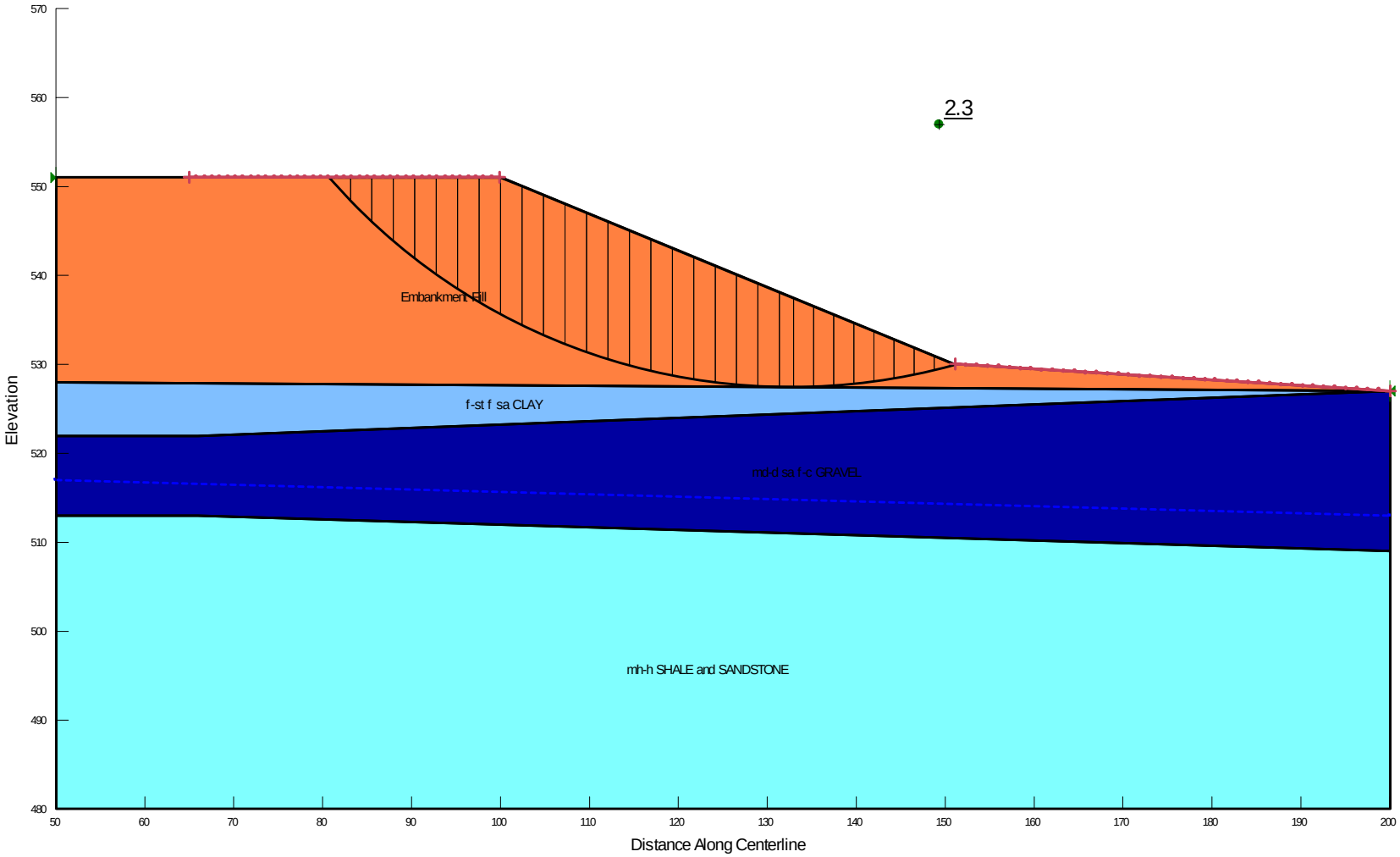
Description: Tan and reddish brown silty fine to coarse SAND with trace gravel (fill)

Classification: **USCS = SM; AASHTO = A-2-4**

ATTACHMENT 8

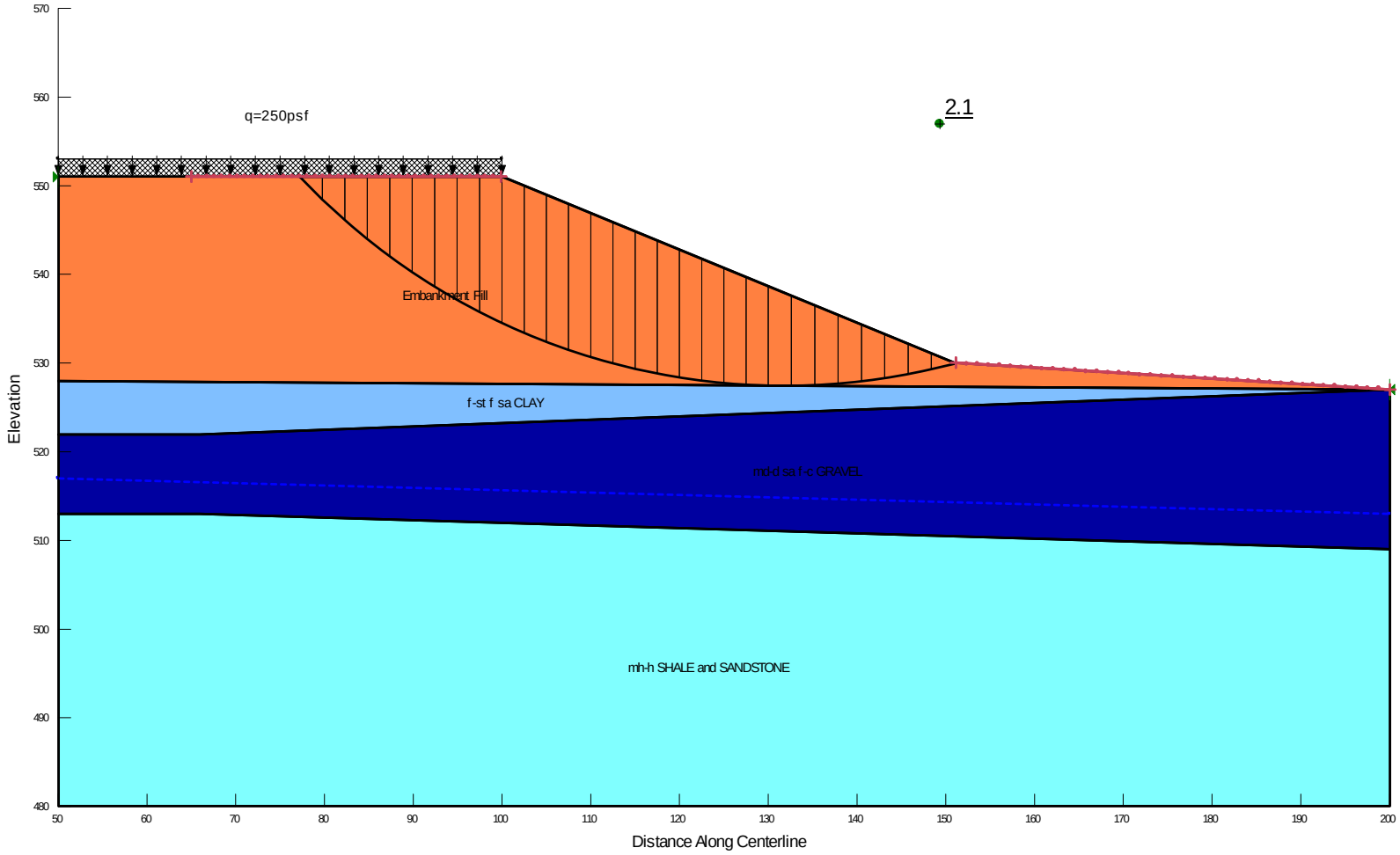
Summary of Stability Analysis Results
ARDOT Job No. 030501 Saline & Caddo Rivers Strs. & Apprs. (S)
Bridge 03089 Over Caddo River
GHBW Job No. 18-040
Pike County, Arkansas

Bridge End	Design Loading Condition	Calculated Minimum Factor of Safety
Bent 1 End Slope	End of Construction	2.3
	Long Term	2.1
	Rapid Drawdown from El 541 to Existing Grade	1.8
	Seismic ($k_h = A_S/2 = 0.04$)	2.1
Bent 6 End Slope	End of Construction	3.9
	Long Term	2.2
	Rapid Drawdown from El 541 to Existing Grade	2.1
	Seismic ($k_h = A_S/2 = 0.04$)	2.1

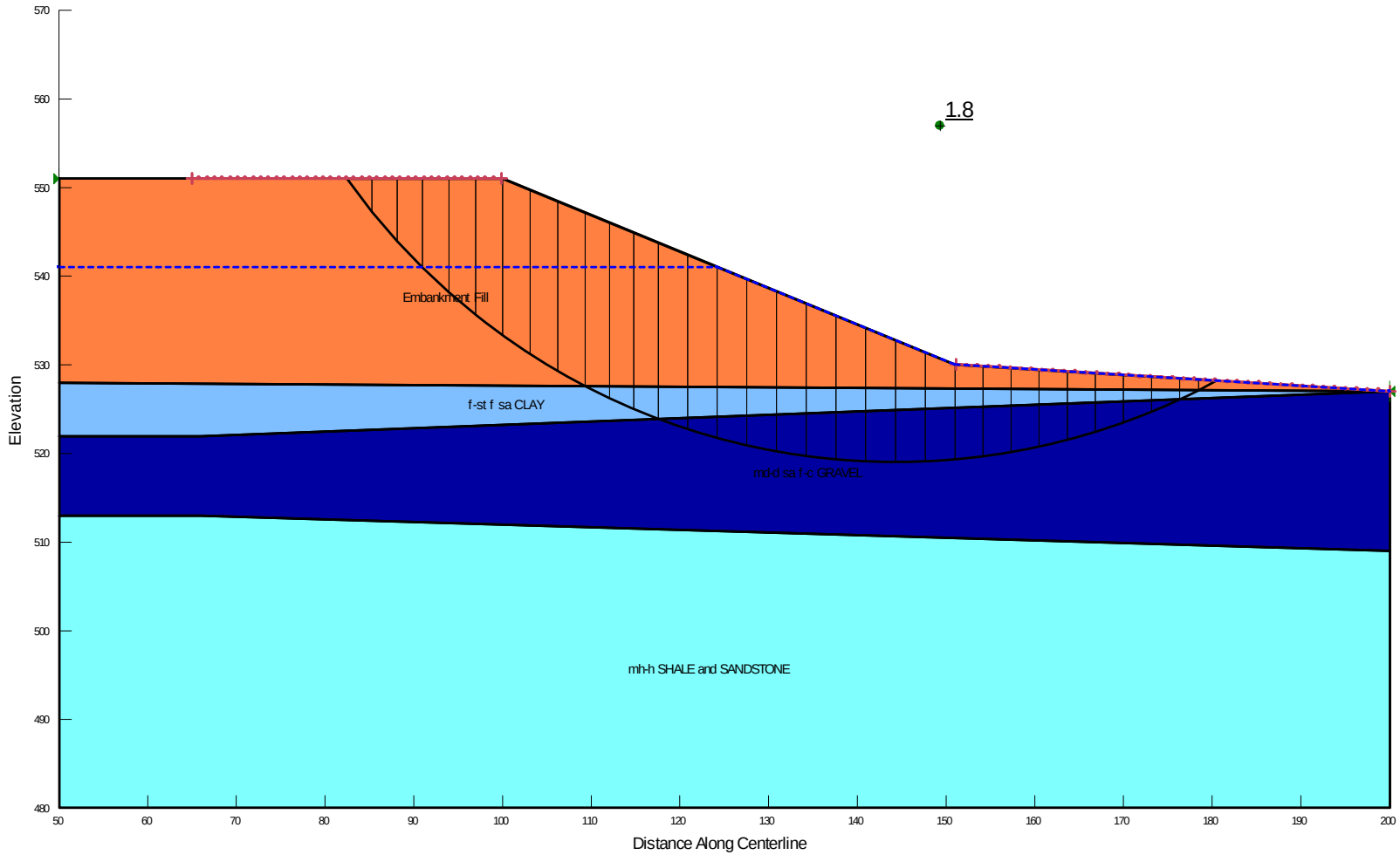


Results of Stability Analyses – End of Construction
Bent 1 End Slope
ARDOT Job No. 030501 Saline & Caddo Rivers Strs. & Apprs. (S)
Bridge 03089 Over Caddo River
GHBW Job No. 18-040
Pike County, Arkansas

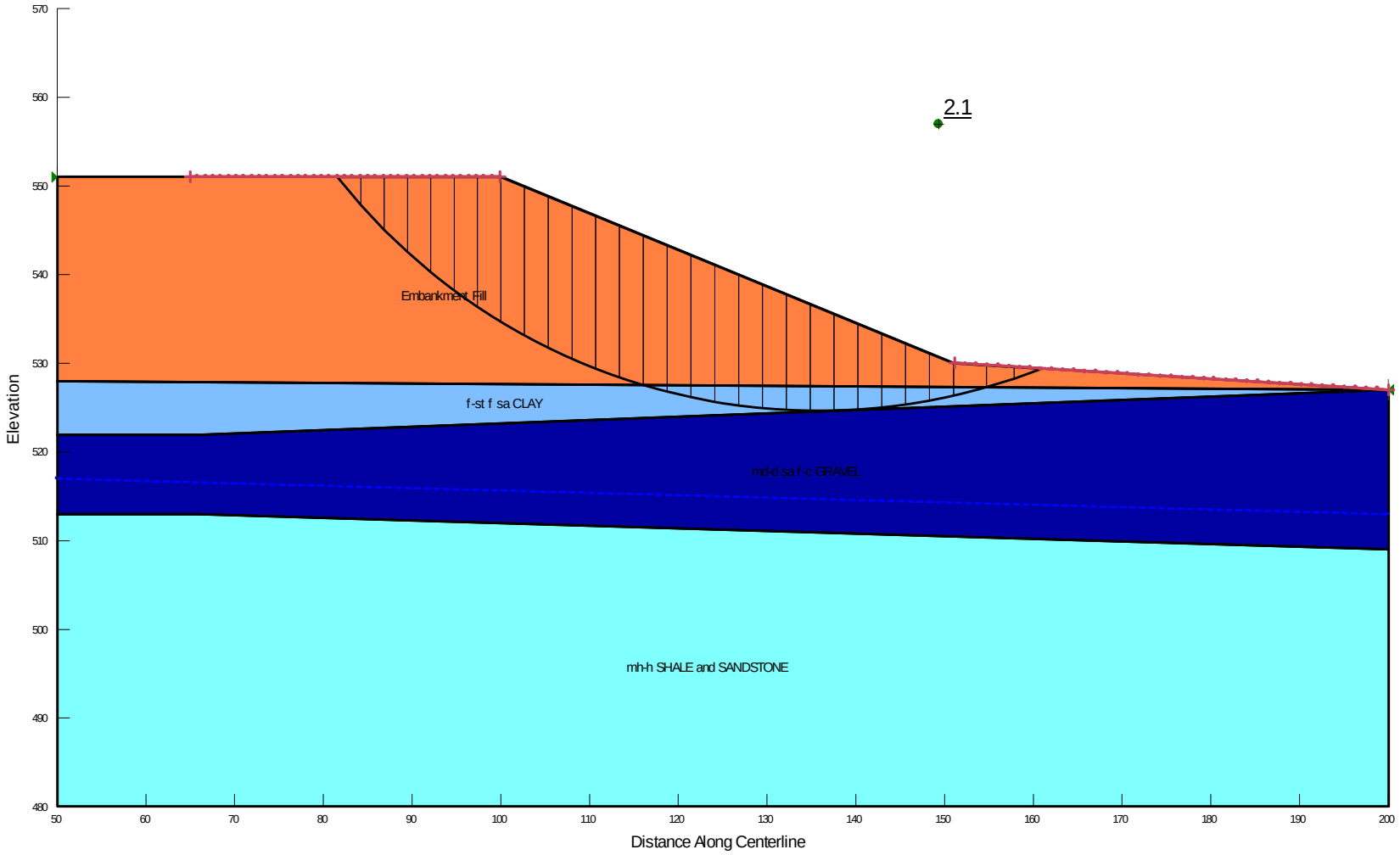
GRUBBS, HOSKYN, BARTON & WYATT, INC.
Consulting Engineers



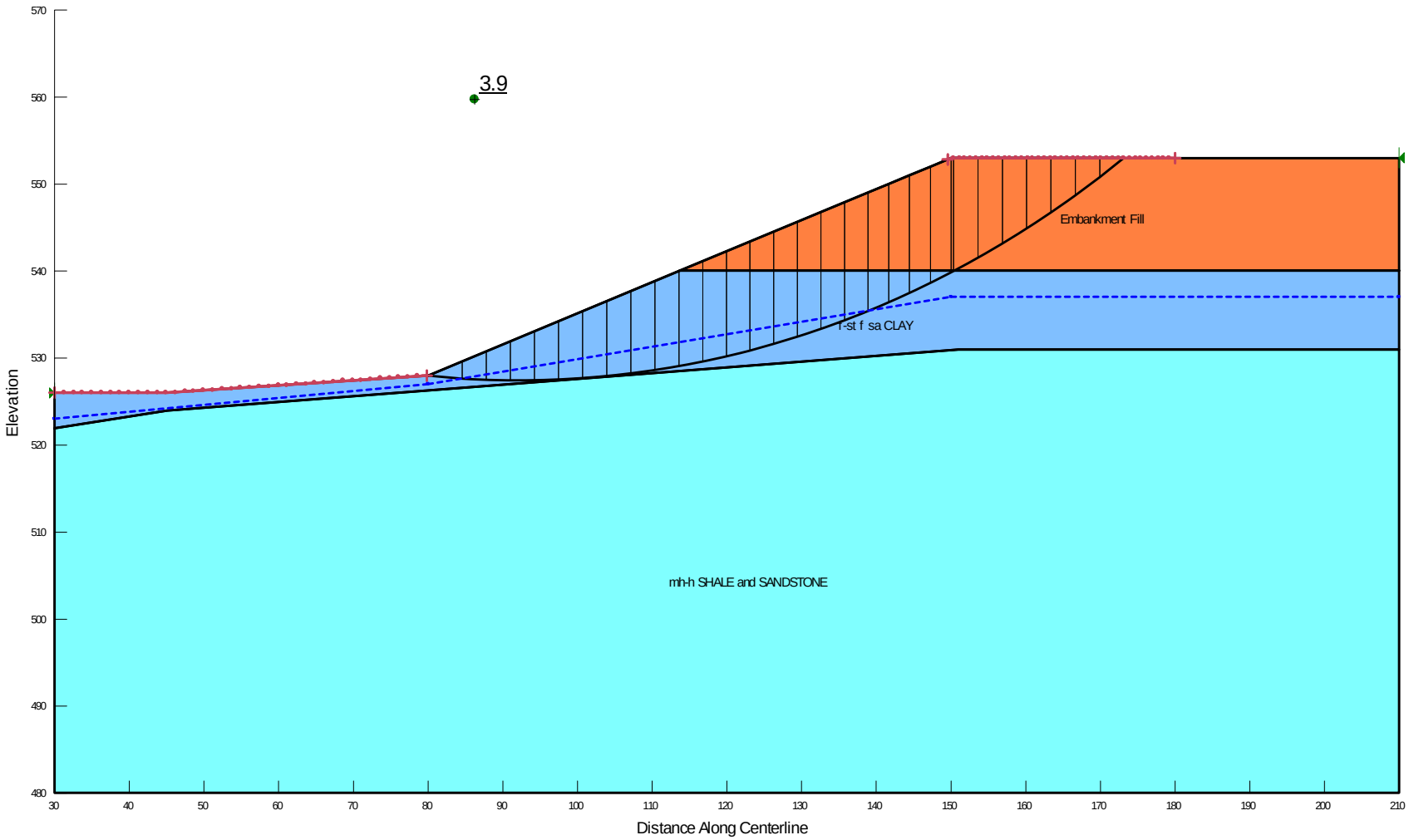
Results of Stability Analyses – Long Term Condition
Bent 1 End Slope
ARDOT Job No. 030501 Saline & Caddo Rivers Strs. & Apprs. (S)
Bridge 03089 Over Caddo River
GHBW Job No. 18-040
Pike County, Arkansas



Results of Stability Analyses – Rapid Drawdown Condition, EI 541 to Existing Grade
Bent 1 End Slope
ARDOT Job No. 030501 Saline & Caddo Rivers Strs. & Apprs. (S)
Bridge 03089 Over Caddo River
GHBW Job No. 18-040
Pike County, Arkansas

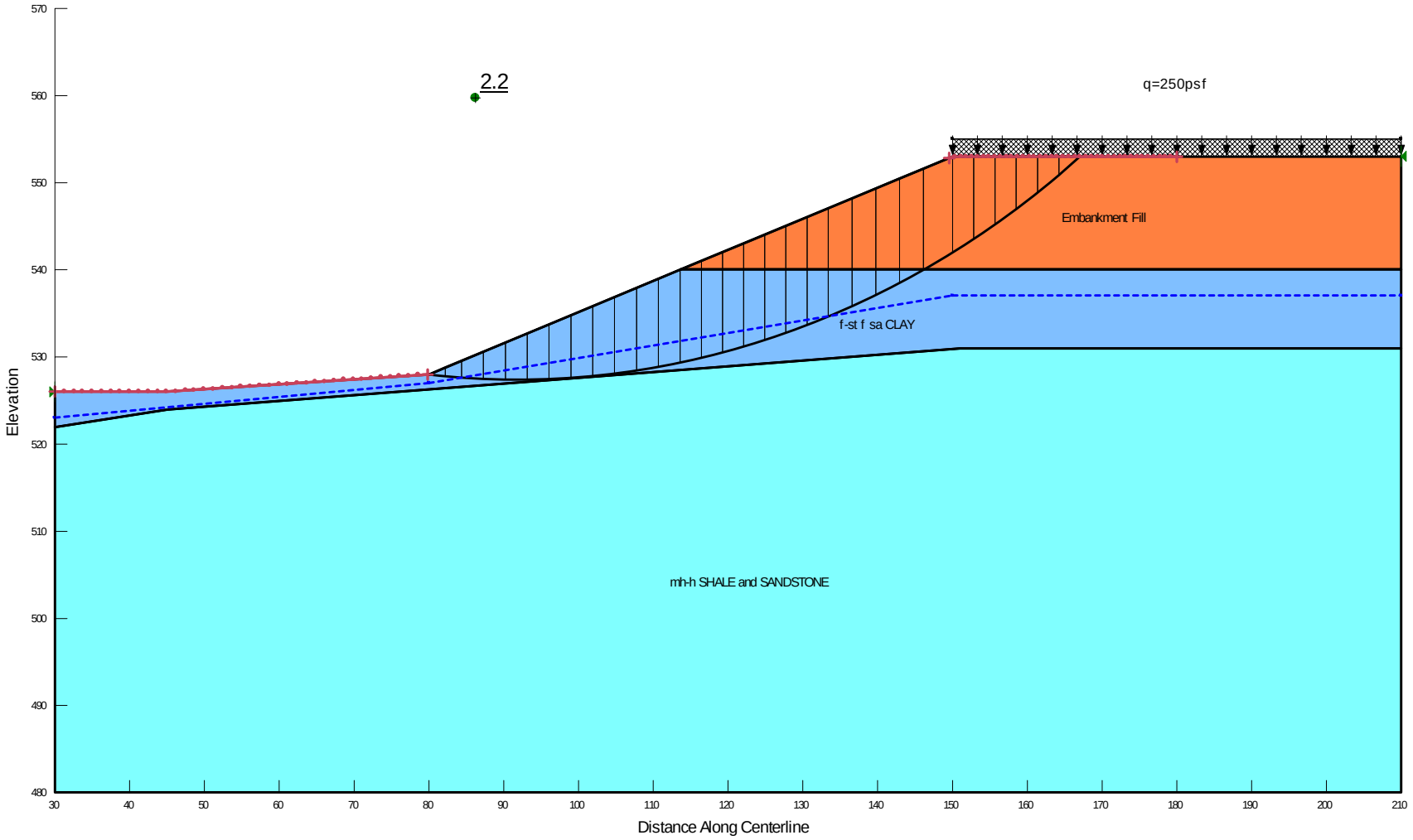


Results of Stability Analyses – Seismic Condition ($k_h = A_S /2 = 0.040$)
Bent 1 End Slope
ARDOT Job No. 030501 Saline & Caddo Rivers Strs. & Apprs. (S)
Bridge 03089 Over Caddo River
GHBW Job No. 18-040
Pike County, Arkansas



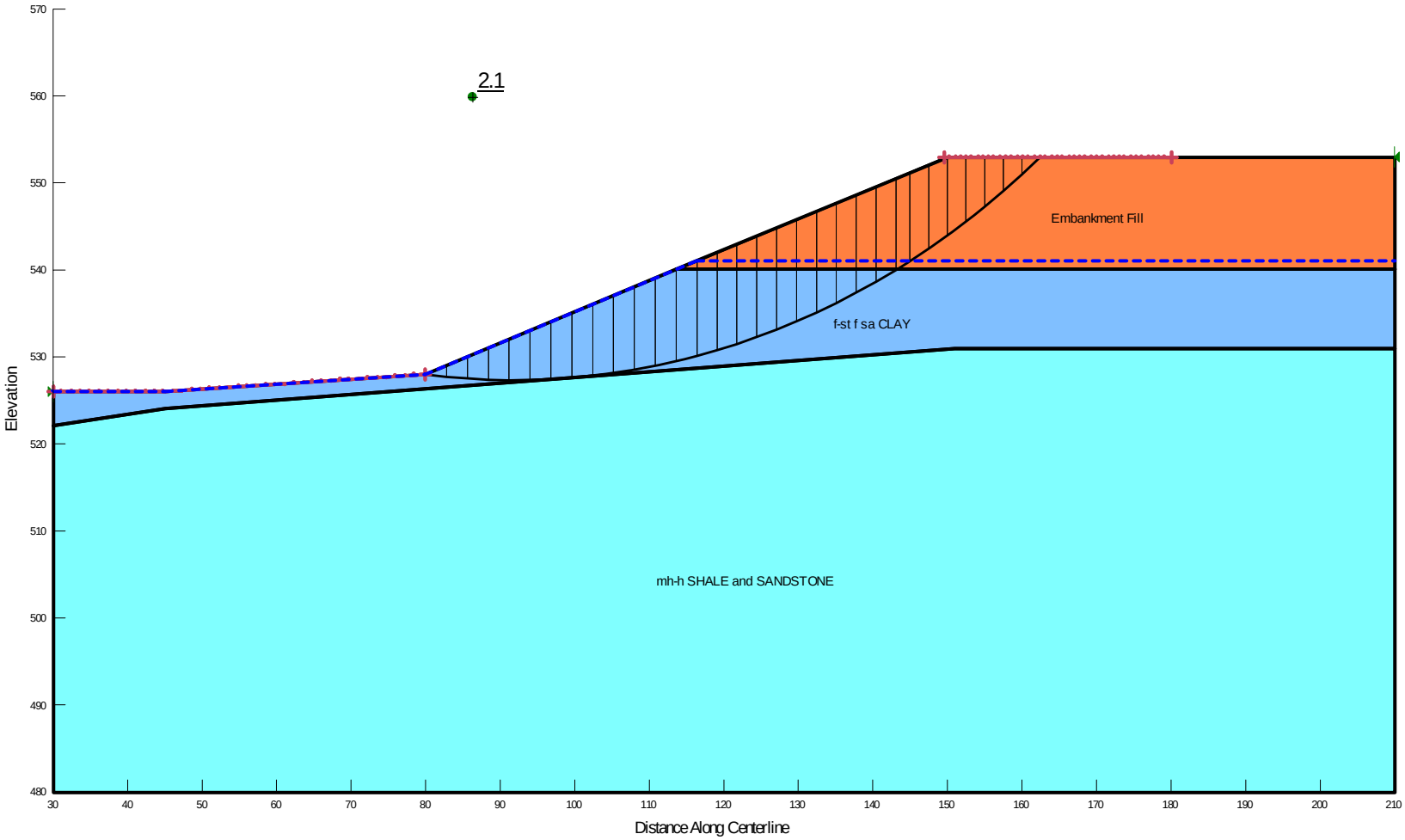
Results of Stability Analyses – End of Construction
Bent 6 End Slope
ARDOT Job No. 030501 Saline & Caddo Rivers Strs. & Apprs. (S)
Bridge 03089 Over Caddo River
GHBW Job No. 18-040
Pike County, Arkansas

GRUBBS, HOSKYN, BARTON & WYATT, INC.
Consulting Engineers

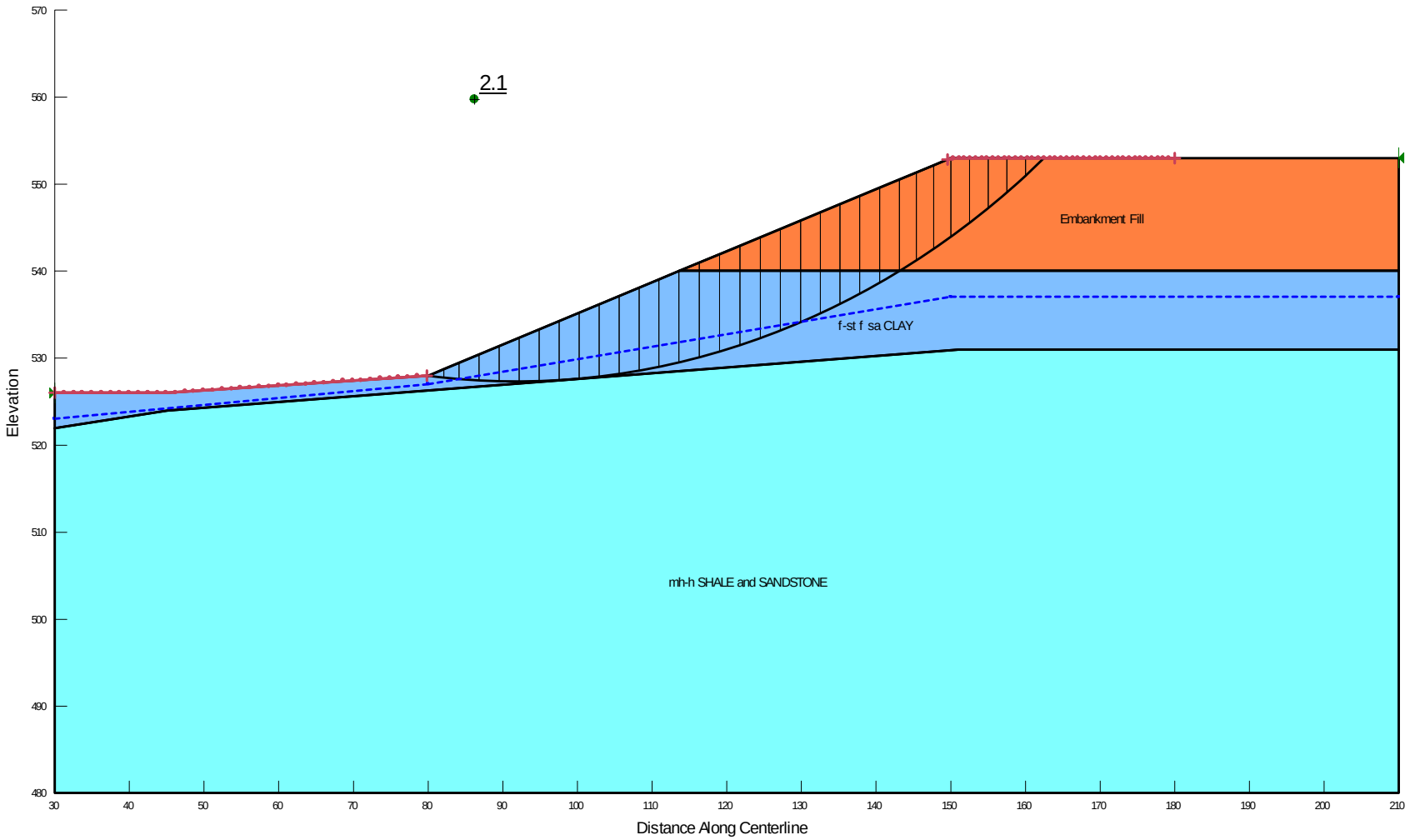


Results of Stability Analyses – Long Term Condition
Bent 6 End Slope
ARDOT Job No. 030501 Saline & Caddo Rivers Strs. & Apprs. (S)
Bridge 03089 Over Caddo River
GHBW Job No. 18-040
Pike County, Arkansas

GRUBBS, HOSKYN, BARTON & WYATT, INC.
Consulting Engineers



Results of Stability Analyses – Rapid Drawdown Condition, EI 541 to Existing Grade
Bent 6 End Slope
ARDOT Job No. 030501 Saline & Caddo Rivers Strs. & Apprs. (S)
Bridge 03089 Over Caddo River
GHBW Job No. 18-040
Pike County, Arkansas



Results of Stability Analyses – Seismic Condition ($k_h = A_S /2 = 0.04$)
Bent 6 End Slope
ARDOT Job No. 030501 Saline & Caddo Rivers Strs. & Apprs. (S)
Bridge 03089 Over Caddo River
GHBW Job No. 18-040
Pike County, Arkansas