Chalk Bluff O&M Building

Geotechnical Engineering Report

August 6, 2025 | Terracon Project No. 35245133

Prepared for:

Invenergy Renewables, LLC
One South Wacker Drive, Suite 2000
Chicago, Illinois 60606

Explore with us

Nationwide
Terracon.com

- Facilities
- Environmental
- Geotechnical
- Materials

25809 Interstate 30 South
Bryant, Arkansas 72022
P (501) 847-9292
Terracon.com

August 6, 2025

Invenergy Renewables, LLC
One South Wacker Drive, Suite 2000
Client City, State ZIP Code

Attn: Lesley Fishser
P: 773-808-2133
E: LFisher@invenergy.com

Re: Geotechnical Engineering Report
Chalk Bluff O&M Building
Highway 357
St. Francis County, Arkansas
Terracon Project No. 35245133

Dear Ms. Lesley Fisher:

We have completed the scope of Geotechnical Engineering services for the above referenced project in general accordance with Terracon Proposal Number P35245133.S1, dated May 16, 2025. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of foundations and unpaved roads for the proposed project.

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

Sincerely,

Terracon

Sarah B. Swain, P.E. (TN)
Senior Staff Engineer

Christopher S. Handley, P.E. (AR)
Principal

Nic Arens, P.E.
Senior Geotechnical Engineer

SME Reviewer: David A. Baska, Ph.D., P.E., C.E.G.
Principal Seismologist/Earthquake Engineer

Table of Contents

Attachments

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

Introduction

This report presents the results of our subsurface exploration and Geotechnical Engineering services performed for the proposed O&M building to be located adjacent to Highway 357, to the south of the intersection of Highway 357 and SFC 544 in St. Francis County, Arkansas. The purpose of these services was to provide information and geotechnical engineering recommendations for the proposed OM building development.

The geotechnical engineering Scope of Services for this project included soil borings, CPT soundings, and geophysical testing. Additional details can be found in the See **Exploration and Testing Procedures** section of this report.

Project Description

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

Item	Description
Information Provided	Project information was provided by Invenergy via email received on May 8, 2025. The information included: ▪ A PDF file titled, "CHALK BLUFF_Soil Boring Location", which shows a site plan of the O&M building and associated pavement and drive areas. ▪ A KMZ titled, "Chalk Bluff-AR_OM Building 30p_2025-03-24", showing the physical location of the planned O&M building.
Project Description	We understand that our client intends to develop a 450 MWac photovoltaic (PV) electric power plant with an array area of about 2,850 acres. We understand that this O&M building will be in support of the planned array and substation.
Proposed Structures	The project appears to consist of single-story O&M building with an approximate footprint of 6,900 square feet. Associated paved parking and an additional gravel-surfaced truck turnaround is also planned for the site.
Maximum Loads	The following information was provided: ▪ 15 kips maximum column loading ▪ 2,500 pounds per linear foot for walls

Item	Description
Grading/Slopes	Grading plans were not provided; however, we have considered up to 2 feet of cut and/or fill may be required to develop final grades in areas. We also anticipate that final slope angles no steeper than 3H:1V (Horizontal: Vertical) nor taller than 5 feet will be required.
Unpaved Roads	Unpaved roads are planned for the site as described below: ▪ Access roads are to support post-construction traffic which we understand will be primarily light maintenance vehicles. The roads will be required to support a maximum vehicle load of 80,000 pounds for fire truck access. We understand it is acceptable for the access roads to require ongoing maintenance throughout their design life.

Terracon should be notified if any of the above information is inconsistent with the planned construction, as modifications to our recommendations may be necessary.

Site Conditions

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

Item	Description
Parcel Information	The proposed O&M building is south of the intersection of Highway 357 south and SFC 544. Coordinates near the center of the site are: 35.0475°N latitude and 90.4386°W longitude. See **Site Location**
Existing Improvements	The project site consists of fields that are used primarily for agricultural purposes.
Existing Topography	The site appeared to be relatively level. From a google Earth aerial image, we estimate an elevation difference of about 5 feet throughout the O&M development.

Geotechnical Characterization

Site Geology

Northeastern Arkansas was originally part of the bay of the Gulf of Mexico. As the bay filled and separated from the sea, it was altered by rivers, primarily the Mississippi River. The tertiary deposits were carved away, and rivers replaced the marine deposits with sand, silt and clay. The course of the various rivers in the area changed over thousands of years and reshaped eastern Arkansas. The region eventually became known as the Mississippi Embayment.

The specific geologic unit mapped on and adjacent to the site by the USGS includes alluvial deposits from major stream channels. The alluvial deposits include highly variable sequences of unconsolidated gravels, sand gravels, sands, silty sands, silts, clayey silts and clays.

Soil Survey

The Soil Survey for St. Francis County, Arkansas, as prepared by the United States Department of Agriculture (USDA), Soil Conservation Service (now renamed the Natural Resource Conservation Service – NRCS), identifies one soil type at the subject site. The Web Soil Survey (WSS) presents shallow (typically upper 80 inches) soil stratification information. The typical stratification and estimated seasonal high groundwater levels for the map units, are given in the following table.

Summary of Soil in Project Vicinity – from USDA Web Soil Survey				
Map Unit Name	Percentage of Site Area	Stratification		Estimated Seasonal High Groundwater Level (in-bgs)
		Depth Range (inches)	USCS	
DuA – Dundee silt loam, 0 to 1 percent slopes	100	0 to 48	CH, CL, ML	18 to 36

In general, the soil survey indicates the near-surface soils are composed of silt, clay, or mixtures of these soils with shallow groundwater.

It should be noted that the NRCS Soil Survey is not intended as a substitute for site-specific geotechnical exploration; rather it is a useful tool in planning a project scope in that it provides information relative to the soil types likely to be encountered. Boundaries between adjacent soil types on the NRSC Soil Survey maps are approximate.

In general, the shallow subsurface conditions identified in the borings conducted for this project generally agree with the NRCS Soil Survey.

Exploration Results

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

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

Model Layer	Layer Name	General Description
1	Fine-Grained Soils	Medium stiff to very stiff lean clay, sandy lean clay
2	Fat Clay	Medium stiff to stiff fat clay
3	Coarse-Grained Soils	Medium dense to very dense poorly graded sand with clay, clayey sand, poorly graded sand

Our exploration also included seismic cone penetration test (sCPT) soundings. Since the sCPT process does not involve collection of physical samples, the soil types identified by the piezocone are estimates (indications based on correlations and may vary from what is present. The physical samples recovered from the borings performed as part of the O&M building found similar soil conditions to that described by the sCPT correlations.

Groundwater

Groundwater was found at a depth of about 30 feet below the ground surface (bgs) at the time of our field exploration. Groundwater conditions may be different at the time of construction. Mapping by the Natural Resources Conservation Service (NRCS) indicates a seasonal high groundwater level within 18 to 36 inches of ground surface. We believe a seasonal high groundwater level between 18 to 36 inches of ground surface is likely perched groundwater. We do not believe this groundwater is connected to the deeper groundwater found during our field exploration. Groundwater conditions may change because of seasonal variations in rainfall, runoff, and other conditions not apparent at the time of drilling. Long-term groundwater monitoring was outside the scope of services for this project.

Seismic Considerations

The seismic design requirements for buildings and other structures are based on Seismic Design Category. Site Classification is required to determine the Seismic Design Category for a structure. The Site Classification is based on the upper 100 feet of the site profile defined by a time averaged value of shear wave velocity or weighted harmonic mean value of either standard penetration resistance or undrained shear strength in accordance with Section 20.4 of ASCE 7-16 and the International Building Code (IBC). Based on the soil properties observed at the site and as described on the exploration logs and results, our professional opinion is that **Site Class F** be considered for the project.

The seismic evaluation of the site identified potentially liquefiable soils. According to the IBC and ASCE 7-16, this potential for liquefaction classifies the site as Site Class F and requires a site response analysis. Terracon performed the analysis and the results are summarized below.

Reference Used	**Site Class**
ASCE 7-16	F[1]
Seismic Design Parameter	**Value**
S_s	1.048g[2]
S_1	0.365g[2]
F_a	1.081[2]
F_v	2.5[3]
S_{DS}	0.604g[3]
S_{D1}	0.487g[3]
S_{MS}	0.906g[3]
S_{M1}	0.730g[3]

1. Site Class F because of liquefiable soils, Site Class D assuming no liquefaction given the value of V_{S100}.
2. Value from www.seismicmaps.org utilizing Risk Category II latitude 35.0507° N and longitude 90.4307° W.
3. Value from site-specific ground motion study.

Liquefaction

Earthquake ground shaking can transform loose deposits of sand and low-plasticity clay/silt below the water table into a viscous fluid. Sand particles will densify when vibrated; however, when the deposit is saturated and loaded rapidly, the water that fills the voids will be squeezed and particle grain-to-grain contact will be reduced. As the pore water pressure builds, the soil can liquefy. Liquefaction leads to a reduction in soil strength and features such as sand boils/blows can be created as the liquefied materials move through cracks to areas of lower pressure. Liquefaction hazards and ground displacements generally decrease with age of sediment deposition. For example, Holocene soils are more susceptible than Pleistocene deposits.

Additional information regarding liquefaction in the vicinity of the project site was provided in our liquefaction literature search previously prepared in our Report of Updated Liquefaction Hazard Evaluation, for the Chalk Bluff array and substation dated, March 18, 2024.

Geophysical Survey

Terracon performed a limited seismic survey consisting of one Multi-Channel Analysis of Surface Waves (MASW) line at the site of the proposed Chalk Bluff O&M Building to obtain shear wave velocity values of the soil within the upper 100 feet. The line was oriented south to north with CPT-2 and SPT-1 at 132 and 190 feet along the array, respectively. Locations are presented on the attached exploration plan.

Our method of investigation utilized a standard fixed-array set of MASW geophones. The array consisted of 24 4.5Hz geophones, spaced 10 feet apart along a sensor cable. For the passive survey, ambient noise (such as nearby traffic or construction) on the site was recorded by a seismograph. For the active survey, three sledgehammer strikes were performed every 10 feet against a metal plate along the array.

The data was returned to our office and processed using dispersion analysis software (SurfSeis, developed by the Kansas Geological Survey) that extracts the fundamental-mode dispersion curve(s). The active and passive surveys performed were combined to produce a broader-band overtone image to better identify the dispersion trends. The resulting curve was inverted and modeled to yield a 1D shear-wave velocity profile along the array to 100 feet below ground surface. The velocity model from the MASW survey is presented in the attachments.

Our model is based on time-averaged shear wave velocity calculations in the upper 100 feet (V_{s100}), in accordance with the procedure outlined in ASCE 7-16. The V_{s100} for the site averaged 713 feet/second which corresponds to Site Class D as defined by ASCE 7-16.

Site-Specific Ground Motion Study

A site-specific ground motion study for the substation and solar array was provided in our Report of Site-Specific Ground Motion Study, dated January 6, 2025. The study consisted of a site response analysis per Chapter 21 of ASCE 7. Subsurface conditions and shear wave velocity measurements were reviewed at the O&M building, substation, and array areas. It is our opinion that this previous study can also be applied to the O&M building at the Chalk Bluff site.

Liquefaction Susceptibility of the Site Soils

Soils at the project site consist predominantly of fine-grained soils (fat clays and lean clays) overlying sands. The fine-grained soils ranged from low plasticity to highly plastic. We used the screening techniques of Boulanger and Idriss (2006) and Bray and Sancio (2006) to evaluate susceptibility of the site soils to liquefaction. These methods employ Atterberg limit test results for which the soil is considered susceptible to liquefaction if the plasticity index (PI) is less than 7 to 12 depending on the screening technique.

Multiple Scenario Liquefaction Hazard Analysis

In practice, liquefaction hazard analysis is usually evaluated using a deterministic approach in which a single earthquake magnitude (M), usually the mean or mode, is selected. In contrast, a multiple scenario approach to liquefaction hazard analysis considers the full range of M and allows the relative contribution from each value of M to be considered. The result is a more accurate evaluation of liquefaction triggering and consequences for a given return period.

Approach to Liquefaction Triggering Analysis

We evaluated the potential for liquefaction triggering using the simplified procedure originally developed by Seed and Idriss (1971). The procedure compares the cyclic stress ratio (CSR) induced by the earthquake to the cyclic resistance ratio (CRR) of the soil deposit. At locations within the soil profile where the value of CSR exceeds the value of CRR, the soil is predicted to liquefy. In the simplified procedure, the depth profile of CSR is computed using the following equation.

$$\mathrm{CSR} = 0.65\frac{\tau_{\max}}{\sigma'_{vc}} = 0.65\frac{\sigma_{vc}}{\sigma'_{vc}}\frac{a_{\max}}{g}r_d$$

Where:

- σ_{vc} is the overburden stress,
- σ'_{vc} is the effective overburden stress,

- a_{max} is equivalent to peak ground acceleration,
- g is the gravitational constant, and
- r_d is a shear stress reduction coefficient.

Uncertainty in the stress reduction coefficient, r_d, increases with increasing depth, and Idriss and Boulanger (2008) recommend that the estimation of r_d be applied to depths less than about 65 feet. Site response analyses may be required to model soil liquefaction at depths greater than 65 feet.

We used the USGS Earthquake Hazard Toolbox to obtain values of peak ground acceleration (PGA) and the distribution of M for the 2,475-year return period. The table below lists the PGA value for V_{S100} = 713 feet/sec (217 m/sec) and the USGS disaggregation report showing the percent contribution for each value of M is attached. Note that the value in the table below differs from the value of MCE_G peak ground acceleration adjusted for site class effects (i.e., PGA_M) presented in our previously submitted geotechnical report.

Return Period (years)	PGA (g)
2475	0.58

In the simplified procedure, the values of CRR are computed at discrete locations within the soil profile from the field exploration data. Although both SPT borings and CPT soundings may be used to evaluate liquefaction, consensus within the geotechnical profession is that the near-continuous record from CPT soundings is the more accurate method of analysis. Therefore, we computed CRR from CPT-1 and CPT-2

Approach to Estimating Ground Surface Displacements

We used the methods described by Idriss and Boulanger (2008) to compute lateral displacement and post-liquefaction reconsolidation settlement from the CPT sounding data. The methods employ the volumetric strain model of Ishihara and Yoshimine (1992) for reconsolidation settlement and Zhang et al. (2004) for lateral displacement. We assumed a ground slope of 0.5 percent when computing lateral displacement.

Results of Multiple Scenario Liquefaction Hazard Analysis

The attached figures present the liquefaction triggering and displacement results for CPT-1 and CPT-2 for a return period of 2,475. The figures are depth profiles of tip resistance, soil behavior type index, CRR and CSR, factor of safety, and reconsolidation settlement.

The base of the non-liquefied crust is established by either the depth to groundwater or the soil type (i.e., not susceptible to liquefaction based on plasticity or density).

Groundwater observations were made during the performance of SPT borings and CPT soundings at the site. Because of the low permeability of most of the soils at the site, groundwater was not observed in many of the SPT borings during the short time the explorations were allowed to remain open. The groundwater depths were interpreted by our Arkansas professional staff based on exploration logs from the most recent and previous exploration programs at the site and known land use.

A thick non-liquefied crust over a liquefied stratum may act as a bridging layer that redistributes stresses and results in more uniform ground surface settlement. In this manner, a well-constructed foundation system may settle but not suffer significant damage, because the differential settlement is relatively minor. We applied the method presented in Figure 1 (reproduced from Ishihara, 1985) to distinguish between ground surface damage (e.g., sand boils, ejecta deposited on the ground surface) and the absence of such damage. The method relies upon a combination of non-liquefied surface layer thickness, liquefied layer thickness, and peak ground acceleration (PGA) to examine the reduction in consequences associated with one-dimensional reconsolidation settlement and ground surface distress.

Based on the crust thickness at the site, ground surface damage is anticipated for ground motions with a return period of 2,475 years.

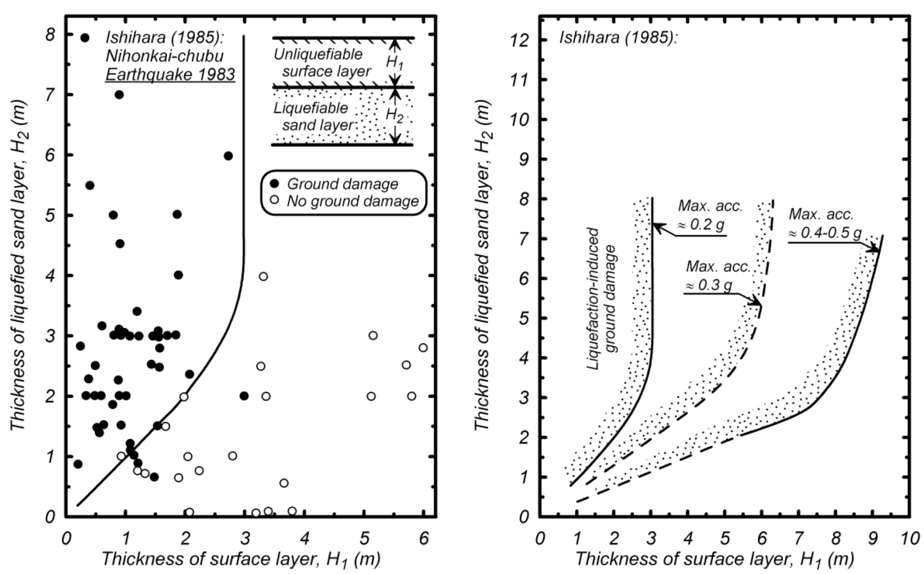


Figure 1. Combinations of non-liquefiable surface layer thickness, liquefiable layer thickness, and peak ground surface acceleration that distinguish between ground surface damage and the absence of such damage (Ishihara, 1985).

Sensitivity Analysis for Groundwater Depth

We performed sensitivity analyses for depth to groundwater. This was accomplished by computing ground surface settlement values at each exploration location for a return period of 2,475 years with groundwater depths of 30 (initial), 25, 20, 15, and 10 feet. The settlement values are listed in the table below in addition to the values previously computed for our best estimate of the annual average groundwater depth.

CPT No.	Groundwater Depth (ft)	Crust Base Depth (ft)[1]	Settlement (inches) for Different Groundwater Depths (ft)				
			Initial	25	20	15	10
CPT-1	30	21	2.1	3.9	5.2	5.3	5.3
CPT-2	30	22	2.1	3.5	4.7	4.8	4.8

[1]Crust base depth is the depth to the bottom of the non-liquefied crust for the 2,475-year return period and initial groundwater depth estimates (see report text).

The depth to groundwater has the greatest effect on ground surface settlement when groundwater depths exceed about 20 feet. These locations have a non-liquefiable clay crust (about 21 to 22 feet in thickness) which explains the relatively small differences in settlement when groundwater is shallower than about 20 feet below ground surface.

Conclusions and Recommendations

The purpose of our services was to provide a liquefaction hazard evaluation for the project. This was accomplished with a literature review, field and laboratory testing, a multiple scenario approach to evaluating the liquefaction hazard, and sensitivity analyses. Based on the existing subsurface information, we conclude the following for ground motions with a 2,475-year return period:

- Maximum differential settlement at the ground surface over a horizontal distance of 100 feet will be less than about 1 inch.
- Lateral displacements are unlikely to occur at the O&M Building location.
- The site is anticipated to experience ground surface damage at a return period of 2,475 years.

O&M Building Shallow Foundations

Geotechnical Considerations

The recommendations provided in this section are based on the SPT borings and CPT soundings drilled in the planned O&M building location along with the assumed structural loads provided earlier in this report. Based on the results of the borings, shallow foundation systems are available to be used provided the maximum assumed loads are not exceeded.

Topsoil, organic matter, stumps, existing fill, or other unsuitable materials should not be left in place below the O&M building area. All foundations should bear on suitable natural soil, or on properly compacted structural fill.

Spread Footing and Isolated Slab Foundations

The near surface soils at the planned O&M building consisted of medium stiff to very stiff clay soils. Clay soils were also indicated in the CPT soundings. Fat clay soils observed are expansive and are prone to volume changes with variations in moisture content.

Fat clay soils were not encountered within the upper 5 feet of the soil borings, however potentially low strength soils were encountered. We recommend 2 feet of fill to be used to provide uniform support for floor slabs. If soft soils are encountered, overexcavate and replace.

The following sections present design recommendations and construction considerations for the shallow foundations for proposed lightly loaded structures and related structural elements.

Spread Footing and Mat/Slab Foundation Design Recommendations

Description	Columns	Walls	Mats
Net allowable bearing pressure [1]	2,000 psf		
Modulus of subgrade reaction for slab-on-grade design (K_{v1})	100 pounds per square inch per in (psi/in) for point loading conditions		
Bearing material	Native lean clay or LVC		
Minimum dimensions	30 inches	18 inches	N/A
Minimum embedment below finished grade[2]	12 inches		
Approximate total settlement [3]	1 inch		
Estimated differential settlement	½ inch between columns	½ inch over 30 feet	½ inch over 30 feet
Ultimate coefficient of sliding friction[4]	0.35		

Description	Columns	Walls	Mats

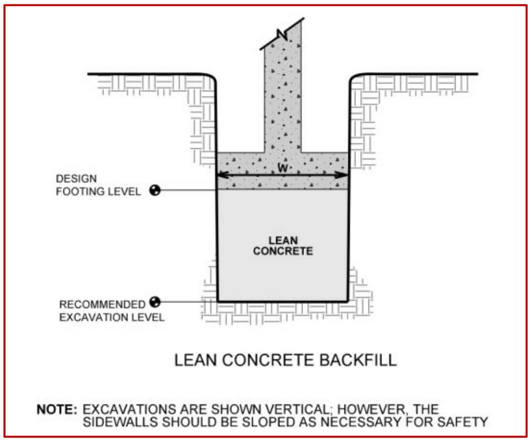
1. The recommended net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. It assumes any unsuitable soils, if encountered, will be replaced with compacted structural fill. A factor of safety of 3.0 was utilized.
2. Required for the allowable bearing pressure, erosion protection and to reduce the effects of seasonal moisture variations in the subgrade soils.
3. The foundation settlement will depend upon the variations within the subsurface soil profile, the structural loading conditions, the embedment depth of the footings, the thickness of compacted fill, and the quality of the earthwork operations. Footings should be proportioned to relatively constant dead-load pressure in order to reduce differential movement between adjacent footings.
4. Sliding friction along the base of the footing will not develop where net uplift conditions exist.

The allowable foundation bearing pressures apply to dead loads plus design live load conditions. The design bearing pressure may be increased by one-third when considering total loads that include wind conditions. The weight of the foundation concrete below grade may be neglected in dead load calculations.

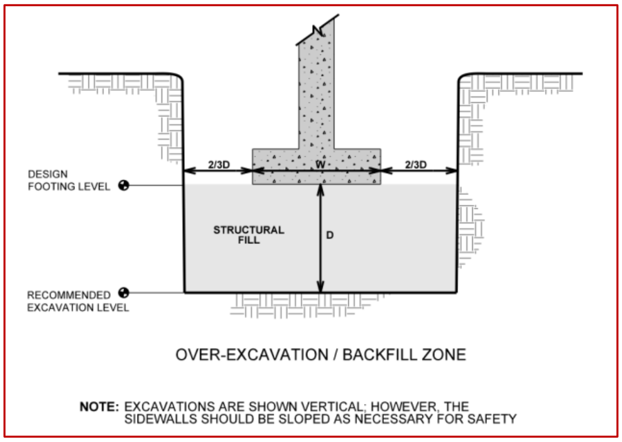
Spread Footing Construction Considerations

The bottom of all foundation excavations should be free of water and loose soil prior to placing concrete. Concrete should be placed soon after excavating to reduce bearing soil disturbance. Care should be taken to prevent wetting or drying of the bearing materials during construction. Extremely wet or dry material or any loose or disturbed material in the bottom of the footing excavations should be removed before foundation concrete is placed. Should the soils at bearing level become excessively dry, disturbed or saturated, the affected soil should be removed, or moisture conditioned and recompacted prior to placing concrete. Place a lean concrete mud-mat over the bearing soils if the excavations must remain open overnight or for an extended period of time.

If unsuitable bearing soils are observed at the base of the planned footing excavation, the excavation should be extended deeper to suitable soils, and the footings could bear directly on these soils at the lower level or on lean concrete backfill placed in the excavations. The lean concrete replacement zone is illustrated on the sketch below.



Overexcavation for structural fill placement below footings should be conducted as shown below. The overexcavation should be backfilled up to the footing base elevation, with low volume change engineered fill placed, as recommended in the **Earthwork** section.



Earthwork

Grading plans were not available at the time of this report. Based on the available information, we have assumed that earthwork for the project will include clearing and grubbing, trenching for cables and conduits, cutting and filling to achieve roadway grade, and excavations for stormwater management. The earthwork described in the following sections is preliminary in nature and intended for planning general site grading, access roadways, and drainage.

Site Preparation

It is recommended that areas of proposed slab-on-grade or mat foundation structures be stripped of any tilled soil, topsoil, or soft/loose overburden soils containing organic matter. In access roadway and new fill areas of the site, the tilled soils/topsoil will create difficult access issues, particularly when the soils possess high moisture content. These materials can be modified to increase their strength and any planned approaches to improve the strength of these soils should be tested. Please note, that any soil placed over topsoil will settle with time with the magnitude of the settlement being directly related to the thickness of these types of soils. Therefore, any materials consisting of topsoil, tilled soils, vegetation, and organic matter should be stripped and wasted off site or could be re-spread in landscaped areas after completion of grading operations. Topsoil thickness was not recorded in the field; however we anticipate the topsoil depth is approximately 6 inches and due to prior usage of the site for agricultural purposes, it is possible that the previously tilled horizon would be comprised of highly organic soils to deeper depths. Stripping depths could vary across the site, and we recommend actual stripping depths be evaluated by a representative of Terracon during construction to aid in preventing removal of excess material.After performing the site grading activities associated with cutting/filling the site to design grade; and prior to placing structural fill in areas to receive fill, the subgrade should be proofrolled to aid in locating soft or loose areas. Proofrolling of cohesive soils should be accomplished with a fully loaded, tandem axle dump truck or other suitable pneumatic tired equipment weighing at least 20-tons. Based on conditions encountered in the borings, significant measures for subgrade stabilization should be anticipated.

Any soft or yielding areas encountered within the new fill areas and access road areas during proofrolling operations should be undercut to expose firm stable soils or re-worked in place to a suitable acceptable condition. Chemical modification of the subgrade in the access road locations may be an alternative to removal, though any planned modification should be tested prior to implementation. It should be noted that an undercut depth somewhat greater than normal may be needed if the construction occurs during periods of inclement weather. The actual amount of undercut would need to be determined in the field during construction and is dependent on the subsurface conditions encountered, weather conditions and equipment used in the construction. Chemical stabilization is generally considered to be more cost effective than undercut and replacement of large areas if suitable temperature conditions exist.

Once the foundation excavation is made, the exposed subgrade soils should be examined by geotechnical personnel to determine that the suitable bearing materials have been encountered. If unsuitable soils are encountered, these soils should either be undercut to expose suitable soils or stabilized in place.

Native soils exposed at or within 12 inches below the slab subgrade level which do not meet low volume change material requirements should be undercut and replaced with suitable low volume change material structural fill to provide for a minimum 2½ -foot thick layer of suitable subgrade. Alternately, the top 12-inches of the subgrade should be chemically stabilized.

Fill Material Types

Fill required to achieve design grade should be classified as structural fill and general fill. Structural fill is material used below, or within 10 feet of structures, pavements or constructed slopes. General fill is material used to achieve grade outside of these areas.

Reuse of On-Site Soil: Based on the soil conditions observed, it is unlikely that the onsite soils will be suitable for reuse as fill. Material properties for on-site and imported materials for use as structural fill are noted in the table below:

Fill Type[1]	USCS Classification	Acceptable Areas for Placement
Low Volume Change (LVC) Material	GM, SC, CL (LL<45 and PI<25) [2]	All locations and elevations, except where free-draining material is required
High Plasticity Cohesive Structural Fill	CH (LL≥ and PI≥30)	Green (non-structural) areas
Drainage Fill [3]	SP, SW, GW	Below floor slabs and mat foundations

1. Structural fill should consist of approved materials that are relatively free of organic matter and debris. A sample of each material type should be submitted to the Geotechnical Engineer for evaluation prior to use on this site.
2. LL=Liquid Limit. PI=Plasticity Index. Fill meeting a PI of 10 to 20 is preferred but may be difficult to find. Utilizing lean clay soils with a liquid limit of less than 45 percent and a plasticity index between 20 and 25 percent is generally accepted in the area, although this will somewhat increase the risk of shrink-swell movement.
3. Well-graded, free-draining granular material. A general gradation should be 100% passing the 1½-inch sieve, about 40 percent passing the No. 10 sieve, and less than 6 percent fines.

Structural Fill Compaction Requirements

Structural fill should meet the following compaction requirements.

Item	Description
Maximum Lift Thickness	■ 8 inches or less in loose thickness when heavy, self-propelled compaction equipment is used ■ 4 to 6 inches in loose thickness when hand-guided equipment (i.e., jumping jack or plate compactor) is used
Minimum Compaction Requirements[1,2,3]	■ ≥95% of maximum density in utility trenches, access roads, and below slabs ■ ≥98% of maximum dry density for the top 1 foot of access road subgrades and for the aggregate surface layer
Water Content Range	Low plasticity cohesive: -1% to +3% of optimum Moderate-to-High plasticity cohesive: +1 to +4% of optimum Granular: Workable moisture levels[4]

1. Maximum density and optimum water content as determined by the standard-energy moisture-density relationship (Proctor test, ASTM D 698).
2. If the granular material placed below grade-supported slabs is a coarse sand or gravel, or of a uniform size, or has a low fines content, compaction comparison to relative density may be more appropriate. In this case, granular materials should be compacted to at least 65% relative density (ASTM D 4253 and D 4254).
3. Consideration can be given to compacting all fill below proposed roadways to 95% during mass grading. Immediately prior to construction, we recommend that the subgrade below exterior roadways be rough-graded and then scarified and recompacted. We recommend this process include scarifying the subgrade to a depth of about 8 inches, moisture conditioning the scarified soil to within the recommended range and compacting the scarified soil to at least 98%. Scarified soils which cannot be recompacted to this degree should be undercut and replaced with stable material.
4. Specifically, moisture levels should be maintained low enough to allow for satisfactory compaction to be achieved without the cohesionless fill material pumping when proofrolled or containing excess water (ponding). Materials not amenable to density testing should be placed and compacted to a stable condition observed by the Geotechnical Engineer or representative.

Utility Trench Backfill

Any soft or unsuitable materials encountered at the bottom of utility trench excavations should be removed and replaced with structural fill or bedding material in accordance with public works specifications for the utility be supported. This recommendation is particularly applicable to utility work requiring grade control and/or in areas where subsequent grade raising could cause settlement in the subgrade supporting the utility. Trench excavation should not be conducted below a downward 1:1 projection from existing foundations without engineering review of shoring requirements and geotechnical observation during construction.

On-site materials are considered suitable for backfill of utility and pipe trenches from 1 foot above the top of the pipe to the final ground surface, provided the material is free of organic matter and deleterious substances.

Trench backfill should be mechanically placed and compacted as discussed earlier in this report. Compaction of initial lifts should be accomplished with hand-operated tampers or other lightweight compactors. Where trenches are placed beneath slabs or footings, the backfill should satisfy the gradation and expansion index requirements of structural fill discussed in this report. Flooding or jetting for placement and compaction of backfill is not recommended.

Utility trenches are a common source of water infiltration and migration. Utility trenches that penetrate beneath the structure should be effectively sealed to restrict water intrusion and flow through the trenches, which could migrate below the structure. Each trench should be provided with an effective trench plug that extends at least 5 feet from the face of the structure exterior. The plug material should consist of cementitious flowable fill or low permeability clay. The trench plug material should be placed to surround the utility line. If clay is used to construct the trench plug, the clay should be placed and compacted in accordance with the water content and compaction recommendations for structural fill provided in this report.

Earthwork Construction Considerations

A geotechnical representative or qualified person should be retained during the construction phase of the project to observe earthwork and to perform necessary tests and observations during subgrade preparation, proofrolling, placement and compaction of structural fill, backfilling of excavations into completed subgrades, and just prior to construction of foundations, slabs, and pavements.

Care should be taken to avoid disturbance of prepared subgrades. Unstable subgrade conditions can develop during general construction operations, particularly if the soils are wetted and/or subjected to repetitive construction traffic. If unstable subgrade conditions develop, stabilization measures will need to be employed. Construction traffic over the completed subgrade should be avoided to the extent practical. If the subgrade becomes frozen, desiccated, saturated, or disturbed, the affected materials should be removed or these materials should be scarified, moisture conditioned, and compacted prior to floor slab construction.

Based on conditions encountered in the borings, significant seepage is generally not expected in excavations for this project (e.g., for footing construction and utility installation). If seepage is encountered in excavations during construction, the contractor is responsible for designing, implementing, and maintaining appropriate dewatering methods to control seepage and facilitate construction. In our experience, dewatering of excavations in clay soils can typically be accomplished using sump pits and pumps. If seepage occurs where sand seams or sand layers are encountered in excavations, a more extensive dewatering system may be required.

As a minimum, excavations should be performed in accordance with OSHA 29 CFR, Part 1926, Subpart P, "Excavations" and its appendices, and in accordance with any applicable local, state, and federal safety regulations. The contractor should be aware that slope height, slope inclination, and excavation depth should in no instance exceed those specified by these safety regulations. Flatter slopes than those dictated by these regulations may be required depending upon the soil conditions encountered and other external factors. These regulations are strictly enforced and if they are not followed, the owner, contractor, and/or earthwork and utility subcontractor could be liable and subject to substantial penalties. Under no circumstances should the information provided in this report be interpreted to mean that Terracon is responsible for construction site safety or the contractor's activities. Construction site safety is the sole responsibility of the contractor who shall also be solely responsible for the means, methods, and sequencing of the construction operations.

Construction Observation and Testing

The earthwork efforts should be observed and tested by a representative of the Geotechnical Engineer. Observation and testing should include documentation of removal of vegetation and topsoil, proofrolling, and mitigation of soft/unstable areas delineated by the proofroll.

Field density tests should be conducted during placement and compaction of engineered fill. The testing frequency should be in accordance with the following table.

Fill Placement Area	Recommended Testing Frequency (ASTM D6938)
Equipment Slabs	A minimum of 1 test per slab per vertical foot of fill placed

Fill Placement Area	Recommended Testing Frequency (ASTM D6938)
Utility Trench Backfill	Each vertical foot of fill placed should be tested at an interval of every 1,000 linear feet of fill placed for load bearing areas, and every 5,000 linear feet for non-load bearing areas

If compaction does not meet specified requirements, the Geotechnical Engineer may require additional tests as considered necessary to check on the uniformity of compaction. No additional layers of fill should be placed until the field density test results indicate that the specified density has been obtained.

In areas of foundation excavations, the bearing subgrade should be evaluated under the direction of the Geotechnical Engineer. In the event unanticipated conditions are encountered, the Geotechnical Engineer should prescribe mitigation options.

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

Gravel-Surfaced Drives and Parking

Roadway designs are provided for the traffic conditions and pavement life conditions as noted in the **Project Description**. A critical aspect of roadway performance is site preparation. Roadway designs noted in this section are contingent upon the site being prepared as recommended in **Earthwork**. Additionally, our recommendations are based on *Chapter 4 Low-Volume Road Design* found in AASHTO 1993.

Native Soil Subgrades

CBR testing of a representative sample of the onsite soils is still ongoing. Based on the observed soil conditions as well as our experience within the project area a subgrade CBR of 3 was used in the design of the pavement sections in this report. A CBR test was run for one location and the results from the test are provided below.

Exploration Location	Maximum Dry Density (pcf)	Optimum Moisture Content (%)	Degree of Compaction (%)	CBR (%)
P-3	103.8	19.8	93	2.9
			96	3.4

Design Parameters

We understand unpaved access roads are planned throughout the site. The unpaved road sections for post-construction use have been developed under the following assumptions:

Aggregate Roadway Design Parameters

Parameter	Design Value	Comments
Traffic Loading	10,000 ESALs[1]	Assumed
Design Life	30 years	Assumed
Design CBR	3.0	Based on laboratory and local experience
US Climate Region	II	Based on AASHTO guidelines
Resilient Modulus	20,000 psi (frozen) 2,000 psi (saturated) 4,500 psi (wet) 6,500 psi (dry)	Based on CBR of 3 percent and AASHTO guidelines
Aggregate Base Elastic Modulus	20,000 psi	Assumed
Allowable Rut Depth	2 inches	Assumed
Design Serviceability Loss	2.0	Assumed
Vehicle Tire Pressure	80 psi	Assumed

1. ESAL = 18 kips Equivalent Single Axle Load

Access Road Sections

As a minimum, we recommend the following options for unpaved access roads:

Typical Unpaved Road Section – Post Construction Traffic		
Base Course Thickness[1]	**Subbase Type**	**Geogrid Stabilization**
12	Compacted Native Soil	No[2]

Typical Unpaved Road Section – Post Construction Traffic		
Base Course Thickness[1]	**Subbase Type**	**Geogrid Stabilization**
8	Compacted Native Soil	Yes
8	Cement Treated Subgrade	No

1. Base materials should meet ARDOT Class 7 Base course material or other alternate gradation as approved by the Geotechnical Engineer. Conditions at the time of construction may affect thickness recommendations.
2. The need for geogrid may be dependent upon conditions at time of construction. If wet conditions exist during field construction, a geogrid consisting of Tensar NX850 or equivalent may be necessary at the base of the pavement section prior to base course placement.

There will be a need for an ongoing maintenance program. Ruts or potholes that develop should be filled with additional aggregate base rather than by re-grading. Also, the unpaved roadway would need to be constructed with adequate drainage to prevent the ponding of water which would contribute to additional ongoing maintenance.

General Comments

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

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

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

Site characteristics as provided are for design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly effect excavation cost. Any parties charged with estimating excavation costs should seek their own site characterization for specific purposes to obtain the specific level of detail necessary for costing. Site safety and cost estimating including excavation support and dewatering requirements/design are the responsibility of others. Construction and site development have the potential to affect adjacent properties. Such impacts can include damages due to vibration, modification of groundwater/surface water flow during construction, foundation movement due to undermining or subsidence from excavation, as well as noise or air quality concerns. Evaluation of these items on nearby properties are commonly associated with contractor means and methods and are not addressed in this report. The owner and contractor should consider a preconstruction/precondition survey of surrounding development. If changes in the nature, design, or location of the project are planned, our conclusions and recommendations shall not be considered valid unless we review the changes and either verify or modify our conclusions in writing.

Attachments

Field Exploration Results

Contents:

Site Location

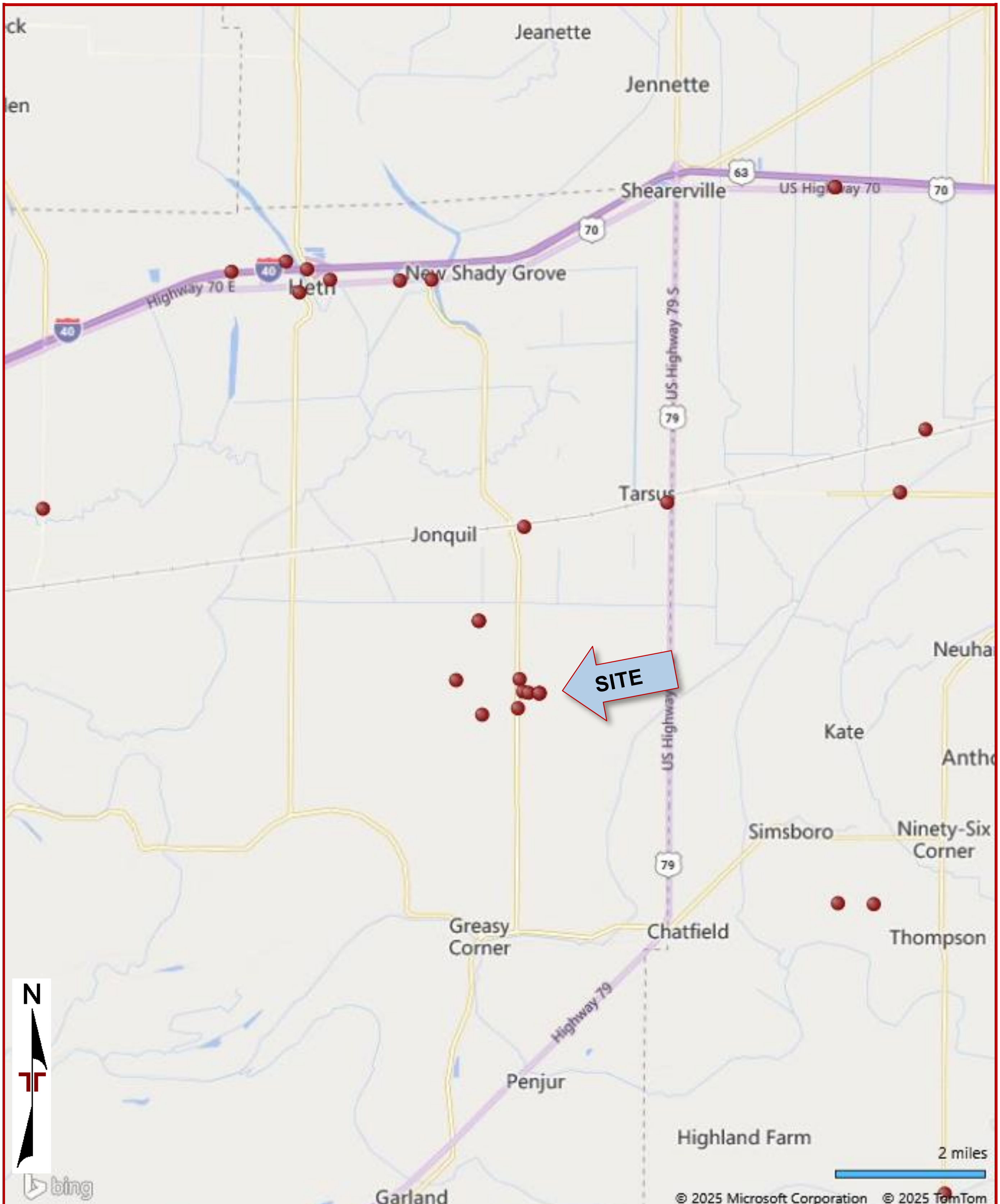


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES   MAP PROVIDED BY MICROSOFT BING MAPS

Exploration Plan

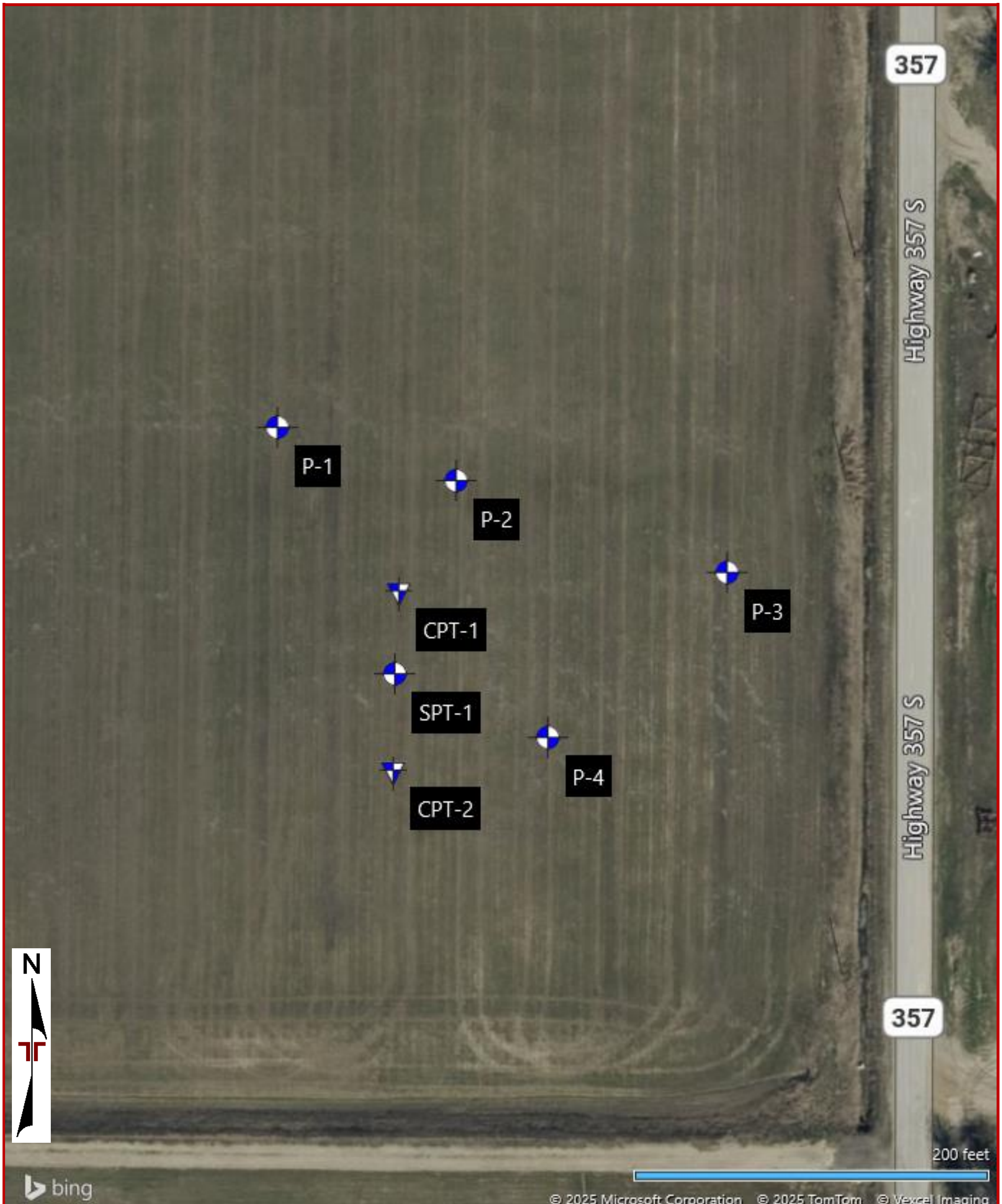


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES MAP PROVIDED BY MICROSOFT BING MAPS

Exploration and Testing Procedures

Field Exploration

Number of Explorations	Type of Exploration	Depth or Description
4	Soil Boring	10
1		100
2	CPT Sounding	56.5 to 73.3 [1]

1. Depths were planned to be 100 feet; however, cone refusal was encountered

Boring Layout and Elevations: Terracon personnel provided the boring layout using handheld GPS equipment (estimated horizontal accuracy of about ±10 feet) and referencing existing site features. Approximate ground surface elevations were estimated using Google Earth. If elevations and a more precise boring layout are desired, we recommend borings be surveyed.

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

The CPT soundings were performed by pushing a 10-square centimeter electric cone penetrometer at an approximate rate of 20 millimeters/second using the hydraulic cylinders of the drilling rig. The cone penetrometer is equipped with electronic load cells to measure tip resistance and sleeve resistance, and a pressure transducer measures the generated ambient pore pressure. Digital data representing the tip resistance, the sleeve penetration, the pore pressure and the CPT sounding inclination are typically measured at 50 mm intervals during penetration using a CPT data acquisition system or logger. The testing and calibration of the Cone Penetrometer Test device was conducted in general conformance with ASTM D 5778.

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

Terracon
25809 I 30
Bryant, AR

General Notes

Sampling	Water Level		Field Tests	
Standard Penetration Test; Split Spoon	▽	Water Initially Encountered	N	Standard Penetration Test Resistance (Blows/Ft.)
	▽	Water Level After a Specified Period of Time	(HP)	Hand Penetrometer
	▼	Water Level After a Specified Period of Time	(T)	Torvane
		Cave In Encountered	(DCP)	Dynamic Cone Penetrometer
			UC	Unconfined Compressive Strength
			(PID)	Photo-Ionization Detector
			(OVA)	Organic Vapor Analyzer

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

Descriptive Soil Classification

Soil classification as noted on the soil boring logs is based Unified Soil Classification System. Where sufficient laboratory data exist to classify the soils consistent with ASTM D2487 "Classification of Soils for Engineering Purposes" this procedure is used. ASTM D2488 "Description and Identification of Soils (Visual-Manual Procedure)" is also used to classify the soils, particularly where insufficient laboratory data exist to classify the soils in accordance with ASTM D2487. In addition to USCS classification, coarse grained soils are classified on the basis of their in-place relative density, and fine-grained soils are classified on the basis of their consistency. See "Strength Terms" table below for details. The ASTM standards noted above are for reference to methodology in general. In some cases, variations to methods are applied as a result of local practice or professional judgment.

Location And Elevation Notes

Exploration point locations as shown on the Exploration Plan and as noted on the soil boring logs in the form of Latitude and Longitude are approximate. See Exploration and Testing Procedures in the report for the methods used to locate the exploration points for this project. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

Strength Terms

Relative Density of Coarse-Grained Soils (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance		Consistency of Fine-Grained Soils (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance		
Relative Density	**Standard Penetration or N-Value (Blows/Ft.)**	**Consistency**	**Unconfined Compressive Strength Qu (tsf)**	**Standard Penetration or N-Value (Blows/Ft.)**
Very Loose	0 - 3	Very Soft	less than 0.25	0 - 1
Loose	4 - 9	Soft	0.25 to 0.50	2 - 4
Medium Dense	10 - 29	Medium Stiff	0.50 to 1.00	5 - 8
Dense	30 - 50	Stiff	1.00 to 2.00	9 - 15
Very Dense	> 50	Very Stiff	2.00 to 4.00	16 - 30
		Hard	> 4.00	> 30

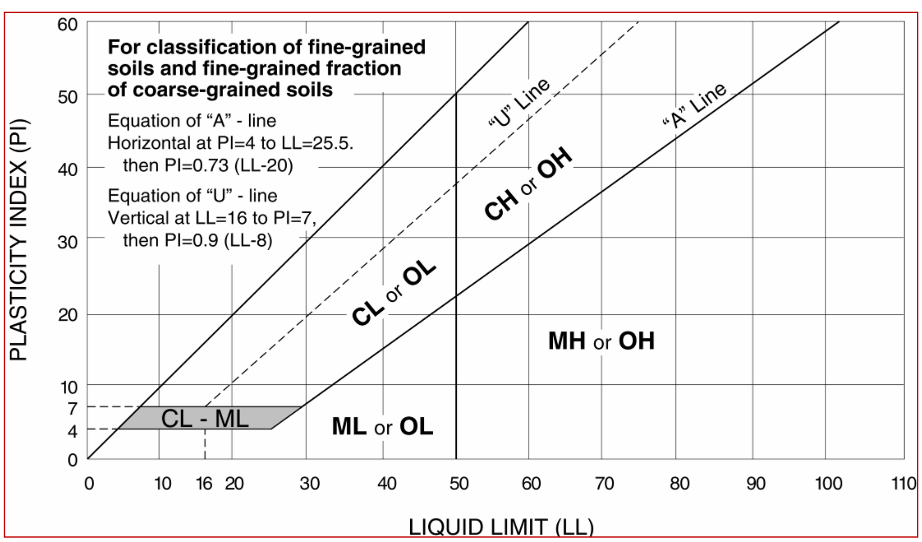
Relevance of Exploration and Laboratory Test Results

Exploration/field results and/or laboratory test data contained within this document are intended for application to the project as described in this document. Use of such exploration/field results and/or laboratory test data should not be used independently of this document.

Unified Soil Classification System

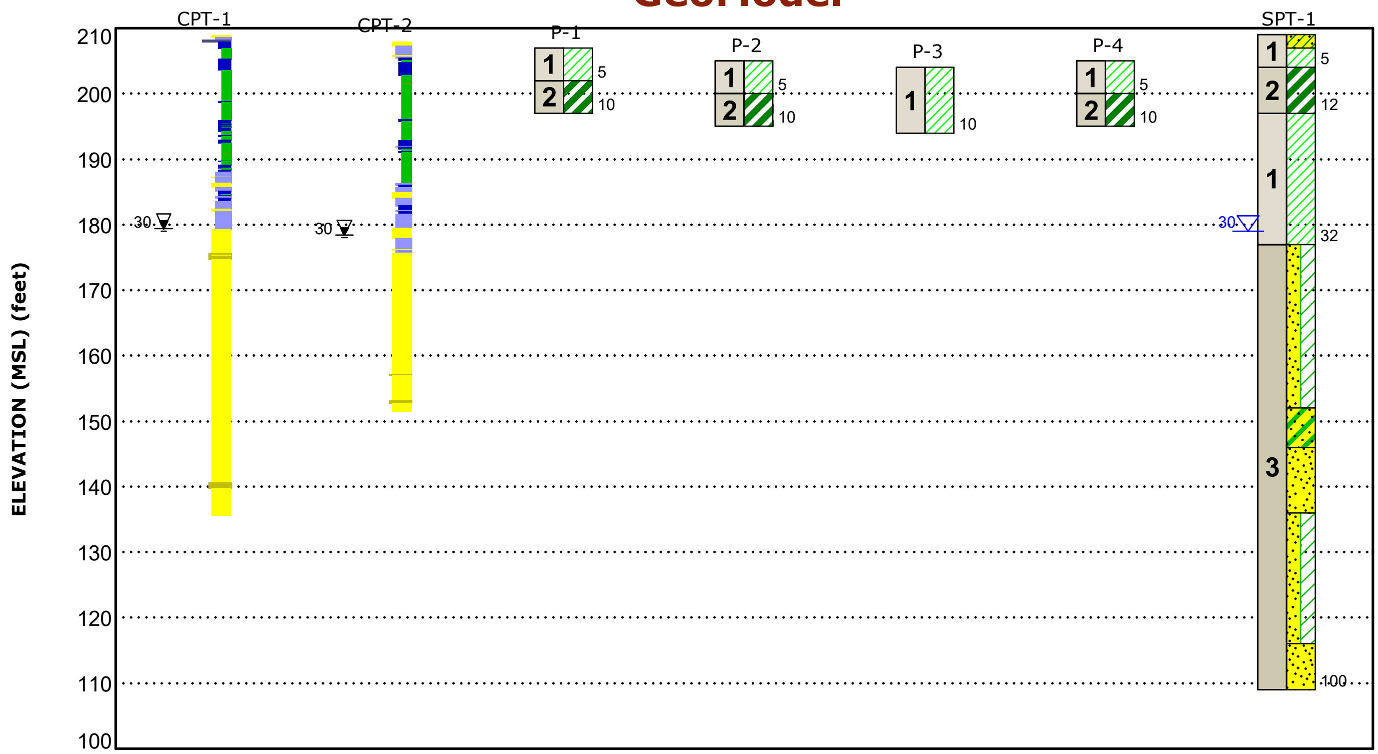
Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]				Soil Classification: Group Symbol	Soil Classification: Group Name [B]
Coarse-Grained Soils: More than 50% retained on No. 200 sieve	**Gravels:** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels:**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

[A] Based on the material passing the 3-inch (75-mm) sieve.
[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.
[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.
[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay.
[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$
[F] If soil contains ≥ 15% sand, add "with sand" to group name.
[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.
[H] If fines are organic, add "with organic fines" to group name.
[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.
[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.
[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.
[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.
[N] PI ≥ 4 and plots on or above "A" line.
[O] PI < 4 or plots below "A" line.
[P] PI plots on or above "A" line.
[Q] PI plots below "A" line.



Terracon
25809 I 30
Bryant, AR

GeoModel



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

Model Layer	Layer Name	General Description
1	**Fine-Grained Soils**	Medium stiff to very stiff lean clay, sandy lean clay
2	**Fat Clay**	Medium stiff to stiff fat clay
3	**Coarse-Grained Soils**	Medium dense to very dense poorly graded sand with clay, clayey sand, poorly graded sand

Legend

- Lean Clay
- Fat Clay
- Sandy Lean Clay
- Poorly-graded Sand with Clay
- Clayey Sand
- Poorly-graded Sand

First Water Observation

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

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

Terracon
25809 I 30
Bryant, AR

Boring Log No. P-1

Location: See Exploration Plan

Latitude: 35.0480° Longitude: -90.4388°

Elevation: 207 (Ft.)

Model Layer	Graphic Log	Depth (Ft.) / Description	Elevation	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	HP (tsf)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
1		**LEAN CLAY (CL)**, brown/gray, medium stiff, trace sand					2-2-3 N=5	1.0	25.5		
							3-3-3 N=6	0.5	28.2		
							3-3-3 N=6	0.5	30.4		
		5.0	202	5							
2		**FAT CLAY (CH)**, brown/gray, stiff					3-4-5 N=9	1.0	40.7		
							2-3-5 N=8	2.25	27.0	52-22-30	
		10.0	197	10							

Boring Terminated at 10 Feet

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

Water Level Observations
Groundwater not encountered

Drill Rig
546

Hammer Type
Automatic

Driller
EB

Notes

Advancement Method
Hollow Stem Augers

Abandonment Method
Boring backfilled with auger cuttings upon completion.

Logged by
JR

Boring Started
07-03-2025

Boring Completed
07-03-2025

Terracon
25809 I 30
Bryant, AR

Boring Log No. P-2

Location: See Exploration Plan

Latitude: 35.0479° Longitude: -90.4385°

Elevation: 205 (Ft.)

Model Layer	Graphic Log	Depth (Ft.) / Material Description	Elevation	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	HP (tsf)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
1		**LEAN CLAY (CL)**, brown/gray, medium stiff									
						X	2-2-3 N=5	0.75	27.5		
						X	2-2-3 N=5	0.5	24.4		
						X	2-3-3 N=6	0.25	28.6		
		5.0	200	5							
2		**FAT CLAY (CH)**, brown/gray, medium stiff				X	3-4-4 N=8	0.5	36.2		
						X	2-2-3 N=5	0.75	35.9		
		10.0	195	10							
		Boring Terminated at 10 Feet									

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

Water Level Observations
Groundwater not encountered

Drill Rig
546

Hammer Type
Automatic

Driller
EB

Notes

Advancement Method
Hollow Stem Augers

Abandonment Method
Boring backfilled with auger cuttings upon completion.

Logged by
JR

Boring Started
07-03-2025

Boring Completed
07-03-2025

Terracon
25809 I 30
Bryant, AR

Boring Log No. P-3

Location: See Exploration Plan

Latitude: 35.0478° Longitude: -90.4380°

Depth (Ft.) Elevation: 204 (Ft.)

Model Layer	Graphic Log	Description	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	HP (tsf)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
1		**LEAN CLAY (CL)**, brown/gray, medium stiff								
					X	1-2-2 N=4		26.3		
					X	2-2-2 N=4		29.7		
					X	2-2-3 N=5	0.75	30.0		
			5		X	3-3-4 N=7	1.5	31.7		
		10.0 / 194	10		X	2-3-4 N=7	0.25	23.4		
		Boring Terminated at 10 Feet								

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

Water Level Observations
Groundwater not encountered

Drill Rig
546

Hammer Type
Automatic

Driller
EB

Notes

Advancement Method
Hollow Stem Augers

Abandonment Method
Boring backfilled with auger cuttings upon completion.

Logged by
JR

Boring Started
07-03-2025

Boring Completed
07-03-2025

Terracon
25809 I 30
Bryant, AR

Boring Log No. P-4

Location: See Exploration Plan

Latitude: 35.0475° Longitude: -90.4383°

Depth (Ft.) Elevation: 205 (Ft.)

Model Layer	Graphic Log	Description	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	HP (tsf)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
1		**LEAN CLAY (CL)**, brown/gray, medium stiff				2-3-3 N=6	0.75	25.2		
						2-3-3 N=6		27.5	30-22-8	
		5.0 / 200				2-3-3 N=6		30.8		
2		**FAT CLAY (CH)**, brown/gray, medium stiff	5			3-4-4 N=8	1.25	43.9		
		10.0 / 195	10			2-3-4 N=7		36.1		

Boring Terminated at 10 Feet

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

Water Level Observations
Groundwater not encountered

Drill Rig
546

Hammer Type
Automatic

Driller
EB

Notes

Advancement Method
Hollow Stem Augers

Abandonment Method
Boring backfilled with auger cuttings upon completion.

Logged by
JR

Boring Started
07-03-2025

Boring Completed
07-03-2025

Terracon
25809 I 30
Bryant, AR

Boring Log No. SPT-1

Location: See Exploration Plan

Latitude: 35.0476° Longitude: -90.4386°

Depth (Ft.) — Elevation: 209 (Ft.)

Model Layer	Depth (Ft.) / Description	Elevation	Sample Depth (Ft.)	Field Test Results	HP (tsf)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
1	**SANDY LEAN CLAY (CL)**, brown/red, medium stiff		0.5-2.0	3-3-3 N=6	2.0	21.5		
	2.0	207						
1	**LEAN CLAY (CL)**, gray/brown, medium stiff, trace silt to 5'		2.0-3.5	3-3-3 N=6	0.25	26.0		
			3.5-5.0	2-2-3 N=5	1.25	22.5	45-21-24	
	5.0	204						
2	**FAT CLAY (CH)**, gray/brown, medium stiff		5.0-6.5	4-4-4 N=8	0.5	36.2		
			8.5-10.0	2-3-4 N=7	0.75	31.7		
	12.0	197						
1	**LEAN CLAY (CL)**, gray/brown, medium stiff to very stiff, trace silt 12'-17'		13.5-15.0	2-3-5 N=8	0.25	26.9		
			18.5-20.0	1-2-2 N=4	0.25	36.6		
			23.5-25.0	3-3-3 N=6		29.7		91.4

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

Notes

Water Level Observations
▽ Groundwater encountered at 30' while drilling

Advancement Method
Hollow Stem Auger 0' - 30'
Mud Rotary Drilling 30' - 100'

Abandonment Method
Boring backfilled with auger cuttings upon completion.

Drill Rig
546

Hammer Type
Automatic

Driller
EB

Logged by
JR

Boring Started
07-03-2025

Boring Completed
07-03-2025

Boring Log No. SPT-1

Location: See Exploration Plan

Latitude: 35.0476° Longitude: -90.4386°

Depth (Ft.) Elevation: 209 (Ft.)

Model Layer	Graphic Log	Description	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	HP (tsf)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
1		**LEAN CLAY (CL)**, gray/brown, medium stiff to very stiff, trace silt 12'-17' *(continued)*								
			30	▽	X	5-7-9 N=16		36.7		70.9
		32.0 — 177								
3		**POORLY GRADED SAND WITH CLAY (SP-SC)**, brown/gray, medium dense to very dense								
			35		X	8-9-12 N=21		17.4		
			40		X	8-10-13 N=23		21.9		
			45		X	12-13-14 N=27		22.5		
			50		X	14-20-21 N=41		19.8		7.6

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

Water Level Observations
▽ Groundwater encountered at 30' while drilling

Drill Rig
546

Hammer Type
Automatic

Driller
EB

Notes

Advancement Method
Hollow Stem Auger 0' - 30'
Mud Rotary Drilling 30' - 100'

Abandonment Method
Boring backfilled with auger cuttings upon completion.

Logged by
JR

Boring Started
07-03-2025

Boring Completed
07-03-2025

Terracon
25809 I 30
Bryant, AR

Boring Log No. SPT-1

Location: See Exploration Plan

Latitude: 35.0476° Longitude: -90.4386°

Depth (Ft.) Elevation: 209 (Ft.)

Model Layer: 3

Depth (Ft.)	Elevation (Ft.)	Material Description
		POORLY GRADED SAND WITH CLAY (SP-SC), brown/gray, medium dense to very dense *(continued)*
57.0	152	**CLAYEY SAND (SC)**, brown/gray, dense
63.0	146	**POORLY GRADED SAND (SP)**, brown/gray, dense to very dense
73.0	136	**POORLY GRADED SAND WITH CLAY (SP-SC)**, brown/gray, dense to very dense

Sample Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	HP (tsf)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
53.5-55		SPT	19-21-31 N=52		19.7		
58.5-60		SPT	12-18-25 N=43		19.0		19.9
63.5-65		SPT	9-19-27 N=46		17.1		
68.5-70		SPT	19-30-35 N=65		14.9		
73.5-75		SPT	20-22-50/3" N=50+		19.1		9.1

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

Water Level Observations
▽ Groundwater encountered at 30' while drilling

Drill Rig
546

Hammer Type
Automatic

Driller
EB

Notes

Advancement Method
Hollow Stem Auger 0' - 30'
Mud Rotary Drilling 30' - 100'

Abandonment Method
Boring backfilled with auger cuttings upon completion.

Logged by
JR

Boring Started
07-03-2025

Boring Completed
07-03-2025

Boring Log No. SPT-1

Location: See Exploration Plan

Latitude: 35.0476° Longitude: -90.4386°

Model Layer	Depth (Ft.) / Description	Elevation: 209 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	HP (tsf)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
3	**POORLY GRADED SAND WITH CLAY (SP-SC)**, brown/gray, dense to very dense *(continued)*				SPT	9-17-23 N=40		19.4		
			80							
					SPT	9-22-27 N=49		21.5		
			85							
					SPT	15-19-23 N=42		21.9		
			90							
	93.0	116								
	POORLY GRADED SAND (SP), brown/gray, dense to very dense				SPT	13-18-22 N=40		17.3		
			95							
					SPT	29-36-44 N=80		16.6		
	100.0	109	100							

Boring Terminated at 100 Feet

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

Water Level Observations
Groundwater encountered at 30' while drilling

Drill Rig
546

Hammer Type
Automatic

Driller
EB

Notes

Advancement Method
Hollow Stem Auger 0' - 30'
Mud Rotary Drilling 30' - 100'

Abandonment Method
Boring backfilled with auger cuttings upon completion.

Logged by
JR

Boring Started
07-03-2025

Boring Completed
07-03-2025

Chalk Bluff O&M Building
Hwy 149 | Heth, AR
Terracon Project No. 35255076

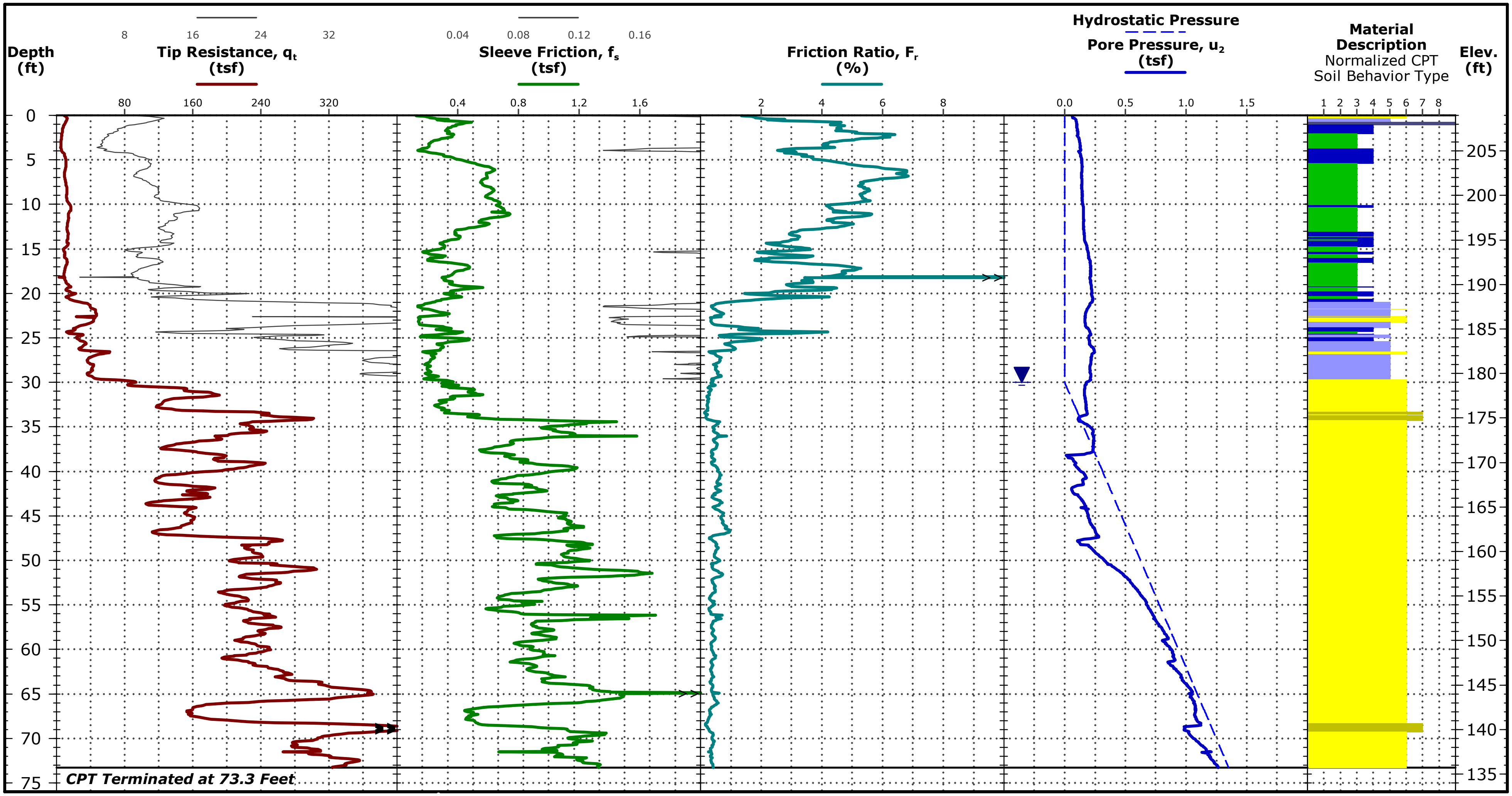
CPT Sounding ID CPT-1

Latitude: 35.047746° Longitude: -90.438618°

Terracon
25809 I 30
Bryant, AR

Elevation: 209 (ft)

CPT Started: 6/24/2025
CPT Completed: 6/24/2025



See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data, if any.

See Supporting Information for explanation of symbols and abbreviations.

Notes

Test Location: See Exploration Plan

CPT Equipment

CPT Rig:

Operator: JMP

CPT sensor calibration reports available upon request

Probe No. 5903 with net area ratio of 0.829

Manufactured by Geotech A.B.- Calibrated 9/13/2024

Tip and sleeve areas of 15 cm^2 and 225 cm^2

Water Level Observation

30 ft estimated water depth

(used in normalizations and correlations)

Normalized Soil Behavior Type
(Robertson 1990)

1 Sensitive, fine grained
2 Organic soils - clay
3 Clay - silty clay to clay
4 Silt mixtures - clayey silt to silty clay
5 Sand mixtures - silty sand to sandy silt
6 Sands - clean sand to silty sand
7 Gravelly sand to dense sand
8 Very stiff sand to clayey sand
9 Very stiff fine grained

Chalk Bluff O&M Building
Hwy 149 | Heth, AR
Terracon Project No. 35255076

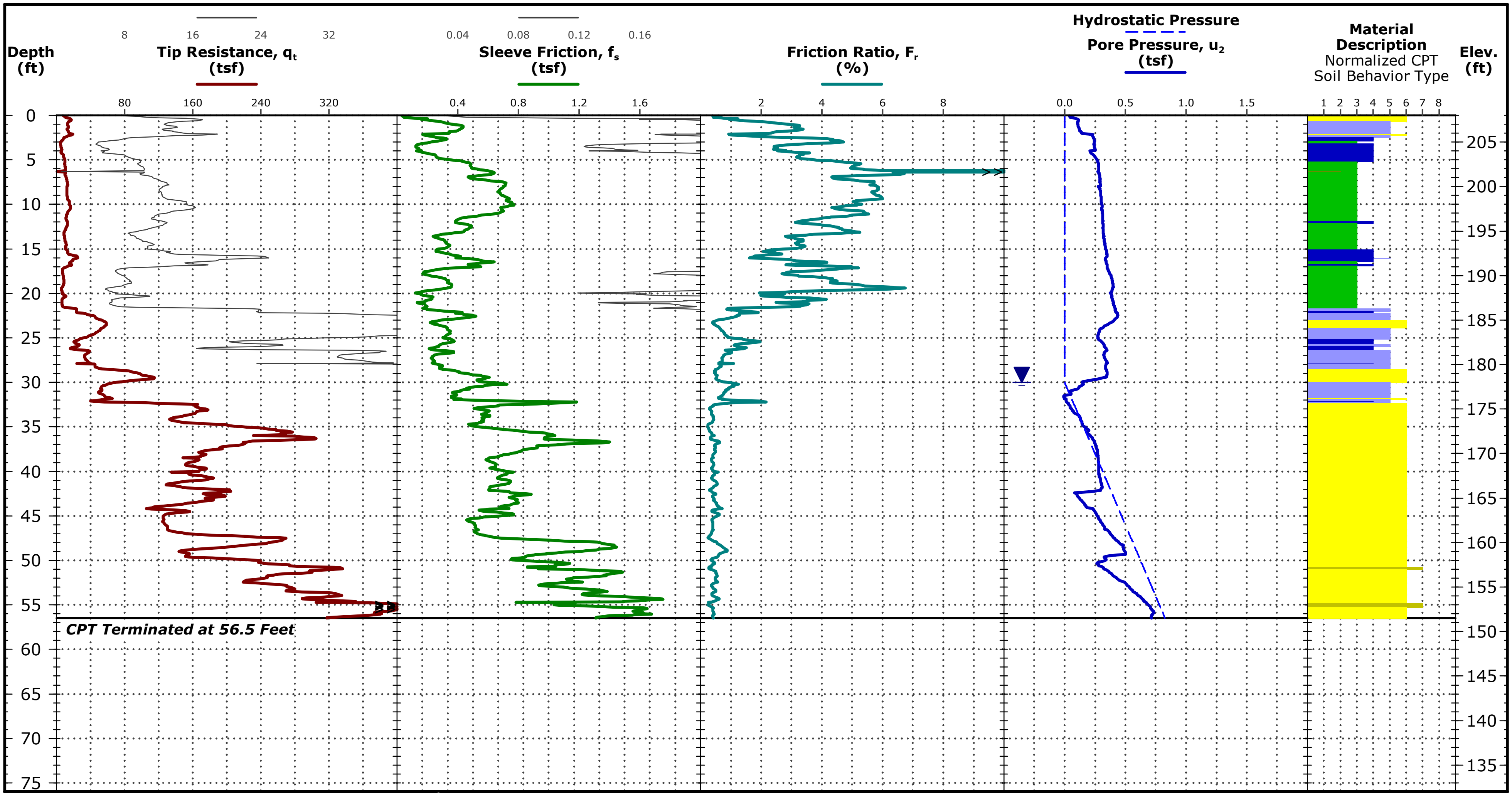
CPT Sounding ID CPT-2

Terracon
25809 I 30
Bryant, AR

Latitude: 35.047469° Longitude: -90.438629°

Elevation: 208 (ft)

CPT Started: 6/24/2025
CPT Completed: 6/24/2025



See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data, if any.

See Supporting Information for explanation of symbols and abbreviations.

Notes

Test Location: See Exploration Plan

CPT Equipment

CPT Rig:

Operator: JMP

CPT sensor calibration reports available upon request

Probe No. 5903 with net area ratio of 0.829

Manufactured by Geotech A.B.- Calibrated 9/13/2024

Tip and sleeve areas of 15 cm^2 and 225 cm^2

Water Level Observation

30 ft estimated water depth

(used in normalizations and correlations)

Normalized Soil Behavior Type
(Robertson 1990)

1 Sensitive, fine grained
2 Organic soils - clay
3 Clay - silty clay to clay
4 Silt mixtures - clayey silt to silty clay
5 Sand mixtures - silty sand to sandy silt
6 Sands - clean sand to silty sand
7 Gravelly sand to dense sand
8 Very stiff sand to clayey sand
9 Very stiff fine grained

US Survey Feet

0 100 200 300 400 500

Legend

- Approximate MASW Line Location
- Approximate Soil Boring Locations
- Approximate CPT Locations

Notes

1) The MASW line performed by Terracon on June 20, 2025 is shown above in YELLOW. Several geophone locations were collected using Google Earth.

2) Aerial imagery provided by Google Earth Pro.

PROJECT MANAGER: SAS	PROJECT NUMBER: 35255076
DRAWN BY: AGW	DRAWING SCALE: AS SHOWN
CHECKED BY: NBR	FILE NAME: E1-Loc.srf
APPROVED BY: CH	DATE DRAWN: 7/24/2025

Terracon

25809 I-30
Bryant, AR 72022

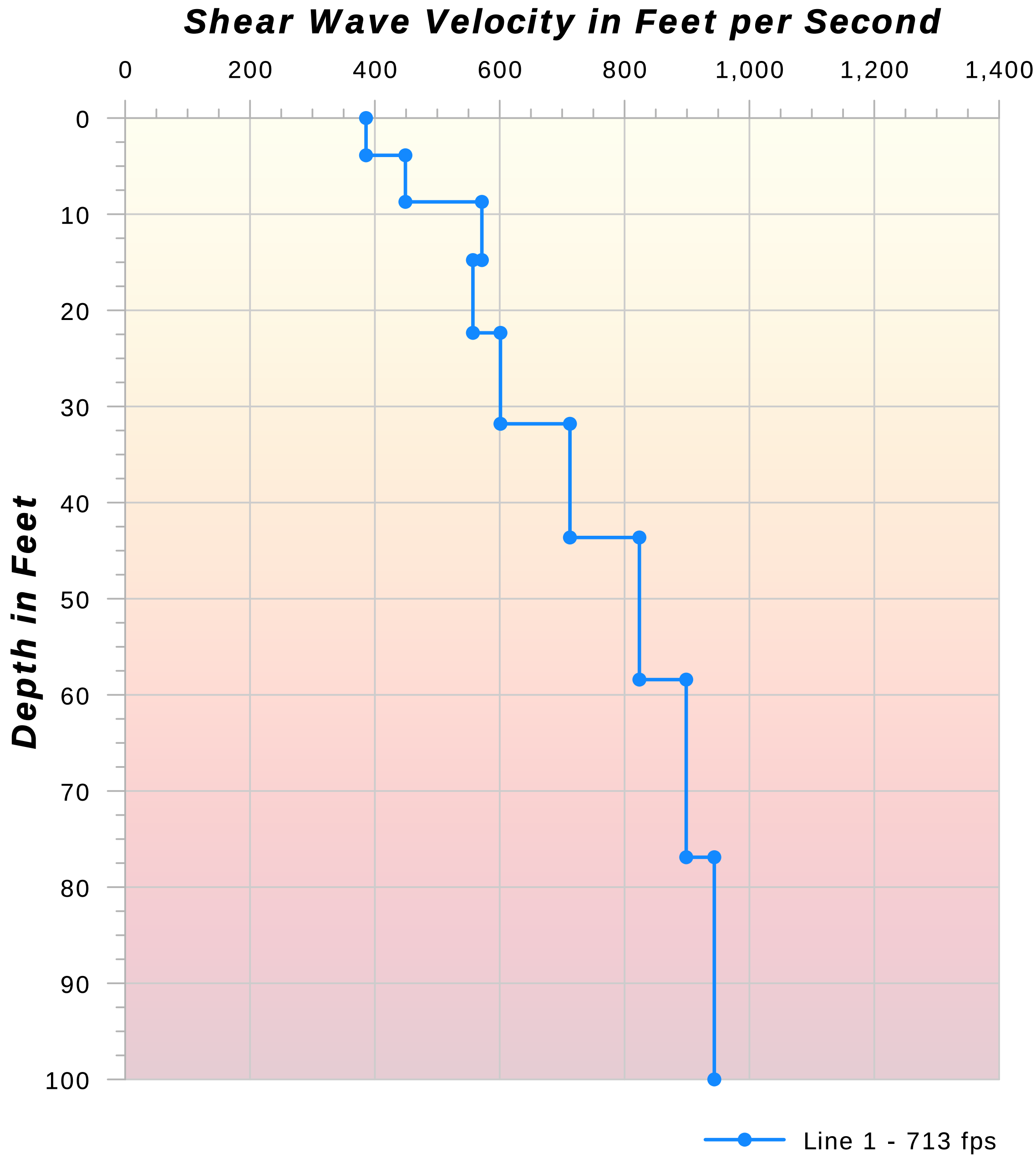
Geophysical Exploration Plan

Chalk Bluff O&M Building
Heth, Arkansas

EXHIBIT

1

Vs100' Model
Chalk Bluff O&M Building



Notes:

1) Seismic testing was conducted by Terracon on June 20, 2025.

2) Shear wave velocity testing and calculations were conducted in general accordance with ASCE 7-16 and IBC 2018.

PROJECT MANAGER: SAS	PROJECT NUMBER: 35255076	Terracon	**Site Classification Data**	EXHIBIT
DRAWN BY: AGW	PROJECT TASK: 1	25809 I-30 Bryant, AR 72022	Chalk Bluff O&M Building Heth, Arkansas	2
CHECKED BY: NBR	FILE NAME: Vs100.gpj			
APPROVED BY: CH	DATE: 6/30/2025			

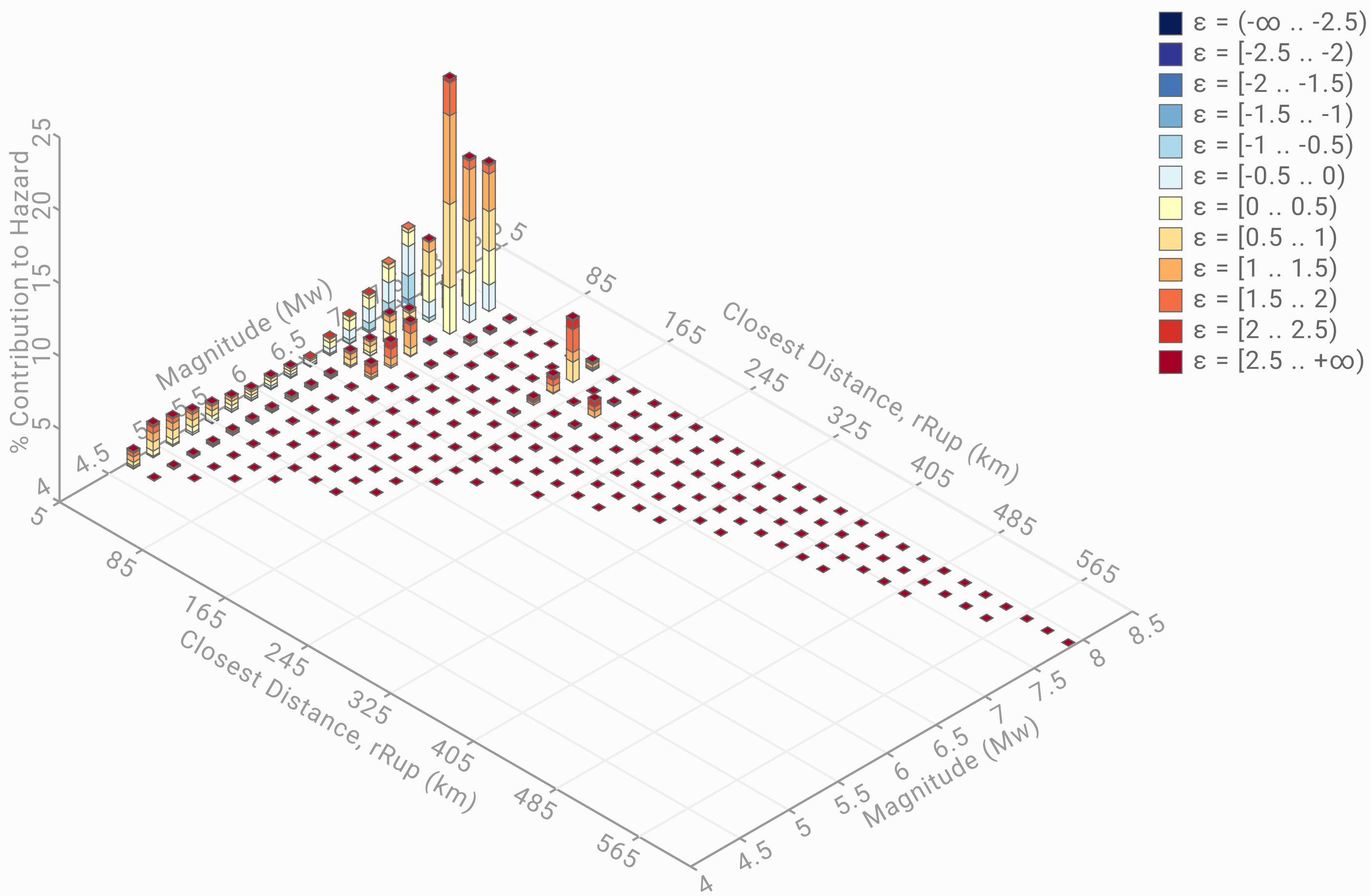
Seismic Considerations Attachments

Contents:

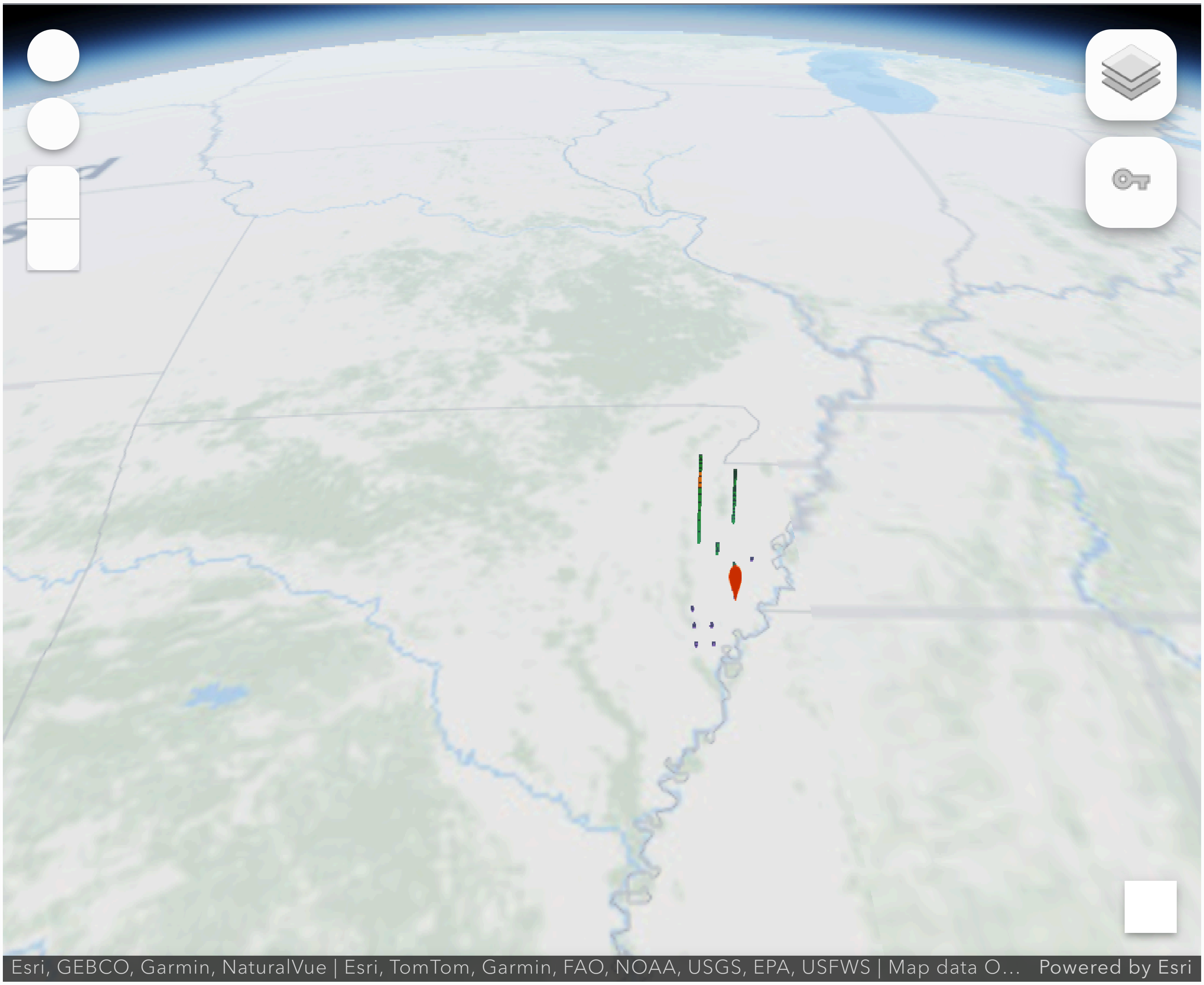
USGS Disaggregation Reports
Kimley Horn Slope Exhibit
Liquefaction Analysis Results

Disaggregation Report

Disaggregation



Geographical Disaggregation



Parameter Summary

Model: NSHM Conterminous U.S. 2018

Latitude: 35.0476 °

Longitude: -90.4386 °

Vs30: 217 m/s

Intensity Measure Type: PGA

Return Period: 2475 (2% in 50)

Component: Total

Disaggregation Summary: Total

Disaggregation targets

Return period : 2475 yrs

Exceedance rate : 4.040e-4 yr^{-1}

PGA ground motion : 5.820e-1 g

Recovered targets

Return period : 2465.7454 yrs

Exceedance rate : 4.056e-4 yr^{-1}

Totals

Binned : 100 %

Residual : 0 %

Trace : 0.88 %

Mean (over all sources)

m : 7.21

r : 45.96 km

ε_0 : 0.72 σ

Mode (largest m-r bin)

m : 7.54

r : 50.72 km

ε_0 : 0.93 σ

Contribution : 17.44 %

Mode (largest m-r-ε_0 bin)

m : 7.54

r : 50.58 km

ε_0 : 1.21 σ

Contribution : 6.08 %

Discretization

r : min = 0.0, max = 1000.0, Δ = 20.0 km

m : min = 4.4, max = 9.4, Δ = 0.2

ε : min = -3.0, max = 3.0, Δ = 0.5 σ

Epsilon keys

ε0 : [-∞ .. -2.5)

ε1 : [-2.5 .. -2.0)

ε2 : [-2.0 .. -1.5)

ε3 : [-1.5 .. -1.0)

ε4 : [-1.0 .. -0.5)

ε5 : [-0.5 .. 0.0)

ε6 : [0.0 .. 0.5)

ε7 : [0.5 .. 1.0)

ε8 : [1.0 .. 1.5)

ε9 : [1.5 .. 2.0)

ε10 : [2.0 .. 2.5)

ε11 : [2.5 .. +∞]

Disaggregation Contributions: Total

Source Set	↳ Source	Type	r	m	ε_0	lon	lat	az	%
Marianna		Zone							14.87
	PointSourceFixedStrike: -90.600, 34.900		6.07	7.19	-0.59	90.600°W	34.900°N	221.91	1.49
	PointSourceFixedStrike: -90.700, 34.900		9.21	7.22	-0.37	90.700°W	34.900°N	235.50	1.25
	PointSourceFixedStrike: -90.700, 34.800		10.03	7.27	-0.35	90.700°W	34.800°N	220.95	1.1
	PointSourceFixedStrike: -90.600, 34.800		12.32	7.23	-0.20	90.600°W	34.800°N	208.17	1.09
	PointSourceFixedStrike: -90.700, 35.000		14.23	7.20	-0.07	90.700°W	35.000°N	257.54	1.03
New Madrid - USGS (center, all) : R1-500-yr		FaultCluster							8.45
	New Madrid - USGS (center, all) : R1-500-yr		58.80	7.60	0.90	90.614°W	35.419°N	338.96	8.45
USGS Extended Margin [2] (fixed) (opt)		Grid							7.5
	PointSourceFinite: -90.439, 35.115		8.69	5.37	0.63	90.439°W	35.115°N	0.00	1.86
	PointSourceFinite: -90.439, 35.160		12.66	5.54	0.94	90.439°W	35.160°N	0.00	1.43
	PointSourceFinite: -90.439, 35.070		5.55	5.27	0.25	90.439°W	35.070°N	0.00	1.36
	PointSourceFinite: -90.439, 35.205		16.74	5.74	1.16	90.439°W	35.205°N	0.00	1.01
SSCn Mesozoic [6] (fixed) (opt)		Grid							7.45
	PointSourceFinite: -90.439, 35.115		8.70	5.37	0.63	90.439°W	35.115°N	0.00	1.86
	PointSourceFinite: -90.439, 35.160		12.67	5.53	0.95	90.439°W	35.160°N	0.00	1.43
	PointSourceFinite: -90.439, 35.070		5.55	5.27	0.25	90.439°W	35.070°N	0.00	1.36
	PointSourceFinite: -90.439, 35.205		16.78	5.72	1.17	90.439°W	35.205°N	0.00	1
New Madrid - USGS (center, all) : R2-750-yr		FaultCluster							5.63
	New Madrid - USGS (center, all) : R2-750-yr		58.80	7.60	0.90	90.614°W	35.419°N	338.96	5.63
Eastern Rift Margin (south, Crittenden Co)		Zone							5.02
	PointSourceFixedStrike: -90.400, 35.200		9.33	7.17	-0.37	90.400°W	35.200°N	11.69	1.26
	PointSourceFixedStrike: -90.300, 35.300		11.22	7.23	-0.26	90.300°W	35.300°N	24.13	1.08
New Madrid - USGS (center)		Fault							4.11
	New Madrid - USGS (center)		45.38	7.60	0.81	90.614°W	35.419°N	338.96	4.11
Eastern Rift Margin (south, River Picks)		Zone							2.94
New Madrid - USGS (center, center-south) : R2-1500-yr		FaultCluster							2.78
	New Madrid - USGS (center, center-south) : R2-1500-yr		55.91	7.60	0.88	90.614°W	35.419°N	338.96	2.78
New Madrid - SSCn (BA-BL : RFT-S : NMN-S) : R2-270-yr		FaultCluster							2.69
	New Madrid - SSCn (BA-BL : RFT-S : NMN-S) : R2-270-yr		77.91	7.66	1.07	90.374°W	35.555°N	5.94	2.69
New Madrid - SSCn (BA-BL : RFT-S : NMN-S) : R3-417-yr		FaultCluster							2.22
	New Madrid - SSCn (BA-BL : RFT-S : NMN-S) : R3-417-yr		77.91	7.66	1.07	90.374°W	35.555°N	5.94	2.22
New Madrid - SSCn (BA-BL : RFT-S : NMN-S) : R1-167-yr		FaultCluster							1.81
	New Madrid - SSCn (BA-BL : RFT-S : NMN-S) : R1-167-yr		77.91	7.66	1.07	90.374°W	35.555°N	5.94	1.81
New Madrid - SSCn (BA-BFZ : RFT-S : NMN-S) : R2-270-yr		FaultCluster							1.79
	New Madrid - SSCn (BA-BFZ : RFT-S : NMN-S) : R2-270-yr		77.91	7.66	1.07	90.374°W	35.555°N	5.94	1.79
New Madrid - USGS (mid-east, all) : R1-500-yr		FaultCluster							1.78
	New Madrid - USGS (mid-east, all) : R1-500-yr		44.48	7.58	0.65	90.507°W	35.346°N	349.41	1.78
New Madrid - SSCn (BA-BFZ : RFT-S : NMN-S) : R3-417-yr		FaultCluster							1.48
	New Madrid - SSCn (BA-BFZ : RFT-S : NMN-S) : R3-417-yr		77.91	7.66	1.07	90.374°W	35.555°N	5.94	1.48
New Madrid - USGS (east, all) : R1-500-yr		FaultCluster							1.35
	New Madrid - USGS (east, all) : R1-500-yr		31.73	7.55	0.33	90.415°W	35.260°N	5.18	1.35
New Madrid - SSCn (BA-BFZ : RFT-S : NMN-S) : R1-167-yr		FaultCluster							1.2
	New Madrid - SSCn (BA-BFZ : RFT-S : NMN-S) : R1-167-yr		77.91	7.66	1.07	90.374°W	35.555°N	5.94	1.2
New Madrid - USGS (mid-east, all) : R2-750-yr		FaultCluster							1.19
	New Madrid - USGS (mid-east, all) : R2-750-yr		44.48	7.58	0.65	90.507°W	35.346°N	349.41	1.19
USGS Extended Margin [2] (adaptive) (opt)		Grid							1.19
SSCn Mesozoic [6] (adaptive) (opt)		Grid							1.18
New Madrid - SSCn (BA-BL : RFT-L : NMN-S) : R2-270-yr		FaultCluster							1.17
	New Madrid - SSCn (BA-BL : RFT-L : NMN-S) : R2-270-yr		78.25	7.66	1.08	90.374°W	35.555°N	5.94	1.17
New Madrid - SSCn (BA-BL : RFT-S : NMN-L) : R2-270-yr		FaultCluster							1.15
	New Madrid - SSCn (BA-BL : RFT-S : NMN-L) : R2-270-yr		77.91	7.66	1.07	90.374°W	35.555°N	5.94	1.15
New Madrid - SSCn (BA-BL : RFT-S : NMN-S) : R4-714-yr		FaultCluster							1.02
	New Madrid - SSCn (BA-BL : RFT-S : NMN-S) : R4-714-yr		77.91	7.66	1.07	90.374°W	35.555°N	5.94	1.02

Application Metadata

Application: Disaggregation
URL: https://earthquake.usgs.gov/nshmp/hazard/disagg

Repository: nshmp-apps
Version: 20.0.1
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-apps

Repository : nshmp-haz
Version: 2.6.11
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-haz

Repository : nshmp-lib
Version: 1.7.7
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-lib

Repository : nshm-conus
Version: 5.2.4
URL: https://code.usgs.gov/ghsc/nshmp/nshms/nshm-conus.git

July 17, 2025, 08:12 AM

Kimley»Horn

CHALK BLUFF SOLAR

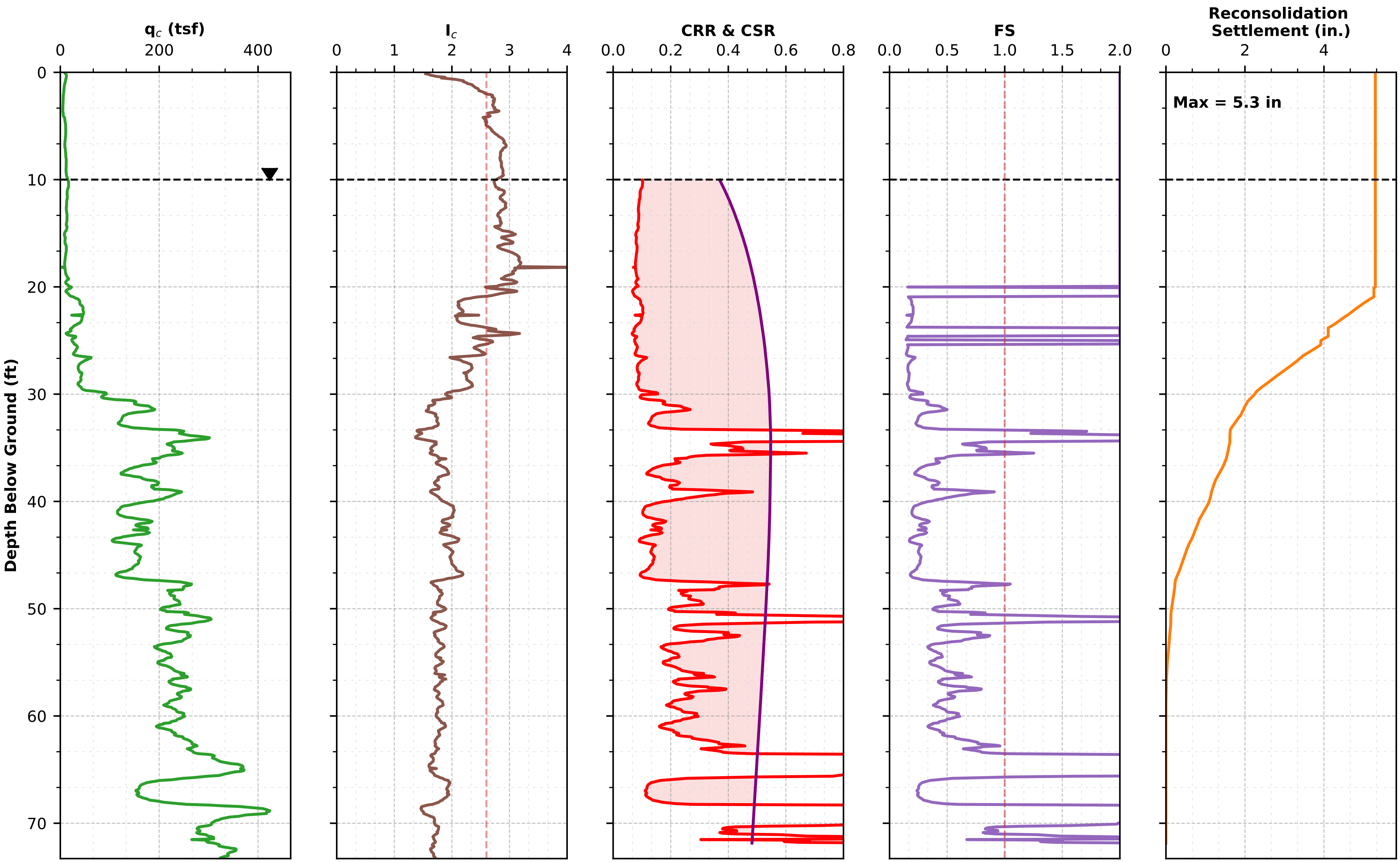
Slope Exhibit for Liquifaction Study

February 29, 2024

Chalk Bluff O&M Building
Highway 149 | Heth, Arkansas
Terracon Project No. 35255076

25809 I-30
Bryant, Arkansas 75022

Multiple Scenario Liquefaction Hazard Analysis
CPT-1 (2475 yr Return Period, GWT at 10 ft)



Notes
1. Calculations follow Idriss & Boulanger (2008)
2. I_c = 2.6

Seismic Parameters
$V_{s(30)}$ = 217.0m/s
PGA = 0.58g
Magnitudes = 4.7 to 7.9

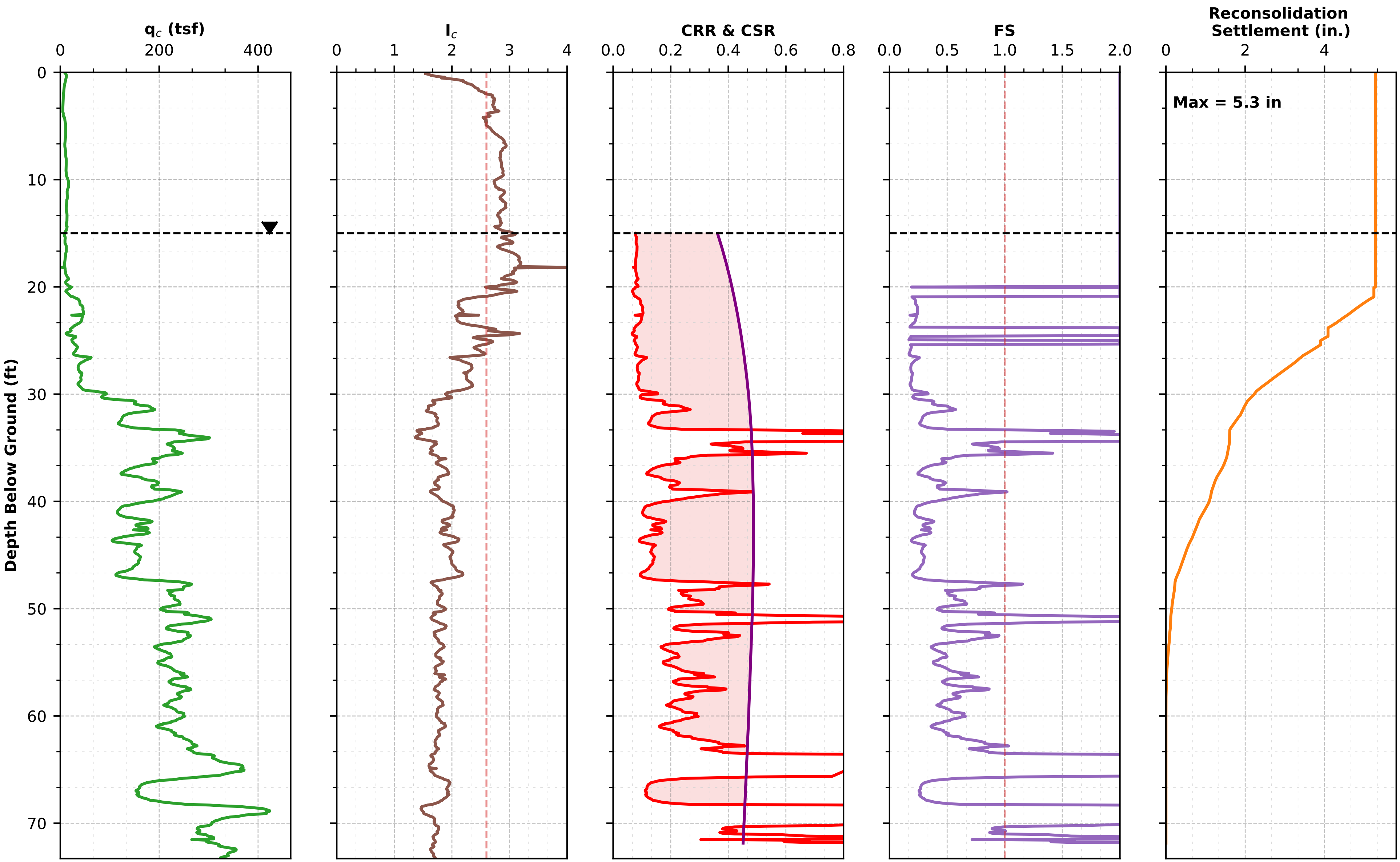
Site Location
Latitude: 35.0476° N
Longitude -90.4386° W

Information
Version: PLHA_CPT_EXCrev11.1
Path: C:\Users\naarens\Liquefaction - Chalk Bluff
User: Nic Arens | Date: July 16, 2025

Chalk Bluff O&M Building
Highway 149 | Heth, Arkansas
Terracon Project No. 35255076

25809 I-30
Bryant, Arkansas 75022

Multiple Scenario Liquefaction Hazard Analysis CPT-1 (2475 yr Return Period, GWT at 15 ft)



Notes
1. Calculations follow Idriss & Boulanger (2008)
2. I_c = 2.6

Seismic Parameters
$V_{s(30)}$ = 217.0m/s
PGA = 0.58g
Magnitudes = 4.7 to 7.9

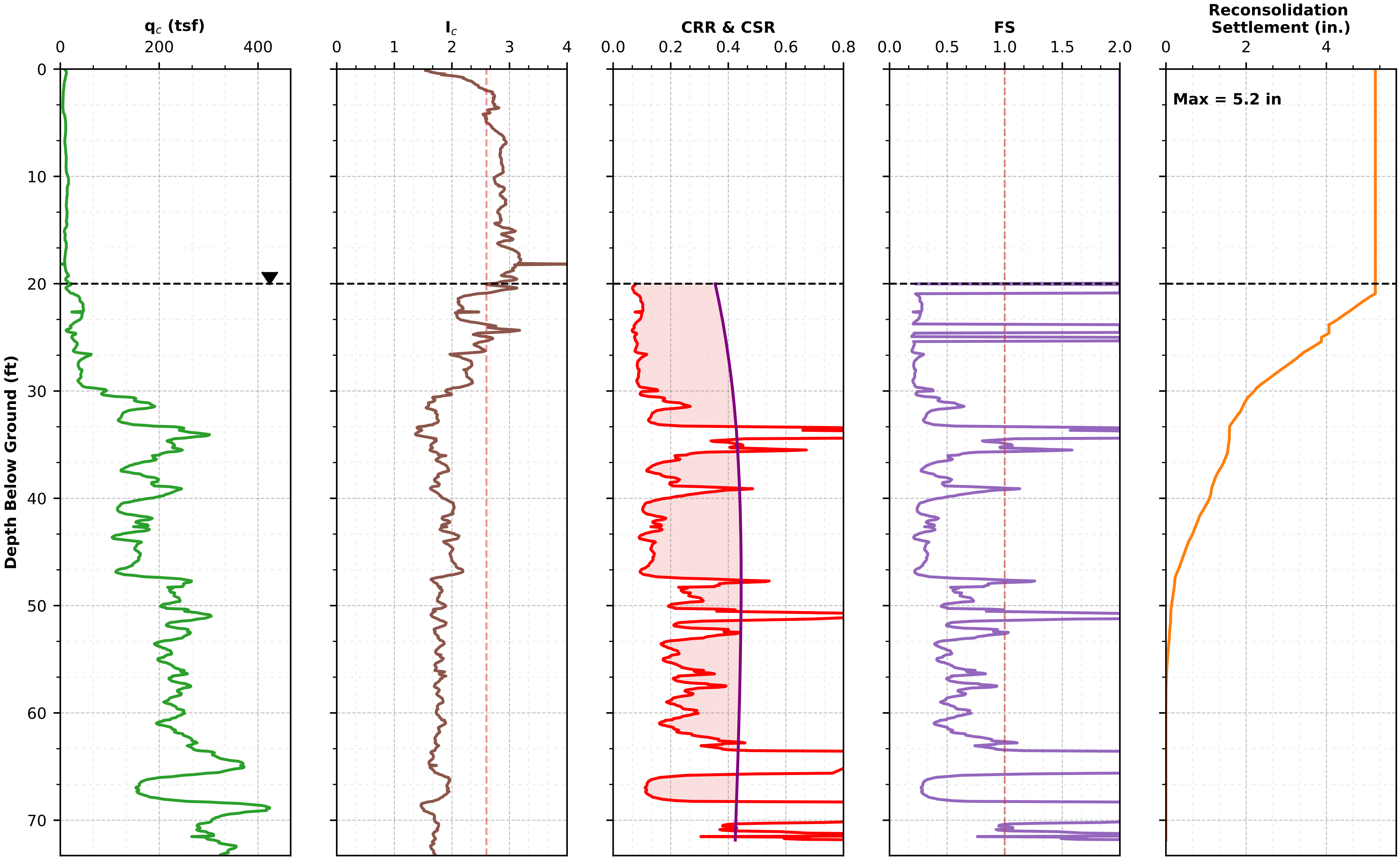
Site Location
Latitude: 35.0476° N
Longitude -90.4386° W

Information
Version: PLHA_CPT_EXCrev11.1
Path: C:\Users\naarens\Liquefaction - Chalk Bluff
User: Nic Arens | Date: July 16, 2025

Chalk Bluff O&M Building
Highway 149 | Heth, Arkansas
Terracon Project No. 35255076

25809 I-30
Bryant, Arkansas 75022

Multiple Scenario Liquefaction Hazard Analysis
CPT-1 (2475 yr Return Period, GWT at 20 ft)



Notes
1. Calculations follow Idriss & Boulanger (2008)
2. I_c = 2.6

Seismic Parameters
$V_{s(30)}$ = 217.0m/s
PGA = 0.58g
Magnitudes = 4.7 to 7.9

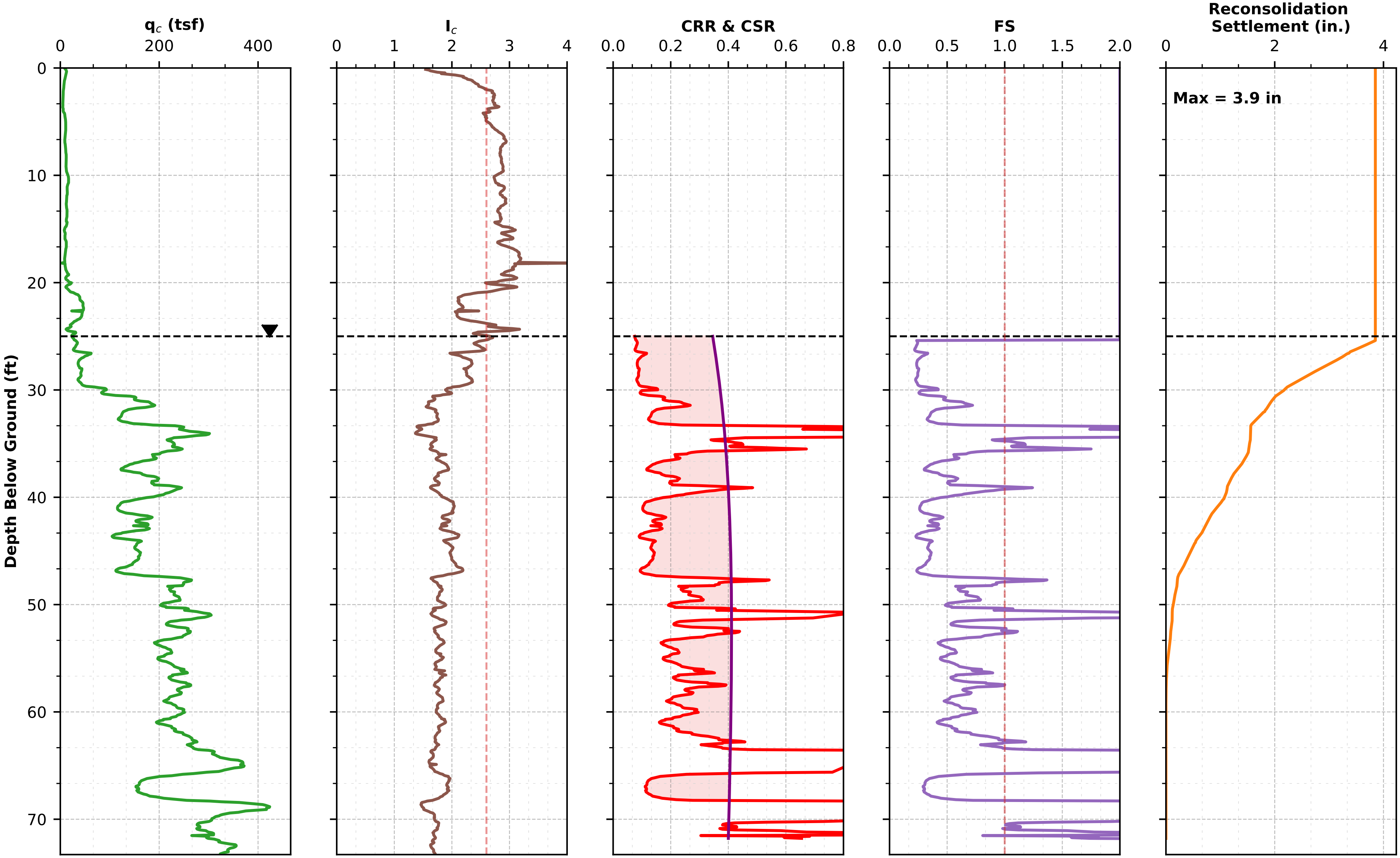
Site Location
Latitude: 35.0476° N
Longitude -90.4386° W

Information
Version: PLHA_CPT_EXCrev11.1
Path: C:\Users\naarens\Liquefaction - Chalk Bluff
User: Nic Arens | Date: July 16, 2025

Chalk Bluff O&M Building
Highway 149 | Heth, Arkansas
Terracon Project No. 35255076

Terracon
Explore with us
25809 I-30
Bryant, Arkansas 75022

Multiple Scenario Liquefaction Hazard Analysis
CPT-1 (2475 yr Return Period, GWT at 25 ft)



Notes
1. Calculations follow Idriss & Boulanger (2008)
2. I_c = 2.6

Seismic Parameters
$V_{s(30)}$ = 217.0m/s
PGA = 0.58g
Magnitudes = 4.7 to 7.9

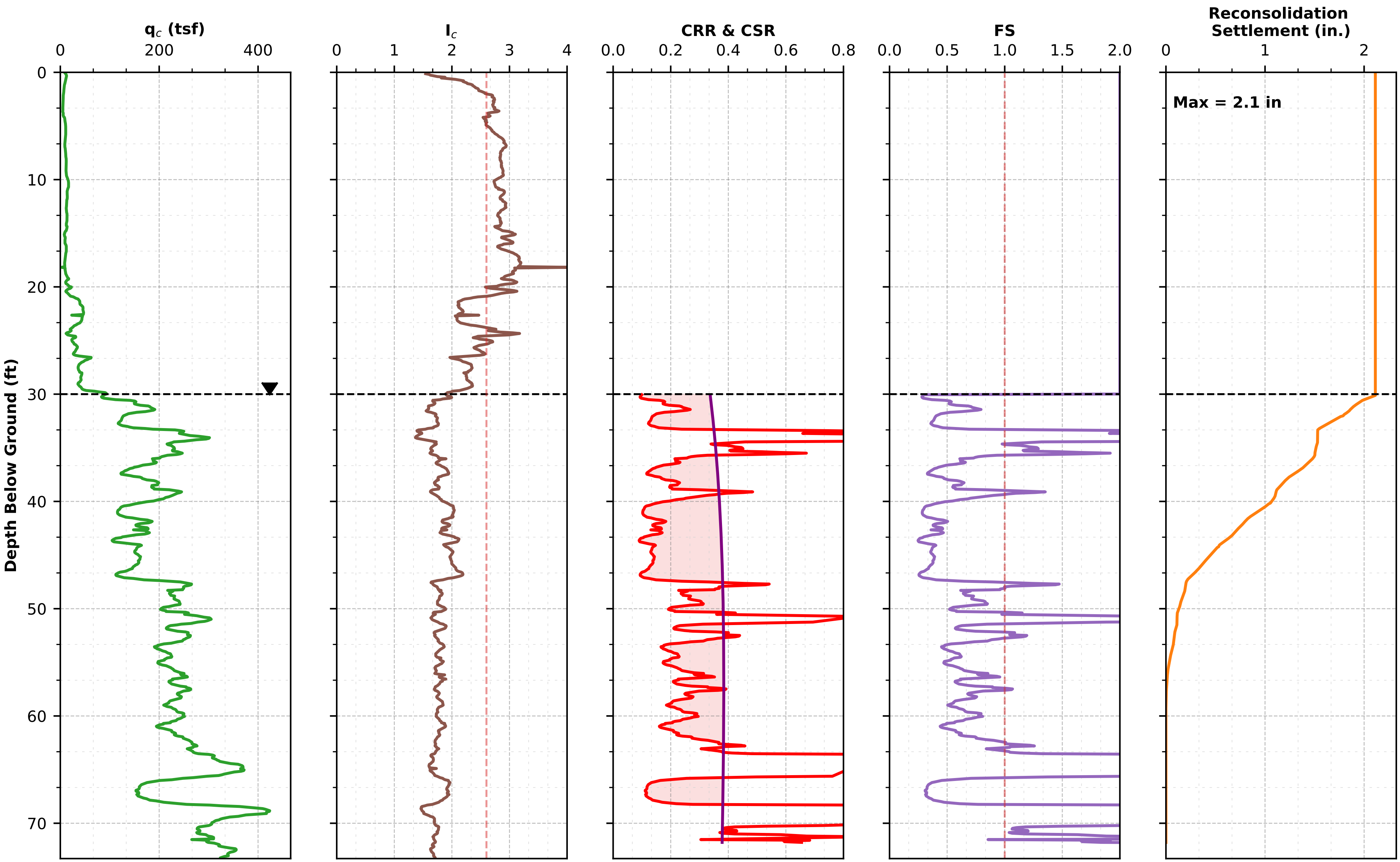
Site Location
Latitude: 35.0476° N
Longitude -90.4386° W

Information
Version: PLHA_CPT_EXCrev11.1
Path: C:\Users\naarens\Liquefaction - Chalk Bluff
User: Nic Arens | Date: July 16, 2025

Chalk Bluff O&M Building
Highway 149 | Heth, Arkansas
Terracon Project No. 35255076

25809 I-30
Bryant, Arkansas 75022

Multiple Scenario Liquefaction Hazard Analysis
CPT-1 (2475 yr Return Period, GWT at 30 ft)



Notes
1. Calculations follow Idriss & Boulanger (2008)
2. I_c = 2.6

Seismic Parameters
$V_{s(30)}$ = 217.0m/s
PGA = 0.58g
Magnitudes = 4.7 to 7.9

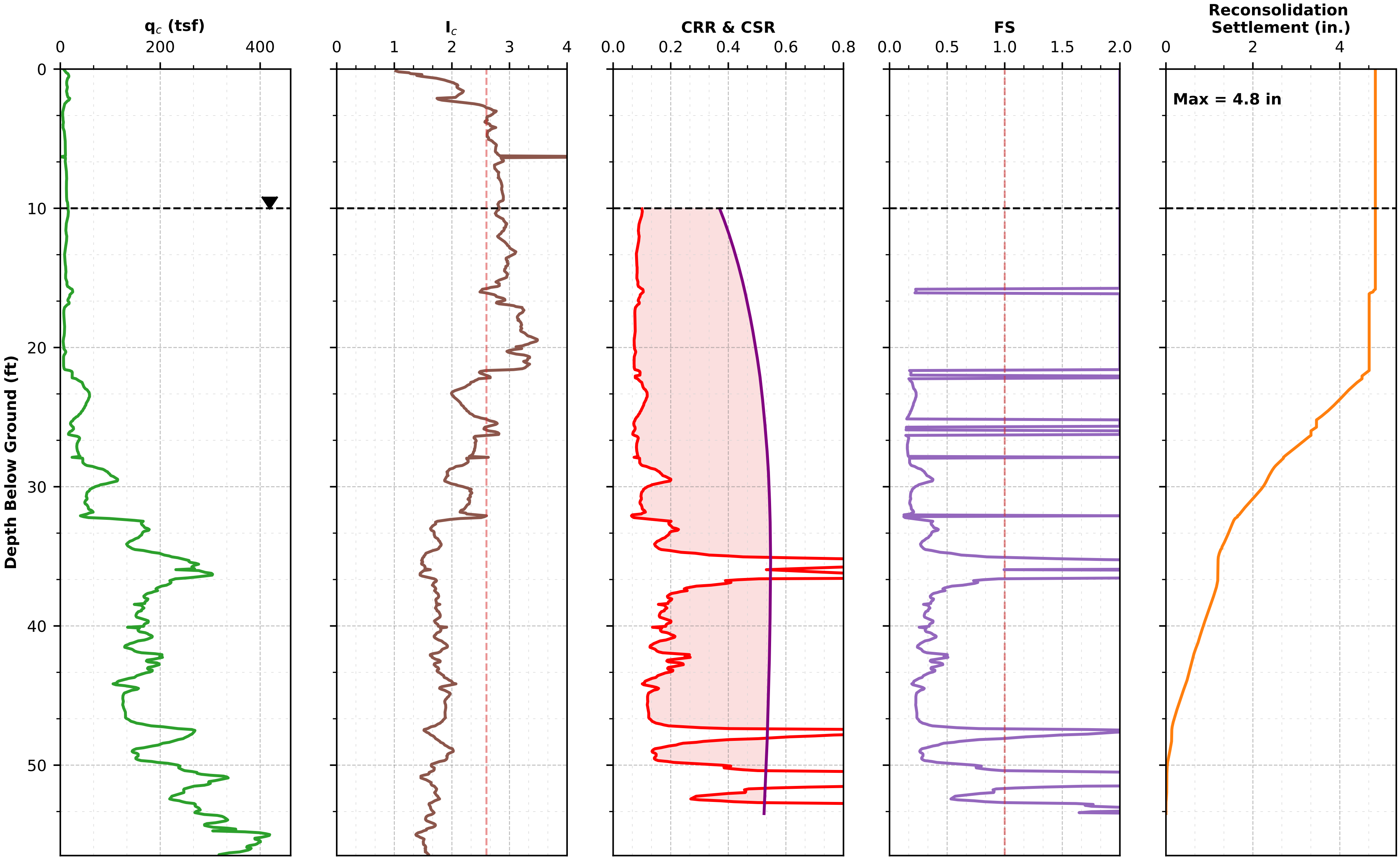
Site Location
Latitude: 35.0476° N
Longitude -90.4386° W

Information
Version: PLHA_CPT_EXCrev11.1
Path: C:\Users\naarens\Liquefaction - Chalk Bluff
User: Nic Arens | Date: July 16, 2025

Chalk Bluff O&M Building
Highway 149 | Heth, Arkansas
Terracon Project No. 35255076

25809 I-30
Bryant, Arkansas 75022

Multiple Scenario Liquefaction Hazard Analysis
CPT-2 (2475 yr Return Period, GWT at 10 ft)



Notes
1. Calculations follow Idriss & Boulanger (2008)
2. I_c = 2.6

Seismic Parameters
$V_{s(30)}$ = 217.0m/s
PGA = 0.58g
Magnitudes = 4.7 to 7.9

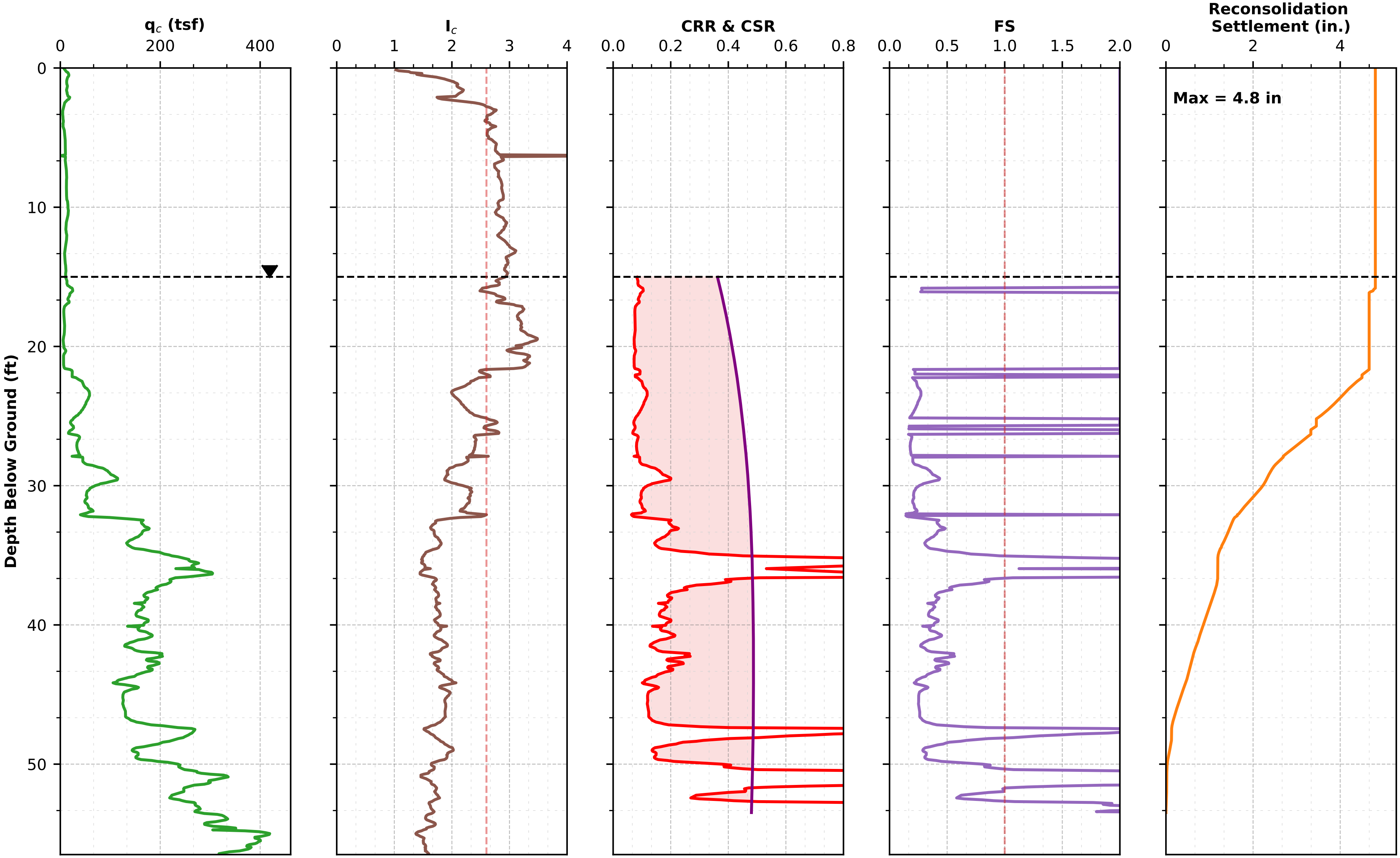
Site Location
Latitude: 35.0476° N
Longitude -90.4386° W

Information
Version: PLHA_CPT_EXCrev11.1
Path: C:\Users\naarens\Liquefaction - Chalk Bluff
User: Nic Arens | Date: July 16, 2025

Chalk Bluff O&M Building
Highway 149 | Heth, Arkansas
Terracon Project No. 35255076

25809 I-30
Bryant, Arkansas 75022

Multiple Scenario Liquefaction Hazard Analysis
CPT-2 (2475 yr Return Period, GWT at 15 ft)



Notes
1. Calculations follow Idriss & Boulanger (2008)
2. I_c = 2.6

Seismic Parameters
$V_{s(30)}$ = 217.0m/s
PGA = 0.58g
Magnitudes = 4.7 to 7.9

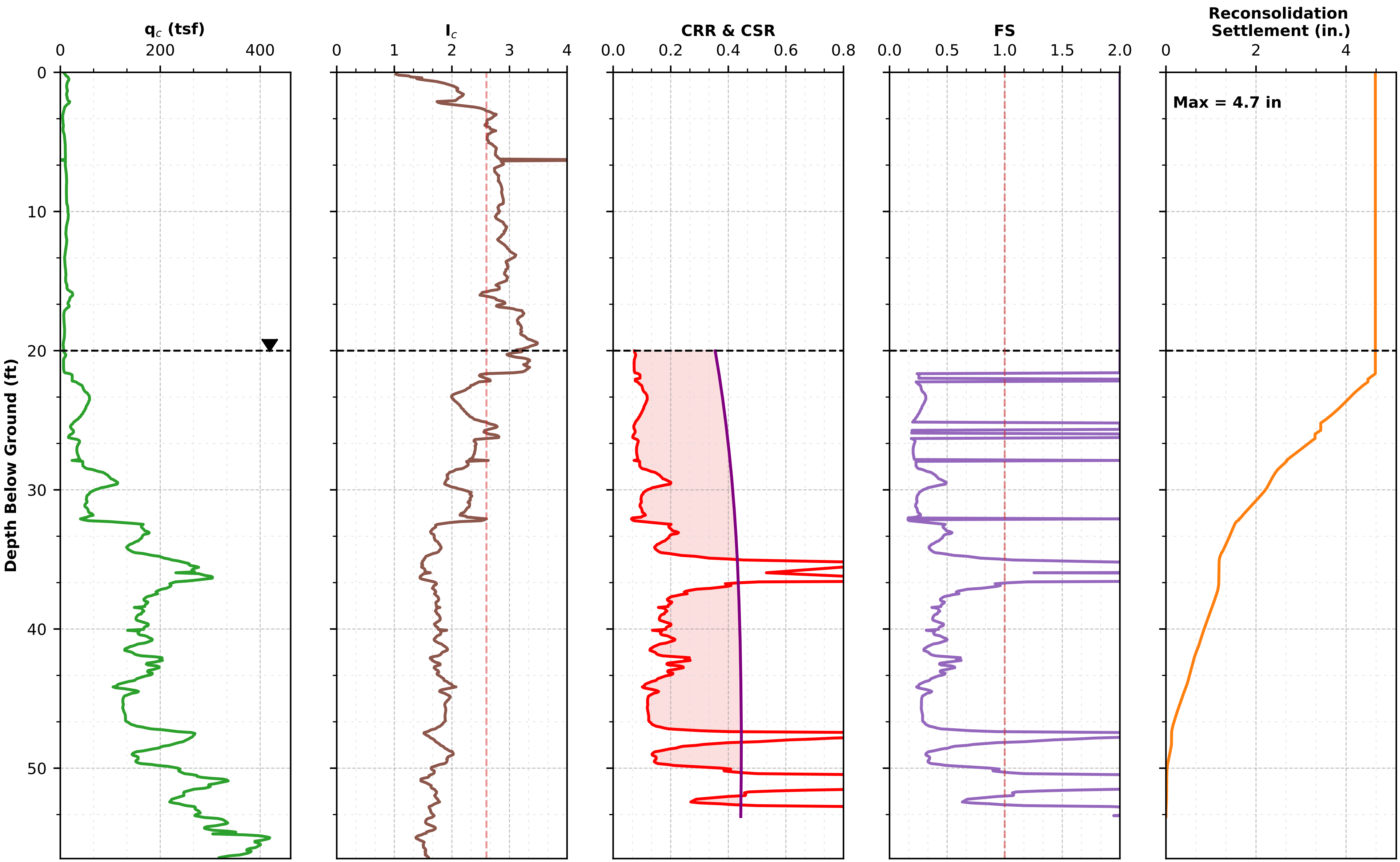
Site Location
Latitude: 35.0476° N
Longitude -90.4386° W

Information
Version: PLHA_CPT_EXCrev11.1
Path: C:\Users\naarens\Liquefaction - Chalk Bluff
User: Nic Arens | Date: July 16, 2025

Chalk Bluff O&M Building
Highway 149 | Heth, Arkansas
Terracon Project No. 35255076

25809 I-30
Bryant, Arkansas 75022

Multiple Scenario Liquefaction Hazard Analysis
CPT-2 (2475 yr Return Period, GWT at 20 ft)



Notes
1. Calculations follow Idriss & Boulanger (2008)
2. I_c = 2.6

Seismic Parameters
$V_{s(30)}$ = 217.0m/s
PGA = 0.58g
Magnitudes = 4.7 to 7.9

Site Location
Latitude: 35.0476° N
Longitude -90.4386° W

Information
Version: PLHA_CPT_EXCrev11.1
Path: C:\Users\naarens\Liquefaction - Chalk Bluff
User: Nic Arens | Date: July 16, 2025

Chalk Bluff O&M Building

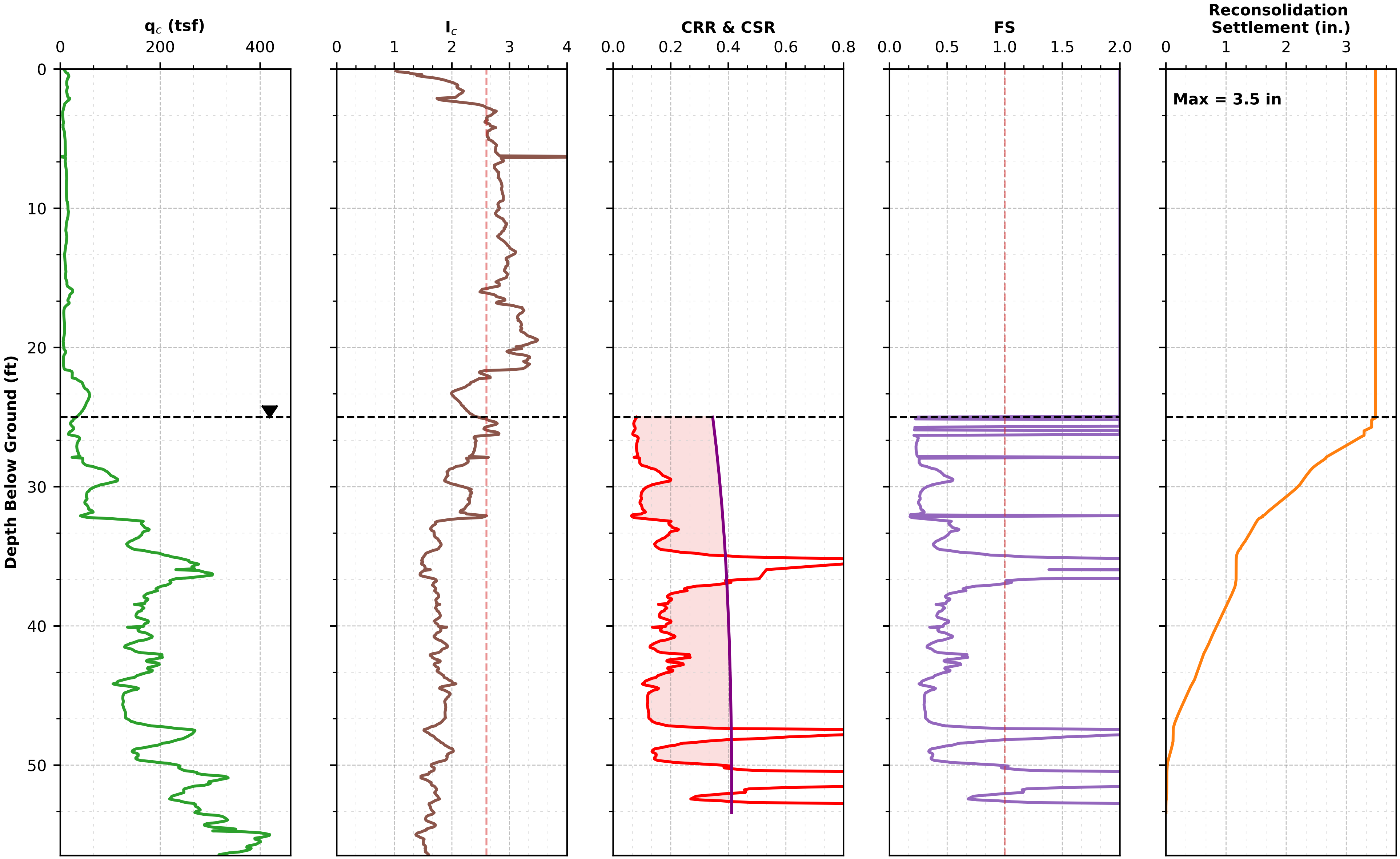
Highway 149 | Heth, Arkansas

Terracon Project No. 35255076

25809 I-30

Bryant, Arkansas 75022

Multiple Scenario Liquefaction Hazard Analysis
CPT-2 (2475 yr Return Period, GWT at 25 ft)



Notes

1. Calculations follow Idriss & Boulanger (2008)
2. I_c = 2.6

Seismic Parameters

$V_{s(30)}$ = 217.0m/s

PGA = 0.58g

Magnitudes = 4.7 to 7.9

Site Location

Latitude: 35.0476° N

Longitude -90.4386° W

Information

Version: PLHA_CPT_EXCrev11.1

Path: C:\Users\naarens\Liquefaction - Chalk Bluff

User: Nic Arens | Date: July 16, 2025

Chalk Bluff O&M Building

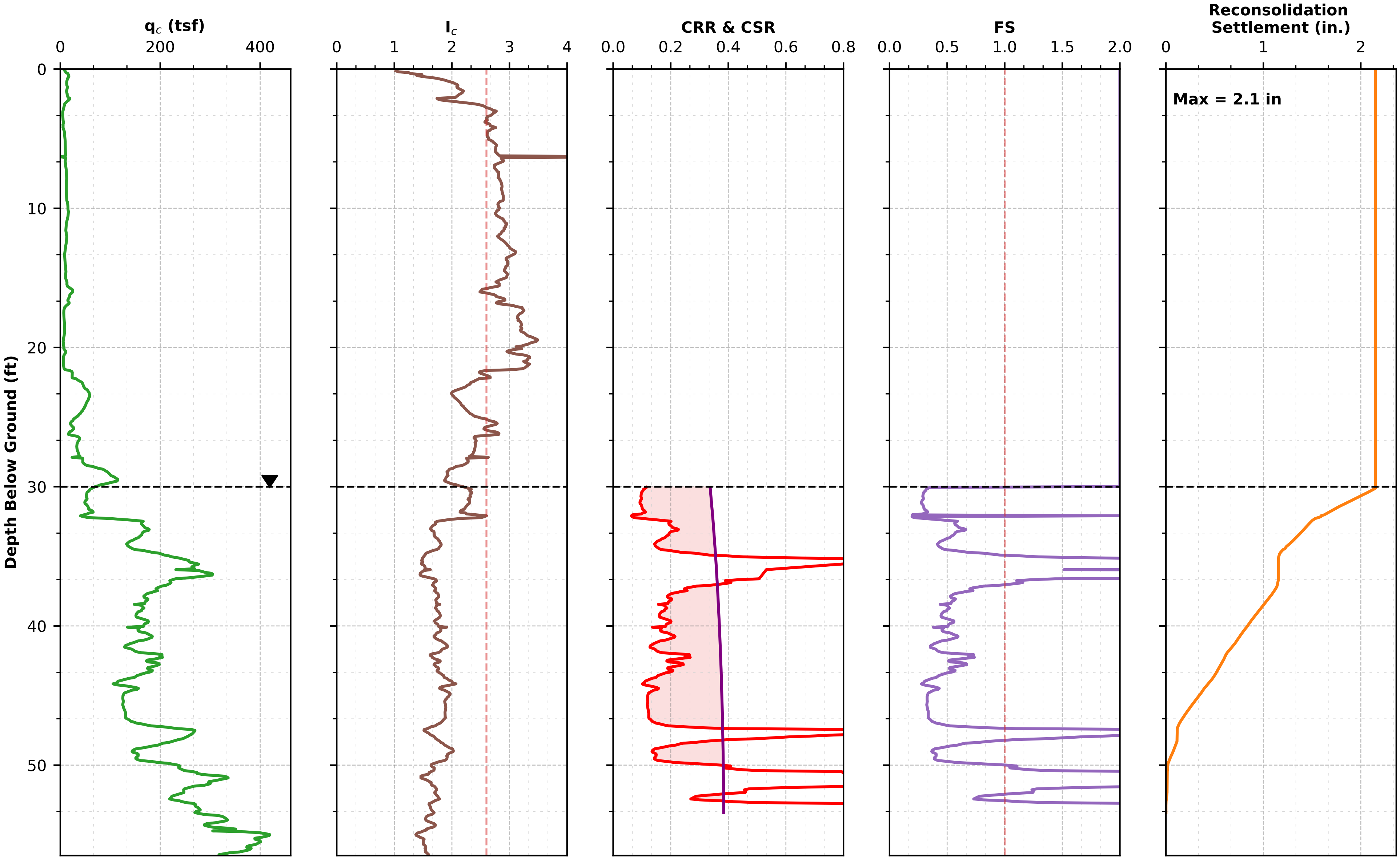
Highway 149 | Heth, Arkansas

Terracon Project No. 35255076

25809 I-30

Bryant, Arkansas 75022

Multiple Scenario Liquefaction Hazard Analysis
CPT-2 (2475 yr Return Period, GWT at 30 ft)



Notes
1. Calculations follow Idriss & Boulanger (2008)
2. I_c = 2.6

Seismic Parameters

$V_{s(30)}$ = 217.0m/s

PGA = 0.58g

Magnitudes = 4.7 to 7.9

Site Location

Latitude: 35.0476° N

Longitude -90.4386° W

Information

Version: PLHA_CPT_EXCrev11.1

Path: C:\Users\naarens\Liquefaction - Chalk Bluff

User: Nic Arens | Date: July 16, 2025