ARKANSAS DEPARTMENT OF TRANSPORTATION

SUBSURFACE INVESTIGATION

STATE JOB NO. 030458

FEDERAL AID PROJECT NO. NHPP-0050(33)

LITTLE MISSOURI RIVER & RELIEF STRS. & APPRS. (S)

STATE HIGHWAY 19 **SECTION** 5 & 6

IN NEVADA & PIKE **COUNTY**

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

ARKANSAS DEPARTMENT OF TRANSPORTATION
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January 14, 2020

TO: Mr. Trinity Smith, Engineer of Roadway Design

SUBJECT: Job No. 030458
Little Missouri River & Relief Strs. & Apprs. (S)
Route 19 Sections 5 & 6
Nevada & Pike Counties

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

Asphalt Concrete Hot Mix

Type	Asphalt Cement %	Mineral Aggregate %
Surface Course	5.2	94.8
Binder Course	4.5	95.5
Base Course	4.0	96.0

Michael C. Benson
Materials Engineer

MCB:pt:bjj
Attachment
cc: State Constr. Eng. – Master File Copy
District 3 Engineer
System Information and Research Div.
G. C. File

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

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January 22, 2020
Job No. 18-183

Garver, LLC
4701 Northshore Drive
North Little Rock, Arkansas 72118

Attn: Mr. John Ruddell, P.E., S.E.
Vice President, Bridge Design Manager

GEOTECHNICAL INVESTIGATION
ARDOT No. 030458 LITTLE MISSOURI RIVER & RELIEF STRS. & APPRS. (S)
NEVADA and PIKE COUNTIES, ARKANSAS

INTRODUCTION

Submitted herein are the results of the geotechnical investigation performed for ARDOT Job No. 030458 Little Missouri River & Relief Strs. & Apprs. (S). Specifically, results and recommendations relevant to Bridge 03095, Hwy. 19 over the Little Missouri River in Nevada and Pike Counties, Arkansas are provided herein. This geotechnical investigation was authorized on behalf of Garver, LLC by the subconsultant agreement of September 26, 2018. Results of this study have been provided to Garver, LLC (Engineer) as data were developed. Interim recommendations for roadway subgrade support were provided on March 5, 2019. Recommendations for structure foundations were provided on August 5, 2019.

We understand the replacement bridge will be a continuous composite plate girder unit with five (5) bents, four (4) spans, and a total length of approximately 502 feet. We also understand that a foundation system consisting of steel piles is planned at the bridge ends (Bents 1 and 5) and drilled shafts are planned at the interior bents (Bents 2, 3, and 4). Foundation loads of the new bridge are anticipated to be moderate. Simple slopes will be utilized at the bridge ends and for side slopes. A preliminary bridge layout is provided in Appendix A.

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

- Visiting the site to observe landforms and surface conditions.

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

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

SUBSURFACE EXPLORATION

Subsurface conditions at the replacement bridge location were investigated by drilling five (5) sample borings (Borings 1 to 5) to depths of 75 to 100 feet. Subgrade conditions in the alignments of the approach roads were explored by drilling four (4) sample borings (Borings 6 to 9) advanced to 10- to 20-ft depth. Two (2) bulk samples of the subgrade soils were also obtained from shallow test pits (Test Pit 3/15A and 3/15B) to provide samples for laboratory testing.

The project location is shown on Plate 1. The approximate boring locations are shown on Plates 2A to 2C. The subsurface exploration program is summarized in the table below.

Summary of Exploration Program

Boring No.	Approx Hwy. 19 Sta	Offset, ft	Approx Surf El, ft	Completion Depth, ft
1	60+85	30 Rt	238	75
2	59+80	CL	239	100
3	59+15	CL	239	75
4	57+10	10 Lt	240	75
5	55+80	20 Rt	239	75
6	53+40	35 Lt	255	20
7	50+70	30 Lt	253	10
8	63+40	35 Rt	242	20
9	66+00	35 Rt	242	20

The boring logs, presenting descriptions of the soil and rock strata encountered in the borings and the results of the field and laboratory tests, are included as Plates 3 through 17. The centerline station and offset of the boring locations and approximate ground surface elevation, as inferred from the topographic information provided by the Engineer, is also shown on the logs. It must be recognized that the elevations shown are approximate and actual elevations may vary. Keys to the terms and symbols used on the logs are presented as Plates 18 and 19. A generalized subsurface profile in the bridge alignment is provided in Appendix B.

The bridge borings were drilled with a truck-mounted SIMCO 2800 rotary-drilling rigs. The roadway borings were drilled with a truck-mounted SIMCO 2400 rotary-drilling rig. Samples were typically obtained at 2-ft intervals to 10-ft depth and at 5-ft intervals thereafter. Soil and marlstone 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.

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

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

LABORATORY TESTING

To evaluate pertinent soil properties, laboratory tests consisting of classification tests and natural water content determinations were performed. A total of 106 natural water content determinations were performed to develop information on *in-situ* soil water content. Water content results are plotted on the boring logs in accordance with the scale and symbols shown in the legend located in the upper-right corner of the logs.

To verify visual classification and to evaluate soil plasticity, 18 liquid and plastic limit (Atterberg limits) determinations and 30 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 or denoted as "non-plastic". The percentage of soil passing through the No. 200 Sieve is noted in the "- No. 200 %" column on the appropriate log forms. Classification test results, along with soil classification by the Unified Soil Classification System and AASHTO designations, are summarized in Appendix C. Grain-size distribution curves are also provided in Appendix C. The 50, 30, and 10 percent passing soil particle size (i.e., D_{50}, D_{30}, and D_{10}, respectively) are shown on the grain-size curves.

Two (2) laboratory Proctor tests (AASHTO T 99) were performed on representative bulk soil samples obtained in the approach road alignments to evaluate the moisture-density relationship of potential subgrade soils. The Proctor and bulk sample classification test results are provided in Appendix D. Pavement subgrade support properties of the potential subgrade soils were evaluated by performing two (2) California Bearing Ratio (CBR, AASHTO T 193) tests on the collected bulk samples. The CBR test results are also provided in Appendix D.

GENERAL SITE and SUBSURFACE CONDITIONS

Site Conditions

The replacement Hwy. 19 Bridge over the Little Missouri River is planned at Hwy. 19 Log Mile 11.46, approximately Hwy. 19 Sta 55+78 to Sta 60+81, in Nevada and Pike Counties, Arkansas. The existing bridge is a two-lane, nine-span, steel, stringer/multi-beam or girder structure supported on footings. The replacement bridge will be located on the downstream (east) side of the existing bridge. The Little Missouri River channel is relatively broad and shallow and somewhat meandering. The terrain in the floodplain is flat.

The existing roadway is on a moderately high embankment. The terrain on each side of the roadway is low and flat, with a fall towards the river channel. Surface drainage of the bridge location in the flat terrain adjacent to the roadway embankment is considered poor to fair. The river channel slopes visually appear to be stable with thickly established vegetation. The crest of the bank is lined with medium to large trees and variable moderate to thick underbrush.

The existing Hwy. 19 is a two-lane roadway paved with asphalt concrete. As noted, the roadway is on an embankment. Surface drainage of the existing roadway is good and drainage of the surrounding terrain varies from poor to fair.

Site Geology

The project alignment is located in the Gulf Coastal Plain Physiographic Province. The site vicinity is the mapped exposure of Quaternary Alluvium. The Alluvium is comprised of recent stream-deposited alluvial sediments which include gravel, sand, silt, clay and mixtures of these clastic components. The thickness of the Alluvial deposits is variable and these units typically overly consolidated Cretaceous sediments. The alluvium in this area is thought to be underlain by the Ozan Formation. The Late Cretaceous Ozan Formation is comprised of sandy micaceous marl and fossiliferous sandy marl and is reported to be approximately 200 ft thick. The marl is formed of loosely consolidated calcareous clays, silts and sands containing glauconite. The depth of bedrock (Paleozoic rocks) in this area is reported to be about 800 feet.

Seismic Conditions

In light of the surface geology of the replacement bridge site, the average soil and rock conditions revealed by the borings with the relatively deep alluvial soils, and our experience in the area, a Seismic Site Class D (stiff soil profile) is considered fitting for the Hwy. 19 bridge site with respect to the criteria of the AASHTO LRFD Bridge Design Specifications Seventh Edition 2014[1]. Given the location and AASHTO code-based values, the 1.0-sec period spectral acceleration coefficient for Site Class D (S_1) is 0.056 and the 1.0-sec period spectral acceleration coefficient (S_{D1}) value for Site Class D is 0.135. Utilizing these parameters, Table 3.10.6-1[2] indicates that a Seismic Performance Zone 1 is fitting for the Hwy. 19 bridge site. In reference to the 2011 edition of the AASHTO Guide Specifications, the Peak Ground Acceleration (PGA) having a 7 percent chance of exceedance in 75 years (or mean return period of approximately 1000 years) is predicted to be 0.101 for a Seismic Site Class D for the bridge location.

Subsurface Conditions

Based on the results of the borings, the subsurface stratigraphy may be generalized into four (4) primary strata as follows.

Stratum I: The surface soil stratum is on-site fill. The fill is comprised of very soft to firm brown and tan fine sandy clay, medium dense brown and tan silt, loose reddish brown and tan clayey fine sand, and stiff reddish brown silty clay extending to 2- to 3.5-ft depth. The fill exhibits variable very poor to fair compaction with SPT N-values ranging from 4 blows per ft to 17 blows per foot. The depth, content, and compaction of the on-site fill may vary across the site.

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

Stratum II: The surficial soils are underlain to 13- to 18-ft depth by very loose to medium dense brown, tan, gray, and brownish gray silty fine sand, clayey fine sand, silty fine to medium sand, silt, and fine sandy silt. Discontinuous fine sandy clay, silty clay, and clay layers and strata are locally present within the predominant granular soils this stratum. The cohesionless soils have very low to medium relative density, high compressibility, and a low potential for liquefaction.

Stratum III: Medium dense to dense brown, tan, reddish brown, and reddish tan sandy fine to coarse gravel is below the variable granular soils at elevations ranging from approximately El 221 to El 227. The sandy fine to coarse gravel has medium to high relative density and low compressibility.

Stratum IV: The embankment fill and overburden soils are underlain by low hardness to moderately hard dark gray marlstone. The marlstone is fossiliferous, micaceous, and calcareous. The marlstone also includes arenaceous zones. Additionally, the basal marlstone is highly plastic with high shear strength and low compressibility.

Groundwater Conditions

Groundwater was encountered in the borings at 5- to 9-ft depth (±El 230 to ±El 234) at the bridge location in May 2019. Groundwater levels will vary, depending upon seasonal precipitation, surface runoff and infiltration, and water levels in the nearby river and other surface water features.

ANALYSES and RECOMMENDATIONS

Foundation Design for Bridges

Foundations for the replacement 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 5) and on drilled shafts at the interior bents (Bents 2, 3, and 4). Recommendations for foundations are discussed in the following report sections.

Bridge Ends (Bent 1 and Bent 5): Steel 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.

Nominal (ultimate) geotechnical pile capacity curves for steel HP12x53 and HP14x73 piles are presented in Appendix E. As shown on the nominal capacity curves, the geotechnical pile capacity is considered for pile penetration through the upper granular soils and the predominant marlstone. We recommend that all steel piles be fitted with rock points.

Nominal axial pile geotechnical capacities have been developed using static pile capacity formulae and the results of the borings. Piles are assumed to be driven from the plan pile cap bottom at El 246 or El 247, as shown on the preliminary bridge layout. The nominal capacities are based on single, isolated foundations. Piles spaced closer than three (3) pile widths may develop lower individual capacity due to group effects, and further analysis is recommended for a closely-spaced pile layout.

Based on AASHTO LRFD geotechnical design procedures, an effective resistance factor (φ_{stat}) of 0.45 is recommended for evaluation of factored compression capacity. For evaluation of factored uplift capacities, a resistance factor (φ_{up}) of 0.25 is recommended. These resistance factors are based on Strength Limit States. For Extreme Events Limit States such as earthquake loading and collision, resistance factors of 1.0 and 0.8 are recommended for evaluating compression and uplift capacities, respectively. Post-construction settlement of piles installed to the recommended factored capacities should be less than 1.0 inch.

Computed capacities for driven piling are based on driving piles to the required penetration, rather than use of jetting or other methods. Pre-boring is not expected to be required for pile installation. When jetting, etc., is used to aid pile installation, the conditions used in calculations may not be met. Hence, capacities may be significantly different and calculated capacities should be re-evaluated.

Piles should be installed in compliance with ARDOT Standard Specifications Section 805. 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 driving. We have recommended that all piles be fitted with rock points.

As a minimum, safe bearing capacity of production piles should be determined by ARDOT Standard Specifications Section 805.09, Method A. Blow counts on steel piles should be

limited to about 20 blows per inch. Practical pile refusal may be defined as a penetration of 0.5 in. or less for the final 10 blows. Driving records should be available for review by the Engineer during pile installation. To verify capacity, the piles should be re-struck after a minimum of 72 hours following initial driving. Re-striking blow counts should verify capacity.

We recommend a minimum pile penetration extending at least 10 ft below existing grades (at the base of embankment fill). Pre-boring is not expected to be required for low-displacement steel piles. Given the relatively minor embankment fill and the soil conditions, downdrag loads on piles are expected to be negligible.

Drilled Shaft Foundations – Bents 2, 3, and 4

Axial Capacities. Bents 2, 3, and 4 of the Hwy. 19 over the Little Missouri River Bridge will be in or near the river channel. Drilled shafts are recommended for support of the foundation loads of these bents. Drilled shafts should be founded in the moderately hard dark gray marlstone (Stratum IV). A minimum embedment of 10 ft or two (2) shaft diameters into the moderately hard marlstone, whichever is greater, recommended below the bottom of the permanent casing and scour depth. For drilled shafts founded in the moderately hard marlstone as recommended, a maximum nominal bearing capacity of 50 kips per sq ft is recommended. A resistance factor (φ_{stat}) of 0.55 is recommended for evaluation of drilled shaft end bearing.

Circumferential shaft friction will also be developed for that portion of shaft penetration extending below the bottom elevation of the permanent casing. For skin friction in the low hardness to moderately hard marlstone bearing stratum, a maximum nominal skin resistance value of 1750 lbs per sq ft is recommended. A resistance factor (φ_{stat}) of 0.60 is recommended for compression. For evaluation of uplift capacity, a resistance factor (φ_{up}) of 0.35 is recommended. Any skin friction of the shaft penetration above the bottom elevation of the permanent casing should be neglected from axial shaft capacity determination. Total and differential settlement of properly installed drilled shafts founded in the moderately hard marlstone should be less than 1.0 inch.

A minimum shaft diameter of 60 in. is recommended for drilled shafts. A minimum shaft length of three (3) diameters is also recommended. Based on the results of the borings, the estimated minimum shaft depths and tip elevations are summarized below in Table 1. The estimated shaft length is based on a shaft diameter of 60 inches.

Table 1: Estimated Minimum 60-in.-diameter Shaft Lengths

Bent No.	Estimated Permanent Casing Bottom El, ft	Estimated Minimum Shaft Length, ft	Estimated Minimum Shaft Tip El, ft
2	207	42	197
3	209	47	199
4	210	38	200

The minimum shaft lengths and estimated shaft tip elevations shown in Table 1 are estimates only and have been based on the results of the borings, the inferred surface or mudline elevation at the particular location, and anticipated grades. Suitable bearing stratum and final shaft lengths must be field verified. Actual shaft lengths and shaft tip elevations must be based on the specific subsurface conditions, compression and uplift capacity requirements, and plan shaft diameters.

As-built drilled shaft lengths will vary with the required penetration into the bearing stratum and specific subsurface conditions. Depending on specific subsurface conditions, localized deepening or shortening of shaft depths will be warranted. All drilled shaft excavations should be observed by the Engineer to verify suitable bearing and adequate penetration.

Stability of End Slopes

The replacement bridge will include new end slope configurations on the north and south ends of the bridge. The proposed embankments on the north and south sides are planned with 2-horizontal to 1-vertical (2H:1V) configurations. The north and south embankments will have a maximum height of about 17 feet.

To evaluate suitability of the plan configurations, slope stability analyses were 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 0.05. For evaluating the rapid drawdown condition, a water surface elevation drop from El 250 to existing grades was assumed. The sections used for the analyses are shown in the graphical results provided in Appendix F.

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

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

Subgrade Support

The results of the approach road borings and test pits indicate that the on-site subgrade soils will be comprised primarily of sandy fine gravel and clay. These soils are anticipated to classify by AASHTO M 145 as A-7-6, A-2-4 and A-1-b. The A-7-6 classification correlates with poor subgrade support for pavements. Locally-available borrow which is likely to be used as unclassified embankment fill could have similar classification, but is expected to be primarily fine-grained soils classifying as A-4, A-6, or A-7-6.

Based on the results of the borings and bulk sampling and correlation with the AASHTO classification, subgrade support of the on-site soils is expected to be very poor to poor. Subgrade preparation is anticipated to require stabilization, either by undercut and replacement or addition of stabilization additives. The results of the borings performed in the approach road alignments indicate the zone of weak and unstable subgrade soils extends to 4 ft below existing grades to in excess of 8 ft below existing grades. It is anticipated that undercutting and backfilling with stone backfill (Standard Specifications for Highway Construction, Edition of 2014, Section 207) will be warranted to limit undercut depths to about 3 ft below existing grades.

In lieu of undercutting and replacing unsuitable soils, consideration may be given to using additives to improve soil workability and stabilize weak areas. Hydrated lime, quick lime, Portland cement, fly ash, or suitable alternate materials may be used as verified by appropriate testing and approved by the Engineer. Additives can be effective where the depth of unstable soils is relatively shallow. Treatment will be less effective in areas where the zone of unstable soils is deep. The optimum application rate and treatment depth of stabilization additive must be determined by specific laboratory tests performed on the alignment subgrade soils. Given the depth of weak soils in this alignment, minimum treatment depths of 18 to 24 in., more or less, would be expected.

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. The low-plasticity subgrade can be developed by undercut and backfill or addition of stabilization additives. For highly-plastic clay subgrade soils, a lime addition rate of 5 percent by dry soil weight may be assumed for estimation purposes. This equates to an application weight of about 4 lbs per sq yd per in. of

treatment depth. As recommended above, the optimum application rate of stabilization additive should be determined by specific laboratory tests performed on the specific subgrade soils.

The following parameters are recommended for use in pavement design for the anticipated subgrade of the on-site clayey soils and similar borrow soils.

- Resilient Modulus (M_R): 2550 lbs per sq inch
- R value: 4.5

Site Grading and Subgrade Preparation

Site grading and site preparation in the project 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 toes. Particular care must be taken to muck our all saturated and organic-laden soils in the existing roadside swales.

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, stripping, any cut, and prior to fill placement or otherwise continuing with subgrade preparation, the subgrade should be evaluated by thorough proof-rolling. 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 embankment fill or as directed by the Engineer. Based on the results

of the borings, localized undercutting could be required to develop subgrade stability. The roadway borings indicate that the zone of weak soils extends 4 ft to in excess of 13 ft below existing grades. Consequently, to limit undercut depths the use of stone backfill (Standard Specifications for Highway Construction, 2014 Edition, Section 207) will be warranted.

In lieu of undercutting and replacing unsuitable soils in roadway areas, consideration may be given to using additives to improve soil workability and to stabilize weak areas. Hydrated lime, quick lime, Portland cement, fly ash, or suitable alternate materials may be used as verified by appropriate testing and approved by the Engineer. Given the predominance of granular soils revealed by the borings, the use of Portland cement or fly ash would be expected to be advantageous on this site. Use of lime may be more effective for areas of fine-grained, clayey soil subgrade soils. Additives can be effective where the depth of unstable soils is relatively shallow. Treatment will be less effective in areas where the zone of unstable soils is deep. The optimum application rate of stabilization additive must be determined by specific laboratory tests performed on the alignment subgrade soils. Given the depth of weak subgrade soils revealed by the borings, minimum treatment depths of 18 to 24 in., more or less, would be expected.

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

Subgrade preparation should comply with Standard Specifications for Highway Construction, 2014 Edition, Section 212. Embankments should be constructed in accordance with ARDOT criteria (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. Cofferdam construction could be required for interior bent foundation construction. Density and water content of all earthwork should be maintained until the embankments and bridge work is completed.

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

Shallow perched groundwater may be encountered in the near-surface soils, particularly at lower elevations and during times of high seepage flow. The volume of groundwater produced can be highly variable depending on stream levels and the condition of the soils in the immediate vicinity of excavations. In addition, seasonal surface seeps or springs could develop as infiltrated surface water from areas of higher terrain migrate downgradient.

Seepage into excavations and cuts can typically be controlled by ditching or sump-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. Use of coarse stone fill should be avoided in areas where piles will be driven. 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. 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 abutments. 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 driving.

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. Practical pile refusal may be defined as a penetration of 0.5 in. or less for the final 10 blows.

Drilled Shafts

Drilled shaft foundations are planned in or near the river channel. Permanent casing will be utilized to control seepage and caving of the granular alluvial soils into pier excavations. Where the excavation cannot be dewatered, a cleanout or muck bucket should be used for final cleanup. For underwater concrete placement, a rigid tremie or a concrete pump with rigid extension should be used to place concrete below water. All drilled shaft excavations should be observed by the Engineer or Department to verify construction in accordance with the plans and specifications.

CLOSURE

The Engineer or Department or a designated representative thereof should monitor site preparation, grading work and foundation and pavement construction. Subsurface conditions

significantly at variance with those encountered in the borings should be brought to the attention of the Geotechnical Engineer. The conclusions and recommendations of this report should then be reviewed in light of the new information.

The following illustrations are attached and complete this submittal.

Plate 1	Site Vicinity Map
Plates 2a to 2c	Plans of Borings
Plates 3 through 17	Boring Logs
Plates 18 and 19	Keys to Terms and Symbols
Appendix A	Preliminary Bridge Layout
Appendix B	Generalized Subsurface Profile
Appendix C	Laboratory Test Results
Appendix D	Subgrade Support Test Results
Appendix E	Nominal Axial Pile Capacity Curves
Appendix F	Stability Analyses Results

* * * * *

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

Sincerely,

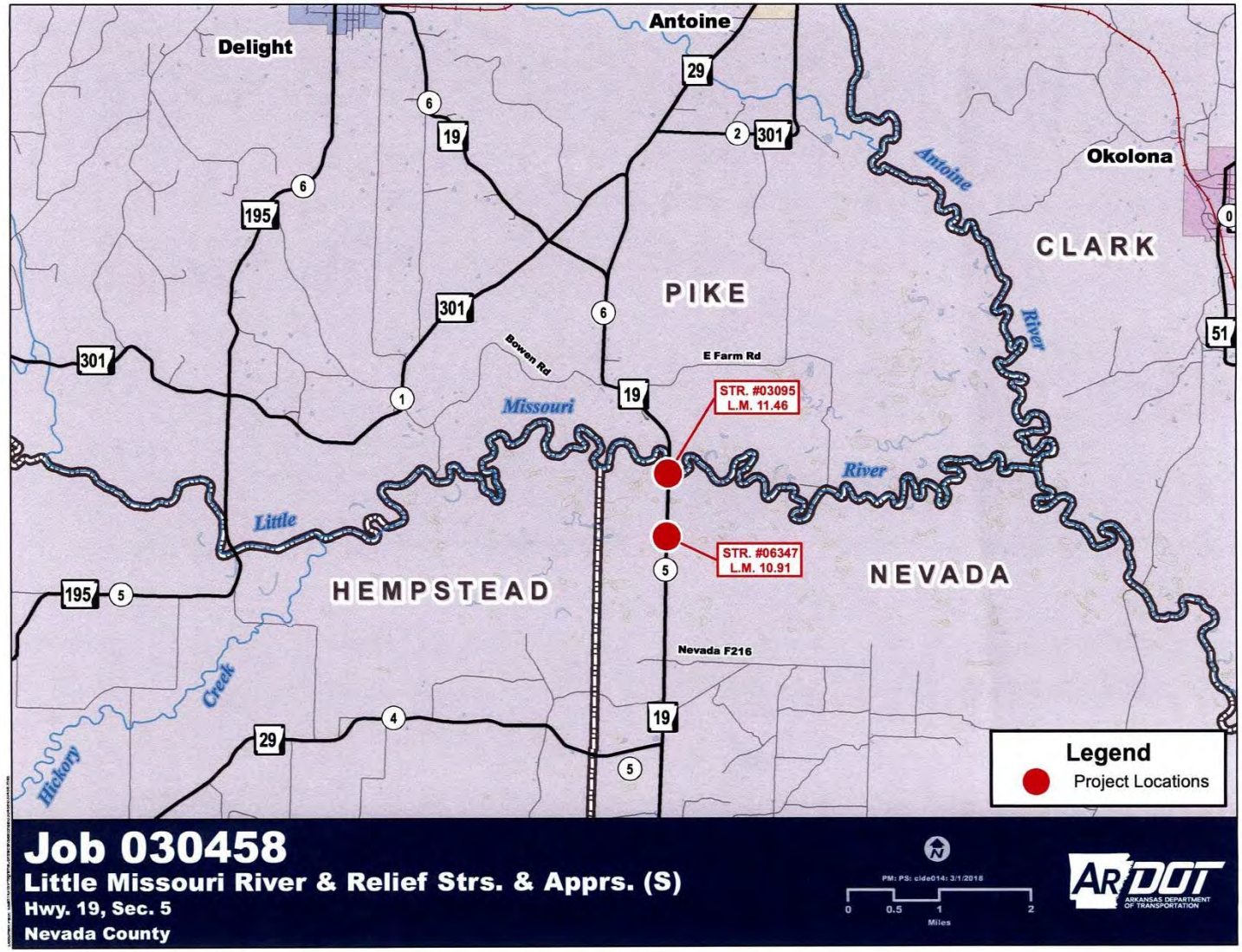
GRUBBS, HOSKYN,
BARTON &WYATT, INC.

Ben Davis, P.E.
Project Engineer

Mark E. Wyatt, P.E.
President

BJD/MEW:jw

Copies Submitted: Garver, LLC
Attn: Mr. John H. Ruddell, P.E., S.E. (1-email)
Attn: Mr. John Cantabery, P.E. (1-email)



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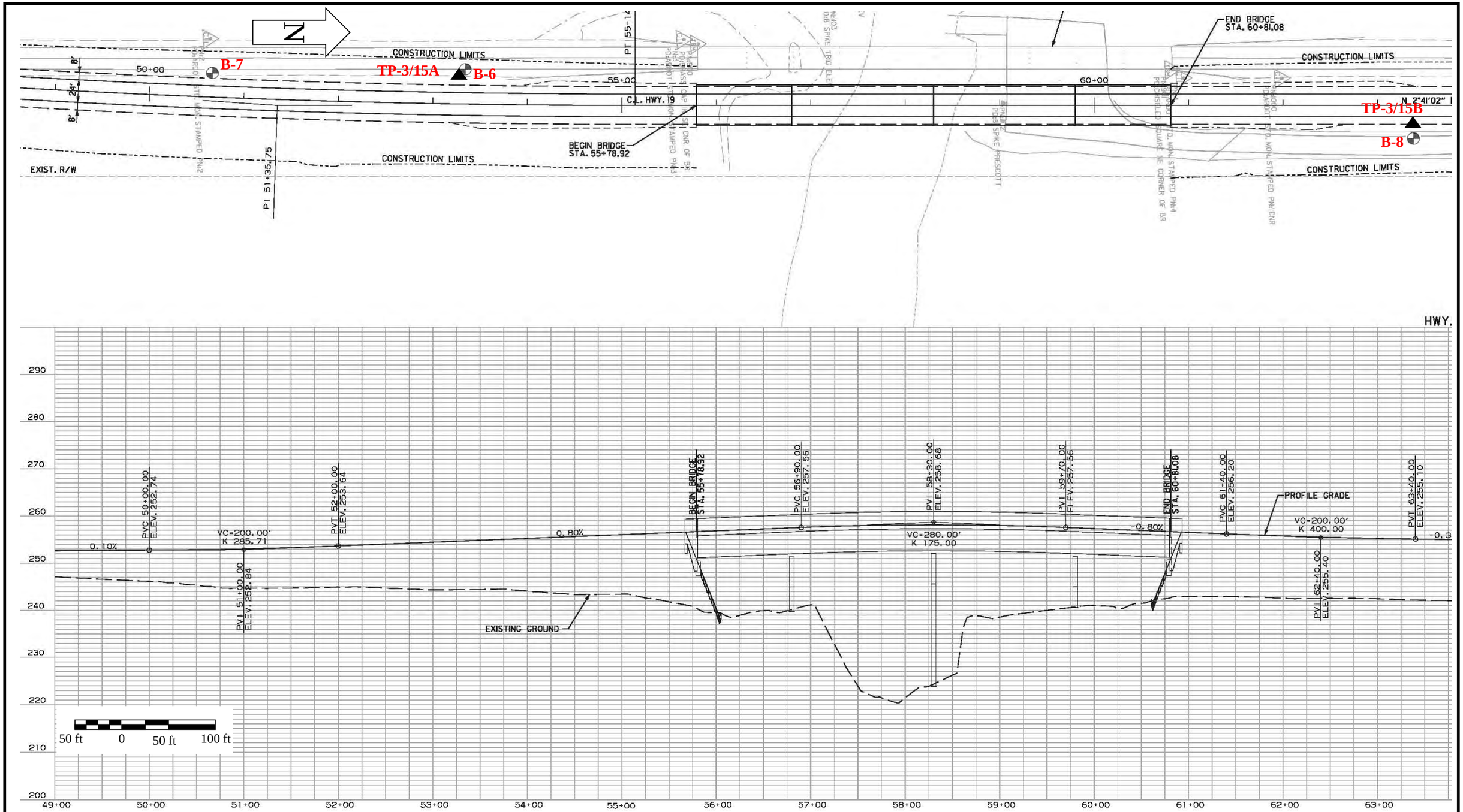
CONSULTING ENGINEERS

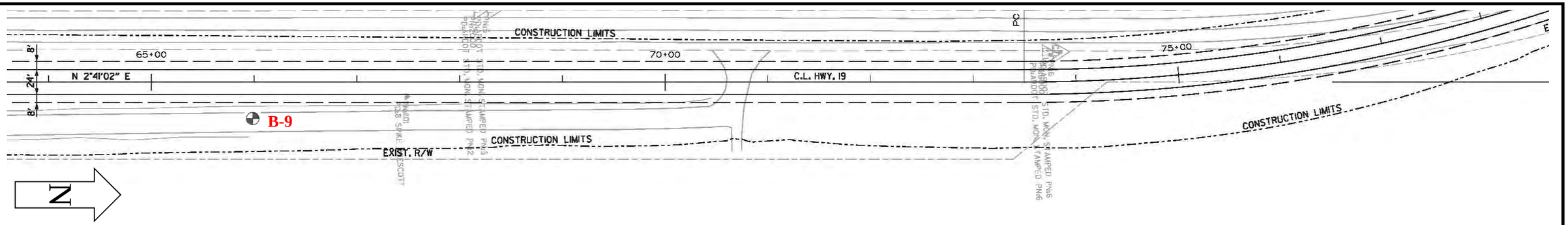
Site Vicinity Map
030458 Little Missouri River
Nevada County, Arkansas

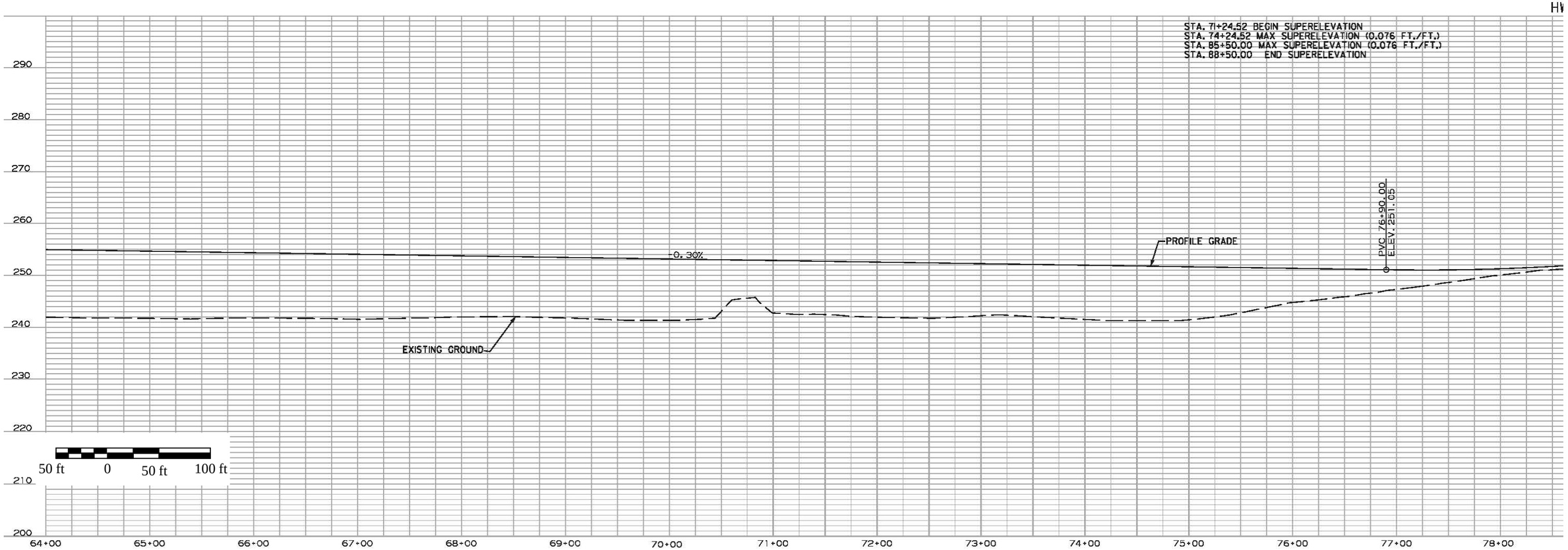
Job No. 18-183

Plate 1



Grubbs, Hoskyn, Barton & Wyatt, INC. CONSULTING ENGINEERS	**PLAN OF BORINGS and TEST PITS** **030458 Little Missouri River** **Nevada County, Arkansas**	**Scale: As Shown** **Date: March 2019**	**Job No. 18-183**	**PLATE 2A**





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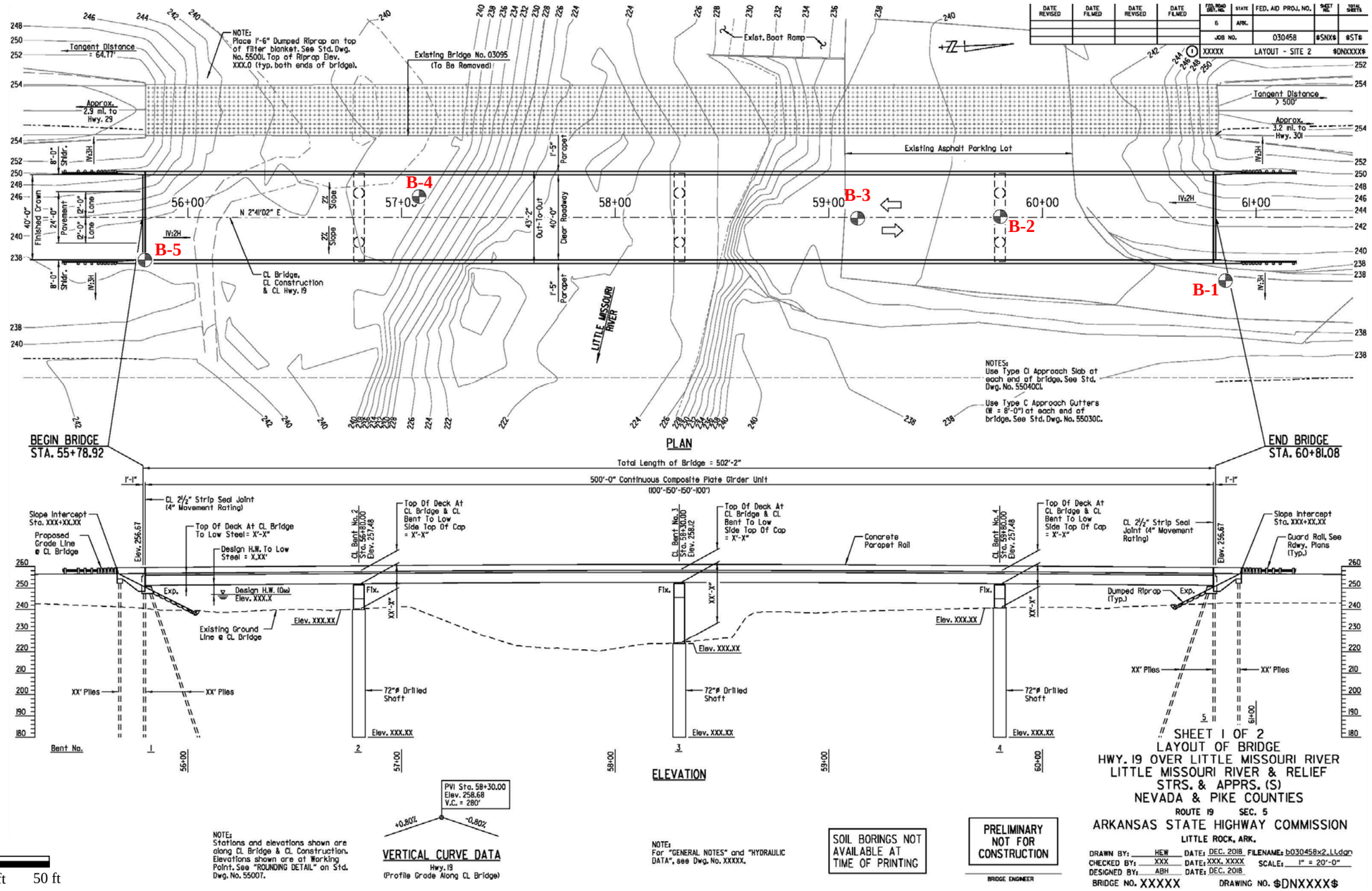
PLAN OF BORINGS and TEST PITS
030458 Little Missouri River
Nevada County, Arkansas

Scale: As Shown

Date: March 2019

Job No. 18-183

PLATE 2B



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PLAN OF BORINGS
030458 Little Missouri River
Nevada County, Arkansas

Scale: As Shown

Date: March 2019

Job No. 18-183

PLATE 2C

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

LOG OF BORING NO. 1

030458 - Bridge 03095 over Little Missouri River
Pike and Nevada County, Arkansas

TYPE: Auger to 10 ft /Wash

LOCATION: Approx Sta 60+85, 30 ft Rt

SURF. EL: 238±

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	- No. 200 %
	1.5 Inches: Asphalt Concrete			
	7 Inches: Aggregate Base (clayey fine to coarse gravel)	7		
	Firm brown and tan fine sandy clay (fill)	23		
5	Medium dense brown silty fine sand	6		44
	- loose at 4 to 6 ft - very loose below 6 ft	0/WOH		
10	Loose tan and brown silty fine to medium sand	9		13
15	Medium dense tan sandy fine to coarse gravel	12		1
20	- dense at 18 to 23 ft	33		
25	- medium dense, silty below 23 ft	26		
30	Moderately hard dark gray marlstone, fossiliferous and calcareous, micaceous	50/11"		64
35		50/8"		88
40		50/9"		
	- with limestone partings and seams at 43 to 48 ft	50/3"		

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

-NON-PLASTIC-

COMPLETION DEPTH: 75.0 ft
DATE: 5-10-19

DEPTH TO WATER IN BORING: 5.5 ft

DATE: 5/10/2019

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

LOG OF BORING NO. 1

030458 - Bridge 03095 over Little Missouri River
Pike and Nevada County, Arkansas

TYPE: Auger to 10 ft /Wash

LOCATION: Approx Sta 60+85, 30 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				50/9"			
			- slightly arenaceous below 53 ft				
55				50/8"			
60				50/3"			
65				50/4"			
70				50/5"			
75				50/4"			
80							
85							

COMPLETION DEPTH: 75.0 ft
DATE: 5-10-19

DEPTH TO WATER IN BORING: 5.5 ft

DATE: 5/10/2019

LGBNEW 18-183.GPJ 8-6-19

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

LOG OF BORING NO. 2

030458 - Bridge 03095 over Little Missouri River
Pike and Nevada County, Arkansas

TYPE: Auger to 13.5 ft /Wash

LOCATION: Approx Sta 59+80, 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 %
			SURF. EL: 239±				
			1.5 inches: Asphalt Concrete				
			5 inches: Aggregate Base (Clayey fine to coarse gravel)	17			
			Medium dense brown and tan silt w/a little fine gravel (fill)	4			
5			Very soft to soft brown silty clay - soft below 4 ft	5			
			Very loose brown silt	2			
			Loose brown fine sandy silt	5		G_s = 2.66	74
10							
			Medium dense brown fine to medium sand, slightly silty w/some fine to coarse gravel	20			6
15							
			Medium dense brown sandy fine gravel	16			
20							
25				27			1
			Moderately hard dark gray marlstone, calcareous and fossiliferous, micaceous	50/10"			
30						2.55	
				50/9"	108		81
35							
				50/9"	104		
40							
				50/9"			

COMPLETION DEPTH: 100.0 ft
DATE: 5-14-19

DEPTH TO WATER IN BORING: 5 ft

DATE: 5/14/2019

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Consulting Engineers

LOG OF BORING NO. 2

030458 - Bridge 03095 over Little Missouri River
Pike and Nevada County, Arkansas

TYPE: Auger to 13.5 ft /Wash

LOCATION: Approx Sta 59+80, 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 %
			(continued)				
50				50/9"			
				50/6"	98		3.46
55							
			- slightly arenaceous below 58 ft	50/9"			
60							
				50/7"			
65							
				50/10"	98		
70							
				50/10"			
75							
			- low hardness at 78 to 88 ft	50			
80							
				50	101		
85							
			- moderately hard below 88 ft	50/11"			

COMPLETION DEPTH: 100.0 ft
DATE: 5-14-19

DEPTH TO WATER IN BORING: 5 ft
DATE: 5/14/2019

LGBNEW 18-183.GPJ 8-9-19

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

LOG OF BORING NO. 2

030458 - Bridge 03095 over Little Missouri River
Pike and Nevada County, Arkansas

TYPE: Auger to 13.5 ft /Wash

LOCATION: Approx Sta 59+80, 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 %
			(continued)				
95				50/10"			
100				50/9"			
105							
110							
115							
120							
125							
130							

COMPLETION DEPTH: 100.0 ft
DATE: 5-14-19

DEPTH TO WATER IN BORING: 5 ft
DATE: 5/14/2019

LGBNEW 18-183.GPJ 8-9-19

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

LOG OF BORING NO. 3

030458 - Bridge 03095 over Little Missouri River
Pike and Nevada County, Arkansas

TYPE: Auger to 20 ft /Wash

LOCATION: Approx Sta 59+15, CL

SURF. EL: 239±

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	- No. 200 %
	4 Inches: Asphalt Concrete			
	5 Inches: Aggregate Base (clayey fine to coarse gravel)	11		
	Medium dense tan silt w/a little fine gravel (fill)	9		
5	Loose reddish brown and tan clayey fine sand (fill)	0/WOH		
	Very soft brownish gray and gray clay w/occasional organics and ferrous stains	4		
10	Very loose to loose gray and tan clayey fine sand - loose below 8 ft	6		
15	Medium dense brown and tan sandy fine to coarse gravel, slightly silty	27		7
20	- dense at 18 to 23 ft	42		
25	- dense to very dense below 23 ft	50/8"		
30	Low hardness dark gray marlstone calcareous and fossiliferous, micaceous	36		
35		48		97
40		47		
		50	106	3.86

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

COMPLETION DEPTH: 75.0 ft
DATE: 5-15-19

DEPTH TO WATER IN BORING: 5.3 ft
DATE: 5/15/2019

LGBNEW 18-183.GPJ 8-9-19

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

LOG OF BORING NO. 3

030458 - Bridge 03095 over Little Missouri River
Pike and Nevada County, Arkansas

TYPE: Auger to 20 ft /Wash

LOCATION: Approx Sta 59+15, 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 %
			(continued)				
50			- moderately hard below 48 ft	50/10"			
55			- slightly arenaceous below 53 ft	50/10"			
60				50/7"			
65				50/8"			
70				50/4"			
75				50/10"			
80							
85							

COMPLETION DEPTH: 75.0 ft
DATE: 5-15-19

DEPTH TO WATER IN BORING: 5.3 ft

DATE: 5/15/2019

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

LOG OF BORING NO. 4

030458 - Bridge 03095 over Little Missouri River
Pike and Nevada County, Arkansas

TYPE: Auger to 23.5 ft /Wash

LOCATION: Approx Sta 57+10, 10 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: 240±				
			Stiff reddish brown silty clay w/some fine to coarse gravel (fill)	15			
			Firm to stiff reddish tan sandy clay w/organic stains	10			79
5			- soft below 4 ft	5			
			Stiff reddish tan and tan fine sandy clay, silty	12			50
			Medium dense reddish brown silty fine sand	14			35
10							
			Medium dense reddish tan sandy fine to coarse gravel, slightly silty	18			
15							
			- dense at 18 to 23 ft - gray below 18 ft	44			7
20							
			- medium dense below 23 ft	19			
25							
			Stiff dark gray clay, calcareous	17			
30							
			Moderately hard dark gray marlstone, calcareous, fossiliferous and micaceous	50/8"			
35							
				50/8"			
40							
				50/11"	104		

COMPLETION DEPTH: 75.0 ft
DATE: 5-17-19

DEPTH TO WATER IN BORING: 8.5 ft

DATE: 5/17/2019

LGBNEW 18-183.GPJ 8-9-19

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

LOG OF BORING NO. 4

030458 - Bridge 03095 over Little Missouri River
Pike and Nevada County, Arkansas

TYPE: Auger to 23.5 ft /Wash

LOCATION: Approx Sta 57+10, 10 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				50/11"			
55			- slightly arenaceous below 53 ft -low hardness at 53 to 63 ft	50			
60				46			
65			- moderately hard below 63 ft	50/10"			
70				50/10"			
75			- more arenaceous below 73 ft	50/5"			
80							
85							

COMPLETION DEPTH: 75.0 ft
DATE: 5-17-19

DEPTH TO WATER IN BORING: 8.5 ft
DATE: 5/17/2019

LGBNEW 18-183.GPJ 8-9-19

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

LOG OF BORING NO. 5

030458 - Bridge 03095 over Little Missouri River
Pike and Nevada County, Arkansas

TYPE: Auger to 18.5 ft /Wash

LOCATION: Approx Sta 55+80, 20 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: 239±				
			Very soft to soft reddish brown fine sandy clay (fill)	4			
			Very soft to soft yellowish tan and tan silty clay w/ferrous stains	4			
5			Medium dense gray and tan fine sandy silt	13			
				14			60
10			Very loose tan and gray silty fine to medium sand	3			17
15			Medium dense reddish brown sandy fine to coarse gravel	12			4
			- dense below 18 ft				
20				32			4
25			Low hardness dark gray marlstone, calcareous and fossiliferous, micaceous	39			
30				39			
			- moderately hard below 33 ft				
35				50/11"			
40				50/8"			
				50/9"			

COMPLETION DEPTH: 75.0 ft
DATE: 5-18-19

DEPTH TO WATER IN BORING: 9 ft

DATE: 5/18/2019

LGBNEW 18-183.GPJ 8-6-19

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

LOG OF BORING NO. 5

030458 - Bridge 03095 over Little Missouri River
Pike and Nevada County, Arkansas

TYPE: Auger to 18.5 ft /Wash

LOCATION: Approx Sta 55+80, 20 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				50/11"			
55				50/10"			
			- slightly arenaceous at 58 to 63 ft				
60				50/10"			
65				50/8"			
70				50/10"			
75				50/11"			
80							
85							

COMPLETION DEPTH: 75.0 ft
DATE: 5-18-19

DEPTH TO WATER IN BORING: 9 ft
DATE: 5/18/2019

LGBNEW 18-183.GPJ 8-6-19

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

LOG OF BORING NO. 6

030458 - Bridge 03095 over Little Missouri River
Pike and Nevada County, Arkansas

TYPE: Auger

LOCATION: Approx Sta 53+40, 35 ft Lt

SURF. EL: 255±

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	- No. 200 %
	3 inches: Asphalt Concrete			
	Loose reddish tan clayey fine to coarse sand w/some fine to coarse gravel (fill)	8		88
	Firm gray and olive gray clay (fill)	9		
	- soft below 4 ft	6		
5				
	Stiff gray, reddish brown and tan silty clay, slightly sandy	21		84
		16		
10				
	- soft below 13 ft	6		
15				
	Firm to stiff light gray silty clay w/ferrous nodules	10		
20				
25				

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

COMPLETION DEPTH: 20.0 ft
DATE: 3-20-19

DEPTH TO WATER
IN BORING: 17 ft at Completion
DATE: 3/20/2019

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

LOG OF BORING NO. 7

030458 - Bridge 03095 over Little Missouri River
Pike and Nevada County, Arkansas

TYPE: Auger

LOCATION: Approx Sta 50+70, 30 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: 253±				
			3 inches: Asphalt Concrete				
			Loose reddish tan sandy fine gravel, slightly clayey (fill)	9			11
			Firm olive gray and tan clay, slightly sandy (fill)	7			89
			- stiff below 4 ft	17			
5							
			Stiff to very stiff brown and gray silty clay	24			
			- stiff below 8 ft	12			
10							
15							

COMPLETION DEPTH: 10.0 ft
DATE: 3-20-19

DEPTH TO WATER IN BORING: Dry

DATE: 3/20/2019

LGBNEW 18-183.GPJ 8-6-19

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

LOG OF BORING NO. 8

030458 - Bridge 03095 over Little Missouri River
Pike and Nevada County, Arkansas

TYPE: Auger

LOCATION: Approx Sta 63+40, 35 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: 242±				
			2 inches: Asphalt Concrete				
			Loose reddish tan sandy fine to coarse gravel (fill)	7			12
			Stiff brown and tan silty clay	12			55
5			Medium dense brown fine sandy silt - loose at 4 - 6 ft	7			
			Very loose light gray silty fine sand, slightly clayey w/occasional decayed organics	0/WOH			35
10				3			
			Medium dense gray and tan sandy fine to coarse gravel, silty	12			
15							
				15			
20							
25							

COMPLETION DEPTH: 20.0 ft
DATE: 3-20-19

DEPTH TO WATER IN BORING: 8.5 ft

DATE: 3/20/2019

LGBNEW 18-183.GPJ 8-6-19

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

LOG OF BORING NO. 9

030458 - Bridge 03095 over Little Missouri River
Pike and Nevada County, Arkansas

TYPE: Auger

LOCATION: Approx Sta 66+00, 35 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: 242±				
			1 inch: Asphalt Concrete				
			Loose reddish tan silty fine to coarse gravel w/fine to coarse sand (probable fill)	9			17
			Very loose brown silt, slightly clayey	3			85
5			Very loose to loose brown silty fine sand	4			39
			- very loose below 6 ft - with silty clay pockets at 6 - 8 ft	3			
10				1			
			Medium dense tan and gray sandy fine to coarse gravel, silty	13			
15							
20				26			
25							

COMPLETION DEPTH: 20.0 ft
DATE: 3-20-19

DEPTH TO WATER IN BORING: 3 ft
DATE: 3/20/2019

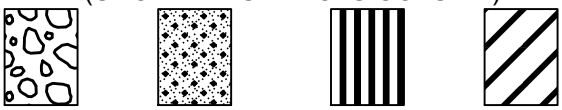
LGBNEW 18-183.GPJ 8-6-19

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

SYMBOLS AND TERMS USED ON BORING LOGS

SOIL TYPES

(SHOWN IN SYMBOLS COLUMN)

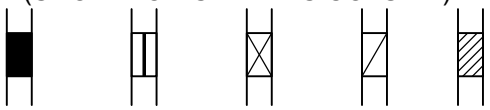


Gravel Sand Silt Clay

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.

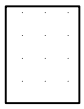
Terms used on this report for describing soils according to their texture or grain size distribution are in accordance with the UNIFIED SOIL CLASSIFICATION SYSTEM, as described in Technical Memorandum No.3-357, Waterways Experiment Station, March 1953

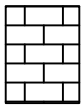
KEY 5-20-19

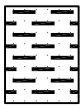
Grubbs, Hoskyn, Barton & Wyatt, Inc.
Consulting Engineers

BORING LOG TERMS – ROCK

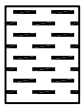
ROCK TYPES
(SHOWN IN SYMBOLS COLUMN)


Sandstone


Limestone


Siltstone


Coal


Shale

Joint Characteristics –

Spacing	
Very Close	0.75 to 2.5 in.
Close	2.5 to 8 in.
Moderately Close	8 to 24 in.
Wide	2 to 6 ft
Very Wide	More than 6 ft

Bedding Characteristics –

Very Thin	0.75 to 2.5 in.
Thin	2.5 to 8 in.
Medium	8 to 24 in.
Thick	2 to 6 ft
Massive	More than 6 ft

Lithologic Characteristics –

Clayey
Shaly
Calcareous (limy)
Siliceous
Sandy (Arenaceous)
Silty
Plastic Seams

Parting – Less than 1/16 inch
Seam – 1/16 to 1/2 inch
Layer – 1/2 to 12 inches
Stratum – Greater than 12 inches

Hardness–

Soft (S) – Reserved for plastic material alone.

Friable (F) – Easily crumbled by hand, pulverized or reduced to powder and is too soft to be cut with a pocket knife.

Low Hardness (LH) – Can be gouged deeply or carved with a pocket knife.

Moderately Hard (MH) – Can be readily scratched by a knife blade; scratch leaves a heavy trace of dust and scratch is readily visible after the powder has been blown away.

Hard (H) – Can be scratched with difficulty; scratch produces little powder and is often faintly visible; traces of the knife steel may be visible.

Very hard (VH) – Cannot be scratched with a pocket knife. Knife steel marks left on surface.

Texture –

Fine – Barely seen with naked eye
Medium – Barely seen up to 1/8 in.
Coarse – 1/8 in. to 1/4 in.

Structure –

Bedding
- Flat – 0° – 5°
- Gently Dipping – 5° – 35°
- Moderately Dipping – 55° – 85°
- Steeply Dipping – 55° – 85°

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

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 FHWA 3-2-12

APPENDIX A

DATE REVISED	DATE FILMED	DATE REVISED	DATE FILMED

FED. ROAD DIST. NO.	STATE	FED. AID PROJ. NO.	SHEET NO.	TOTAL SHEETS
6	ARK.			
JOB NO.		030458	SNX	ST
XXXXX		LAYOUT - SITE 2		$DNXXXX$

NOTE:
Place 1'-6" Dumped Riprap on top of filter blanket. See Std. Dwg. No. 55001. Top of Riprap Elev. XXX.0 (typ. both ends of bridge).

Tangent Distance = 64.77'

Approx. 2.9 mi. to Hwy. 29

Existing Bridge No. 03095 (To Be Removed)

Exist. Boat Ramp

Existing Asphalt Parking Lot

Tangent Distance > 500'

Approx. 3.2 mi. to Hwy. 301

8'-0" Shldr.

IV:3H

40'-0" Finished Crown

24'-0" Pavement

12'-0" Lane

12'-0" Lane

IV:2H

2% Slope

2% Slope

43'-2" Out-To-Out

40'-0" Clear Roadway

1'-5" Parapet

1'-5" Parapet

56+00

57+00

58+00

59+00

60+00

61+00

N 2°41'02" E

CL Bridge, CL Construction & CL Hwy. 19

LITTLE MISSOURI RIVER

NOTES:
Use Type CI Approach Slab at each end of bridge. See Std. Dwg. No. 55040CI.

Use Type C Approach Gutters (W = 8'-0") at each end of bridge. See Std. Dwg. No. 55030C.

BEGIN BRIDGE
STA. 55+78.92

END BRIDGE
STA. 60+81.08

PLAN

Total Length of Bridge = 502'-2"

1'-1"

500'-0" Continuous Composite Plate Girder Unit
(100'-150'-150'-100')

1'-1"

CL 2½" Strip Seal Joint (4" Movement Rating)

Slope Intercept Sta. XXX+XX.XX

Proposed Grade Line @ CL Bridge

Elev. 256.67

Top Of Deck At CL Bridge To Low Steel = X'-X"

Design H.W. To Low Steel = X.XX'

CL Bent No. 2 Sta. 56+80.00 Elev. 257.48

Top Of Deck At CL Bridge & CL Bent To Low Side Top Of Cap = X'-X"

CL Bent No. 3 Sta. 58+30.00 Elev. 258.12

Top Of Deck At CL Bridge & CL Bent To Low Side Top Of Cap = X'-X"

Concrete Parapet Rail

CL Bent No. 4 Sta. 59+80.00 Elev. 257.48

Top Of Deck At CL Bridge & CL Bent To Low Side Top Of Cap = X'-X"

CL 2½" Strip Seal Joint (4" Movement Rating)

Elev. 256.67

Slope Intercept Sta. XXX+XX.XX

Guard Rail, See Rdwy. Plans (Typ.)

Exp.

Design H.W. (Q_{50}) Elev. XXX.X

Fix.

XX'-X"

Existing Ground Line @ CL Bridge

Elev. XXX.XX

Dumped Riprap (Typ.)

XX' Piles

72"ø Drilled Shaft

Bent No. 1 2 3 4

ELEVATION

PVI Sta. 58+30.00
Elev. 258.68
V.C. = 280'

+0.80% -0.80%

VERTICAL CURVE DATA

Hwy. 19
(Profile Grade Along CL Bridge)

NOTE:
Stations and elevations shown are along CL Bridge & CL Construction. Elevations shown are at Working Point. See "ROUNDING DETAIL" on Std. Dwg. No. 55007.

FOR R/W DATA AND GUARDRAIL DETAILS, SEE ROADWAY PLANS

NOTE:
For "GENERAL NOTES" and "HYDRAULIC DATA", see Dwg. No. XXXXX.

SOIL BORINGS NOT AVAILABLE AT TIME OF PRINTING

PRELIMINARY NOT FOR CONSTRUCTION

BRIDGE ENGINEER

SHEET 1 OF 2
LAYOUT OF BRIDGE
HWY. 19 OVER LITTLE MISSOURI RIVER
LITTLE MISSOURI RIVER & RELIEF
STRS. & APPRS. (S)
NEVADA & PIKE COUNTIES

ROUTE 19 SEC. 5

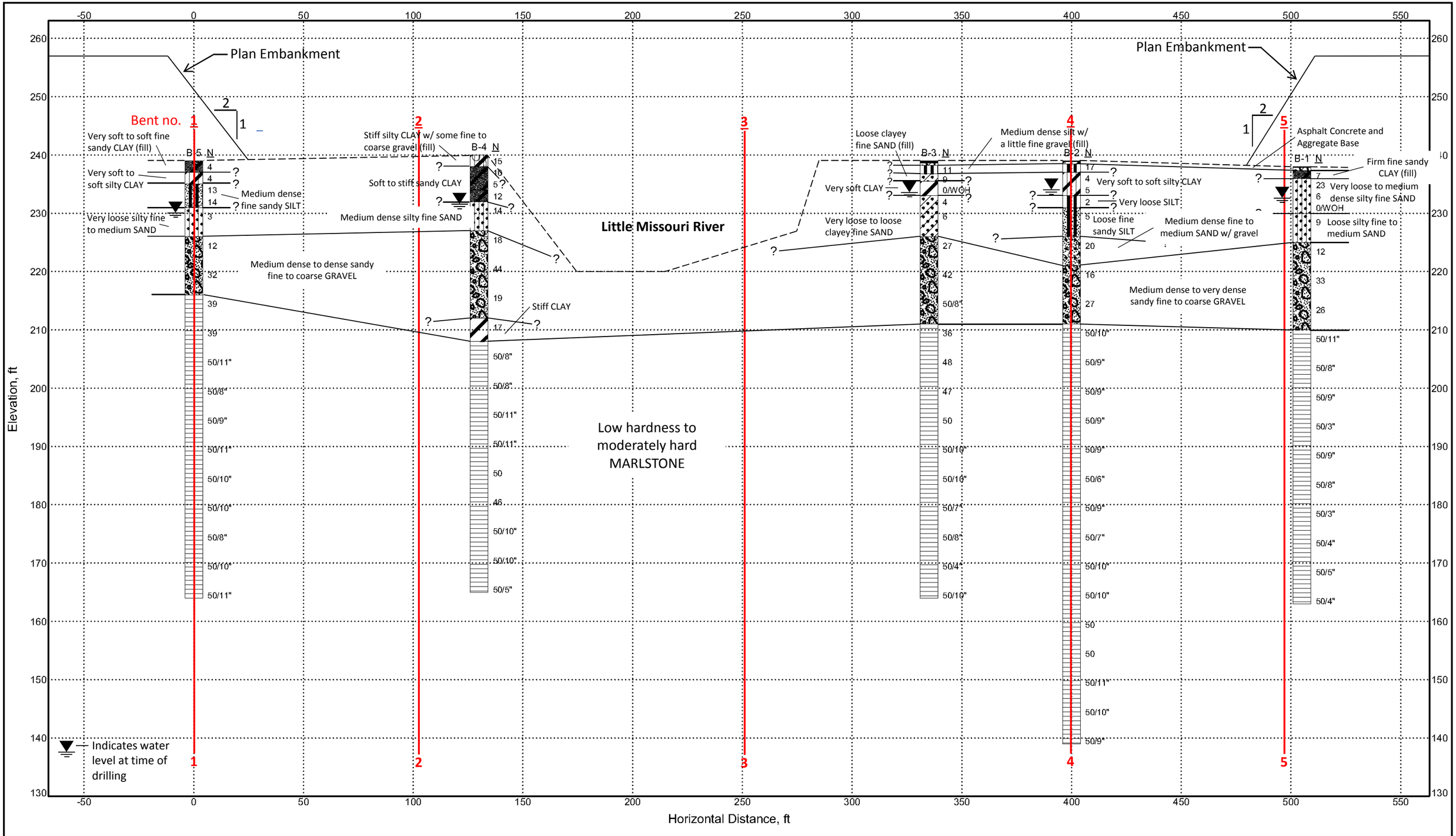
ARKANSAS STATE HIGHWAY COMMISSION

LITTLE ROCK, ARK.

DRAWN BY: HEW DATE: DEC. 2018 FILENAME: b030458x2_LI.dgn
CHECKED BY: XXX DATE: XXX. XXXX SCALE: 1" = 20'-0"
DESIGNED BY: ABH DATE: DEC. 2018
BRIDGE NO. XXXXX DRAWING NO. $DNXXXX$

ABHall 1/2/2019 10:06:31 AM
WORKSPACE: ARDOT Bridge
L:\207\1701550 - Little Missouri River and Relief\Drawings\b030458x2_LI(River Bridge).dgn
REVISED DATE:

APPENDIX B



Grubbs, Hoskyn, Barton & Wyatt, Inc.

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

SCALE: As Shown

Generalized Subsurface Profile
030458 - Bridge 03095 over Little Missouri River
Pike and Nevada County, Arkansas

Project Number: 18-183

APPENDIX C

SUMMARY of CLASSIFICATION TEST RESULTS

PROJECT: ARDOT 030458 - Bridge 03095 over Little Missouri River
LOCATION: Pike and Nevada County, Arkansas
GHBW JOB NUMBER: 18-183

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		
1	4.5-5.5	21	NON-PLASTIC			100	100	100	100	100	100	99	44	SM	A-4
1	9-10	21	---	---	---	100	100	100	99	91	87	68	13	SM	A-2-4
1	14-15	10	---	---	---	100	100	82	58	35	20	10	1	GW	A-1-a
1	29-30	21	75	26	49	100	90	85	76	72	69	66	64	MARL	
1	34-35	22	70	22	48	---	---	---	---	98	---	---	88	MARL	
2	9-10	26	21	20	1	100	100	100	100	100	100	100	74	ML	A-4
2	14-15	17	---	---	---	100	100	88	80	74	70	55	6	SM-SP	A-3
2	24-25	9	---	---	---	100	100	100	95	50	8	1	1	GP	A-1-a
2	33-34	20	51	20	31	---	---	---	---	99	---	---	81	MARL	
2	53-54	21	62	23	39	---	---	---	---	100	---	---	89	MARL	
3	14-15	9	---	---	---	100	100	81	62	47	32	20	7	GM-GW	A-1-a
3	33-34	27	63	23	40	---	---	---	---	100	---	---	97	MARL	
3	64-65	20	62	20	42	---	---	---	---	---	---	---	---	MARL	
4	2.5-3.5	20	35	20	15	---	---	---	---	100	---	---	79	CL	A-6
4	6.5-7.5	19	21	16	5	---	---	---	---	100	---	---	50	SM-SC	A-4
4	9-10	18	---	---	---	---	---	---	---	100	---	---	35	SM	A-2-4
4	19-20	12	---	---	---	100	96	86	61	43	30	19	7	SM-SP	A-1-a
4	43-44	19	68	24	44	---	---	---	---	---	---	---	---	MARL	
4	59-60	26	65	20	45	---	---	---	---	---	---	---	---	MARL	
5	6.5-7.5	16	---	---	---	---	---	---	---	100	---	---	60	ML	A-4
5	9-10	23	---	---	---	100	100	100	100	100	99	81	17	SM	A-2-4
5	14-15	16	---	---	---	---	---	---	---	51	---	---	4	GP	A-2-4

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

PLATE

SUMMARY of CLASSIFICATION TEST RESULTS

PROJECT: ARDOT 030458 - Bridge 03095 over Little Missouri River
LOCATION: Pike and Nevada County, Arkansas
GHBW JOB NUMBER: 18-183

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		
5	19-20	8	---	---	---	100	88	83	36	18	14	12	4	GP	A-1-a
5	39-40	22	70	22	48	---	---	---	---	---	---	---	---	MARL	
6	1-1.5	32	72	24	48	---	---	---	---	98	---	---	88	CH	A-7-6
6	6.5-7.5	14	26	16	10	---	---	---	---	100	---	---	84	CL	A-4
7	0.5-1.5	7	24	15	9	100	100	90	71	56	45	35	11	SC-SP	A-2-4
7	2.5-3.5	32	64	23	41	---	---	---	---	99	---	---	89	CH	A-7-6
8	0.5-1.5	6	---	---	---	100	87	72	44	29	23	18	12	GC-GP	A-2-4
8	3-3.5	18	---	---	---	---	---	---	---	100	---	---	55	ML	A-4
8	6.5-7.5	25	---	---	---	---	---	---	---	100	---	---	35	SM	A-2-4
9	0.5-1	6	18	16	2	100	79	66	56	43	34	27	17	GM	A-1-b
9	2.5-3.5	25	23	20	3	---	---	---	---	100	---	---	85	ML	A-4
9	4.5-5.5	21	---	---	---	---	---	---	---	100	---	---	39	SM	A-4

18-183

GRAIN SIZE CURVE

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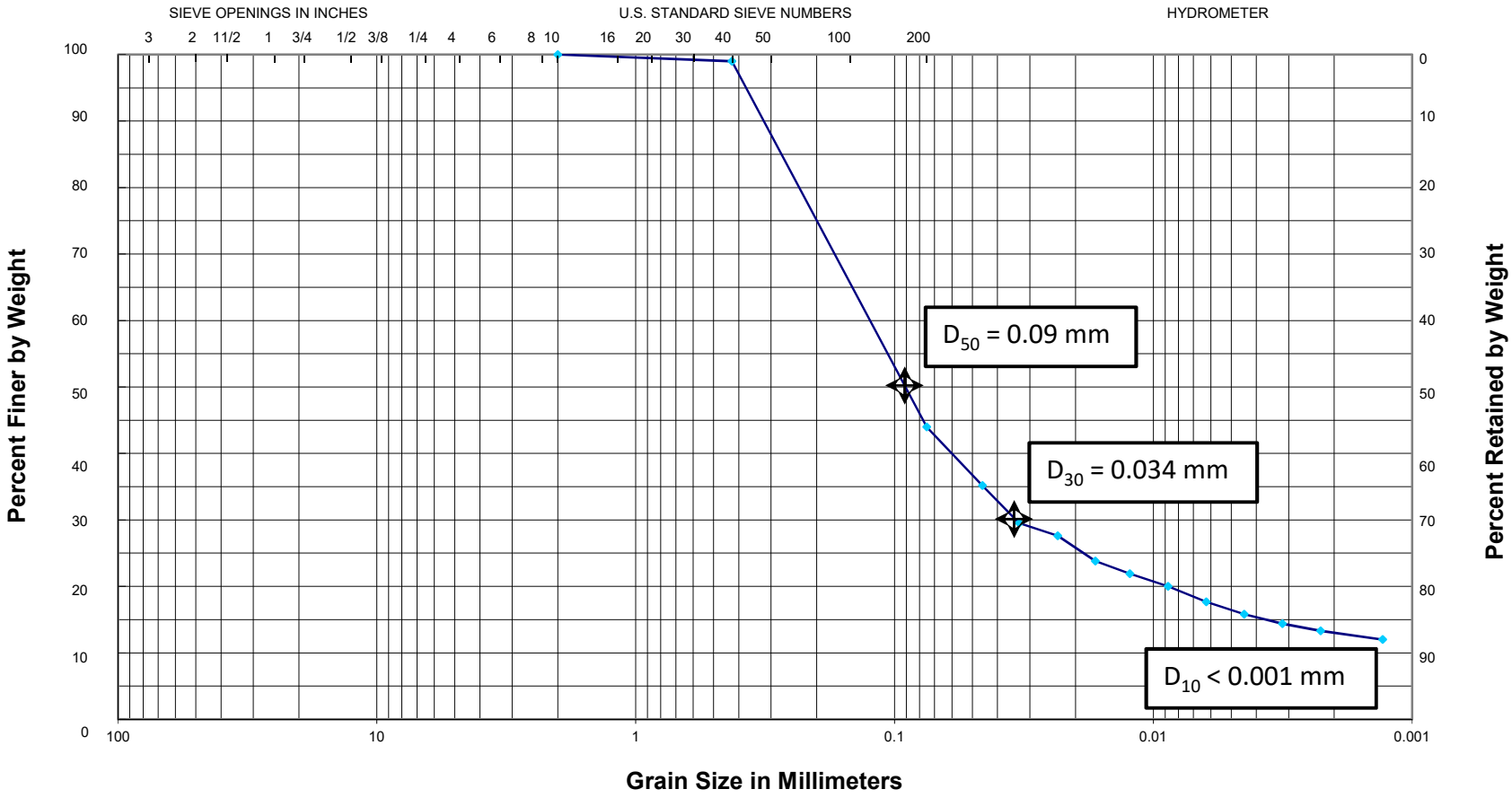
CONSULTING ENGINEERS



GRAVEL		SAND			SILT	CLAY
COARSE	FINE	COARSE	MEDIUM	FINE		

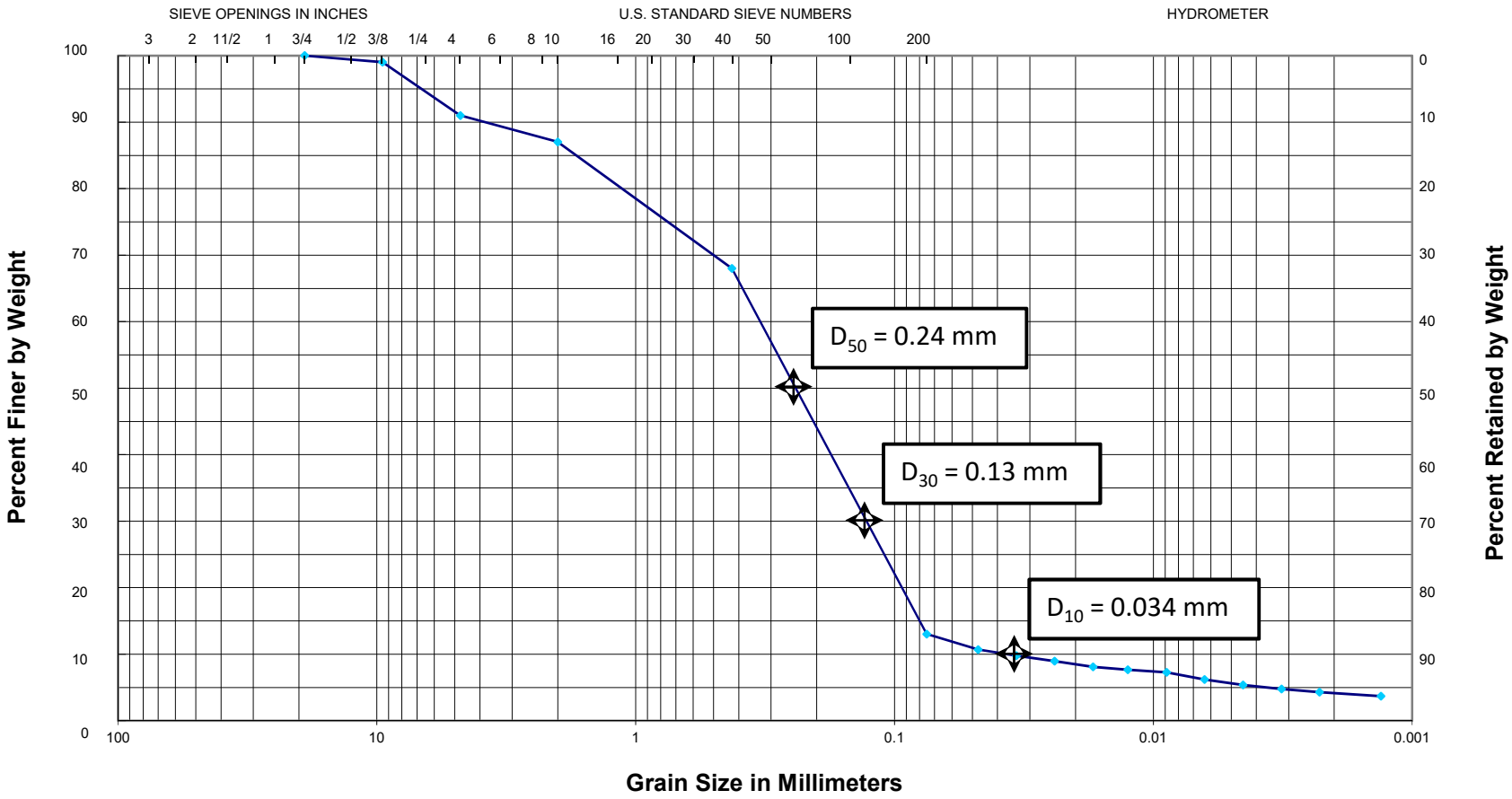
Sample: Boring 1, 4.5-5.5 ft; NON-PLASTIC
Description: Brown silty fine SAND

USCS Classification = SM
AASHTO Classification = A-4

18-183

GRAIN SIZE CURVE

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



GRAVEL		SAND			SILT	CLAY
COARSE	FINE	COARSE	MEDIUM	FINE		

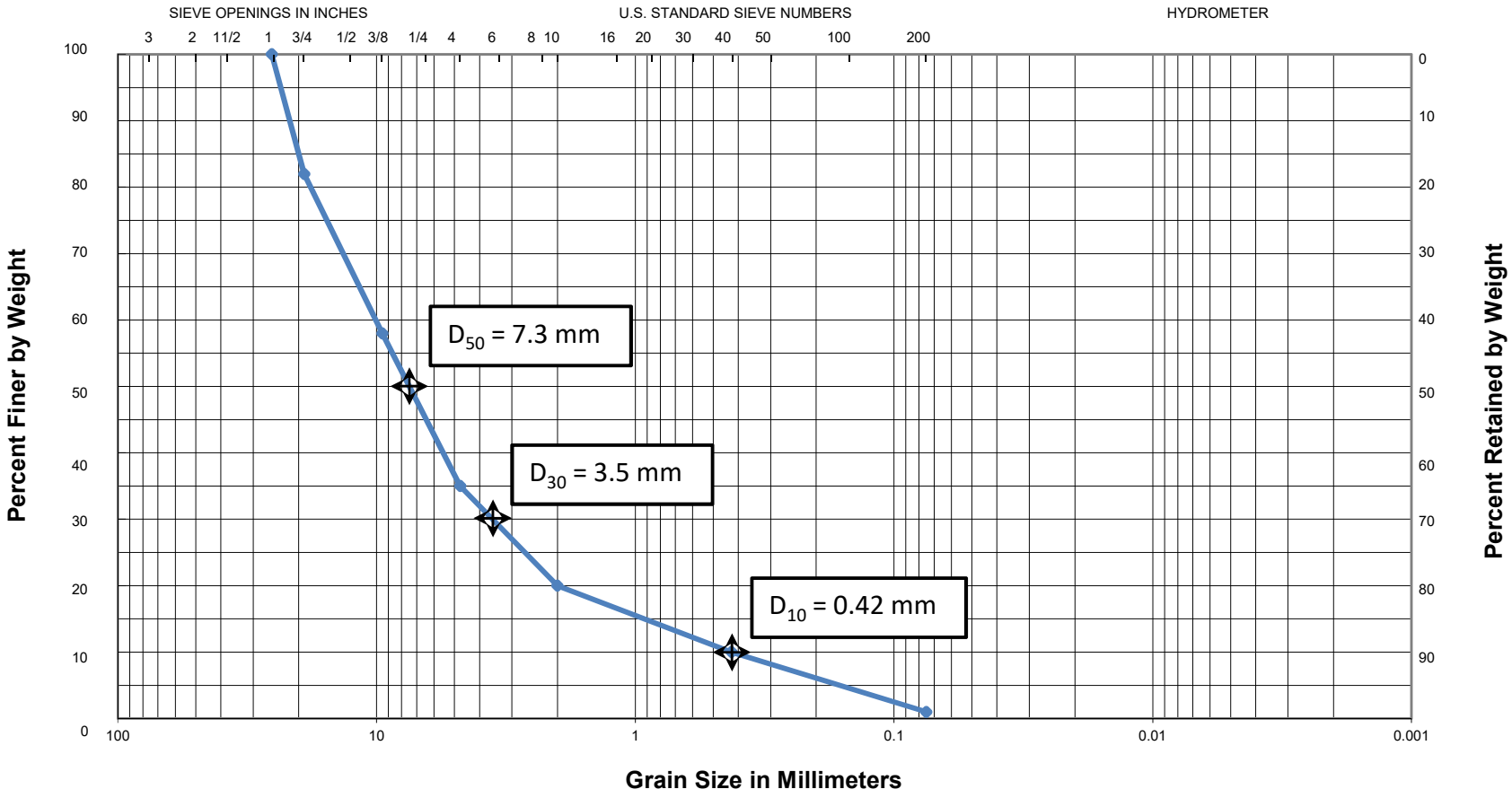
Sample: Boring 1, 9-10 ft;
Description: Tan and brown silty fine to medium SAND

USCS Classification = SM
AASHTO Classification = A-2-4

18-183

GRAIN SIZE CURVE

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



GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

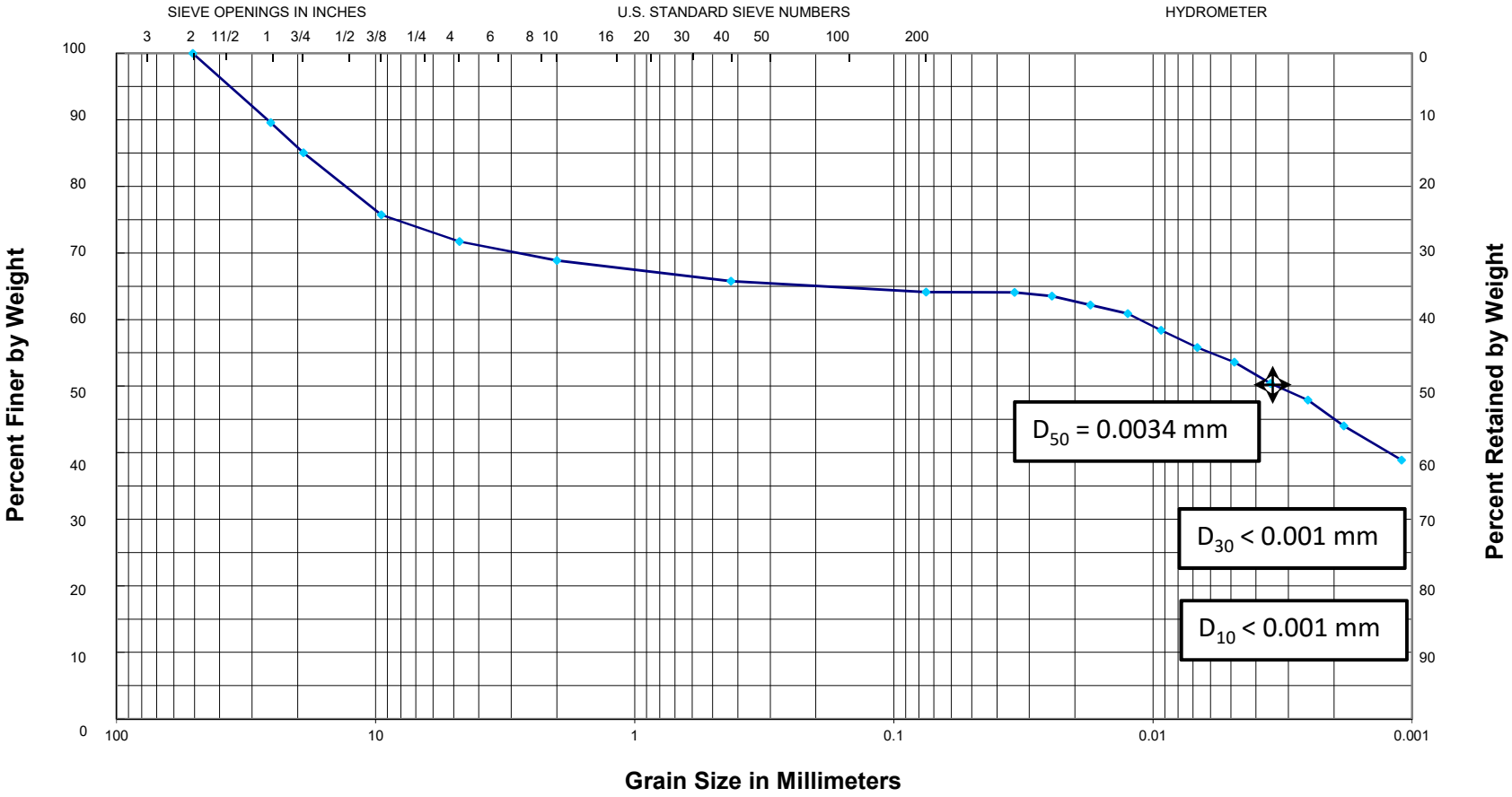
Sample: Boring 1, 14-15 ft;
Description: Tan sandy fine to coarse GRAVEL

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

18-183

GRAIN SIZE CURVE

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



GRAVEL		SAND			SILT	CLAY
COARSE	FINE	COARSE	MEDIUM	FINE		

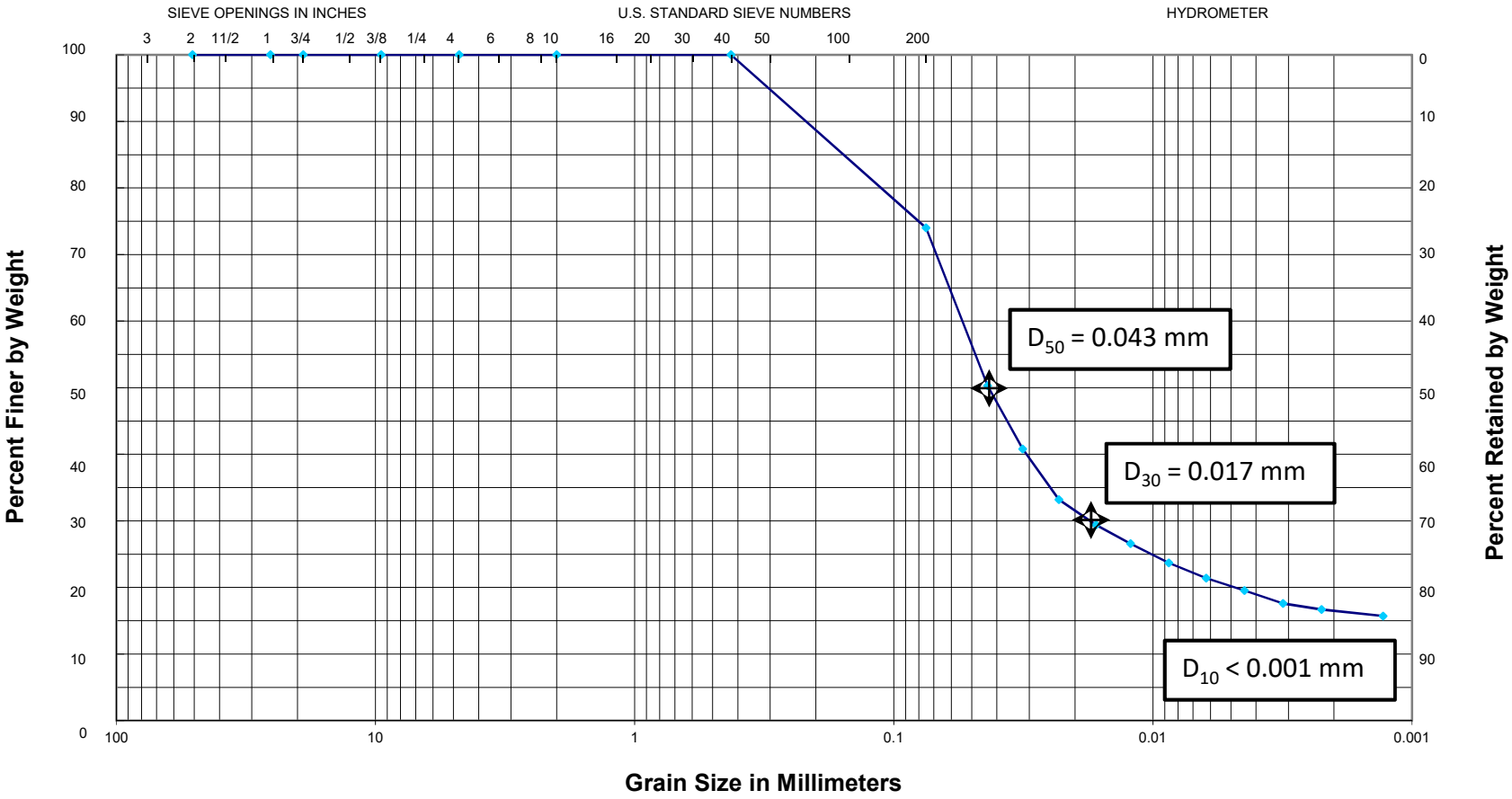
Sample: Boring 1, 29-30 ft; LL = 75, PL = 26, PI = 49
Description: Dark gray MARL, fossiliferous and calcareous, micaceous

USCS Classification = CH
AASHTO Classification = A-7-6

18-183

GRAIN SIZE CURVE

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



GRAVEL		SAND			SILT	CLAY
COARSE	FINE	COARSE	MEDIUM	FINE		

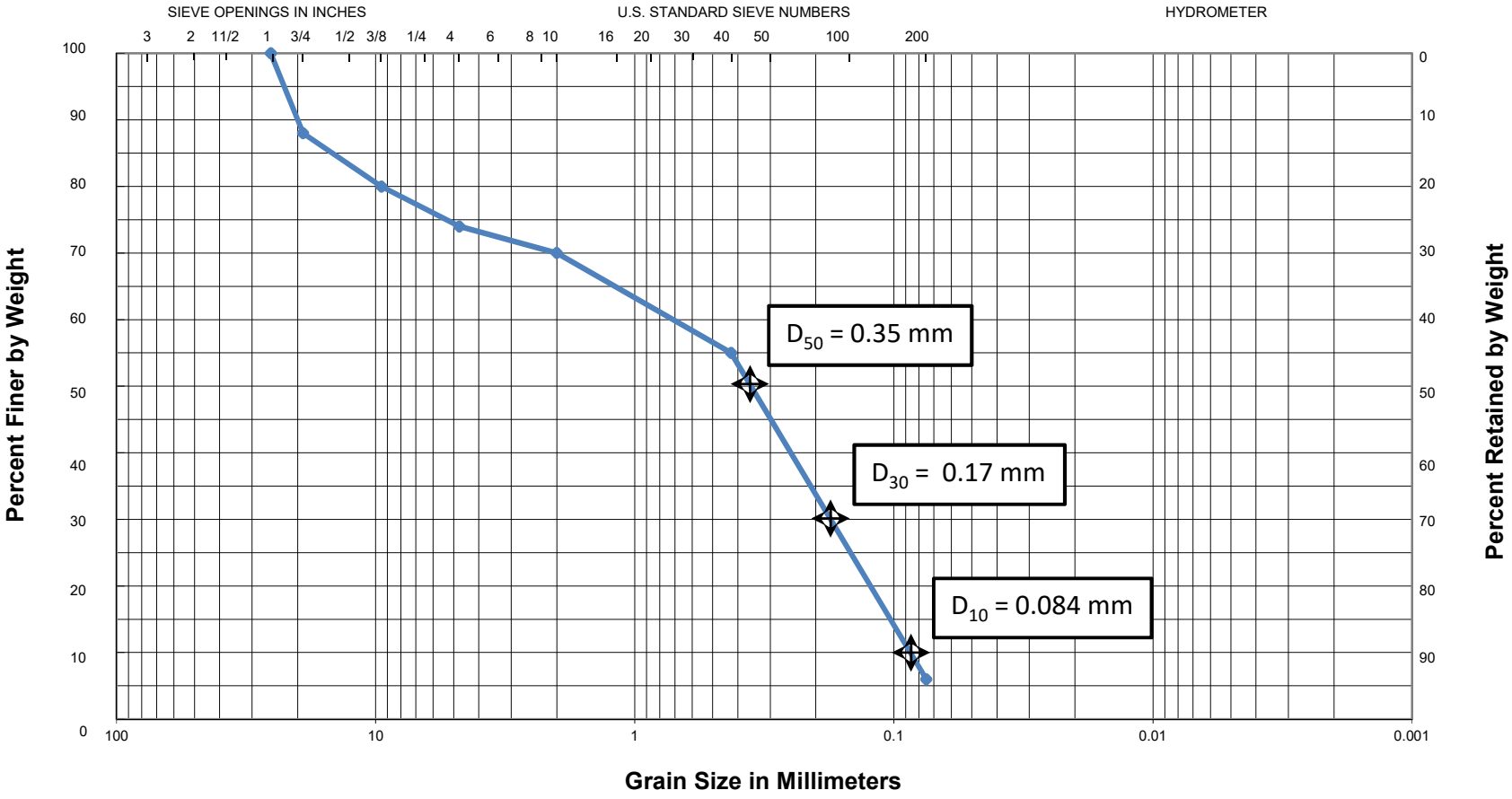
Sample: Boring 2, 9-10 ft; LL = 21, PL = 20, PI = 1
Description: Brown fine sandy SILT

USCS Classification = ML
AASHTO Classification = A-4

18-183

GRAIN SIZE CURVE

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



GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

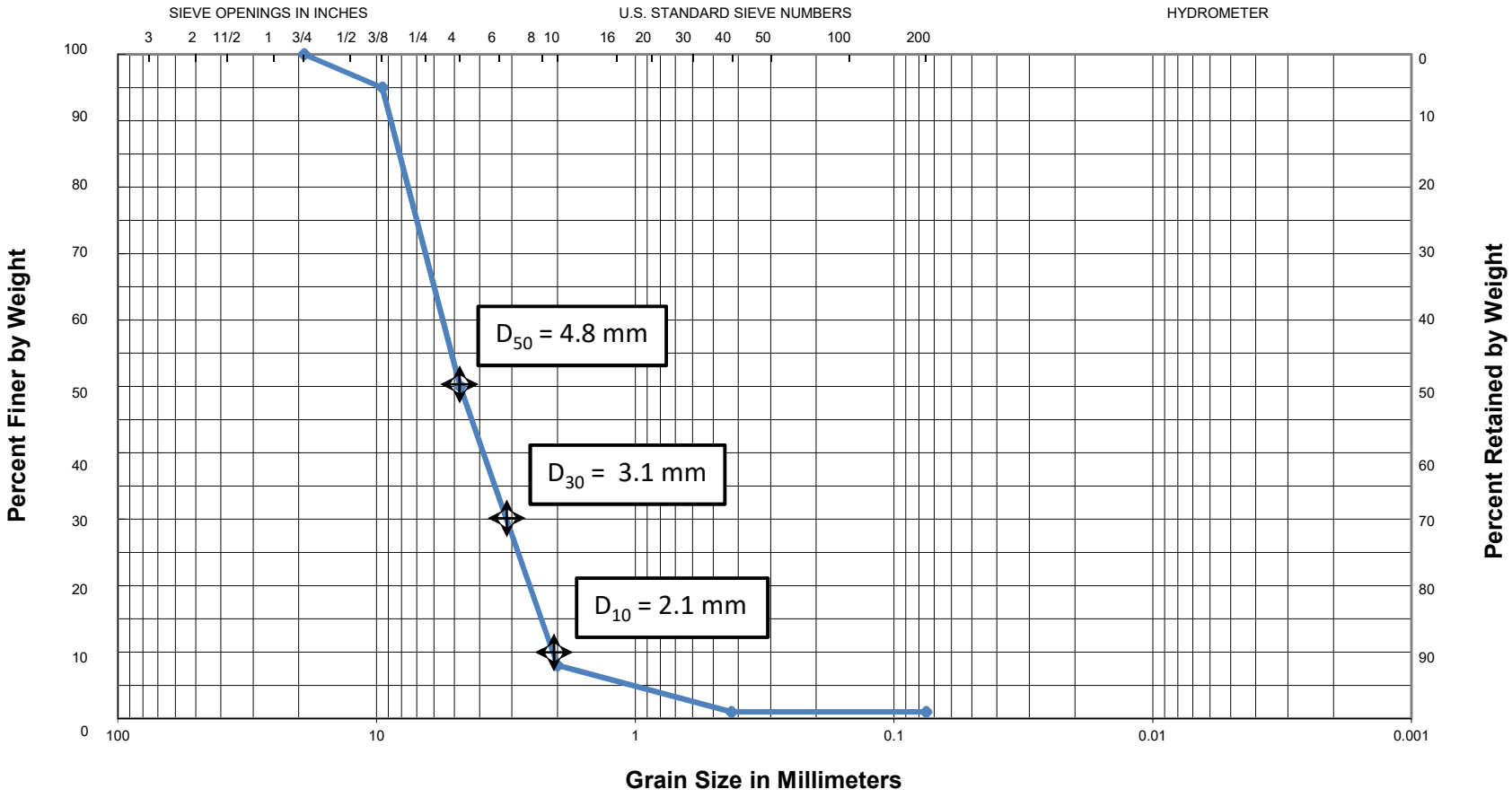
Sample: Boring 2, 14-15 ft;
Description: Brown fine to medium SAND, slightly silty w/ some fine to coarse gravel

USCS Classification = SM-SP
AASHTO Classification = A-3

18-183

GRAIN SIZE CURVE

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



GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

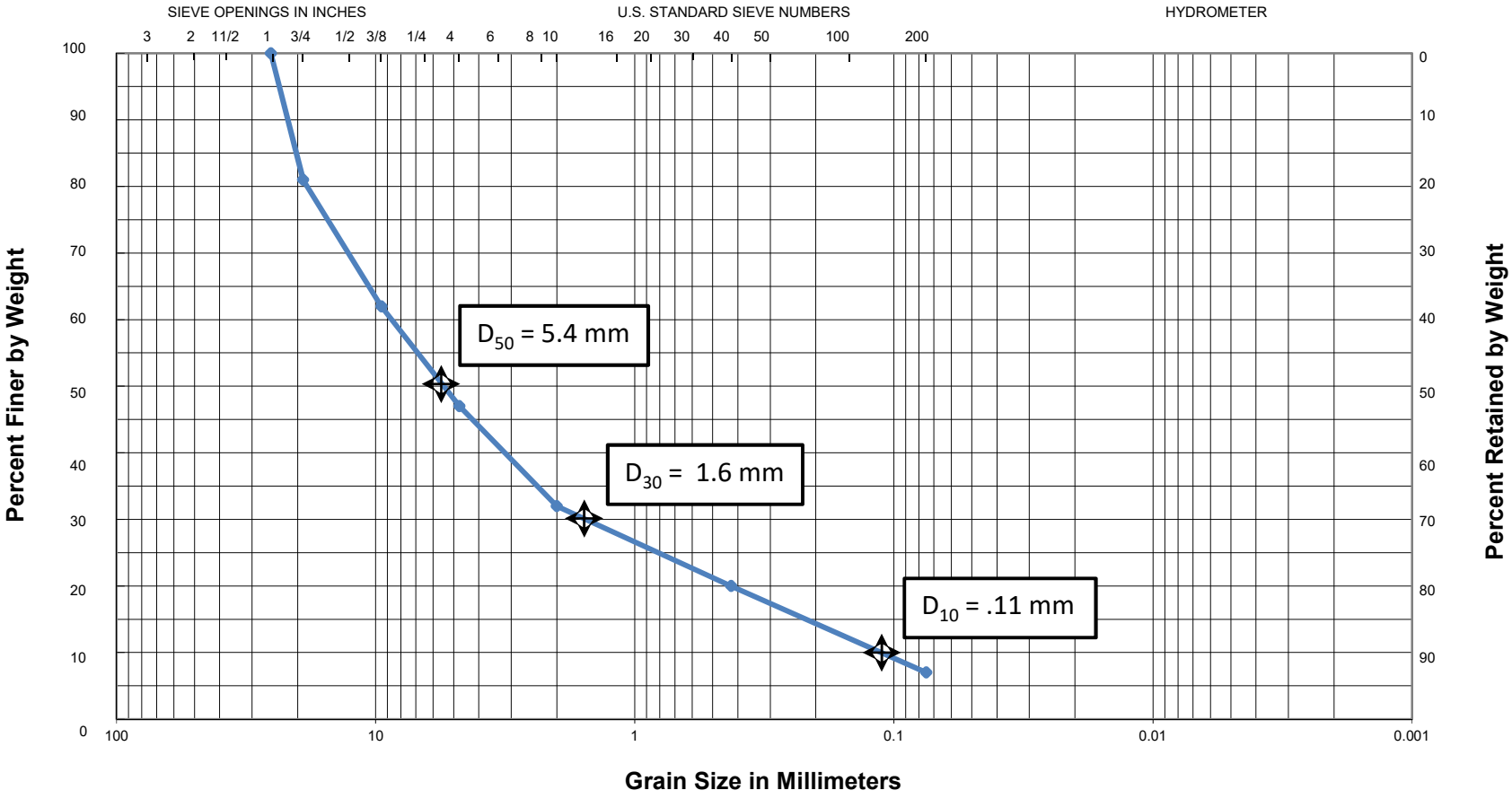
Sample: Boring 2, 24-25 ft;
Description: Brown sandy fine GRAVEL

USCS Classification = GP
AASHTO Classification = A-1-a

18-183

GRAIN SIZE CURVE

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



GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

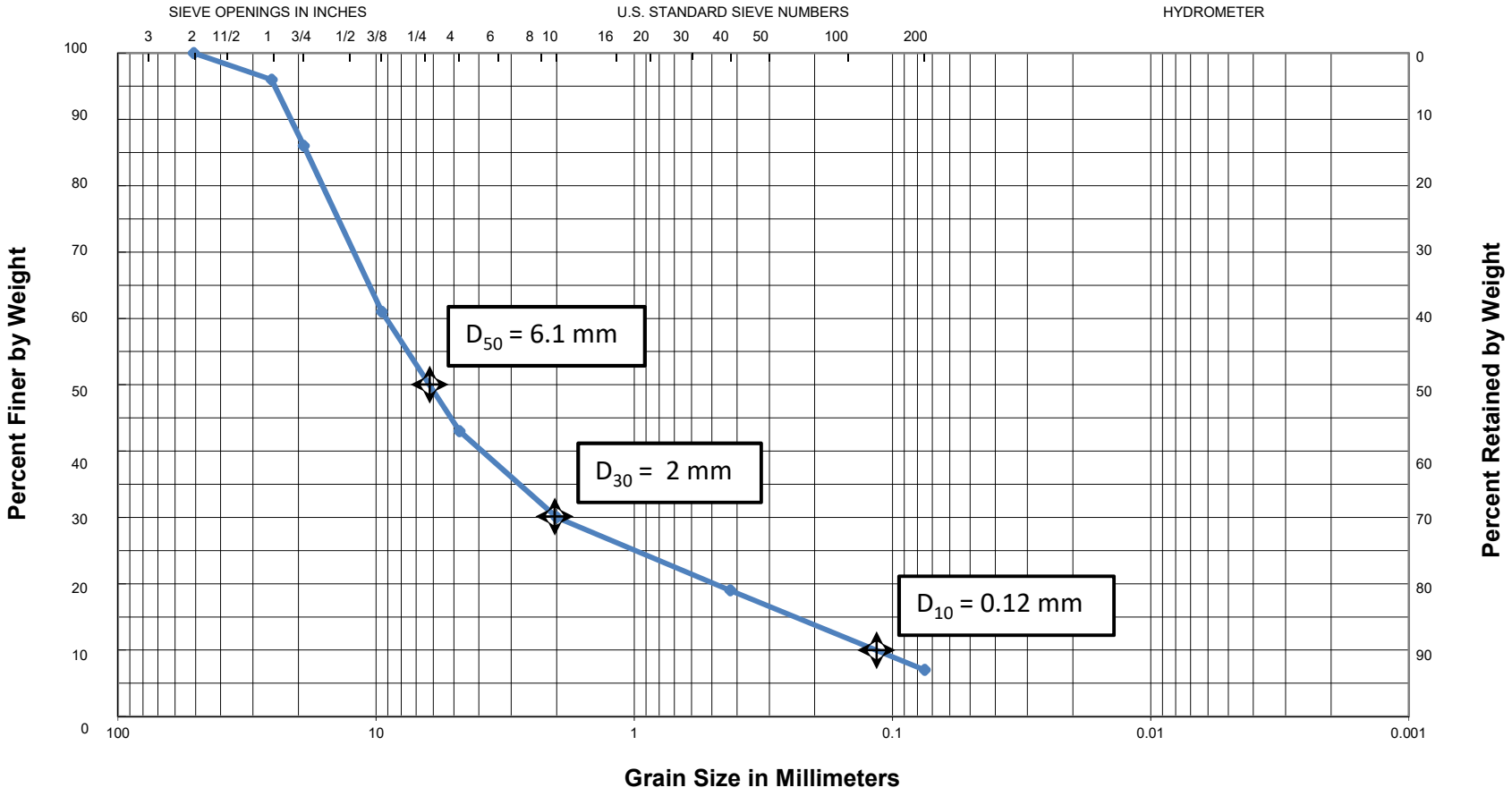
Sample: Boring 3, 14-15 ft;
Description: Brown and tan sandy fine to coarse GRAVEL, slightly silty

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

18-183

GRAIN SIZE CURVE

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



GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

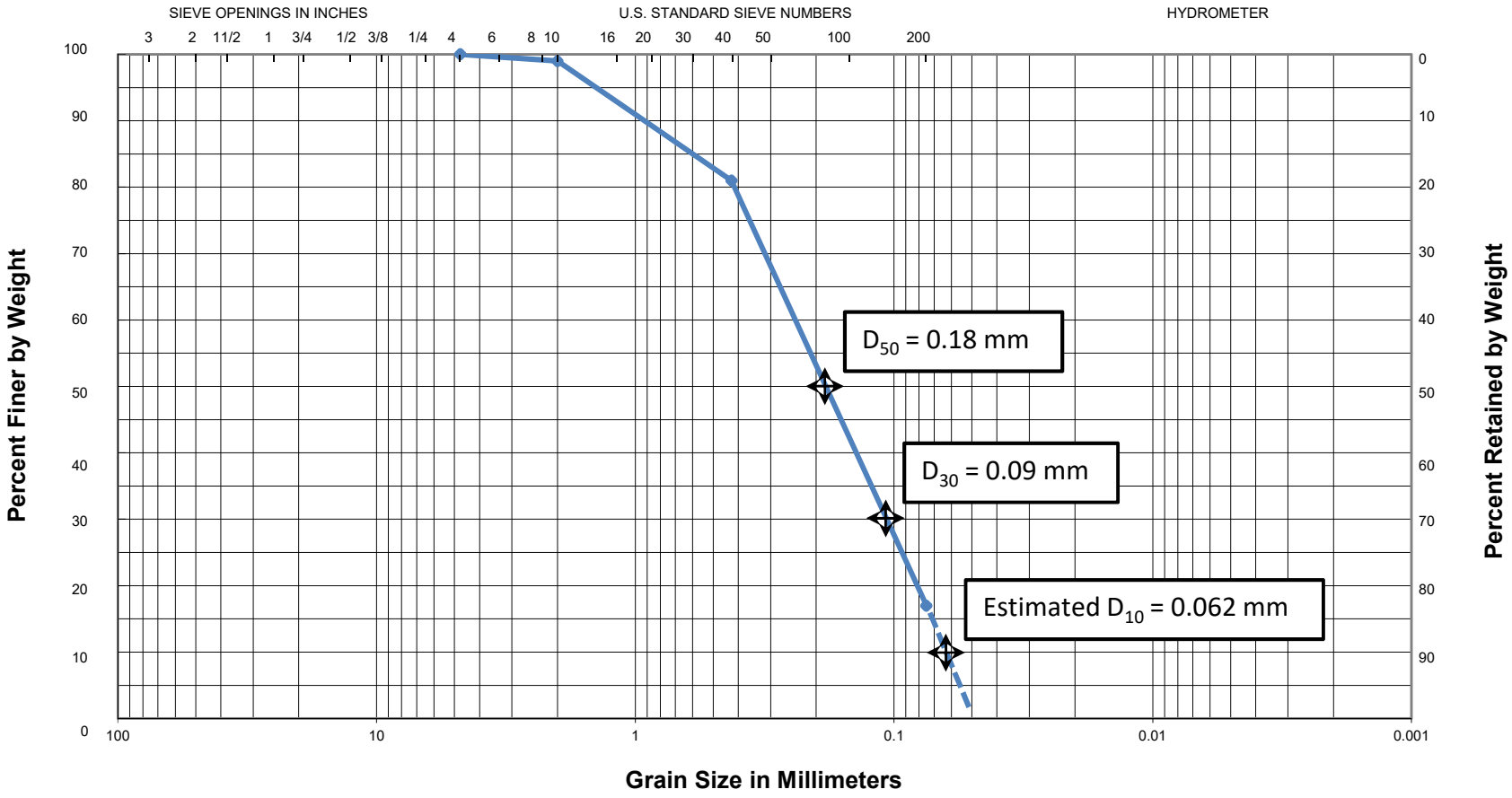
Sample: Boring 4, 19-20 ft;
Description: Gray sandy fine to coarse GRAVEL, slightly silty

USCS Classification = SM-SP
AASHTO Classification = A-1-a

18-183

GRAIN SIZE CURVE

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



GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

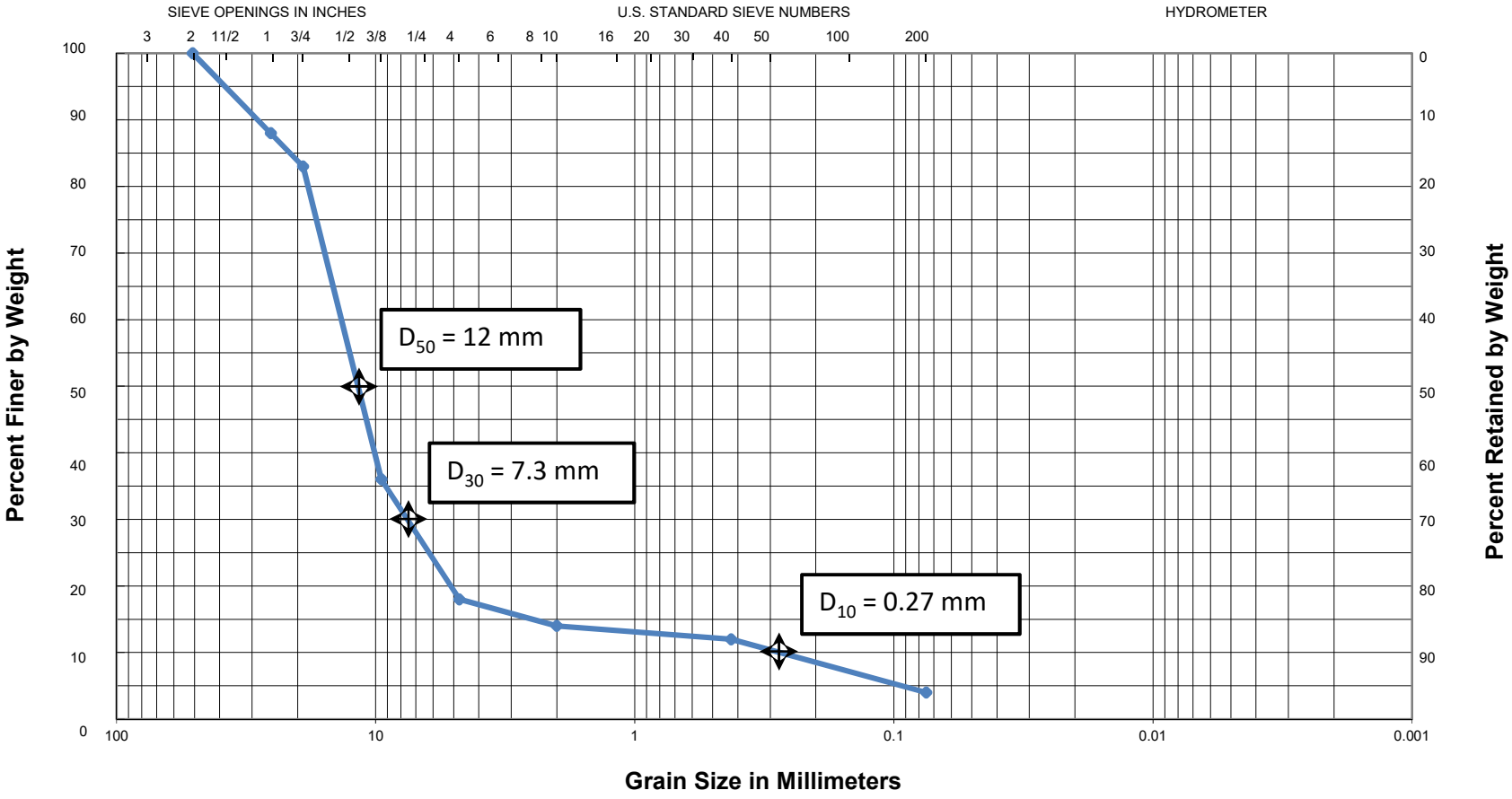
Sample: Boring 5, 9-10 ft;
Description: Tan and gray silty fine to medium SAND

USCS Classification = SM
AASHTO Classification = A-2-4

18-183

GRAIN SIZE CURVE

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



GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

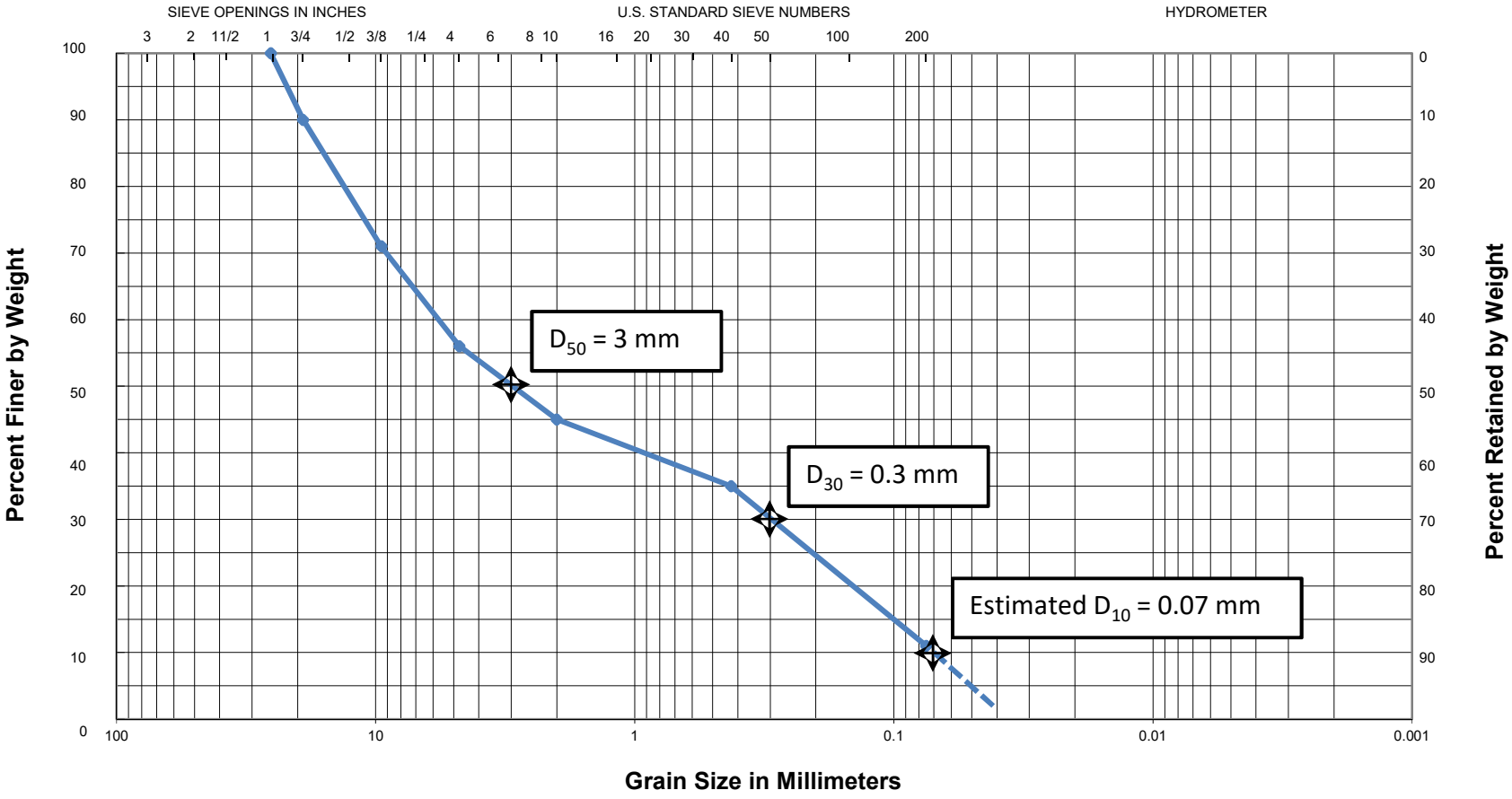
Sample: Boring 5, 19-20 ft;
Description: Brown sandy fine to coarse GRAVEL

USCS Classification = GP
AASHTO Classification = A-1-a

18-183

GRAIN SIZE CURVE

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



GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

Sample: Boring 7, 0.5-1.5 ft; LL = 24, PL = 15, PI = 9
Description: Reddish tan fine to coarse SAND, slightly clayey w/ some fine to coarse gravel (fill)

USCS Classification = SC-SP
AASHTO Classification = A-2-4

18-183

GRAIN SIZE CURVE

Grubbs, Hoskyn, Barton & Wyatt, INC.
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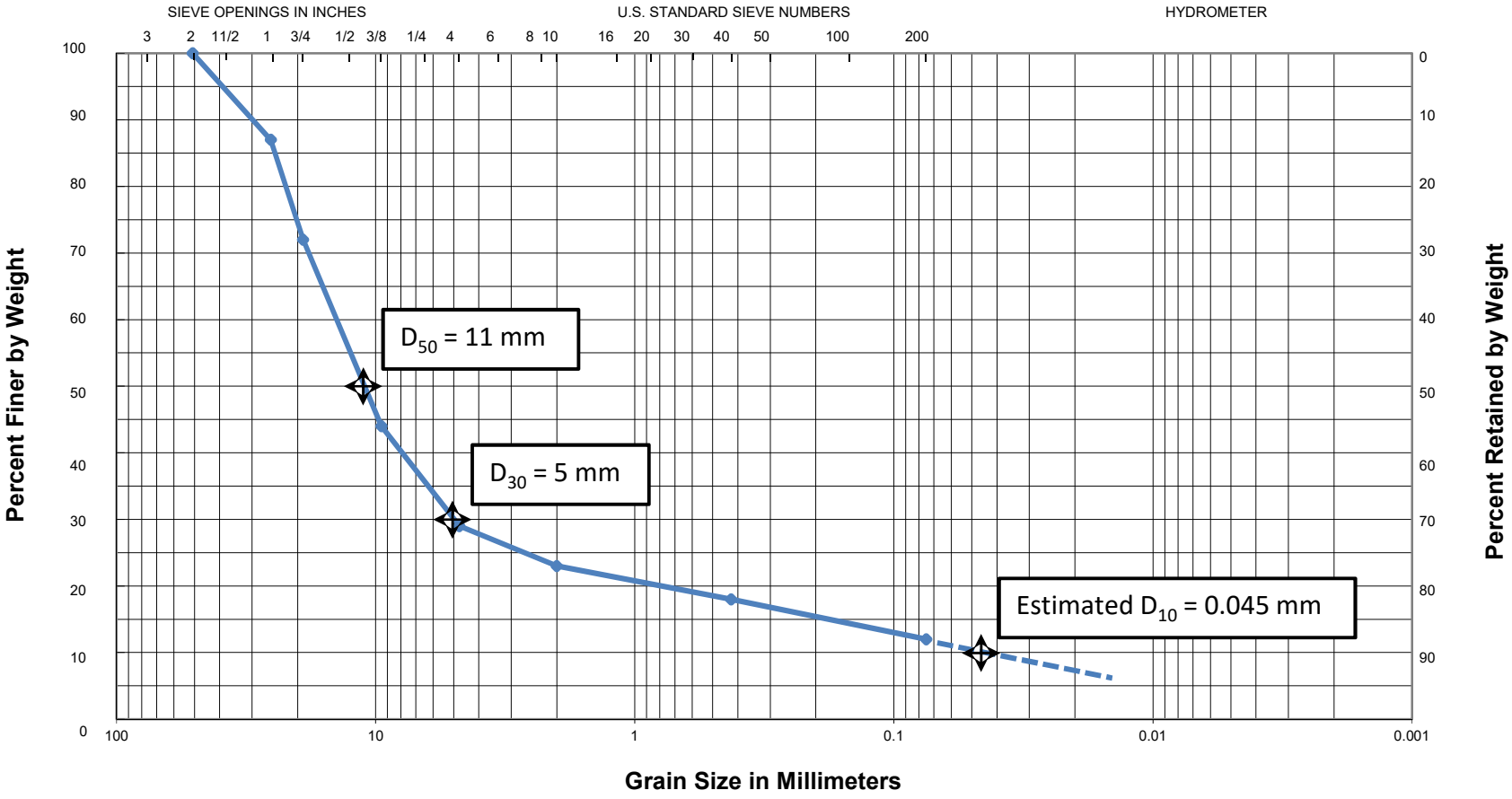


GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

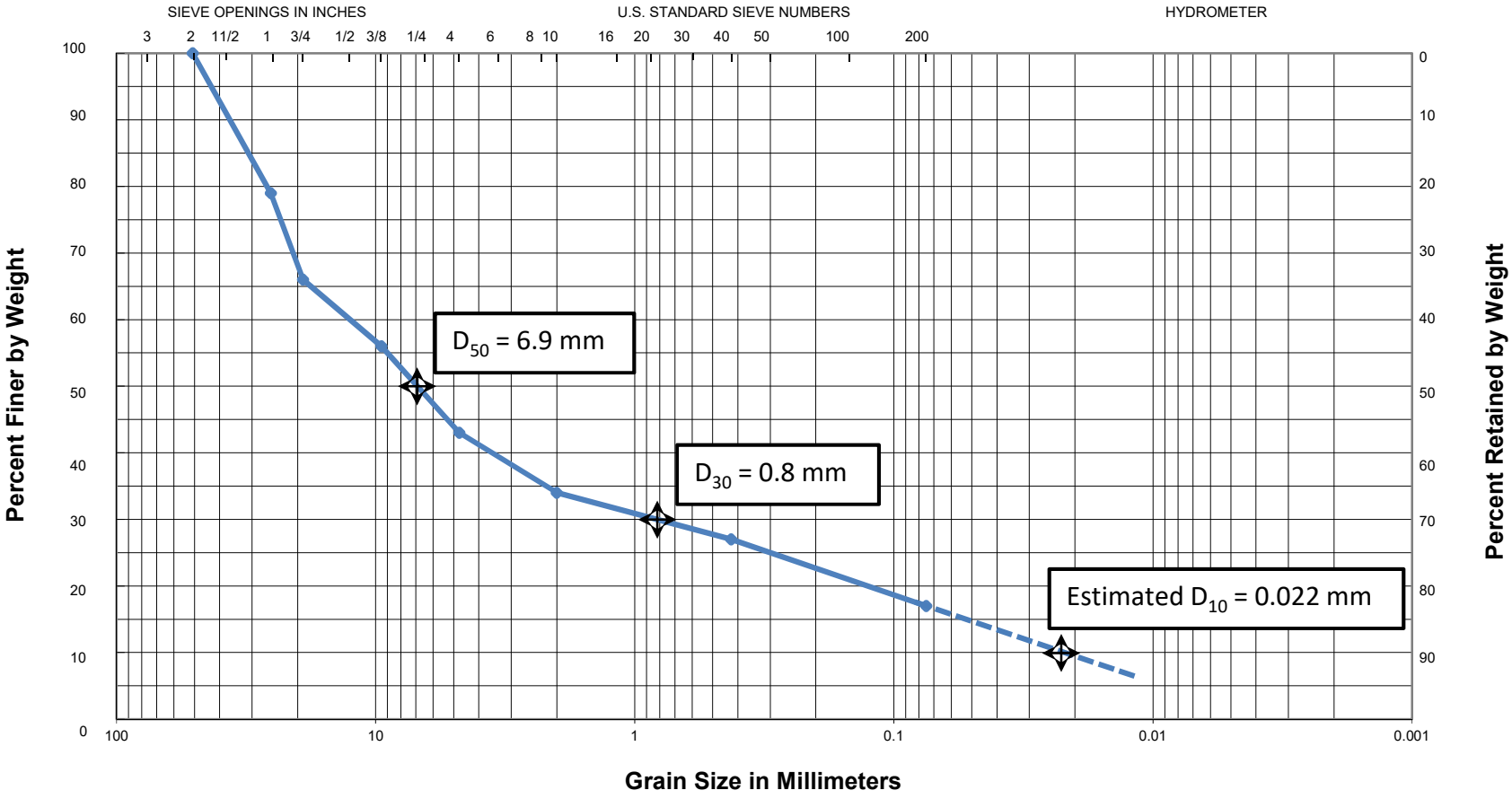
Sample: Boring 8, 0.5-1.5 ft
Description: Reddish tan sandy fine to coarse GRAVEL (fill)

USCS Classification = GC-GP
AASHTO Classification = A-2-4

18-183

GRAIN SIZE CURVE

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



GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

Sample: Boring 9, 0.5-1.5 ft; LL = 18, PL = 16, PI = 2
Description: Reddish tan sandy fine to coarse GRAVEL, slightly clayey

USCS Classification = GM
AASHTO Classification = A-1-b

APPENDIX D

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)

Project: ARDOT 030458 Little Missouri River - Nevada County, Arkansas Job No: 18-183

Material Description: Dark brown fine sandy CLAY w/ some fine to coarse gravel

Location Sampled/Source: 3/15A

Sample Depth, ft: 0.5-1

Date Sampled: 3/15/2019

Date Tested: 3/26/2019

Tested By: LLC

Report Date: 4/3/2019

LAB COMPACTION PROCEDURE: AASHTO T-99 Method: A	
Maximum Unit Dry Wt. (pcf):	104.9
Optimum Water Content (%):	18.7

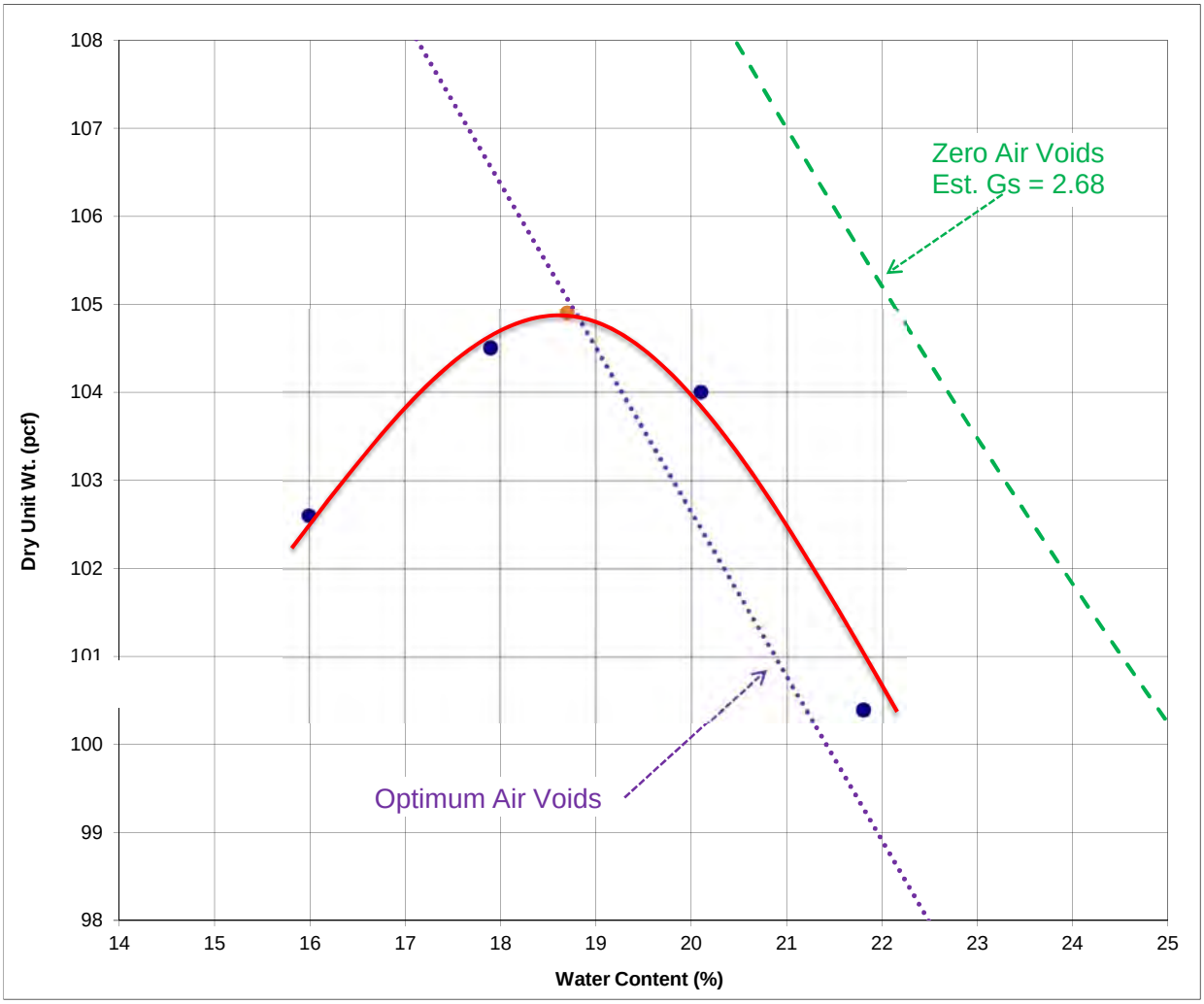
As Recieved Water Content: 20.8 %

ATTERBERG LIMITS AASHTO T-89 & T-90
Liquid Limit: 48
Plastic Limit: 20
Plasticity Index: 28

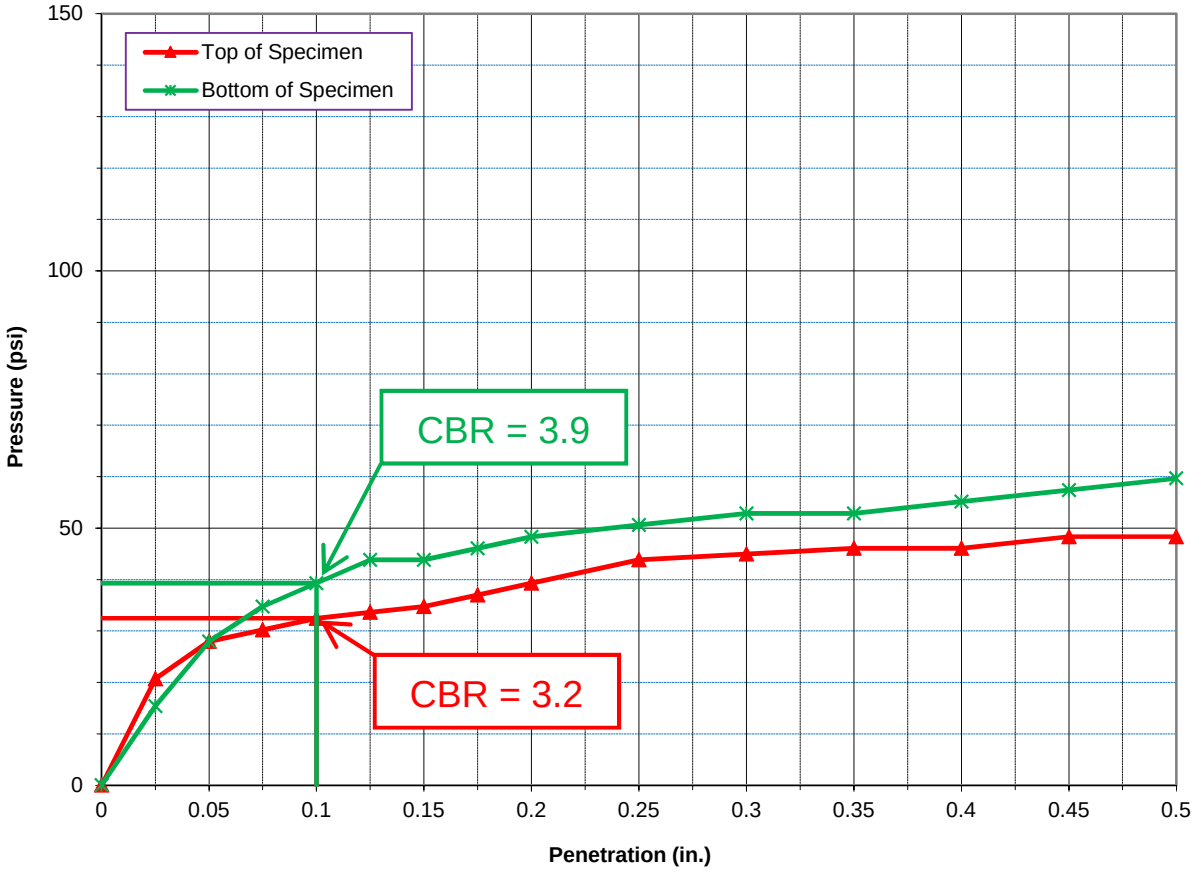
USCS Classification:
CL

AASHTO Classification:
A-7-6

GRADATION AASHTO T-88	
Sieve Number	Percent Passing
3 in.	100
2 in.	96
3/4 in.	91
3/8 in.	86
#4	81
#10	75
#40	70
#200	59



Laboratory CBR Test Report
(AASHTO T-193)



Boring No./Depth, ft	Classification		Natural Moisture Content, %	Assumed Specific Gravity	Liquid Limit, %	Plastic Limit, %	% Retained No.4	% Passing No.200
	USCS	AASHTO						
3/15A @ 0.5-1	CL	A-7-6	20.5	2.68	48	20	19	59
PROCTOR TEST RESULTS (AASHTO T-99)				**MATERIAL DESCRIPTION**				
Optimum Moisture Content = 18.7% Maximum Dry Density = 104.9 pcf				Dark brown fine sandy CLAY w/ some fine to coarse gravel				

Remarks:
As Molded: 181.1 pcf @ 20.1%; Percent swell: 1.5%

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

Project: ARDOT 030458 - Little Missouri River
GHBW Project Number: 18-183
Location: Nevada County, Arkansas
Sample Date: 3/15/19
Test Date: 3/26/19

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)

Project: ARDOT 030458 Little Missouri River - Nevada County, Arkansas Job No: 18-183
Material Description: Brown fine sandy CLAY, w/ trace fine to coarse gravel
Location Sampled/Source: 3/15B
Sample Depth, ft: 0.5-1
Date Sampled: 3/15/2019
Date Tested: 3/26/2019
Tested By: LLC
Report Date: 4/3/2019

LAB COMPACTION PROCEDURE: AASHTO T-99 Method: A	
Maximum Unit Dry Wt. (pcf):	106.2
Optimum Water Content (%):	18.7

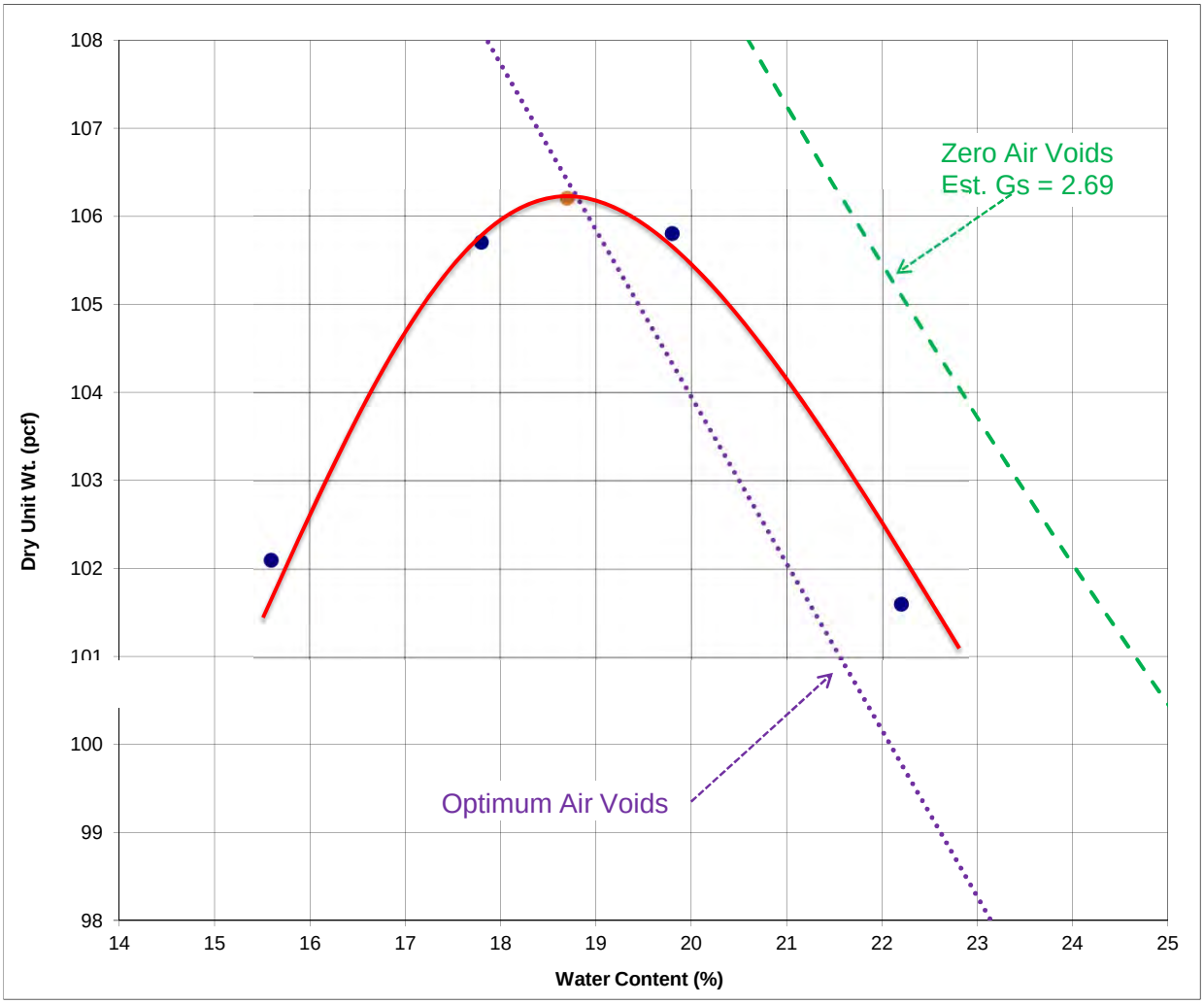
As Recieved Water Content: 24.1 %

ATTERBERG LIMITS AASHTO T-89 & T-90
Liquid Limit: 45
Plastic Limit: 20
Plasticity Index: 25

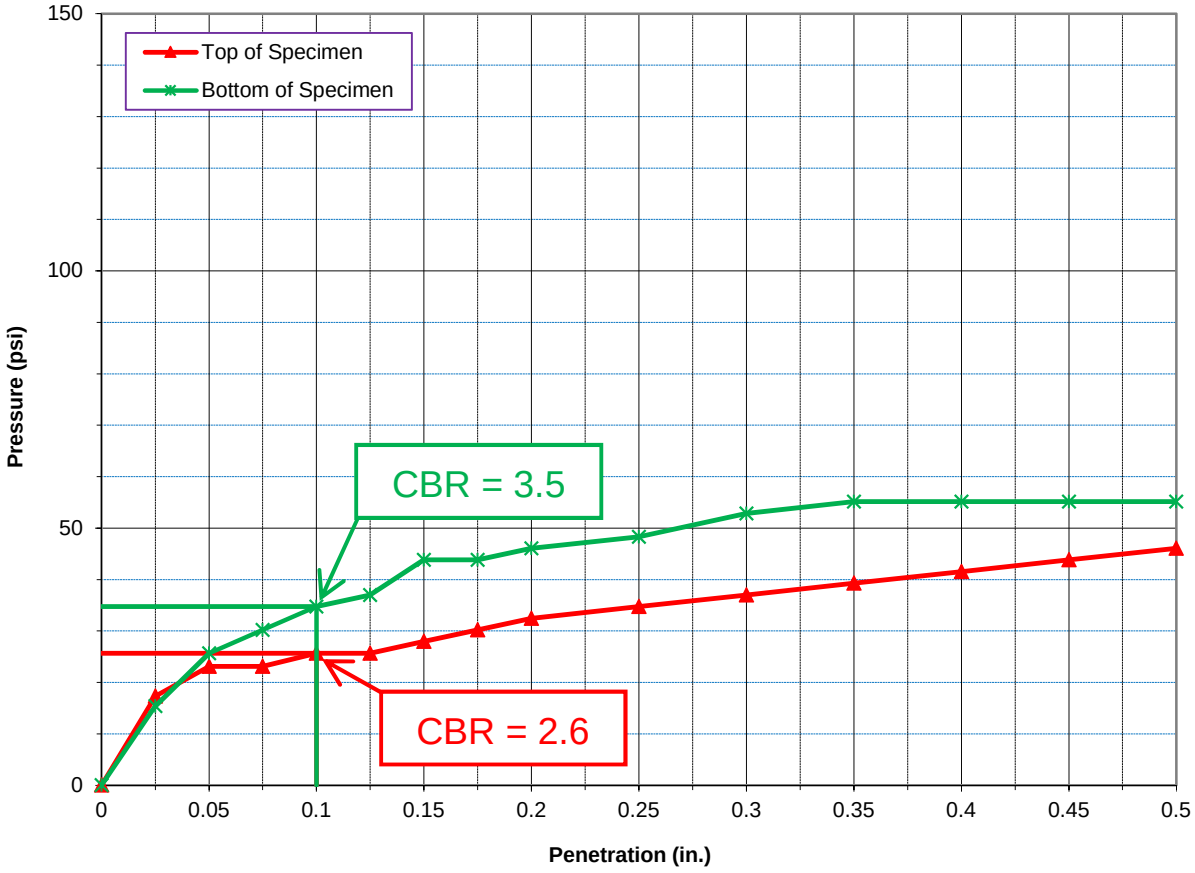
USCS Classification:
CL

AASHTO Classification:
A-7-6

GRADATION AASHTO T-88	
Sieve Number	Percent Passing
2 in.	100
3/4 in.	94
3/8 in.	93
#4	92
#10	90
#40	87
#200	73



Laboratory CBR Test Report
(AASHTO T-193)



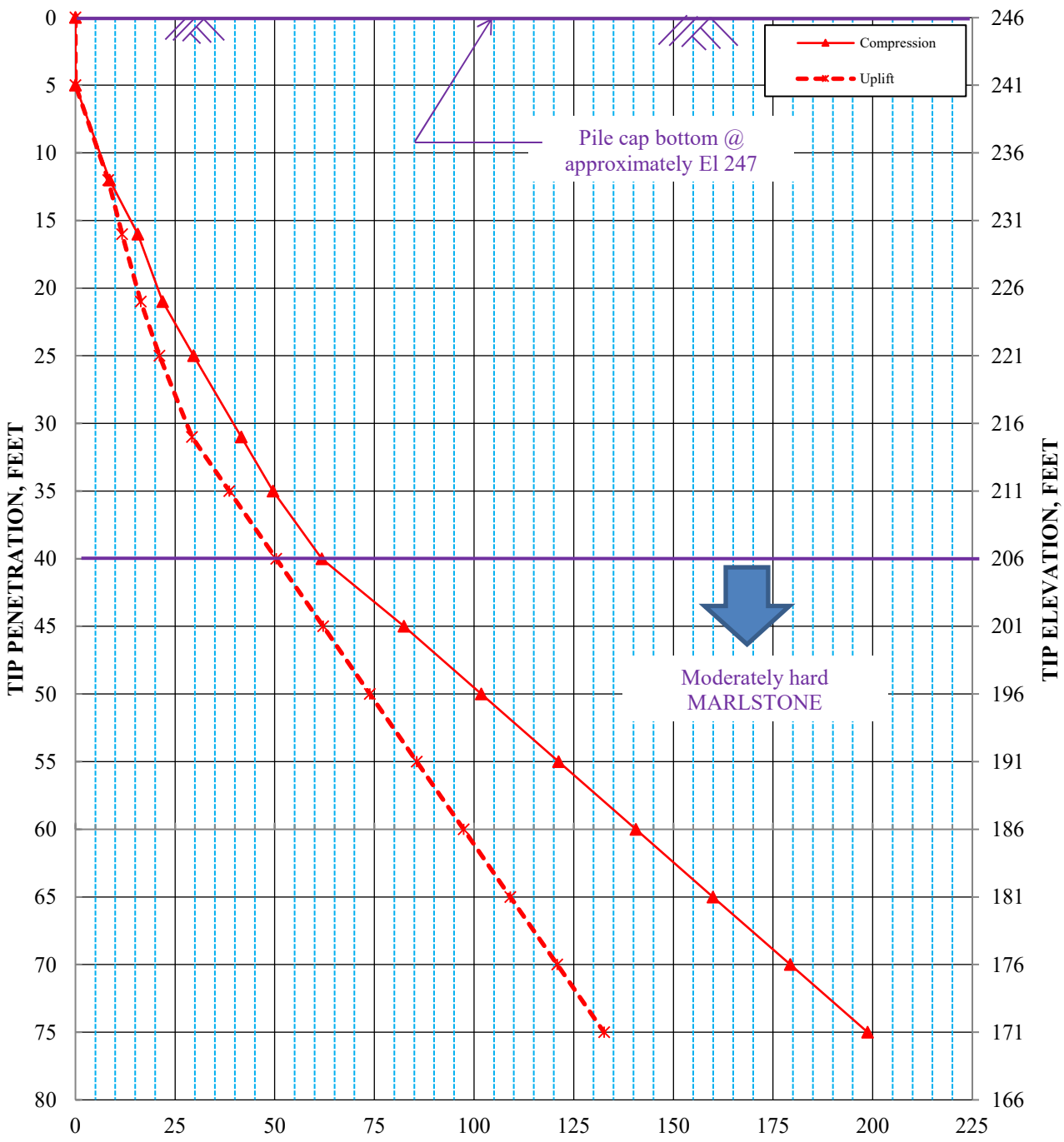
Boring No./Depth, ft	Classification		Natural Moisture Content, %	Assumed Specific Gravity	Liquid Limit, %	Plastic Limit, %	% Retained No.4	% Passing No.200
	USCS	AASHTO						
3/15B @ 0.5-1	CL	A-7-6	20.6	2.69	45	20	7	73
PROCTOR TEST RESULTS (AASHTO T-99)				**MATERIAL DESCRIPTION**				
Optimum Moisture Content = 18.7% Maximum Dry Density = 106.2 pcf				Brown fine sandy CLAY, w/ trace fine to coarse gravel				

Remarks:
As Molded:191.1 pcf @ 19.1%; Percent swell: 2.8%

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

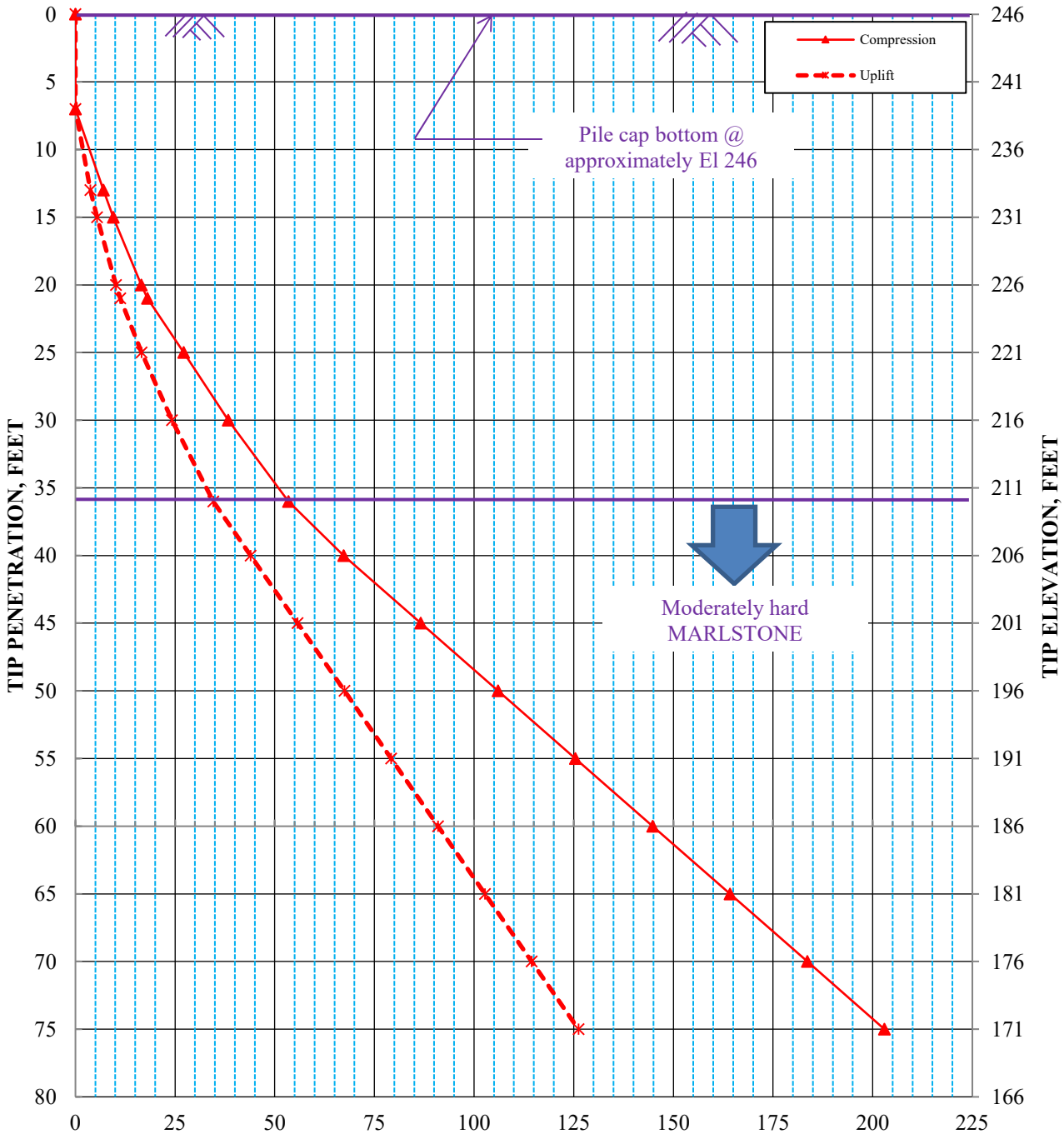
Project: ARDOT 030458 - Little Missouri River
GHBW Project Number: 18-183
Location: Nevada County, Arkansas
Sample Date: 3/15/19
Test Date: 3/26/19

APPENDIX E



NOMINAL SINGLE PILE CAPACITY, TONS
HP14x73 Steel Piles
Bent 1 (Sotuh Bridge End)
ARDOT 030458 Hwy. 19 over Little Missouri River
Pike and Nevada County, Arkansas

Note: 1. Piles assumed to be driven to refusal.
2. No downdrag.



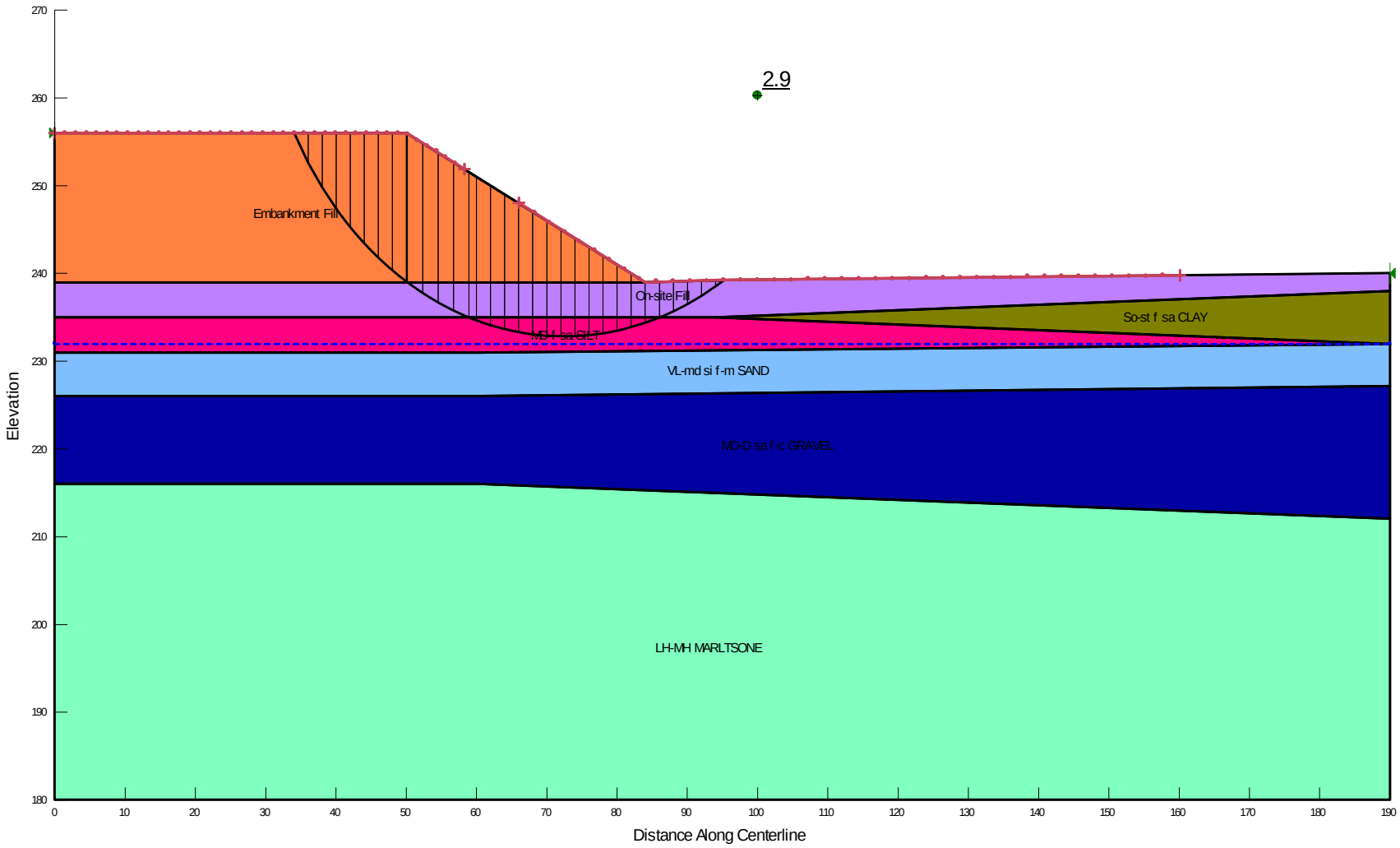
NOMINAL SINGLE PILE CAPACITY, TONS
HP14x73 Steel Piles
Bent 5 (North Bridge End)
ARDOT 030458 Hwy. 19 over Little Missouri River
Pike and Nevada County, Arkansas

Note: 1. Piles assumed to be driven to refusal.
2. No downdrag.

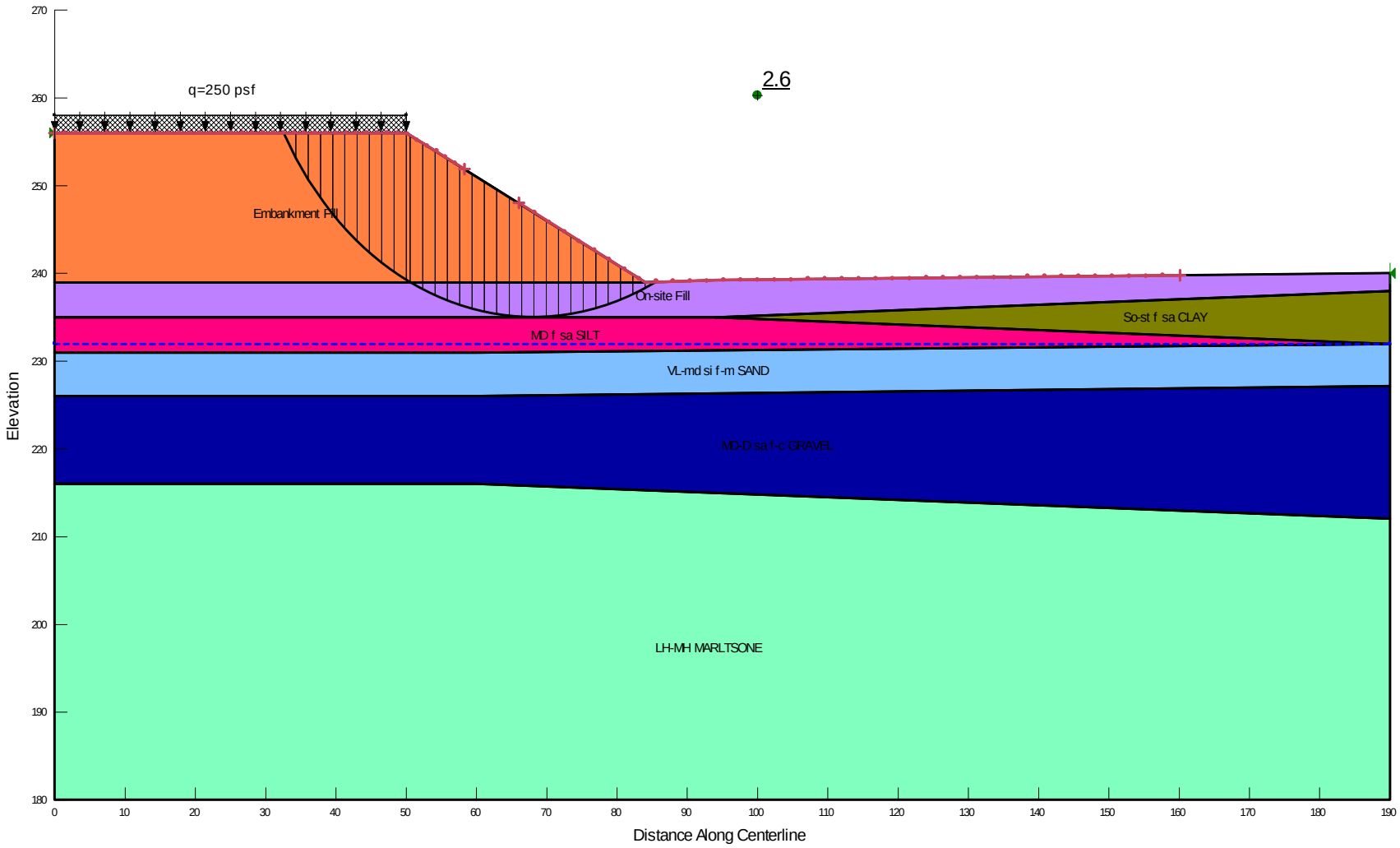
APPENDIX F

Summary of Stability Analysis Results
ARDOT Job No. 030458 Little Missouri River & Relief Strs. & Apprs. (S)
Hwy. 19 Over Little Missouri River
GHBW Job No. 18-183
Nevada and Pike Counties, Arkansas

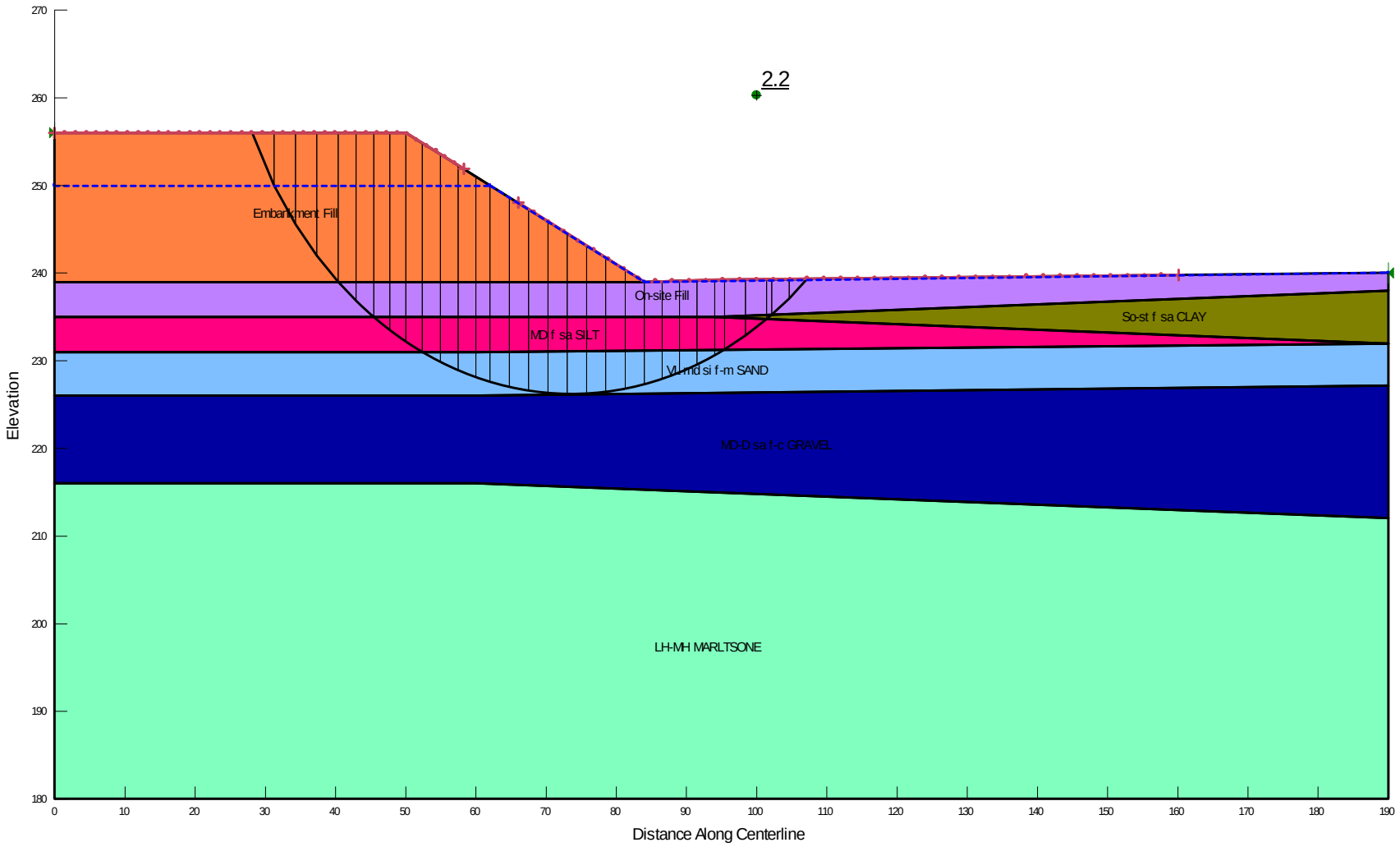
Bridge End	Design Loading Condition	Calculated Minimum Factor of Safety
Bent 1 End Slope	End of Construction	2.9
	Long Term	2.6
	Rapid Drawdown from El 250 to Existing Grade	2.2
	Seismic ($k_h = A_S/2 = 0.05$)	2.6
Bent 5 End Slope	End of Construction	3.7
	Long Term	3.3
	Rapid Drawdown from El 250 to Existing Grade	2.3
	Seismic ($k_h = A_S/2 = 0.05$)	3.2



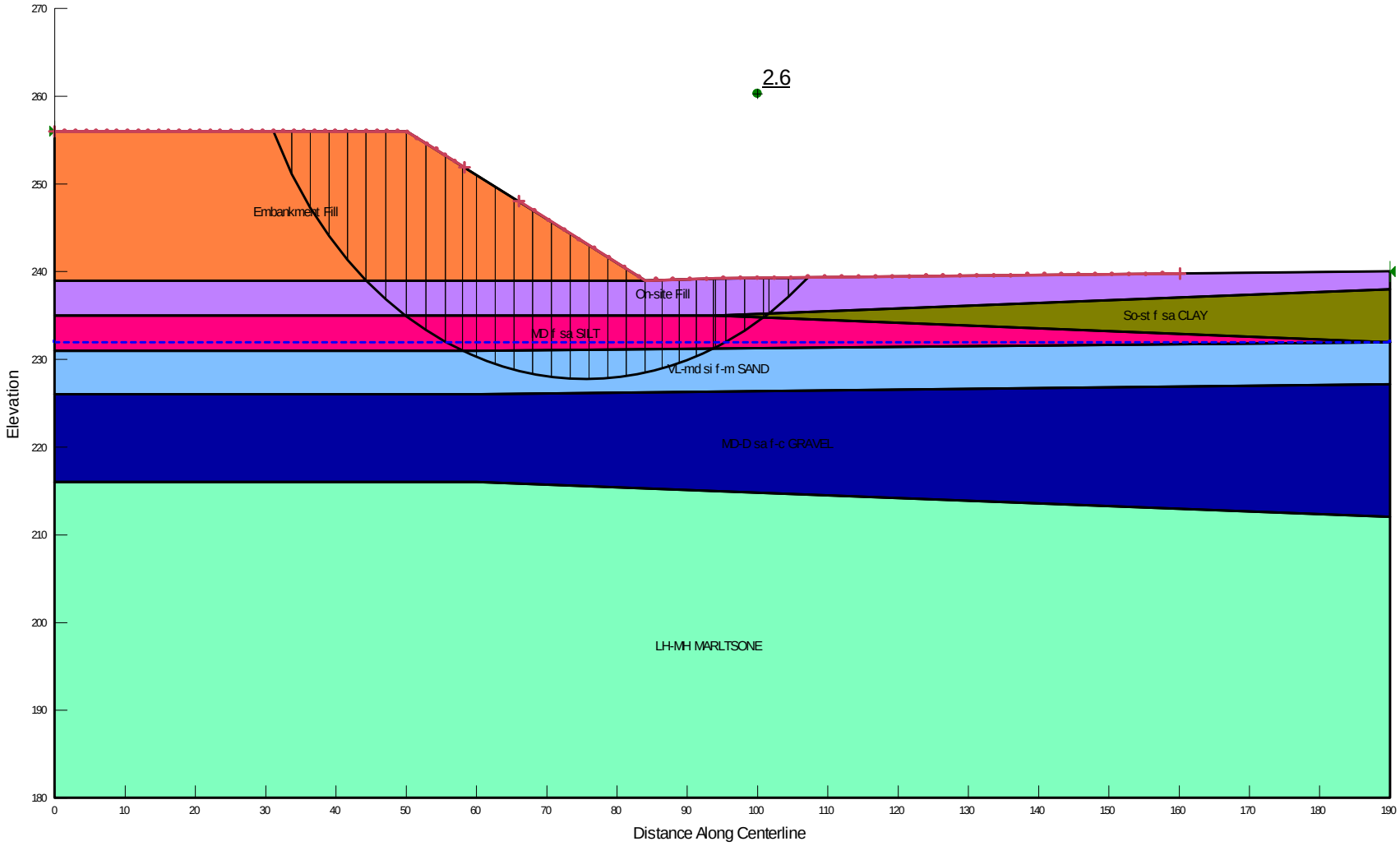
Results of Stability Analyses – End of Construction
Bent 1 End Slope
ARDOT Job No. 030458 Little Missouri River & Relief Strs. & Apprs. (S)
Hwy. 19 Over Little Missouri River
GHBW Job No. 18-183
Nevada and Pike Counties, Arkansas



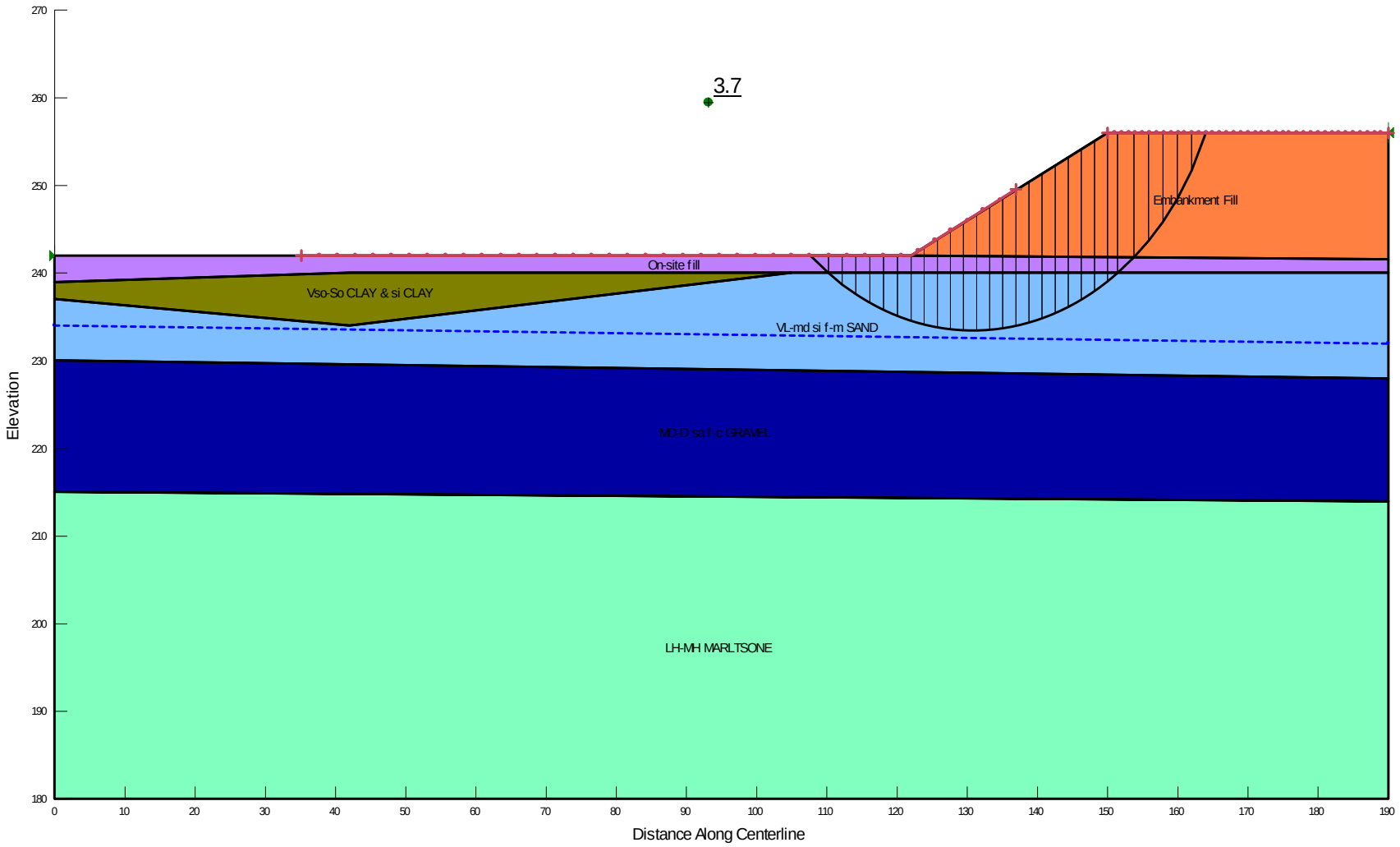
Results of Stability Analyses – Long Term Condition
Bent 1 End Slope
ARDOT Job No. 030458 Little Missouri River & Relief Strs. & Apprs. (S)
Hwy. 19 Over Little Missouri River
GHBW Job No. 18-183
Nevada and Pike Counties, Arkansas



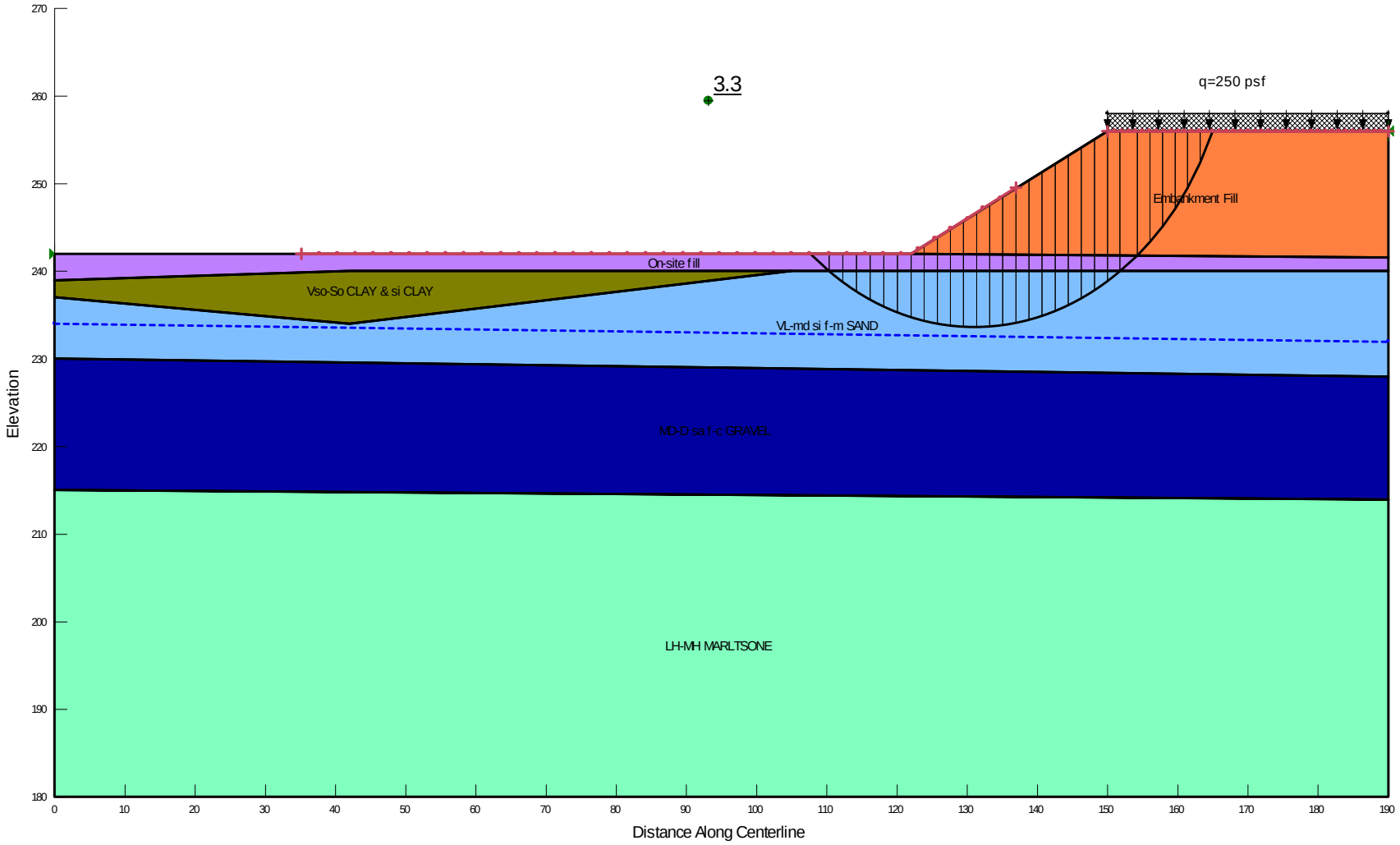
Results of Stability Analyses – Rapid Drawdown Condition, EI 250 to Existing Grade
Bent 1 End Slope
ARDOT Job No. 030458 Little Missouri River & Relief Strs. & Apprs. (S)
Hwy. 19 Over Little Missouri River
GHBW Job No. 18-183
Nevada and Pike Counties, Arkansas



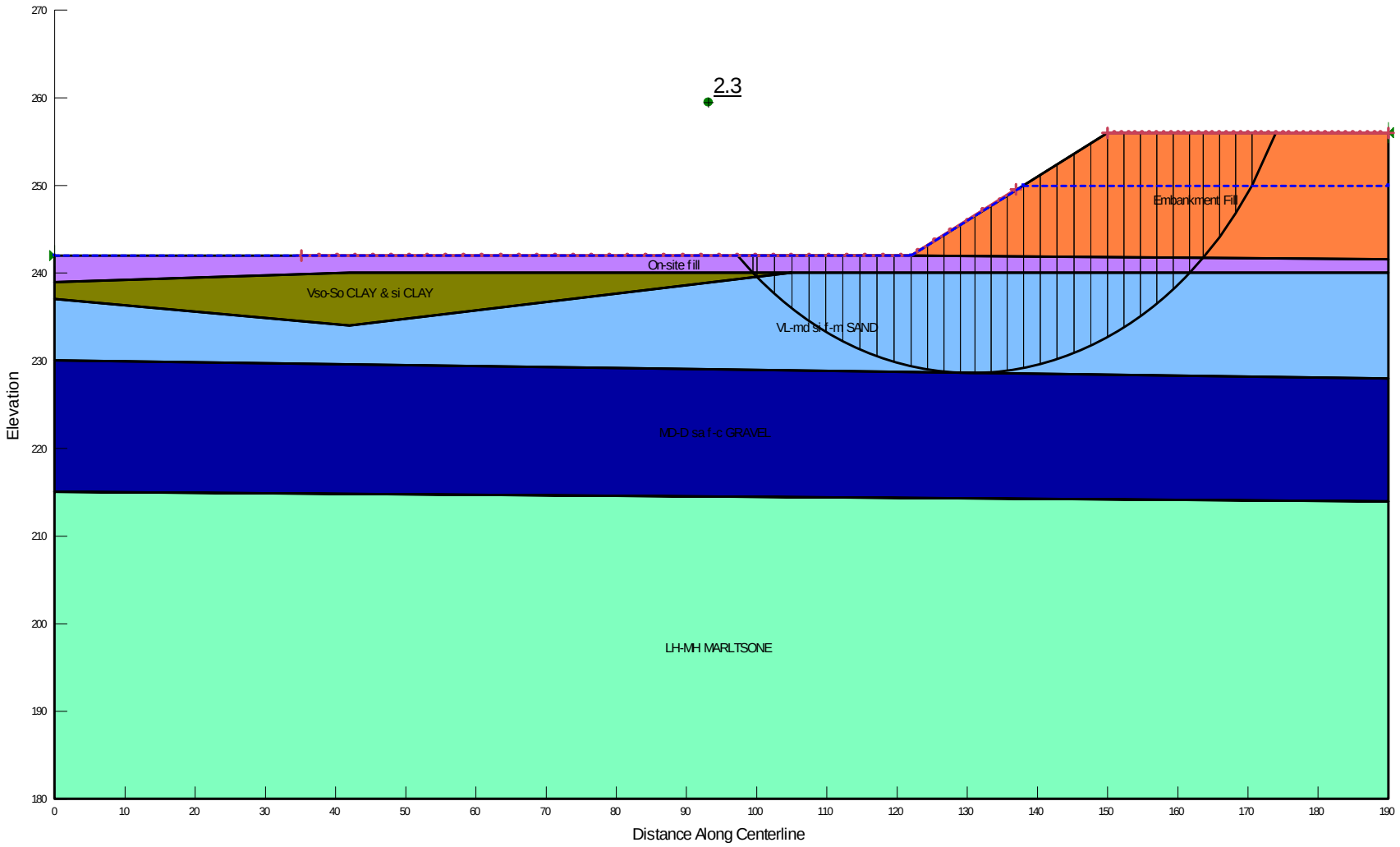
Results of Stability Analyses – Seismic Condition ($k_h = A_S /2 = 0.05$)
Bent 1 End Slope
ARDOT Job No. 030458 Little Missouri River & Relief Strs. & Apprs. (S)
Hwy. 19 Over Little Missouri River
GHBW Job No. 18-183
Nevada and Pike Counties, Arkansas



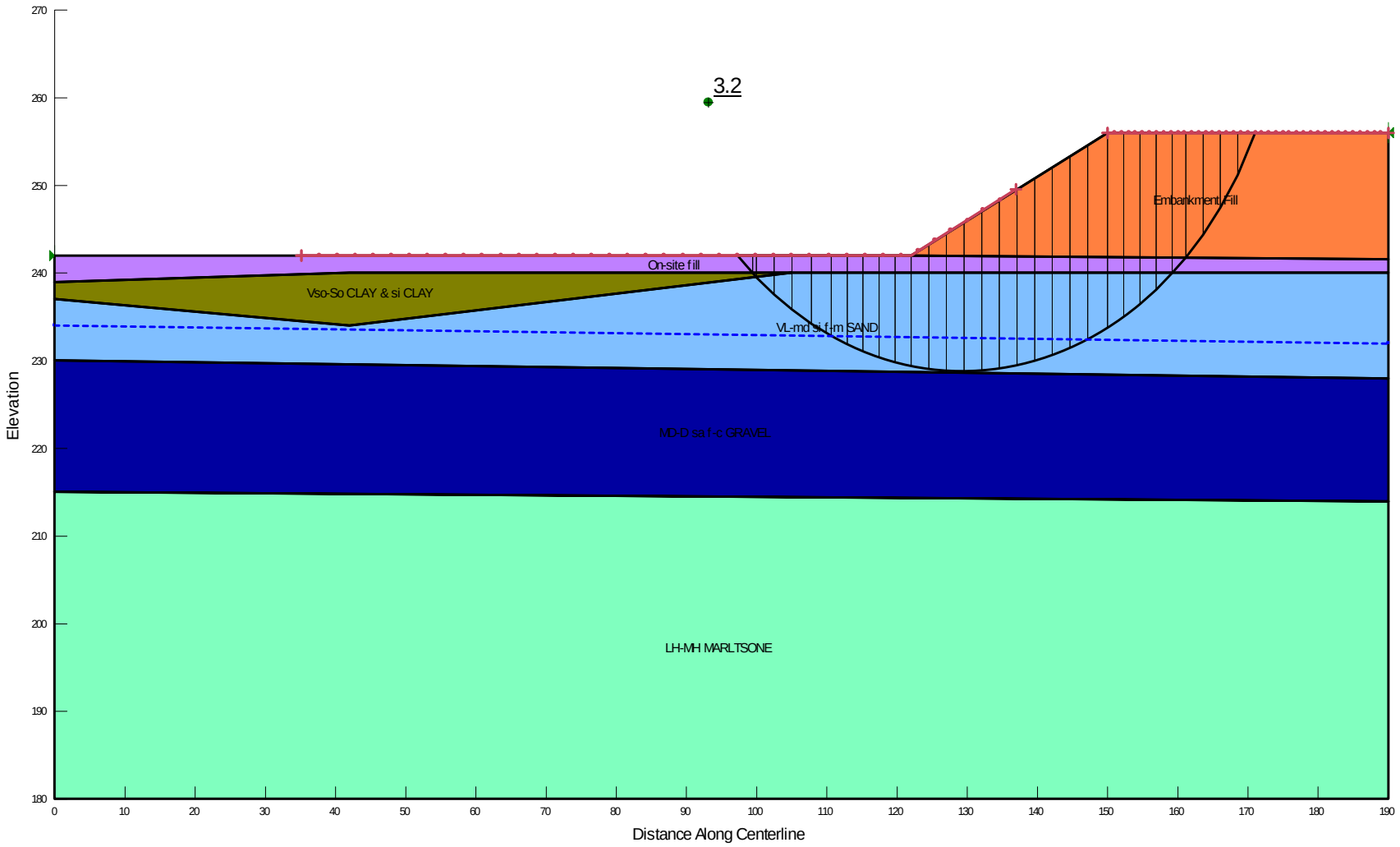
Results of Stability Analyses – End of Construction
Bent 5 End Slope
ARDOT Job No. 030458 Little Missouri River & Relief Strs. & Apprs. (S)
Hwy. 19 Over Little Missouri River
GHBW Job No. 18-183
Nevada and Pike Counties, Arkansas



Results of Stability Analyses – Long Term Condition
Bent 5 End Slope
ARDOT Job No. 030458 Little Missouri River & Relief Strs. & Apprs. (S)
Hwy. 19 Over Little Missouri River
GHBW Job No. 18-183
Nevada and Pike Counties, Arkansas



Results of Stability Analyses – Rapid Drawdown Condition, EI 250 to Existing Grade
Bent 5 End Slope
ARDOT Job No. 030458 Little Missouri River & Relief Strs. & Apprs. (S)
Hwy. 19 Over Little Missouri River
GHBW Job No. 18-183
Nevada and Pike Counties, Arkansas



Results of Stability Analyses – Seismic Condition ($k_h = A_S /2 = 0.05$)
Bent 5 End Slope
ARDOT Job No. 030458 Little Missouri River & Relief Strs. & Apprs. (S)
Hwy. 19 Over Little Missouri River
GHBW Job No. 18-183
Nevada and Pike Counties, 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

Memo

To: John Cantabery / John Ruddell
Company: Garver LLC
From: Mark Wyatt
Date: March 25, 2019
Job No: 18-183
Ref: Recommendations for Pavement Subgrade Support
ARDOT 030458 Little Missouri River & Relief Strs. & Apprs. (S)
Nevada and Pike Counties, Arkansas

John and John,

Submitted herewith are preliminary results of the bulk sampling and sample borings obtained for the new approach roads for the Hwy. 19 over the Little Missouri River for ARDOT 030458. Recommendations for subgrade support are also provided herein.

Subsurface Exploration

The scope of this project is limited to the replacement of Bridge #03095. The project location is shown on Plate 1. The approximate boring locations are shown on the Preliminary Plans of Borings, Plates 2a and 2b. Logs of the borings drilled in the approach roads, presenting descriptions of the subsurface strata encountered and results of field tests are included as Plates 3 through 6. A key to the terms and symbols used on the logs is presented as Plate 7.

In addition to the sample borings, two (2) test pits were excavated to obtain bulk samples for use in visual classification and laboratory testing related to determination of subgrade support properties. The preliminary results of the test pits are summarized below.

Sample:	3/15A (south side of bridge)
Location:	Sta 53+30, 25 ft left
Description:	Grayish brown silty CLAY with a little fine to coarse sand (existing embankment fill)
Liquid Limit:	48
Plastic Limit:	20
Plasticity Index:	28
Percent retained on #4 sieve:	0
Percent passing #200 sieve:	73
USCS Classification:	CL
AASHTO Classification:	A-7-6
Preliminary CBR:	2.5

Sample: 3/15B (north side of bridge)
Location: Sta 63+40, 20 ft right
Description: Grayish brown and brown silty CLAY with a little fine gravel
USCS Classification: CL (visual)
AASHTO Classification: A-7-6 (visual)
Preliminary CBR: 3

Conclusions and Recommendations

The initial results of the approach road borings and test pits indicate that the on-site subgrade soils will be comprised primarily of silty clay and clay. These soils are anticipated to classify by AASHTO M 145 as A-7-6 with some localized A-2-4 and A-2-6. The A-7-6 classification correlates with poor subgrade support for pavements. Locally-available borrow which is likely to be used as unclassified embankment fill could have similar classification, but is expected to be primarily fine-grained soils classifying as A-4, A-6, or A-7-6.

Based on the initial results of the borings and bulk sampling and correlation with the AASHTO classification, subgrade support of the on-site soils is expected to be very poor to poor. Subgrade preparation is anticipated to require stabilization, either by undercut and replacement or addition of stabilization additives. The results of the borings performed in the approach road alignments indicate the zone of weak and unstable subgrade soils extends to 4 ft below existing grades to in excess of 8 ft below existing grades. It is anticipated that undercutting and backfilling with stone backfill (Standard Specifications for Highway Construction, Edition of 2014, Section 207) will be warranted to limit undercut depths to about 3 ft below existing grades.

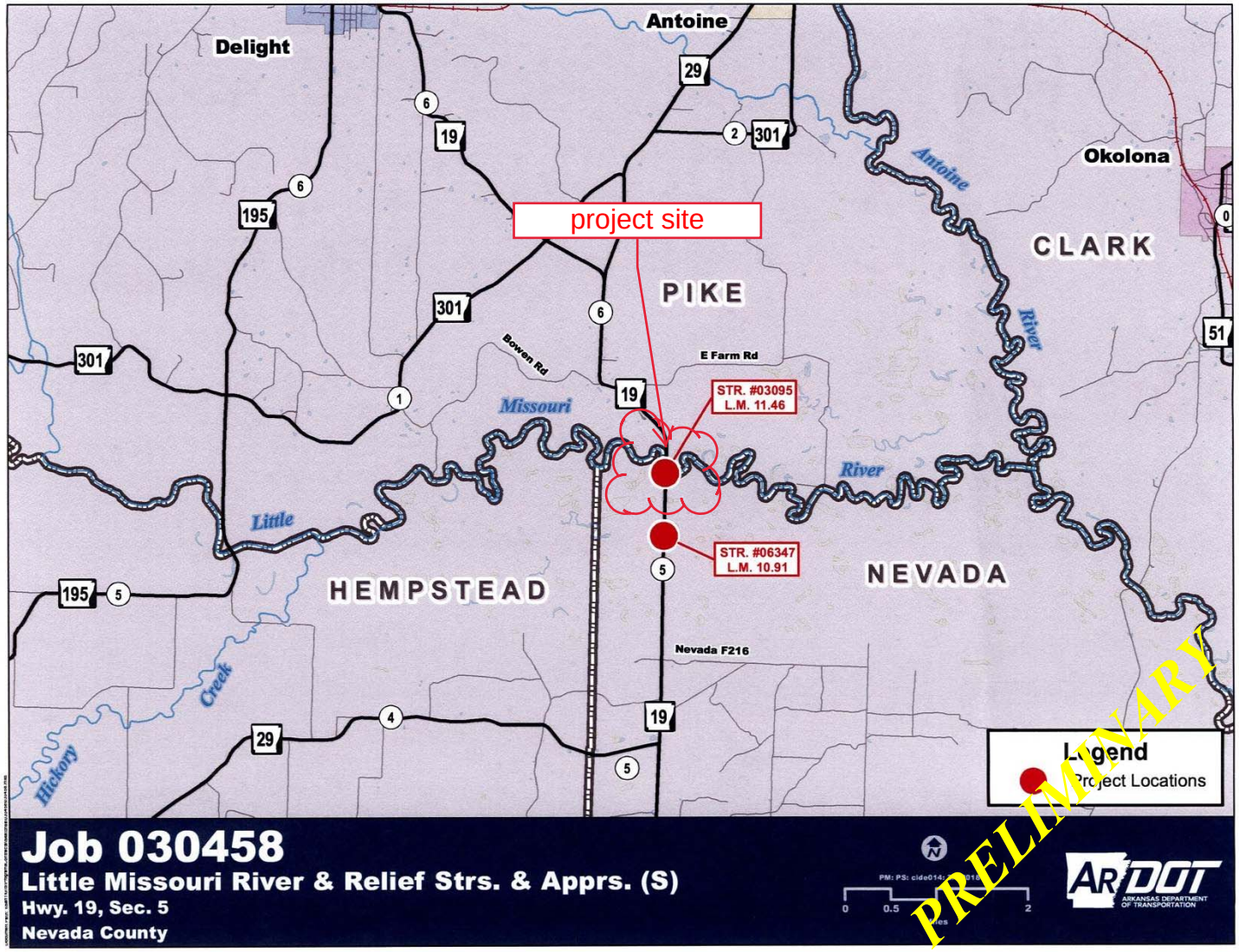
In lieu of undercutting and replacing unsuitable soils, consideration may be given to using additives to improve soil workability and stabilize weak areas. Hydrated lime, quick lime, Portland cement, fly ash, or suitable alternate materials may be used as verified by appropriate testing and approved by the Engineer. Additives can be effective where the depth of unstable soils is relatively shallow. Treatment will be less effective in areas where the zone of unstable soils is deep. The optimum application rate and treatment depth of stabilization additive must be determined by specific laboratory tests performed on the alignment subgrade soils. Given the depth of weak soils in this alignment, minimum treatment depths of 18 to 24 in., more or less, would be expected.

We recommend that any soils classifying as A-7-6 and soils with a plasticity index (PI) in excess of 18 and with more than 35 percent passing the No. 200 sieve be excluded from use as subgrade within 18 in. of the plan subgrade elevation. The top 18 in. of subgrade soils should have a maximum plasticity index (PI) of 18. The low-plasticity subgrade can be developed by undercut and backfill or addition of stabilization additives. For the on-site highly-plastic silty clay/clay subgrade soils, a lime addition rate of 5 percent by dry soil weight may be assumed for estimation purposes. This equates to an application weight of about 4 lbs per sq yd per in. of treatment depth. As recommended above, the optimum application rate of stabilization additive should be determined by specific laboratory tests performed on the specific subgrade soils.

The following parameters are recommended for use in pavement design for the anticipated subgrade of the on-site clayey soils and similar borrow soils.

- Resilient Modulus (M_R): 2550 lbs per sq inch
- R value: 4.5

Should you have any questions regarding this information, or when we can be of additional service, please call on us.



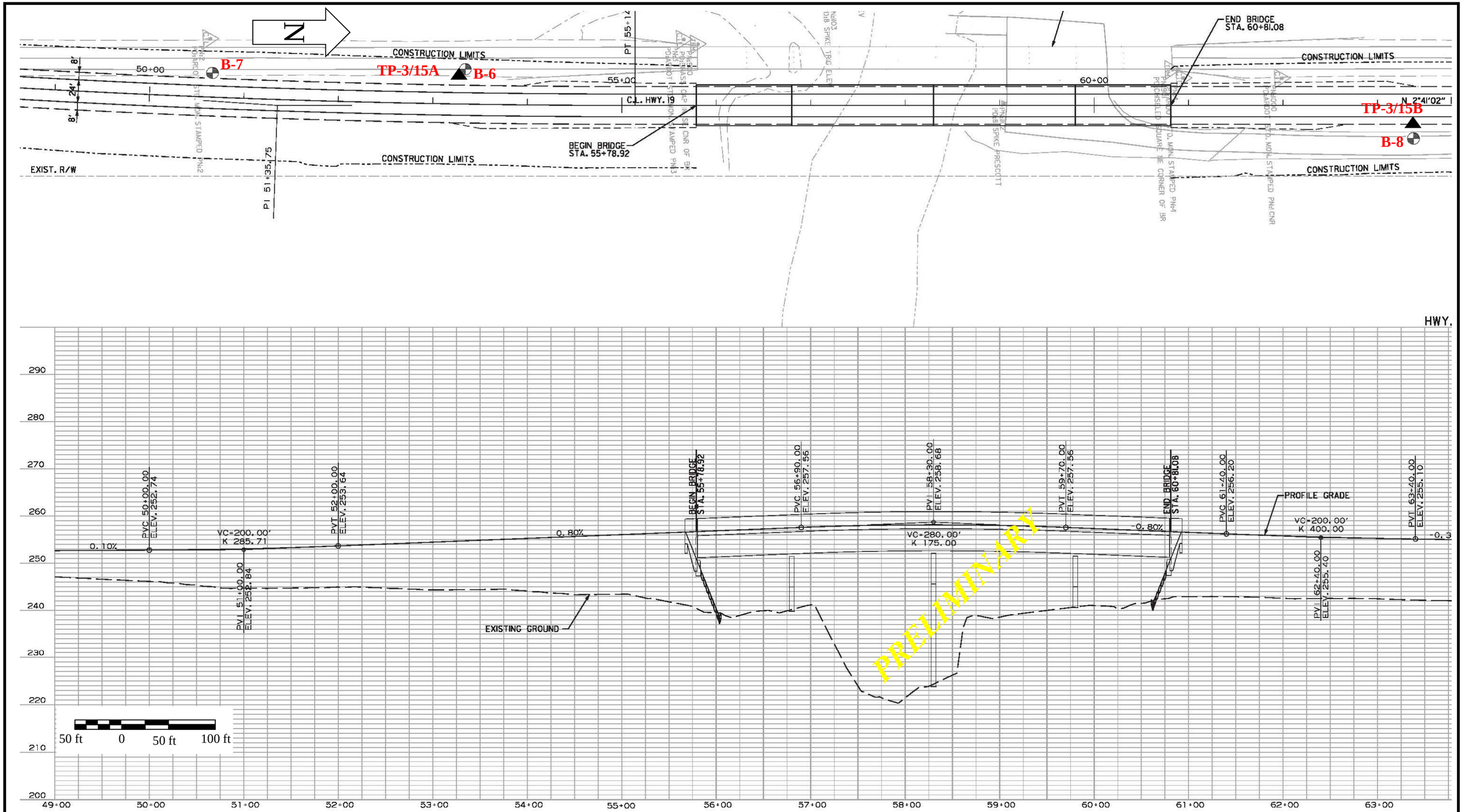
N

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

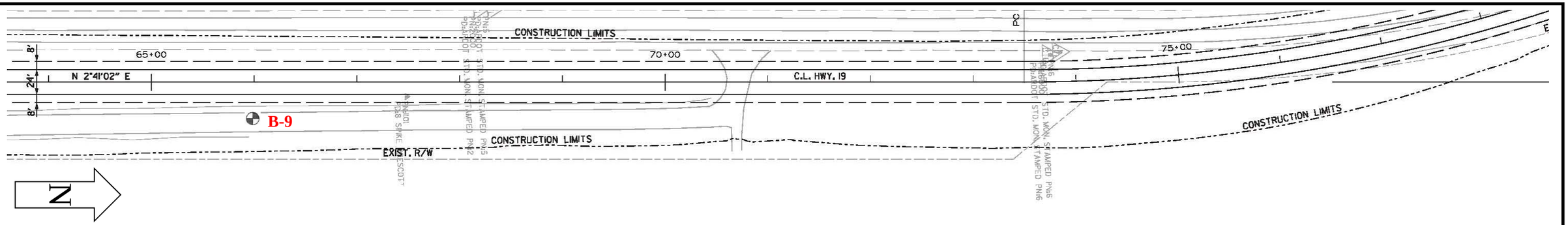
Site Vicinity Map
030458 Little Missouri River
Nevada County, Arkansas

Job No. 18-183

Plate 1



Grubbs, Hoskyn, Barton & Wyatt, INC. CONSULTING ENGINEERS	**PLAN OF BORINGS and TEST PITS** **030458 Little Missouri River** **Nevada County, Arkansas**	**Scale: As Shown** **Date: March 2019**	**Job No. 18-183**	**PLATE 2A**



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

PLAN OF BORINGS and TEST PITS
030458 Little Missouri River
Nevada County, Arkansas

Scale: As Shown

Date: March 2019

Job No. 18-183

PLATE 2B

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

LOG OF BORING NO. 6

030458 - Bridge 03095 over Little Missouri River
Pike and Nevada County, Arkansas

TYPE: Auger

LOCATION: Approx Sta 53+40, 35 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: 255±				
			3 inches: Asphalt Concrete				
			Loose reddish tan clayey fine to coarse sand w/some fine to coarse gravel (fill)	8			
			Firm gray and olive gray clay w/occasional calcareous nodules (fill)	9			
5			- soft below 4 ft	6			
			Stiff gray, reddish brown and tan silty clay, slightly sandy	21			
			Stiff gray and tan silty clay	16			
10							
			- soft below 13 ft	6			
15							
			Firm to stiff light gray silty clay w/ferrous nodules	10			
20							
25							

COMPLETION DEPTH: 20.0 ft
DATE: 3-20-19

DEPTH TO WATER
IN BORING: 17 ft at Completion

DATE: 3/20/2019

LGBNEW 18-183.GPJ 3-22-19

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

LOG OF BORING NO. 7

030458 - Bridge 03095 over Little Missouri River
Pike and Nevada County, Arkansas

TYPE: Auger

LOCATION: Approx Sta 50+70, 30 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: 253±				
			3 inches: Asphalt Concrete				
			Loose reddish tan clayey fine to medium sand w/some fine to coarse gravel (fill)	9			
			Firm olive gray and tan clay (fill)	7			
			- stiff below 4 ft				
5				17			
			Stiff to very stiff brown and gray silty clay	24			
			- stiff below 8 ft				
10				12			
15							

PRELIMINARY

COMPLETION DEPTH: 10.0 ft
DATE: 3-20-19

DEPTH TO WATER IN BORING: Dry

DATE: 3/20/2019

LGBNEW 18-183.GPJ 3-22-19

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

LOG OF BORING NO. 8

030458 - Bridge 03095 over Little Missouri River
Pike and Nevada County, Arkansas

TYPE: Auger

LOCATION: Approx Sta 63+40, 35 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: 242±				
			2 inches: Asphalt Concrete				
			Loose reddish tan clayey fine to coarse sand w/some fine to coarse gravel (fill)	7			
			Stiff brown and tan silty clay	12			
			Medium dense brown fine sandy silt				
5			- loose at 4 - 6 ft	7			
			- very loose below 6 ft	0/WOH			
			Very loose light gray silty fine sand, slightly clayey w/occasional decayed organics	3			
10							
			Medium dense gray and tan sandy fine to coarse gravel, silty	12			
15							
				15			
20							
25							

COMPLETION DEPTH: 20.0 ft
DATE: 3-20-19

DEPTH TO WATER IN BORING: 8.5 ft

DATE: 3/20/2019

LGBNEW 18-183.GPJ 3-22-19

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

LOG OF BORING NO. 9

030458 - Bridge 03095 over Little Missouri River
Pike and Nevada County, Arkansas

TYPE: Auger

LOCATION: Approx Sta 66+00, 35 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: 242±				
			1 inch: Asphalt Concrete				
			Loose reddish tan sandy fine to coarse gravel, slightly clayey	9			
			Very soft brown clay	3			
5			Very loose to loose brown silty fine sand	4			
			- very loose below 6 ft - with silty clay pockets at 6 - 8 ft	3			
10				1			
			Medium dense tan and gray sandy fine to coarse gravel, silty	13			
15							
20				26			
25							

PRELIMINARY

COMPLETION DEPTH: 20.0 ft
DATE: 3-20-19

DEPTH TO WATER IN BORING: 3 ft

DATE: 3/20/2019

LGBNEW 18-183.GPJ 3-22-19

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SYMBOLS AND TERMS USED ON BORING LOGS

SOIL TYPES

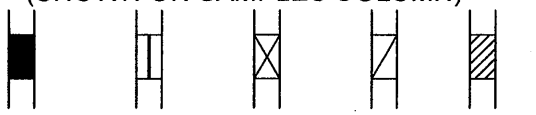
(SHOWN IN SYMBOLS COLUMN)

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 6-30-10