STRUCTURE FOUNDATION EXPLORATION

HEN-24/17D-00.43, PID 117712

Proposed Diamond Interchange

County Road 17D over US Highway 24

Napoleon Township, Henry County, Ohio

Submitted to *Burgess & Niple, Inc*.

Date *March 27, 2024*

Prepared by

100Th Anniversary

LEADING THROUGH THE NEXT 100 YEARS

OHIO DEPARTMENT OF TRANSPORTATION

March 27, 2024 CT Project No. 230230

Mr. Brian Toombs, P.E.
Burgess & Niple, Inc.
330 Rush Alley, Suite 700
Columbus, Ohio 432

Re: FINAL REPORT
Structure Foundation Exploration
HEN-24/17D-00.43, PID 117712
Proposed Diamond Interchange
County Road 17D over US Highway 24
Napoleon Township, Henry County, Ohio

Dear Mr. Toombs:

Following is the final report of the geotechnical subsurface investigation performed by CT Consultants, Inc. (CT) for the referenced project conducted for Burgess & Niple, Inc. (B&N). This study was performed in accordance with CT Proposal No. 2330101R, dated December 15, 2022, and authorized with an Agreement for Subconsultant Services on January 4, 2023 and Work Order #01 dated January 27, 2023.

This report contains the results of our study, our engineering interpretation of the results with respect to the project characteristics, and our recommendations for design and construction of bridge foundations, new embankment fill, and pavements as well as potential modifications to subgrade soils. Subgrade evaluations were performed in accordance with ODOT GDM Section 600 “Plan Subgrades.” Following a “DRAFT” submittal of this report on August 29, 2023, this report incorporates responses to comments provided by ODOT provided via email on March 18, 2024, and we are now submitting the report as “FINAL” in accordance with ODOT protocol.

Should you have any questions regarding this report or require additional information, please contact our office.

Respectfully,

CT Consultants, Inc.

STATE OF OHIO
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FINAL REPORT
STRUCTURE FOUNDATION EXPLORATION
HEN-24/17D-00.43, PID 117712
PROPOSED DIAMOND INTERCHANGE
COUNTY ROAD 17D OVER US HIGHWAY 24
NAPOLEON TOWNSHIP, HENRY COUNTY, OHIO

FOR

BURGESS & NIPLE, INC.
330 RUSH ALLEY, SUITE 700
COLUMBUS, OHIO 43215

SUBMITTED

MARCH 27, 2024

CT PROJECT NO. 230230

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EXECUTIVE SUMMARY

This structure foundation/roadway exploration report has been prepared for the proposed diamond interchange at the intersection of US Highway 24 (US-24) and County Road 17D in Napoleon Township, Henry County, Ohio, designated as HEN-24/17D-00.43, PID No. 117712. This exploration included performance of 38 test borings. A summary of the findings, conclusions, and recommendations of this study are as follows:

1. Borings performed along the paved shoulders of US 24 generally encountered surface materials consisting of asphalt varying in thickness from 8 to 10 inches, underlain by aggregate base varying in thickness from 8 to 12 inches. Borings performed along County Road 17D generally encountered surface materials consisting of concrete varying in thickness from 5½ to 12 inches, underlain by aggregate base varying in thickness from 5 to 10 inches. The remaining borings which were not performed through existing pavements encountered surface materials consisting of topsoil, varying from 4 to 15 inches in thickness. Existing granular fill materials were encountered underlying the surface materials in Borings B-004, B-019, B-035, and B-036, extending to depths ranging from 3 to 4 feet below existing grades. The granular fill materials consisted of crushed stone with sand, silt, and clay; gravel and stone fragments; as well as gravel and stone fragments with sand. Existing cohesive fill materials were encountered underlying the surface materials in Borings B-001, B-003, B-014, B-024, and B-038, as well as underlying the existing granular fill materials in Boring B-036, extending to depths ranging from approximately 3½ to 4 feet below existing grades. The cohesive fill materials consisted of silty clay as well as clay. A zone of granular existing fill materials was encountered underlying the cohesive existing fill materials in Boring B-024 to a depth of 9½ feet (approximate Elev. 691). This boring was performed between two culverts, and this material is presumed backfill material. The granular existing fill materials consisted of crushed stone with sand.

2. Based on the results of our field and laboratory tests, the subsoils encountered underlying the surface materials can generally be characterized by four strata of cohesive soils, underlain by bedrock. Stratum I consisted of predominantly stiff to very stiff cohesive soils encountered underlying the surface materials and existing fill materials in approximately 80 percent of the borings, to depths ranging from approximately 1 to 8 feet below existing grades (approximate Elevs. 705 to 692). The Stratum I cohesive soils consisted of silt and clay (ODOT A-6a); silty clay (ODOT A-6b); as well as clay (ODOT A-7-6). Stratum II consisted of predominantly very stiff to hard cohesive soils encountered underlying the surface materials and existing fill materials in approximately 20 percent of the borings, as well as Stratum I in the remaining borings, to depths ranging from approximately 23½ to 33½ feet (approximate Elevs. 677 to 666). The Stratum II cohesive soils consisted of sandy silt (A-4a); silt and clay (ODOT A-6a); silty clay (ODOT A-6b); as well as clay (ODOT A-7-6). Stratum III consisted of predominantly medium stiff to stiff cohesive soils encountered underlying Stratum II to depths ranging from approximately 38 to 43 feet (approximate Elevs. 663 to 659). The Stratum III cohesive soils consisted of silt

and clay (ODOT A-6a); silty clay (ODOT A-6b); as well as clay (ODOT A-7-6). **Stratum IV** consisted of hard cohesive till soils (commonly referred to as "hardpan" in this region) encountered underlying Stratum III to depths ranging from 46½ to 58½ feet (approximate Elevs. 652 to 641). The Stratum IV hardpan soils consisted of sandy silt (A-4a); silt and clay (ODOT A-6a); as well as silty clay (ODOT A-6b).

3. Weathered shale bedrock was encountered underlying Stratum IV to depths ranging from approximately 54 to 60½ feet (approximate Elevs. 645 to 639). Auger refusal on "intact" shale bedrock was encountered in each of the remaining borings at depths ranging from 58 to 65½ feet (approximate Elevs. 642 to 640).

4. This project includes new embankment fill to be placed on slopes generally at two horizontal to one vertical (2H:1V) at the abutments, decreasing to 4H:1V beyond the approach slabs. As such, it is anticipated that some of the embankment fill placement would fall under the specifications of ODOT Geotechnical Bulletin GDM Section 800, "Special Benching and Sidehill Embankment Fills," dated July 21, 2023. Isolated areas will include fill placement along slopes that are steeper than 4H:1V, and may include sliver fills with design fill widths based on "neat" lines and plateaus of less than 8 feet. Where sidehill fills are planned on the face of an existing slope which is steeper than 4H:1V, ODOT Office of Geotechnical Engineering (OGE) recommends special benching to assure that the new fill section and existing embankment are "knitted" together.

5. The calculated settlements on the order of 6¼ to 8 inches for the maximum fill heights of approximately 22 to 23 feet indicated for this project are not anticipated to be problematic. Some of this settlement will be occurring during construction so that post-construction settlement will be less than the calculated theoretical values. For a typical limit of 1 inch or less of post-construction foundation/embankment settlement, the settlement period is anticipated to be on the order of 1 to 11 months at the greatest extreme, but is anticipated to be toward the lower end of this range, averaging on the order of 1 to 6 months.

6. The foundation soils beneath the proposed MSE walls, when constructed to their full heights, provides enough resistance against bearing capacity failure for undrained loading conditions. Total settlement of the analyzed MSE wall sections was calculated to be on the order of 1¾ to 2¾ inches. Fill placement will need to be stopped temporarily if pore pressures exceed 60 psi above pre-construction levels at the rear abutment and forward abutment. Depending on the rate of MSE wall fill construction, this level of pore pressure may not be generated, or may not occur before allowing a greater height of fill placement.

7. The bridge abutments and intermediate pier will bear on friction piles driven to the top of the Stratum IV hardpan soils. Potential downdrag loads on piles due to settlement of the upper profile soils induced by embankment fill could significantly affect design foundation loads and may preclude the use of friction piles. If piles are to be installed before 60 percent consolidation has occurred from the embankment

fill, it would likely be necessary to protect pile foundations from downdrag forces and under this circumstance, friction piles may not be feasible.

8. We understand that the culvert will be designed using LRFD specifications. At the **service** limit state, the factored bearing resistance was determined to be 6 ksf based on the base of the culvert bearing on in the Stratum II predominantly very stiff to hard cohesive soils. The bearing pressure at the base of the wingwall for Bridge No. HEN-00024-0029 (SFN 3501509) was indicated to be 2.84 ksf, for which settlement was calculated to be on the order of 2¼ to 2¾ inches. The bearing pressure at the base of the wingwall for Bridge No. HEN-00024-0053 (SFN 3501511) was indicated to be 2.59 ksf, for which settlement was calculated to be on the order of 2 to 2½ inches. It is our recommendation to limit the service limit bearing resistance in order to limit settlement. At the **strength** limit state, the factored bearing resistance was calculated to be 9.3 ksf based on the Stratum II predominantly very stiff to hard cohesive bearing soils. The bearing soils should be confirmed as being native cohesive soils with an unconfined compressive strength of at least 3,500 pounds per square foot (hand penetrometer reading of 3.5 tsf or greater).

9. The majority of the alignment will require embankment fill to achieve pavement subgrade elevations. The design CBR value for asphalt pavements should consider the material that will be utilized for embankment fill.

10. For portions of the project where pavement subgrade borings were performed for new roadway and ramp alignment that will approximate existing roadway alignment without significant grade change, an evaluation of the subgrade soils was completed in general accordance with ODOT Geotechnical Design Manual (GDM) Section 600 (July 2023). Subgrade analysis evaluations indicate modifications consisting of undercuts ranging from 12 inches to 21 inches and replacement with new granular engineered fill. Based on the subgrade analysis and our understanding of the project, is our recommendation to plan for a global undercut generally to a depth of 12 inches (15 inches along Ramp B) and replacement with geotextile and granular engineered fill extending along US 24 from taper to gore. For the subgrades along the ramps, extending from the gore to where embankment fill is less than 6 feet in height, global chemical stabilization using cement or lime is recommended to a depth of 12 inches along Ramps A, C, and D, and to a depth of 14 inches along Ramp B.

11. Based on the subgrade analyses, a design CBR value of 5 percent were determined for CR 17D where grades will not vary significantly from current grades (non-embankment areas).

This executive summary highlights our evaluations and recommendations and should only be utilized in conjunction with the accompanying report, including the detailed findings, analysis and recommendations, and qualifications presented herein.

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1.0 INTRODUCTION

This structure foundation/roadway exploration report has been prepared for the proposed diamond interchange at the intersection of US Highway 24 (US-24) and County Road 17D in Napoleon Township, Henry County, Ohio, designated as HEN-24/17D-00.43, PID No. 117712. The general project area is shown on the attached Site Location Map (Plate 1.0).

This study was performed in accordance with CT Proposal No. 2330101R, dated December 15, 2022, and authorized with a Burgess & Niple, Inc. (B&N) Agreement for Subconsultant Services on January 4, 2023 and Work Order #01 dated January 27, 2023.

1.1 Purpose and Scope of Exploration

The purpose of this exploration was to obtain soils data to evaluate the following:

- Magnitude and rate of potential settlement associated with the construction of the proposed ramp embankments for a new bridge structure for a tight diamond interchange,
- Bridge foundations for a new bridge structure,
- Lateral earth pressure, bearing, and global stability recommendations for proposed MSE retaining walls (anticipated to be 30 feet or less in exposed height) at each of the abutments,
- Subgrade conditions for the proposed ramps, including evaluation of subgrades near existing grades at the inside portion of the new ramps as well as relatively minor fill (generally 2 to 4 feet) for the outside portion of the new ramps due to the existing ditches along US-24,
- Pavement section build-up and subgrade conditions for the existing shoulders along
- US-24 at the proposed ramp transitions, along CR 17D at the approaches to the new intersection, as well as in the existing center of the intersection where the at-grade pavements will be removed, and
- Soil subgrade data to perform ODOT Geotechnical Design Manual (GDM) Section 600 (formerly GB-1) "Plan Subgrades" spreadsheet analysis for CR 17D and the new ramps (where less than 6 feet of fill is planned) at the transition to the US-24 roadway.

This report summarizes our understanding of the proposed construction, describes the investigative and testing procedures utilized to evaluate the subsurface conditions at the site, and presents our findings from the field and laboratory testing. This report also presents our evaluations and conclusions in accordance with ODOT Geotechnical Design Manual (GDM) Section 600 (formerly GB-1) (July 21, 2023. This report also provides design and construction recommendations for new roadway embankments, pavements, and bridge structure associated with the proposed new interchange.

This report includes:

> A description of the type and thickness of surface cover at the boring locations.

> A description of the subsurface soil, rock, and groundwater conditions encountered in the borings.

> Design recommendations for pavements, as well as bridge pier and abutment foundations.

> Recommendations concerning soil and groundwater-related construction procedures such as site preparation, earthwork (including embankment construction), foundation and pavement construction, and related field testing.

Appendix G includes pertinent ODOT Geotechnical Engineering Design Checklists that apply to the scope of this report.

This exploration did not include an environmental assessment of the surface or subsurface materials at the site.

1.2 Proposed Construction

It is our understanding that the project to perform a structure foundation/roadway exploration for the referenced project. The project is located at the intersection of US Highway 24 (US-24) and County Road 17D in Napoleon Township, Henry County, Ohio.

Fill will be placed for new embankments along CR 17D for the new interchange. Maximum fill heights are indicated to be on the order of 23 feet. Proposed slopes along the embankments are indicated to be two horizontal to one vertical (2H:1V) at the abutments, decreasing to 4H:1V beyond the approach slabs. We have assumed that the new fill will consist of cohesive soils from a nearby borrow source.

The bridge abutments will be semi-integral with spread footings bearing within a mechanically stabilized earth (MSE) embankment. It is our understanding that precast concrete panels and MSE techniques will be utilized to create a vertical face at the abutments and wingwalls. The backfill material within the MSE portion of the embankment will consist of select granular backfill meeting either ODOT 703.17, Aggregate Materials for 304, or 703.11, Structural Backfill Type 2.

The bottoms of the abutment foundations are indicated at Elevs. 712.70 and 712.95 at the rear and forward abutments, respectively. The tops of the MSE wall are at Elev. 714.00.

Based on proposed road grades of Elevs. 723.93 and 722.94 at the rear and forward abutments, respectively, the leveling pad foundations bearing at approximate Elevs. 696.50

and 697.00, respectively, total wall heights of proposed walls are 26.43 feet and 25.94 feet were evaluated. We understand that abutment piles will be sleeved within the MSE wall reinforced fill zone.

We understand that the new bridge will be a two-span structure. The bridge abutments will be semi-integral with spread footings bearing within a mechanically stabilized earth (MSE) embankment. Foundations for the abutments and pier are planned to consist of driven piles.

It is our understanding that new box culverts will be required to maintain streamflow in Brooks Ditch below Ramp B and Ramp C. The culverts will be constructed with full height headwalls.

Bridge No. HEN-00024-0029 (SFN 3501509) is planned under Ramp C. The proposed culvert will have an 12-feet span, 8-feet rise, and approximately 82 feet in length. The culvert inverts are indicated to be Elevs. 692.95 and 692.59 at the inlet and outlet, respectively, with foundations bearing at a depth of 3 feet below the inverts. The headwall/wingwall footings are shown at the inlet to bear at Elev. 689.95, with a width of 7 feet, and a total length of approximately 43.9 feet. At the outlet, the headwall/wingwall footings are shown to bear at Elev. 689.56, with a width of 7 feet, and a total length of approximately 46.1 feet.

Bridge No. HEN-00024-0053 (SFN 3501511) is planned under Ramp B. The proposed culvert will have an 12-feet span, 8-feet rise, and approximately 53 feet in length. The culvert inverts are indicated to be Elevs. 692.15 and 691.96 at the inlet and outlet, respectively, with foundations bearing at a depth of 3 feet below the inverts. The headwall/wingwall footings are shown at the inlet to bear at Elev. 689.15, with a width of 6 feet, and a total length of approximately 44.1 feet. At the outlet, the headwall/wingwall footings are shown to bear at Elev. 688.96, with a width of 6 feet, and a total length of approximately 44.3 feet.

Based on "Typical Sections" sheets for the project provided with the Stage 2 Submittal, dated August 14, 2023, our evaluations considered pavement cross-sections of 17 inches (approximately 1.4 feet) the proposed ramp superelevated sections, and 15.25 inches (approximately 1.3 feet) for the new County Road 17D pavements and pavements extending along the shoulders of US 24 which precede stationing for the proposed ramps.

2.0 GEOLOGY AND OBSERVATIONS OF THE PROJECT

2.1 General Geology and Hydrogeology

The project site lies within the Maumee Lake Plains Region of the Huron-Erie Lake Plains Physiographic Section of Ohio. Within this region, the upper profile geology includes predominantly Pleistocene-age silts and clays that were lake-laid (lacustrine) sediments, deposited in historic glacial lakes following retreat and melting of glacial ice. The lacustrine soils are underlain by glacial till deposits, underlain by sedimentary bedrock.

The lacustrine soils consist of predominantly silty clays and lean clays, and may exhibit alternating thin layers of interbedded silts and clays known as varves. Varved soils are characteristic of lacustrine deposits, and the thin layering is typically attributed to seasonal or other cyclic variations of sedimentation in the lake waters. In addition, thin sand seams and partings may be encountered.

The glacial till, also referred to as moraine, was deposited by the advance and retreat of glacial ice. Due to the weight of the ice mass, the till deposits are moderately to highly over-consolidated, that is, the existing soil deposits have experienced a previous vertical stress significantly higher than the present effective vertical stress due to the remaining overlying soil strata in the profile. The till may contain cobbles and/or boulders in the till soil matrix. Additionally, seams of granular soils may be encountered within glacial tills. These granular seams may or may not be water bearing.

Bedrock in the project area is broadly mapped on the "Geologic Map of Ohio" as Devonian-age Olentangy shale. Borings performed for this investigation encountered bedrock at elevations varying from approximate Elevs. 652 to 640.

The USDA Natural Resources Conservation Service (NRCS) Web Soil Survey indicates that native upper profile soils in the project area are mapped as predominantly Hoytville silty clay loam, with isolated areas of Haskins fine sandy loam, Haskins loam, as well as Nappanee loam. For each mapped unit, landform, parent material, drainage class, and permeability information is summarized in Table 2.1.

<table>
<tr><th colspan="6">Table 2.1. Mapped Soil Survey Data</th></tr>
<tr><th>Map Unit Symbol</th><th>Map Unit Name</th><th>Landform</th><th>Parent material</th><th>Drainage Class</th><th>Permeability</th></tr>
<tr><td>HcA</td><td>Hoytville silty clay loam, 0 to 1 percent slopes</td><td>Nearshore zones (relict), wave-worked till plains</td><td>Clayey lodgment till</td><td>Very poorly drained</td><td>Very low</td></tr>
<tr><td>HkA</td><td>Haskins fine sandy loam, 0 to 2 percent slopes</td><td>Ridges on beach ridges, ridges on outwash plains, ridges on stream terraces, knolls on outwash plains, knolls on stream terraces, knolls on beach ridges</td><td rowspan="2">Glaciolacustrine deposits over basal till</td><td rowspan="4">Somewhat poorly drained</td><td rowspan="4">Low to moderately low</td></tr>
<tr><td>HlA</td><td>Haskins loam, 0 to 2 percent slopes</td><td>Knolls on beach ridges, knolls on outwash plains, knolls on stream terraces</td></tr>
<tr><td>NaA</td><td>Nappanee loam, 0 to 2 percent slopes</td><td>Rises on lake plains, knolls on lake plains, lake plains, flats on lake plains</td><td rowspan="2">Wave-planed basal till</td></tr>
<tr><td>NtA</td><td>Nappanee silty clay loam, 0 to 2 percent slopes</td><td>Lake plains, flats on lake plains, knolls on lake plains, rises on lake plains</td></tr>
</table>

2.2 Observations of the Project

CT performed a site reconnaissance on April 27, 2023.

Site grades were generally flat. Ditches along CR 17D tended to be shallow (1 to 2 feet in depth) and dry. Ditches along US 24 were approximately 6 to 7 feet in depth, and dry. Brooks Ditch meandered across the site from the northeast to the southwest with a bottom approximately 8 feet below surrounding grades, and water was present within Brooks Ditch. To maintain streamflow below the intersection, a box culvert (SFN 3501345) extended 282 feet diagonally from the northeast to the southwest. The visible portions of the culvert and headwalls appeared in very good condition outwardly, without noticeable signs of erosion or distress.

The existing pavement along US 24 was observed to be in good condition, with minimal longitudinal cracking along the centerline and at the shoulders of the roadway. Transverse cracking was very infrequent, and potholes or other signs of wear were not observed.

The existing pavement along CR 17D was observed to be in fair condition, with occasional longitudinal and transverse cracking.

Surrounding land usage was primarily agricultural, with residential lots along CR 17D south of US 24.

3.0 EXPLORATION

3.1 Historic Borings

Historic borings in the project area include subgrade borings along US-24 circa 1962 (without SPT data) and 2004 (with SPT data). Due to the construction that has occurred along US-24 following performance of these historic roadway borings, they will not be included in our evaluations.

Two historic culvert borings were performed in 2005 within the project area. These borings are in the general area of the new bridge abutments. These historic borings were terminated at a depth of 30 feet. As such, deeper test borings will be required as part of this exploration for new bridge foundation evaluations, and these historic borings will not be included in our evaluations.

Based on historic data, subgrade soils along US 24 may consist of ODOT A-4a, A-6a, A-6b, and A-7-6 soils. Based on ODOT GDM Section 600, soils classified as ODOT A-4b, A-2-5, A-5, A-7-5, A-8a, A-8b, or rock have been designated as being problematic with respect to pavement subgrade support. The historically encountered soils at this site may not be particularly problematic based on ODOT GDM Section 600, but the encountered cohesive soils tend to be moisture sensitive and may require chemical stabilization or removal and replacement if determined to be unstable.

Boring data from these investigations are presented for reference in Appendix H.

We have assumed that the information provided in the historic borings was accurate and correct, at the time of those respective investigations, but cannot guarantee as such. Additionally, subgrade soil conditions may have changed or may have been modified due to construction performed following completion of the historic subsurface explorations.

3.2 Project Exploration Program

This exploration included 38 test borings, designated as Borings B-001-0-22 through B-038-0-22, performed by CT during the period from May 1 through August 13, 2023. The borings have been identified in accordance with ODOT protocol, but the "-0-22" portion of the nomenclature is generally omitted for discussion in this report. The borings were located in the field by CT in accordance with the geometric study plans dated April 17, 2023. The approximate locations of the borings are shown on the Test Boring Location Plan (Plate 2.0).

Horizontal coordinates and ground surface elevations at the boring locations were surveyed by DGL and are shown on the Logs of Test Borings.

Borings B-001 through B-006, and B-033 through B-038 were performed as ODOT Type A subgrade borings, and were terminated at depths of 6 to 7½ feet below existing grade.

Boring B-016 was performed as an ODOT Type B roadway boring, and was terminated at a depth of 10 feet.

Borings B-007, B-008, B-010, B-012, B-013, B-017, B-018, B-020 through B-023, B-026, B-027, B-029, B-031, and B-032 were performed as ODOT Type B1 embankment borings. These borings were terminated at depths ranging from 15 to 20 feet.

Borings B-014, B-015, B-019, B-024, and B-025 were performed as ODOT Type E1 bridge borings. These borings were extended to auger refusal and were generally extended an additional 10 feet by rock core methods. Boring B-019 was terminated after extending 5 feet into the rock.

Borings B-009, B-011, B-028, and B-030 were performed as ODOT Type E2a culvert borings. These borings were extended into a minimum of 20 feet of 20 blows per foot (based on the Standard Penetration Test, discussed in the following section) material, and were terminated at depths ranging from 53.5 to 58.8 feet (approximate Elevs. 645 to 639).

Experience indicates that the actual subsoil conditions at a site could vary from those generalized on the basis of test borings made at specific locations. Therefore, it is essential that a geotechnical engineer be retained to provide soil and rock engineering and inspection services during the site preparation, excavation, and foundation phases of the proposed project. This is to observe compliance with the design concepts, specifications, and recommendations, and to allow design changes in the event subsurface conditions differ from those anticipated prior to the start of construction.

3.3 Boring Methods

The test borings performed during this exploration were drilled with a CME 75 truck-mounted drilling rig, a Diedrich D70 track-mounted drilling rig, a CME 550X ATV-mounted drilling rig, as well as a track-mounted Geoprobe ® 7822DT with drilling capabilities. The borings were extended utilizing 3¼-inch inside diameter hollow-stem augers, 3½-inch outside diameter solid stem augers, as well as a hand-operated bucket auger. Within the subgrade borings, split-spoon drive samples were obtained continuously. During auger advancement, samples were obtained continuously over 18-inch split-spoon sample drives in Type A roadway borings. Samples were obtained at 2½-foot intervals in the Type B and B1 embankment borings. Samples were obtained at 2½-foot intervals to a depth of 20 or 25 feet and at 5-foot intervals thereafter in Type E1 and E2a bridge and culvert borings.

Split-spoon (SS) soil samples were obtained by the Standard Penetration Test Method (ASTM D 1586), and were sealed in jars and transported to our laboratory for further classification and testing. The Standard Penetration Test (SPT) consists of driving a 2-inch outside diameter split-spoon sampler into the soil with a 140-pound weight falling freely through a distance of 30 inches. The sampler was driven in three successive 6-inch increments, with the number of blows per increment being recorded. The number of blows per increment was recorded at each depth interval, and these data are presented under the "SPT" column on the Logs of Test Borings attached to this report. The sum of the number of blows required to advance the sampler the second and third 6-inch increments is termed the Standard Penetration Resistance, or N_m-value, and is typically reported in blows per foot (bpf). The N_m-values were corrected to an equivalent rod energy ratio of 60 percent, N_{60}. The calibrated hammer/rod energy ratios are summarized in the following table. The N_{60}-values are presented on the attached Logs of Test Borings attached to this report.

Table 3.3. Drilling Rig Calibration Data

Drilling Rig	Calibration Date	Hammer/Rod Energy Ratio
CME 75	February 20, 2023	72.9 percent
Diedrich D70	April 13, 2022	90.0 percent
CME 550X	February 20, 2023	75.2 percent
GeoProbe®	March 16, 2022	91.0 percent*

* This energy ratio is limited to an upper bound of 90 percent for the purposes of analyses and reporting in accordance with the ODOT Specification for Geotechnical Explorations (SGE).

Boring B-033 was advanced 6 feet below existing grade by hand sampling methods. Samples were obtained continuously using an 18-inch split-spoon sampler drive. Penetration tests were performed at the same intervals using a hand-operated Housel hammer. This method consists of driving a 2-inch outside diameter split-barrel sampler into the soil with a 38-pound weight falling freely through a distance of 30 inches. The sampler was driven in three successive 6-inch increments, with the number of blows per increment being recorded. The number of blows required to advance the sampler the second and third 6-inch increments was then converted into an equivalent Standard Penetration Test (SPT) resistance, or N-value, for a 140-pound hammer falling through a distance of 30-inches (ASTM D 1586). The equivalent SPT blow counts and equivalent SPT N-values are presented on the Log of Test Boring for Boring B-033. The hammer/rod energy ratio for the hand-operated Housel hammer was assumed to be 60 percent, such that N_{60} equal N_m. The split-spoon samples were sealed in jars and transported to our laboratory for further classification and testing.

Twenty Shelby tube samples, designated ST on the Logs of Test Borings, were obtained by hydraulically advancing a 3-inch diameter, thin-walled sampler approximately 24 inches beyond the hollow-stem auger into relatively undisturbed soil in accordance with ASTM D 1587. The Shelby tubes were then extracted from the subsoils, and the ends were capped and sealed. The samples were transported to our laboratory where they were extruded, classified, and tested.

Soil conditions encountered in the test borings are presented in the Logs of Test Borings along with information related to sample data, SPT results, water conditions observed in the borings, and laboratory test data. In conjunction with published data and typical correlations, the N_{60}-values can be evaluated as a measure of soil compactness/consistency as well as shear strength and bearing capacity.

Field and laboratory data were incorporated into gINT™ software for presentation purposes. It should be noted that these logs have been prepared on the basis of laboratory classification and testing as well as field logs of the encountered soils.

3.4 Laboratory Testing Program

All soil samples were visually or manually classified in accordance with the ODOT Soil Classification System. Atterberg limits tests (ASTM D 4318) and particle size analyses (ASTM D 6913 and D 7928) were performed on selected samples to determine soil classification and index properties.

All samples of the subsoils were also tested in our laboratory for moisture content (ASTM D 2216). Dry density determinations and unconfined compressive strength tests by the constant rate of strain method (ASTM D 2166) were performed on thirteen Shelby tube samples as well as selected intact cohesive samples. Unconfined compressive strength estimates were obtained for the remaining intact cohesive samples using a calibrated hand penetrometer. Nineteen samples were tested for sulfate content in accordance with ODOT Supplemental Specification 1122. These test results are presented on the Logs of Test Borings attached to this report.

Additionally, unconsolidated-undrained (UU) triaxial compressive strength tests (ASTM D 2850) were performed on three recovered Shelby tube samples. The UU tests were performed on specimens tested at confining pressures approximately equal to ½-, 1-, and 2-times the existing overburden pressure at the sample depth. The results of these tests are attached to this report in Appendix A.

Direct shear tests (ASTM D 3080) were performed on five Shelby tube samples. The direct shear tests were performed using normal stresses approximately equal to ½-, 1-, and 1½- or 2-times the approximate overburden pressure at the sample depth. The results of these tests are attached to this report in Appendix A.

One-dimensional consolidation tests (ASTM D 2435) were performed on six Shelby tube samples. The results of these tests are presented in Appendix A.

Recovered rock core specimens were visually classified in general accordance with Ohio Department of Transportation (ODOT) "Specifications for Geotechnical Explorations" (SGE) criteria. Selected intact rock specimens were tested for unconfined compressive strength in accordance with ASTM D 7012, Method C. Results of these tests are presented on the Logs of Test Borings and the attached Unconfined Compressive Strength Test results.

The rock core specimens were prepared using a table saw to obtain flat perpendicular ends with respect to the longitudinal specimen, then the ends were capped using capping compound to ensure they were relatively flat. The planeness of the bearing surfaces of the specimens were checked by means of a straightedge and feeler gauge, and the capped surfaces were determined to be plane within 0.002 inches (0.05 mm). The surfaces of the specimens in contact with the lower bearing block of the testing machine were similarly evaluated for perpendicularity to the axis by less than 1 degree (approximately equivalent to a deviance of 0.07 inches along the 4-inch specimen). ASTM D 7012 requires that we indicate the sample was not prepared using specialized equipment per ASTM D 4543, and that the reported results may differ from those obtained using a test specimen prepared per ASTM D 4543. However, the difference should be insignificant for strong rock, such as encountered for this project, but the difference can be more pronounced for weak rock.

4.0 FINDINGS

4.1 General Site Conditions

Our observations of the site conditions were summarized in Section 2.2.

Borings B-001, B-003, B-004, B-035, B-036, and B-038 were performed along the paved shoulders of US 24, and generally encountered surface materials consisting of asphalt varying in thickness from 8 to 10 inches, underlain by aggregate base varying in thickness from 8 to 12 inches.

Table 4.1.A. Summary of Encountered Surface Materials – US 24

Boring Number	Thickness of Surface Material (inches)		Subgrade Soil
	Asphalt	Aggregate Base	
B-001	9	11	FILL – A-6b
B-003	9	8	A-6b
B-004	8	12	FILL – A-2-7
B-035	8	12	FILL – A-1-b
B-036	8	12	FILL – A-1-b
B-038	10	12	FILL – A-7-6

Borings B-016 through B-023 were performed along County Road 17D, and generally encountered surface materials consisting of concrete varying in thickness from 5½ to 12 inches, underlain by aggregate base varying in thickness from 5 to 10 inches.

Table 4.1.B. Summary of Encountered Surface Materials – CR 17D

Boring Number	Thickness of Surface Material (inches)		Subgrade Soil
	Asphalt	Aggregate Base	
B-016	9	6	A-6a
B-017	9	5	A-6a
B-018	8¾	7¼	A-6b
B-019	12	10	FILL – A-1-a
B-020	9	5	A-7-6
B-021	9	7	A-6b
B-022	5½	9½	A-6b
B-023	12	5	A-7-6

The remaining borings which were not performed through existing pavements encountered surface materials consisting of topsoil, varying from 4 to 15 inches in thickness.

Existing granular fill materials were encountered underlying the surface materials in Borings B-004, B-019, B-035, and B-036, extending to depths ranging from 3 to 4 feet below existing grades. The granular fill materials consisted of crushed stone with sand, silt, and clay; gravel and stone fragments; as well as gravel and stone fragments with sand. SPT

N_{60}-values ranged from 7 to 22 blows per foot (bpf), indicating loose to medium dense compactness. Moisture contents varied from 5 to 25 percent.

Existing cohesive fill materials were encountered underlying the surface materials in Borings B-001, B-003, B-014, B-024, and B-038, as well as underlying the existing granular fill materials in Boring B-036, extending to depths ranging from approximately 3½ to 4 feet below existing grades. The cohesive fill materials consisted of silty clay as well as clay. SPT N_{60}-values generally ranged from 6 to 13 bpf, indicative of predominantly medium stiff to stiff consistency. Moisture contents typically varied from 17 to 26 percent.

A zone of granular existing fill materials was encountered underlying the cohesive existing fill materials in Boring B-024 to a depth of 9½ feet (approximate Elev. 691). This boring was performed between two culverts, and this material is presumed backfill material. The granular existing fill materials consisted of crushed stone with sand. SPT N_{60}-values ranged from 15 to 42 bpf, indicating medium dense to dense compactness, and moisture contents were on the order of 7 percent.

4.2 General Soil and Bedrock Conditions

Based on the results of our field and laboratory tests, the subsoils encountered underlying the surface materials can generally be characterized by four strata of cohesive soils, underlain by bedrock. These strata have been interpreted based on broad geological depositional patterns, as well as soil texture, moisture contents, dry unit weights, unconfined compressive strengths, and SPT N_{60}-values recorded in the borings. It should be noted that the demarcations between cohesive soil strata can be transitional with respect to strength and moisture conditions.

Additional descriptions of the stratigraphy encountered in the borings are presented on the Logs of Test Borings.

Stratum I consisted of predominantly stiff to very stiff cohesive soils encountered underlying the surface materials and existing fill materials in approximately 80 percent of the borings, to depths ranging from approximately 1 to 8 feet below existing grades (approximate Elevs. 705 to 692). Boring B-033 was terminated within Stratum I at a depth of 6 feet (approximate Elevs. 694). The Stratum I cohesive soils consisted of silt and clay (ODOT A-6a); silty clay (ODOT A-6b); as well as clay (ODOT A-7-6). Trace organics were encountered in the uppermost sample in occasional borings. SPT N_{60}-values generally ranged from 9 to 30 bpf, although occasional lower values were also encountered, indicating some soils bordering on medium stiff consistency. Unconfined compressive strengths generally varied from 2,070 to 9,000 psf, although the strengths at the upper end of this range could be indicative of desiccation and/or transition to the underlying higher strength soils. Moisture contents ranged from 12 to 25 percent.

A zone of granular soils was encountered underlying Stratum I in Boring B-038. The boring was terminated within the granular soils at a depth of 7½ feet. An SPT N_{60}-value of 17 bpf, indicating very dense compactness, and a moisture content of 19 percent were determined for the recovered sample.

Stratum II consisted of predominantly very stiff to hard cohesive soils encountered underlying the surface materials and existing fill materials in approximately 20 percent of the borings, as well as Stratum I in the remaining borings, to depths ranging from approximately 23½ to 33½ feet (approximate Elevs. 677 to 666). The remaining non-structure borings (Borings B-001 through B-008, B-010, B-013, B-016, B-017, B-018, B-020 through B-023, and B-026 through B-037) were terminated within this stratum at depths ranging from feet to 6 to 20 feet. The Stratum II cohesive soils consisted of sandy silt (A-4a); silt and clay (ODOT A-6a); silty clay (ODOT A-6b); as well as clay (ODOT A-7-6). Within this stratum, SPT N_{60}-values generally ranged from 16 bpf to split-spoon refusal (SSR, 50 or more blows over 6 inches or less penetration). Unconfined compressive strengths ranged from 4,000 psf to greater than 9,000 psf (the highest obtainable reading using a calibrated hand penetrometer). Undrained shear strength (s_u) values ranged from 2,850 to 4,690 psf. Moisture contents ranged from 13 to 30 percent.

Stratum III consisted of predominantly medium stiff to stiff cohesive soils encountered underlying Stratum II to depths ranging from approximately 38 to 43 feet (approximate Elevs. 663 to 659). The Stratum III cohesive soils consisted of silt and clay (ODOT A-6a); silty clay (ODOT A-6b); as well as clay (ODOT A-7-6). Within this stratum, SPT N_{60}-values generally ranged from 6 to 15 bpf. Unconfined compressive strengths were on the order of 1,245 psf and greater. Moisture contents ranged from 14 to 37 percent.

Stratum IV consisted of hard cohesive till soils (commonly referred to as "hardpan" in this region) encountered underlying Stratum III to depths ranging from 46½ to 58½ feet (approximate Elevs. 652 to 641). Boring B-009 was terminated within the hardpan at a depth of 58.3 feet. The Stratum IV hardpan soils consisted of sandy silt (A-4a); silt and clay (ODOT A-6a); as well as silty clay (ODOT A-6b). Within the hardpan, SPT N_{60}-values generally ranged from 28 bpf to SSR. Unconfined compressive strengths were determined to 9,000 psf or greater (the maximum obtainable reading using a calibrated hand penetrometer). Moisture contents ranged from 7 to 15 percent.

A zone of granular soils was encountered underlying Stratum IV in Boring B-030 to a depth of 53 feet (approximate Elev. 645). The granular soils consisted of coarse and fine sand (ODOT A-3a). Within this zone, the SPT resulted in SSR, indicating very dense compactness, and a moisture content of 12 percent was determined for the recovered sample.

Weathered shale bedrock was encountered underlying Stratum IV in Borings B-011, B-015, B-019, B-024, B-025, B-028, and B-030, to depths ranging from approximately 54 to 60½ feet (approximate Elevs. 645 to 639). Borings B-011, B-028, and B-030 were terminated within the weathered shale. A distinct weathered rock zone was not encountered in Boring B-014.

Auger refusal on "intact" shale bedrock was encountered in each of the remaining borings at depths ranging from 58 to 65½ feet (approximate Elevs. 642 to 640). Upon encountering auger refusal, the remaining were extended into the bedrock by coring methods. The encountered rock consisted of generally slightly weathered shale, which was moderately strong to strong, and jointed – generally highly fractured to moderately fractured. Rock core data are summarized in Table 4.2.

Table 4.2. Summary of Rock Core Data

Boring Number	Rock Core	Depth Below Ground Surface (feet)	Approximate Elevation (feet)	Rock Core Recovery (%)	RQD (%)	Unconfined Compressive Strength (psi)
B-014	NQ2-1	58 to 63	641 to 636	90	40	-
	NQ2-2	63 to 68	636 to 631	92	92	5,680
B-015	NQ2-1	60½ to 65½	640 to 635	100	68	-
	NQ2-2	65½ to 70½	635 to 630	100	53	7,830
B-019	NQ2-1	60 to 65	642 to 637	100	38	8,240
B-024	NQ2-1	59 to 64	641 to 636	90	80	8,970
	NQ2-2	64 to 69	636 to 631	92	100	-
B-025	NQ2-1	59 to 64	640 to 635	90	72	7,450
	NQ2-2	64 to 69	635 to 630	100	53	-

Rock core photographic logs are attached to this report in Appendix B.

RQD values typically varied from 38 to 80 percent, indicating the rock mass quality of the shale bedrock in the upper bedrock profile can be generally described as varying from poor to good.

4.3 Groundwater Conditions

Groundwater was encountered during drilling in five borings at depths ranging from 6½ to 58 feet below existing grades (approximate Elevs. 696 to 640). Groundwater was observed upon completion of drilling four borings at depths ranging from approximately 18 to 55 feet (approximate Elevs. 682 to 642). Groundwater was not encountered nor observed in any of the remaining borings. It should be noted that the borings were drilled and backfilled within the same day. As such, stabilized water levels may not have occurred over this limited time period. Instrumentation was not installed to observe long-term groundwater levels.

Based on the soil characteristics and moisture conditions encountered in the borings, it is our opinion that the "normal" groundwater level will generally be encountered at a depth of 11 to 13 feet below existing grades (approximate Elevs. 691 to 684). However, it should be noted that groundwater elevations can fluctuate with seasonal and climatic influences. In particular, "perched" groundwater conditions may be encountered within existing fill materials underlain by relatively impermeable cohesive soils, such as encountered in Boring B-024. Therefore, the groundwater conditions may vary at different times of the year from those encountered during this investigation.

4.4 Remedial Measures

This project includes new embankment fill to be placed on slopes generally at two horizontal to one vertical (2H:1V) at the abutments, decreasing to 4H:1V beyond the approach slabs. As such, it is anticipated that some of the embankment fill placement would fall under the specifications of ODOT Geotechnical Bulletin GDM Section 800, "Special Benching and Sidehill Embankment Fills," dated July 21, 2023. Isolated areas will include fill placement along slopes that are steeper than 4H:1V, and may include sliver fills with design fill widths based on "neat" lines and plateaus of less than 8 feet. Where sidehill fills are planned on the face of an existing slope which is steeper than 4H:1V, ODOT Office of Geotechnical Engineering (OGE) recommends special benching to assure that the new fill section and existing embankment are "knitted" together. Additional discussion regarding special benching is provided in Section 5.1.1.

Regardless of overall global slope stability, slopes graded steeper than 3H:1V may be prone to shallow surface sloughing. This type of shallow sliding is generally not problematic (by itself), but left unchecked, it can lead to progressive slope movements that eventually impact overall performance of the embankment. In addition to slope protection, such as well-established vegetative cover and rock-lined channels in surface run-off collection ditches and swales, we recommend that surface drainage from pavement areas on the crest of the embankment should be directed to catch basins or storm drains and not allowed to sheet flow over the slope. Global stability evaluations for the new embankments were beyond the scope of this exploration. However, additional general discussion regarding stability of the proposed embankment slopes is provided in Section 5.1.2.

The calculated settlements on the order of 6¼ to 8 inches for the maximum fill heights of approximately 22 to 23 feet indicated for this project are not anticipated to be problematic. Some of the embankment settlement will occur during placement of the fill. For a typical limit of 1 inch or less of post-construction foundation/embankment settlement, the settlement period is anticipated to be on the order of 1 to 11 months at the greatest extreme, but is anticipated to be toward the lower end of this range, averaging on the order of 1 to 6 months. Additional discussion regarding embankment settlement is provided in Section 5.1.3.

The foundation soils beneath the proposed MSE walls, when constructed to their full heights, provides enough resistance against bearing capacity failure for undrained loading conditions. Total settlement of the analyzed MSE wall sections was calculated to be on the order of 1¾ to 2¾ inches. We understand that piles will be sleeved through the MSE wall backfill to avoid downdrag loads on the piling. In any case, we have assumed that adequate time will be allotted for MSE wall settlement, and the piles will be "restruck" after 90% consolidation has occurred, such that downdrag loads will not be a design consideration for the piles. Fill placement will need to be stopped temporarily if pore pressures exceed 60 psi above pre-construction levels at the rear abutment and forward abutment. Depending on the rate of MSE wall fill construction, this level of pore pressure may not be generated, or may not occur before allowing a greater height of fill placement. Additional discussion regarding the proposed MSE wall is provided in Section 5.2.

The bridge abutments and intermediate pier will bear on friction piles driven to the top of the Stratum IV hardpan soils. Potential downdrag loads on piles due to settlement of the upper profile soils induced by embankment fill could significantly affect design foundation loads and may preclude the use of friction piles. If piles are to be installed before the majority of settlement has occurred from the embankment fill, it would likely be necessary to protect pile foundations from downdrag forces and under this circumstance, friction piles may not be feasible. Additional discussion regarding the bridge abutments and piers is provided in Section 5.3.

It is our understanding that new box culverts will be required to maintain streamflow in Brooks Ditch below Ramp B and Ramp C. For culvert and headwall installation, depending on streamflow and water levels at the time of construction, it may be advantageous to utilize temporary sheetpiling to support excavations that will extend below stream level. As with any installation within a ditch area, there may be areas of encountered sediment or softened/saturated soils at bearing elevations, which would require over-excavation. Additional discussion of culvert support and installation is provided in Section 5.4.

The culverts will be constructed with full height headwalls. The bearing pressure at the base of the wingwall for Bridge No. HEN-00024-0029 (SFN 3501509) was indicated to be 2.84 ksf, for which settlement was calculated to be on the order of 2¼ to 2¾ inches. The bearing pressure at the base of the wingwall for Bridge No. HEN-00024-0053 (SFN 3501511) was indicated to be 2.59 ksf, for which settlement was calculated to be on the order of 2 to 2½ inches. It is our recommendation to limit the service limit bearing resistance in order to limit settlement. Additional discussion of headwall foundations is provided in Section 5.5.

The subgrade analyses for areas where proposed CR 17D and ramp alignments approximate existing roadway alignment without significant grade change indicate that modification should be anticipated to be required. Subgrade analysis evaluations indicate modifications consisting of undercuts ranging from 12 inches to 21 inches and replacement with new granular engineered fill. Based on the subgrade analysis and our understanding of the project, is our recommendation to plan for a global undercut generally to a depth of 12 inches (15 inches along Ramp B) and replacement with geotextile and granular engineered fill extending along US 24 from taper to gore. For the subgrades along the ramps, extending from the gore to where embankment fill is less than 6 feet in height, global chemical stabilization using cement or lime is recommended to a depth of 12 inches along Ramps A, C, and D, and to a depth of 14 inches along Ramp B. Additional discussion of this subgrade analysis is provided in Section 5.6.

5.0 ANALYSES AND RECOMMENDATIONS

The following analyses and recommendations are based on our understanding of the proposed construction and upon the data obtained during our field exploration. If the project information or location as outlined is incorrect or should change significantly, a review of these recommendations should be made by CT.

5.1 New Embankment Fill

Fill will be placed for new embankments along CR 17D for the new interchange. Maximum fill heights are indicated to be on the order of 23 feet. Proposed slopes along the embankments are indicated to be two horizontal to one vertical (2H:1V) at the abutments, decreasing to 4H:1V beyond the approach slabs. We have assumed that the new fill will consist of cohesive soils from a nearby borrow source.

5.1.1 Special Benching and Sidehill Embankment Fills

Where fill will be placed along slopes that are flatter than 4 horizontal to 1 vertical (4H:1V) but steeper than 8H:1V, ODOT Construction and Materials Specifications (CMS) Item 203.05, which describes "standard specification" benching, should be followed.

Special benching is to be used whenever there will be a stability problem with new fill and/or there are weak soils in an existing slope. Special benching is utilized to improve stability in a sidehill fill placed on an existing slope, or to remediate an unstable existing slope. Based on our site reconnaissance, the existing slopes in the project area appear to be performing satisfactorily, and are not in need of remediation due to instability.

Based on the project drawings, the proposed embankments will generally include fill in areas with relatively flat grades, fill in areas of previous cut such that the fill will be "buttressed" between existing slopes, or fill along slopes which include more than 8 feet of plateau at the toe of the new fill. For these areas, only "standard specification" benching would be required.

Isolated areas may include fill placement along slopes that are steeper than 4H:1V, and may include sliver fills with design fill widths based on "neat" lines and plateaus of less than 8 feet. Where sidehill fills are planned on the face of an existing slope which is steeper than 4H:1V, ODOT Office of Geotechnical Engineering (OGE) recommends special benching to assure that the new fill section and existing embankment are "knitted" together.

Fill placement along slopes steeper than 4H:1V are anticipated to require special benching in the following areas:

> US 24 in the vicinity of Sta. 122+00 to 124+00, left of centerline;

> US 24 in the vicinity of Sta. 127+00 to 131+00, left of centerline; and

> County Road 17D in the vicinity of Sta. 229+96, left of centerline.

Examples of special benching for these sections is included in Appendix A, "Embankment Evaluations and Calculations."

In general, one to two benches are prescribed for the existing slopes. Along County Road 17D, the bench intercepts the existing roadway, for which special measures for maintenance of traffic (MOT) will be required.

The soils in the vicinity of the project area where benching will be performed consist of native cohesive soils. For these soils, the ODOT Geotechnical Design Manual (GDM) Section 800 indicates that a 1H:1V backslope should be planned. Based on the conditions encountered in the borings, a 1H:1V backslope should be generally achievable for short-term excavations. Although not anticipated based on the test borings, if granular soils are encountered, GDM Section 800 indicates that a backslope at 1¾H:1V may be more appropriate, assuming an effective friction angle of approximately 30 degrees.

Based on ODOT guidelines for special benching, plans should contain Plan Note G109 from the ODOT Location & Design Manual, Volume 3.

5.1.2 Global Stability

Global stability evaluations for the new embankment slopes were beyond the scope of this exploration. Proposed slopes along the embankments are indicated to be two horizontal to one vertical (2H:1V) at the abutments, decreasing to 4H:1V beyond the approach slabs. Global stability evaluations were performed for the proposed mechanistically stabilized earth (MSE) retaining walls at the abutments, the results of which are presented in Section 5.2.1 of this report.

Regardless of overall global slope stability, slopes graded steeper than 3H:1V may be prone to shallow surface sloughing. This type of shallow sliding is generally not problematic (by itself), but left unchecked, it can lead to progressive slope movements that eventually impact overall performance of the embankment.

In addition to slope protection, such as well-established vegetative cover and rock-lined channels in surface run-off collection ditches and swales, we recommend that surface drainage from pavement areas on the crest of the embankment should be directed to catch basins or storm drains and not allowed to sheet flow over the slope.

5.1.3 Settlement

For each of the encountered soil strata, soil compressibility parameters were evaluated for use in embankment settlement calculations. The compressibility parameters were evaluated using one-dimensional consolidation test results, as well as correlations with moisture contents and Atterberg limits test results. Results of the one-dimensional consolidation tests are provided in Appendix A.

Settlement was evaluated based on a maximum embankment fill height of 23 feet, a crest width of 55 feet, and slopes of 2 horizontal to 1 vertical (3H:1V). Total embankment settlement calculations include consolidation of the foundation soils as well as settlement of the embankment fill under its own weight. Calculated total settlement at the analyzed sections, and the corresponding maximum fill heights, are summarized in the following table.

Table 5.1.3. Embankment Settlement

Boring Number	Relative Location	Embankment Slope	Maximum Estimated Fill Height (feet)	Calculated Total Embankment Settlement (inches)
B-015	Rear (South) Abutment	2H:1V	23	6¾ to 8
B-018	Ramp A & Ramp B Intersection	2H:1V	14	4 to 5
B-020	Ramp B & Ramp C Intersection	2H:1V	16	4¾ to 5¾
B-024	Forward (North) Abutment	2H:1V	22	6¼ to 7¼

The calculated settlements for the fill heights indicated above are not anticipated to be problematic for the proposed project. It should be noted that settlement of the embankment soils under their own weight was on the order of 1½ to 4 inches, which represents approximately 32 to 55 percent of the total calculated settlement indicated in the above table. Some of this embankment settlement will occur during placement of the fill. Additionally, field observations of actual settlement generally tend to be less in magnitude than the theoretical calculated settlement.

Based on consolidation test results and correlations with soil index properties, as well as the indicated fill heights and range of compressible cohesive soil layer thicknesses, the time required to achieve 90 percent consolidation was generally calculated to be on the order of 1 to 11 months at the greatest extreme, but is anticipated to be toward the lower end of this range, averaging on the order of 1 to 6 months. It should be noted for the embankment heights and settlement magnitudes indicated above, after 90 percent consolidation, the remaining foundation/embankment settlement would be less than 1 inch.

If piles are to be installed before 60 percent consolidation has occurred from the embankment fill, it would likely be necessary to protect pile foundations from downdrag forces. Based on consolidation test results and correlations with soil index properties, as well as the indicated fill heights and range of compressible cohesive soil layer thicknesses, the time required to achieve 60 percent consolidation was generally calculated to up to 3½ months. As such, a waiting period of 110 days is planned prior to pile installation at the abutments.

Settlement plates and routine monitoring should be incorporated to verify the actual rates of settlement versus expected values.

Design alternatives such as a surcharge loading and/or wick drains may accelerate settlement rates. However, since the construction schedule allows for a 110-day waiting period prior to pile installation, we do not recommend wick drains to accelerate settlement for this project.

5.1.4 Instrumentation

Piezometers are recommended to monitor settlement. The pore pressure data gathered from piezometers will provide information regarding settlement that has occurred during construction, as well as indicate if additional settlement may be expected well after construction has been completed. The recommended locations for the piezometers are summarized in the following table.

Table 5.1.4.A. Piezometer Schedule

Relative Location	Station	Offset	Top Elevation (feet)	Bottom Elevation (feet)	Max. Pore Pressure Over Initial Pressure
Rear (South) Abutment	216+94	5′ RT	704± (existing subgrade)	654±	60 PSI
Forward (North) Abutment	219+65	5′ LT	704± (existing subgrade)	654±	60 PSI

Likewise, settlement platforms are also recommended for this project to monitor settlement as fill is placed. The recommended locations for the settlement platforms are summarized in the following table.

Table 5.1.4.B. Settlement Platform Schedule

Relative	Station	Offset	Base Elevation

Location			(feet)
Ramp A & Ramp B Intersection	213+25	5' RT	702± (existing subgrade)
Rear (South) Abutment	216+94	5' LT	704± (existing subgrade)
Forward (North) Abutment	219+65	5' RT	704± (existing subgrade)
Ramp B & Ramp C Intersection	223+50	5' LT	700± (existing subgrade)

Additional discussion regarding instrumentation is provided in Section 5.9.3 of this report.

5.2 MSE Retaining Walls

The bridge abutments will be semi-integral with spread footings bearing within a mechanically stabilized earth (MSE) embankment. It is our understanding that precast concrete panels and MSE techniques will be utilized to create a vertical face at the abutments and wingwalls. The backfill material within the MSE portion of the embankment will consist of select granular backfill meeting either ODOT 703.17, Aggregate Materials for 304, or 703.11, Structural Backfill Type 2.

The retaining walls are planned to be modular structures designed by a proprietary wall manufacturer specializing in MSE wall systems. We are not privy to the particular design criteria and reinforcement features of the proprietary MSE wall that will be used for this application. Internal stability, façade details, and reinforcement features will be proprietary and the responsibility of the MSE wall supplier.

Evaluations and analyses were completed utilizing AASHTO LRFD design methods based on general MSE wall principles and geometric considerations. Soils-related evaluations and analyses are attached to this report. As indicated in the sections that follow, our analyses indicate that MSE walls will be viable systems with considerations to reinforcement length within the wall and over-excavation of cohesive soils below the wall and replacement with granular engineered fill for sliding resistance. However, the wall manufacturer should review sliding and overturning stability to verify that the resistance evaluations completed using AASHTO methods apply compatibly to their wall system.

The bottoms of the abutment foundations are indicated at Elevs. 712.70 and 712.95 at the rear and forward abutments, respectively. The tops of the MSE wall are at Elev. 714.00.

Based on proposed road grades of Elevs. 723.93 and 722.94 at the rear and forward abutments, respectively, the leveling pad foundations bearing at approximate Elevs. 696.50

and 697.00, respectively, total wall heights of proposed walls are 26.43 feet and 25.94 feet were evaluated. We understand that abutment piles will be sleeved within the MSE wall reinforced fill zone.

Evaluations and analyses performed by CT were limited to the following:

> External stability and bearing resistance,

> Global stability of MSE wall/embankment geometry at the abutments,

> Estimated settlement associated with the MSE walls, and

> Sliding and overturning/eccentricity of the MSE wall system.

Borings B-014 and B-025 were utilized for our evaluations. Sliding, overturning, and bearing resistance, global stability, and settlement analyses were considered for each of the evaluated sections.

As indicated in the attached calculation sheets, the results of external stability analyses indicate the length of the reinforced zone will need to be increased (beyond the minimum industry standard of 0.7 times the wall height) to 0.83 and 0.85 times the overall reinforced height for the rear and forward abutment, respectively.

Based on the analyses described in the following sections, minimum recommended reinforcement lengths are summarized in the following table.

Table 5.2. Minimum Recommended Reinforcement Lengths

Abutment	Rear	Forward
Effective Wall Height (feet)	26.43	25.94
Reinforcement Length (feet)	22.0	22.0
Length to Height Ratio	0.83	0.85
Undercut of cohesive bearing soils and replacement with new granular engineered fill?	No	No

As part of our analyses, an additional uniform surcharge of 250 pounds per square foot (psf) was assumed for traffic loads. For global stability and bearing resistance evaluations, traffic loads were applied from the back of the abutment and extending away from the bridge for the portions of the walls along the bridge abutments. For overturning and sliding stability evaluations, traffic loads were applied up to the back of the MSE wall.

5.2.1 Global Stability Analysis

Global stability of the proposed MSE wall was modeled using a 2-D Limit Equilibrium Slope Stability Program Slide 2.0 developed by Rocscience to evaluate the proposed retaining structure. Analyses for the retaining wall were performed to establish short-term, end-of-construction (undrained) safety factors using total stress soil parameters (TSSP) and long-term, post-construction (drained) safety factors using effective stress soil parameters (ESSP) for potential failure surfaces outside of the gravity blocks/MSE reinforced zone. The reinforced soil mass associated with the MSE wall was modeled as a "monolithic" element, essentially as a "rigid" body; internal stability of the reinforced soil mass was not evaluated. Using this program, a myriad of potential failure surfaces can be generated theoretically, from which the factor of safety can be determined as to whether sufficient resisting soil strength can be mobilized to counteract the driving forces (weight of soil, seepage, and surcharge loads) that would cause the slope to move downward. The factor of safety is the ratio of the resisting forces to the driving forces.

Global instability typically is manifested by pronounced movements of a large arc or wedge of soil that result in bulging at the toe of the slope as well as observable displacement of soil at or near the crest of the slope. This crest displacement may be exhibited by a near-vertical tension crack at the back edge of the displaced soil mass, or may be significant enough to exhibit a downward movement of soil that creates a "scarp" such that a sharp drop occurs in an otherwise level ground surface. Global instability of the embankment at this site could create a significant impact due to the potential for such movement to encompass the retaining wall and the roadway.

Soil strengths were evaluated based on unconfined compressive strength test results, hand penetrometer readings, direct shear tests, as well as SPT N_{60}-values, moisture content, unit weight (density), and soil plasticity data of the encountered soils. Additionally, correlations with published data were utilized to estimate soil properties. The gravity block/MSE wall system was modeled as a rigid body; internal stability of the retaining wall system was not evaluated.

In accordance with ODOT Supplemental Specification 840.04.A.6, the groundwater was modeled within the reinforced soil at the invert elevations of the drainage pipes. The drainage pipes are indicated to have inverts of 698.25 and 698.7 at the rear and forward abutments, respectively.

The soil parameters utilized for analysis are presented in the following table "Soil Design Parameters for Global Stability." The properties of the soil strata may vary somewhat with layer and depth; the layers and assigned soil properties used in the analyses are detailed in the attached calculations. The diagrams associated with these analyses illustrate the assumed wall geometry and potential critical failure surfaces associated with the global stability of the wall.

Table 5.2.1.A. Soil Design Parameters for Global Stability					
Layer	Total Unit Weight (psf)	Short-Term, Undrained Case (Initial Construction)		Long-Term, Drained Case (Post Construction)	
		Internal Angle of Friction, Φ (degrees)	Undrained Shear Strength (cohesion), s_u (psf)	Internal Angle of Friction, Φ (degrees)	Effective cohesion, c′ (psf)
MSE wall select granular fill	120	34	0	34*	0*
New Embankment Fill – ODOT 304	120	0	2,500	30	0
Existing cohesive fill materials	130	0	2,500	28	250
Stratum I	130	0	1,750	30.9	175
Stratum II	130	0	3,500	29.2	284
Stratum III	135	0	1,600	28.7	160
Stratum IV	135	0	5,000	38.0	359
Shale Bedrock	150	0	10,000	40.0	949

*These values, along with the proposed reinforcement, should be used by the retaining wall designer to evaluate the internal stability. This zone was modeled for our analyses using "infinite strength" such that the potential failure surfaces circumnavigate the reinforcement zone to evaluate global stability.

The granular backfill located within the reinforcement/anchorage zone behind the MSE wall was modeled assuming "infinite strength," such that potential failure surfaces circumnavigate this zone to evaluate global stability. For internal stability evaluations by the MSE wall designer, an internal angle of friction of 34 degrees should be used based on typical ODOT design criteria for proprietary walls, as well as including the proposed reinforcement. Actual strengths and unit weights of the MSE select fill (tieback) zone may vary within the design constraints for the internal stability of the MSE wall.

Global stability factors of safety determined using the most critical failure surface are presented in the following table. The table also incorporates calculated resistance factors based on the factors of safety (FoS).

Table 5.2.1.B. Global Stability Analysis Results				
Model	Short-Term, Undrained (TSSP) Case (Initial Construction)		Long-Term, Drained (ESSP)* (Post Construction)	
	Factor of Safety	Resistance Factor	Factor of Safety	Resistance Factor
Rear Abutment	5.26	0.19	2.00	0.50
Forward Abutment	4.44	0.23	1.86	0.54

*The granular backfill located within the reinforcement/anchorage zone behind the MSE wall was modeled assuming "infinite strength," such that failure surfaces circumnavigate this zone to evaluate global stability.

Based on the modeled soil profile and strength parameters, the resistance factors calculated for the short-term and long-term cases were determined to meet AASHTO standards since they were less than the recommended maximum resistance factor of 0.75 (approximate FoS=1.3) for embankments not supporting abutment foundations (which are pile-supported for these structures).

Graphical output from each analysis is attached to this report. The output graphically depicts the ten potential failure surfaces with the lowest factors of safety determined from thousands of trial failure surfaces analyzed for each case.

5.2.2 Sliding and Overturning Stability

Based on the expected MSE wall geometry and the encountered subsoils, stability analyses for sliding and overturning of the MSE wall were performed. The MSE wall was considered a monolithic, rigid structure in these analyses.

Overturning stability was evaluated by comparing the calculated eccentricity of the wall geometry to the maximum eccentricity with the resultant force within the middle two-thirds of the base of the wall. It was assumed that the backfill will consist of cohesive soils with a minimum effective internal angle of friction (ϕ') of 30 degrees behind the stabilized earth section of fill. As such, a coefficient of active earth pressure, K_a, of 0.33 was used for the overturning analysis at the abutment sections.

Using design reinforcing lengths indicated in Table 5.2, the walls were determined to be adequate with regard to eccentricity, as presented in the MSE Wall Evaluations and Calculations attached to this report.

The LRFD factored sliding resistance (R_R) is determined by $\phi_T R_T$, where R_T is the nominal sliding resistance on the base of the wall, and ϕ_T is the resistance factor. For MSE walls, ϕ_T = 1.0.

The MSE walls are anticipated to bear in Stratum II predominantly very stiff to hard native cohesive soils. For cohesive soil beneath the MSE wall, the sliding resistance may be taken as the lesser of:

> The cohesion of the clay, or

> Where footings are supported on at least 6 inches of compacted granular material, one-half the normal stress on the interface between the footing and soil.

For the analyzed MSE walls, we assumed the footings would be supported on granular material, and thus, nominal sliding resistance R_T calculations are governed by one-half the normal stress on the interface between the footing and soil. Results of external stability analysis for the abutment section indicate that the length of the reinforced zone will need to be 0.83 and 0.85 times the overall reinforced height in order to ensure sufficient resistance against sliding failure.

5.2.3 Bearing Resistance

Bearing resistance of the foundation soils was considered for the evaluated section. The MSE walls are anticipated to bear in Stratum II predominantly very stiff to hard native cohesive soils. However, the underlying Stratum III predominantly medium stiff to stiff native cohesive soils were within the influence zone. For our analyses, an average of the undrained shear strengths from Stratum II and Stratum III was conservatively used.

A resistance factor of 0.65 should be utilized for bearing resistance analyses in MSE wall design. Nominal (unfactored) bearing resistances (q_n), factored bearing resistances (q_R), and maximum factored bearing pressures for the evaluated wall sections are summarized in the following table.

Table 5.2.3 Bearing Resistance Analysis Results

Analyzed Section	Soil Strength Mode Failure	Nominal Bearing Resistance, q_n (ksf)	Factored Bearing Resistance, q_R (ksf)	Factored Bearing Pressure (ksf)	
				Service Limit State	Strength Limit State
Rear Abutment	Undrained, c = 2,550 psf	13.5	8.8	4.2	6.0
	Drained, Φ' = 28.7°	20.4	13.3		
Forward Abutment	Undrained, c = 2,550 psf	13.4	8.7	4.1	5.8
	Drained, Φ' = 28.7°	17.9	11.6		

The foundation soils beneath the proposed MSE walls, when constructed to their full heights, provides enough resistance against bearing capacity failure for undrained loading conditions. Based on ODOT guidelines, foundation plans should contain the following typical note:

The Wall 2 (rear abutment) reinforced soil mass, as designed, produces a maximum Service Limit State bearing pressure of 4.2 kips per square foot and a maximum Strength Limit State bearing pressure of 6.0 kips per square foot. The factored bearing resistance is 8.8 kips per square foot.

The Wall 3 (forward abutment) reinforced soil mass, as designed, produces a maximum Service Limit State bearing pressure of 4.1 kips per square foot and a maximum Strength Limit State bearing pressure of 5.8 kips per square foot. The factored bearing resistance is 8.7 kips per square foot.

5.2.4 Settlement

Settlement evaluation was performed for the abutment MSE wall section. Total settlement of the analyzed MSE wall sections was calculated to be on the order of 1¾ to 2¾ inches. We understand that piles will be sleeved through the MSE wall backfill to avoid downdrag loads on the piling. In any case, we have assumed that adequate time will be allotted for MSE wall settlement, and the piles will be “restruck” after 90% consolidation has occurred, such that downdrag loads will not be a design consideration for the piles.

Based on the results of the one-dimensional consolidation tests, laboratory coefficient of consolidation (c_v) values for stresses on the order of 1 to 2 tons per square foot (anticipated for the settlement bearing pressures for the new MSE fill) were determined to vary from 0.12 to 0.61 ft^2 per day. Based on a review of liquid limit values for the samples from each layer, c_v values of 0.3 ft^2 per day to greater than 2.0 ft^2 per day would be expected for these soils undergoing consolidation in the recompression range of stresses.

Based on experience, the c_v values determined for the consolidation test samples may be too low for Northwest Ohio soils. Based on the c_v values determined from published data, as well as estimated drainage lengths in the compressible strata on the order of 2 to 16 feet, we estimate that 90 percent of the settlement due to the MSE wall fill and new abutment fill is expected to occur within approximately 1 to 5 months from completion of fill construction. We recommend that settlement be monitored to verify that the majority of the settlement has occurred prior to construction of the stub abutment resulting in post-construction settlement that is negligible.

Due to the underlying Stratum III predominantly medium stiff to stiff cohesive soils, pore pressure monitoring will be required to evaluate effective stress conditions associated with consolidation and strength gain in the foundation soils. Fill placement will need to be stopped temporarily if pore pressures exceed 60 psi above pre-construction levels at the rear abutment and forward abutment.

Differential settlement along the walls will depend on localized variations in the subsurface profile. In general, the settlement is expected to be relatively uniform, with maximum differential settlement over the entire wall length estimated to be less than 0.32 inches per 100 inches, within the tolerable differential settlement criterion of 1/100 typically used for MSE walls with pre-cast facing elements.

5.3 Bridge Foundations

We understand that the new bridge will be a two-span structure. The bridge abutments will be semi-integral with spread footings bearing within a mechanically stabilized earth (MSE) embankment. Foundations for the abutments and pier are planned to consist of driven piles.

5.3.1 Driven Piles Foundations

It is planned to support the abutments and pier on pile foundations. For friction piles, the ODOT Bridge Design Manual (BDM) indicates that piles should be specified as CIP pipe piles. For the abutments and pier, 1 foot of stickup is planned into the pile cap. Maximum total factored load for the abutment piles were indicated to be 244 kips, and 247 kips for pier piles. It was also indicated that the piles would be 14-inch diameter piles.

Pile resistance analyses were performed for each pier location using FHWA pile analysis software DRIVEN. In the DRIVEN analyses, adhesion for cohesive soils was modeled using the Tomlinson method (1979). Based on our experience in Northwest Ohio, the lower profile "hardpan" layer is better modeled by treating these soils as an FHWA "cohesionless" soil by assigning an effective internal angle of friction (ϕ') to this layer, and therefore, the "hardpan" layer was modeled using a ϕ' value of 38 degrees, based on an average SPT N_{60}-value of 71 bpf. Resistance for granular soils was determined by the Peck, Hanson, and Thornburn method (1974).

Results of the DRIVEN analyses are attached to this report in Appendix E, and are summarized in the following table. The summary table includes the estimated pile length and order length. The estimated pile length includes the calculated length from anticipated pile cut-off elevation to pile tip elevation, rounded to the nearest 5 feet. The order length is the estimated length plus 5 feet.

Table. 5.3.1. Estimated CIP Pipe Pile Lengths and Order Lengths

Location	Boring Number	Bottom of Pile Cap Elevation (feet)	Pile Cut-Off Elevation (feet)	Recommended (Minimum) Pile Tip Elevation (feet)	Estimated Pile Length (feet)	Order Pile Length (feet)
Rear (South) Abutment	B-014	712.70	713.70	661.0	55	60
Pier	B-019	695.50	696.50	658.7	40	45
Forward (North) Abutment	B-025	712.95	713.95	660.0	55	60

Potential downdrag loads on piles due to settlement of the upper profile soils induced by embankment fill could significantly affect design foundation loads and may preclude the use of friction piles. If piles are to be installed before 60 percent settlement has occurred from the embankment fill (discussed in Section 5.1.3), it would likely be necessary to protect pile foundations from downdrag forces and under this circumstance, friction piles may not be feasible.

The maximum center-to-center spacing of driven piles should be 8 feet for capped pile abutments and the front row of stub abutments per ODOT BDM specifications. The maximum center-to-center spacing of driven piles should be 7 feet for the front row of wall-type abutments and retaining walls.

Driven piles should be installed under adequate specifications and monitored by a qualified geotechnical engineer. A static pile load test (ASTM D 1143) is required only if the total pile order length for an individual structure exceeds 10,000 feet for piling of the same size and capacity. As such, a static pile load test is not expected to be required for this project. However, as mentioned previously, pile design is based on piles installed in accordance with ODOT CMS Item 523 "Dynamic Load Test." ODOT typically requires dynamic load testing to establish the driving criteria (i.e., blow count) for all piling not driven to refusal on bedrock. For an individual structure, the Designer shall specify one dynamic load testing item for each pile size. If multiple pile capacities are required for a given pile size, the Designer shall specify one testing item for each pile size. If multiple pile capacities are required for a given pile size, the Designer shall specify one testing item for each capacity. Although not anticipated, if static load tests are required, additional provisions include two dynamic load testing items and two restrike items for each static load test item. One dynamic load testing item consists of testing a minimum of two piles and performing a Case Pile Wave Analysis Program (CAPWAP) analysis on one of the two piles. One restrike item consists of performing dynamic testing on two piles and performing CAPWAP analysis on one of the two piles. Driven piles should be installed under adequate specifications and monitored by a qualified geotechnical engineer.

If suitable pile resistance is not observed in the field with driving of the entire pile order length, a pile setup period may be required. The ODOT BDM indicates a minimum 7-day waiting period. It is our experience that pile setup can occur within a few days, but more typically occurs within one to three weeks.

While cobbles and/or boulders were not encountered in the borings performed for this investigation, they are not uncommon in glacial till soils such as those present at this site. These conditions, if encountered, could hamper pile-driving operations and possibly damage some piles. If some piles are observed to meet refusal at depths markedly less than those indicated by the borings, cobble or boulder obstruction may be indicated. If these conditions are persistently encountered, a pile load test should be performed to evaluate the capacity of the pile(s). Alternately, for a project of this size, one or more replacement piles could be driven, at less expense than the cost of a load test.

5.3.2 Driveability Analysis

WEAP evaluations were performed using GRLWEAP™ software considering the ultimate capacity planned for this project.

The planned pile hammer for the project was not indicated at this time. A Delmag D 19-42 hammer was utilized for this evaluation. Pile hammer and associated hammer cushion standard data from GRLWEAP™ software were utilized for our evaluations.

Soil input data was initially generated using FHWA DRIVEN for each evaluated boring, with parameters modified based on the recommended procedure outlined in ODOT GDM 1304.2.1.

Our evaluations considered the largest pile evaluated for this project, using properties following the recommended procedure outlined in ODOT GDM 1304.2.2.

Results of the WEAP evaluations at the UBV / maximum R_{ndr} planned for this project are summarized in the following table, and are attached to this report.

Table 5.3.2. Summary of WEAP Results at Planned UBV / Maximum R_{ndr}

Location	Associated Boring Number	Delmag D19-42	
		Maximum Compression Stress (ksi)	Blow Count (blows/ft)
Rear Abutment	B-014	40.7*	135.9**
Pier	B-019	41.4*	130.2**
Forward Abutment	B-025	27.6	13.3

*For an ASTM A709 50 ksi steel pile, overstress constitutes any compressive stress greater than 0.9 φda fy = (0.9)(1.00)(50 ksi) = 45 ksi. A 50 ksi steel pile should be planned at the Rear Abutment and Pier.
**The evaluated blow count exceeds the hammer refusal considered at 100 blows/ft for both the rear abutment and pier locations. However, this blow count is only observed within one pile diameter of the minimum tip elevation determined using DRIVEN. As such, sufficient resistance is anticipated once pile driving is ceased at 100 blows/ft.

If a pile hammer other than what was utilized for this evaluation is planned for this project, the evaluation should be performed using that hammer. Additionally, if the values presented in the above table are not suitable for design, alternative pile hammers could be evaluated.

5.4 Culvert Support and Installation

It is our understanding that new box culverts will be required to maintain streamflow in Brooks Ditch below Ramp B and Ramp C. The culverts will be constructed with full height headwalls.

Bridge No. HEN-00024-0029 (SFN 3501509) is planned under Ramp C. The proposed culvert will have an 12-feet span, 8-feet rise, and approximately 82 feet in length. The culvert inverts are indicated to be Elevs. 692.95 and 692.59 at the inlet and outlet, respectively, with foundations bearing at a depth of 3 feet below the inverts.

Bridge No. HEN-00024-0053 (SFN 3501511) is planned under Ramp B. The proposed culvert will have an 12-feet span, 8-feet rise, and approximately 53 feet in length. The culvert inverts are indicated to be Elevs. 692.15 and 691.96 at the inlet and outlet, respectively, with foundations bearing at a depth of 3 feet below the inverts.

5.4.1 Culvert Support

Based on the conditions encountered in Borings B-009, B-011, B-028, and B-030, the soils at the anticipated invert depths are expected to consist of Stratum II predominantly very stiff to hard cohesive soils, all which are considered generally suitable for the support of the proposed culvert, using bedding materials in accordance with ODOT Construction and Material Specifications (CMS) and manufacturer's guidelines.

Although not anticipated to be prevalent, if unsuitable soils are encountered at the invert elevations, they must be undercut to firm subgrade conditions. In areas of extensive poor subgrade conditions, unsuitable soils should be undercut as needed to establish a stable base for support of the culvert. The undercut zones should be replaced with engineered fill, properly placed and compacted as outlined in Section 5.9.2 of this report. If saturated soil or groundwater seepage is encountered, we recommend that a coarse, open-graded aggregate be utilized (ODOT Table 703.01-1, No. 57 or No. 67 stone).

We recommend that the culverts be installed as soon as practical after excavation operations and that water not be allowed to pond in the excavation. If it is necessary to leave the exposed subgrade open for any extended period of time, the contractor may need to undercut the subgrade soils below the design bearing elevation, and replace the bottom of the excavation with 12 inches of stone to facilitate dewatering and maintenance of a firm subgrade condition. Should an excavation be allowed to collect and pond water, it may be necessary to undercut saturated or unstable subgrade and replace it with additional stone.

Along the proposed culvert alignment, we recommend that the trench excavation at the invert elevation of the proposed culvert be inspected by a geotechnical engineer or qualified representative. This is to confirm that the bearing soils are consistent with those encountered in the test borings, and that the exposed materials are capable of supporting the proposed culvert and/or that engineered fill has been properly placed and compacted.

5.4.2 Open-Cut Installation Methods

The sides of the temporary excavations for culvert installation should be adequately sloped to provide stable sides and safe working conditions. Otherwise, the excavation must be properly braced against lateral movements. In any case, applicable Occupational Safety and Health Administration (OSHA) standards must be followed. It is the responsibility of the installation contractor to develop appropriate installation methods and specify pertinent equipment prior to commencement of work, and to obtain the services of a geotechnical engineer to design or approve sloped or benched excavations and/or lateral bracing systems as required by OSHA criteria.

Although the encountered cohesive soils and anticipated "normal" groundwater at or near the culvert invert the culvert invert should be generally conducive to stable excavation slopes, provisions should be made for the culvert installation to proceed as a sloped-bank excavation, or as a steeper trench-type cut with properly designed and installed lateral bracing. The latter system may include the use of a portable trench box or a sliding trench shield.

If the excavation is to be performed with sloped banks, adequate stable slopes must be provided in accordance with OSHA criteria, summarized in Section 5.9.4 of this report.

Depending on streamflow and ditch water levels at the time of construction, it may be advantageous to utilize temporary sheetpiling to support excavations that will extend below stream level.

5.5 Headwall Foundations

5.5.1 Bridge No. HEN-00024-0029 (SFN 3501509)

The headwall/wingwall footings are shown at the inlet to bear at Elev. 689.95, with a width of 7 feet, and a total length of approximately 43.9 feet. At the outlet, the headwall/wingwall footings are shown to bear at Elev. 689.56, with a width of 7 feet, and a total length of approximately 46.1 feet.

Based on the conditions encountered in the borings, the soils at the anticipated culvert headwall bearing elevations are expected to consist of Stratum II predominantly very stiff to hard native cohesive soils, which are considered generally suitable for support of the proposed headwall foundations. As with any installation within a ditch area, there may be areas of encountered sediment or softened/saturated soils at bearing elevations, which would require over-excavation. The bearing soils should be confirmed as being native cohesive soils with an unconfined compressive strength of at least 7,000 pounds per square foot (hand penetrometer reading of 3.5 tsf or greater).

We understand that the culvert bearing slab will be designed using LRFD specifications. At the **strength** limit state, we recommend a nominal bearing resistance (q_n) of 18.6 ksf for the culvert base bearing in Stratum II predominantly very stiff to hard native cohesive soils. At the strength limit state, the resistance factor (ϕ_b) is 0.5. Therefore, the factored bearing resistance (q_r) is 9.3 ksf. From a conventional allowable stress design comparison, this is roughly akin to calculating an ultimate bearing capacity and applying a factor of safety.

At the **service** limit state, a nominal (unfactored) bearing resistance (q_n) of 6 kips per square foot (ksf) was determined for the culvert base bearing in Stratum II predominantly very stiff to hard native cohesive soils. At the service limit state, the resistance factor (ϕ_b) is 1.0. Therefore, the factored bearing resistance (q_r) is 6 ksf. From a conventional allowable stress design comparison, this is roughly akin to using an allowable bearing pressure. **It should be noted that settlement may be beyond tolerable limits should a culvert exhibit this magnitude of bearing pressure.**

Settlement of the culvert was calculated by conventional consolidation theory utilizing recompression indices for the over-consolidated cohesive soils based on the results of consolidation testing for Strata II and III, as well as correlations with moisture content for Stratum IV (hardpan). The bearing pressure at the base of the wingwall was indicated to be 2.84 ksf, for which settlement was calculated to be on the order of 2¼ to 2¾ inches. If the service loading exceeds 2.84 ksf, increased settlement would be expected. As such, it is our recommendation to limit the service limit bearing resistance to match the loading requirement.

5.5.2 Bridge No. HEN-00024-0053 (SFN 3501511)

The headwall/wingwall footings are shown at the inlet to bear at Elev. 689.15, with a width of 6 feet, and a total length of approximately 44.1 feet. At the outlet, the headwall/wingwall footings are shown to bear at Elev. 688.96, with a width of 6 feet, and a total length of approximately 44.3 feet.

Based on the conditions encountered in the borings, the soils at the anticipated culvert headwall bearing elevations are expected to consist of Stratum II predominantly very stiff to hard native cohesive soils, which are considered generally suitable for support of the proposed headwall foundations. As with any installation within a ditch area, there may be areas of encountered sediment or softened/saturated soils at bearing elevations, which would require over-excavation. The bearing soils should be confirmed as being native cohesive soils with an unconfined compressive strength of at least 7,000 pounds per square foot (hand penetrometer reading of 3.5 tsf or greater).

We understand that the culvert bearing slab will be designed using LRFD specifications. At the **strength** limit state, we recommend a nominal bearing resistance (q_n) of 18.6 ksf for the culvert base bearing in Stratum II predominantly very stiff to hard native cohesive soils. At the strength limit state, the resistance factor (ϕ_b) is 0.5. Therefore, the factored bearing resistance (q_r) is 9.3 ksf. From a conventional allowable stress design comparison, this is roughly akin to calculating an ultimate bearing capacity and applying a factor of safety.

At the **service** limit state, a nominal (unfactored) bearing resistance (q_n) of 6 kips per square foot (ksf) was determined for the culvert base bearing in Stratum II predominantly very stiff to hard native cohesive soils. At the service limit state, the resistance factor (ϕ_b) is 1.0. Therefore, the factored bearing resistance (q_r) is 6 ksf. From a conventional allowable stress design comparison, this is roughly akin to using an allowable bearing pressure. **It should be noted that settlement may be beyond tolerable limits should a culvert exhibit this magnitude of bearing pressure.**

Settlement of the culvert was calculated by conventional consolidation theory utilizing recompression indices for the over-consolidated cohesive soils based on the results of consolidation testing for Strata II and III, as well as correlations with moisture content for Stratum IV (hardpan). The bearing pressure at the base of the wingwall was indicated to be 2.59 ksf, for which settlement was calculated to be on the order of 2 to 2½ inches. If the service loading exceeds 2.59 ksf, increased settlement would be expected. As such, it is our recommendation to limit the service limit bearing resistance to match the loading requirement.

5.5.3 Additional Headwall Foundation Considerations

Although not anticipated to be prevalent, if unsuitable bearing soils are encountered during culvert installation, over-excavation should extend through these materials to suitable bearing soils. The base of the over-excavation should be widened 6 inches for every foot of depth extending beyond the edge of the culvert. For the relatively high strength limit state factored bearing resistance of 9.3 ksf and service limit state factored bearing resistance of 6 ksf (if utilized) indicated above, the over-excavated areas should be backfilled with lean concrete having a minimum compressive strength of 1,500 pounds per square inch (psi) or other flowable controlled-density fill having a minimum compressive strength of 300 psi. If design incorporates a strength limit state and service limit state factored bearing resistance of 4 ksf or less, then dense-graded aggregate may be utilized for backfill. The aggregate should be placed and compacted as described in Section 5.9.2. If foundations will be placed at the base of the over-excavation or the lean concrete fill option will be utilized, widening the footing over-excavation will not be required. If the controlled-density fill option is utilized, the footing over-excavation shall be widened as discussed above.

For culvert walls that are restrained at the top of the wall, lateral earth pressures should be assumed for "at-rest" conditions. It is anticipated that excavated on-site cohesive soils will comprise the majority of the backfill behind the new culvert walls. For the cohesive soils, an active earth pressure coefficient (k_a) of 0.31 should be used in determining the lateral pressure acting on the walls, along with a total (moist) soil unit weight of 130 pounds per cubic foot (pcf).

If lower at-rest earth pressures are preferred for structural reasons, we recommend that a select, free-draining granular fill (such as No. 57 or 67 stone) be utilized for the entire culvert backfill zone extending to the surface from the base of the wall at 45 degrees. For these granular fill types, k_o may be taken as 0.4, and the soil unit weight may be assumed as 120 pcf.

Lateral load due to hydrostatic pressures below the design groundwater depth should be included in design of below-grade walls. Additionally, the earth pressures indicated above are based on a level backfill condition behind the culvert wall. If there are areas beyond the horizontal roadway portion of the backfill area that include sloping backfill behind the top of the wall, surcharge loading or equivalent higher earth pressure coefficients should be evaluated, based on backfill material, backfill slope, and proximity to the wall. In general, 50 percent of the vertical surcharge load may be assumed for lateral loading in the design of the wall.

Backfill for the culvert should be placed concurrently on both sides to avoid unbalanced forces that could cause sliding. If this method of backfilling is not possible and one side will be backfilled prior than the other, sliding can be evaluated as presented below.

We recommend that passive pressure be considered negligible at the toe of the wall due to the potential for erosion and/or freeze-thaw behavior that would significantly reduce reliance on passive earth pressure. As such, the LRFD nominal sliding resistance (R_R) is determined by $\phi_T R_T$, where R_T is the nominal sliding resistance on the base of the footing.

For cohesive soils, nominal sliding resistance R_T is the lesser of the following:

- The cohesion (c) of the clay, for which we recommend c be taken as 3,500 psf, or
- Although not anticipated to be the case, where footings are supported on at least 6 inches of compacted granular material, one-half the normal stress on the interface between the footing and soil.

For sliding resistance on clays, the resistance factor ϕ_T should be taken as 0.85.

We recommend all slopes on the toe side of the headwall have erosion protection, such as vegetated topsoil, riprap, and/or man-made materials. Seeding of the exterior slopes should be completed as soon as possible after construction is complete.

5.5.4 Standard Headwall Foundation Considerations

It was indicated that slightly modified ODOT standard concrete headwalls for precast box culverts (Sheet HWDD-1) will be utilized for this project. The standard concrete headwalls are indicated to be based on design using a minimum undrained shear strength (s_u), or cohesion (c), of 1,500 pounds per square foot (psf) when the walls are bearing on cohesive soils. The design s_u or c value for the Stratum II predominantly very stiff to hard cohesive bearing soils encountered during this investigation is 3,500 psf, which meets the minimum design requirement. Likewise, the standard concrete headwalls are indicated to be based on an internal angle of friction (drained) of $\phi' = 28$ degrees for foundation soil. Based on the results of direct shear testing, we estimate a ϕ' of at least 29 degrees for the foundation soil, which also meets the minimum design requirement.

It should be noted that the standard headwall design values are based on backfill with a slope not exceeding 2 horizontal to 1 vertical (2H:1V) consisting of soil with an internal angle of friction (ϕ) of at least 30 degrees and a total soil unit weight of 120 pounds per cubic foot (pcf) or less. As such, the backfill behind headwalls should not consist of on-site excavated cohesive soils, since they do not meet these criteria. Rather, a select, free-draining granular fill (such as No. 57 or 67 stone) could be utilized. For these granular fill types, ϕ may be taken as 37 degrees, and the soil unit weight may be assumed as 120 pcf. This material should be placed for the entire headwall backfill zone extending to the surface from the base of the wall at 63 degrees from the horizontal [Slip Line/Failure Envelope of 45 + (ϕ/2) degrees for active earth pressure condition].

We recommend all slopes on the toe side of the wall have erosion protection, such as vegetated topsoil, riprap, and/or man-made materials. Seeding of the exterior slopes should be completed as soon as possible after construction is complete.

5.6 GDM Section 600 "Plan Subgrades" Evaluation

5.6.1 Subgrade Analysis Worksheet

For portions of the project where pavement subgrade borings were performed for new roadway and ramp alignment that will approximate existing roadway alignment without significant grade change, an evaluation of the subgrade soils was completed in general accordance with ODOT Geotechnical Design Manual (GDM) Section 600 (July 2023). As part of this evaluation, the ODOT "Subgrade Analysis" worksheet (V14.6, 02/11/22) was completed and is attached to this report.

Based on "Typical Sections" sheets for the project provided with the Stage 2 Submittal, dated August 14, 2023, our evaluations considered pavement cross-sections of 17 inches (approximately 1.4 feet) the proposed ramp superelevated sections, and 15.25 inches (approximately 1.3 feet) for the new County Road 17D pavements and pavements extending along the shoulders of US 24 which precede stationing for the proposed ramps.

Based on GDM Section 600, soils classified as ODOT A-4b, A-2-5, A-5, A-7-5, A-8a, A-8b, or rock have been designated as being problematic with respect to pavement subgrade support. None of these soil types were encountered at planned subgrade elevations in the borings performed for this exploration.

Based on GDM Section 600 criteria, subgrade soils with moisture contents greater than 3 percent above optimum likely indicate the presence of unstable subgrade that may require some form of subgrade modification. For this site, approximately 37 percent of tested cohesive subgrade soil samples and 75 percent of granular soils were greater than 3 percent above the optimum as determined using GDM Section 600 criteria.

It should be noted that all but eight of the 41 evaluated samples with moisture contents greater than 3 percent above optimum had moisture contents greater than or equal to 5 percent above optimum. Thus, where moisture contents were wet of optimum, they were appreciably wet of optimum. These data indicate that scarification and aeration methods may not be feasible to achieve satisfactory proof rolling and stabilization of the predominantly cohesive subgrades. However, scarification and aeration methods may be utilized in areas where granular subgrades wet of optimum are present, provided weather conditions and construction schedule will allow such soil modification.

The type and thickness of subgrade modification is determined by GDM Section 600 criteria based on the average, low SPT N_{60}-value (N_{60L}) of the subgrade soils in a particular portion of the project area, hand penetrometer values, soil type, and moisture content. Based on these criteria, approximately each of the borings contained subgrade soils which indicated subgrade modification is likely to be required. Possible alternatives for those areas where modification of the subgrade soils is indicated could include the following, using GDM Section 600 criteria based on the encountered conditions:

> Global undercut to a depth of 12 inches (15 inches along Ramp B) and replacement with geotextile and granular engineered fill, or

> global chemical stabilization to a depth of 12 inches (14 inches along Ramp B).

The subgrade analysis spreadsheet indicates lime or cement stabilization as an option of this project. It is our understanding that recent projects in Northwest Ohio, which included similar cohesive soils to those at this project site, were planned to include global lime stabilization for subgrade modification. It was indicated that, for some of those projects, suitable strength could not be achieved with lime stabilization mix designs using a typical/economical lime percentage.

If it is planned to use the undercut and replacement option, a summary of the depths of undercut and replacement indicated by the subgrade analysis based on the borings performed along each segment are presented in the following tables.

Table 5.6.1.A. Subgrade Analysis Indicated Undercut Depths – County Road 17D			
Boring Number(s)	Recommended Depth of Undercut and Replacement with Granular Engineered Fill (inches)	Recommended Subgrade Modification Approximate Extents	Approximate Project Segment Length (feet)
B-016 and B-017	No treatment indicated by Subgrade Analysis	Sta. 207+88 (Start of Project) to Sta. 211+75	387
B-021 through B-023		Sta. 225+50 to Sta. 229+96 (End of Project)	446

Table 5.6.1.B. Subgrade Analysis Indicated Undercut Depths – Ramp A			
Boring Number(s)	Recommended Depth of Undercut and Replacement with Granular Engineered Fill (inches)	Recommended Subgrade Modification Approximate Extents	Approximate Project Segment Length (feet)
B-003	15	Sta. 127+72 (US 24, Start of Ramp) to Sta. 130+00 (US 24)	200
B-005 through B-010	No treatment indicated by Subgrade Analysis	Sta. 130+00 (US 24) to Sta. 130+77 (US 24)	77
		Sta. 400+77 (Ramp A) to Sta. 412+00 (6 feet embankment height)	1,123

Table 5.6.1.C. Subgrade Analysis Indicated Undercut Depths – Ramp B			
Boring Number(s)	Recommended Depth of Undercut and Replacement with Granular Engineered Fill (inches)	Recommended Subgrade Modification Approximate Extents	Approximate Project Segment Length (feet)
B-028 Through B-031	No treatment indicated by Subgrade Analysis	Sta. 503+50 (6 feet embankment height) to Sta. 512+50 (Ramp B)	900
B-033	21	Sta. 512+50 (Ramp B) to Sta. 514+10 (Ramp B)	160
		Sta. 158+61 (US 24) to Sta. 161+25 (US 24)	264
B-035	No treatment indicated by Subgrade Analysis	Sta. 161+25 (US 24) to Sta. 165+25 (US 24)	400
B-037	12	Sta. 165+25 (US 24) to Sta. 169+25 (US 24)	400
B-038	18	Sta. 169+25 (US 24) to Sta. 171+11 (End of Project)	186

Table 5.6.1.D. Subgrade Analysis Indicated Undercut Depths – Ramp C			
Boring Number(s)	Recommended Depth of Undercut and Replacement with Granular Engineered Fill (inches)	Recommended Subgrade Modification Approximate Extents	Approximate Project Segment Length (feet)
B-001	No treatment indicated by Subgrade Analysis	Sta. 121+31 (US 24, Start of Project) to Sta. 124+00 (US 24)	269
B-002	12	Sta. 124+00 (US 24) to Sta. 128+00 (US 24)	400
B-004	No treatment indicated by Subgrade Analysis	Sta. 128+00 (US 24) to Sta. 132+00 (US 24)	400
B-006	12	Sta. 132+00 (US 24) to Sta. 133+81 (US 24)	181
		Sta. 603+81 (Ramp C) to Sta. 606+00 (Ramp C)	219
B-008 through B-011	No treatment indicated by Subgrade Analysis	Sta. 606+00 (Ramp C) to Sta. 614+00 (6 feet embankment height)	800

Table 5.6.1.E. Subgrade Analysis Indicated Undercut Depths – Ramp D			
Boring Number(s)	Recommended Depth of Undercut and Replacement with Granular Engineered Fill (inches)	Recommended Subgrade Modification Approximate Extents	Approximate Project Segment Length (feet)
B-029 and B-032	No treatment indicated by Subgrade Analysis	Sta. 700+00 (Ramp A) to Sta. 712+75 (Ramp A)	1,275
B-034	12	Sta. 712+75 (Ramp A) to Sta. 715+45 (Ramp A)	270
		Sta. 161+74 (US 24) to Sta. 163+25 (US 24)	150
B-036	No treatment indicated by Subgrade Analysis	Sta. 163+25 (US 24) to Sta. 164+74 (US 24, Start of Ramp)	149

It should be noted that, in the above tables, transitions were based on the station approximately half way between borings indicating areas of recommended treatment and borings indicating no treatment or varying undercut depth was required by subgrade analyses.

Based on the Subgrade analysis results for County Road 17D, it is anticipated that over-excavation and replacement with new granular engineered fill will be more economical for this portion of the project compared to global chemical stabilization with lime or cement.

Based on the Subgrade analysis results for the ramps, it is anticipated that global chemical stabilization to a depth of 12 inches along Ramps A, C, and D, or 14 inches along Ramp B, will be more economical compared to over-excavation and replacement with new granular engineered fill.

5.6.2 Construction Considerations

Undercut and Replacement Option

Where undercut and replacement is utilized, all fill should consist of ODOT Item 304 Aggregate Base or Item 703.16C, Granular Material Type B or Type C. As prescribed by GDM Section 600 criteria, excavate unstable subgrades to 18 inches beyond the edge of the surface of the pavement, paved shoulders, or paved medians, including under new curbs and gutters. Always drain the excavation to an underdrain, catch basin, or pipe. It is recommended that geotextile fabric (referenced in ODOT Item 204, and specified as ODOT Item 712.09, Type D) be utilized on the subgrade at the bottom of the undercut zone. Although not anticipated to be required based on the conditions encountered in the borings and the proposed sections and grades, if particularly unstable subgrades are encountered during construction, or undercuts exceed approximately 18 inches, a geogrid could be used to reduce the total undercut and replacement of the unsuitable soils by 6 inches. Do not use geotextile or geogrid in the areas of underdrains.

Chemical Stabilization Option

GDM Section 600 indicates that, if it is determined that 30 percent or more of the subgrade area must be stabilized, consideration should be given to stabilizing the entire project (global chemical stabilization).

The total estimated length for the undercuts outlined in Tables 5.6.1.B through 5.6.1.E is 2,430 feet, which equates to approximately ½ mile. As such, for projects where the total length of required undercuts is equal to or greater than 0.1 mile, it is common that global chemical stabilization to a depth of 12 inches can be more economical compared to over-excavation and replacement with new granular engineered fill.

However, more than half of the total length of subgrade that requires modification (1,658 feet total) is located along ramps that abut US 24. In these areas, narrow subgrade widths and tight corners increase the difficulty of chemical stabilization such that over-excavation and replacement may be more economical. Regardless, more than 0.1 mile length remains for stabilization along the proposed ramps such that chemical stabilization can still be performed economically.

Cement should be considered for chemical stabilization of the project. Based on GDM Section 600 guidelines, 5 percent cement may be specified to estimate the quantity of cement required for the project. Based on the GDM Section 600 prescribed method (using a dry density of 115 pounds per cubic foot), the quantity of cement for a depth of 12 inches would be 51.75 pounds per square yard. When performing chemical stabilization design, use the dry density of the soil on the project as determined in the field.

As prescribed by GDM Section 600 criteria, chemical stabilization must extend 18 inches beyond the edge of the pavement surface (on both sides), and where appropriate, 18 inches beyond paved shoulders or paved medians, including under new curbs and gutters.

General

Consideration should be given to the maintenance of traffic plan and the amount of time required to stabilize the subgrades. Based on the drawings submitted with the Stage 2 submittal dated August 14, 2023, trench widening will only occur on one side of the pavement at a time, and the trench widening shall be completed to a depth of no more than 3 inches below the existing pavement by the end of each workday. As such, in the areas that abut US 24, chemical stabilization is not feasible given the five- to six-day window required for curing chemical stabilized subgrade soils in accordance with ODOT Item 206.

It should be noted that subgrade analyses are used as a pre-construction tool to plan subgrade modification alternatives. **Actual subgrade modification will depend on field observations of proof-rolling conditions at the time of construction.** Changes in soil moisture content could create more or less favorable subgrade conditions that may result in adjustments to subgrade modification or soil stabilization requirements at the time of construction.

5.6.3 Sulfate Content Considerations

As required by GDM Section 600, sulfate content tests (ODOT Supplement 1122) were performed on a sample within the upper 3 feet of proposed subgrades. The sulfate content test results are summarized in the following table.

Table 5.6.3. Sulfate Content							
Boring Number	Sulfate Content (mg/kg)		Boring Number	Sulfate Content (mg/kg)		Boring Number	Sulfate Content (mg/kg)
B-001	250		B-008	230		B-033	240
B-002	230		B-009	260		B-034	230
B-003	240		B-011	250		B-035	<100
B-004	230		B-015	240		B-036	<100
B-005	240		B-016	250		B-037	240
B-006	240		B-022	240		B-038	230
B-007	240		B-023	250			

GDM Section 600 indicates that chemical stabilization cannot be utilized when sulfate contents for the majority of the samples exceed 3,000 parts per million (ppm), or individual soil samples exhibit sulfate contents of greater than 5,000 ppm. Based on the tested samples, sulfate content will not preclude the use of chemical stabilization for this project.

5.6.4 Planned Subgrade Modification Recommendation

Based on the subgrade analysis and our understanding of the project, is our recommendation to plan for a global undercut generally to a depth of 12 inches (15 inches along Ramp B) and replacement with geotextile and granular engineered fill extending along US 24 from taper to gore. For the subgrades along the ramps, extending from the gore to where embankment fill is less than 6 feet in height, global chemical stabilization using cement or lime is recommended to a depth of 12 inches along Ramps A, C, and D, and to a depth of 14 inches along Ramp B.

5.7 Flexible (Asphalt) Pavement Design

The majority of the alignment will require embankment fill to achieve pavement subgrade elevations. The design CBR value for asphalt pavements should consider the material that will be utilized for embankment fill.

For portions of the project where pavement subgrade borings were performed for new roadway and ramp alignment that will approximate existing roadway alignment without significant grade change, based on the subgrade analysis, a design CBR value of 5 percent was determined for each of the segments of the project. It should be noted that the CBR determination by the subgrade analysis spreadsheet is based on the average Group Index of all the evaluated samples, which was 13. Group indices for the tested samples ranged from 0 to 17, which would correlate with a CBR value of 3 to 12 percent. Based on the average design value calculations from the subgrade analysis spreadsheet, it does not appear to be unconservative to use the spreadsheet design CBR value of 5 percent for new pavement sections throughout the project area.

Based on the ODOT Pavement Design Manual (PDM), the subgrade resilient modulus (M_r, in psi) is calculated by multiplying the CBR value by 1,200. Therefore, the M_r for this project would be 6,000 psi. If global chemical stabilization is utilized, the ODOT PDM indicates that the improved subgrade resilient modulus due to global chemical stabilization ($M_{r\text{-}GCS}$) is calculated by multiplying the M_r value by 1.36. Therefore, for this project, the $M_{r\text{-}GCS}$ would be 8,160 psi.

It should also be noted that the design CBR value is based on subgrades compacted to at least 100 percent of the maximum dry density as determined by ASTM D 698 (Standard Proctor) or verified as stable through proof-rolling in accordance with Section 5.3 of this report.

All pavement design and paving operations should conform to ODOT specifications. The pavement and subgrade preparation procedures outlined in this report should result in a reasonably workable and satisfactory pavement. It should be recognized, however, that all pavements need repairs or overlays over time as a result of progressive yielding under repeated loading for a prolonged period.

It is recommended that proof rolling, placement of aggregate base, and placement of asphalt be performed within as short a time period as possible. Exposure of the aggregate base to rain, snow, or freezing conditions may lead to deterioration of the subgrade and/or base materials due to excessive moisture conditions and to difficulties in achieving the required compaction.

5.8 Construction Dewatering and Groundwater Control

As stated previously, groundwater was encountered during drilling in five borings at depths ranging from 6½ to 58 feet below existing grades (approximate Elevs. 696 to 640), and was observed upon completion of drilling four borings at depths ranging from approximately 18 to 55 feet (approximate Elevs. 682 to 642).

Based on the limited data available, such as the soil characteristics and the moisture conditions encountered in the borings, it is our opinion that the “normal” groundwater level may be encountered at a depth of 11 to 13 feet below existing grades (approximate Elevs. 691 to 684). It should be noted that groundwater elevations can fluctuate with seasonal and climatic influences. In particular, “perched” groundwater may be encountered at the soil/bedrock interface.

Based on the predominantly clayey soil profile at the site, adequate control of seasonal groundwater seepage, perched water, and surface water run-off into shallow excavations should be achievable by minor dewatering systems, such as pumping from prepared sumps.

5.9 Construction

5.9.1 Site and Subgrade Preparation

Site and subgrade preparation activities should conform to ODOT CMS Item 204 specifications.

Upon completion of the clearing and undercutting activities, all areas that are to receive fill, or that have been excavated to proposed final subgrade elevation, should be inspected by a geotechnical engineer.

Pavement subgrades should be proof rolled in accordance with ODOT CMS 204.06. The subgrade analysis for areas where new roadway alignment approximate existing roadway alignment without significant grade change indicates that modification should be anticipated to be required. Subgrade analysis evaluations indicate undercuts ranging from 12 to 21 inches and replacement with new granular engineered fill.

Where new embankment fill is placed to achieve pavement subgrade elevations, the subgrade soils should be suitable for support of the new pavements unless they are disturbed by weather or construction traffic.

5.9.2 Fill

Material for engineered fill or backfill required to achieve design grades should meet ODOT Item 203 “Embankment Fill” placement and compaction requirements.

The upper profile on-site soils consist of predominantly cohesive existing fill materials as well as native cohesive soils, with isolated areas of granular existing fill materials. For the cohesive soils, a sheepsfoot roller should provide the most effective soil compaction. Where granular existing fill materials are encountered, and where new dense-graded aggregate pavement base materials are placed, a vibratory smooth-drum roller would be required to provide effective compaction.

5.9.3 Instrumentation

Settlement platforms and vibrating wire piezometers shall be installed prior to beginning the placement of the backfill. Survey points at each substructure unit shall be established and monitored on a regular basis.

Vibrating wire piezometers shall be installed per manufacturer instructions and specifications and per ODOT Geotechnical Design Manual guidelines. The piezometers shall provide pore water pressure readings at about 5-foot intervals from 5 feet to 50 feet below existing grades (approximate Elevs. 699 to 654). The pore water pressure readings shall be reported to the project engineer on a daily basis. When pore water pressure is developed, record and report the values to the engineer for evaluation. If the pressures exceed 60 psi above pre-construction levels, or if settlement exceeds the anticipated maximum 8 inches during fill placement, fill placement shall be suspended until pressures dissipate. In any case, CT shall be notified to provide further guidance.

Likewise, settlement platforms are also recommended for this project to monitor settlement as fill is placed. Settlement platforms shall be fabricated and installed in general accordance with ASTM D 6598. We recommend that each platform be surveyed by the contractor's surveyor three times per week during fill operations and an average of once per week throughout the monitoring period. Surveys of the platforms will also need to be performed immediately prior to and immediately after installing extensions during fill placement activities. Each settlement monitor survey record should include a record of the top of fill elevation adjacent to the settlement monitor.

5.9.4 Excavations and Slopes

The sides of temporary excavations for utility installations and other construction should be adequately sloped to provide stable sides and safe working conditions. Otherwise, the excavation must be properly braced against lateral movements. In any case, applicable Occupational Safety and Health Administration (OSHA) safety standards must be followed.

Based on the encountered soils, excavation may encounter the following OSHA type soils:

> Type A soils (native cohesive soils with unconfined compressive strengths of 3,000 pounds per square foot (psf) or greater),

> Type B soils (native cohesive soils with unconfined compressive strengths greater than 1,000 psf but less than 3,000 psf), and

> Type C soils (fill materials).

For temporary excavations in Type A, B, and C soils, side slopes must be no steeper than ¾ horizontal to 1 vertical (¾H:1V), 1H:1V, and 1½H:1V, respectively. For situations where a higher strength soil is underlain by a lower strength soil and the excavation extends into the lower strength soil, the slope of the entire excavation is governed by that required by the lower strength soil. In all cases, flatter slopes may be required if lower strength soils or adverse seepage conditions are encountered during construction.

For permanent excavations and slopes, we recommend that grades generally be no steeper than 3H:1V. Based on the provided plans, embankment slopes are generally planned to be 2H:1V. It should be noted that ODOT routinely uses 2H:1V slopes for roadway embankments. While these steeper slopes may used, it should be noted that the embankment faces are more prone to erosion and sloughing. Additional discussions regarding GDM Section 800 “Special Benching” and slope stability were presented in Sections 5.1.1 and 5.1.2, respectively.

6.0 QUALIFICATION OF RECOMMENDATIONS

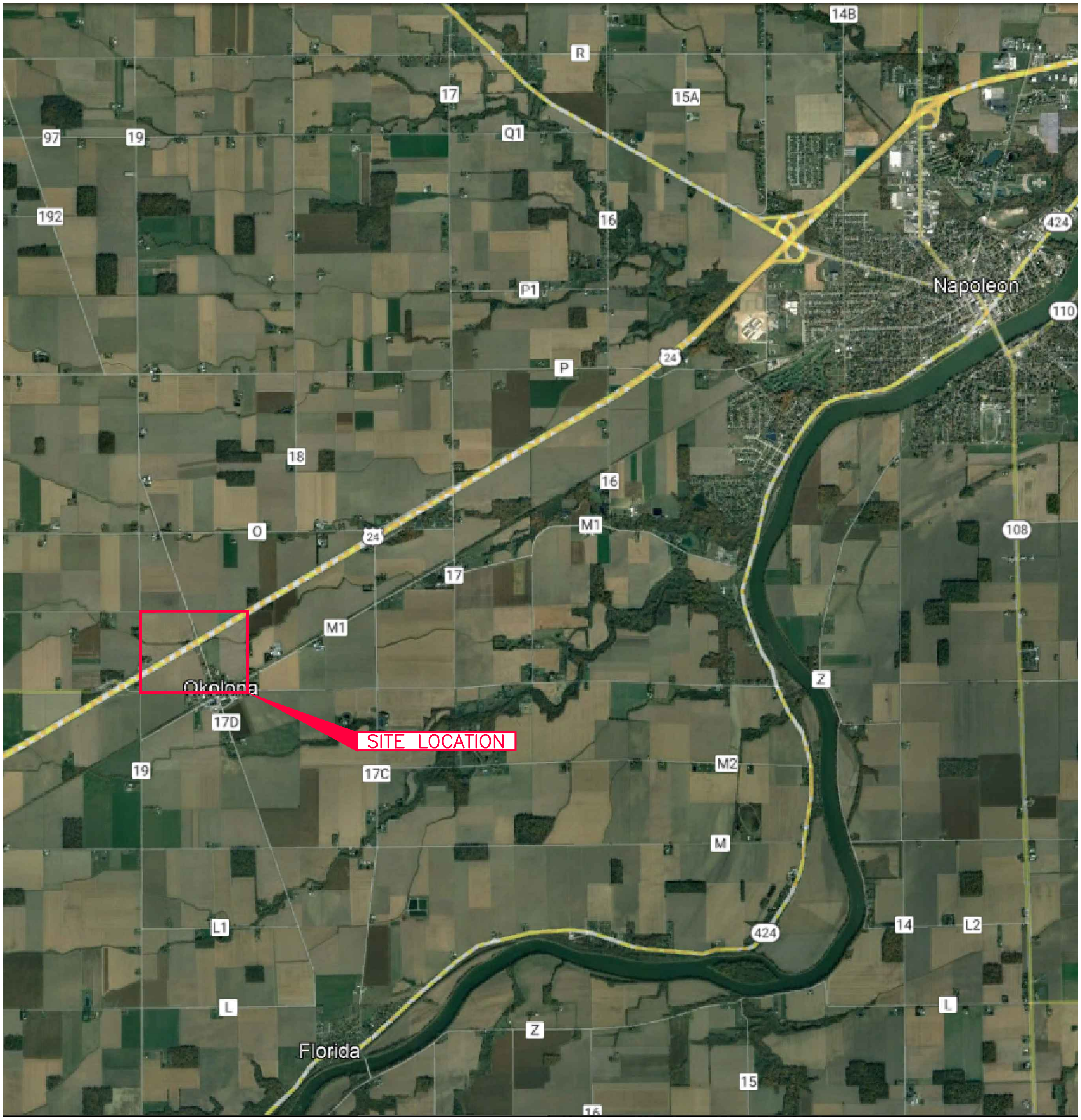
Our evaluation of the embankment fill, foundation, and pavement design and construction conditions has been based on the data obtained during our field investigation, criteria in ODOT GDM Section 600 "Plan Subgrades" and GDM Section 800 "Special Benching and Sidehill Embankment Fills," as well as furnished information about the proposed project. The general subsurface conditions were based on interpretation of the data obtained at specific boring locations. Regardless of the thoroughness of a subsurface exploration, there is the possibility that conditions between borings will differ from those at the boring locations, that conditions are not as anticipated by the designers, or that the construction process has altered the soil conditions. This is especially true for previously developed sites. Therefore, experienced geotechnical engineers should observe earthwork and foundation construction to confirm that the conditions anticipated in design are noted. Otherwise, CT assumes no responsibility for construction compliance with the design concepts, specifications, or recommendations.

The design recommendations in this report have been developed on the basis of the previously described project characteristics and subsurface conditions. If project criteria or locations change, a qualified geotechnical engineer should be permitted to determine whether the recommendations must be modified. The findings of such a review will be presented in a supplemental report.

The nature and extent of variations between the borings may not become evident until the course of construction. If such variations are encountered, it will be necessary to reevaluate the recommendations of this report after on-site observations of the conditions.

Our professional services have been performed, our findings derived, and our recommendations prepared in accordance with generally accepted geotechnical engineering principles and practices. This warranty is in lieu of all other warranties either expressed or implied. CT is not responsible for the conclusions, opinions, or recommendations of others based on this data.

PLATES



LEGEND

APPROXIMATE SITE LOCATION

N

APPROXIMATE SCALE – MILES

0 1 2

PLATE 1.0

SITE LOCATION MAP

HEN–24/17D–00.43, PID 117712

COUNTY ROAD 17D OVER US HIGHWAY 24

NAPOLEON TOWNSHIP, HENRY COUNTY, OHIO

PREPARED FOR

BURGESS & NIPLE, INC.

COLUMBUS, OHIO

DRAWN	TRR/8–4–23	CHECKED	KCH/8–10–23
REVISED		APPROVED	
JOB NO.	230230		
DRAWING NUMBER	**230230–01G**		

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BASE PLAN "SCHEMATIC PLAN" DATED JUNE 22, 2023, PREPARED BY BURGESS & NIPLE, INC.

LEGEND

B-001-0-22 ⊕ APPROXIMATE TEST BORING LOCATION

APPROXIMATE SCALE – FEET
0 300 600

PLATE 2.0
TEST BORING LOCATION PLAN
HEN-24/17D-00.43, PID 117712
COUNTY ROAD 17D OVER US HIGHWAY 24
NAPOLEON TOWNSHIP, HENRY COUNTY, OHIO

PREPARED FOR
BURGESS & NIPLE, INC.
COLUMBUS, OHIO

DRAWN	TRR/8-7-23	CHECKED	KCH/8-10-23
REVISED		APPROVED	
JOB NO.	230230		
DRAWING NUMBER	230230-02G		

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FIGURES

PROJECT: HEN-24/17D-00.43	DRILLING FIRM / OPERATOR: TTL / CW	DRILL RIG: CME 75 TRUCK 844	STATION / OFFSET: 121+97, 61' LT.
TYPE: SUBGRADE	SAMPLING FIRM / LOGGER: TTL / KKC	HAMMER: CME AUTOMATIC	ALIGNMENT: U.S. ROUTE 24
PID: 117712 SFN:	DRILLING METHOD: 3.5" SSA	CALIBRATION DATE: 2/20/23	ELEVATION: 707.4 (NAVD88) EOB: 7.5 ft.
START: 6/7/23 END: 6/7/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 72.9	LAT / LONG: -84.228209, 41.356378

EXPLORATION ID B-001-0-22

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 707.4	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
ASPHALT - 9 INCHES	706.6																		
AGGREGATE BASE - 11 INCHES	705.7	1																	
HARD, BROWN, **SILTY CLAY**, SOME SAND, LITTLE CRUSHED STONE, DAMP FILL		2	22 50/4"	-	100	SS-1A	-	-	-	-	-	-	-	-	-	-	A-1-b (V)	-	
						SS-1B	-	-	-	-	-	-	-	-	-	20	A-6b (V)	-	
	703.4	3 / 4	3 4 5	11	100	SS-2	>4.5	6	8	8	20	58	38	21	17	23	A-6b (11)	250	
STIFF, GRAY/BROWN, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP	702.4	5	12 12 12	29	100	SS-3	4.00	-	-	-	-	-	-	-	-	30	A-6b (V)	-	
VERY STIFF, GRAY/BROWN, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, MOIST (MANURE ODOR NOTED) @6': VERY STIFF TO HARD, BROWN, SOME SAND	699.9	6 / 7 / EOB	11 13 12	30	100	SS-4	>4.5	3	6	19	21	51	39	20	19	18	A-6b (11)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.25 BAG ASPHALT PATCH; AUGER CUTTINGS MIXED WITH 0.5 BAG BENTONITE CHIPS

PROJECT: HEN-24/17D-00.43 TYPE: SUBGRADE PID: 117712 SFN: START: 6/12/23 END: 6/12/23	DRILLING FIRM / OPERATOR: TTL / JP SAMPLING FIRM / LOGGER: TTL / KKC DRILLING METHOD: HSA SAMPLING METHOD: SPT	DRILL RIG: GEOPROBE 7822DT HAMMER: AUTOMATIC HAMMER CALIBRATION DATE: 3/16/22 ENERGY RATIO (%): 90*	STATION / OFFSET: 126+04, 68' LT. ALIGNMENT: U.S. ROUTE 24 ELEVATION: 705.8 (NAVD88) EOB: 6.0 ft. LAT / LONG: -84.226945, 41.356960	EXPLORATION ID B-002-0-22 PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 705.8	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
TOPSOIL - 15 INCHES	704.5	1	3 3 3	9	100	SS-1	3.50	-	-	-	-	-	-	-	-	21	A-7-6 (V)	-	
STIFF TO VERY STIFF, BROWN/GRAY, **CLAY**, SOME SILT, LITTLE SAND, TRACE GRAVEL, TRACE ORGANICS, DAMP	704.3	2	6 8 10	27	100	SS-2	>4.5	2	3	13	24	58	44	22	22	21	A-7-6 (14)	230	
VERY STIFF TO HARD, BROWN/GRAY, **CLAY**, SOME SILT, LITTLE SAND, TRACE GRAVEL, DAMP (TRACE ORGANICS IN SS-2 SAMPLE) @3': VERY STIFF, BROWN, TRACE IRON OXIDE STAIN SEAM	701.3	3 4	7 9 9	27	100	SS-3	4.00	-	-	-	-	-	-	-	-	21	A-7-6 (V)	-	
VERY STIFF TO HARD, BROWN/GRAY, **CLAY**, SOME SILT, LITTLE SAND, TRACE GRAVEL, TRACE CALCITE STAIN SEAM, DAMP	699.8	5 EOB 6	8 8 8	24	100	SS-4	>4.5	2	7	20	26	45	39	21	18	20	A-6b (10)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS MIXED WITH 0.5 BAG BENTONITE CHIPS

STANDARD ODOT LOG W/ SULFATES (8.5 X 11) - OH DOT.GDT - 3/27/24 14:14 - X:\PROJECTS\230230.GPJ

PROJECT: HEN-24/17D-00.43 TYPE: SUBGRADE PID: 117712 SFN: START: 6/7/23 END: 6/7/23	DRILLING FIRM / OPERATOR: TTL / CW SAMPLING FIRM / LOGGER: TTL / KKC DRILLING METHOD: HSA SAMPLING METHOD: SPT	DRILL RIG: CME 75 TRUCK 844 HAMMER: CME AUTOMATIC CALIBRATION DATE: 2/20/23 ENERGY RATIO (%): 72.9	STATION / OFFSET: 128+18, 62' RT. ALIGNMENT: U.S. ROUTE 24 ELEVATION: 705.5 (NAVD88) EOB: 7.5 ft. LAT / LONG: -84.226036, 41.356951 EXPLORATION ID B-003-0-22 PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 705.5	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
ASPHALT - 9 INCHES	704.7																		
AGGREGATE BASE - 8 INCHES	704.1	1																	
MEDIUM STIFF, BROWN/GRAY, **SILTY CLAY**, SOME SAND, SOME CRUSHED STONE, DAMP FILL	701.7	2 3	5 3 3	7	89	SS-1	>4.5	25	12	14	23	26	34	18	16	17	A-6b (5)	240	
STIFF TO VERY STIFF, GRAY, **SILTY CLAY**, SOME SAND, LITTLE GRAVEL, MOIST @4.8': BROWN/GRAY, TRACE IRON OXIDE STAIN SEAM	699.3	4 5 6	4 4 4	10	100	SS-2	3.75	15	12	15	24	34	38	19	19	23	A-6b (8)	-	
			6 6 6	15	100	SS-3	3.00	-	-	-	-	-	-	-	-	20	A-6b (V)	-	
VERY STIFF TO HARD, BROWN/GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, TRACE IRON OXIDE STAIN SEAM, DAMP	698.0	7 EOB	12 11 10	26	100	SS-4	>4.5	-	-	-	-	-	-	-	-	18	A-6b (V)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.25 BAG ASPHALT PATCH; AUGER CUTTINGS MIXED WITH 0.5 BAG BENTONITE CHIPS

PROJECT: HEN-24/17D-00.43	DRILLING FIRM / OPERATOR: TTL / CW	DRILL RIG: CME 75 TRUCK 844	STATION / OFFSET: 130+26, 62' LT.	EXPLORATION ID B-004-0-22
TYPE: SUBGRADE	SAMPLING FIRM / LOGGER: TTL / KKC	HAMMER: CME AUTOMATIC	ALIGNMENT: U.S. ROUTE 24	
PID: 117712 SFN:	DRILLING METHOD: 3.5" SSA	CALIBRATION DATE: 2/20/23	ELEVATION: 705.3 (NAVD88) EOB: 7.5 ft.	PAGE 1 OF 1
START: 6/7/23 END: 6/7/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 72.9	LAT / LONG: -84.225611, 41.357534	

MATERIAL DESCRIPTION AND NOTES	ELEV. 705.3	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
ASPHALT - 8 INCHES	704.6																		
AGGREGATE BASE - 12 INCHES	703.6	1																	
MEDIUM DENSE, BROWN/GRAY, **CRUSHED STONE WITH SAND, SILT, AND CLAY**, WET FILL	702.3	2	4 8 10	22	89	SS-1A	-	-	-	-	-	-	-	-	-	-	A-1-b (V)	-	
						SS-1B	-	7	36	29	20	8	43	24	19	25	A-2-7 (1)	230	
STIFF, BROWN/GRAY, **SILTY CLAY**, "AND" SAND, SOME GRAVEL, MOIST TO DAMP		3 4	6 7 8	18	100	SS-2	>4.5	20	15	23	23	19	39	22	17	22	A-6b (3)	-	
@4.8': VERY STIFF, LITTLE SAND, TRACE GRAVEL		5	8 9 9	22	100	SS-3	4.00	-	-	-	-	-	-	-	-	22	A-6b (V)	-	
@6': VERY STIFF TO HARD, TRACE IRON OXIDE STAIN SEAM, DAMP	697.8	6 7 EOB	11 12 12	29	100	SS-4	>4.5	-	-	-	-	-	-	-	-	17	A-6b (V)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.25 BAG ASPHALT PATCH; AUGER CUTTINGS MIXED WITH 0.5 BAG BENTONITE CHIPS

STANDARD ODOT LOG W/ SULFATES (8.5 X 11) - OH DOT.GDT - 3/27/24 14:14 - X:\PROJECTS\230230.GPJ

PROJECT: HEN-24/17D-00.43	DRILLING FIRM / OPERATOR: TTL / CW	DRILL RIG: GEOPROBE 7822DT	STATION / OFFSET: 132+31, 82' RT.
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: TTL / KKC	HAMMER: AUTOMATIC HAMMER	ALIGNMENT: U.S. ROUTE 24
PID: 117712 SFN:	DRILLING METHOD: SSA	CALIBRATION DATE: 3/16/22	ELEVATION: 701.6 (NAVD88) EOB: 6.0 ft.
START: 6/27/23 END: 6/27/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 90*	LAT / LONG: -84.224701, 41.357479

EXPLORATION ID B-005-0-22

MATERIAL DESCRIPTION AND NOTES	ELEV. 701.6	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
TOPSOIL - 4 INCHES	701.3																		
VERY STIFF, GRAY/BROWN, **CLAY**, SOME SILT, SOME SAND, LITTLE GRAVEL, TRACE ORGANICS, DAMP	699.6	1	3 6 6	18	67	SS-1	>4.5	18	12	14	28	28	46	26	20	17	A-7-6 (9)	240	
STIFF, GRAY/BROWN, **CLAY**, SOME SILT, SOME SAND, TRACE GRAVEL, TRACE ORGANICS, DAMP		2	4 4 4	12	89	SS-2	>4.5	-	-	-	-	-	-	-	-	19	A-7-6 (V)	-	
@3.3': MEDIUM STIFF, BROWN/GRAY, MOIST	697.1	3, 4	3 2 3	8	100	SS-3	3.50	2	4	16	25	53	43	21	22	22	A-7-6 (13)	-	
STIFF TO VERY STIFF, BROWN/GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, MOIST	695.6	5, EOB 6	3 4 5	14	100	SS-4	4.00	-	-	-	-	-	-	-	-	19	A-6b (V)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS MIXED WITH 0.5 BAG BENTONITE CHIPS

PROJECT: HEN-24/17D-00.43	DRILLING FIRM / OPERATOR: TTL / CW	DRILL RIG: CME 75 TRUCK 844	STATION / OFFSET: 134+32, 80' LT.	EXPLORATION ID B-006-0-22
TYPE: SUBGRADE	SAMPLING FIRM / LOGGER: TTL / KKC	HAMMER: CME AUTOMATIC	ALIGNMENT: U.S. ROUTE 24	
PID: 117712 SFN:	DRILLING METHOD: HSA	CALIBRATION DATE: 2/20/23	ELEVATION: 702.5 (NAVD88) EOB: 6.0 ft.	PAGE 1 OF 1
START: 6/5/23 END: 6/5/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 72.9	LAT / LONG: -84.224369, 41.358143	

MATERIAL DESCRIPTION AND NOTES	ELEV. 702.5	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
TOPSOIL - 7 INCHES	701.9																		
STIFF, BROWN, **SILTY CLAY**, SOME SAND, TRACE GRAVEL, TRACE ORGANICS, DAMP	701.0	1	7 4 4	10	83	SS-1	>4.5	-	-	-	-	-	-	-	-	12	A-6b (V)	-	
STIFF, BROWN/GRAY, **CLAY**, SOME SILT, SOME SAND, TRACE GRAVEL, DAMP (TRACE ORGANICS IN SS-2 SAMPLE)		2	4 4 5	11	100	SS-2	>4.5	2	4	21	25	48	42	24	18	22	A-7-6 (11)	240	
		3–4	3 4 5	11	100	SS-3	4.25	-	-	-	-	-	-	-	-	22	A-7-6 (V)	-	
@4.5': VERY STIIFF TO HARD, GRAY/BROWN, LITTLE SAND, TRACE IRON OXIDE STAIN SEAM, TRACE CALCITE STAIN SEAM	696.5	5 – EOB 6	5 7 7	17	100	SS-4	3.25	2	4	14	25	55	51	24	27	22	A-7-6 (17)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS MIXED WITH 0.5 BAG BENTONITE CHIPS

STANDARD ODOT LOG W/ SULFATES (8.5 X 11) - OH DOT.GDT - 3/27/24 14:15 - X:\PROJECTS\230230.GPJ

PROJECT: HEN-24/17D-00.43	DRILLING FIRM / OPERATOR: TTL / CW	DRILL RIG: GEOPROBE 7822DT	STATION / OFFSET: 406+21, 18' LT.	EXPLORATION ID B-007-0-22
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: TTL / KKC	HAMMER: AUTOMATIC HAMMER	ALIGNMENT: RAMP A	
PID: 117712 SFN:	DRILLING METHOD: SSA	CALIBRATION DATE: 3/16/22	ELEVATION: 700.5 (NAVD88) EOB: 10.0 ft.	PAGE 1 OF 1
START: 6/27/23 END: 6/27/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 90*	LAT / LONG: -84.223472, 41.358022	

MATERIAL DESCRIPTION AND NOTES	ELEV. 700.5	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
TOPSOIL - 4 INCHES	700.2																		
STIFF, GRAY/BROWN, **CLAY**, SOME SILT, SOME SAND, TRACE GRAVEL, DAMP	697.5	1–2	4 5 4	14	89	SS-1	>4.5	1	3	17	23	56	44	24	20	19	A-7-6 (13)	240	
STIFF, GRAY/BROWN, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, TRACE CALCITE STAIN SEAM, DAMP	694.5	3–5	2 3 4	11	100	SS-2	>4.5	-	-	-	-	-	-	-	-	19	A-6b (V)	-	
VERY STIFF TO HARD, GRAY/BROWN, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, TRACE CALCITE STAIN SEAM, DAMP		6–7	7 9 9	27	100	SS-3	>4.5	7	7	16	23	47	32	20	12	16	A-6a (8)	-	
@8': BROWN	690.5	8–9, EOB 10	11 15 15	45	100	SS-4	>4.5	-	-	-	-	-	-	-	-	15	A-6a (V)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS MIXED WITH 0.5 BAG BENTONITE CHIPS

PROJECT: HEN-24/17D-00.43	DRILLING FIRM / OPERATOR: TTL / JP	DRILL RIG: GEOPROBE 7822DT	STATION / OFFSET: 608+00, 3' LT.	EXPLORATION ID B-008-0-22
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: TTL / KKC	HAMMER: AUTOMATIC HAMMER	ALIGNMENT: RAMP C	
PID: 117712 SFN:	DRILLING METHOD: 3.5" SSA	CALIBRATION DATE: 3/16/22	ELEVATION: 701.3 (NAVD88) EOB: 15.0 ft.	PAGE 1 OF 1
START: 6/12/23 END: 6/12/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 90*	LAT / LONG: -84.223314, 41.358760	

MATERIAL DESCRIPTION AND NOTES	ELEV. 701.3	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
TOPSOIL - 12 INCHES	700.3	0 - 1																	
VERY STIFF TO HARD, GRAY/BROWN, **CLAY**, SOME SILT, LITTLE SAND, TRACE GRAVEL, TRACE IRON OXIDE STAIN SEAM, TRACE ORGANICS, DAMP @1.0' TO 2.5': Qu=7,690 PSF, γ_{WET}=122.6 PCF, γ_{DRY}=106.1 PCF	697.8	1 - 2.5	6 8 8	24	100	SS-1	>4.5	1	4	15	27	53	44	22	22	16	A-7-6 (14)	230	
STIFF TO VERY STIFF, BROWN/GRAY, **CLAY**, SOME SILT, SOME SAND, TRACE GRAVEL, TRACE IRON OXIDE STAIN SEAM, MOIST	695.3	3.5 - 5	1 4 5	14	100	SS-2	3.50	4	4	18	25	49	44	21	23	23	A-7-6 (14)	-	
HARD, BROWN/GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, TRACE IRON OXIDE STAIN SEAM, DAMP	692.8	6 - 7.5	15 16 16	48	100	SS-3	>4.5	-	-	-	-	-	-	-	-	16	A-6b (V)	-	
HARD, BROWN/GRAY, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, DAMP @8.5' TO 10.5': Qu=12,700 PSF, γ_{WET}=128.2 PCF, γ_{DRY}=110.8 PCF		8.5 - 10	9 13 15	42	100	SS-4	>4.5	3	8	19	26	44	34	20	14	16	A-6a (9)	-	
	687.8	11 - 12.5	20 20 20	60	100	SS-5	>4.5	-	-	-	-	-	-	-	-	16	A-6a (V)	-	
VERY STIFF, BROWN/GRAY, **SILTY CLAY**, SOME GRAVEL. LITTLE SAND, DAMP	686.3	13.5 - 15 (EOB)	4 6 8	21	100	SS-6	-	25	4	12	21	38	38	20	18	15	A-6b (8)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS MIXED WITH 0.5 BAG BENTONITE CHIPS

PROJECT: HEN-24/17D-00.43	DRILLING FIRM / OPERATOR: TTL / CW	DRILL RIG: CME 550X ATV	STATION / OFFSET: 610+27, 63' LT.	EXPLORATION ID B-009-0-22
TYPE: CULVERT	SAMPLING FIRM / LOGGER: TTL / KKC	HAMMER: CME AUTOMATIC	ALIGNMENT: RAMP C	
PID: 117712 SFN:	DRILLING METHOD: HSA	CALIBRATION DATE: 2/20/23	ELEVATION: 699.2 (NAVD88) EOB: 58.3 ft.	PAGE 1 OF 2
START: 8/13/23 END: 8/13/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 75.2	LAT / LONG: -84.222949, 41.359326	

MATERIAL DESCRIPTION AND NOTES	ELEV. 699.2	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	HOLE SEALED
TOPSOIL - 7 INCHES	698.6																		
STIFF, DARK BROWN, **CLAY**, SOME SILT, LITTLE SAND, TRACE GRAVEL, TRACE ORGANICS, DAMP	695.7	1–3	5 5 5	13	100	SS-1	4.50	1	5	13	26	55	42	22	20	20	A-7-6 (12)	260	
VERY STIFF TO HARD, BROWN, **SILTY CLAY**, SOME SAND, TRACE GRAVEL, MOIST		4–5	4 6 8	18	100	SS-2	4.50	-	-	-	-	-	-	-	-	17	A-6b (V)	-	
@6': HARD, MOIST TO DAMP		6–8	10 20 24	55	100	SS-3	4.50	4	7	15	25	49	32	15	17	15	A-6b (11)	-	
		9–10	6 8 10	23	100	SS-4	4.50	-	-	-	-	-	-	-	-	15	A-6b (V)	-	
@9.5': VERY STIFF TO HARD, GRAY/BROWN, LITTLE SAND @11.0' TO 12.5': Qu=5,155 PSF, γ_{WET}=131.0 PCF, γ_{DRY}=113.7 PCF @11': VERY STIFF, GRAY, MOIST	685.7	11–13	4 6 7	16	100	SS-5	4.00	2	5	14	24	55	29	12	17	15	A-6b (11)	-	
STIFF TO VERY STIFF, GRAY, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, MOIST		14–15	4 5 5	13	100	SS-6	3.25	3	6	11	21	59	30	15	15	17	A-6a (10)	-	
@16.0' TO 17.5': Qu=5,280 PSF, γ_{WET}=132.3 PCF, γ_{DRY}=112.8 PCF @16': VERY STIFF	680.7	16–18	3 6 9	19	100	SS-7	3.50	-	-	-	-	-	-	-	-	17	A-6a (V)	-	
STIFF TO VERY STIFF, GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, MOIST		19–20	4 5 5	13	100	SS-8	3.75	1	6	11	21	61	29	11	18	17	A-6b (11)	-	
@21.0' TO 22.5': Qu=3,450 PSF, γ_{WET}=127.8 PCF, γ_{DRY}=109.8 PCF @21': VERY STIFF		21–23	4 6 11	21	100	SS-9	3.00	-	-	-	-	-	-	-	-	16	A-6b (V)	-	
	670.7	24–28	7 7 8	19	100	SS-10	4.00	1	5	10	20	64	30	14	16	17	A-6b (10)	-	
VERY STIFF, GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, MOIST		29	4 5 8	16	100	SS-11	2.25	-	-	-	-	-	-	-	-	28	A-6b (V)	-	

PID: 117712	SFN:	PROJECT: HEN-24/17D-00.43	STATION / OFFSET: 610+27, 63' LT.	START: 8/13/23	END: 8/13/23	PG 2 OF 2	B-009-0-22

MATERIAL DESCRIPTION AND NOTES	ELEV. 669.2	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	HOLE SEALED
VERY STIFF, GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, MOIST *(continued)*	665.7	31–33																	
MEDIUM STIFF TO STIFF, GRAY, **SILTY CLAY**, TRACE SAND, TRACE GRAVEL, MOIST @33.5' TO 35.0': Qu=1,395 PSF, γ_{WET}=126.2 PCF, γ_{DRY}=100.2 PCF		34–35	4 5 6	14	100	SS-12	1.25	1	1	5	25	68	32	16	16	26	A-6b (10)	-	
	661.2	36–38																	
HARD, GRAY, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, DAMP		39–40	17 23 29	65	100	SS-13	-	-	-	-	-	-	-	-	-	10	A-6a (V)	-	
@41': LITTLE GRAVEL		41–43																	
@43.5': TRACE GRAVEL, MOIST		44–45	20 25 35	75	100	SS-14	4.50	5	9	11	22	53	23	11	12	12	A-6a (9)	-	
		46–48.5	50/2"	-	100	SS-15	4.50	-	-	-	-	-	-	-	-	12	A-6a (V)	-	
@53.5': LITTLE GRAVEL, DAMP		49–53.5	50/2"	-	100	SS-16	-	-	-	-	-	-	-	-	-	9	A-6a (V)	-	
	640.9	54–58 EOB																	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PUMPED 17 CF CEMENT-BENTONITE GROUT

PROJECT: HEN-24/17D-00.43	DRILLING FIRM / OPERATOR: TTL / TB	DRILL RIG: DIEDRICH D70 TRACK	STATION / OFFSET: 410+07, 8' LT.	EXPLORATION ID B-010-0-22
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: TTL / KKC	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: RAMP A	
PID: 117712 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 4/13/22	ELEVATION: 701.6 (NAVD88) EOB: 15.0 ft.	PAGE 1 OF 1
START: 5/16/23 END: 5/16/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 90	LAT / LONG: -84.222093, 41.358254	

MATERIAL DESCRIPTION AND NOTES	ELEV. 701.6	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	HOLE SEALED
TOPSOIL - 10 INCHES	700.8																		
STIFF, BROWN, **SILTY CLAY**, LITTLE SAND, DAMP @1.0' TO 2.5': Qu=2,375 PSF, γ_{WET}=122.9 PCF, γ_{DRY}=105.7 PCF	698.6	1 - 2	2 3 6	14	100	SS-1	4.50	0	5	11	20	64	38	21	17	16	A-6b (11)	-	
VERY STIFF TO HARD, BROWN, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP		3.5 - 5	4 7 10	26	100	SS-2	4.50	-	-	-	-	-	-	-	-	15	A-6b (V)	-	
@6': HARD	693.1	6 - 7.5	10 16 24	60	100	SS-3	4.50	5	5	6	19	65	37	18	19	16	A-6b (12)	-	
HARD, BROWN, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP		8.5 - 10	4 10 16	39	100	SS-4	4.50	2	6	6	19	67	36	19	17	16	A-6b (11)	-	
@11.0' TO 12.5': Qu=5,675 PSF, γ_{WET}=129.4 PCF, γ_{DRY}=111.3 PCF @11': VERY STIFF TO HARD, BROWN/GRAY, TRACE GRAVEL	688.1	11 - 12.5	10 12 16	42	100	SS-5	4.50	-	-	-	-	-	-	-	-	16	A-6b (V)	-	
VERY STIFF, GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP	686.6	13.5 - 15 EOB	4 6 8	21	100	SS-6	4.00	4	4	14	27	51	35	19	16	18	A-6b (10)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 4 CF CEMENT-BENTONITE GROUT

PROJECT: HEN-24/17D-00.43 TYPE: CULVERT PID: 117712 SFN: START: 8/8/23 END: 8/9/23	DRILLING FIRM / OPERATOR: TTL / CW/JP SAMPLING FIRM / LOGGER: TTL / KKC DRILLING METHOD: HSA SAMPLING METHOD: SPT / ST	DRILL RIG: CME 550X ATV HAMMER: CME AUTOMATIC CALIBRATION DATE: 2/20/23 ENERGY RATIO (%): 75.2	STATION / OFFSET: 612+44, 70' RT. ALIGNMENT: RAMP C ELEVATION: 698.4 (NAVD88) EOB: 53.8 ft. LAT / LONG: -84.222198, 41.359625

EXPLORATION ID: B-011-0-22

MATERIAL DESCRIPTION AND NOTES	ELEV. 698.4	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	HOLE SEALED
TOPSOIL - 8 INCHES	697.7																		
STIFF TO VERY STIFF, BROWN, **SILTY CLAY**, TRACE SAND, TRACE ORGANICS, MOIST	694.9	1 – 3	4 4 4	10	89	SS-1	3.00	0	2	6	24	68	40	19	21	22	A-6b (12)	250	
VERY STIFF TO HARD, BROWN, **SILTY CLAY**, SOME SAND, TRACE GRAVEL, TRACE ORGANICS, MOIST	692.4	4 – 5	4 7 11	23	100	SS-2	4.50	3	6	15	24	52	32	12	20	15	A-6b (12)	-	
HARD, BROWN, **SILTY CLAY**, SOME SAND, TRACE GRAVEL, MOIST	689.4	6 – 8	13 16 19	44	89	SS-3	4.50	5	5	15	24	51	33	15	18	16	A-6b (11)	-	
VERY STIFF TO HARD, GRAY, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, MOIST @9.0' TO 10.5': Qu=8,880 PSF, γ_{WET}=134.1 PCF, γ_{DRY}=116.4 PCF	687.4	9 – 10	5 7 11	23	100	SS-4A	-	-	-	-	-	-	-	-	-	-	A-6b (V)	-	
						SS-4B	4.50	-	-	-	-	-	-	-	-	15	A-6a (V)	-	
STIFF, GRAY, **SILTY CLAY**, LITTLE SAND, TRACE ROCK FRAGMENTS, TRACE GRAVEL, MOIST @11.0' TO 12.5': Qu=4,655 PSF, γ_{WET}=124.7 PCF, γ_{DRY}=105.3 PCF		11 – 13	3 5 7	15	100	SS-5	4.25	2	5	14	27	52	35	13	22	18	A-6b (13)	-	
@13.5': VERY STIFF		14 – 15	3 6 8	18	100	SS-6	3.50	-	-	-	-	-	-	-	-	18	A-6b (V)	-	
		16 – 18			0	ST-7	-	-	-	-	-	-	-	-	-	-	A-6b (V)	-	
@18.5': SOME SAND	677.4	19 – 20	6 7 9	20	100	SS-8	3.25	4	8	19	25	44	30	12	18	17	A-6b (10)	-	
STIFF TO VERY STIFF, GRAY, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, DAMP @21.0' TO 22.5': Qu=4,215 PSF, γ_{WET}=130.3 PCF, γ_{DRY}=111.6 PCF		21 – 23	3 6 7	16	100	SS-9	3.75	2	11	10	22	55	29	18	11	17	A-6a (8)	-	
@23.5': STIFF TO VERY STIFF	669.9	24 – 28	4 4 5	11	100	SS-10	3.75	-	-	-	-	-	-	-	-	17	A-6a (V)	-	
		29	3 3 5	10	100	SS-11	2.25	1	3	11	24	61	47	24	23	28	A-7-6 (15)	-	

PID: 117712	SFN:	PROJECT: HEN-24/17D-00.43	STATION / OFFSET: 612+44, 70' RT.	START: 8/8/23	END: 8/9/23	PG 2 OF 2	B-011-0-22

MATERIAL DESCRIPTION AND NOTES	ELEV. 668.4	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	HOLE SEALED
STIFF TO VERY STIFF, GRAY, **CLAY**, SOME SILT, LITTLE SAND, TRACE GRAVEL, MOIST @28.5' TO 30.0': Qu=2,545 PSF, γ_{WET}=124.4 PCF, γ_{DRY}=97.3 PCF *(continued)*	665.4	31–33																	
STIFF TO VERY STIFF, GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP		34–35	4 5 7	15	100	SS-12	3.75	-	-	-	-	-	-	-	-	15	A-6b (V)	-	
	659.9	36–38																	
HARD, GRAY, **SANDY SILT**, LITTLE CLAY, TRACE GRAVEL, DAMP		39–40	12 26 47	91	100	SS-13	-	7	10	23	48	12	26	17	9	9	A-4a (5)	-	
		44–45	19 35 47	103	100	SS-14	-	-	-	-	-	-	-	-	-	9	A-4a (V)	-	
	651.9	46 (TR)																	
GRAY, **WEATHERED SHALE**		47	50/2"	-	100	SS-15	-	-	-	-	-	-	-	-	-	4	Rock (V)	-	
		48–49	50/2"	-	100	SS-16	-	-	-	-	-	-	-	-	-	12	Rock (V)	-	
	644.6	53 (EOB)	50/3"	-	100	SS-17	-	-	-	-	-	-	-	-	-	10	Rock (V)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PUMPED 15 CF CEMENT-BENTONITE GROUT

PROJECT: HEN-24/17D-00.43	DRILLING FIRM / OPERATOR: TTL / TB	DRILL RIG: DIEDRICH D70 TRACK	STATION / OFFSET: 413+96, 7' LT.	EXPLORATION ID B-012-0-22
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: TTL / KKC	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: RAMP A	
PID: 117712 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 4/13/22	ELEVATION: 701.1 (NAVD88) EOB: 20.0 ft.	PAGE 1 OF 1
START: 5/16/23 END: 5/16/23	SAMPLING METHOD: SPT / ST	ENERGY RATIO (%): 90	LAT / LONG: -84.220675, 41.358270	

MATERIAL DESCRIPTION AND NOTES	ELEV. 701.1	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	HOLE SEALED
TOPSOIL - 10 INCHES	700.3																		
STIFF, BROWN, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, MOIST TO DAMP	698.1	1–2	2 3 6	14	100	SS-1	4.50	-	-	-	-	-	-	-	-	18	A-6b (V)	-	
VERY STIFF TO HARD, BROWN, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP	696.1	3.5–5	4 7 10	26	100	SS-2	4.50	-	-	-	-	-	-	-	-	16	A-6b (V)	-	
VERY STIFF TO HARD, BROWN, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, DAMP @5.0' TO 7.0': Qu=3,258 PSF, γ_{WET}=137.2 PCF, γ_{DRY}=119.6 PCF	693.1	5–7			100	ST-3	4.50	6	7	16	25	46	31	18	13	15	A-6a (8)	-	
HARD, BROWN, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP	690.1	8.5–10	10 10 15	38	100	SS-4	4.50	-	-	-	-	-	-	-	-	16	A-6a (V)	-	
VERY STIFF TO HARD, GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP		11–12.5	5 10 10	30	100	SS-5	4.25	-	-	-	-	-	-	-	-	15	A-6b (V)	-	
@13': VERY STIFF @13.5' TO 15.0': Qu=5,630 PSF, γ_{WET}=132.1 PCF, γ_{DRY}=113.9 PCF		13.5–15	4 5 8	20	100	SS-6	4.00	-	-	-	-	-	-	-	-	16	A-6b (V)	-	
@16': VERY STIFF TO HARD	682.6	16–17.5	9 12 15	41	100	SS-7	3.75	-	-	-	-	-	-	-	-	15	A-6b (V)	-	
VERY STIFF, GRAY, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP @18.5' TO 20.0': Qu=4,070 PSF, γ_{WET}=131.6 PCF, γ_{DRY}=112.8 PCF	681.1	18.5–20 (EOB 20)	4 5 8	20	100	SS-8	3.00	5	5	5	20	65	29	18	11	17	A-6a (8)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 4 CF CEMENT-BENTONITE GROUT

PROJECT: HEN-24/17D-00.43	DRILLING FIRM / OPERATOR: TTL / JP	DRILL RIG: GEOPROBE 7822DT	STATION / OFFSET: 616+23, 2' RT.	EXPLORATION ID B-013-0-22
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: TTL / KKC	HAMMER: AUTOMATIC HAMMER	ALIGNMENT: RAMP C	
PID: 117712 SFN:	DRILLING METHOD: 3.5" SSA	CALIBRATION DATE: 3/16/22	ELEVATION: 699.3 (NAVD88) EOB: 20.0 ft.	PAGE 1 OF 1
START: 6/12/23 END: 6/12/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 90*	LAT / LONG: -84.221693, 41.360535	

MATERIAL DESCRIPTION AND NOTES	ELEV. 699.3	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
TOPSOIL - 14 INCHES	698.1																		
STIFF TO VERY STIFF, GRAY/BROWN, **CLAY**, SOME SILT, LITTLE SAND, TRACE GRAVEL, DAMP (TRACE ORGANICS IN SS-1 SAMPLE)		1–2.5	4 5 5	15	100	SS-1	3.50	-	-	-	-	-	-	-	-	21	A-7-6 (V)	-	
@3.5' TO 5.0': Qu=2,070 PSF, γ_{WET}=124.3 PCF, γ_{DRY}=99.5 PCF @3.5': TRACE IRON OXIDE STAIN SEAM, MOIST	693.3	3.5–5	3 3 4	11	100	SS-2	2.50	6	2	14	25	53	44	23	21	25	A-7-6 (13)	-	
HARD, BROWN/GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, TRACE IRON OXIDE STAIN SEAM, DAMP		6–7.5	8 13 14	41	100	SS-3	>4.5	-	-	-	-	-	-	-	-	15	A-6b (V)	-	
@8.5': VERY STIFF TO HARD, TRACE CALCITE STAIN SEAM		8.5–10	4 7 10	26	100	SS-4	>4.5	-	-	-	-	-	-	-	-	16	A-6b (V)	-	
@11': VERY STIFF	686.3	11–12.5	3 4 8	18	100	SS-5	4.00	-	-	-	-	-	-	-	-	17	A-6b (V)	-	
VERY STIFF, GRAY, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, DAMP @13': GRAY		13.5–15	4 6 11	26	100	SS-6	3.50	5	7	18	26	44	32	18	14	17	A-6a (9)	-	
@16.0' TO 17.5': Qu=9,185 PSF, γ_{WET}=133.5 PCF, γ_{DRY}=116.3 PCF @16': VERY STIFF TO HARD		16–17.5	2 4 8	18	100	SS-7	>4.5	-	-	-	-	-	-	-	-	15	A-6a (V)	-	
	679.3	18.5–20 EOB 20	3 6 9	23	100	SS-8	>4.5	-	-	-	-	-	-	-	-	16	A-6a (V)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS MIXED WITH 1 BAG BENTONITE CHIPS

PROJECT: HEN-24/17D-00.43	DRILLING FIRM / OPERATOR: TTL / TB	DRILL RIG: DIEDRICH D70 TRACK	STATION / OFFSET: 217+33, 69' LT.	EXPLORATION ID B-014-0-22
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: TTL / KKC	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: C.R.-17D	
PID: 117712 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 4/13/22	ELEVATION: 699.2 (NAVD88) EOB: 68.0 ft.	PAGE 1 OF 3
START: 5/10/23 END: 7/18/23	SAMPLING METHOD: SPT / ST	ENERGY RATIO (%): 90	LAT / LONG: -84.220567, 41.359315	

MATERIAL DESCRIPTION AND NOTES	ELEV. 699.2	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	HOLE SEALED
TOPSOIL - 5 INCHES	698.8																		
STIFF, BROWN, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, TRACE ORGANICS, MOIST FILL	697.2	1–2	4 3 5	12	89	SS-1A	3.75	-	-	-	-	-	-	-	-	19	A-6b (V)	-	
						SS-1B	-	-	-	-	-	-	-	-	-	-	A-6a (V)	-	
VERY STIFF, BROWN, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, MOIST		3																	
@4.0' TO 6.0': Qu=7,768 PSF, γ_{WET}=130.3 PCF, γ_{DRY}=113.1 PCF		4–6			96	ST-2	3.50	2	3	8	21	66	27	13	14	15	A-6a (10)	-	
@6': VERY STIFF TO HARD	691.2	6–7.5	6 8 11	29	100	SS-3	4.50	-	-	-	-	-	-	-	-	15	A-6a (V)	-	
VERY STIFF TO HARD, BROWN, **SANDY SILT**, SOME CLAY, TRACE GRAVEL, DAMP	688.2	8.5–10	5 7 11	27	100	SS-4	4.50	-	-	-	-	-	-	-	-	14	A-4a (V)	-	
HARD, BROWN, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP @11.0' TO 12.5': Qu=9,200 PSF, γ_{WET}=128.4 PCF, γ_{DRY}=111.1 PCF	685.7	11–12.5	8 11 16	41	100	SS-5	4.50	2	5	14	24	55	33	19	14	16	A-6a (10)	-	
VERY STIFF TO HARD, GRAY, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, MOIST TO DAMP @13.5' TO 15.0': Qu=5,115 PSF, γ_{WET}=130.6 PCF, γ_{DRY}=111.0 PCF		13.5–15	5 10 11	32	100	SS-6	3.50	5	5	14	25	51	30	18	12	18	A-6a (9)	-	
@16': DAMP	680.7	16–17.5	10 16 17	50	100	SS-7	4.00	-	-	-	-	-	-	-	-	16	A-6a (V)	-	
VERY STIFF, GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, MOIST		18.5–20	3 5 10	23	100	SS-8	3.75	-	-	-	-	-	-	-	-	17	A-6b (V)	-	
@21.0' TO 23.0': Qu=6,984 PSF, γ_{WET}=133.2 PCF, γ_{DRY}=114.2 PCF		21–23			100	ST-9	3.50	5	4	8	19	64	32	15	17	17	A-6b (11)	-	
		23.5–25	5 6 10	24	100	SS-10	3.75	-	-	-	-	-	-	-	-	16	A-6b (V)	-	
		28.5–30	2 5 8	20	100	SS-11	3.25	-	-	-	-	-	-	-	-	16	A-6b (V)	-	

PID: 117712	SFN:	PROJECT: HEN-24/17D-00.43	STATION / OFFSET: 217+33, 69' LT.	START: 5/10/23	END: 7/18/23	PG 2 OF 3	B-014-0-22

MATERIAL DESCRIPTION AND NOTES	ELEV. 669.2	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	HOLE SEALED
VERY STIFF, GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, MOIST *(continued)*	665.7	31 – 33																	
STIFF TO VERY STIFF, GRAY, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, MOIST TO DAMP @33.5' TO 35.0': Qu=3,490 PSF, γ_{WET}=131.9 PCF, γ_{DRY}=112.3 PCF		34 – 35	4 5 7	18	100	SS-12	2.50	2	3	10	25	60	30	18	12	18	A-6a (9)	-	
	660.7	36 – 38																	
HARD, GRAY, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP		39 – 40	4 9 22	47	100	SS-13	4.50	3	4	12	24	57	30	18	12	14	A-6a (9)	-	
	655.2	41 – 43	25 42 50/4"	-	100	SS-14A	-	-	-	-	-	-	-	-	-	-	A-6a (V)	-	
HARD, GRAY, **SANDY SILT**, SOME CLAY, TRACE GRAVEL, DAMP		44				SS-14B	4.50	7	11	22	37	23	25	15	10	9	A-4a (5)	-	
		45 – 48																	
		49 – 50	12 24 31	83	100	SS-15	4.50	-	-	-	-	-	-	-	-	10	A-4a (V)	-	
		51 – 53																	
@53.5': LITTLE GRAVEL, TRACE CLAY		54	50/2"	-	100	SS-16	-	15	13	21	46	5	25	16	9	6	A-4a (3)	-	
	641.2	55 – 57, TR 58																	
SHALE, GRAY, MODERATELY WEATHERED, MODERATELY STRONG, JOINTED - FRACTURED TO MODERATELY FRACTURED, TIGHT; RQD 40%, REC 90%.		58 – 61	40		90	NQ2-1											CORE		

MATERIAL DESCRIPTION AND NOTES	ELEV. 637.1	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	HOLE SEALED
	636.2	63																	
SHALE, GRAY, MODERATELY WEATHERED, MODERATELY STRONG, JOINTED - MODERATELY FRACTURED TO SLIGHTLY FRACTURED, TIGHT; RQD 92%, REC 92%. @63.0' TO 64.0': Qu=5,680 PSI, γ_{DRY}=161.3 PCF	631.2	64–67, EOB 68	92		92	NQ2-2											CORE		

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PUMPED 20 CF CEMENT-BENTONITE GROUT

STANDARD ODOT LOG W/ SULFATES (8.5 X 11) - OH DOT.GDT - 3/27/24 14:15 - X:\PROJECTS\230230.GPJ

PROJECT: HEN-24/17D-00.43	DRILLING FIRM / OPERATOR: TTL / CW	DRILL RIG: CME 75 TRUCK 844	STATION / OFFSET: 219+05, 69' LT.
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: TTL / KKC	HAMMER: CME AUTOMATIC	ALIGNMENT: C.R.-17D
PID: 117712 SFN:	DRILLING METHOD: 3.25" HSA / NQ2	CALIBRATION DATE: 2/20/23	ELEVATION: 700.7 (NAVD88) EOB: 70.5 ft.
START: 7/25/23 END: 7/26/23	SAMPLING METHOD: SPT / ST / NQ2	ENERGY RATIO (%): 72.9	LAT / LONG: -84.220772, 41.359762

EXPLORATION ID B-015-0-22

MATERIAL DESCRIPTION AND NOTES	ELEV. 700.7
TOPSOIL - 3 INCHES	700.4
VERY STIFF TO HARD, BROWN/GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP	697.5
STIFF TO VERY STIFF, BROWN, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, TRACE IRON OXIDE STAIN SEAM, DAMP @3.5' TO 5.0': Qu=5,945 PSF, γ_{WET}=126.1 PCF, γ_{DRY}=106.5 PCF	694.7
VERY STIFF TO HARD, BROWN, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP @11.0' TO 13.0': Qu=7,183 PSF, γ_{WET}=124.7 PCF, γ_{DRY}=107.9 PCF @11': BROWN/GRAY, SOME SAND @12.5': GRAY	687.2
VERY STIFF, GRAY, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP @16.0' TO 17.5': Qu=6,110 PSF, γ_{WET}=132.1 PCF, γ_{DRY}=113.7 PCF @16': VERY STIFF TO HARD	682.2
STIFF, GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP	679.7
VERY STIFF TO HARD, GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP	677.2
STIFF TO VERY STIFF, GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP @23.5' TO 25.0': Qu=5,205 PSF, γ_{WET}=131.1 PCF, γ_{DRY}=112.4 PCF	672.2
MEDIUM STIFF TO STIFF, GRAY, **CLAY**, LITTLE SILT, TRACE SAND, MOIST	

SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	HOLE SEALED
10 10 10	24	83	SS-1	>4.5	-	-	-	-	-	-	-	-	15	A-6b (V)	-	
3 4 5	11	100	SS-2	3.75	3	4	13	25	55	38	21	17	18	A-6b (11)	240	
7 9 10	23	100	SS-3	>4.5	5	4	10	22	59	36	19	17	16	A-6b (11)	-	
6 10 14	29	100	SS-4	>4.5	-	-	-	-	-	-	-	-	15	A-6b (V)	-	
		54	ST-5	>4.5	6	5	16	25	48	37	21	16	16	A-6b (10)	-	
4 7 10	21	100	SS-6	4.00	5	4	13	24	54	31	18	13	17	A-6a (9)	-	
10 15 17	39	100	SS-7	3.50	4	5	9	26	56	32	19	13	16	A-6a (9)	-	
2 5 6	13	100	SS-8	4.25	-	-	-	-	-	-	-	-	17	A-6b (V)	-	
11 12 13	30	100	SS-9	4.25	-	-	-	-	-	-	-	-	17	A-6b (V)	-	
3 4 6	12	100	SS-10	3.50	-	-	-	-	-	-	-	-	17	A-6b (V)	-	
2 2 3	6	100	SS-11	2.00	0	3	5	19	73	55	27	28	37	A-7-6 (18)	-	

PID: 117712 | SFN: | PROJECT: HEN-24/17D-00.43 | STATION / OFFSET: 219+05, 69' LT. | START: 7/25/23 | END: 7/26/23 | PG 2 OF 3 | B-015-0-22

MATERIAL DESCRIPTION AND NOTES	ELEV. 670.7	DEPTHS
MEDIUM STIFF TO STIFF, GRAY, **CLAY**, LITTLE SILT, TRACE SAND, MOIST *(continued)*	668.7	31–32
VERY STIFF, GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, MOIST @32.0' TO 33.0': Qu=4,569 PSF, γ_{WET}=128.6 PCF, γ_{DRY}=106.4 PCF	667.2	32–33.5
STIFF TO VERY STIFF, GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP	663.2	33.5–37.5
VERY STIFF TO HARD, GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP @38.5' TO 40.0': Qu=7,940 PSF, γ_{WET}=133.3 PCF, γ_{DRY}=115.6 PCF	657.7	37.5–43
HARD, GRAY, **SANDY SILT**, SOME CLAY, TRACE ROCK FRAGMENTS, DAMP @48.5': LITTLE ROCK FRAGMENTS	642.7	43–58 (W 642.7 TR)
GRAY, **WEATHERED SHALE**	640.2	58–60.5

SPT/RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	HOLE SEALED
		100	ST-12A	1.50	-	-	-	-	-	-	-	-	-	A-7-6 (V)	-	
			ST-12B	2.75	1	3	8	24	64	37	20	17	21	A-6b (11)	-	
3 5 6	13	100	SS-13	3.25	-	-	-	-	-	-	-	-	15	A-6b (V)	-	
4 8 11	23	100	SS-14	>4.5	-	-	-	-	-	-	-	-	15	A-6b (V)	-	
25 38 50/5"	-	88	SS-15	>4.5	7	9	15	35	34	25	16	9	9	A-4a (7)	-	
13 26 25	62	100	SS-16	>4.5	-	-	-	-	-	-	-	-	9	A-4a (V)	-	
33 47 48	115	100	SS-17	-	-	-	-	-	-	-	-	-	7	A-4a (V)	-	
50/2"	-	100	SS-18	-	-	-	-	-	-	-	-	-	11	Rock (V)	-	

STANDARD ODOT LOG W/ SULFATES (8.5 X 11) - OH DOT.GDT - 3/27/24 14:15 - X:\PROJECTS\230230.GPJ

PID: 117712	SFN:	PROJECT: HEN-24/17D-00.43	STATION / OFFSET: 219+05, 69' LT.	START: 7/25/23	END: 7/26/23	PG 3 OF 3	B-015-0-22

MATERIAL DESCRIPTION AND NOTES	ELEV. 638.6	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	HOLE SEALED
SHALE, GRAY, MODERATELY WEATHERED, STRONG, JOINTED - HIGHLY FRACTURED, TIGHT; RQD 0%, REC 100%. *(continued)*	637.1	63	68		100	NQ2-1											CORE		
SHALE, GRAY, MODERATELY WEATHERED, STRONG, JOINTED - FRACTURED TO MODERATLY FRACTURED, TIGHT; RQD 88%, REC 100%. @65.6' TO 66.0': Qu=7,830 PSI, γ_{DRY}=157.2 PCF		64 65 66 67																	
@67.7' TO 68.5': HIGHLY FRACTURED FRAGMENTS		68	53		100	NQ2-2											CORE		
	630.2	69 70 EOB																	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PUMPED 20 CF CEMENT-BENTONITE GROUT

STANDARD ODOT LOG W/ SULFATES (8.5 X 11) - OH DOT.GDT - 3/27/24 14:15 - X:\PROJECTS\230230.GPJ

PROJECT: HEN-24/17D-00.43	DRILLING FIRM / OPERATOR: TTL / CW	DRILL RIG: CME 75 TRUCK 844	STATION / OFFSET: 208+53, 6' LT.	EXPLORATION ID B-016-0-22
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: TTL / KKC	HAMMER: CME AUTOMATIC	ALIGNMENT: C.R.-17D	
PID: 117712 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 2/20/23	ELEVATION: 702.1 (NAVD88) EOB: 10.0 ft.	PAGE 1 OF 1
START: 5/4/23 END: 5/4/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 72.9	LAT / LONG: -84.219276, 41.357096	

MATERIAL DESCRIPTION AND NOTES	ELEV. 702.1	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
ASPHALT - 9 INCHES	701.3																		
AGGREGATE BASE - 6 INCHES	700.8	1				SS-1A	-	-	-	-	-	-	-	-	-	-	A-1-b (V)	-	
VERY STIFF TO HARD, GRAY, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, TRACE ORGANICS, DAMP	699.9	2	6 6 7	16	89	SS-1B	>4.5	0	5	19	20	56	35	20	15	16	A-6a (10)	250	
						SS-1C	-	-	-	-	-	-	-	-	-	-	A-6b (V)	-	
STIFF, GRAY/BROWN, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP		3																	
		4	3 5 5	12	100	SS-2	4.25	3	6	12	19	60	37	19	18	18	A-6b (11)	-	
	695.7	5 6																	
VERY STIFF TO HARD, BROWN, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP		7	10 12 12	29	100	SS-3	>4.5	-	-	-	-	-	-	-	-	16	A-6b (V)	-	
	693.6	8																	
HARD, BROWN, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, TRACE IRON OXIDE STAIN SEAM, DAMP	692.1	9 EOB 10	13 17 20	45	100	SS-4	>4.5	-	-	-	-	-	-	-	-	15	A-6b (V)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.5 BAG ASPHALT PATCH; AUGER CUTTINGS MIXED WITH 0.5 BAG BENTONITE CHIPS

STANDARD ODOT LOG W/ SULFATES (8.5 X 11) - OH DOT.GDT - 3/27/24 14:15 - X:\PROJECTS\230230.GPJ

PROJECT: HEN-24/17D-00.43	DRILLING FIRM / OPERATOR: TTL / CW	DRILL RIG: CME 75 TRUCK 844	STATION / OFFSET: 210+98, 7' RT.	EXPLORATION ID B-017-0-22
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: TTL / KKC	HAMMER: CME AUTOMATIC	ALIGNMENT: C.R.-17D	
PID: 117712 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 2/20/23	ELEVATION: 702.4 (NAVD88) EOB: 20.0 ft.	PAGE 1 OF 1
START: 5/5/23 END: 5/5/23	SAMPLING METHOD: SPT / ST	ENERGY RATIO (%): 72.9	LAT / LONG: -84.219530, 41.357740	

MATERIAL DESCRIPTION AND NOTES	ELEV. 702.4	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	HOLE SEALED
ASPHALT - 9 INCHES	701.6																		
AGGREGATE BASE - 5 INCHES	701.2	1				SS-1A	-	-	-	-	-	-	-	-	-	-	A-1-b (V)	-	
STIFF, GRAY, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, TRACE ORGANICS, DAMP TO MOIST	699.4	2	3 5 6	13	89	SS-1B	4.50	1	4	8	20	67	35	20	15	20	A-6a (10)	-	
STIFF TO VERY STIFF, GRAY/BROWN, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, TRACE IRON OXIDE STAIN SEAM, MOIST	696.1	3–5	3 4 5	11	100	SS-2	4.00	-	-	-	-	-	-	-	-	21	A-6b (V)	-	
VERY STIFF TO HARD, BROWN, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, TRACE IRON OXIDE STAIN SEAM, DAMP @8.0' TO 10.0': Qu=5,996 PSF, γ_{WET}=133.9 PCF, γ_{DRY}=116.5 PCF @8" GRAY/BROWN, LITTLE GRAVEL	691.4	6–7	9 10 10	24	100	SS-3	>4.5	-	-	-	-	-	-	-	-	16	A-6b (V)	-	
		8–10			58	ST-4	>4.5	18	6	8	17	51	38	19	19	15	A-6b (10)	-	
HARD, GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, TRACE IRON OXIDE STAIN SEAM, DAMP	689.4	11–12	6 16 23	47	100	SS-5	>4.5	-	-	-	-	-	-	-	-	16	A-6b (V)	-	
STIFF, GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP @13.5' TO 15.0': Qu=6,400 PSF, γ_{WET}=127.9 PCF, γ_{DRY}=110.6 PCF	686.4	13–15	3 5 7	15	100	SS-6	4.25	-	-	-	-	-	-	-	-	16	A-6b (V)	-	
VERY STIFF TO HARD, GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP		16–17	14 17 20	45	100	SS-7	3.75	-	-	-	-	-	-	-	-	16	A-6b (V)	-	
	682.4	18–20 EOB	4 7 8	18	100	SS-8	4.25	-	-	-	-	-	-	-	-	17	A-6b (V)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.5 BAG ASPHALT PATCH; PUMPED 5 CF CEMENT-BENTONITE GROUT

PROJECT: HEN-24/17D-00.43	DRILLING FIRM / OPERATOR: TTL / CW	DRILL RIG: CME 75 TRUCK 844	STATION / OFFSET: 213+53, 4' LT.	EXPLORATION ID B-018-0-22
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: TTL / KKC	HAMMER: CME AUTOMATIC	ALIGNMENT: C.R.-17D	
PID: 117712 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 2/20/23	ELEVATION: 702.1 (NAVD88) EOB: 25.0 ft.	PAGE 1 OF 1
START: 5/5/23 END: 5/5/23	SAMPLING METHOD: SPT / ST	ENERGY RATIO (%): 72.9	LAT / LONG: -84.219884, 41.358389	

MATERIAL DESCRIPTION AND NOTES	ELEV. 702.1	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	HOLE SEALED
ASPHALT - 8.75 INCHES	701.4																		
AGGREGATE BASE - 7.25 INCHES	700.8	1				SS-1A	-	-	-	-	-	-	-	-	-	-	A-1-b (V)	-	
STIFF, BROWN/GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, TRACE ORGANICS, DAMP	698.6	2	4 5 6	13	89	SS-1B	>4.5	-	-	-	-	-	-	-	-	16	A-6b (V)	-	
STIFF, GRAY/BROWN, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, TRACE CALCITE STAIN SEAM, TRACE IRON OXIDE STAIN SEAM, DAMP	696.1	3-5	3 5 6	13	100	SS-2	>4.5	4	6	5	19	66	31	18	13	14	A-6a (9)	-	
HARD, GRAY/BROWN, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, TRACE IRON OXIDE STAIN SEAM, DAMP @6.0' TO 7.5': Qu=10,600 PSF, γ_{WET}=126.0 PCF, γ_{DRY}=109.7 PCF		6-7	13 16 18	41	100	SS-3	>4.5	-	-	-	-	-	-	-	-	15	A-6b (V)	-	
@8.5': BROWN/GRAY	691.1	8-10	7 14 23	45	100	SS-4	>4.5	-	-	-	-	-	-	-	-	15	A-6b (V)	-	
HARD, GRAY, **SILT AND CLAY**, LITTLE GRAVEL, LITTLE SAND, DAMP	689.1	11-13			25	ST-5	>4.5	17	4	9	19	51	30	18	12	14	A-6a (8)	-	
VERY STIFF TO HARD, GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP		14-15	5 7 9	19	100	SS-6	4.25	-	-	-	-	-	-	-	-	17	A-6b (V)	-	
@16': HARD		16-17	16 17 17	41	100	SS-7	>4.5	-	-	-	-	-	-	-	-	14	A-6b (V)	-	
@18.5': VERY STIFF TO HARD	681.1	18-20	4 9 10	23	100	SS-8	4.25	-	-	-	-	-	-	-	-	16	A-6b (V)	-	
VERY STIFF TO HARD, GRAY, **SILT AND CLAY**, LITTLE GRAVEL. LITTLE SAND, DAMP @21.0' TO 23.0': Qu=5,525 PSF, γ_{WET}=134.9 PCF, γ_{DRY}=118.2 PCF		21-23			96	ST-9	>4.5	14	5	6	19	56	29	18	11	14	A-6a (8)	-	
	677.1	24-25 EOB	3 6 9	18	100	SS-10	3.50	-	-	-	-	-	-	-	-	17	A-6a (V)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.5 BAG ASPHALT PATCH; PUMPED 7 CF CEMENT-BENTONITE GROUT

PROJECT: HEN-24/17D-00.43	DRILLING FIRM / OPERATOR: TTL / CW	DRILL RIG: CME 75 TRUCK 844	STATION / OFFSET: 218+26, 48' RT.	EXPLORATION ID B-019-0-22
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: TTL / KKC	HAMMER: CME AUTOMATIC	ALIGNMENT: C.R.-17D	
PID: 117712 SFN:	DRILLING METHOD: 3.5" SSA / NQ2	CALIBRATION DATE: 2/20/23	ELEVATION: 701.7 (NAVD88) EOB: 65.0 ft.	PAGE 1 OF 3
START: 6/30/23 END: 6/30/23	SAMPLING METHOD: SPT / ST / NQ2	ENERGY RATIO (%): 72.9	LAT / LONG: -84.220313, 41.359642	

MATERIAL DESCRIPTION AND NOTES	ELEV. 701.7	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	HOLE SEALED
ASPHALT - 12 INCHES	700.7																		
AGGREGATE BASE - 10 INCHES	699.9		5 3 3	7	89	SS-1A	-	-	-	-	-	-	-	-	-	-	A-1-b (V)	-	
LOOSE, BROWN, **GRAVEL AND STONE FRAGMENTS**, LITTLE SAND, TRACE SILT, TRACE CLAY, TRACE ORGANICS, DAMP FILL	698.2					SS-1B	-	79	11	3	6	1	NP	NP	NP	5	A-1-a (0)	-	
STIFF, BROWN, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP TO MOIST FILL (TRACE ORGANICS IN SS-2 SAMPLE) @3.5' TO 5.0': Qu=6,070 PSF, γ_{WET}=125.4 PCF, γ_{DRY}=107.1 PCF			3 5 7	15	100	SS-2	4.00	-	-	-	-	-	-	-	-	17	A-6b (V)	-	
@4': VERY STIFF, GRAY/BROWN, MOIST	693.2		7 11 9	24	100	SS-3	3.25	-	-	-	-	-	-	-	-	18	A-6b (V)	-	
STIFF TO VERY STIFF, BROWN/GRAY, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, TRACE ORGANICS, MOIST @8.5' TO 10.0': Qu=2,245 PSF, γ_{WET}=124.3 PCF, γ_{DRY}=104.2 PCF	692.0		3 3 4	9	100	SS-4A	2.00	5	8	13	23	51	29	17	12	19	A-6a (9)	-	
HARD, BROWN, **SANDY SILT**, SOME CLAY, TRACE GRAVEL, DAMP						SS-4B	-	-	-	-	-	-	-	-	-	-	A-4a (V)	-	
	688.7		11 15 15	36	100	SS-5	4.50	-	-	-	-	-	-	-	-	16	A-4a (V)	-	
VERY STIFF TO HARD, GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP @13.5' TO 15.0': Qu=6,340 PSF, γ_{WET}=125.5 PCF, γ_{DRY}=107.0 PCF	685.7		5 7 9	19	100	SS-6	4.25	-	-	-	-	-	-	-	-	17	A-6b (V)	-	
HARD, GRAY, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP	683.2		10 15 17	39	100	SS-7	4.00	9	5	6	18	62	32	18	14	14	A-6a (10)	-	
VERY STIFF, GRAY, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP			5 8 11	23	100	SS-8	4.00	-	-	-	-	-	-	-	-	17	A-6a (V)	-	
@21': HARD			10 13 15	34	100	SS-9	-	2	5	11	22	60	31	19	12	16	A-6a (9)	-	
@23.5': VERY STIFF TO HARD	675.7		3 5 8	16	100	SS-10	4.00	-	-	-	-	-	-	-	-	17	A-6a (V)	-	
HARD, GRAY, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, MOIST @26.0' TO 28.0': Qu=9,017 PSF, γ_{WET}=139.3 PCF, γ_{DRY}=119.7 PCF	673.2				100	ST-11	4.25	6	4	10	19	61	30	15	15	16	A-6a (10)	-	
VERY STIFF TO HARD, GRAY, **CLAY**, SOME SILT, TRACE SAND, DAMP			3 5 8	16	100	SS-12	4.25	0	0	1	26	73	46	23	23	15	A-7-6 (14)	-	

PID: 117712	SFN:	PROJECT: HEN-24/17D-00.43	STATION / OFFSET: 218+26, 48' RT.	START: 6/30/23	END: 6/30/23	PG 2 OF 3	B-019-0-22

MATERIAL DESCRIPTION AND NOTES	ELEV. 671.7	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	HOLE SEALED
VERY STIFF TO HARD, GRAY, **CLAY**, SOME SILT, TRACE SAND, DAMP *(continued)*	668.2	31 – 33																	
STIFF TO VERY STIFF, GRAY, **SILTY CLAY**, TRACE SAND, TRACE GRAVEL, MOIST	663.2	34 – 38	3 5 6	13	100	SS-13	3.00	-	-	-	-	-	-	-	-	26	A-6b (V)	-	
VERY STIFF TO HARD, GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP @38.5' TO 40.0': Qu=5,455 PSF, γ_{WET}=134.2 PCF, γ_{DRY}=117.0 PCF	658.7	39 – 43	4 5 8	16	100	SS-14	4.25	-	-	-	-	-	-	-	-	15	A-6b (V)	-	
HARD, GRAY, **SANDY SILT**, SOME CLAY, LITTLE GRAVEL, DAMP		44 – 48	25 40 50/1"	-	100	SS-15	4.50	11	8	18	33	30	26	16	10	8	A-4a (6)	-	
@48.5': TRACE GRAVEL	648.2	49 – 53	15 24 31	67	94	SS-16	-	8	7	21	42	22	24	17	7	10	A-4a (6)	-	
GRAY, **WEATHERED SHALE**		TR 54 – 58	50/3"	-	100	SS-17	-	-	-	-	-	-	-	-	-	9	Rock (V)	-	
	641.7	59	50/2"	-	100	SS-18	-	-	-	-	-	-	-	-	-	11	Rock (V)	-	
SHALE, GRAY, SLIGHTLY WEATHERED, STRONG, JOINTED - FRACTURED TO MODERATELY FRACTURED, TIGHT; RQD 38%, REC 100%.		60 – 61																	

PID: 117712	SFN:	PROJECT: HEN-24/17D-00.43	STATION / OFFSET: 218+26, 48' RT.	START: 6/30/23	END: 6/30/23	PG 3 OF 3	B-019-0-22

MATERIAL DESCRIPTION AND NOTES	ELEV. 639.6	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	HOLE SEALED
SHALE, GRAY, SLIGHTLY WEATHERED, STRONG, JOINTED - FRACTURED TO MODERATELY FRACTURED, TIGHT; RQD 38%, REC 100%. *(continued)* @63.5' TO 63.9': Qu=8,240 PSI, γ_{DRY}=158.9 PCF @63.9' TO 64.6': HIGHLY FRACTURED FRAGMENTS @64.9': HIGHLY FRACTURED FRAGMENTS	636.7	63 64 EOB 65	38		100	NQ2-1											CORE		

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.25 BAG ASPHALT PATCH; PUMPED 18 CF CEMENT-BENTONITE GROUT

PROJECT: HEN-24/17D-00.43	DRILLING FIRM / OPERATOR: TTL / CW	DRILL RIG: CME 75 TRUCK 844	STATION / OFFSET: 223+18, 7' RT.
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: TTL / KKC	HAMMER: CME AUTOMATIC	ALIGNMENT: C.R.-17D
PID: 117712 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 2/20/23	ELEVATION: 699.8 (NAVD88) EOB: 25.0 ft.
START: 5/1/23 END: 5/1/23	SAMPLING METHOD: SPT / ST	ENERGY RATIO (%): 72.9	LAT / LONG: -84.220970, 41.360937

EXPLORATION ID B-020-0-22

MATERIAL DESCRIPTION AND NOTES	ELEV. 699.8	DEPTHS
ASPHALT - 9 INCHES	699.0	
AGGREGATE BASE - 5 INCHES	698.6	
VERY STIFF TO HARD, GRAY, **CLAY**, SOME SILT, SOME SAND, TRACE GRAVEL, DAMP (TRACE ORGANICS IN SS-1 SAMPLE) @1.2' TO 2.5': Qu=8,240 PSF, γ_{WET}=119.2 PCF, γ_{DRY}=100.8 PCF @2.8': VERY STIFF, GRAY/BROWN, DAMP TO MOIST	693.5	
HARD, BROWN, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, TRACE IRON OXIDE STAIN SEAM, DAMP @8.5' TO 10.0': Qu=5,370 PSF, γ_{WET}=126.2 PCF, γ_{DRY}=109.6 PCF @8.5': VERY STIFF TO HARD @10.8': HARD, GRAY	686.2	
VERY STIFF TO HARD, GRAY, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, DAMP	683.8	
HARD, GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP @18.5': VERY STIFF TO HARD	678.8	
VERY STIFF, GRAY, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP @21.0' TO 23.0': Qu=7,854 PSF, γ_{WET}=137.9 PCF, γ_{DRY}=118.9 PCF	676.3	
VERY STIFF, GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP	674.8	EOB 25

DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	HOLE SEALED
1-2.5	6 7 8	18	89	SS-1	4.25	-	-	-	-	-	-	-	-	18	A-7-6 (V)	-	
3.5-5	7 9 11	24	100	SS-2	2.75	1	4	19	25	51	43	22	21	22	A-7-6 (13)	-	
6-7.5	11 14 17	38	100	SS-3A	-	-	-	-	-	-	-	-	-	-	A-7-6 (V)	-	
				SS-3B	4.25	-	-	-	-	-	-	-	-	15	A-6b (V)	-	
8.5-10	7 15 16	38	100	SS-4	>4.5	-	-	-	-	-	-	-	-	15	A-6b (V)	-	
11-12.5	7 15 16	38	100	SS-5	4.25	-	-	-	-	-	-	-	-	15	A-6b (V)	-	
13.5-15	5 10 12	27	100	SS-6	>4.5	6	7	16	26	45	31	19	12	14	A-6a (8)	-	
16-17.5	20 25 22	57	100	SS-7	>4.5	-	-	-	-	-	-	-	-	16	A-6b (V)	-	
18.5-20	5 8 8	19	100	SS-8	4.25	-	-	-	-	-	-	-	-	16	A-6b (V)	-	
21-23			92	ST-9	4.00	5	1	9	20	65	31	19	12	16	A-6a (9)	-	
23.5-25	4 7 8	18	100	SS-10	3.50	-	-	-	-	-	-	-	-	17	A-6b (V)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.5 BAG ASPHALT PATCH; PUMPED 7 CF CEMENT-BENTONITE GROUT

PROJECT: HEN-24/17D-00.43	DRILLING FIRM / OPERATOR: TTL / CW	DRILL RIG: CME 75 TRUCK 844	STATION / OFFSET: 225+67, 8' RT.	EXPLORATION ID B-021-0-22
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: TTL / KKC	HAMMER: CME AUTOMATIC	ALIGNMENT: C.R.-17D	
PID: 117712 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 2/20/23	ELEVATION: 700.9 (NAVD88) EOB: 20.0 ft.	PAGE 1 OF 1
START: 5/2/23 END: 5/2/23	SAMPLING METHOD: SPT / ST	ENERGY RATIO (%): 72.9	LAT / LONG: -84.221274, 41.361558	

MATERIAL DESCRIPTION AND NOTES	ELEV. 700.9	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	HOLE SEALED
ASPHALT - 9 INCHES	700.1																		
AGGREGATE BASE - 7 INCHES	699.6	1	4 5 7			SS-1A	-	-	-	-	-	-	-	-	-	-	A-1-b (V)	-	
STIFF, BROWN/GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP @3': TRACE IRON OXIDE STAIN SEAM, MOIST @3.5' TO 5.0': Qu=3,955 PSF, γ_{WET}=124.5 PCF, γ_{DRY}=102.9 PCF		2		15	100	SS-1B	>4.5	-	-	-	-	-	-	-	-	18	A-6b (V)	-	
		3–5	3 5 7	15	100	SS-2	4.25	-	-	-	-	-	-	-	-	21	A-6b (V)	-	
	694.7	6																	
HARD, BROWN, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, TRACE IRON OXIDE STAIN SEAM, DAMP		7	10 15 16	38	100	SS-3	>4.5	6	5	16	25	48	31	19	12	16	A-6a (8)	-	
	692.4	8																	
VERY STIFF TO HARD, BROWN, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, TRACE IRON OXIDE STAIN SEAM, DAMP		9–10	4 9 15	29	100	SS-4	>4.5	-	-	-	-	-	-	-	-	15	A-6b (V)	-	
@11.0' TO 12.5': Qu=3,800 PSF, γ_{WET}=127.4 PCF, γ_{DRY}=111.0 PCF @11': HARD		11–12	7 14 19	40	100	SS-5	>4.5	-	-	-	-	-	-	-	-	15	A-6b (V)	-	
@13': VERY STIFF TO HARD, GRAY		13–15	4 8 11	23	100	SS-6	4.25	-	-	-	-	-	-	-	-	16	A-6b (V)	-	
@16.0' TO 18.0': Qu=7,824 PSF, γ_{WET}=133.1 PCF, γ_{DRY}=116.3 PCF @16': VERY STIFF, MOIST		16–18			83	ST-7	3.50	4	4	7	21	64	29	13	16	14	A-6b (10)	-	
	680.9	19–20 EOB	4 7 11	22	100	SS-8	3.50	-	-	-	-	-	-	-	-	16	A-6b (V)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.5 BAG ASPHALT PATCH; PUMPED 5 CF CEMENT-BENTONITE GROUT

PROJECT: HEN-24/17D-00.43	DRILLING FIRM / OPERATOR: TTL / CW	DRILL RIG: CME 75 TRUCK 844	STATION / OFFSET: 228+54, 9' LT.	EXPLORATION ID B-022-0-22
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: TTL / KKC	HAMMER: CME AUTOMATIC	ALIGNMENT: C.R.-17D	
PID: 117712 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 2/20/23	ELEVATION: 702.5 (NAVD88) EOB: 15.0 ft.	PAGE 1 OF 1
START: 5/1/23 END: 5/1/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 72.9	LAT / LONG: -84.221754, 41.362308	

MATERIAL DESCRIPTION AND NOTES	ELEV. 702.5	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	HOLE SEALED
ASPHALT - 5.5 INCHES	702.0																		
AGGREGATE BASE - 9.5 INCHES	701.2	1				SS-1A	-	-	-	-	-	-	-	-	-	-	A-1-b (V)	-	
VERY STIFF, GRAY/BROWN, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, MOIST	699.9	2	7 12 13	30	100	SS-1B	3.50	-	-	-	-	-	-	-	-	21	A-6b (V)	240	
STIFF, GRAY/BROWN, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, TRACE ORGANICS, MOIST @3.5' TO 5.0': Qu=2,565 PSF, γ_{WET}=124.5 PCF, γ_{DRY}=101.6 PCF	696.5	3 4 5	3 4 6	12	100	SS-2	1.25	-	-	-	-	-	-	-	-	23	A-6b (V)	-	
VERY STIFF, GRAY/BROWN, **SILTY CLAY**, SOME SAND, TRACE GRAVEL, MOIST	694.2	6 7 8	9 10 11	26	100	SS-3	1.00	5	7	16	26	46	36	20	16	26	A-6b (10)	-	
HARD, GRAY/BROWN, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP		9 10	8 15 19	41	100	SS-4	>4.5	5	5	11	25	54	37	19	18	16	A-6b (11)	-	
@11.8': TRACE IRON OXIDE STAIN SEAM		11 12 13	7 12 16	34	100	SS-5	>4.5	-	-	-	-	-	-	-	-	15	A-6b (V)	-	
@13': STIFF TO VERY STIFF @13.5' TO 15.0': Qu=2,590 PSF, γ_{WET}=126.3 PCF, γ_{DRY}=109.3 PCF	687.5	14 EOB 15	3 6 9	18	100	SS-6	2.75	-	-	-	-	-	-	-	-	16	A-6b (V)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.5 BAG ASPHALT PATCH; PUMPED 4 CF CEMENT-BENTONITE GROUT

PROJECT: HEN-24/17D-00.43	DRILLING FIRM / OPERATOR: TTL / CW	DRILL RIG: CME 75 TRUCK 844	STATION / OFFSET: 229+74, 10' RT.	EXPLORATION ID B-023-0-22
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: TTL / KKC	HAMMER: CME AUTOMATIC	ALIGNMENT: C.R.-17D	
PID: 117712 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 2/20/23	ELEVATION: 701.8 (NAVD88) EOB: 10.0 ft.	PAGE 1 OF 1
START: 5/1/23 END: 5/1/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 72.9	LAT / LONG: -84.221733, 41.362617	

MATERIAL DESCRIPTION AND NOTES	ELEV. 701.8	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
ASPHALT - 12 INCHES	700.8																		
AGGREGATE BASE - 5 INCHES	700.4	1	11 8 8	19	0	SS-1A	-	-	-	-	-	-	-	-	-	-	A-1-b (V)	-	
STIFF TO VERY STIFF, GRAY, **CLAY**, SOME SILT, LITTLE SAND, TRACE GRAVEL, TRACE IRON OXIDE STAIN SEAM, MOIST (SS-1 NOTED AS AUGER SAMPLE) @2.4': BROWN/GRAY @3.5' TO 5.0': Qu=2,890 PSF, γ_{WET}=120.1 PCF, γ_{DRY}=97.4 PCF		2				SS-1B	-	-	-	-	-	-	-	-	-	24	A-7-6 (V)	-	
		3																	
		4–5	3 3 5	10	100	SS-2	2.50	4	3	15	27	51	44	22	22	23	A-7-6 (14)	250	
		6–7	5 6 8	17	100	SS-3	2.00	2	2	15	25	56	43	22	21	27	A-7-6 (13)	-	
	693.8	8																	
VERY STIFF TO HARD, GRAY/BROWN, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, TRACE IRON OXIDE STAIN SEAM, DAMP	691.8	9 – EOB 10	10 13 14	33	100	SS-4	>4.5	-	-	-	-	-	-	-	-	16	A-6b (V)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.5 BAG ASPHALT PATCH; AUGER CUTTINGS MIXED WITH 0.5 BAG BENTONITE CHIPS

PROJECT: HEN-24/17D-00.43	DRILLING FIRM / OPERATOR: TTL / TB	DRILL RIG: DIEDRICH D70 TRACK	STATION / OFFSET: 217+45, 56' RT.	EXPLORATION ID B-024-0-22
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: TTL / KKC	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: C.R.-17D	
PID: 117712 SFN:	DRILLING METHOD: 3.25" HSA / NQ2	CALIBRATION DATE: 4/13/22	ELEVATION: 700.2 (NAVD88) EOB: 69.0 ft.	PAGE 1 OF 3
START: 5/9/23 END: 5/10/23	SAMPLING METHOD: SPT / ST / NQ2	ENERGY RATIO (%): 90	LAT / LONG: -84.220156, 41.359460	

MATERIAL DESCRIPTION AND NOTES	ELEV. 700.2
TOPSOIL - 8 INCHES	699.5
AGGREGATE BASE - 6 INCHES	699.0
MEDIUM STIFF, BROWN, **SILT AND CLAY**, SOME SAND, TRACE CRUSHED STONE, DAMP FILL	697.2
DENSE, GRAY, **CRUSHED STONE WITH SAND**, LITTLE SILT, TRACE CLAY, DAMP FILL @6': MEDIUM DENSE	690.7
STIFF, GRAY/BROWN, **SILT AND CLAY**, LITTLE GRAVEL, LITTLE SAND, DAMP	689.2
HARD, BROWN, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, MOIST @13': VERY STIFF, BROWN/GRAY, DAMP @13.5' TO 15.0': Qu=3,915 PSF, γ_{WET}=142.1 PCF, γ_{DRY}=123.5 PCF @16.0' TO 18.0': UU TRIAXIAL: Su = 2,850 PSF (VERY STIFF), γ_{WET}=134.4 PCF, γ_{DRY}=117.1 PCF @16': LITTLE GRAVEL @17': GRAY @21': HARD @23.5' TO 25.0': Qu=4,165 PSF, γ_{WET}=141.6 PCF, γ_{DRY}=120.3 PCF @23.5': VERY STIFF, SOME SAND, MOIST	673.2
STIFF, GRAY, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, MOIST	

DEPTHS: W 693.7 (at 6–7 ft); ▼ (at 18 ft)

SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	HOLE SEALED
3 2 3	8	83	SS-1A	-	-	-	-	-	-	-	-	-	-	A-1-b (V)	-	
			SS-1B	-	8	6	16	25	45	32	18	14	17	A-6a (9)	-	
13 14 14	42	89	SS-2	-	46	21	13	19	1	NP	NP	NP	7	A-1-b (0)	-	
4 6 6	18	67	SS-3	-	-	-	-	-	-	-	-	-	7	A-1-b (V)	-	
6 6 4	15	67	SS-4A	-	-	-	-	-	-	-	-	-	-	A-1-b (V)	-	
			SS-4B	-	-	-	-	-	-	-	-	-	15	A-6a (V)	-	
7 12 19	47	100	SS-5	-	1	7	12	25	55	32	17	15	18	A-6a (10)	-	
4 6 8	21	100	SS-6	-	-	-	-	-	-	-	-	-	15	A-6a (V)	-	
		88	ST-7	3.00	10	5	13	26	46	31	19	12	15	A-6a (8)	-	
4 7 10	26	100	SS-8	-	-	-	-	-	-	-	-	-	17	A-6a (V)	-	
10 14 16	45	100	SS-9	-	-	-	-	-	-	-	-	-	17	A-6a (V)	-	
4 7 10	26	100	SS-10	-	2	6	15	24	53	30	16	14	18	A-6a (10)	-	
4 4 6	15	100	SS-11	-	-	-	-	-	-	-	-	-	18	A-6a (V)	-	

PID: 117712	SFN:	PROJECT: HEN-24/17D-00.43	STATION / OFFSET: 217+45, 56' RT.	START: 5/9/23	END: 5/10/23	PG 2 OF 3	B-024-0-22

MATERIAL DESCRIPTION AND NOTES	ELEV. 670.2	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	HOLE SEALED
STIFF, GRAY, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, MOIST *(continued)*		31–33																	
@33.5' TO 35.0': Qu=3,010 PSF, γ_{WET}=141.4 PCF, γ_{DRY}=122.8 PCF @33.5': STIFF TO VERY STIFF		34–35	4 4 7	17	100	SS-12	-	-	-	-	-	-	-	-	-	15	A-6a (V)	-	
@36.0' TO 38.0': Qu=5,755 PSF, γ_{WET}=136.8 PCF, γ_{DRY}=119.5 PCF @36': VERY STIFF, LITTLE GRAVEL	662.2	36–38			83	ST-13	3.00	11	4	9	19	57	28	17	11	14	A-6a (8)	-	
HARD, GRAY, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP @38.5' TO 40.0': Qu=10,365 PSF, γ_{WET}=132.9 PCF, γ_{DRY}=116.4 PCF		39–40	9 16 27	65	100	SS-14	-	-	-	-	-	-	-	-	-	14	A-6a (V)	-	
@42': SOME SAND		41–45	19 31 41	108	89	SS-15	-	5	9	15	25	46	32	18	14	9	A-6a (9)	-	
@48.5': LITTLE SAND	647.2	46–53	12 16 21	56	100	SS-16	-	-	-	-	-	-	-	-	-	12	A-6a (V)	-	
HARD, GRAY, **SANDY SILT**, SOME CLAY, LITTLE GRAVEL, DAMP	644.7	54–55 (TR)	16 37 50	131	89	SS-17	-	16	11	20	25	28	24	20	4	11	A-4a (4)	-	
GRAY, **WEATHERED SHALE**, **WITH SAND, SILT, AND CLAY**	641.2	56–59	50/3"	-	100	SS-18	-	-	-	-	-	-	-	-	-	16	Rock (V)	-	
SHALE, GRAY, SLIGHTLY WEATHERED, STRONG, JOINTED - MODERATELY FRACTURED TO SLIGHTLY FRACTURED, TIGHT; RQD 84%, REC 91%. @59' TO 59.3': HIGHLY FRACTURED FRAGMENTS @60.1' TO 60.3': HIGHLY FRACTURED FRAGMENTS		60–61	80		90	NQ2-1											CORE		

PID: 117712	SFN:	PROJECT: HEN-24/17D-00.43	STATION / OFFSET: 217+45, 56' RT.	START: 5/9/23	END: 5/10/23	PG 3 OF 3	B-024-0-22

MATERIAL DESCRIPTION AND NOTES	ELEV. 638.0	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	HOLE SEALED
@61.0' TO 61.5': Qu=8,970 PSI, γ_{DRY}=158.8 PCF **SHALE**, GRAY, SLIGHTLY WEATHERED, STRONG, JOINTED - MODERATELY FRACTURED TO SLIGHTLY FRACTURED, TIGHT; RQD 84%, REC 91%. @59' TO 59.3': HIGHLY FRACTURED FRAGMENTS *(continued)* @65.4' TO 66.0': HIGHLY FRACTURED FRAGMENTS	631.2	63 64 65 66 67 68 EOB 69	100		92	NQ2-2											CORE		

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 17 CF CEMENT-BENTONITE GROUT

PROJECT: HEN-24/17D-00.43	DRILLING FIRM / OPERATOR: TTL / CW	DRILL RIG: CME 75 TRUCK 844	STATION / OFFSET: 219+37, 74' RT.
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: TTL / KKC	HAMMER: CME AUTOMATIC	ALIGNMENT: C.R.-17D
PID: 117712 SFN:	DRILLING METHOD: 3.25" HSA / NQ2	CALIBRATION DATE: 2/20/23	ELEVATION: 698.5 (NAVD88) EOB: 69.0 ft.
START: 7/29/23 END: 7/30/23	SAMPLING METHOD: SPT / ST / NQ2	ENERGY RATIO (%): 72.9	LAT / LONG: -84.220320, 41.359974

EXPLORATION ID B-025-0-22

MATERIAL DESCRIPTION AND NOTES	ELEV. 698.5	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	HOLE SEALED
TOPSOIL - 5 INCHES	698.1																		
STIFF TO VERY STIFF, BROWN/GRAY, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, DAMP	695.5	1 – 2	3 5 5	12	89	SS-1	2.00	6	6	18	22	48	34	20	14	19	A-6a (9)	-	
VERY STIFF TO HARD, GRAY/BROWN, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, TRACE IRON OXIDE STAIN SEAM, DAMP		3 – 5	4 8 12	24	100	SS-2	>4.5	-	-	-	-	-	-	-	-	17	A-6a (V)	-	
@6.0' TO 8.0': Qu=11,473 PSF, γ_{WET}=139.6 PCF, γ_{DRY}=122.1 PCF @6': HARD		6 – 8			96	ST-3	>4.5	5	5	14	25	51	34	20	14	14	A-6a (10)	-	
@8.5': VERY STIFF TO HARD, BROWN	687.5	9 – 10	4 10 13	28	100	SS-4	>4.5	-	-	-	-	-	-	-	-	16	A-6a (V)	-	
VERY STIFF TO HARD, GRAY/BROWN, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP @11.0' TO 12.5': Qu=11,020 PSF, γ_{WET}=127.8 PCF, γ_{DRY}=110.2 PCF		11 – 12	3 5 8	16	100	SS-5	>4.5	-	-	-	-	-	-	-	-	16	A-6b (V)	-	
@13.3': GRAY		13 – 15	3 7 8	18	100	SS-6	>4.5	4	5	10	19	62	38	22	16	16	A-6b (10)	-	
@16': HARD	680.0	16 – 18	12 14 14	34	100	SS-7	4.25	-	-	-	-	-	-	-	-	16	A-6b (V)	-	
STIFF TO VERY STIFF, BROWN/GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP @18.5' TO 20.0': Qu=3,655 PSF, γ_{WET}=120.6 PCF, γ_{DRY}=103.1 PCF	677.5	19 – 20	2 4 6	12	100	SS-8	3.50	-	-	-	-	-	-	-	-	17	A-6b (V)	-	
HARD, GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP	675.0	21 – 23	7 13 13	32	100	SS-9	>4.5	-	-	-	-	-	-	-	-	17	A-6b (V)	-	
STIFF TO VERY STIFF, GRAY, **SILTY CLAY**, TRACE SAND, TRACE GRAVEL, DAMP		24 – 25	2 3 5	10	100	SS-10	3.50	6	4	5	20	65	34	18	16	17	A-6b (10)	-	
@26.0' TO 28.0': Qu=4,478 PSF, γ_{WET}=132.8 PCF, γ_{DRY}=114.0 PCF @26': VERY STIFF, LITTLE SAND	670.0	26 – 28			100	ST-11	2.00	5	5	14	25	51	37	20	17	17	A-6b (11)	-	
MEDIUM STIFF, GRAY, **CLAY**, SOME SILT, TRACE SAND, MOIST		29	2 2 3	6	100	SS-12	2.25	0	2	4	21	73	60	29	31	36	A-7-6 (20)	-	

PID: 117712	SFN:	PROJECT: HEN-24/17D-00.43	STATION / OFFSET: 219+37, 74' RT.	START: 7/29/23	END: 7/30/23	PG 2 OF 3	B-025-0-22

MATERIAL DESCRIPTION AND NOTES	ELEV. 668.5	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	HOLE SEALED
MEDIUM STIFF, GRAY, **CLAY**, SOME SILT, TRACE SAND, MOIST *(continued)*	665.0	31 – 33																	
STIFF TO VERY STIFF, GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP @33.5' TO 35.0': Qu=1,245 PSF, γ_{WET}=132.8 PCF, γ_{DRY}=116.1 PCF	660.0	34 – 38	2 4 5	11	100	SS-13	2.75	-	-	-	-	-	-	-	-	14	A-6b (V)	-	
VERY STIFF TO HARD, GRAY, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP	655.5	39 – 43	9 11 12	28	100	SS-14	>4.5	5	4	9	21	61	32	17	15	14	A-6a (10)	-	
HARD, GRAY, **SILTY CLAY**, LITTLE SAND, TRACE ROCK FRAGMENTS, DAMP		44 – 45	20 30 33	77	94	SS-15	>4.5	-	-	-	-	-	-	-	-	9	A-6b (V)	-	
@48.5' TO 50.0': Qu=15,365 PSF, γ_{WET}=131.9 PCF, γ_{DRY}=117.6 PCF	646.0	49 – 52	11 20 30	61	94	SS-16	>4.5	-	-	-	-	-	-	-	-	12	A-6b (V)	-	
DENSE, GRAY, **WEATHERED SHALE WITH SAND AND SILT**, TRACE CLAY, DAMP		TR — 53 – 54	25 50/3"	-	100	SS-17	-	40	15	15	21	9	NP	NP	NP	8	A-2-4 (0)	-	
	639.5	58 – 59	50/2"	-	100	SS-18	-	-	-	-	-	-	-	-	-	11	Rock (V)	-	
SHALE, GRAY, SLIGHTLY WEATHERED, MODERATELY STRONG, JOINTED - FRACTURED TO MODERATELY FRACTURED, TIGHT; RQD 63%, REC 95%.		60 – 61	72		90	NQ2-1											CORE		

PID: 117712	SFN:	PROJECT: HEN-24/17D-00.43	STATION / OFFSET: 219+37, 74' RT.	START: 7/29/23	END: 7/30/23	PG 3 OF 3	B-025-0-22

MATERIAL DESCRIPTION AND NOTES	ELEV. 636.4	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	HOLE SEALED
@61.7' TO 62.1': Qu=7,450 PSI, γ_{DRY}=155.7 PCF **SHALE**, GRAY, SLIGHTLY WEATHERED, MODERATELY STRONG, JOINTED - FRACTURED TO MODERATELY FRACTURED, TIGHT; RQD 63%, REC 95%. *(continued)* @62.6': HIGHLY FRACTURED FRAGMENT @62.9': HIGHLY FRACTURED FRAGMENT @63.9': HIGHLY FRACTURED FRAGMENTS @65.3': HIGHLY FRACTURED FRAGMENT @67.3': HIGHLY FRACTURED FRAGMENT	629.5	63 64 65 66 67 68 EOB 69	53		100	NQ2-2											CORE		

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PUMPED 19 CF CEMENT-BENTONITE GROUT

STANDARD ODOT LOG W/ SULFATES (8.5 X 11) - OH DOT.GDT - 3/27/24 14:16 - X:\PROJECTS\230230.GPJ

PROJECT: HEN-24/17D-00.43	DRILLING FIRM / OPERATOR: TTL / TB	DRILL RIG: DIEDRICH D70 TRACK	STATION / OFFSET: 503+02, 1' RT.	EXPLORATION ID B-026-0-22
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: TTL / KKC	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: RAMP B	
PID: 117712 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 4/13/22	ELEVATION: 700.0 (NAVD88) EOB: 20.0 ft.	PAGE 1 OF 1
START: 5/16/23 END: 5/16/23	SAMPLING METHOD: SPT / ST	ENERGY RATIO (%): 90	LAT / LONG: -84.219015, 41.358873	

MATERIAL DESCRIPTION AND NOTES	ELEV. 700.0	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	HOLE SEALED
TOPSOIL - 12 INCHES	699.0																		
STIFF TO VERY STIFF, BROWN, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP	697.0	1–2	2 3 6	14	100	SS-1	3.00	-	-	-	-	-	-	-	-	17	A-6b (V)	-	
VERY STIFF TO HARD, BROWN, **SILTY CLAY**, LITTLE SAND, LITTLE GRAVEL, DAMP @3': LITTLE GRAVEL @3.5' TO 5.0': Qu=8,735 PSF, γ_{WET}=129.5 PCF, γ_{DRY}=113.5 PCF	694.0	3.5–5	3 6 9	23	100	SS-2	4.50	12	6	10	23	49	39	20	19	14	A-6b (11)	-	
HARD, BROWN, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP		6–7.5	10 15 19	51	100	SS-3	4.50	-	-	-	-	-	-	-	-	16	A-6a (V)	-	
	689.0	8.5–10	6 11 16	41	100	SS-4	4.50	-	-	-	-	-	-	-	-	15	A-6a (V)	-	
VERY STIFF TO HARD, GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP @11.0' TO 13.0': Qu=6,409 PSF, γ_{WET}=140.8 PCF, γ_{DRY}=123.3 PCF		11–13			100	ST-5	4.50	4	5	11	24	56	34	18	16	14	A-6b (10)	-	
@14': VERY STIFF		13.5–15	3 5 8	20	100	SS-6	4.00	-	-	-	-	-	-	-	-	15	A-6b (V)	-	
		16–17.5	5 7 10	26	72	SS-7	3.75	-	-	-	-	-	-	-	-	17	A-6b (V)	-	
@18.5' TO 20.0': Qu=4,080 PSF, γ_{WET}=136.9 PCF, γ_{DRY}=116.9 PCF @18.5': STIFF	680.0	18.5–20 (EOB 20)	3 5 7	18	100	SS-8	3.25	-	-	-	-	-	-	-	-	17	A-6b (V)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 5 CF CEMENT-BENTONITE GROUT

PROJECT: HEN-24/17D-00.43	DRILLING FIRM / OPERATOR: TTL / CW	DRILL RIG: GEOPROBE 7822DT	STATION / OFFSET: 702+58, 16' RT.
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: TTL / KKC	HAMMER: AUTOMATIC HAMMER	ALIGNMENT: RAMP D
PID: 117712 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 3/16/22	ELEVATION: 699.7 (NAVD88) EOB: 20.0 ft.
START: 5/18/23 END: 5/18/23	SAMPLING METHOD: SPT / ST	ENERGY RATIO (%): 90*	LAT / LONG: -84.220133, 41.360997

EXPLORATION ID B-027-0-22

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 699.7	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	HOLE SEALED
TOPSOIL - 8 INCHES	699.0																		
STIFF, BROWN, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, MOIST		1–2	3 3 4	11	89	SS-1	4.25	-	-	-	-	-	-	-	-	20	A-6b (V)	-	
		4–5	5 5 5	15	89	SS-2	4.00	-	-	-	-	-	-	-	-	20	A-6b (V)	-	
@5.0' TO 7.0': Qu=3,833 PSF, γ_{WET}=135.3 PCF, γ_{DRY}=116.5 PCF @5': DAMP	691.7	5–7			67	ST-3	4.50	2	5	14	22	57	38	19	19	16	A-6b (12)	-	
HARD, BROWN, **SANDY SILT**, LITTLE CLAY, TRACE GRAVEL, DAMP	688.7	8.5–10	10 13 18	47	100	SS-4	4.50	-	-	-	-	-	-	-	-	15	A-4a (V)	-	
VERY STIFF TO HARD, GRAY, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP @11.0' TO 12.5': Qu=6,650 PSF, γ_{WET}=126.5 PCF, γ_{DRY}=112.1 PCF		11–12.5	6 9 12	32	100	SS-5	4.00	-	-	-	-	-	-	-	-	13	A-6a (V)	-	
		13.5–15	6 7 10	26	100	SS-6	4.50	-	-	-	-	-	-	-	-	16	A-6a (V)	-	
@16': SOME SAND		16–17.5	4 7 9	24	100	SS-7	4.25	1	6	7	21	65	31	17	14	16	A-6a (10)	-	
@18.5' TO 20.0': Qu=6,320 PSF, γ_{WET}=137.1 PCF, γ_{DRY}=117.8 PCF @18.5': VERY STIFF	679.7	18.5–20 EOB	5 7 10	26	100	SS-8	4.00	-	-	-	-	-	-	-	-	16	A-6a (V)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PUMPED 5 CF CEMENT-BENTONITE GROUT

STANDARD ODOT LOG W/ SULFATES (8.5 X 11) - OH DOT.GDT - 3/27/24 14:16 - X:\PROJECTS\230230.GPJ

PROJECT: HEN-24/17D-00.43 TYPE: CULVERT PID: 117712 SFN: START: 5/8/23 END: 5/8/23	DRILLING FIRM / OPERATOR: TTL / TB SAMPLING FIRM / LOGGER: TTL / KKC DRILLING METHOD: 3.25" HSA SAMPLING METHOD: SPT / ST	DRILL RIG: DIEDRICH D70 TRACK HAMMER: DIEDRICH AUTOMATIC CALIBRATION DATE: 4/13/22 ENERGY RATIO (%): 90	STATION / OFFSET: 506+58, 60' LT. ALIGNMENT: RAMP B ELEVATION: 698.2 (NAVD88) EOB: 58.8 ft. LAT / LONG: -84.218579, 41.359808	EXPLORATION ID B-028-0-22 PAGE 1 OF 2

MATERIAL DESCRIPTION AND NOTES	ELEV. 698.2	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	HOLE SEALED
TOPSOIL - 8 INCHES	697.5																		
STIFF, BROWN, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP	694.7	1–2	3 4 5	14	6	SS-1	4.50	2	5	12	26	55	39	20	19	16	A-6b (12)	-	
VERY STIFF TO HARD, BROWN, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP		4–5	5 7 11	27	83	SS-2	4.50	-	-	-	-	-	-	-	-	16	A-6b (V)	-	
@6': LITTLE GRAVEL	690.2	6–7	6 10 14	36	100	SS-3	4.50	12	4	9	18	57	37	19	18	14	A-6b (11)	-	
HARD, BROWN, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP		9–10	9 17 20	56	100	SS-4	4.50	-	-	-	-	-	-	-	-	15	A-6a (V)	-	
@11.0' TO 12.5': Qu=6,845 PSF, γ_{WET}=130.5 PCF, γ_{DRY}=113.3 PCF @11': VERY STIFF TO HARD, GRAY		11–12	5 8 11	29	100	SS-5	4.50	3	5	14	26	52	34	19	15	15	A-6a (10)	-	
@13': VERY STIFF		14–15	4 4 7	17	100	SS-6	3.25	-	-	-	-	-	-	-	-	17	A-6a (V)	-	
@16.0' TO 18.0': UU TRIAXIAL: Su = 4,690 PSF (VERY STIFF), γ_{WET}=135.8 PCF, γ_{DRY}=118.9 PCF @16': VERY STIFF TO HARD SOME SAND	679.7	16–18			100	ST-7	4.25	4	8	19	26	43	31	19	12	14	A-6a (8)	-	
VERY STIFF, GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP		19–20	4 7 10	26	100	SS-8	2.50	-	-	-	-	-	-	-	-	17	A-6b (V)	-	
@21.0' TO 22.5': Qu=5,350 PSF, γ_{WET}=139.9 PCF, γ_{DRY}=120.2 PCF	674.7	21–22	4 5 9	21	100	SS-9	3.00	-	-	-	-	-	-	-	-	16	A-6b (V)	-	
VERY STIFF TO HARD, GRAY, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP	671.2	24–25	7 10 11	32	100	SS-10	4.00	3	5	6	20	66	32	18	14	15	A-6a (10)	-	
STIFF TO VERY STIFF, GRAY, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, MOIST		29	3 4 5	14	100	SS-11	2.50	-	-	-	-	-	-	-	-	22	A-6a (V)	-	

STANDARD ODOT LOG W/ SULFATES (8.5 X 11) - OH DOT.GDT - 3/27/24 14:17 - X:\PROJECTS\230230.GPJ

PID: 117712	SFN:	PROJECT: HEN-24/17D-00.43	STATION / OFFSET: 506+58, 60' LT.	START: 5/8/23	END: 5/8/23	PG 2 OF 2	B-028-0-22

MATERIAL DESCRIPTION AND NOTES	ELEV. 668.2	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	HOLE SEALED
STIFF TO VERY STIFF, GRAY, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, MOIST *(continued)*		31 – 33																	
@33.5' TO 35.0': Qu=2,475 PSF, γ_{WET}=142.4 PCF, γ_{DRY}=118.7 PCF @33.5': TRACE SAND		34	3 5 7	18	100	SS-12	2.25	1	3	6	22	68	31	18	13	20	A-6a (9)	-	
	660.2	35 – 38																	
HARD, GRAY, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP		39	11 22 38	90	89	SS-13	-	1	6	5	20	68	31	20	11	12	A-6a (8)	-	
	657.2	40 – 41																	
HARD, GRAY, **SANDY SILT**, "AND" CLAY, TRACE GRAVEL, DAMP		42 – 43 (▼)																	
		44	17 25 39	96	100	SS-14	4.50	-	-	-	-	-	-	-	-	9	A-4a (V)	-	
		45 – 48																	
@48.5' TO 50.0': Qu=14,615 PSF, γ_{WET}=135.7 PCF, γ_{DRY}=118.3 PCF		49	13 22 31	80	89	SS-15	4.50	1	3	6	39	51	28	20	8	15	A-4a (8)	-	
	645.2	50 – 53 (TR)																	
GRAY, **WEATHERED SHALE**, **WITH SAND, SILT, AND CLAY**		54	32 50/2"	-	88	SS-16	-	-	-	-	-	-	-	-	-	8	Rock (V)	-	
		55 – 58 (W 640.2)																	
@58.5': WET, (FREE WATER NOTED)	639.4	EOB	50/3"	-	100	SS-17	-	-	-	-	-	-	-	-	-	20	Rock (V)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 15 CF CEMENT-BENTONITE GROUT

PROJECT: HEN-24/17D-00.43	DRILLING FIRM / OPERATOR: TTL / CW	DRILL RIG: GEOPROBE 7822DT	STATION / OFFSET: 706+58, 19' RT.	EXPLORATION ID B-029-0-22
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: TTL / KKC	HAMMER: AUTOMATIC HAMMER	ALIGNMENT: RAMP D	
PID: 117712 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 3/16/22	ELEVATION: 699.9 (NAVD88) EOB: 15.0 ft.	PAGE 1 OF 1
START: 5/18/23 END: 5/18/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 90*	LAT / LONG: -84.218705, 41.360965	

MATERIAL DESCRIPTION AND NOTES	ELEV. 699.9	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	HOLE SEALED
TOPSOIL - 7 INCHES	699.3																		
STIFF TO VERY STIFF, BROWN, **SILTY CLAY**, TRACE SAND, DAMP		1–2	3 4 4	12	89	SS-1	4.00	-	-	-	-	-	-	-	-	20	A-6b (V)	-	
@3.5' TO 5.0': Qu=5,325 PSF, γ_{WET}=133.6 PCF, γ_{DRY}=112.4 PCF @3.5': MOIST TO DAMP	693.9	3–5	3 5 5	15	89	SS-2	3.00	-	-	-	-	-	-	-	-	19	A-6a (V)	-	
HARD, BROWN, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP	691.4	6–7	11 12 13	38	89	SS-3	4.50	2	5	11	24	58	32	19	13	16	A-6a (9)	-	
HARD, BROWN, **SANDY SILT**, "AND" CLAY, TRACE GRAVEL, DAMP	688.4	8–10	7 10 12	33	100	SS-4	4.50	4	5	8	36	47	30	20	10	16	A-4a (8)	-	
		11	6 11 13	36	100	SS-5A	-	-	-	-	-	-	-	-	-	-	A-4a (V)	-	
HARD, GRAY, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP	686.4	12–13				SS-5B	4.25	-	-	-	-	-	-	-	-	16	A-6a (V)	-	
VERY STIFF, GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP	684.9	14–15 EOB	5 5 10	23	100	SS-6	3.25	-	-	-	-	-	-	-	-	17	A-6b (V)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PUMPED 4 CF CEMENT-BENTONITE GROUT

PROJECT: HEN-24/17D-00.43	DRILLING FIRM / OPERATOR: TTL / TB	DRILL RIG: DIEDRICH D70 TRACK	STATION / OFFSET: 508+10, 68' RT.	EXPLORATION ID B-030-0-22
TYPE: CULVERT	SAMPLING FIRM / LOGGER: TTL / KKC	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: RAMP B	
PID: 117712 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 4/13/22	ELEVATION: 697.7 (NAVD88) EOB: 58.8 ft.	PAGE 1 OF 2
START: 5/8/23 END: 5/9/23	SAMPLING METHOD: SPT / ST	ENERGY RATIO (%): 90	LAT / LONG: -84.217891, 41.359966	

MATERIAL DESCRIPTION AND NOTES	ELEV. 697.7	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	HOLE SEALED
TOPSOIL - 5 INCHES	697.3																		
STIFF TO VERY STIFF, BROWN, **SILTY CLAY**, SOME SAND, TRACE ORGANICS, DAMP @1.0' TO 2.5': Qu=3,165 PSF, γ_{WET}=132.7 PCF, γ_{DRY}=112.2 PCF	694.7	1–2	3 2 4	9	78	SS-1	2.00	0	1	20	26	53	36	19	17	18	A-6b (11)	-	
VERY STIFF TO HARD, BROWN, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, TRACE ORGANICS, DAMP		4–5	4 6 8	21	89	SS-2	4.50	-	-	-	-	-	-	-	-	14	A-6a (V)	-	
@6': HARD		6–7	7 11 15	39	89	SS-3	4.50	-	-	-	-	-	-	-	-	15	A-6a (V)	-	
@8.5': SOME SAND		9–10	7 13 17	45	100	SS-4	4.50	4	7	16	26	47	32	18	14	15	A-6a (9)	-	
@11.3': VERY STIFF, GRAY, LITTLE SAND		11–12	5 7 9	24	100	SS-5	3.75	-	-	-	-	-	-	-	-	17	A-6a (V)	-	
@13': UU TRIAXIAL: Su=4,235 PSF (VERY STIFF), γ_{WET}=133.5 PCF, γ_{DRY}=117.1 PCF	681.7	13–15			83	ST-6	4.00	7	5	14	24	50	30	19	11	14	A-6a (8)	-	
VERY STIFF, GRAY, **SILTY CLAY**, SOME SAND, TRACE GRAVEL, DAMP		16–17	4 6 8	21	100	SS-7	4.00	-	-	-	-	-	-	-	-	17	A-6b (V)	-	
		19–20	4 6 7	20	100	SS-8	3.25	3	7	18	25	47	36	20	16	17	A-6b (10)	-	
@21': VERY STIFF		21–22	6 9 11	30	100	SS-9	3.50	-	-	-	-	-	-	-	-	16	A-6b (V)	-	
@23.5' TO 25.0': Qu=5,040 PSF, γ_{WET}=135.6 PCF, γ_{DRY}=116.2 PCF	670.7	24–25	3 5 7	18	100	SS-10	4.00	1	7	18	26	48	38	19	19	17	A-6b (11)	-	
STIFF TO VERY STIFF, GRAY, **SILTY CLAY**, SOME SAND, TRACE GRAVEL, DAMP		29	3 4 5	14	100	SS-11	3.50	-	-	-	-	-	-	-	-	17	A-6b (V)	-	

STANDARD ODOT LOG W/ SULFATES (8.5 X 11) - OH DOT.GDT - 3/27/24 14:17 - X:\PROJECTS\230230.GPJ

PID: 117712	SFN:	PROJECT: HEN-24/17D-00.43	STATION / OFFSET: 508+10, 68' RT.	START: 5/8/23	END: 5/9/23	PG 2 OF 2	B-030-0-22

MATERIAL DESCRIPTION AND NOTES	ELEV. 667.7	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	HOLE SEALED
STIFF TO VERY STIFF, GRAY, **SILTY CLAY**, SOME SAND, TRACE GRAVEL, DAMP *(continued)*		31–33																	
@33.5' TO 35.0': Qu=3,390 PSF, γ_{WET}=131.5 PCF, γ_{DRY}=114.4 PCF		34	4 4 7	17	100	SS-12	3.25	3	7	18	25	47	39	20	19	15	A-6b (11)	-	
	660.2	35–37																	
HARD, GRAY, **SANDY SILT**, SOME CLAY, TRACE GRAVEL, DAMP		38–39	13 26 39	98	100	SS-13	-	-	-	-	-	-	-	-	-	8	A-4a (V)	-	
		40–44	17 25 38	95	100	SS-14	4.50	8	8	15	39	30	30	22	8	9	A-4a (7)	-	
	649.7	W 649.7 (45–48)																	
VERY DENSE, GRAY, **COARSE AND FINE SAND**, SOME SILT, LITTLE GRAVEL, TRACE CLAY, DAMP		48.5	50/5"	-	80	SS-15	-	15	16	35	31	3	27	22	5	12	A-3a (0)	-	
	644.7	TR (49–53)																	
GRAY, **WEATHERED SHALE**, **WITH SAND, SILT, AND CLAY**		54	38 50	-	83	SS-16	-	-	-	-	-	-	-	-	-	9	Rock (V)	-	
		▼ (55–58)																	
@58.5': WET, (FREE WATER NOTED)	638.9	EOB	50/3"	-	100	SS-17	-	-	-	-	-	-	-	-	-	26	Rock (V)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 15 CF CEMENT-BENTONITE GROUT

PROJECT: HEN-24/17D-00.43 TYPE: ROADWAY PID: 117712 SFN: START: 5/16/23 END: 5/16/23	DRILLING FIRM / OPERATOR: TTL / TB SAMPLING FIRM / LOGGER: TTL / KKC DRILLING METHOD: 3.25" HSA SAMPLING METHOD: SPT	DRILL RIG: DIEDRICH D70 TRACK HAMMER: DIEDRICH AUTOMATIC CALIBRATION DATE: 4/13/22 ENERGY RATIO (%): 90	STATION / OFFSET: 511+04, 1' RT. ALIGNMENT: RAMP B ELEVATION: 696.2 (NAVD88) EOB: 15.0 ft. LAT / LONG: -84.217363, 41.360670	EXPLORATION ID B-031-0-22 PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 696.2	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	HOLE SEALED
TOPSOIL - 10 INCHES	695.4																		
STIFF, BROWN, **SILTY CLAY**, SOME SAND, MOIST	693.2	1 – 2	2 2 4	9	100	SS-1	1.50	0	4	16	27	53	37	20	17	24	A-6b (11)	-	
VERY STIFF, BROWN, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP	690.2	3.5 – 5	5 6 8	21	100	SS-2	3.00	-	-	-	-	-	-	-	-	16	A-6a (V)	-	
HARD, BROWN, **SANDY SILT**, SOME CLAY, TRACE GRAVEL, DAMP @6.0' TO 7.5': Qu=14,970 PSF, γ_{WET}=134.7 PCF, γ_{DRY}=117.1 PCF		6 – 7.5	6 14 17	47	100	SS-3	4.50	2	7	16	43	32	29	21	8	15	A-4a (8)	-	
		8.5 – 10	7 11 17	42	100	SS-4	4.50	-	-	-	-	-	-	-	-	15	A-4a (V)	-	
	684.2	11 – 12.5	7 11 14	38	100	SS-5A	-	-	-	-	-	-	-	-	-	-	A-4a (V)	-	
HARD, GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP						SS-5B	4.25	-	-	-	-	-	-	-	-	16	A-6b (V)	-	
@13.5' TO 15.0': Qu=6,030 PSF, γ_{WET}=139.6 PCF, γ_{DRY}=119.3 PCF @13.5': VERY STIFF	681.2	13.5 – 15 EOB	5 7 9	24	100	SS-6	3.50	-	-	-	-	-	-	-	-	17	A-6b (V)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 4 CF CEMENT-BENTONITE GROUT

STANDARD ODOT LOG W/ SULFATES (8.5 X 11) - OH DOT.GDT - 3/27/24 14:17 - X:\PROJECTS\230230.GPJ

PROJECT: HEN-24/17D-00.43	DRILLING FIRM / OPERATOR: TTL / CW	DRILL RIG: CME 75 TRUCK 844	STATION / OFFSET: 710+76, 19' RT.	EXPLORATION ID B-032-0-22
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: TTL / KKC	HAMMER: CME AUTOMATIC	ALIGNMENT: RAMP D	
PID: 117712 SFN:	DRILLING METHOD: HSA	CALIBRATION DATE: 2/20/23	ELEVATION: 701.3 (NAVD88) EOB: 15.0 ft.	PAGE 1 OF 1
START: 6/5/23 END: 6/5/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 72.9	LAT / LONG: -84.217233, 41.361294	

MATERIAL DESCRIPTION AND NOTES	ELEV. 701.3	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	HOLE SEALED
TOPSOIL - 5 INCHES	700.9																		
STIFF, GRAY/BROWN, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, TRACE ORGANICS, DAMP	697.8	1–3	3 5 7	15	89	SS-1	>4.5	-	-	-	-	-	-	-	-	15	A-6b (V)	-	
VERY STIFF, GRAY/BROWN, **CLAY**, SOME SILT, SOME SAND, TRACE GRAVEL, TRACE IRON OXIDE STAIN SEAM, DAMP		4–5	5 7 10	21	100	SS-2	3.75	3	4	19	25	49	41	20	21	19	A-7-6 (12)	-	
@6.0' TO 7.5': Qu=11,705 PSF, γ_{WET}=128.8 PCF, γ_{DRY}=111.2 PCF @6': HARD	692.8	6–8	7 13 15	34	100	SS-3	>4.5	-	-	-	-	-	-	-	-	16	A-7-6 (V)	-	
VERY STIFF, GRAY/BROWN, **SILTY CLAY**, SOME SAND, TRACE GRAVEL, DAMP	690.3	9–10	8 12 16	34	100	SS-4	>4.5	6	6	17	23	48	33	17	16	16	A-6b (10)	-	
HARD, GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, TRACE IRON OXIDE STAIN SEAM, DAMP @11.0' TO 12.5': Qu=13,975 PSF, γ_{WET}=129.0 PCF, γ_{DRY}=111.8 PCF		11–13	10 13 24	45	100	SS-5	>4.5	-	-	-	-	-	-	-	-	15	A-6b (V)	-	
	686.3	14–15 EOB	9 13 17	36	100	SS-6	>4.5	-	-	-	-	-	-	-	-	15	A-6b (V)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 4 CF CEMENT-BENTONITE GROUT

PROJECT: HEN-24/17D-00.43	DRILLING FIRM / OPERATOR: TTL / CW	DRILL RIG: BUCKET AUGER	STATION / OFFSET: 159+33, 80' RT.	EXPLORATION ID B-033-0-22
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: TTL / KKC	HAMMER: 39 LB HOUSEL HAMMER	ALIGNMENT: U.S. ROUTE 24	
PID: 117712 SFN:	DRILLING METHOD: HAND AUGER	CALIBRATION DATE: N/A	ELEVATION: 700.0 (NAVD88) EOB: 6.0 ft.	PAGE 1 OF 1
START: 8/11/23 END: 8/11/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 60	LAT / LONG: -84.216226, 41.361251	

MATERIAL DESCRIPTION AND NOTES	ELEV. 700.0	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
TOPSOIL - 6 INCHES	699.5																		
MEDIUM STIFF, BROWN, **SILTY CLAY**, SOME SAND, TRACE GRAVEL, TRACE ORGANICS, MOIST		1	1 2 3	5	78	SS-1	3.00	7	13	14	24	42	38	21	17	24	A-6b (9)	240	
@1.5': DAMP TO MOIST		2	3 4 4	8	89	SS-2	3.75	-	-	-	-	-	-	-	-	21	A-6b (V)	-	
@3': MOIST	695.5	3 / 4	2 2 3	5	100	SS-3	4.00	-	-	-	-	-	-	-	-	22	A-6b (V)	-	
STIFF, BROWN, **SILTY CLAY**, SOME SAND, TRACE GRAVEL, DAMP	694.0	5 / EOB 6	3 6 4	10	100	SS-4	4.50	5	5	16	23	51	36	19	17	16	A-6b (11)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS MIXED WITH 0.5 BAG BENTONITE CHIPS

STANDARD ODOT LOG W/ SULFATES (8.5 X 11) - OH DOT.GDT - 3/27/24 14:18 - X:\PROJECTS\230230.GPJ

PROJECT: HEN-24/17D-00.43	DRILLING FIRM / OPERATOR: TTL / CW	DRILL RIG: CME 75 TRUCK 844	STATION / OFFSET: 161+16, 65' LT.	EXPLORATION ID B-034-0-22
TYPE: SUBGRADE	SAMPLING FIRM / LOGGER: TTL / KKC	HAMMER: CME AUTOMATIC	ALIGNMENT: U.S. ROUTE 25	
PID: 117712 SFN:	DRILLING METHOD: HSA	CALIBRATION DATE: 2/20/23	ELEVATION: 701.6 (NAVD88) EOB: 6.0 ft.	PAGE 1 OF 1
START: 6/5/23 END: 6/5/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 72.9	LAT / LONG: -84.215919, 41.361848	

MATERIAL DESCRIPTION AND NOTES	ELEV. 701.6	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
TOPSOIL - 6 INCHES	701.1																		
VERY STIFF, GRAY/BROWN, **CLAY**, SOME SILT, SOME SAND, TRACE GRAVEL, TRACE ORGANICS, DAMP	700.1	1	5 8 6	17	44	SS-1	-	8	7	18	25	42	41	22	19	13	A-7-6 (10)	230	
STIFF, BROWN/GRAY, **CLAY**, SOME SILT, LITTLE SAND, TRACE GRAVEL, DAMP TO MOIST	698.6	2	4 5 6	13	100	SS-2	>4.5	-	-	-	-	-	-	-	-	22	A-7-6 (V)	-	
VERY STIFF TO HARD, GRAY/BROWN, **CLAY**, SOME SILT, LITTLE SAND, TRACE GRAVEL, DAMP		3–4	5 7 8	18	100	SS-3	>4.5	-	-	-	-	-	-	-	-	21	A-7-6 (V)	-	
@4.5': VERY STIFF, BROWN, TRACE IRON OXIDE STAIN SEAM, MOIST	695.6	5 – EOB 6	7 7 7	17	100	SS-4	3.50	4	3	16	23	54	44	22	22	22	A-7-6 (14)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS MIXED WITH 0.5 BAG BENTONITE CHIPS

STANDARD ODOT LOG W/ SULFATES (8.5 X 11) - OH DOT.GDT - 3/27/24 14:17 - X:\PROJECTS\230230.GPJ

PROJECT: HEN-24/17D-00.43	DRILLING FIRM / OPERATOR: TTL / CW	DRILL RIG: CME 75 TRUCK 844	STATION / OFFSET: 163+18, 59' RT.	EXPLORATION ID B-035-0-22
TYPE: SUBGRADE	SAMPLING FIRM / LOGGER: TTL / KKC	HAMMER: CME AUTOMATIC	ALIGNMENT: U.S. ROUTE 26	
PID: 117712 SFN:	DRILLING METHOD: HSA	CALIBRATION DATE: 2/20/23	ELEVATION: 702.1 (NAVD88) EOB: 7.5 ft.	PAGE 1 OF 1
START: 6/7/23 END: 6/7/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 72.9	LAT / LONG: -84.215055, 41.361837	

MATERIAL DESCRIPTION AND NOTES	ELEV. 702.1	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
ASPHALT - 8 INCHES	701.4																		
AGGREGATE BASE - 12 INCHES	700.4	1																	
LOOSE, GRAY, **GRAVEL AND STONE FRAGMENTS WITH SAND**, LITTLE SILT, TRACE CLAY, DAMP FILL		2	5 3 3	7	100	SS-1	-	53	18	11	16	2	NP	NP	NP	8	A-1-b (0)	<100	
	698.1	3	4 4	10	100	SS-2A	-	-	-	-	-	-	-	-	-	-	A-1-b (V)	-	
STIFF TO VERY STIFF, GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, MOIST	697.1	4	4			SS-2B	3.00	1	5	21	25	48	39	23	16	25	A-6b (10)	-	
VERY STIFF, GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, TRACE IRON OXIDE STAIN SEAM, DAMP		5	6 6 7	16	100	SS-3	4.00	-	-	-	-	-	-	-	-	19	A-6b (V)	-	
@6.2': GRAY/BROWN	694.6	6 7 EOB	8 9 10	23	100	SS-4	3.50	-	-	-	-	-	-	-	-	18	A-6b (V)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.25 BAG ASPHALT PATCH; AUGER CUTTINGS MIXED WITH 0.5 BAG BENTONITE CHIPS

PROJECT: HEN-24/17D-00.43	DRILLING FIRM / OPERATOR: TTL / CW	DRILL RIG: CME 75 TRUCK 844	STATION / OFFSET: 164+63, 60' LT.	EXPLORATION ID B-036-0-22
TYPE: SUBGRADE	SAMPLING FIRM / LOGGER: TTL / KKC	HAMMER: CME AUTOMATIC	ALIGNMENT: U.S. ROUTE 27	
PID: 117712 SFN:	DRILLING METHOD: HSA	CALIBRATION DATE: 2/20/23	ELEVATION: 702.3 (NAVD88) EOB: 7.5 ft.	PAGE 1 OF 1
START: 6/7/23 END: 6/7/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 72.9	LAT / LONG: -84.214811, 41.362325	

MATERIAL DESCRIPTION AND NOTES	ELEV. 702.3	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
ASPHALT - 8 INCHES	701.6																		
AGGREGATE BASE - 12 INCHES	700.6	1																	
VERY DENSE, BROWN/GRAY, **GRAVEL AND STONE FRAGMENTS WITH SAND**, SOME SILT, TRACE CLAY, WET FILL	699.3	2	23 50/5"	-	100	SS-1	-	22	28	26	20	4	NP	NP	NP	21	A-1-b (0)	<100	
MEDIUM STIFF, BROWN/GRAY, **CLAY**, SOME SAND, SOME SILT, TRACE CRUSHED STONE, MOIST FILL	698.3	3, 4	2 4 7	13	89	SS-2A	4.25	3	6	26	26	39	45	24	21	26	A-7-6 (11)	-	
						SS-2B	-	-	-	-	-	-	-	-	-	-	A-6b (V)	-	
STIFF, BROWN/GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, TRACE ORGANICS, MOIST	697.3	5	7 9 9	22	100	SS-3	>4.5	-	-	-	-	-	-	-	-	23	A-6b (V)	-	
VERY STIFF TO HARD, GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, MOIST @6': TRACE IRON OXIDE STAIN SEAM	694.8	6, 7, EOB	11 12 12	29	100	SS-4	>4.5	-	-	-	-	-	-	-	-	22	A-6b (V)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.25 BAG ASPHALT PATCH; AUGER CUTTINGS MIXED WITH 0.5 BAG BENTONITE CHIPS

PROJECT: HEN-24/17D-00.43	DRILLING FIRM / OPERATOR: TTL / CW	DRILL RIG: CME 75 TRUCK 844	STATION / OFFSET: 167+11, 79' RT.	EXPLORATION ID B-037-0-22
TYPE: SUBGRADE	SAMPLING FIRM / LOGGER: TTL / KKC	HAMMER: CME AUTOMATIC	ALIGNMENT: U.S. ROUTE 28	
PID: 117712 SFN:	DRILLING METHOD: HSA	CALIBRATION DATE: 2/20/23	ELEVATION: 701.0 (NAVD88) EOB: 6.0 ft.	PAGE 1 OF 1
START: 6/5/23 END: 6/5/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 72.9	LAT / LONG: -84.213784, 41.362338	

MATERIAL DESCRIPTION AND NOTES	ELEV. 701.0	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
TOPSOIL - 7 INCHES	700.4		13 5 3	10	100	SS-1A	-	21	20	8	29	22	44	24	20	13	A-7-6 (7)	240	
STIFF, BROWN, **CLAY**, SOME SILT, SOME SAND, SOME GRAVEL, TRACE ORGANICS, DAMP	700.0	1				SS-1B	-	-	-	-	-	-	-	-	-	-	A-6b (V)	-	
VERY STIFF TO HARD, GRAY/BROWN, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, TRACE IRON OXIDE STAIN SEAM, DAMP	698.0	2	5 6 7	16	100	SS-2	>4.5	-	-	-	-	-	-	-	-	17	A-6b (V)	-	
STIFF TO VERY STIFF, GRAY/BROWN, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, TRACE IRON OXIDE STAIN SEAM, DAMP	696.0	3, 4	3 3 4	9	100	SS-3	3.50	3	6	11	23	57	39	22	17	21	A-6b (11)	-	
VERY STIFF, GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, TRACE IRON OXIDE STAIN SEAM, TRACE ORGANICS, DAMP TO MOIST (MANURE ODOR NOTED)	695.0	5, EOB 6	4 6 7	16	100	SS-4	4.00	-	-	-	-	-	-	-	-	22	A-6b (V)	-	

STANDARD ODOT LOG W/ SULFATES (8.5 X 11) - OH DOT.GDT - 3/27/24 14:17 - X:\PROJECTS\230230.GPJ

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS MIXED WITH 0.5 BAG BENTONITE CHIPS

PROJECT: HEN-24/17D-00.43	DRILLING FIRM / OPERATOR: TTL / CW	DRILL RIG: CME 75 TRUCK 844	STATION / OFFSET: 171+04, 60' RT.	EXPLORATION ID B-038-0-22
TYPE: SUBGRADE	SAMPLING FIRM / LOGGER: TTL / KKC	HAMMER: CME AUTOMATIC	ALIGNMENT: U.S. ROUTE 29	
PID: 117712 SFN:	DRILLING METHOD: HSA	CALIBRATION DATE: 2/20/23	ELEVATION: 702.7 (NAVD88) EOB: 7.5 ft.	PAGE 1 OF 1
START: 6/7/23 END: 6/7/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 72.9	LAT / LONG: -84.212590, 41.362928	

MATERIAL DESCRIPTION AND NOTES	ELEV. 702.7	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
ASPHALT - 10 INCHES	701.9																		
AGGREGATE BASE - 12 INCHES	700.9	1																	
MEDIUM STIFF, GRAY, **CLAY**, SOME CRUSHED STONE, SOME SILT, LITTLE SAND, TRACE CALCITE STAIN SEAM, DAMP FILL		2	4 2 3	6	89	SS-1A	-	-	-	-	-	-	-	-	-	-	A-1-b (V)	-	
						SS-1B	>4.5	29	3	16	20	32	44	22	22	19	A-7-6 (8)	230	
	699.2	3	4 5 5	12	100	SS-2A	-	-	-	-	-	-	-	-	-	-	A-7-6 (V)	-	
STIFF TO VERY STIFF, GRAY, **SILTY CLAY**, SOME SAND, TRACE GRAVEL, TRACE IRON OXIDE STAINS SEAM, MOIST		4				SS-2B	2.75	4	7	22	26	41	38	20	18	21	A-6b (10)	-	
@5': DARK GRAY, TRACE ORGANICS, DAMP		5	6 6 6	15	100	SS-3	3.50	-	-	-	-	-	-	-	-	19	A-6b (V)	-	
	696.2	W 696.2 6	7 7 7	17	100	SS-4A	-	-	-	-	-	-	-	-	-	-	A-6b (V)	-	
MEDIUM DENSE, GRAY/BROWN, **COARSE AND FINE SAND**, LITTLE CLAY, LITTLE SILT, TRACE GRAVEL, DAMP	695.2	7 EOB				SS-4B	-	-	-	-	-	-	-	-	-	19	A-3a (V)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.25 BAG ASPHALT PATCH; AUGER CUTTINGS MIXED WITH 0.5 BAG BENTONITE CHIPS

LEGEND KEY

LITHOLOGIC SYMBOLS
(Unified Soil Classification System)

A-1-A: Ohio DOT: A-1-a, gravel and/or stone fragments

A-1-B: Ohio DOT: A-1-b, gravel and/or stone fragments with sand

A-2-7: Ohio DOT: A-2-7, gravel and/or stone fragments with sand, silt and clay

A-3A: Ohio DOT: A-3a, coarse and fine sand

A-4A: Ohio DOT: A-4a, sandy silt

A-6A: Ohio DOT: A-6a, silt and clay

A-6B: Ohio DOT: A-6b, silty clay

A-7-6: Ohio DOT: A-7-6, clay

PAVEMENT OR BASE: Ohio DOT: Pavement or Aggregate base

SHALE: Ohio DOT: Shale

TOPSOIL: Ohio DOT: Sod and Topsoil

SAMPLER SYMBOLS

Thin Walled Undisturbed Sample

WELL CONSTRUCTION SYMBOLS

Bentonite: Bottom of hole

Soil Cuttings Backfill mixed with Bentonite Pellets or Chips

Asphalt or Concrete Pavement Patch

Notes:

1. Exploratory borings were performed during the period from May 1 through August 13, 2023, utilizing 3¼-inch inside diameter hollow-stem augers, 3½-inch outside diameter solid stem augers, as well as a hand-operated bucket auger, and NQ2 rock core barrels.

2. These logs are subject to the limitations, conclusions, and recommendations in the report and should not be interpreted separate from the report.

3. The borings were located in the field by CT in accordance with the geometric study plans dated April 17, 2023. Latitude and longitude coordinates, and ground surface elevations were surveyed by DGL.

Appendix A
Laboratory Test Data

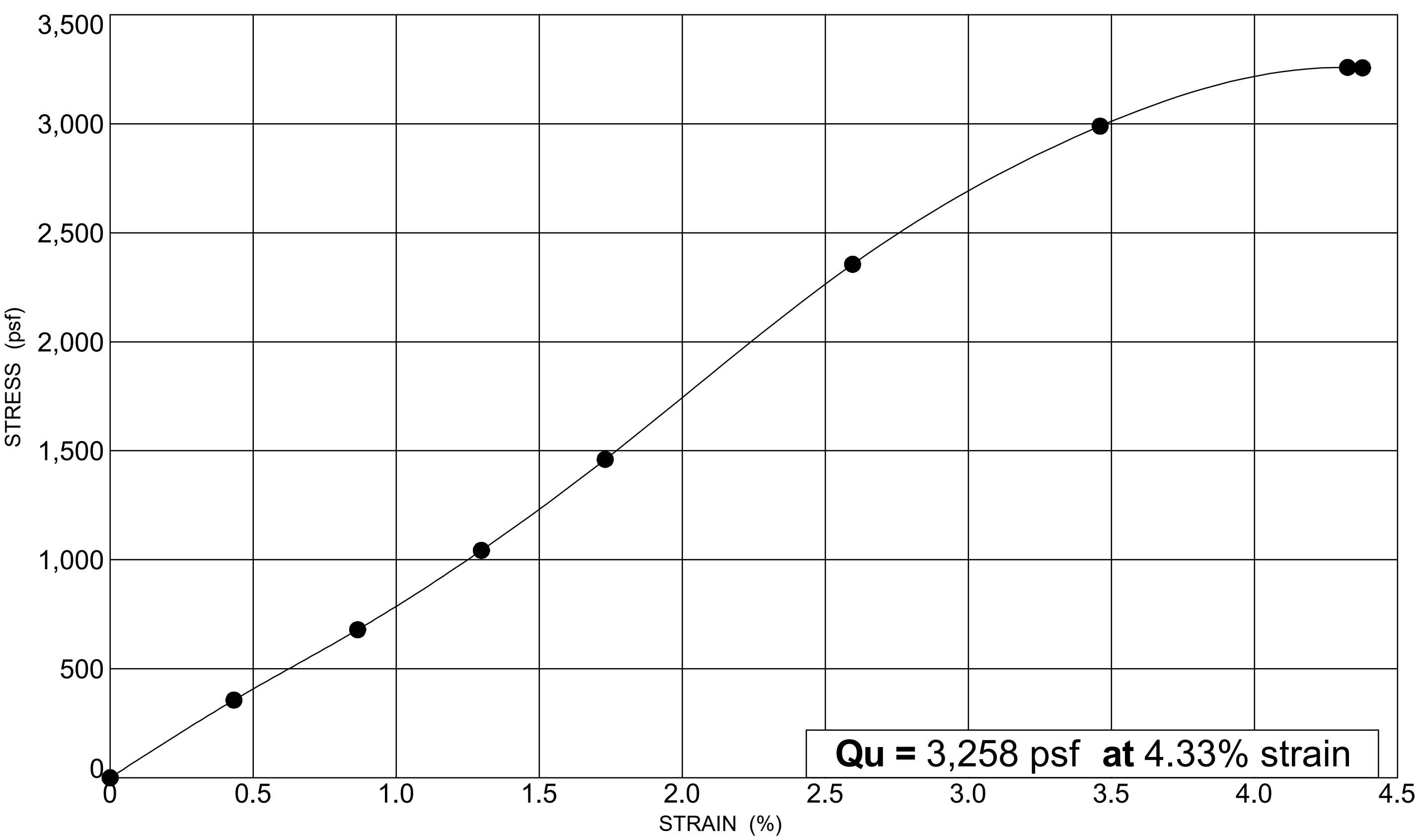
UNCONFINED COMPRESSION TEST
AASHTO T - 208

OHIO DEPARTMENT OF TRANSPORTION
OFFICE OF GEOTECHNICAL ENGINEERING

PROJECT HEN-24/17D-00.43 **PID** 117712
OGE NUMBER N/A **PROJECT TYPE** STRUCTURE FOUNDATION

SAMPLE IDENTIFICATION

BORING ID: B-012-0-22 SAMPLE ID: ST-3
STATION: NOT RECORDED DEPTH: 5.0 - 7.0 feet



SPECIMEN FAILURE SKETCHES OR PHOTOGRAPHS

FRONT VIEW SIDE VIEW

SPECIMEN DETAILS

HEIGHT: 146.800 mm
DIAMETER: 71.600 mm
WET UNIT WT: 137.23 pcf
DRY UNIT WT: 119.64 pcf

TESTED BY: RS 5/19/2023

CLASSIFICATION RESULTS

GRADATION (%)

GR	CS	FS	SI	CL
6	7	16	25	46

ATTERBERG LIMITS / MOISTURE

LL	PL	PI	WC
31	18	13	15

ODOT CLASS: A-6a HP (tsf): 4.5
DESCRIPTION:

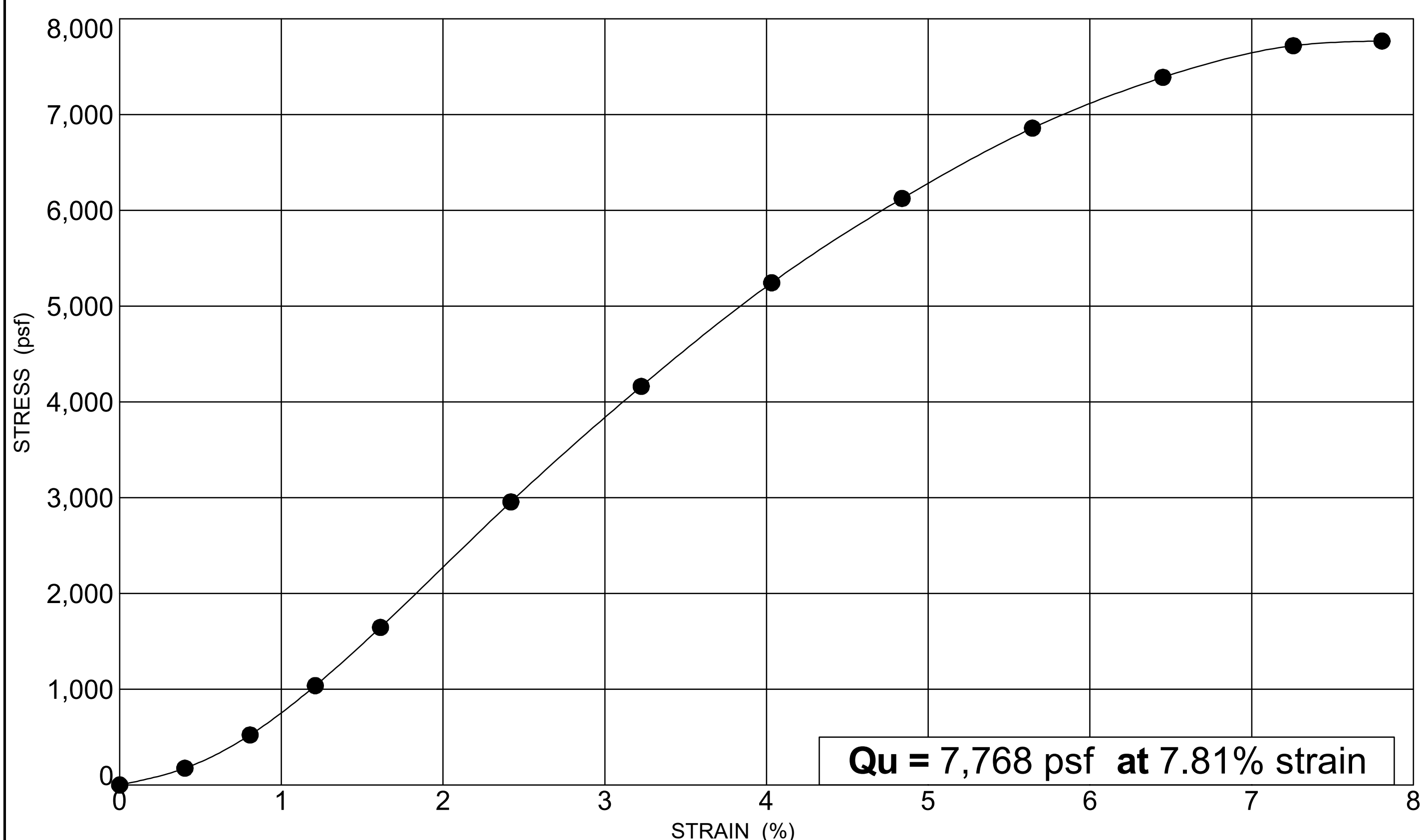
UNCONFINED COMPRESSION TEST
AASHTO T - 208

OHIO DEPARTMENT OF TRANSPORTION
OFFICE OF GEOTECHNICAL ENGINEERING

PROJECT HEN-24/17D-00.43 **PID** 117712
OGE NUMBER N/A **PROJECT TYPE** STRUCTURE FOUNDATION

SAMPLE IDENTIFICATION

BORING ID: B-014-0-22 SAMPLE ID: ST-2
STATION: NOT RECORDED DEPTH: 4.0 - 6.0 feet



SPECIMEN FAILURE SKETCHES OR PHOTOGRAPHS

FRONT VIEW SIDE VIEW

SPECIMEN DETAILS

HEIGHT: 157.500 mm
DIAMETER: 73.700 mm
WET UNIT WT: 130.28 pcf
DRY UNIT WT: 113.09 pcf

TESTED BY: KKC 7/17/2023

CLASSIFICATION RESULTS

GRADATION (%)

GR	CS	FS	SI	CL
2	3	8	21	66

ATTERBERG LIMITS / MOISTURE

LL	PL	PI	WC
27	13	14	15

ODOT CLASS: A-6a HP (tsf): 3.5
DESCRIPTION:

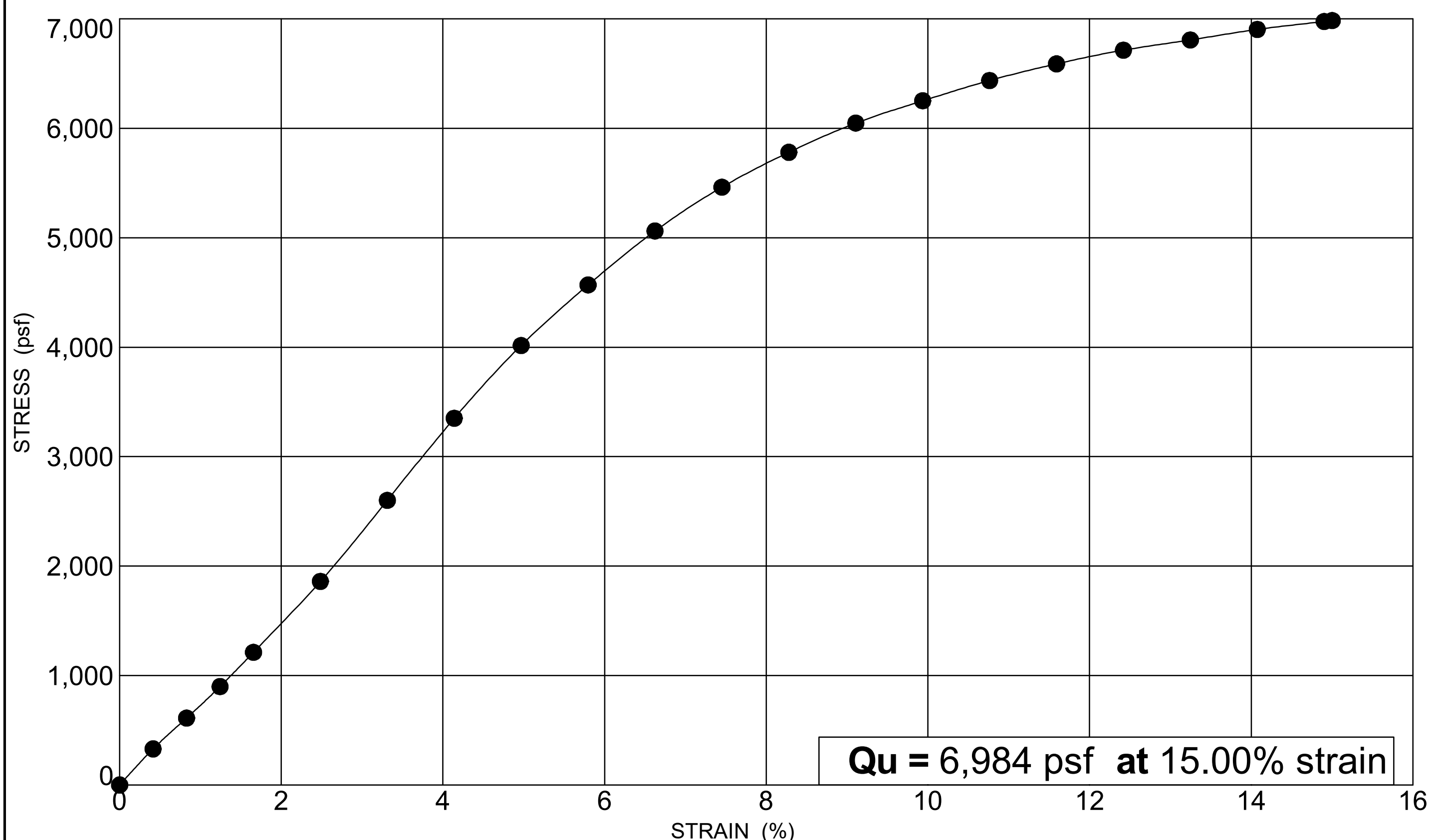
OHIO DEPARTMENT OF TRANSPORTION
OFFICE OF GEOTECHNICAL ENGINEERING

UNCONFINED COMPRESSION TEST
AASHTO T - 208

PROJECT HEN-24/17D-00.43
PID 117712
OGE NUMBER N/A
PROJECT TYPE STRUCTURE FOUNDATION

SAMPLE IDENTIFICATION

BORING ID: B-014-0-22
SAMPLE ID: ST-9
STATION: NOT RECORDED
DEPTH: 21.0 - 23.0 feet



SPECIMEN FAILURE SKETCHES OR PHOTOGRAPHS

FRONT VIEW SIDE VIEW

SPECIMEN DETAILS

HEIGHT: 153.400 mm
DIAMETER: 73.700 mm
WET UNIT WT: 133.19 pcf
DRY UNIT WT: 114.23 pcf

TESTED BY: RS 7/15/2023

CLASSIFICATION RESULTS

GRADATION (%)

GR	CS	FS	SI	CL
5	4	8	19	64

ATTERBERG LIMITS / MOISTURE

LL	PL	PI	WC
32	15	17	17

ODOT CLASS: A-6b HP (tsf): 3.5

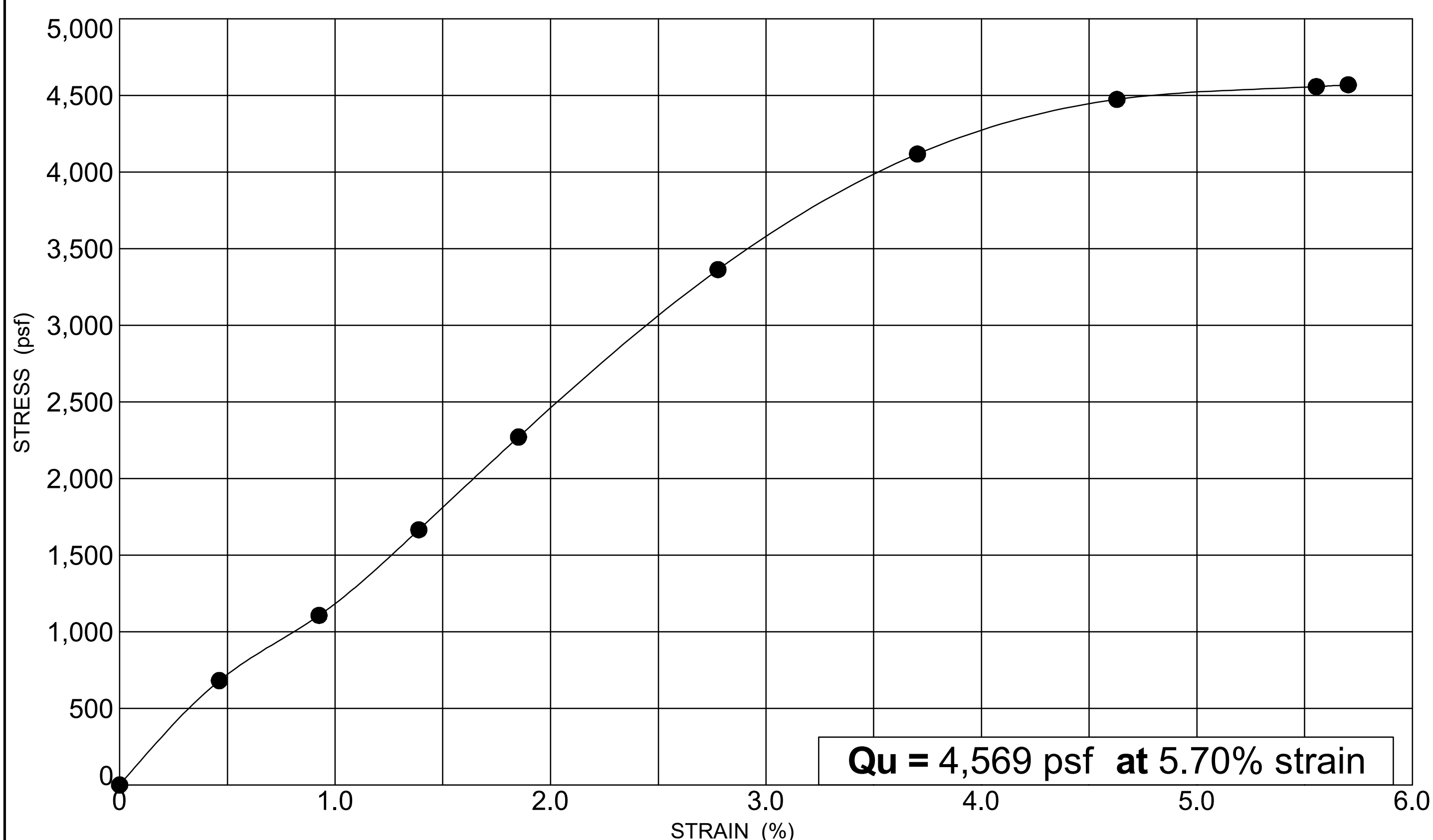
DESCRIPTION:

UNCONFINED COMPRESSION TEST
AASHTO T - 208

PROJECT HEN-24/17D-00.43 **PID** 117712
OGE NUMBER N/A **PROJECT TYPE** STRUCTURE FOUNDATION

SAMPLE IDENTIFICATION

BORING ID: B-015-0-22 SAMPLE ID: ST-12B
STATION: NOT RECORDED DEPTH: 32.0 - 33.0 feet



SPECIMEN FAILURE SKETCHES OR PHOTOGRAPHS

FRONT VIEW SIDE VIEW

SPECIMEN DETAILS

HEIGHT: 137.200 mm
DIAMETER: 73.200 mm
WET UNIT WT: 128.60 pcf
DRY UNIT WT: 106.37 pcf

TESTED BY: KKC 8/1/2023

CLASSIFICATION RESULTS

GRADATION (%)

GR	CS	FS	SI	CL
1	3	8	24	64

ATTERBERG LIMITS / MOISTURE

LL	PL	PI	WC
37	20	17	21

ODOT CLASS: A-6b HP (tsf): 2.75
DESCRIPTION:

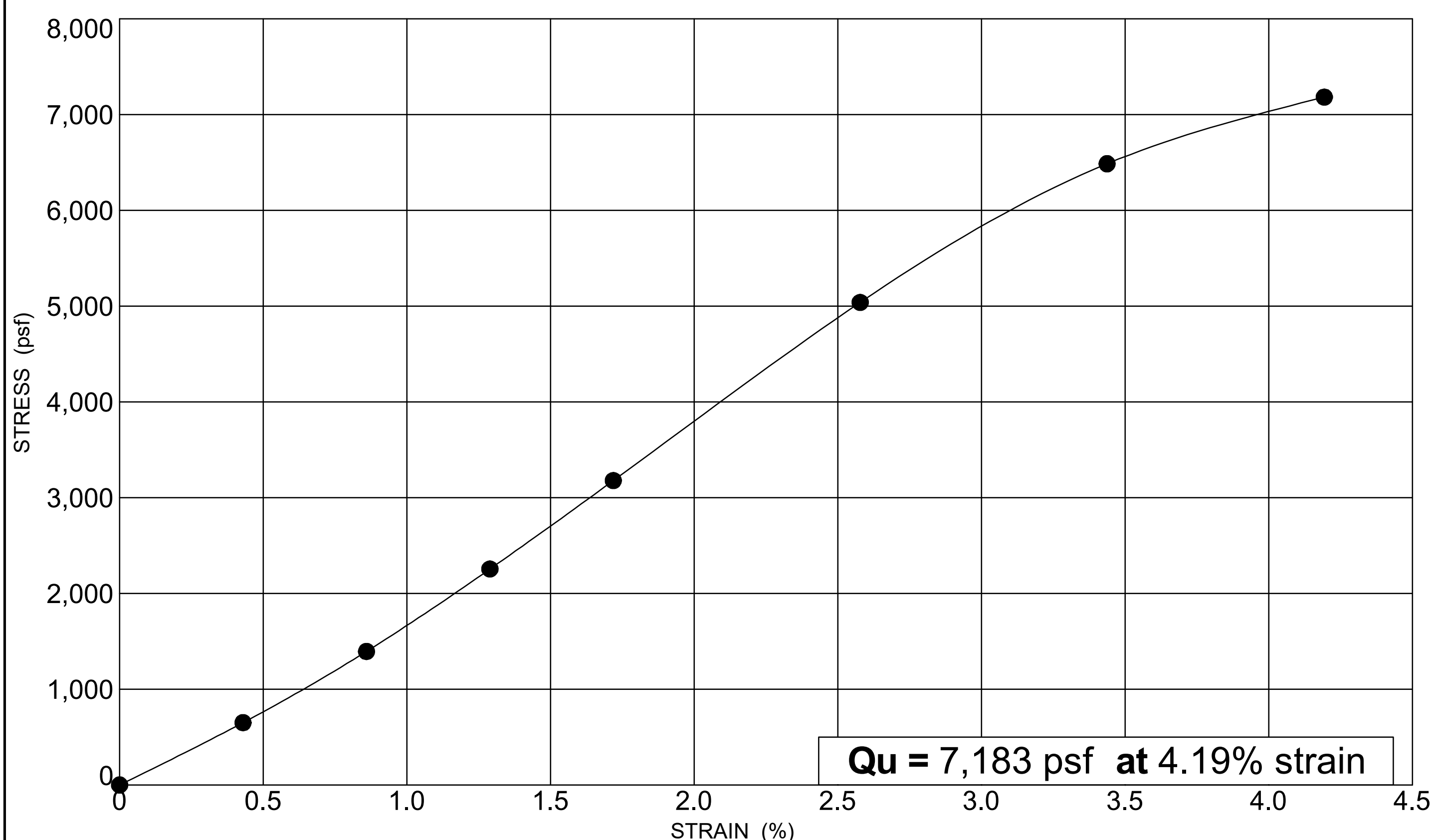
OHIO DEPARTMENT OF TRANSPORTION
OFFICE OF GEOTECHNICAL ENGINEERING

UNCONFINED COMPRESSION TEST
AASHTO T - 208

PROJECT HEN-24/17D-00.43 **PID** 117712
OGE NUMBER N/A **PROJECT TYPE** STRUCTURE FOUNDATION

SAMPLE IDENTIFICATION

BORING ID: B-015-0-22 SAMPLE ID: ST-5
STATION: NOT RECORDED DEPTH: 11.0 - 13.0 feet



SPECIMEN FAILURE SKETCHES OR PHOTOGRAPHS

FRONT VIEW SIDE VIEW

SPECIMEN DETAILS

HEIGHT: 147.800 mm
DIAMETER: 73.200 mm
WET UNIT WT: 124.75 pcf
DRY UNIT WT: 107.91 pcf

TESTED BY: KKC 8/1/2023

CLASSIFICATION RESULTS

GRADATION (%)

GR	CS	FS	SI	CL
6	5	16	25	48

ATTERBERG LIMITS MOISTURE

LL	PL	PI	WC
37	21	16	16

ODOT CLASS: A-6b HP (tsf): >4.5
DESCRIPTION:

OHDOT UNCONFINED COMPRESSION - OH DOT.GDT - 8/17/23 12:54 - S:\PROJECTS\230230.GPJ

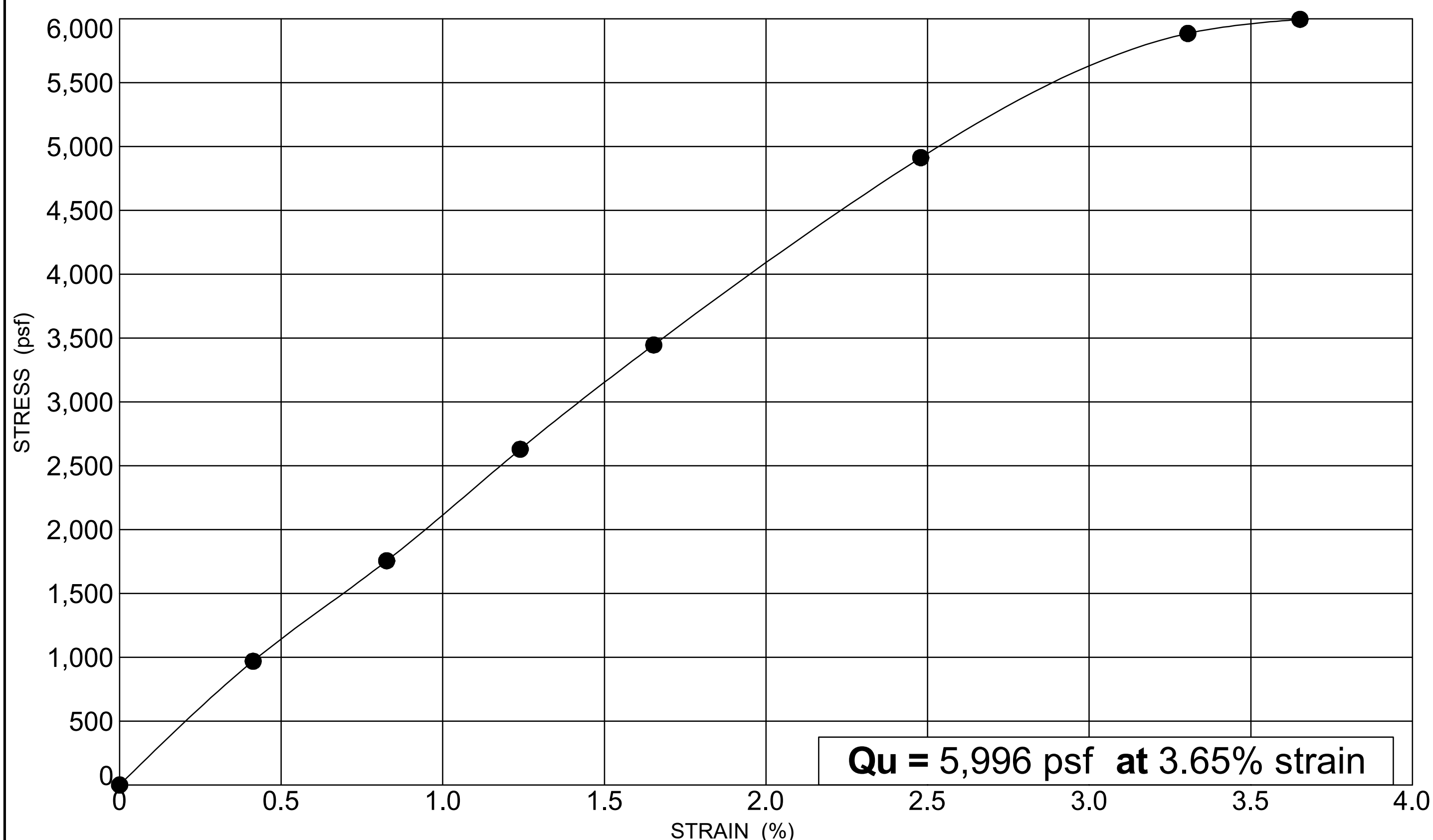
OHIO DEPARTMENT OF TRANSPORTION
OFFICE OF GEOTECHNICAL ENGINEERING

UNCONFINED COMPRESSION TEST AASHTO T - 208

PROJECT HEN-24/17D-00.43 **PID** 117712
OGE NUMBER N/A **PROJECT TYPE** STRUCTURE FOUNDATION

SAMPLE IDENTIFICATION

BORING ID: B-017-0-22 SAMPLE ID: ST-4
STATION: NOT RECORDED DEPTH: 8.0 - 10.0 feet



SPECIMEN FAILURE SKETCHES OR PHOTOGRAPHS

FRONT VIEW SIDE VIEW

SPECIMEN DETAILS

HEIGHT: 153.700 mm
DIAMETER: 73.200 mm
WET UNIT WT: 133.87 pcf
DRY UNIT WT: 116.51 pcf

TESTED BY: KKC 5/10/2023

CLASSIFICATION RESULTS

GRADATION (%)

GR	CS	FS	SI	CL
18	6	8	17	51

ATTERBERG LIMITS / MOISTURE

LL	PL	PI	WC
38	19	19	15

ODOT CLASS: A-6b HP (tsf): >4.5

DESCRIPTION:

OHDOT UNCONFINED COMPRESSION - OH DOT.GDT - 8/17/23 12:48 - S:\PROJECTS\230230.GPJ

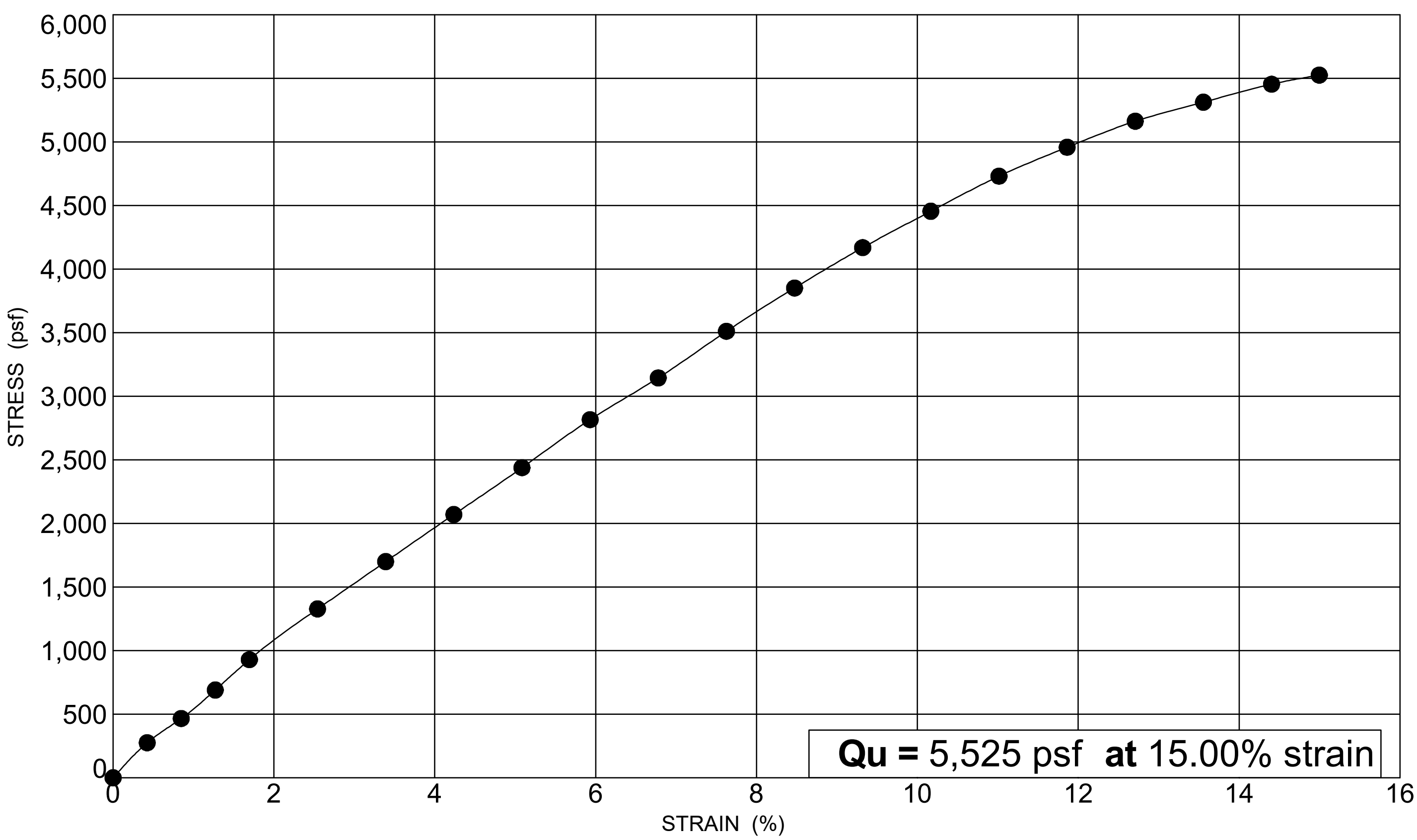
UNCONFINED COMPRESSION TEST
AASHTO T - 208

OHIO DEPARTMENT OF TRANSPORTION
OFFICE OF GEOTECHNICAL ENGINEERING

PROJECT HEN-24/17D-00.43 **PID** 117712
OGE NUMBER N/A **PROJECT TYPE** STRUCTURE FOUNDATION

SAMPLE IDENTIFICATION

BORING ID: B-018-0-22 SAMPLE ID: ST-9
STATION: 213+48 DEPTH: 21.0 - 23.0 feet



SPECIMEN FAILURE SKETCHES OR PHOTOGRAPHS

FRONT VIEW SIDE VIEW

SPECIMEN DETAILS

HEIGHT: 149.900 mm
DIAMETER: 68.600 mm
WET UNIT WT: 134.94 pcf
DRY UNIT WT: 118.16 pcf

TESTED BY: KKC 8/5/2023

CLASSIFICATION RESULTS

GRADATION (%)

GR	CS	FS	SI	CL
14	5	6	19	56

ATTERBERG LIMITS / MOISTURE

LL	PL	PI	WC
29	18	11	14

ODOT CLASS: A-6a HP (tsf): >4.5
DESCRIPTION:

UNCONFINED COMPRESSION TEST
AASHTO T - 208

OHIO DEPARTMENT OF TRANSPORTION
OFFICE OF GEOTECHNICAL ENGINEERING

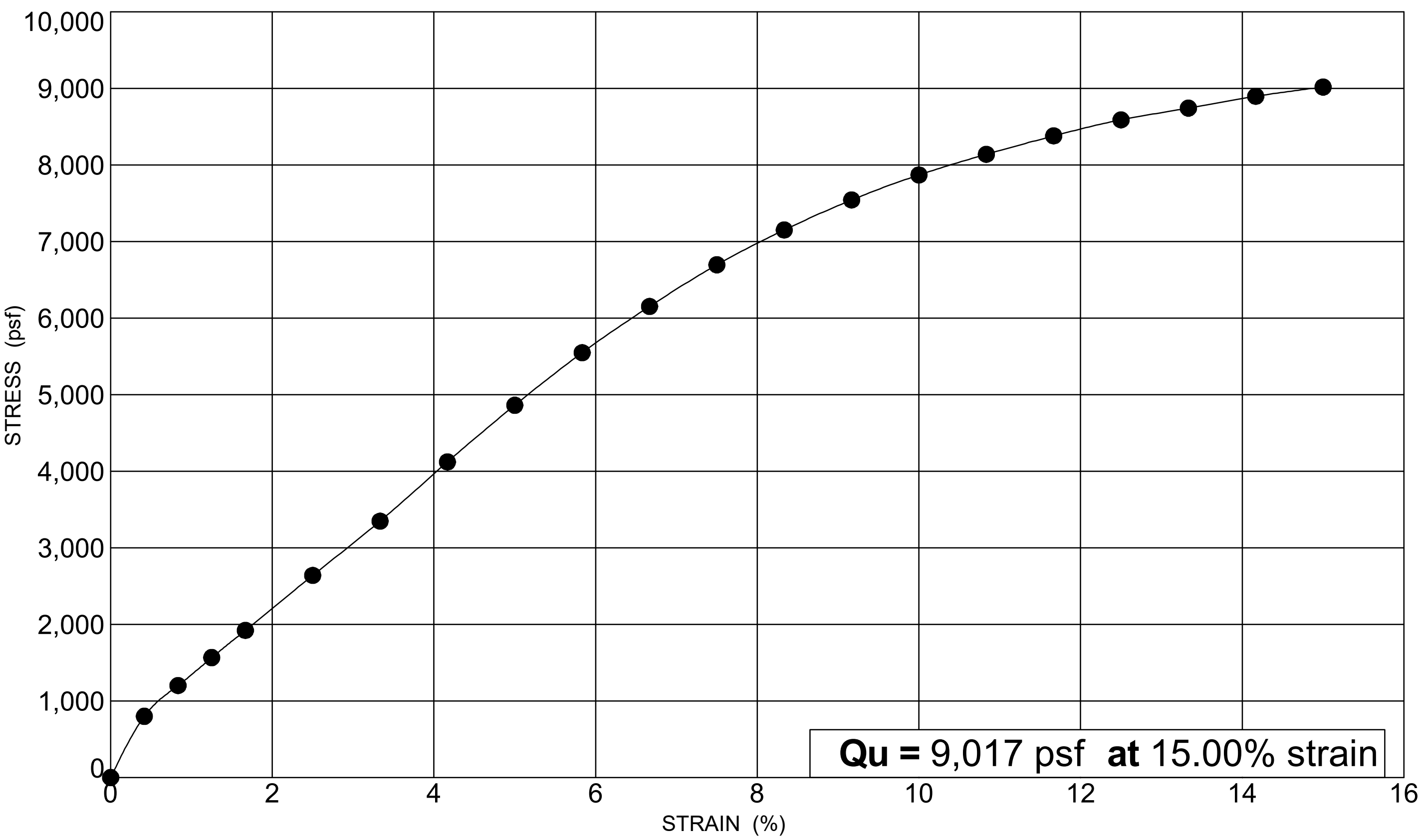
PROJECT HEN-24/17D-00.43 **PID** 117712

OGE NUMBER N/A **PROJECT TYPE** STRUCTURE FOUNDATION

SAMPLE IDENTIFICATION

BORING ID: B-019-0-22 SAMPLE ID: ST-11

STATION: NOT RECORDED DEPTH: 26.0 - 28.0 feet



SPECIMEN FAILURE SKETCHES OR PHOTOGRAPHS

FRONT VIEW SIDE VIEW

SPECIMEN DETAILS

HEIGHT: 152.400 mm

DIAMETER: 72.400 mm

WET UNIT WT: 139.30 pcf

DRY UNIT WT: 119.67 pcf

TESTED BY: RS 7/15/2023

CLASSIFICATION RESULTS

GRADATION (%)

GR	CS	FS	SI	CL
6	4	10	19	61

ATTERBERG LIMITS / MOISTURE

LL	PL	PI	WC
30	15	15	16

ODOT CLASS: A-6a HP (tsf): 4.25

DESCRIPTION:

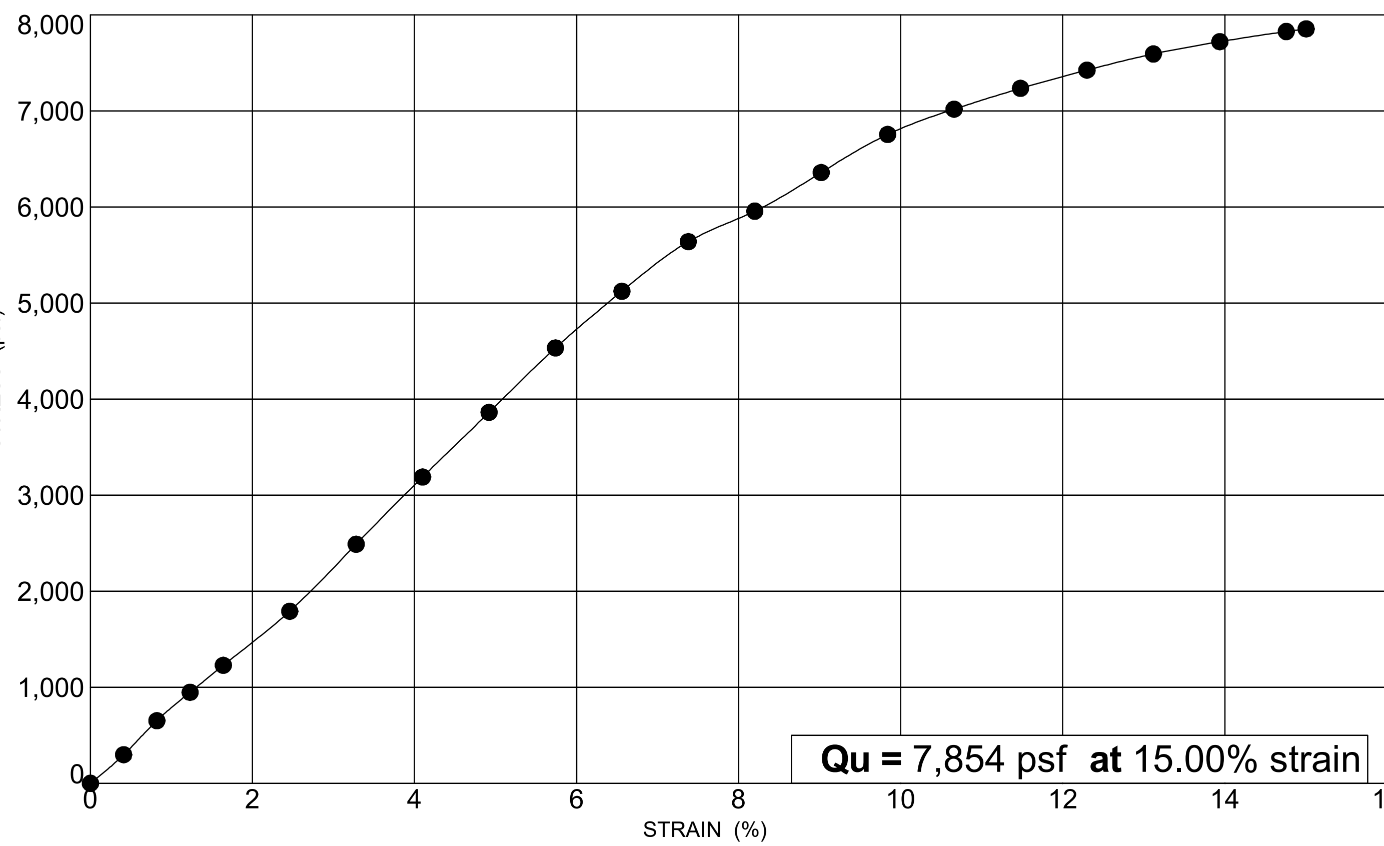
UNCONFINED COMPRESSION TEST
AASHTO T - 208

OHIO DEPARTMENT OF TRANSPORTION
OFFICE OF GEOTECHNICAL ENGINEERING

PROJECT HEN-24/17D-00.43 **PID** 117712
OGE NUMBER N/A **PROJECT TYPE** STRUCTURE FOUNDATION

SAMPLE IDENTIFICATION

BORING ID: B-020-0-22 SAMPLE ID: ST-9
STATION: NOT RECORDED DEPTH: 21.0 - 23.0 feet



SPECIMEN FAILURE SKETCHES OR PHOTOGRAPHS

FRONT VIEW SIDE VIEW

SPECIMEN DETAILS

HEIGHT: 154.900 mm
DIAMETER: 71.100 mm
WET UNIT WT: 137.93 pcf
DRY UNIT WT: 118.90 pcf

TESTED BY: KKC 5/5/2023

CLASSIFICATION RESULTS

GRADATION (%)

GR	CS	FS	SI	CL
5	1	9	20	65

ATTERBERG LIMITS / MOISTURE

LL	PL	PI	WC
31	19	12	16

ODOT CLASS: A-6a HP (tsf): 4.0
DESCRIPTION:

OHDOT UNCONFINED COMPRESSION - OH DOT.GDT - 8/17/23 12:49 - S:\PROJECTS\230230.GPJ

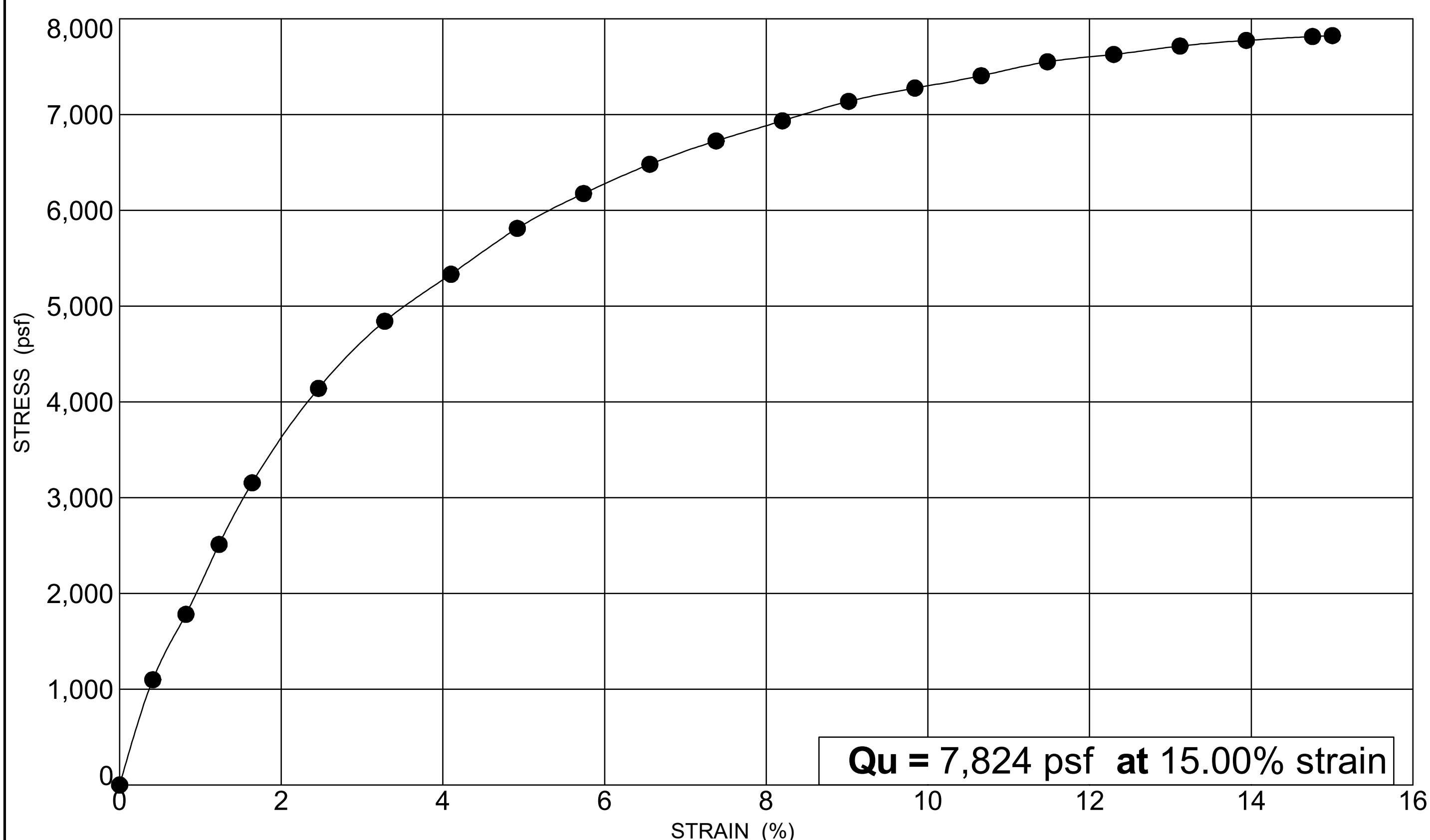
UNCONFINED COMPRESSION TEST
AASHTO T - 208

OHIO DEPARTMENT OF TRANSPORTION
OFFICE OF GEOTECHNICAL ENGINEERING

PROJECT HEN-24/17D-00.43 **PID** 117712
OGE NUMBER N/A **PROJECT TYPE** STRUCTURE FOUNDATION

SAMPLE IDENTIFICATION

BORING ID: B-021-0-22 SAMPLE ID: ST-7
STATION: NOT RECORDED DEPTH: 16.0 - 18.0 feet



SPECIMEN FAILURE SKETCHES OR PHOTOGRAPHS

FRONT VIEW SIDE VIEW

SPECIMEN DETAILS

HEIGHT: 154.900 mm
DIAMETER: 73.200 mm
WET UNIT WT: 133.06 pcf
DRY UNIT WT: 116.31 pcf

TESTED BY: KKC 7/17/2023

CLASSIFICATION RESULTS

GRADATION (%)

GR	CS	FS	SI	CL
4	4	7	21	64

ATTERBERG LIMITS / MOISTURE

LL	PL	PI	WC
29	13	16	14

ODOT CLASS: A-6b HP (tsf): 3.5
DESCRIPTION:

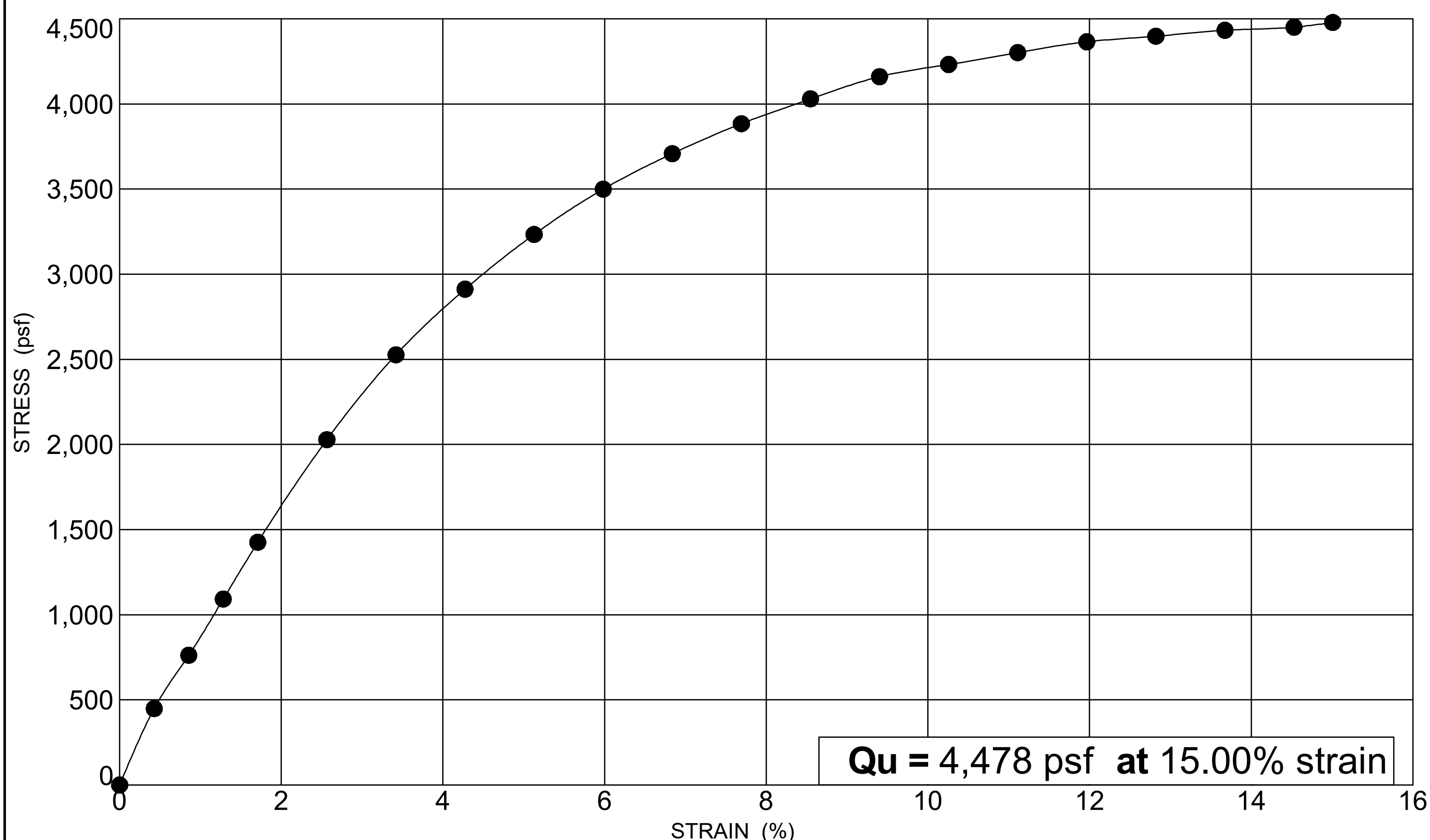
UNCONFINED COMPRESSION TEST
AASHTO T - 208

OHIO DEPARTMENT OF TRANSPORTION
OFFICE OF GEOTECHNICAL ENGINEERING

PROJECT HEN-24/17D-00.43 **PID** 117712
OGE NUMBER N/A **PROJECT TYPE** STRUCTURE FOUNDATION

SAMPLE IDENTIFICATION

BORING ID: B-025-0-22 SAMPLE ID: ST-11
STATION: NOT RECORDED DEPTH: 26.0 - 28.0 feet



SPECIMEN FAILURE SKETCHES OR PHOTOGRAPHS

FRONT VIEW SIDE VIEW

SPECIMEN DETAILS

HEIGHT: 148.600 mm
DIAMETER: 73.200 mm
WET UNIT WT: 132.76 pcf
DRY UNIT WT: 113.96 pcf

TESTED BY: KKC 8/1/2023

CLASSIFICATION RESULTS

GRADATION (%)

GR	CS	FS	SI	CL
5	5	14	25	51

ATTERBERG LIMITS / MOISTURE

LL	PL	PI	WC
37	20	17	17

ODOT CLASS: A-6b HP (tsf): 2.0
DESCRIPTION:

OHDOT UNCONFINED COMPRESSION - OH DOT.GDT - 8/17/23 12:58 - S:\PROJECTS\230230.GPJ

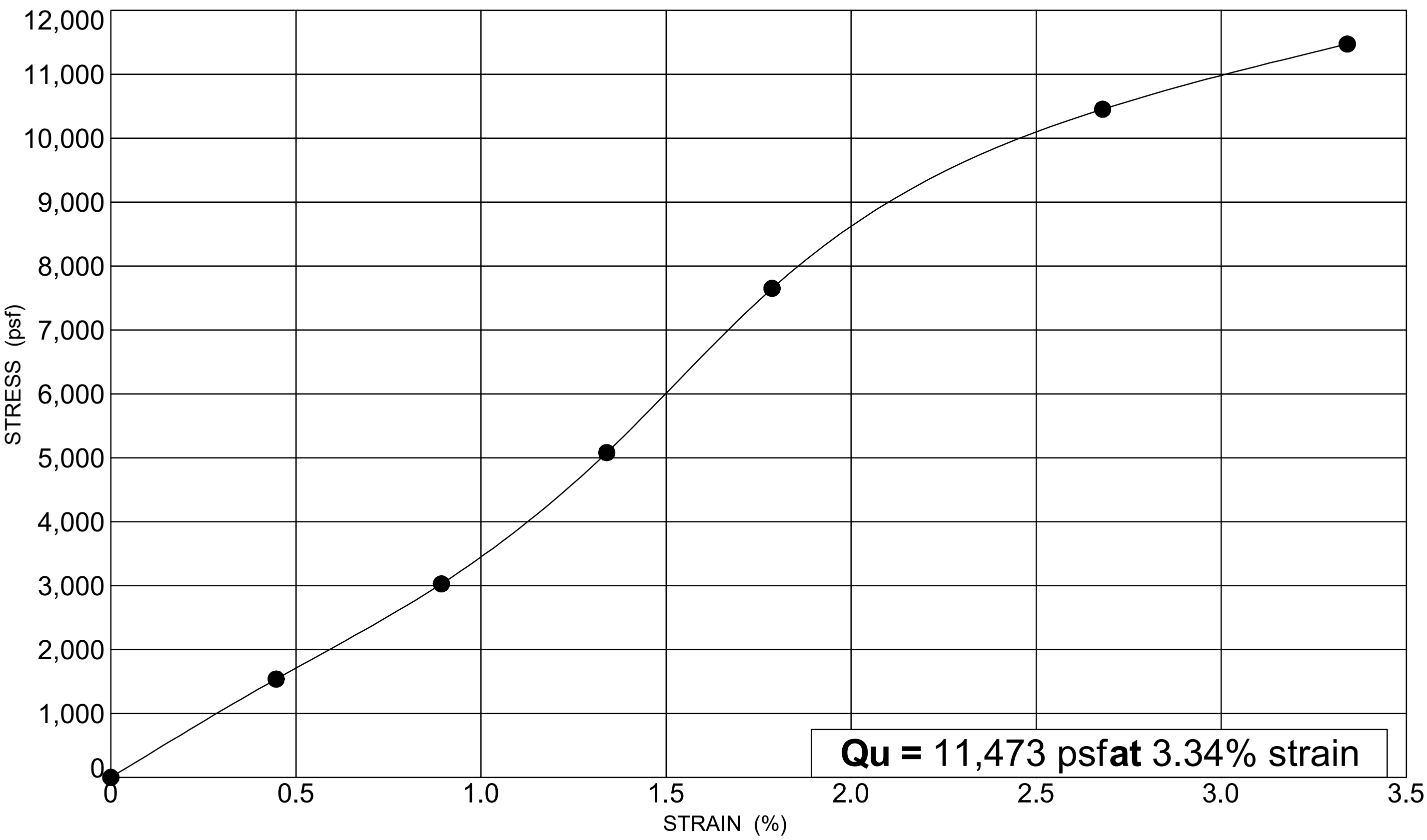
UNCONFINED COMPRESSION TEST
AASHTO T - 208

OHIO DEPARTMENT OF TRANSPORTION
OFFICE OF GEOTECHNICAL ENGINEERING

PROJECT HEN-24/17D-00.43 **PID** 117712
OGE NUMBER N/A **PROJECT TYPE** STRUCTURE FOUNDATION

SAMPLE IDENTIFICATION

BORING ID: B-025-0-22 SAMPLE ID: ST-3
STATION: NOT RECORDED DEPTH: 6.0 - 8.0 feet



SPECIMEN FAILURE SKETCHES OR PHOTOGRAPHS

FRONT VIEW SIDE VIEW

SPECIMEN DETAILS

HEIGHT: 142.200 mm

DIAMETER: 71.600 mm

WET UNIT WT: 139.58 pcf

DRY UNIT WT: 122.11 pcf

TESTED BY: KKC 8/1/2023

CLASSIFICATION RESULTS

GRADATION (%)

GR	CS	FS	SI	CL
5	5	14	25	51

ATTERBERG LIMITS / MOISTURE

LL	PL	PI	WC
34	20	14	14

ODOT CLASS: A-6a HP (tsf): >4.5

DESCRIPTION:

OHDOT UNCONFINED COMPRESSION - OH DOT.GDT - 8/17/23 12:57 - S:\PROJECTS\230230.GPJ

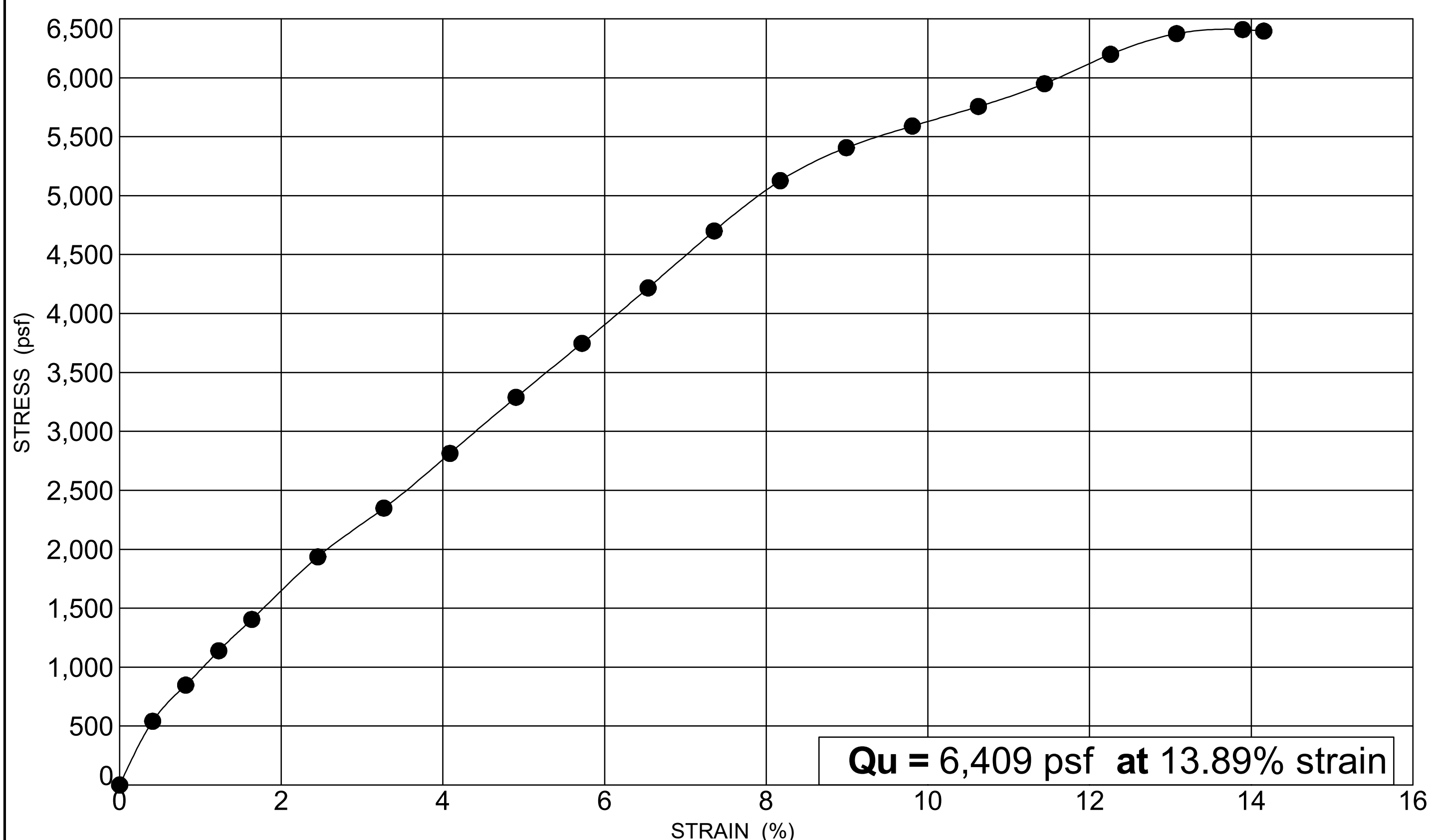
OHIO DEPARTMENT OF TRANSPORTION
OFFICE OF GEOTECHNICAL ENGINEERING

UNCONFINED COMPRESSION TEST
AASHTO T - 208

PROJECT HEN-24/17D-00.43
PID 117712
OGE NUMBER N/A
PROJECT TYPE STRUCTURE FOUNDATION

SAMPLE IDENTIFICATION

BORING ID: B-026-0-22
SAMPLE ID: ST-5
STATION: NOT RECORDED
DEPTH: 11.0 - 13.0 feet



SPECIMEN FAILURE SKETCHES OR PHOTOGRAPHS

FRONT VIEW

SIDE VIEW

SPECIMEN DETAILS

HEIGHT: 155.400 mm
DIAMETER: 68.100 mm
WET UNIT WT: 140.81 pcf
DRY UNIT WT: 123.30 pcf

TESTED BY: RS 5/19/2023

CLASSIFICATION RESULTS

GRADATION (%)

GR	CS	FS	SI	CL
4	5	11	24	56

ATTERBERG LIMITS / MOISTURE

LL	PL	PI	WC
34	18	16	14

ODOT CLASS: A-6b
HP (tsf): 4.5

DESCRIPTION:

OHDOT UNCONFINED COMPRESSION - OH DOT.GDT - 8/17/23 12:50 - S:\PROJECTS\230230.GPJ

UNCONFINED COMPRESSION TEST
AASHTO T - 208

OHIO DEPARTMENT OF TRANSPORTION
OFFICE OF GEOTECHNICAL ENGINEERING

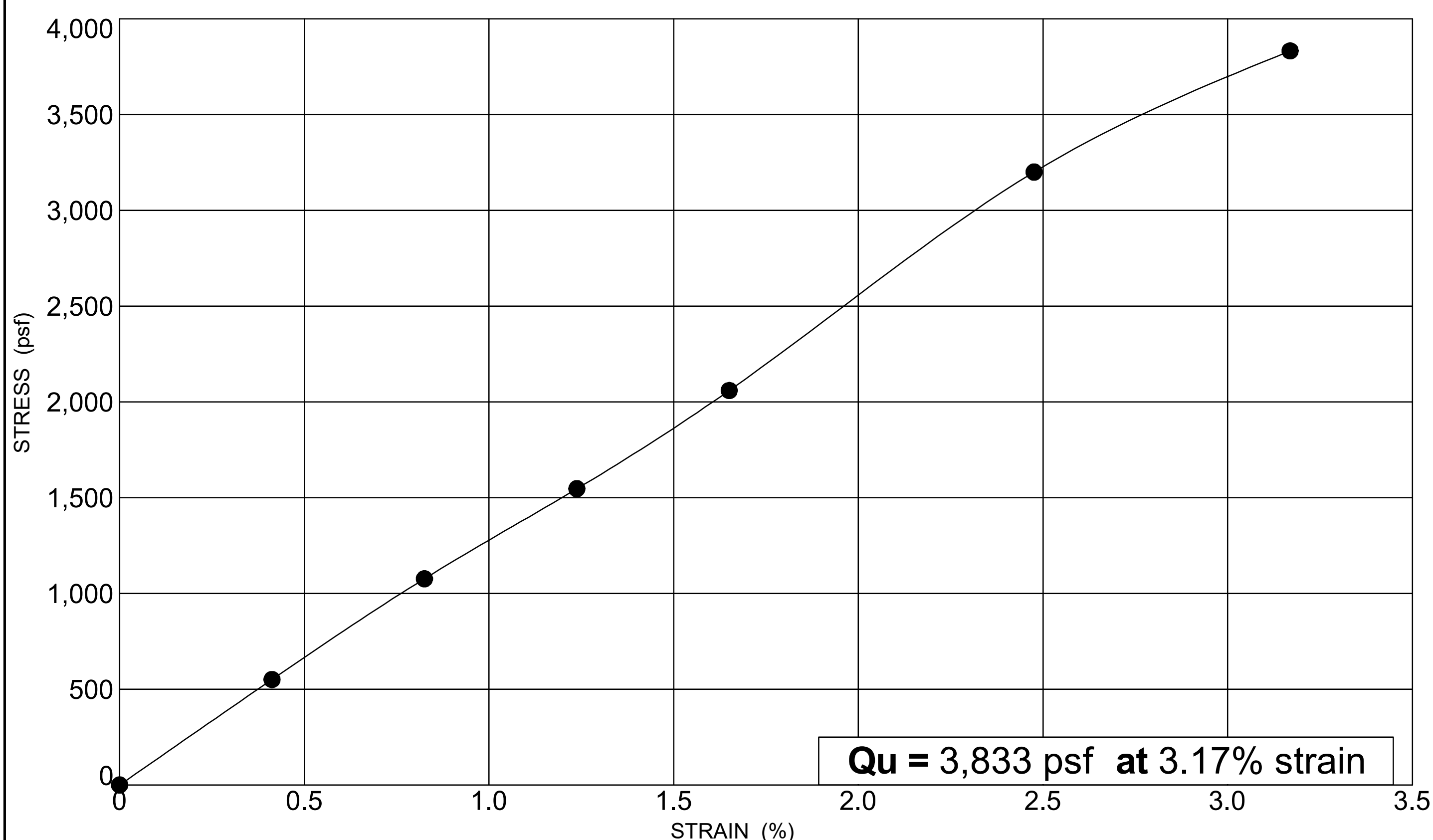
PROJECT HEN-24/17D-00.43 **PID** 117712

OGE NUMBER N/A **PROJECT TYPE** STRUCTURE FOUNDATION

SAMPLE IDENTIFICATION

BORING ID: B-027-0-22 SAMPLE ID: ST-3

STATION: NOT RECORDED DEPTH: 5.0 - 7.0 feet



SPECIMEN FAILURE SKETCHES OR PHOTOGRAPHS

FRONT VIEW SIDE VIEW

SPECIMEN DETAILS

HEIGHT: 153.900 mm

DIAMETER: 72.400 mm

WET UNIT WT: 135.25 pcf

DRY UNIT WT: 116.50 pcf

TESTED BY: RS 5/25/2023

CLASSIFICATION RESULTS

GRADATION (%)

GR	CS	FS	SI	CL
2	5	14	22	57

ATTERBERG LIMITS / MOISTURE

LL	PL	PI	WC
38	19	19	16

ODOT CLASS: A-6b HP (tsf): 4.5

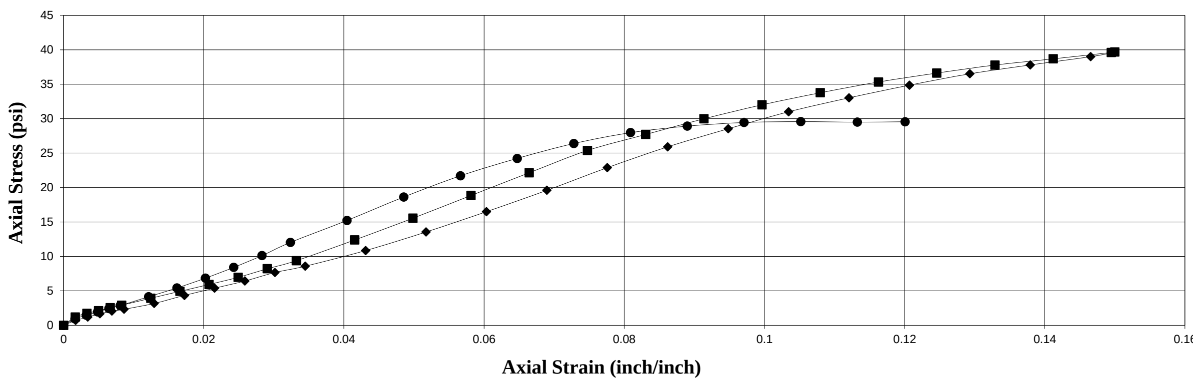
DESCRIPTION:

Unconsolidated - Undrained Triaxial Shear Strength Test

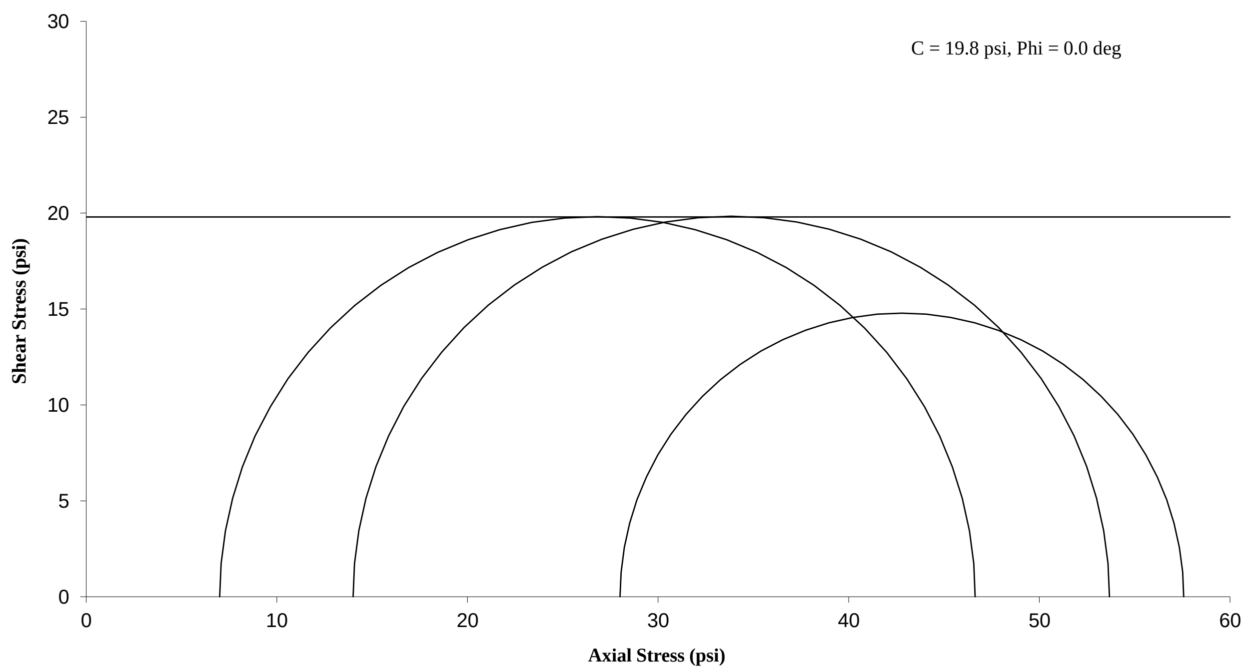
ASTM D 2850

General Sample Data		Triaxial Specimen Data			
TTL Project No.:	230230	Symbol	◆	■	●
Project:	HEN-24/17D-00.43, PID 117712	Init. Specimen Height (in.)	5.80	6.02	6.18
Sample ID:	B-024-0-22 ST-7	Init. Specimen Diameter (in.)	2.83	2.83	2.83
Sample Interval:	16.0 - 18.0'	Init. Moisture Content* (%)	14.8	15.4	17.6
Soil Description:	Gray SILT and CLAY, Little Sand, Little Gravel A-6a (8)	Init. Dry Unit Weight (pcf)	117.1	116.9	108.3
Liquid Limit:	31	Init. Void Ratio	0.46	0.47	0.58
Plastic Limit:	19	Init. Degree of Saturation (%)	87	90	83
Plasticity Index:	12	Minor Principal Stress (psi)	7.0	14.0	28.0
Specific Gravity:	2.75 (Assumed)	Deviator Stress at Failure (psi)	39.6	39.7	29.6
Rate of Strain:	0.03 Inches per Minute	Major Principal Stress (psi)	46.6	53.7	57.6
Failure Criteria:	Peak Deviator Stress or Deviator Stress at 15% Axial Strain	Axial Strain at Failure (%)	15.0	15.0	10.5

Stress/Strain



Mohr Circle Plot



UNCONSOLIDATED, UNDRAINED COMPRESSIVE STRENGTH OF COHESIVE SOILS IN TRIAXIAL COMPRESSION (ASTM D 2850)

Project: HEN-24/17D-00.43, PID 117712
Date: 5/13/2023
Client: Burgess & Niple, Inc.
File: 230230B-024ST-7
Sample ID: B-024-0-22 ST-7
Depth: 16.0 - 18.0'
TTL Project No.: 230230
Specimen ID: "B" (16.5 - 17.0 Feet)

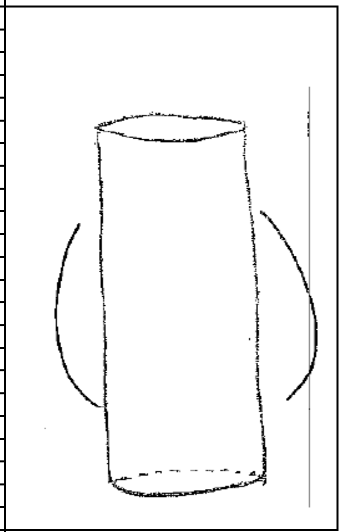
SAMPLE PROPERTIES

Visual Description: Gray SILT and CLAY, Little Sand, Little Gravel A-6a (8)

Diameter: 2.83 in.
Initial Dry Unit Weight of Sample: 117.1 pcf
Area: 6.290 in^2
Initial Moisture Content: 14.8 %
Length: 5.80 in.
Specific Gravity (assumed): 2.75
Initial Void Ratio: 0.46
Initial Degree of Saturation: 87 %
Chamber Pressure: 7 psi
Proving Ring Number: 1155-12-13322

STRESS-STRAIN DATA

Speciman Deformation (in)	Vertical Strain	Proving Ring Reading	Piston Load (lbs)	Corrected Area (in^2)	Deviator Stress (psi)
0.000	0.000	0.0	0.0	6.290	0.0
0.010	0.002	6.5	4.5	6.301	0.7
0.020	0.003	11.0	7.5	6.312	1.2
0.030	0.005	15.5	10.6	6.323	1.7
0.040	0.007	19.0	13.0	6.334	2.1
0.050	0.009	21.5	14.7	6.345	2.3
0.075	0.013	29.5	20.2	6.373	3.2
0.100	0.017	40.5	27.8	6.401	4.3
0.125	0.022	50.5	34.6	6.429	5.4
0.150	0.026	60.5	41.5	6.457	6.4
0.175	0.030	72.5	49.7	6.486	7.7
0.200	0.034	81.5	55.9	6.515	8.6
0.250	0.043	104.0	71.3	6.574	10.9
0.300	0.052	131.0	89.9	6.633	13.5
0.350	0.060	161.0	110.4	6.694	16.5
0.400	0.069	193.0	132.4	6.756	19.6
0.450	0.078	227.5	156.1	6.819	22.9
0.500	0.086	260.0	178.4	6.884	25.9
0.550	0.095	289.0	198.3	6.949	28.5
0.600	0.103	317.0	217.5	7.016	31.0
0.650	0.112	341.0	233.9	7.084	33.0
0.700	0.121	363.5	249.4	7.154	34.9
0.750	0.129	384.5	263.8	7.224	36.5
0.800	0.138	402.0	275.8	7.297	37.8
0.850	0.147	419.0	287.4	7.370	39.0
0.870	0.150	427.5	293.3	7.400	39.6



Sketch of Tested Specimen

RESULTS

Maximum Deviator Stress 39.6 psi

UNCONSOLIDATED, UNDRAINED COMPRESSIVE STRENGTH OF COHESIVE SOILS IN TRIAXIAL COMPRESSION (ASTM D 2850)

Project: HEN-24/17D-00.43, PID 117712
Date: 5/13/2023
Client: Burgess & Niple, Inc.
File: 230230B-024ST-7
Sample ID: B-024-0-22 ST-7
Depth: 16.0 - 18.0'
TTL Project No.: 230230
Specimen ID: "C" (17.0 - 17.5 Feet)

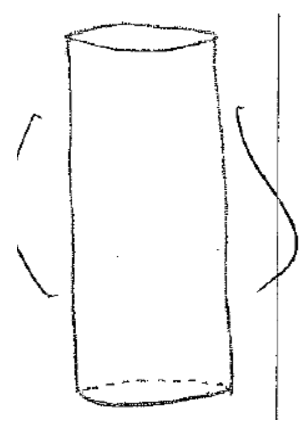
SAMPLE PROPERTIES

Visual Description: Gray SILT and CLAY, Little Sand, Little Gravel A-6a (8)

Diameter: 2.83 in.
Initial Dry Unit Weight of Sample: 116.9 pcf
Area: 6.290 in^2
Initial Moisture Content: 15.4 %
Length: 6.02
Specific Gravity (assumed): 2.75
Initial Void Ratio: 0.47
Initial Degree of Saturation: 90 %
Chamber Pressure: 14 psi
Proving Ring Number: 1155-12-13322

STRESS-STRAIN DATA

Speciman Deformation (in)	Vertical Strain	Proving Ring Reading	Piston Load (lbs)	Corrected Area (in^2)	Deviator Stress (psi)
0.000	0.000	0.0	0.0	6.290	0.0
0.010	0.002	11.0	7.5	6.301	1.2
0.020	0.003	16.0	11.0	6.311	1.7
0.030	0.005	19.5	13.4	6.322	2.1
0.040	0.007	23.5	16.1	6.332	2.5
0.050	0.008	27.0	18.5	6.343	2.9
0.075	0.012	36.5	25.0	6.370	3.9
0.100	0.017	46.0	31.6	6.396	4.9
0.125	0.021	55.5	38.1	6.424	5.9
0.150	0.025	65.5	44.9	6.451	7.0
0.175	0.029	77.5	53.2	6.478	8.2
0.200	0.033	89.0	61.1	6.506	9.4
0.250	0.042	118.5	81.3	6.563	12.4
0.300	0.050	150.0	102.9	6.620	15.5
0.350	0.058	183.5	125.9	6.678	18.8
0.400	0.066	217.5	149.2	6.738	22.1
0.450	0.075	251.5	172.5	6.798	25.4
0.500	0.083	277.0	190.0	6.860	27.7
0.550	0.091	302.5	207.5	6.923	30.0
0.600	0.100	326.0	223.6	6.986	32.0
0.650	0.108	347.0	238.0	7.052	33.8
0.700	0.116	366.5	251.4	7.118	35.3
0.750	0.125	383.5	263.1	7.185	36.6
0.800	0.133	399.5	274.1	7.254	37.8
0.850	0.141	413.0	283.3	7.324	38.7
0.900	0.150	427.0	292.9	7.396	39.6
0.903	0.150	428.0	293.6	7.400	39.7



Sketch of Tested Specimen

RESULTS

Maximum Deviator Stress 39.7 psi

UNCONSOLIDATED, UNDRAINED COMPRESSIVE STRENGTH OF COHESIVE SOILS IN TRIAXIAL COMPRESSION (ASTM D 2850)

Project: HEN-24/17D-00.43, PID 117712 — Date: 5/13/2023

Client: Burgess & Niple, Inc. — File: 230230B-024ST-7

Sample ID: B-024-0-22 ST-7 — Depth: 16.0 - 18.0'

TTL Project No.: 230230 — Specimen ID: "D" (17.5 - 18.0 Feet)

SAMPLE PROPERTIES

Visual Description: Gray SILT and CLAY, Little Sand, Little Gravel A-6a (8)

Diameter: 2.83 in. — Initial Dry Unit Weight of Sample: 108.3 pcf

Area: 6.290 in^2 — Initial Moisture Content: 17.6 %

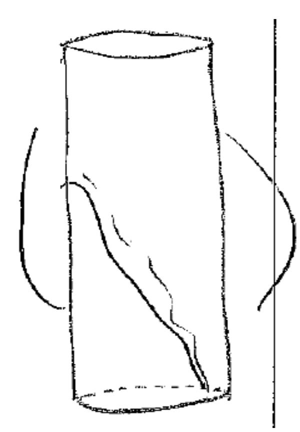
Length: 6.18 in. — Specific Gravity (assumed): 2.75

Initial Void Ratio: 0.58 — Initial Degree of Saturation: 83 %

Chamber Pressure: 28 psi — Proving Ring Number: 1155-12-13322

STRESS-STRAIN DATA

Speciman Deformation (in)	Vertical Strain	Proving Ring Reading	Piston Load (lbs)	Corrected Area (in^2)	Deviator Stress (psi)
0.000	0.000	0.0	0.0	6.290	0.0
0.010	0.002	8.5	5.8	6.300	0.9
0.020	0.003	13.5	9.3	6.311	1.5
0.030	0.005	18.0	12.3	6.321	2.0
0.040	0.006	22.5	15.4	6.331	2.4
0.050	0.008	26.5	18.2	6.341	2.9
0.075	0.012	38.5	26.4	6.367	4.1
0.100	0.016	50.5	34.6	6.394	5.4
0.125	0.020	64.0	43.9	6.420	6.8
0.150	0.024	79.0	54.2	6.447	8.4
0.175	0.028	95.5	65.5	6.473	10.1
0.200	0.032	114.0	78.2	6.501	12.0
0.250	0.040	145.5	99.8	6.555	15.2
0.300	0.049	179.5	123.1	6.611	18.6
0.350	0.057	211.0	144.7	6.668	21.7
0.400	0.065	237.5	162.9	6.725	24.2
0.450	0.073	261.0	179.0	6.784	26.4
0.500	0.081	279.0	191.4	6.844	28.0
0.550	0.089	291.0	199.6	6.905	28.9
0.600	0.097	299.0	205.1	6.967	29.4
0.650	0.105	303.0	207.9	7.030	29.6
0.700	0.113	305.0	209.2	7.094	29.5
0.742	0.120	308.0	211.3	7.148	29.6



Sketch of Tested Specimen

RESULTS

Maximum Deviator Stress 29.6 psi

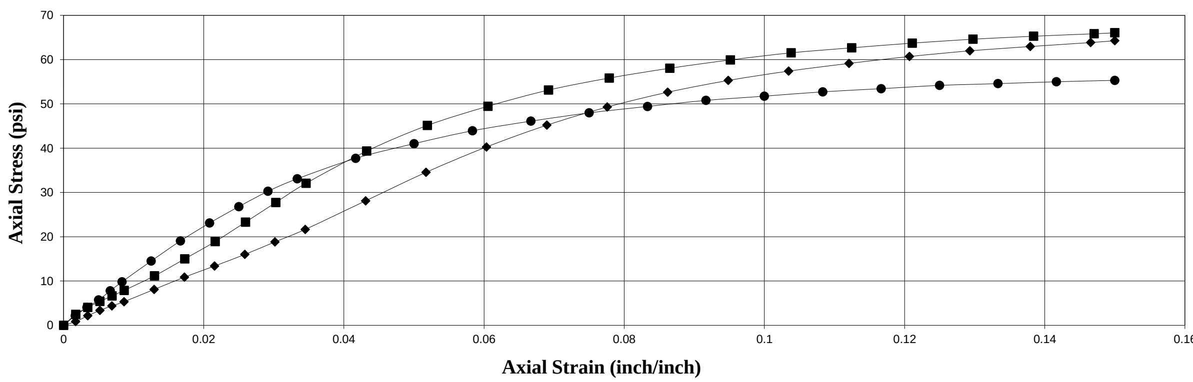
LEADING THROUGH the next 100 years

Unconsolidated - Undrained Triaxial Shear Strength Test

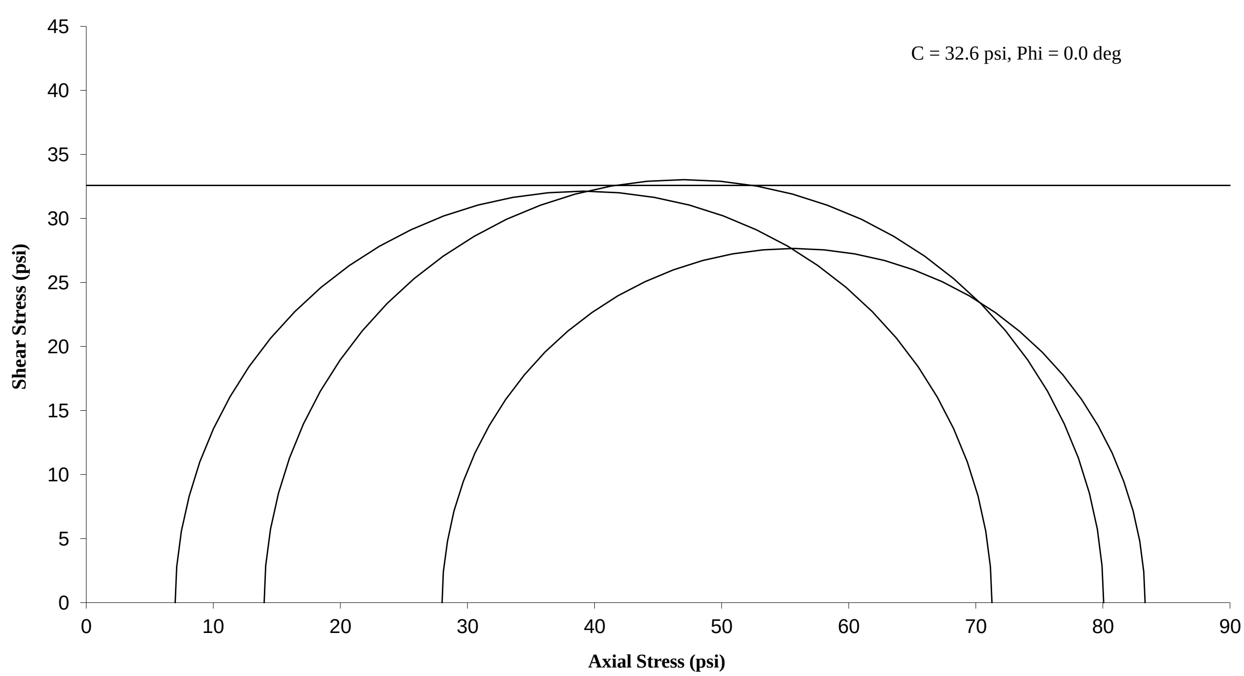
ASTM D 2850

General Sample Data		Triaxial Specimen Data			
TTL Project No.:	230230	Symbol	◆	■	●
Project:	HEN-24/17D-00.43, PID 117712	Init. Specimen Height (in.)	5.80	5.78	6.00
Sample ID:	B-028-0-22 ST-7	Init. Specimen Diameter (in.)	2.88	2.88	2.88
Sample Interval:	16.0 - 18.0'	Init. Moisture Content* (%)	14.1	13.9	14.6
Soil Description:	Gray SILT and CLAY, Some Sand, Trace Gravel A-6a (8)	Init. Dry Unit Weight (pcf)	119.1	117.8	116.6
Liquid Limit:	31	Init. Void Ratio	0.44	0.46	0.47
Plastic Limit:	19	Init. Degree of Saturation (%)	88	83	85
Plasticity Index:	12	Minor Principal Stress (psi)	7.0	14.0	28.0
Specific Gravity:	2.75 (Assumed)	Deviator Stress at Failure (psi)	64.3	66.1	55.3
Rate of Strain:	0.03 Inches per Minute	Major Principal Stress (psi)	71.3	80.1	83.3
Failure Criteria:	Peak Deviator Stress or Deviator Stress at 15% Axial Strain	Axial Strain at Failure (%)	15.0	15.0	15.0

Stress/Strain



Mohr Circle Plot



UNCONSOLIDATED, UNDRAINED COMPRESSIVE STRENGTH OF COHESIVE SOILS IN TRIAXIAL COMPRESSION (ASTM D 2850)

Project: HEN-24/17D-00.43, PID 117712

Client: Burgess & Niple, Inc.

Sample ID: B-028-0-22 ST-7

TTL Project No.: 230230

Date: 5/13/2023

File: 230230B-028ST-7

Depth: 16.0 - 18.0'

Specimen ID: "B" (16.5 - 17.0 Feet)

SAMPLE PROPERTIES

Visual Description: Gray SILT and CLAY, Some Sand, Trace Gravel A-6a (8)

Diameter: 2.88 in.

Area: 6.514 in^2

Length: 5.80 in.

Initial Void Ratio: 0.44

Chamber Pressure: 7 psi

Initial Dry Unit Weight of Sample: 119.1 pcf

Initial Moisture Content: 14.1 %

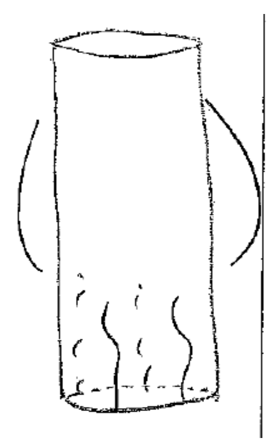
Specific Gravity (assumed): 2.75

Initial Degree of Saturation: 88 %

Proving Ring Number: 1155-12-13322

STRESS-STRAIN DATA

Speciman Deformation (in)	Vertical Strain	Proving Ring Reading	Piston Load (lbs)	Corrected Area (in^2)	Deviator Stress (psi)
0.000	0.000	0.0	0.0	6.514	0.0
0.010	0.002	8.0	5.5	6.526	0.8
0.020	0.003	20.5	14.1	6.537	2.2
0.030	0.005	32.0	22.0	6.548	3.4
0.040	0.007	42.0	28.8	6.560	4.4
0.050	0.009	51.0	35.0	6.571	5.3
0.075	0.013	78.0	53.5	6.600	8.1
0.100	0.017	105.0	72.0	6.629	10.9
0.125	0.022	130.0	89.2	6.658	13.4
0.150	0.026	156.0	107.0	6.687	16.0
0.175	0.030	184.5	126.6	6.717	18.8
0.200	0.034	213.0	146.1	6.747	21.7
0.250	0.043	279.0	191.4	6.808	28.1
0.300	0.052	346.0	237.4	6.870	34.6
0.350	0.060	407.0	279.2	6.933	40.3
0.400	0.069	461.0	316.2	6.997	45.2
0.450	0.078	507.5	348.1	7.062	49.3
0.500	0.086	547.0	375.2	7.129	52.6
0.550	0.095	580.0	397.9	7.197	55.3
0.600	0.103	608.0	417.1	7.266	57.4
0.650	0.112	632.5	433.9	7.337	59.1
0.700	0.121	655.5	449.7	7.409	60.7
0.750	0.129	676.0	463.7	7.482	62.0
0.800	0.138	693.5	475.7	7.557	63.0
0.850	0.147	710.5	487.4	7.633	63.9
0.870	0.150	718.0	492.5	7.664	64.3



Sketch of Tested Specimen

RESULTS

Maximum Deviator Stress 64.3 psi

LEADING THROUGH the next 100 years

UNCONSOLIDATED, UNDRAINED COMPRESSIVE STRENGTH OF COHESIVE SOILS IN TRIAXIAL COMPRESSION (ASTM D 2850)

Project: HEN-24/17D-00.43, PID 117712
Client: Burgess & Niple, Inc.
Sample ID: B-028-0-22 ST-7
TTL Project No.: 230230

Date: 5/13/2023
File: 230230B-028ST-7
Depth: 16.0 - 18.0'
Specimen ID: "C" (17.0 - 17.5 Feet)

SAMPLE PROPERTIES

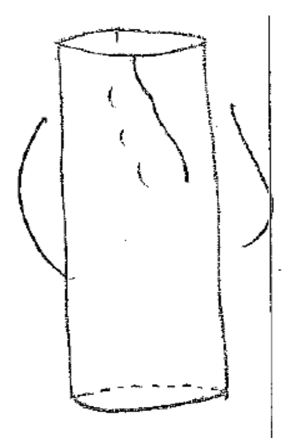
Visual Description: Gray SILT and CLAY, Some Sand, Trace Gravel A-6a (8)

Diameter: 2.88 in.
Area: 6.514 in^2
Length: 5.78
Initial Void Ratio: 0.46
Chamber Pressure: 14 psi

Initial Dry Unit Weight of Sample: 117.8 pcf
Initial Moisture Content: 13.9 %
Specific Gravity (assumed): 2.75
Initial Degree of Saturation: 83 %
Proving Ring Number: 1155-12-13322

STRESS-STRAIN DATA

Speciman Deformation (in)	Vertical Strain	Proving Ring Reading	Piston Load (lbs)	Corrected Area (in^2)	Deviator Stress (psi)
0.000	0.000	0.0	0.0	6.514	0.0
0.010	0.002	23.5	16.1	6.526	2.5
0.020	0.003	38.5	26.4	6.537	4.0
0.030	0.005	51.5	35.3	6.548	5.4
0.040	0.007	63.5	43.6	6.560	6.6
0.050	0.009	75.5	51.8	6.571	7.9
0.075	0.013	107.5	73.7	6.600	11.2
0.100	0.017	145.0	99.5	6.629	15.0
0.125	0.022	183.5	125.9	6.658	18.9
0.150	0.026	227.0	155.7	6.688	23.3
0.175	0.030	271.5	186.2	6.718	27.7
0.200	0.035	315.5	216.4	6.748	32.1
0.250	0.043	390.5	267.9	6.809	39.3
0.300	0.052	452.0	310.1	6.871	45.1
0.350	0.061	500.0	343.0	6.934	49.5
0.400	0.069	542.0	371.8	6.999	53.1
0.450	0.078	575.0	394.5	7.064	55.8
0.500	0.087	603.5	414.0	7.131	58.1
0.550	0.095	629.0	431.5	7.199	59.9
0.600	0.104	652.0	447.3	7.269	61.5
0.650	0.112	670.5	460.0	7.340	62.7
0.700	0.121	688.5	472.3	7.412	63.7
0.750	0.130	705.0	483.6	7.486	64.6
0.800	0.138	719.5	493.6	7.561	65.3
0.850	0.147	733.0	502.8	7.638	65.8
0.867	0.150	738.0	506.3	7.664	66.1



Sketch of Tested Specimen

RESULTS

Maximum Deviator Stress 66.1 psi

LEADING THROUGH the next 100 years

UNCONSOLIDATED, UNDRAINED COMPRESSIVE STRENGTH OF COHESIVE SOILS IN TRIAXIAL COMPRESSION (ASTM D 2850)

Project: HEN-24/17D-00.43, PID 117712
Date: 5/13/2023
Client: Burgess & Niple, Inc.
File: 230230B-028ST-7
Sample ID: B-028-0-22 ST-7
Depth: 16.0 - 18.0'
TTL Project No.: 230230
Specimen ID: "D" (17.5 - 18.0 Feet)

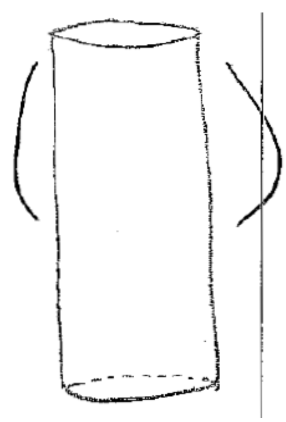
SAMPLE PROPERTIES

Visual Description: Gray SILT and CLAY, Some Sand, Trace Gravel A-6a (8)

Diameter: 2.88 in.
Initial Dry Unit Weight of Sample: 116.6 pcf
Area: 6.514 in^2
Initial Moisture Content: 14.6 %
Length: 6.00 in.
Specific Gravity (assumed): 2.75
Initial Void Ratio: 0.47
Initial Degree of Saturation: 85 %
Chamber Pressure: 28 psi
Proving Ring Number: 1155-12-13322

STRESS-STRAIN DATA

Speciman Deformation (in)	Vertical Strain	Proving Ring Reading	Piston Load (lbs)	Corrected Area (in^2)	Deviator Stress (psi)
0.000	0.000	0.0	0.0	6.514	0.0
0.010	0.002	20.5	14.1	6.525	2.2
0.020	0.003	38.5	26.4	6.536	4.0
0.030	0.005	54.5	37.4	6.547	5.7
0.040	0.007	74.5	51.1	6.558	7.8
0.050	0.008	94.0	64.5	6.569	9.8
0.075	0.013	139.5	95.7	6.597	14.5
0.100	0.017	184.0	126.2	6.625	19.1
0.125	0.021	224.0	153.7	6.653	23.1
0.150	0.025	261.0	179.0	6.681	26.8
0.175	0.029	296.0	203.1	6.710	30.3
0.200	0.033	325.0	223.0	6.739	33.1
0.250	0.042	373.5	256.2	6.798	37.7
0.300	0.050	410.0	281.3	6.857	41.0
0.350	0.058	443.0	303.9	6.918	43.9
0.400	0.067	469.0	321.7	6.980	46.1
0.450	0.075	492.5	337.9	7.043	48.0
0.500	0.083	512.0	351.2	7.107	49.4
0.550	0.092	531.0	364.3	7.172	50.8
0.600	0.100	546.0	374.6	7.238	51.7
0.650	0.108	561.5	385.2	7.306	52.7
0.700	0.117	574.5	394.1	7.375	53.4
0.750	0.125	588.0	403.4	7.445	54.2
0.800	0.133	598.0	410.2	7.517	54.6
0.850	0.142	608.5	417.4	7.590	55.0
0.900	0.150	618.0	423.9	7.664	55.3



Sketch of Tested Specimen

RESULTS

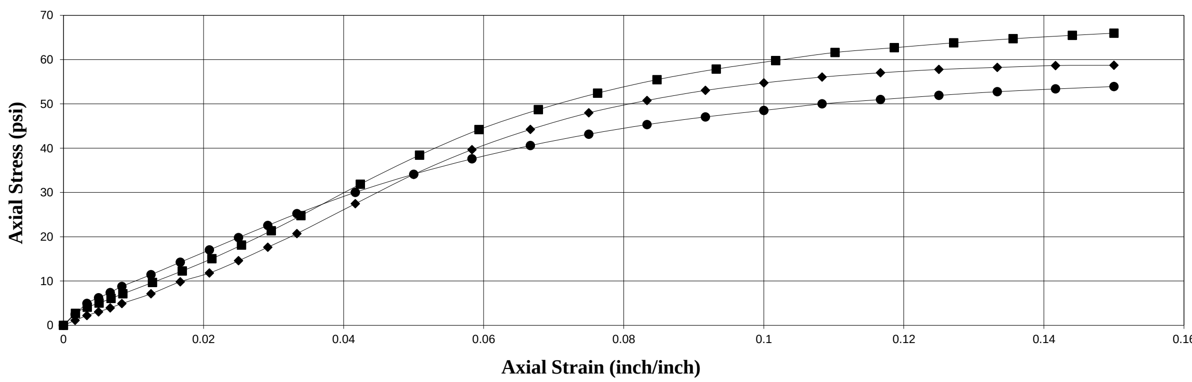
Maximum Deviator Stress 55.3 psi

LEADING THROUGH the next 100 years

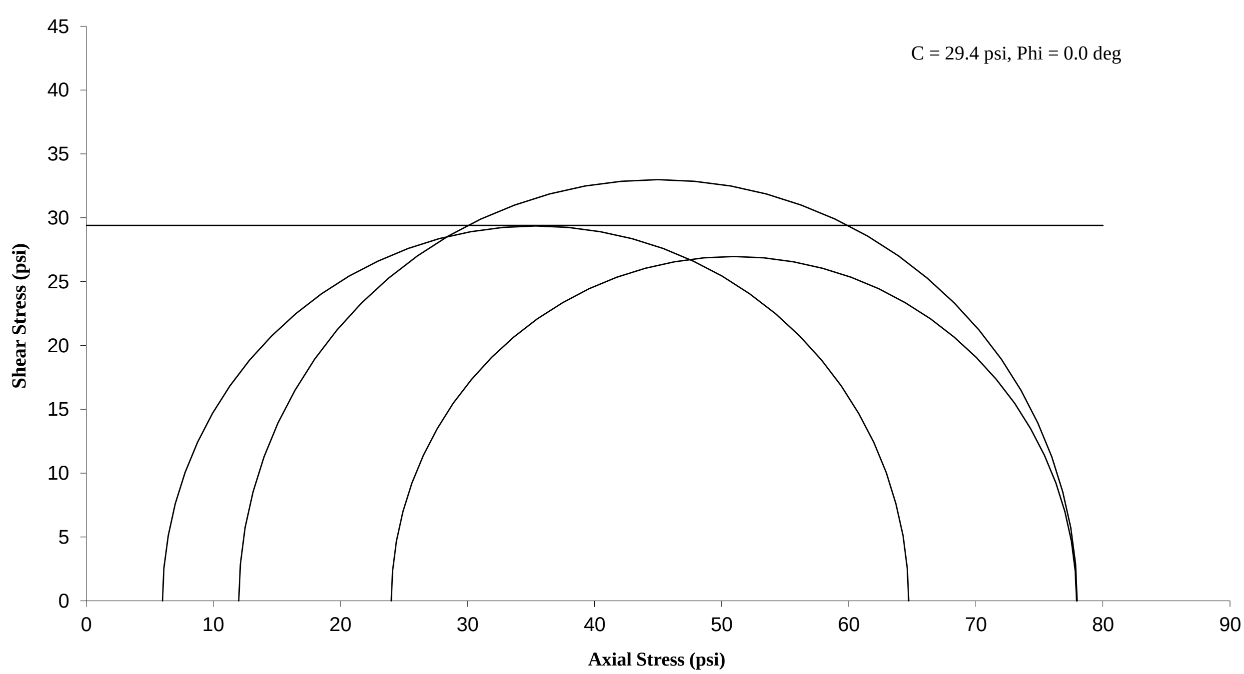
Unconsolidated - Undrained Triaxial Shear Strength Test
ASTM D 2850

General Sample Data		Triaxial Specimen Data			
TTL Project No.:	230230	Symbol	◆	■	●
Project:	HEN-24/17D-00.43, PID 117712	Init. Specimen Height (in.)	6.00	5.90	6.00
Sample ID:	B-030-0-22 ST-6	Init. Specimen Diameter (in.)	2.88	2.88	2.88
Sample Interval:	13.0 - 15.0'	Init. Moisture Content* (%)	14.0	13.7	14.1
Soil Description:	Gray SILT and CLAY, Little Sand, Trace Gravel A-6a (8)	Init. Dry Unit Weight (pcf)	117.3	118.5	117.7
Liquid Limit:	30	Init. Void Ratio	0.46	0.45	0.46
Plastic Limit:	19	Init. Degree of Saturation (%)	83	84	85
Plasticity Index:	11	Minor Principal Stress (psi)	6.0	12.0	24.0
Specific Gravity:	2.75 (Assumed)	Deviator Stress at Failure (psi)	58.7	66.0	53.9
Rate of Strain:	0.03 Inches per Minute	Major Principal Stress (psi)	64.7	78.0	77.9
Failure Criteria:	Peak Deviator Stress or Deviator Stress at 15% Axial Strain	Axial Strain at Failure (%)	15.0	15.0	15.0

Stress/Strain



Mohr Circle Plot



UNCONSOLIDATED, UNDRAINED COMPRESSIVE STRENGTH OF COHESIVE SOILS IN TRIAXIAL COMPRESSION (ASTM D 2850)

Project: HEN-24/17D-00.43, PID 117712
Date: 5/13/2023

Client: Burgess & Niple, Inc.
File: 230230B-030ST-6

Sample ID: B-030-0-22 ST-6
Depth: 13.0 - 15.0'

TTL Project No.: 230230
Specimen ID: "B" (13.5 - 14.0 Feet)

SAMPLE PROPERTIES

Visual Description: Gray SILT and CLAY, Little Sand, Trace Gravel A-6a (8)

Diameter: 2.88 in.
Initial Dry Unit Weight of Sample: 117.3 pcf

Area: 6.514 in^2
Initial Moisture Content: 14.0 %

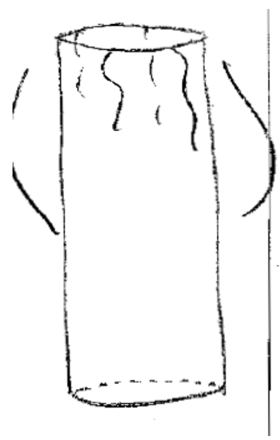
Length: 6.00 in.
Specific Gravity (assumed): 2.75

Initial Void Ratio: 0.46
Initial Degree of Saturation: 83 %

Chamber Pressure: 6 psi
Proving Ring Number: 1155-12-13322

STRESS-STRAIN DATA

Speciman Deformation (in)	Vertical Strain	Proving Ring Reading	Piston Load (lbs)	Corrected Area (in^2)	Deviator Stress (psi)
0.000	0.000	0.0	0.0	6.514	0.0
0.010	0.002	10.5	7.2	6.525	1.1
0.020	0.003	21.0	14.4	6.536	2.2
0.030	0.005	29.0	19.9	6.547	3.0
0.040	0.007	37.5	25.7	6.558	3.9
0.050	0.008	47.0	32.2	6.569	4.9
0.075	0.013	68.5	47.0	6.597	7.1
0.100	0.017	95.0	65.2	6.625	9.8
0.125	0.021	114.5	78.5	6.653	11.8
0.150	0.025	142.0	97.4	6.681	14.6
0.175	0.029	172.5	118.3	6.710	17.6
0.200	0.033	203.5	139.6	6.739	20.7
0.250	0.042	272.0	186.6	6.798	27.4
0.300	0.050	340.5	233.6	6.857	34.1
0.350	0.058	400.0	274.4	6.918	39.7
0.400	0.067	450.0	308.7	6.980	44.2
0.450	0.075	492.5	337.9	7.043	48.0
0.500	0.083	526.0	360.8	7.107	50.8
0.550	0.092	554.5	380.4	7.172	53.0
0.600	0.100	577.5	396.2	7.238	54.7
0.650	0.108	597.0	409.5	7.306	56.1
0.700	0.117	613.0	420.5	7.375	57.0
0.750	0.125	627.0	430.1	7.445	57.8
0.800	0.133	638.0	437.7	7.517	58.2
0.850	0.142	649.0	445.2	7.590	58.7
0.900	0.150	656.0	450.0	7.664	58.7



Sketch of Tested Specimen

RESULTS

Maximum Deviator Stress 58.7 psi

UNCONSOLIDATED, UNDRAINED COMPRESSIVE STRENGTH OF COHESIVE SOILS IN TRIAXIAL COMPRESSION (ASTM D 2850)

Project: HEN-24/17D-00.43, PID 117712
Date: 5/13/2023
Client: Burgess & Niple, Inc.
File: 230230B-030ST-6
Sample ID: B-030-0-22 ST-6
Depth: 13.0 - 15.0'
TTL Project No.: 230230
Specimen ID: "C" (14.0 - 14.5 Feet)

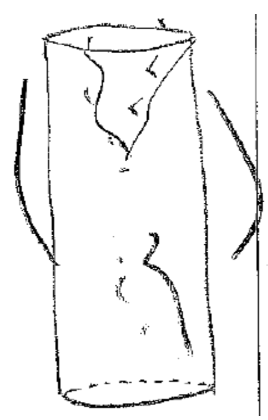
SAMPLE PROPERTIES

Visual Description: Gray SILT and CLAY, Little Sand, Trace Gravel A-6a (8)

Diameter: 2.88 in.
Initial Dry Unit Weight of Sample: 118.5 pcf
Area: 6.514 in^2
Initial Moisture Content: 13.7 %
Length: 5.90
Specific Gravity (assumed): 2.75
Initial Void Ratio: 0.45
Initial Degree of Saturation: 84 %
Chamber Pressure: 12 psi
Proving Ring Number: 1155-12-13322

STRESS-STRAIN DATA

Speciman Deformation (in)	Vertical Strain	Proving Ring Reading	Piston Load (lbs)	Corrected Area (in^2)	Deviator Stress (psi)
0.000	0.000	0.0	0.0	6.514	0.0
0.010	0.002	25.5	17.5	6.525	2.7
0.020	0.003	39.0	26.8	6.537	4.1
0.030	0.005	48.0	32.9	6.548	5.0
0.040	0.007	58.0	39.8	6.559	6.1
0.050	0.008	68.0	46.6	6.570	7.1
0.075	0.013	93.0	63.8	6.598	9.7
0.100	0.017	118.5	81.3	6.627	12.3
0.125	0.021	146.0	100.2	6.655	15.0
0.150	0.025	176.5	121.1	6.684	18.1
0.175	0.030	209.0	143.4	6.714	21.4
0.200	0.034	243.5	167.0	6.743	24.8
0.250	0.042	316.0	216.8	6.803	31.9
0.300	0.051	384.5	263.8	6.863	38.4
0.350	0.059	446.0	306.0	6.925	44.2
0.400	0.068	496.0	340.3	6.988	48.7
0.450	0.076	539.0	369.8	7.052	52.4
0.500	0.085	575.5	394.8	7.118	55.5
0.550	0.093	606.0	415.7	7.184	57.9
0.600	0.102	632.0	433.6	7.252	59.8
0.650	0.110	657.5	451.0	7.321	61.6
0.700	0.119	675.5	463.4	7.391	62.7
0.750	0.127	694.0	476.1	7.463	63.8
0.800	0.136	711.0	487.7	7.536	64.7
0.850	0.144	726.5	498.4	7.611	65.5
0.885	0.150	737.0	505.6	7.664	66.0



Sketch of Tested Specimen

RESULTS

Maximum Deviator Stress 66.0 psi

UNCONSOLIDATED, UNDRAINED COMPRESSIVE STRENGTH OF COHESIVE SOILS IN TRIAXIAL COMPRESSION (ASTM D 2850)

Project: HEN-24/17D-00.43, PID 117712
Date: 5/13/2023
Client: Burgess & Niple, Inc.
File: 230230B-030ST-6
Sample ID: B-030-0-22 ST-6
Depth: 13.0 - 15.0'
TTL Project No.: 230230
Specimen ID: "D" (14.5 - 15.0 Feet)

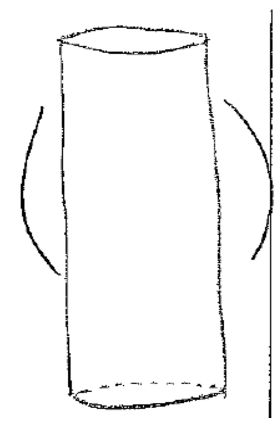
SAMPLE PROPERTIES

Visual Description: Gray SILT and CLAY, Little Sand, Trace Gravel A-6a (8)

Diameter: 2.88 in.
Initial Dry Unit Weight of Sample: 117.7 pcf
Area: 6.514 in^2
Initial Moisture Content: 14.1 %
Length: 6.00 in.
Specific Gravity (assumed): 2.75
Initial Void Ratio: 0.46
Initial Degree of Saturation: 85 %
Chamber Pressure: 24 psi
Proving Ring Number: 1155-12-13322

STRESS-STRAIN DATA

Speciman Deformation (in)	Vertical Strain	Proving Ring Reading	Piston Load (lbs)	Corrected Area (in^2)	Deviator Stress (psi)
0.000	0.000	0.0	0.0	6.514	0.0
0.010	0.002	23.5	16.1	6.525	2.5
0.020	0.003	47.0	32.2	6.536	4.9
0.030	0.005	59.5	40.8	6.547	6.2
0.040	0.007	70.5	48.4	6.558	7.4
0.050	0.008	84.0	57.6	6.569	8.8
0.075	0.013	110.0	75.5	6.597	11.4
0.100	0.017	137.5	94.3	6.625	14.2
0.125	0.021	165.0	113.2	6.653	17.0
0.150	0.025	193.0	132.4	6.681	19.8
0.175	0.029	220.5	151.3	6.710	22.5
0.200	0.033	247.5	169.8	6.739	25.2
0.250	0.042	297.5	204.1	6.798	30.0
0.300	0.050	341.0	233.9	6.857	34.1
0.350	0.058	379.0	260.0	6.918	37.6
0.400	0.067	413.0	283.3	6.980	40.6
0.450	0.075	443.0	303.9	7.043	43.2
0.500	0.083	469.5	322.1	7.107	45.3
0.550	0.092	492.0	337.5	7.172	47.1
0.600	0.100	512.0	351.2	7.238	48.5
0.650	0.108	532.5	365.3	7.306	50.0
0.700	0.117	548.0	375.9	7.375	51.0
0.750	0.125	563.5	386.6	7.445	51.9
0.800	0.133	578.0	396.5	7.517	52.8
0.850	0.142	590.5	405.1	7.590	53.4
0.900	0.150	602.5	413.3	7.664	53.9



Sketch of Tested Specimen

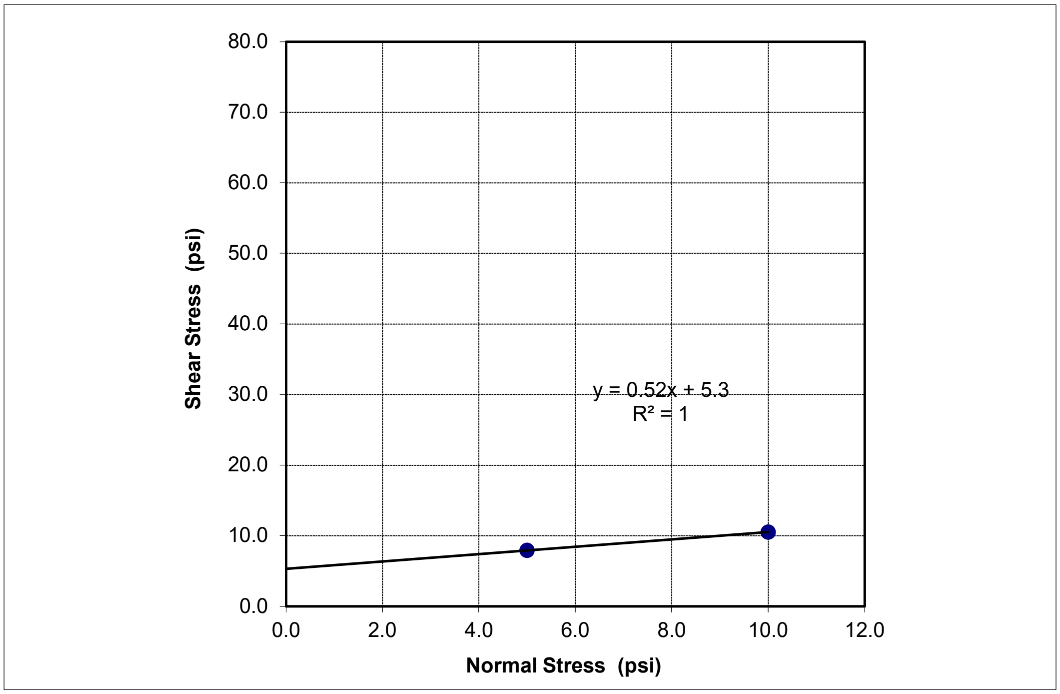
RESULTS

Maximum Deviator Stress 53.9 psi

DIRECT SHEAR TEST DATA

ASTM D 3080

Project Number:	230230	Boring Number.:	B-014-0-22
Project Name:	HEN-24/17D-00.43, PID 117712	Sample Number:	ST-2
Project Location:	Henry County, OH	Sample Depth:	4.0 - 6.0'



Trial Number	Normal Stress (psi)	Shear Stress (psi)	ϕ (degrees)	c (psf)
1	5.0	7.9	27.5	763
2	10.0	10.5		

Atterberg Limits:

Liquid Limit:	27
Plastic Limit:	13
Plasticity Index:	14

Particle Size Analysis:

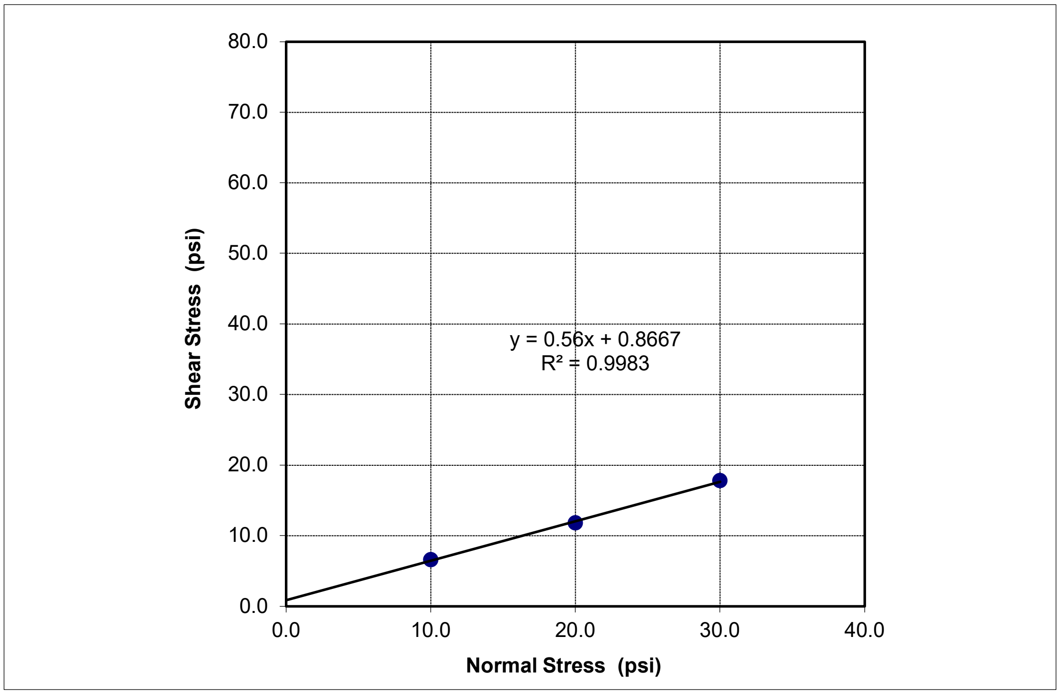
% Gravel:	2
% Sand:	11
% Silt:	21
% Clay:	66

Soil Classification: Gray/Brown SILT and CLAY, Little Sand, Trace Gravel A-6a (10)

DIRECT SHEAR TEST DATA

ASTM D 3080

Project Number:	230230	Boring Number.:	B-015-0-22
Project Name:	HEN-24/17D-00.43, PID 117712	Sample Number:	ST-12
Project Location:	Henry County, OH	Sample Depth:	31.0 - 33.0'



Trial Number	Normal Stress (psi)	Shear Stress (psi)	ϕ (degrees)	c (psf)
1	10.0	6.6	29.2	125
2	20.0	11.8		
3	30.0	17.8		

Atterberg Limits:

Liquid Limit:	37
Plastic Limit:	20
Plasticity Index:	17

Particle Size Analysis:

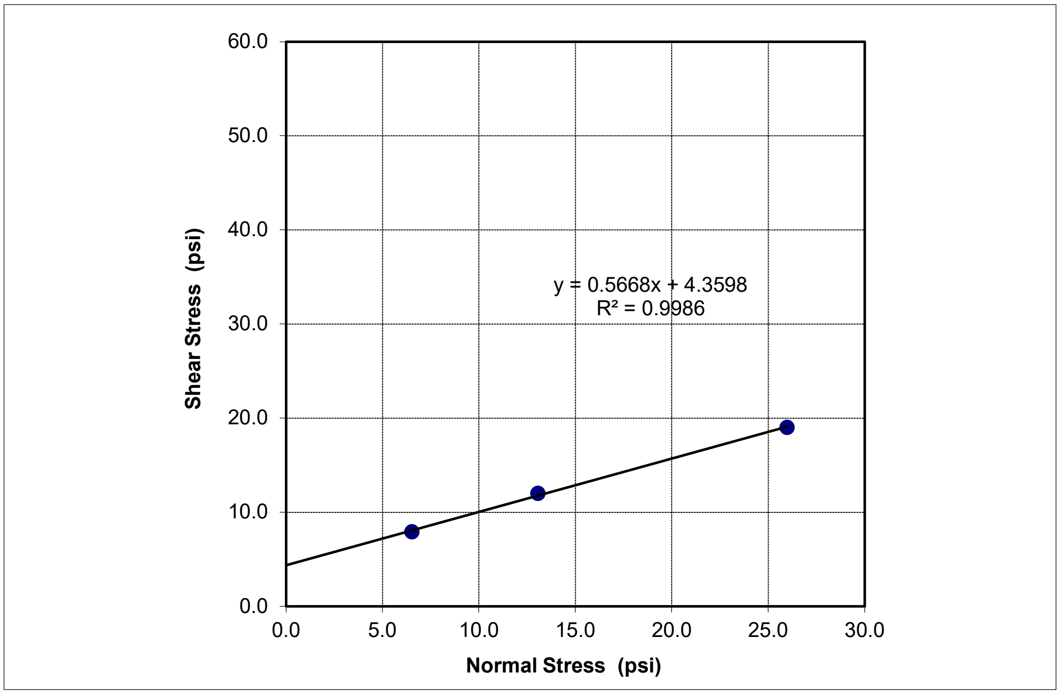
% Gravel:	1
% Sand:	11
% Silt:	24
% Clay:	64

Soil Classification: Gray SILTY CLAY, Little Sand, Trace Gravel A-6b (11)

DIRECT SHEAR TEST DATA

ASTM D 3080

Project Number:	230230	Boring Number.:	B-021-0-22
Project Name:	HEN-24/17D-00.43, PID 117712	Sample Number:	ST-7
Project Location:	Henry County, OH	Sample Depth:	16.0 - 18.0'



Trial Number	Normal Stress (psi)	Shear Stress (psi)	ϕ (degrees)	c (psf)
1	6.5	7.9	29.5	628
2	13.1	12.0		
3	26.0	19.0		

Atterberg Limits:

Liquid Limit:	29
Plastic Limit:	13
Plasticity Index:	16

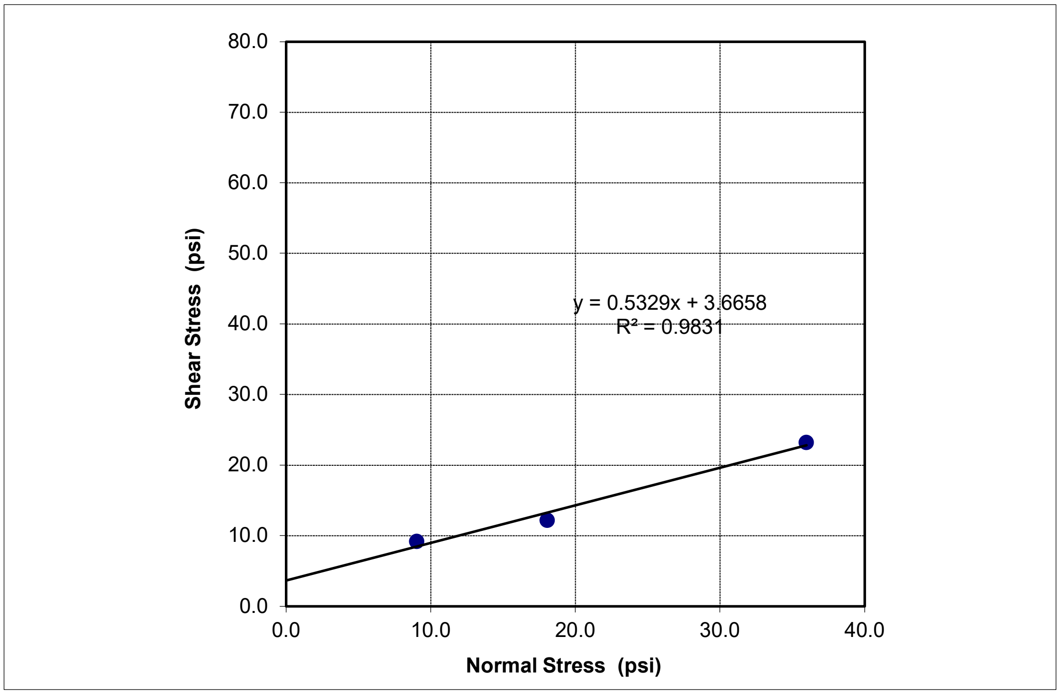
Particle Size Analysis:

% Gravel:	4
% Sand:	11
% Silt:	21
% Clay:	64

Soil Classification: Gray SILTY CLAY, Little Sand, Trace Gravel A-6b (10)

DIRECT SHEAR TEST DATA
ASTM D 3080

Project Number:	230230	Boring Number.:	B-025-0-22
Project Name:	HEN-24/17D-00.43, PID 117712	Sample Number:	ST-11
Project Location:	Henry County, OH	Sample Depth:	26.0 - 28.0'



Trial Number	Normal Stress (psi)	Shear Stress (psi)	ϕ (degrees)	c (psf)
1	9.0	9.2	28.1	528
2	18.1	12.2		
3	36.0	23.2		

Atterberg Limits:

Liquid Limit:	37
Plastic Limit:	20
Plasticity Index:	17

Particle Size Analysis:

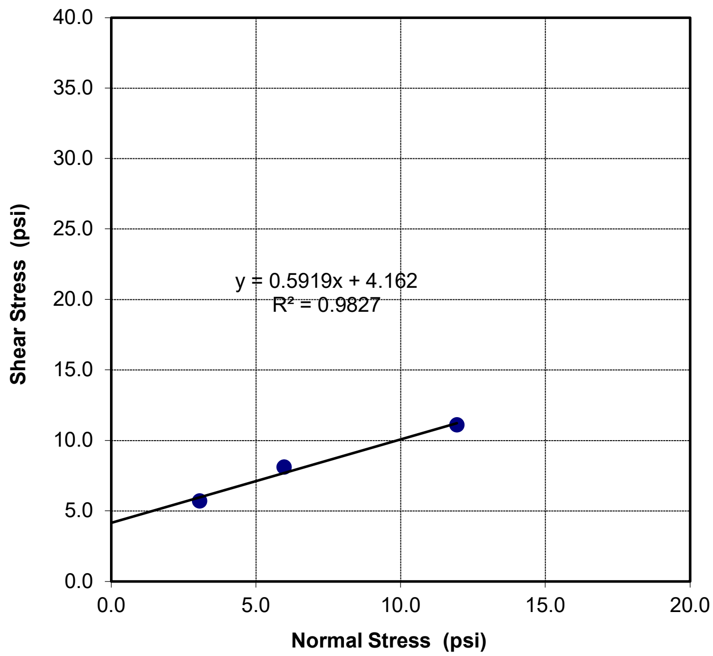
% Gravel:	5
% Sand:	19
% Silt:	25
% Clay:	51

Soil Classification: Gray SILTY CLAY, Little Sand, Trace Gravel A-6b (11)

DIRECT SHEAR TEST DATA

ASTM D 3080

Project Number:	230230	Boring Number.:	B-025-0-22
Project Name:	HEN-24/17D-00.43, PID 117712	Sample Number:	ST-3
Project Location:	Henry County, OH	Sample Depth:	6.0 - 8.0'



Trial Number	Normal Stress (psi)	Shear Stress (psi)	ϕ (degrees)	c (psf)
1	3.1	5.7	30.6	599
2	6.0	8.1		
3	11.9	11.1		

Atterberg Limits:

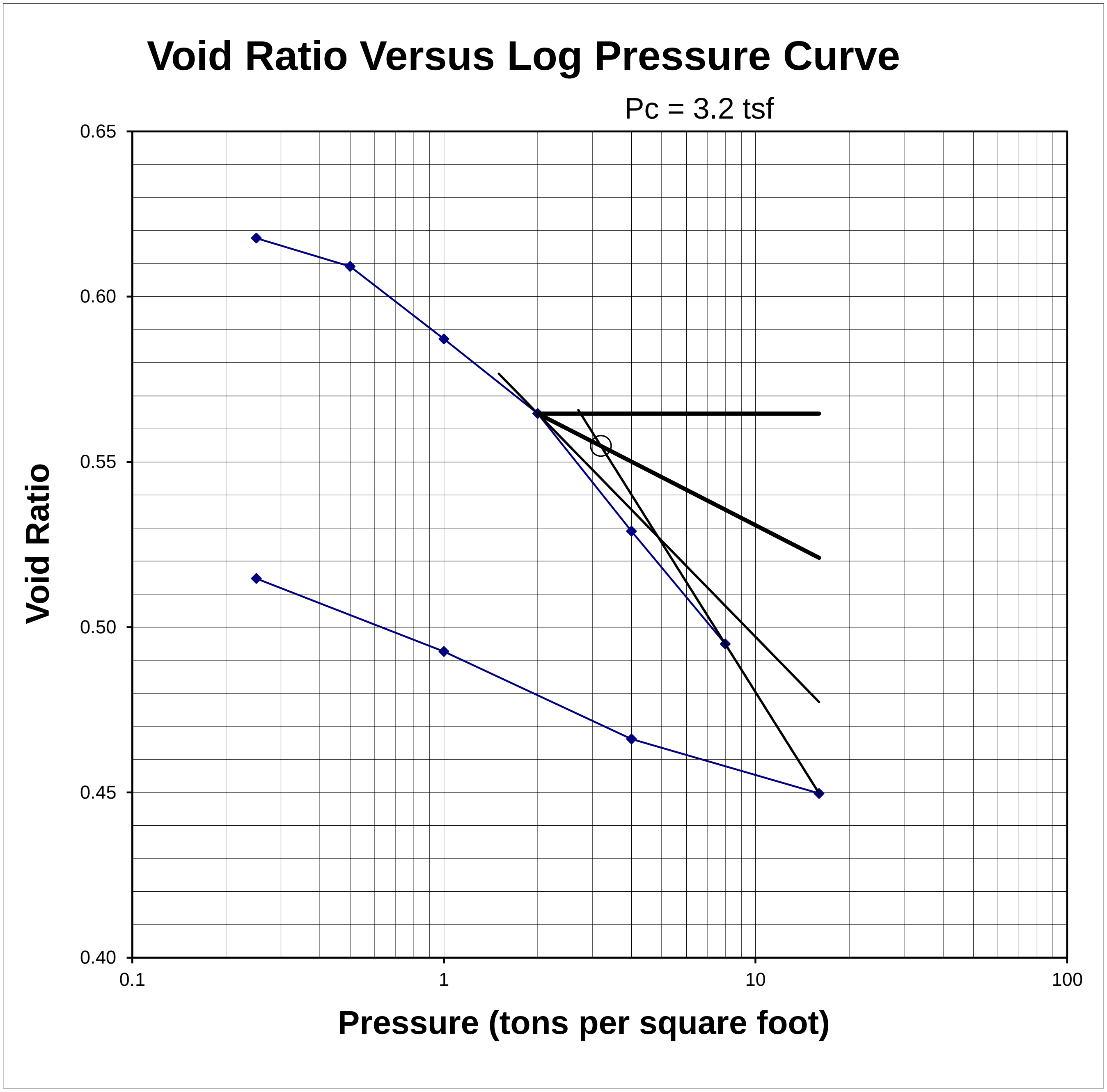
Liquid Limit: 34
Plastic Limit: 20
Plasticity Index: 14

Particle Size Analysis:

% Gravel: 5
% Sand: 19
% Silt: 25
% Clay: 51

Soil Classification: Brown SILT and CLAY, Little Sand, Trace Gravel A-6a (10)

Project No.: 230230
Date: 7/17/2023
Client: Burgess & Niple, Inc.
Project: HEN-24/17D-00.43, PID 117712
Henry County, OH
Boring No.: B-014-0-22
Sample No.: ST-2
Depth: 4.0 - 6.0'



Project No.: 230230
Date: 7/17/2023
Client: Burgess & Niple, Inc.
Project: HEN-24/17D-00.43, PID 117712
Henry County, OH
Boring No.: B-014-0-22
Sample No.: ST-2
Depth: 4.0 - 6.0'

Initial H= 1 inches

Pressure tsf	Final Height (in)	Initial Height (in)	DH	Average H (in)	e	t50 (min)	Ave P (tsf)	Cv (in2/s)	Cv (ft2/d)
0.125	1.00000	1.00000	0.00000	1.0000	0.625				
0.25	0.99525	1.00000	0.00475	0.9976	0.618	1.0	0.125	0.000846	0.507
0.5	0.99000	0.99525	0.01000	0.9926	0.609	1.8	0.375	0.000450	0.270
1	0.97650	0.99000	0.02350	0.9833	0.587	1.5	0.75	0.000545	0.327
2	0.96260	0.97650	0.03740	0.9696	0.565	3.8	1.5	0.000204	0.122
4	0.94070	0.96260	0.05930	0.9517	0.529	3.8	3	0.000197	0.118
8	0.91970	0.94070	0.08030	0.9302	0.495	5.3	6	0.000134	0.080
16	0.89190	0.91970	0.10810	0.9058	0.450	5.9	12	0.000114	0.069
4	0.90200	0.89190	0.09800	0.8970	0.466		10		
1	0.91830	0.90200	0.08170	0.9102	0.493		2.5		
0.25	0.93190	0.91830	0.06810	0.9251	0.515		0.625		

Estimated Cc: 0.150
Estimated Cr: 0.036

Soil Description: Gray/Brown SILT and CLAY, Little Sand, Trace Gravel A-6a (10)
Specific Gravity: 2.733
Liquid Limit: 27
Plastic Limit: 13
Plasticity Index: 14

Initial Water Content:	20.4 %	Final Water Content:	20.4 %
Inital Dry Density:	105.0 pcf	Final Dry Density:	112.6 pcf
Initial Void Ratio:	0.625	Final Void Ratio:	0.515
Initial Degree of Saturation:	89.0 %	Final Degree of Saturation	108.2 %

Estimated Preconsolidation Pressure: 3.2 tsf

The sample for the test was trimmed from a Shelby tube sample using a cutting shoe. Test Method B was used with the specimen inundated during testing. Coefficients of consolidation were computed by log of time method.

Consolidation Laboratory Calculations

Consolidometer: **1**

Method:	ASTM D 2435 Method B		
Project No. :	230230		
Client:	Burgess & Niple, Inc.		
Project:	HEN-24/17D-00.43, PID 117712		
Location:	Henry County, OH		
Boring No. :	B-014-0-22	Visual Description:	Gray/Brown SILT and CLAY, Little Sand, Trace Gravel A-6a (10)
Sample No.:	ST-2	Liquid Limit:	27 %
Depth:	4.0 - 6.0'	Plastic Limit:	13 %
Date of Test:	7/17/2023	Plasticity Index:	14 %

Initial Sample Data			***Final Sample Data***		
Initial Height	1.000 in.		Final Height	0.932 in.	
Ring Dia.	2.493 in.		Ring Dia.	2.493 in.	
Area of Ring	4.8813 in^2		Area of Ring	4.8813 in^2	
Initial Volume	4.8813 in^3	0.00282 ft^3	Final Volume	4.5489 in^3	0.00263 ft^3
Specific Gravity	2.733				
			Final wet mass soil, pan & ring	357.3 g	
			Wt of Pan	50.7 g	
Initial wet mass soil & ring	306.6 g		Final wet mass soil & ring	306.6	
Mass of ring	144.7 g		Mass of ring	144.7 g	
			Final dry mass of soil, pan & ring	329.9 g	
Initial wet mass soil	161.9 g	0.35693 lb	Final wet mass soil	161.9 g	0.35693 lb
			Weight of water	27.4 g	0.06041 lb

Initial Water Content

Mass can & wet soil	502 g
Mass can & dry soil	429.6 g
Mass of can	50 g
Mass of water	72.4 g
Mass of soil	379.6 g
Initial water content	19.07 % (trimmings)

Initial water content	20.37 % (based on final dry weight)		Final water content	20.37 % (based on final dry weight)	
			Final weight of solids (Md)	134.5 g	0.29652 lb
Initial dry density	105.0 pcf		Final dry density	112.6 pcf	
			Final volume of solids (Vs)	3.0031 in^3	0.00174 ft^3
			Final height of solids (Hs)	0.6152 in.	
Initial void ratio (eo)	0.625		Final void ratio (ef)	0.515	
Initial volume of voids (Vvo)	1.8782 in^3	0.00109 ft^3	Final volume of voids (Vvf)	1.5458 in^3	0.00089 ft^3
Initial volume of water (Vwo)	1.6720 in^3	0.00097 ft^3	Final volume of water (Vwf)	1.6720 in^3	0.00097 ft^3
Initial degree of saturation (So)	89.02 %		Final degree of saturation (Sf)	108.17 %	

LEADING THROUGH the next 100 years

Project No. : 230230 Sample No.: ST-2
Boring No. : B-014-0-22 Depth: 4.0 - 6.0'

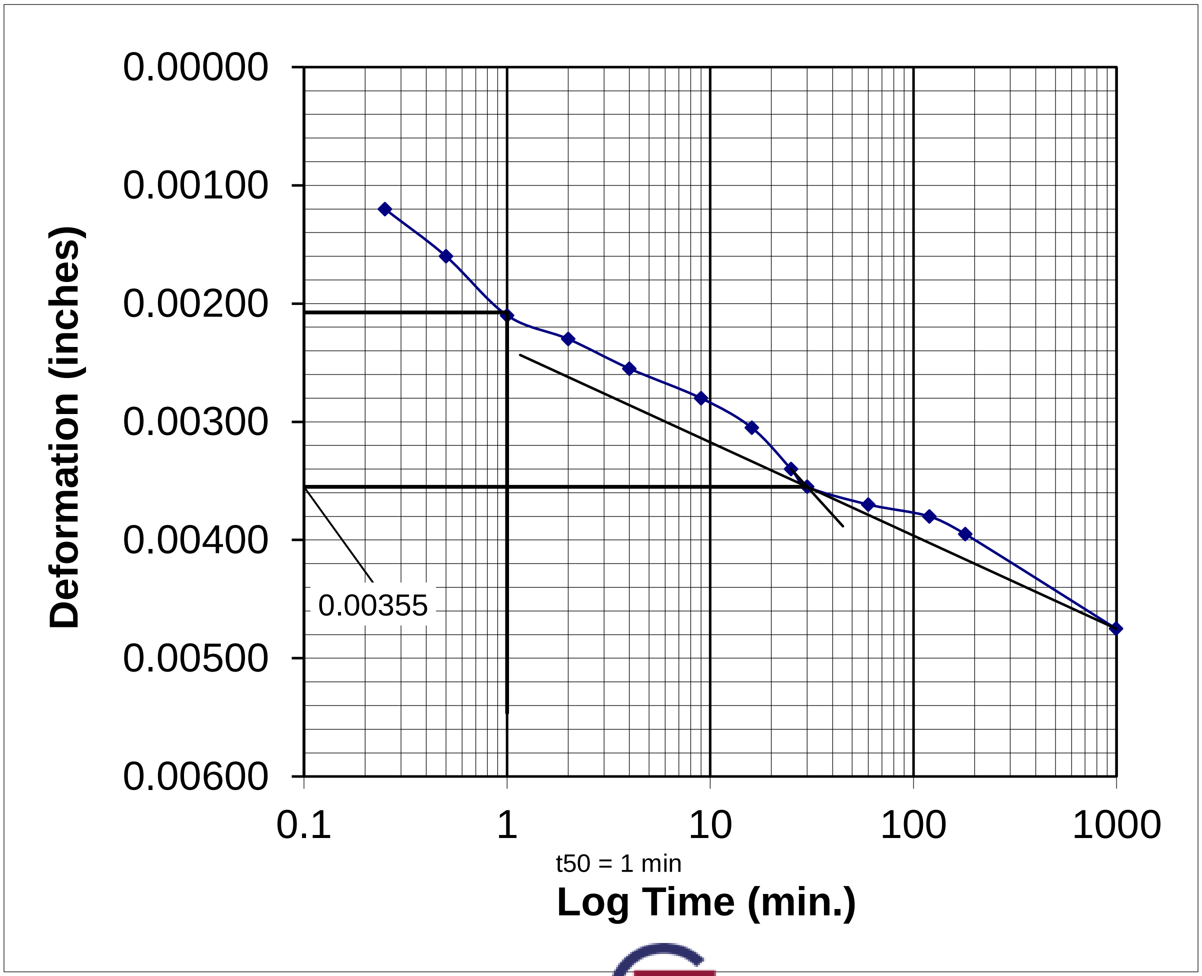
0.25 tsf Load

initial height= 1 inches

Do= D1-(D2-D1)
1) 0.25 to 1.0: 0.00030
2) 0.5 to 2.0: 0.00090
3) 1.0 to 4.0: 0.00165
Do Avg 1&2: 0.00060
Do Avg 1-3: 0.00095
Use Do= 0.00060
D100= 0.00355
D50= D100+0.5(Do-D100)
D50= 0.00207

t50 = 1.0 min.

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.39930				
0.25	0.39810	0.00120	0.00000	0.00120	0.99880
0.5	0.39770	0.00160	0.00000	0.00160	0.99840
1	0.39720	0.00210	0.00000	0.00210	0.99790
2	0.39700	0.00230	0.00000	0.00230	0.99770
4	0.39675	0.00255	0.00000	0.00255	0.99745
9	0.39650	0.00280	0.00000	0.00280	0.99720
16	0.39625	0.00305	0.00000	0.00305	0.99695
25	0.39590	0.00340	0.00000	0.00340	0.99660
30	0.39575	0.00355	0.00000	0.00355	0.99645
60	0.39560	0.00370	0.00000	0.00370	0.99630
120	0.39550	0.00380	0.00000	0.00380	0.99620
180	0.39535	0.00395	0.00000	0.00395	0.99605
995	0.39455	0.00475	0.00000	0.00475	0.99525



LEADING THROUGH the next 100 years

Project No. : 230230 Sample No.: ST-2
Boring No. : B-014-0-22 Depth: 4.0 - 6.0'

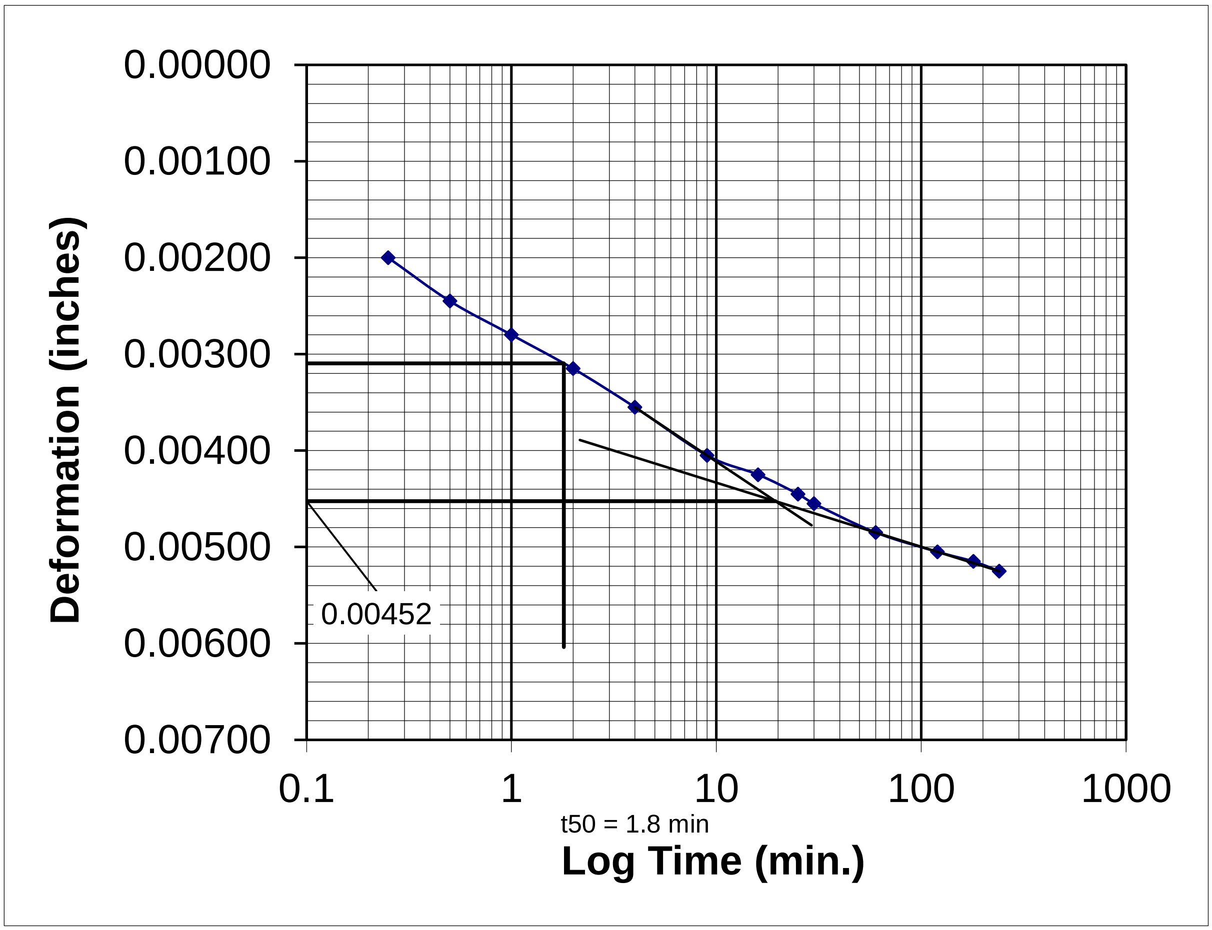
0.5 tsf Load

initial height= 0.99525 inches

Do= D1-(D2-D1)
1) 0.25 to 1.0: 0.00120
2) 0.5 to 2.0: 0.00175
3) 1.0 to 4.0: 0.00205
Do Avg 1&2: 0.00147
Do Avg 1-3: 0.00167
Use Do= 0.00167
D100= 0.00452
D50= D100+0.5(Do-D100)
D50= 0.00310

t50 = 1.8 min.

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.39445				
0.25	0.39245	0.00200	0.00000	0.00200	0.99325
0.5	0.39200	0.00245	0.00000	0.00245	0.99280
1	0.39165	0.00280	0.00000	0.00280	0.99245
2	0.39130	0.00315	0.00000	0.00315	0.99210
4	0.39090	0.00355	0.00000	0.00355	0.99170
9	0.39040	0.00405	0.00000	0.00405	0.99120
16	0.39020	0.00425	0.00000	0.00425	0.99100
25	0.39000	0.00445	0.00000	0.00445	0.99080
30	0.38990	0.00455	0.00000	0.00455	0.99070
60	0.38960	0.00485	0.00000	0.00485	0.99040
120	0.38940	0.00505	0.00000	0.00505	0.99020
180	0.38930	0.00515	0.00000	0.00515	0.99010
240	0.38920	0.00525	0.00000	0.00525	0.99000



Project No. : 230230 Sample No.: ST-2
Boring No. : B-014-0-22 Depth: 4.0 - 6.0'

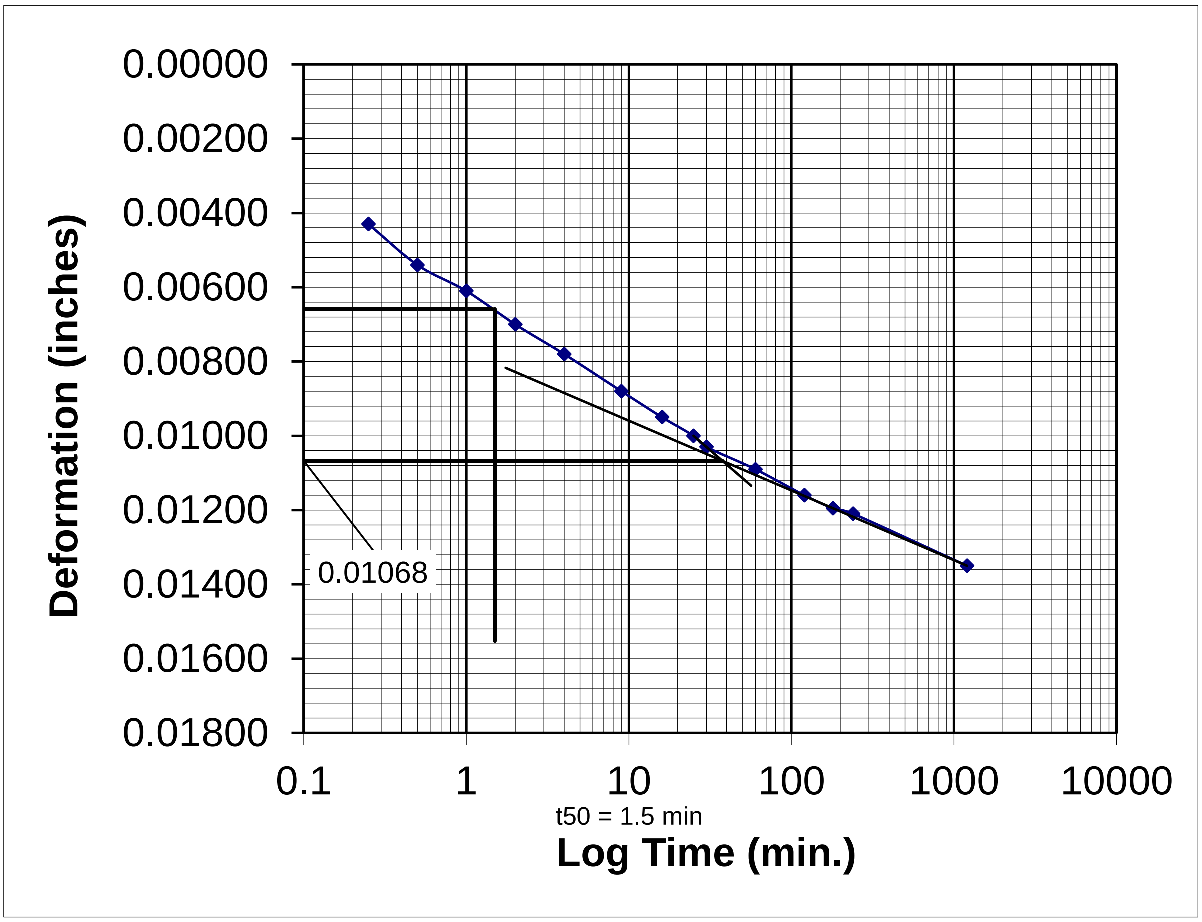
1.0 tsf Load

initial height= 0.99 inches

Do= D1-(D2-D1)
1) 0.25 to 1.0: 0.00250
2) 0.5 to 2.0: 0.00380
3) 1.0 to 4.0: 0.00440
Do Avg 1&2: 0.00315
Do Avg 1-3: 0.00357
Use Do= 0.00250
D100= 0.01068
D50= D100+0.5(Do-D100)
D50= 0.00659

t50 = 1.5 min.

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.38920				
0.25	0.38240	0.00680	0.00250	0.00430	0.98570
0.5	0.38130	0.00790	0.00250	0.00540	0.98460
1	0.38060	0.00860	0.00250	0.00610	0.98390
2	0.37970	0.00950	0.00250	0.00700	0.98300
4	0.37890	0.01030	0.00250	0.00780	0.98220
9	0.37790	0.01130	0.00250	0.00880	0.98120
16	0.37720	0.01200	0.00250	0.00950	0.98050
25	0.37670	0.01250	0.00250	0.01000	0.98000
30	0.37640	0.01280	0.00250	0.01030	0.97970
60	0.37580	0.01340	0.00250	0.01090	0.97910
120	0.37510	0.01410	0.00250	0.01160	0.97840
180	0.37475	0.01445	0.00250	0.01195	0.97805
240	0.37460	0.01460	0.00250	0.01210	0.97790
1205	0.37320	0.01600	0.00250	0.01350	0.97650



Project No. : 230230 Sample No.: ST-2
Boring No. : B-014-0-22 Depth: 4.0 - 6.0'

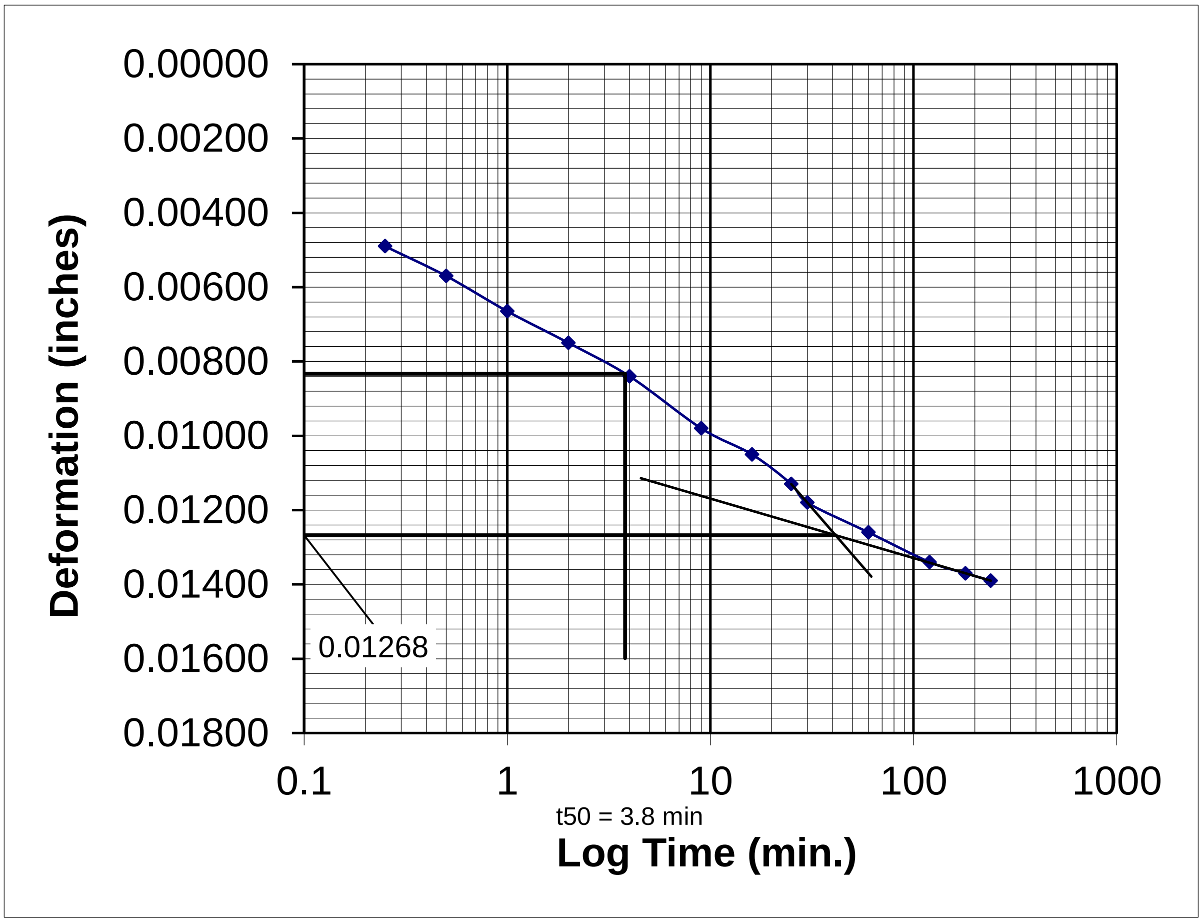
2.0 tsf Load

initial height= 0.9765 inches

Do= D1-(D2-D1)
1) 0.25 to 1.0: 0.00315
2) 0.5 to 2.0: 0.00390
3) 1.0 to 4.0: 0.00490
Do Avg 1&2: 0.00352
Do Avg 1-3: 0.00398
Use Do= 0.00398
D100= 0.01268
D50= D100+0.5(Do-D100)
D50= 0.00833

t50 = 3.8 min.

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.37320				
0.25	0.36540	0.00780	0.00290	0.00490	0.97160
0.5	0.36460	0.00860	0.00290	0.00570	0.97080
1	0.36365	0.00955	0.00290	0.00665	0.96985
2	0.36280	0.01040	0.00290	0.00750	0.96900
4	0.36190	0.01130	0.00290	0.00840	0.96810
9	0.36050	0.01270	0.00290	0.00980	0.96670
16	0.35980	0.01340	0.00290	0.01050	0.96600
25	0.35900	0.01420	0.00290	0.01130	0.96520
30	0.35850	0.01470	0.00290	0.01180	0.96470
60	0.35770	0.01550	0.00290	0.01260	0.96390
120	0.35690	0.01630	0.00290	0.01340	0.96310
180	0.35660	0.01660	0.00290	0.01370	0.96280
240	0.35640	0.01680	0.00290	0.01390	0.96260



Project No. : 230230 Sample No.: ST-2
Boring No. : B-014-0-22 Depth: 4.0 - 6.0'

Do= D1-(D2-D1)
1) 0.25 to 1.0: 0.00120
2) 0.5 to 2.0: 0.00270
3) 1.0 to 4.0: 0.00490
Do Avg 1&2: 0.00195
Do Avg 1-3: 0.00293

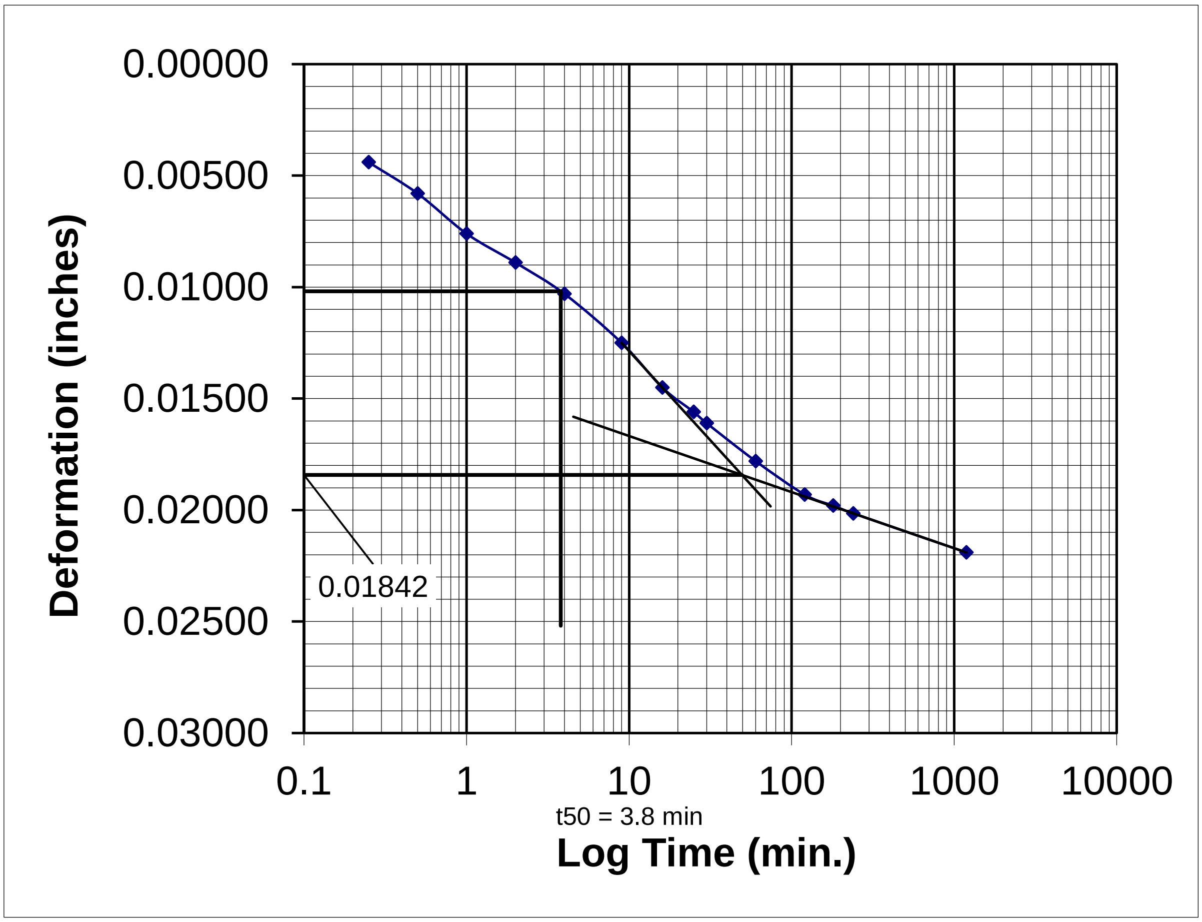
4.0 tsf Load

initial height= 0.9626 inches

Use Do= 0.00195
D100= 0.01842
D50= D100+0.5(Do-D100)
D50= 0.01019

t50 = 3.8 min.

Interval Minutes	**Dial Reading**	**ΔH**	**Deformation Constant**	**TRUE ΔH**	**Height of Sample**
0	0.35640				
0.25	0.34940	0.00700	0.00260	0.00440	0.95820
0.5	0.34800	0.00840	0.00260	0.00580	0.95680
1	0.34620	0.01020	0.00260	0.00760	0.95500
2	0.34490	0.01150	0.00260	0.00890	0.95370
4	0.34350	0.01290	0.00260	0.01030	0.95230
9	0.34130	0.01510	0.00260	0.01250	0.95010
16	0.33930	0.01710	0.00260	0.01450	0.94810
25	0.33820	0.01820	0.00260	0.01560	0.94700
30	0.33770	0.01870	0.00260	0.01610	0.94650
60	0.33600	0.02040	0.00260	0.01780	0.94480
120	0.33450	0.02190	0.00260	0.01930	0.94330
180	0.33400	0.02240	0.00260	0.01980	0.94280
240	0.33365	0.02275	0.00260	0.02015	0.94245
1190	0.33190	0.02450	0.00260	0.02190	0.94070



Project No. : 230230 Sample No.: ST-2
Boring No. : B-014-0-22 Depth: 4.0 - 6.0'

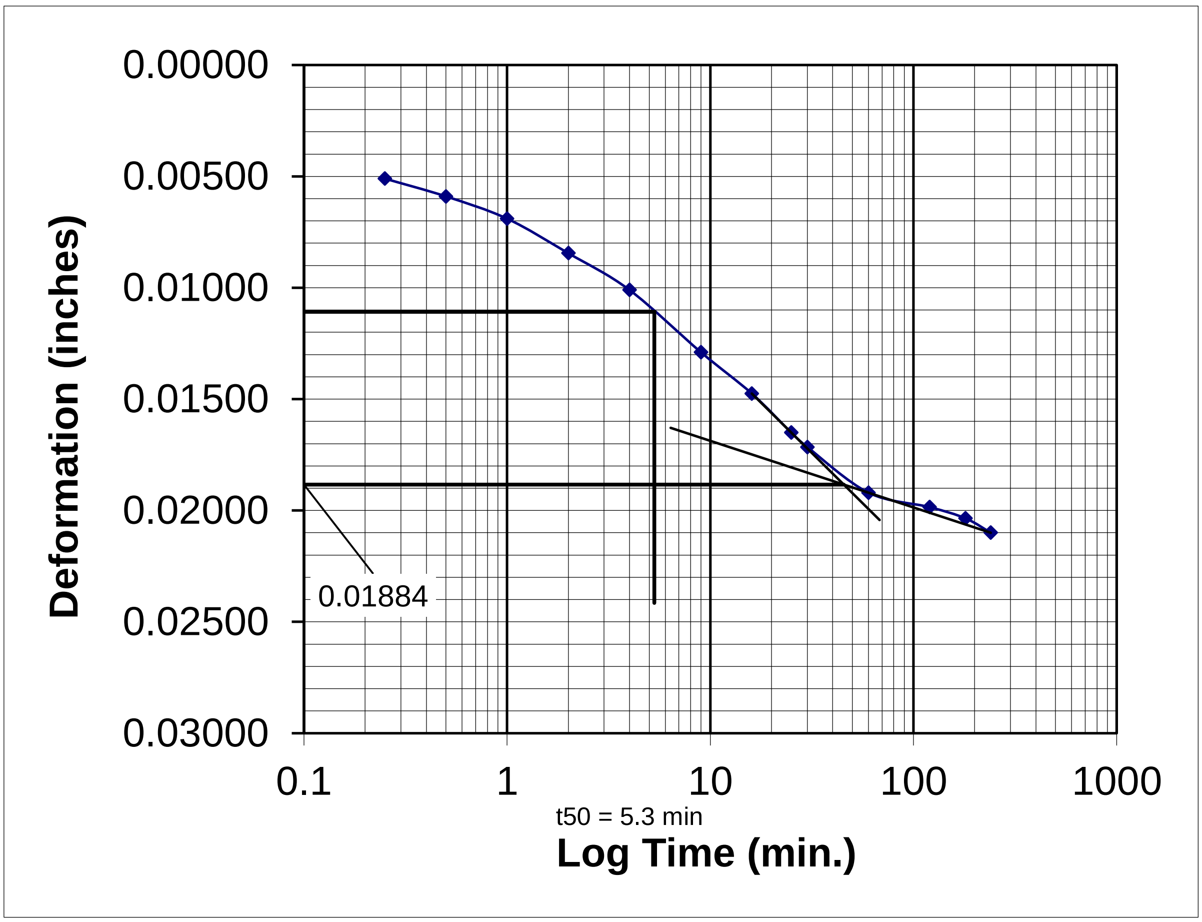
8.0 tsf Load

initial height= 0.94070 inches

Do= D1-(D2-D1)
1) 0.25 to 1.0: 0.00330
2) 0.5 to 2.0: 0.00335
3) 1.0 to 4.0: 0.00370
Do Avg 1&2: 0.00332
Do Avg 1-3: 0.00345
Use Do= 0.00332
D100= 0.01884
D50= D100+0.5(Do-D100)
D50= 0.01108

t50 = 5.3 min.

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.33190				
0.25	0.32460	0.00730	0.00220	0.00510	0.93560
0.5	0.32380	0.00810	0.00220	0.00590	0.93480
1	0.32280	0.00910	0.00220	0.00690	0.93380
2	0.32125	0.01065	0.00220	0.00845	0.93225
4	0.31960	0.01230	0.00220	0.01010	0.93060
9	0.31680	0.01510	0.00220	0.01290	0.92780
16	0.31495	0.01695	0.00220	0.01475	0.92595
25	0.31320	0.01870	0.00220	0.01650	0.92420
30	0.31255	0.01935	0.00220	0.01715	0.92355
60	0.31050	0.02140	0.00220	0.01920	0.92150
120	0.30985	0.02205	0.00220	0.01985	0.92085
180	0.30935	0.02255	0.00220	0.02035	0.92035
240	0.30870	0.02320	0.00220	0.02100	0.91970



Project No. : 230230
Boring No. : B-014-0-22

Sample No.: ST-2
Depth: 4.0 - 6.0'

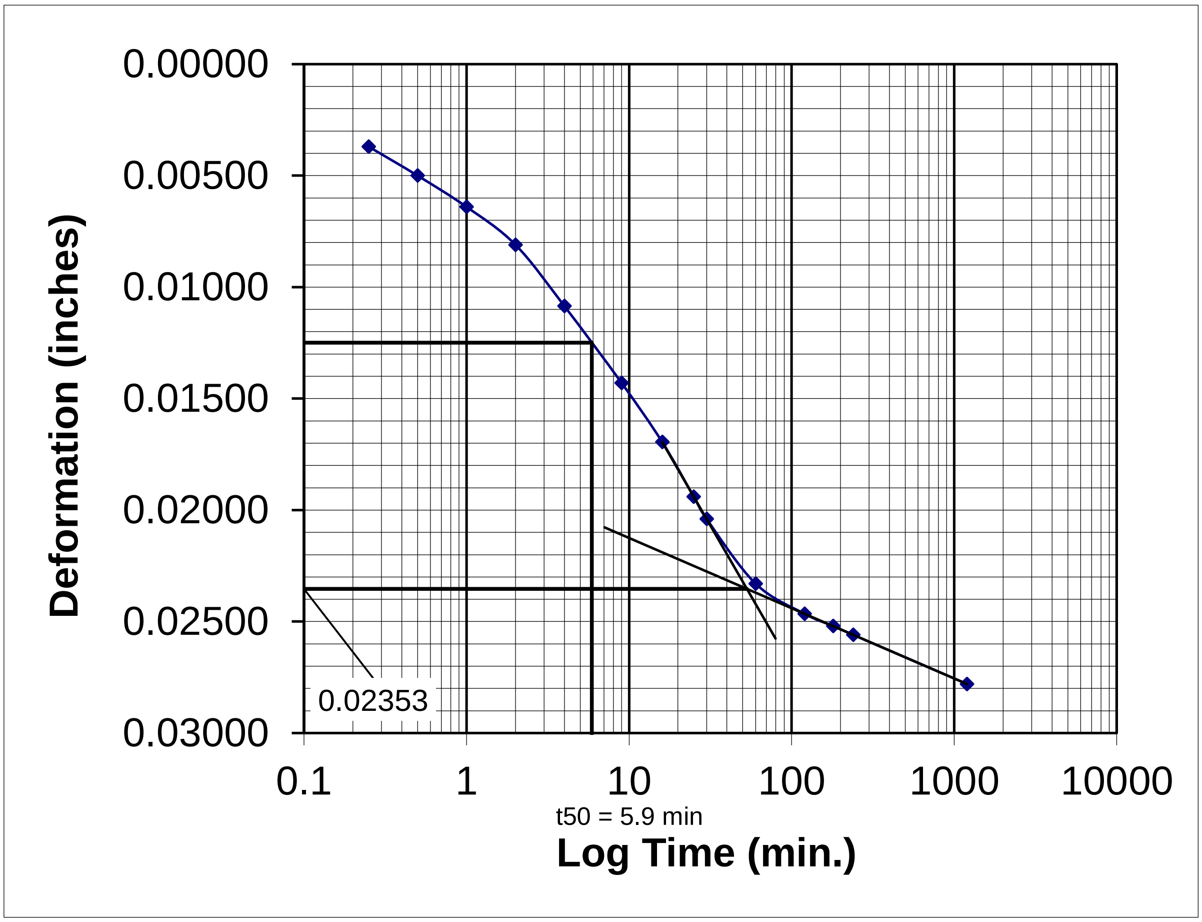
16 tsf Load

initial height= 0.9197 inches

Do= D1-(D2-D1)
1) 0.25 to 1.0: 0.00100
2) 0.5 to 2.0: 0.00190
3) 1.0 to 4.0: 0.00195
Do Avg 1&2: 0.00145
Do Avg 1-3: 0.00162
Use Do= 0.00145
D100= 0.02353
D50= D100+0.5(Do-D100)
D50= 0.01249

t50 = 5.9 min.

Interval Minutes	**Dial Reading**	**ΔH**	**Deformation Constant**	**TRUE ΔH**	**Height of Sample**
0	0.30870				
0.25	0.30310	0.00560	0.00190	0.00370	0.91600
0.5	0.30180	0.00690	0.00190	0.00500	0.91470
1	0.30040	0.00830	0.00190	0.00640	0.91330
2	0.29870	0.01000	0.00190	0.00810	0.91160
4	0.29595	0.01275	0.00190	0.01085	0.90885
9	0.29250	0.01620	0.00190	0.01430	0.90540
16	0.28985	0.01885	0.00190	0.01695	0.90275
25	0.28740	0.02130	0.00190	0.01940	0.90030
30	0.28640	0.02230	0.00190	0.02040	0.89930
60	0.28350	0.02520	0.00190	0.02330	0.89640
120	0.28215	0.02655	0.00190	0.02465	0.89505
180	0.28160	0.02710	0.00190	0.02520	0.89450
240	0.28120	0.02750	0.00190	0.02560	0.89410
1200	0.27900	0.02970	0.00190	0.02780	0.89190



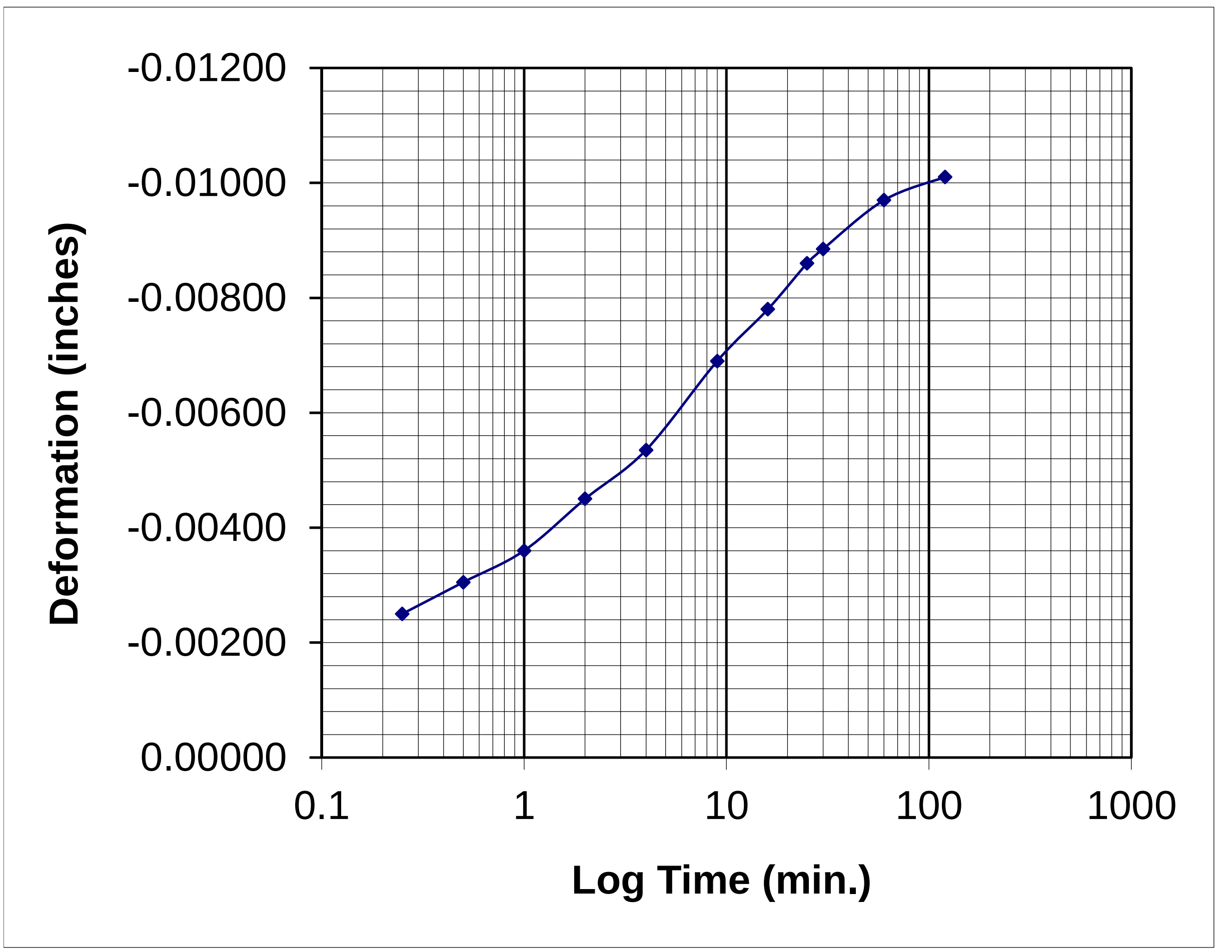
LEADING THROUGH the next 100 years

Project No. : 230230 Sample No.: ST-2
Boring No. : B-014-0-22 Depth: 4.0 - 6.0'

4.0 tsf Unload

initial height= 0.8919 inches

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.27900				
0.25	0.28280	-0.00380	-0.00130	-0.00250	0.89440
0.5	0.28335	-0.00435	-0.00130	-0.00305	0.89495
1	0.28390	-0.00490	-0.00130	-0.00360	0.89550
2	0.28480	-0.00580	-0.00130	-0.00450	0.89640
4	0.28565	-0.00665	-0.00130	-0.00535	0.89725
9	0.28720	-0.00820	-0.00130	-0.00690	0.89880
16	0.28810	-0.00910	-0.00130	-0.00780	0.89970
25	0.28890	-0.00990	-0.00130	-0.00860	0.90050
30	0.28915	-0.01015	-0.00130	-0.00885	0.90075
60	0.29000	-0.01100	-0.00130	-0.00970	0.90160
120	0.29040	-0.01140	-0.00130	-0.01010	0.90200



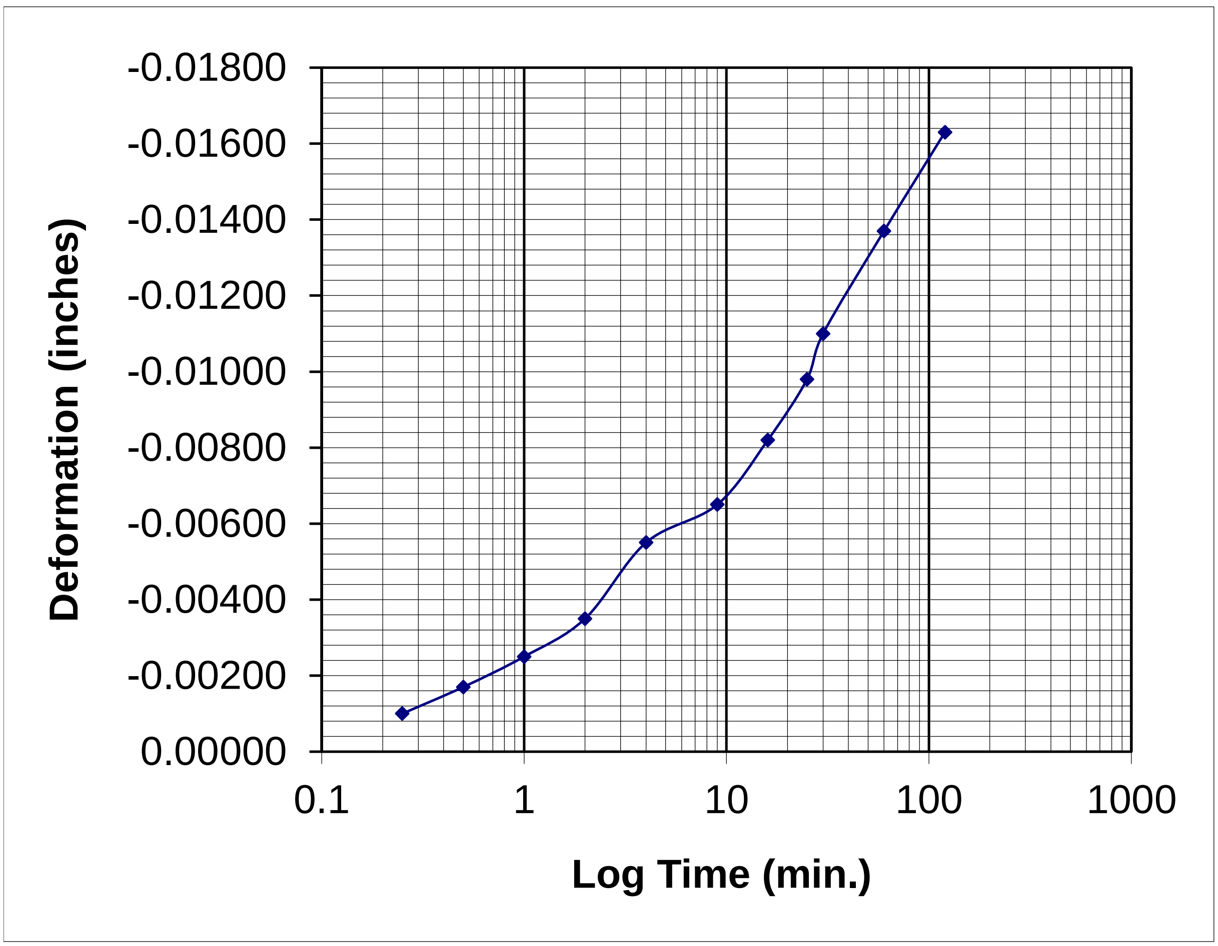
Project No. : 230230
Boring No. : B-014-0-22

Sample No.: ST-2
Depth: 4.0 - 6.0'

1.0 tsf Unload

initial height= 0.902 inches

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.29040				
0.25	0.29330	-0.00290	-0.00190	-0.00100	0.90300
0.5	0.29400	-0.00360	-0.00190	-0.00170	0.90370
1	0.29480	-0.00440	-0.00190	-0.00250	0.90450
2	0.29580	-0.00540	-0.00190	-0.00350	0.90550
4	0.29780	-0.00740	-0.00190	-0.00550	0.90750
9	0.29880	-0.00840	-0.00190	-0.00650	0.90850
16	0.30050	-0.01010	-0.00190	-0.00820	0.91020
25	0.30210	-0.01170	-0.00190	-0.00980	0.91180
30	0.30330	-0.01290	-0.00190	-0.01100	0.91300
60	0.30600	-0.01560	-0.00190	-0.01370	0.91570
120	0.30860	-0.01820	-0.00190	-0.01630	0.91830

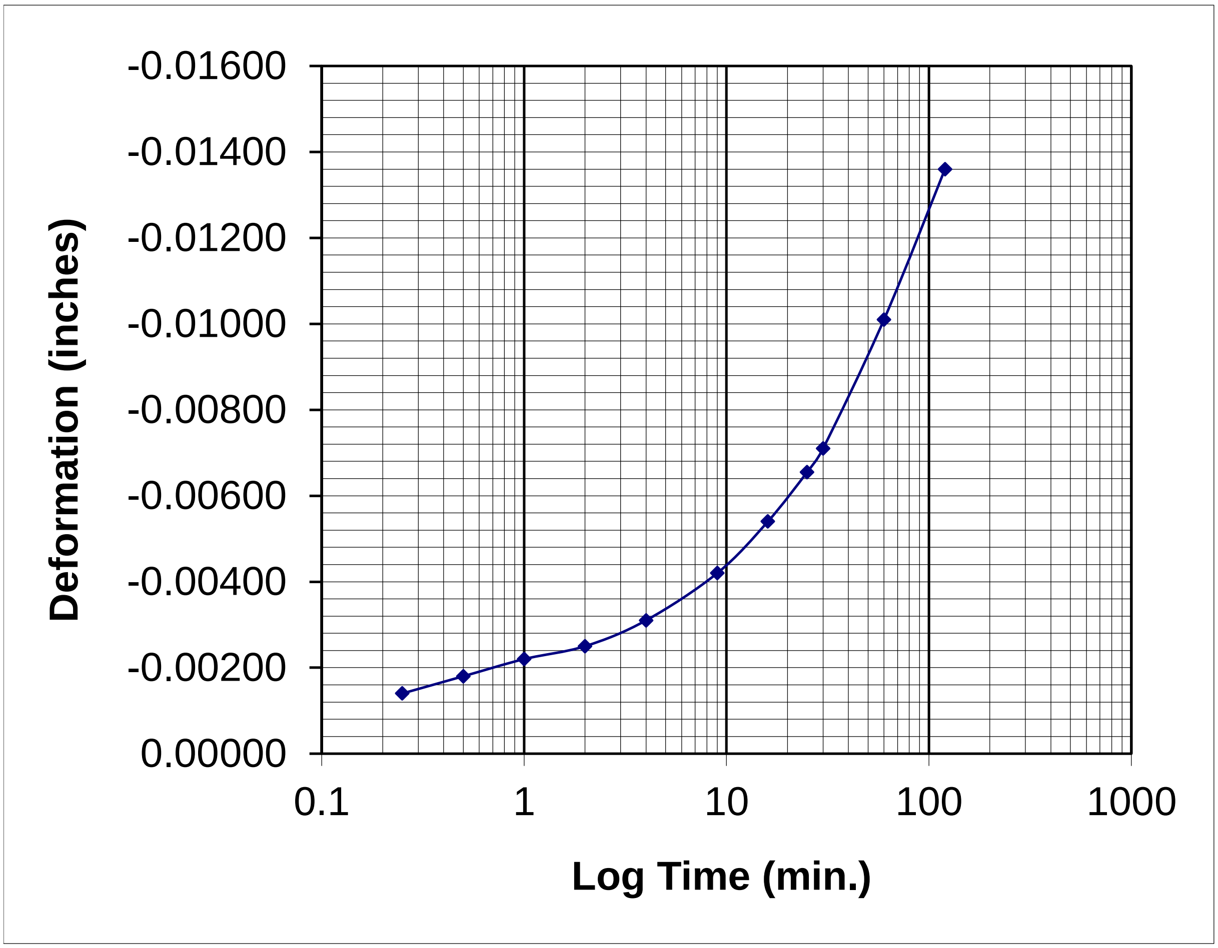


Project No. : 230230 Sample No.: ST-2
Boring No. : B-014-0-22 Depth: 4.0 - 6.0'

0.25 tsf Unload

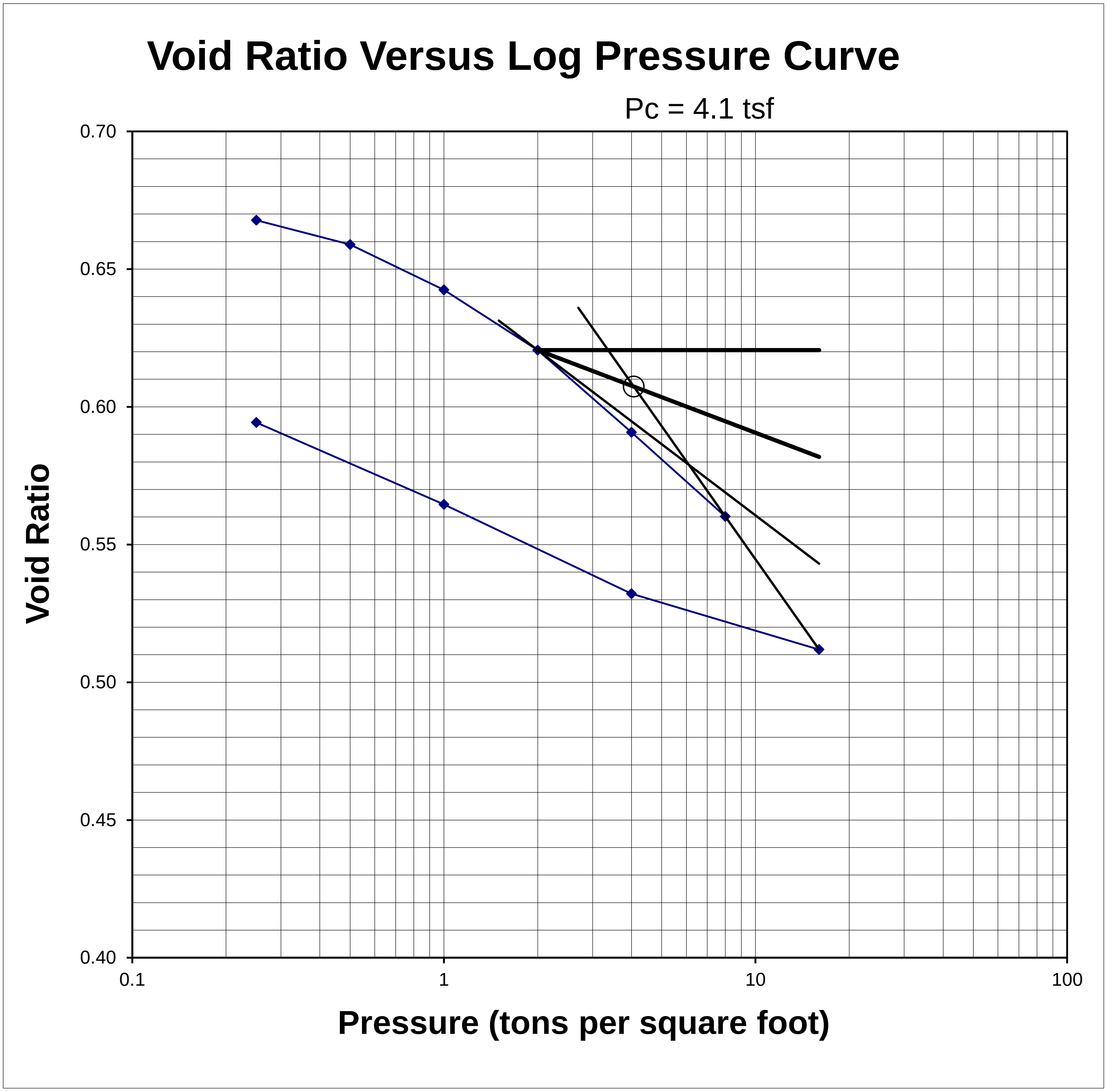
initial height= 0.9183 inches

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.30860				
0.25	0.31000	-0.00140	0.00000	-0.00140	0.91970
0.5	0.31040	-0.00180	0.00000	-0.00180	0.92010
1	0.31080	-0.00220	0.00000	-0.00220	0.92050
2	0.31110	-0.00250	0.00000	-0.00250	0.92080
4	0.31170	-0.00310	0.00000	-0.00310	0.92140
9	0.31280	-0.00420	0.00000	-0.00420	0.92250
16	0.31400	-0.00540	0.00000	-0.00540	0.92370
25	0.31515	-0.00655	0.00000	-0.00655	0.92485
30	0.31570	-0.00710	0.00000	-0.00710	0.92540
60	0.31870	-0.01010	0.00000	-0.01010	0.92840
120	0.32220	-0.01360	0.00000	-0.01360	0.93190



LEADING THROUGH the next 100 years

Project No.: 230230
Date: 8/1/2023
Client: Burgess & Niple, Inc.
Project: HEN-24/17D-00.43, PID 117712
Henry County, OH
Boring No.: B-015-0-22
Sample No.: ST-12
Depth: 31.0 - 33.0'



LEADING THROUGH the next 100 years

Project No.: 230230
Date: 8/1/2023
Client: Burgess & Niple, Inc.
Project: HEN-24/17D-00.43, PID 117712
Henry County, OH
Boring No.: B-015-0-22
Sample No.: ST-12
Depth: 31.0 - 33.0'

Initial H= 1 inches

Pressure tsf	Final Height (in)	Initial Height (in)	DH	Average H (in)	e	t50 (min)	Ave P (tsf)	Cv (in2/s)	Cv (ft2/d)
0.125	1.00000	1.00000	0.00000	1.0000	0.675				
0.25	0.99545	1.00000	0.00455	0.9977	0.668	0.3	0.125	0.002593	1.556
0.5	0.99015	0.99545	0.00985	0.9928	0.659	1.8	0.375	0.000455	0.273
1	0.98035	0.99015	0.01965	0.9853	0.642	2.4	0.75	0.000338	0.203
2	0.96730	0.98035	0.03270	0.9738	0.621	2.8	1.5	0.000275	0.165
4	0.94950	0.96730	0.05050	0.9584	0.591	2.5	3	0.000302	0.181
8	0.93125	0.94950	0.06875	0.9404	0.560	2.3	6	0.000310	0.186
16	0.90240	0.93125	0.09760	0.9168	0.512	1.7	12	0.000411	0.247
4	0.91450	0.90240	0.08550	0.9085	0.532		10		
1	0.93385	0.91450	0.06615	0.9242	0.565		2.5		
0.25	0.95160	0.93385	0.04840	0.9427	0.594		0.625		

Estimated Cc: 0.161
Estimated Cr: 0.046

Soil Description: Gray SILTY CLAY, Little Sand, Trace Gravel A-6b (11)
Specific Gravity: 2.706
Liquid Limit: 37
Plastic Limit: 20
Plasticity Index: 17

Initial Water Content:	24.2 %	Final Water Content:	23.9 %
Inital Dry Density:	100.8 pcf	Final Dry Density:	106.0 pcf
Initial Void Ratio:	0.675	Final Void Ratio:	0.594
Initial Degree of Saturation:	97.1 %	Final Degree of Saturation	108.9 %

Estimated Preconsolidation Pressure: 4.1 tsf

The sample for the test was trimmed from a Shelby tube sample using a cutting shoe. Test Method B was used with the specimen inundated during testing. Coefficients of consolidation were computed by log of time method.

Consolidation Laboratory Calculations

Consolidometer: **1**

Method:	ASTM D 2435 Method B			
Project No. :	230230			
Client:	Burgess & Niple, Inc.			
Project:	HEN-24/17D-00.43, PID 117712			
Location:	Henry County, OH			
Boring No. :	B-015-0-22		Visual Description:	Gray SILTY CLAY, Little Sand, Trace Gravel A-6b (11)
Sample No.:	ST-12		Liquid Limit:	37 %
Depth:	31.0 - 33.0'		Plastic Limit:	20 %
Date of Test:	8/1/2023		Plasticity Index:	17 %

Initial Sample Data			***Final Sample Data***		
Initial Height	1.000 in.		Final Height	0.952 in.	
Ring Dia.	2.493 in.		Ring Dia.	2.493 in.	
Area of Ring	4.8813 in^2		Area of Ring	4.8813 in^2	
Initial Volume	4.8813 in^3	0.00282 ft^3	Final Volume	4.6450 in^3	0.00269 ft^3
Specific Gravity	2.706				
			Final wet mass soil, pan & ring	356.6 g	
			Wt of Pan	51.8 g	
Initial wet mass soil & ring	305.2 g		Final wet mass soil & ring	304.8	
Mass of ring	144.7 g		Mass of ring	144.7 g	
			Final dry mass of soil, pan & ring	325.7 g	
Initial wet mass soil	160.5 g	0.35384 lb	Final wet mass soil	160.1 g	0.35296 lb
			Weight of water	30.9 g	0.06812 lb

Initial Water Content	
Mass can & wet soil	373.5 g
Mass can & dry soil	302.9 g
Mass of can	50.2 g
Mass of water	70.6 g
Mass of soil	252.7 g
Initial water content	27.94 % (trimmings)

Initial water content	24.23 % (based on final dry weight)		Final water content	23.92 % (based on final dry weight)	
			Final weight of solids (Md)	129.2 g	0.28484 lb
Initial dry density	100.8 pcf		Final dry density	106.0 pcf	
			Final volume of solids (Vs)	2.9135 in^3	0.00169 ft^3
			Final height of solids (Hs)	0.5969 in.	
Initial void ratio (eo)	0.675		Final void ratio (ef)	0.594	
Initial volume of voids (Vvo)	1.9677 in^3	0.00114 ft^3	Final volume of voids (Vvf)	1.7315 in^3	0.00100 ft^3
Initial volume of water (Vwo)	1.9100 in^3	0.00111 ft^3	Final volume of water (Vwf)	1.8856 in^3	0.00109 ft^3
Initial degree of saturation (So)	97.07 %		Final degree of saturation (Sf)	108.90 %	

Project No. : 230230 Sample No.: ST-12
Boring No. : B-015-0-22 Depth: 31.0 - 33.0'

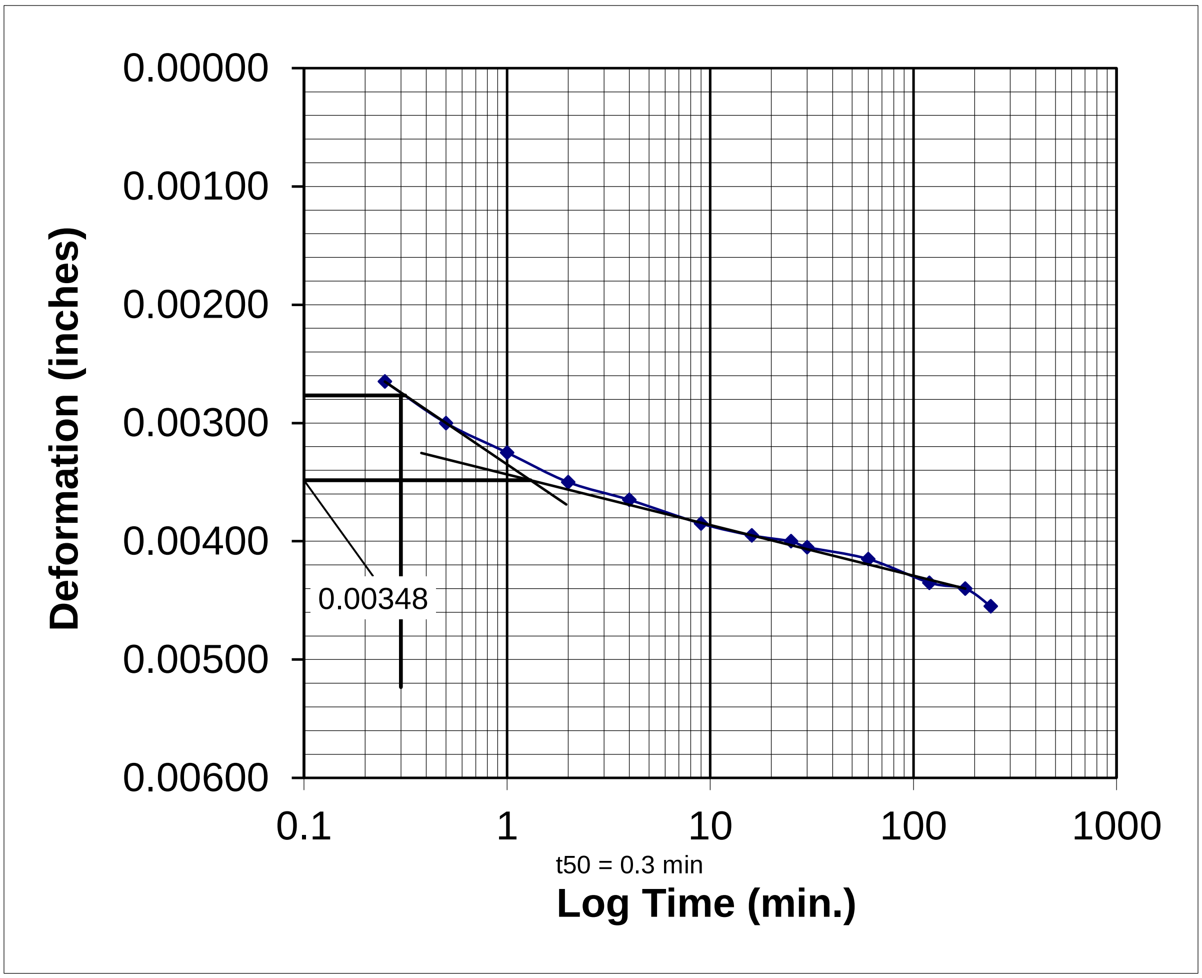
0.25 tsf Load

initial height= 1 inches

Do= D1-(D2-D1)
1) 0.25 to 1.0: 0.00205
2) 0.5 to 2.0: 0.00250
3) 1.0 to 4.0: 0.00285
Do Avg 1&2: 0.00228
Do Avg 1-3: 0.00247
Use Do= 0.00205
D100= 0.00348
D50= D100+0.5(Do-D100)
D50= 0.00277

t50 = 0.3 min.

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.39235				
0.25	0.38970	0.00265	0.00000	0.00265	0.99735
0.5	0.38935	0.00300	0.00000	0.00300	0.99700
1	0.38910	0.00325	0.00000	0.00325	0.99675
2	0.38885	0.00350	0.00000	0.00350	0.99650
4	0.38870	0.00365	0.00000	0.00365	0.99635
9	0.38850	0.00385	0.00000	0.00385	0.99615
16	0.38840	0.00395	0.00000	0.00395	0.99605
25	0.38835	0.00400	0.00000	0.00400	0.99600
30	0.38830	0.00405	0.00000	0.00405	0.99595
60	0.38820	0.00415	0.00000	0.00415	0.99585
120	0.38800	0.00435	0.00000	0.00435	0.99565
180	0.38795	0.00440	0.00000	0.00440	0.99560
240	0.38780	0.00455	0.00000	0.00455	0.99545



Project No. : 230230 | Sample No.: ST-12
Boring No. : B-015-0-22 | Depth: 31.0 - 33.0'

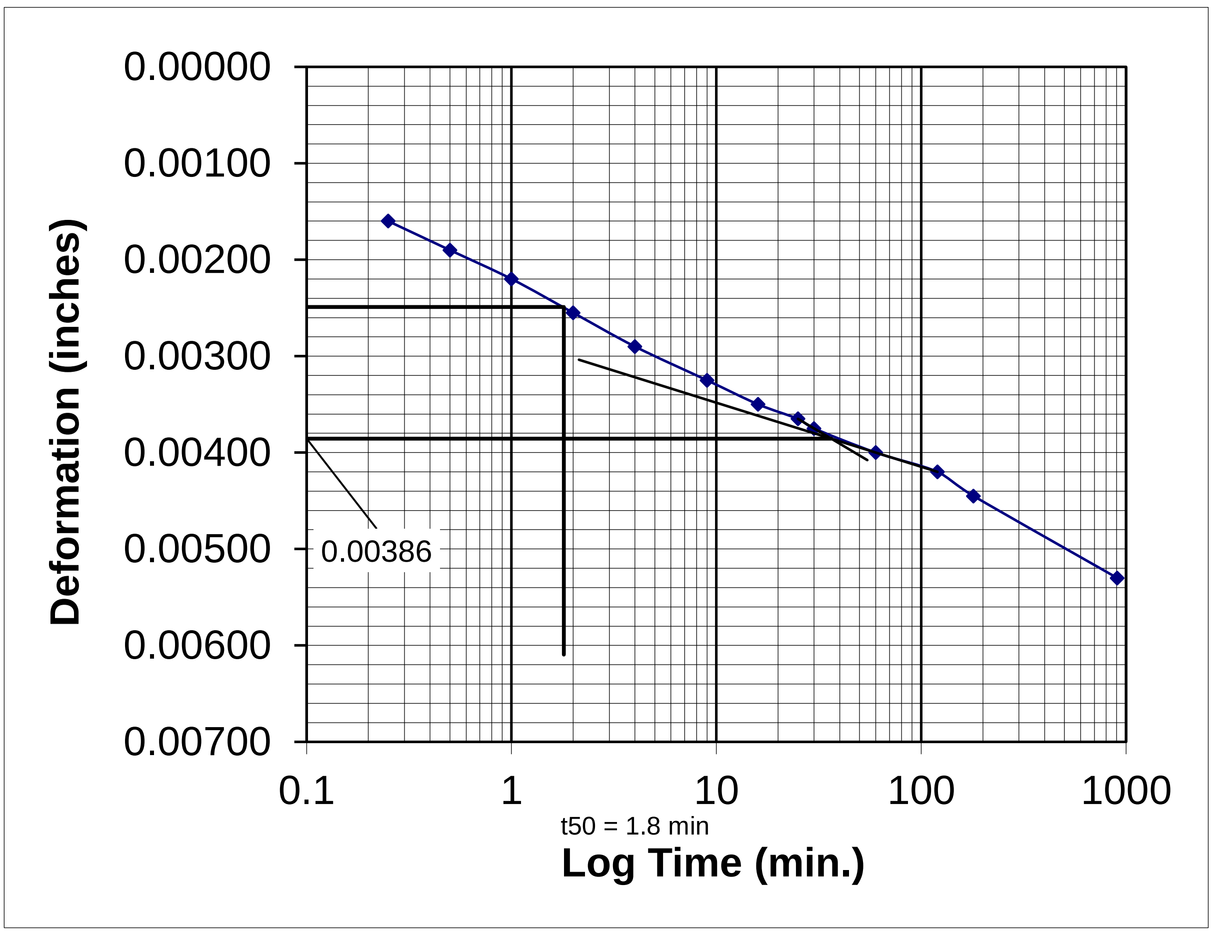
0.5 tsf Load

initial height= 0.99545 inches

Do= D1-(D2-D1)
1) 0.25 to 1.0: 0.00100
2) 0.5 to 2.0: 0.00125
3) 1.0 to 4.0: 0.00150
Do Avg 1&2: 0.00112
Do Avg 1-3: 0.00125
Use Do= 0.00112
D100= 0.00386
D50= D100+0.5(Do-D100)
D50= 0.00249

t50 = 1.8 min.

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.38780				
0.25	0.38620	0.00160	0.00000	0.00160	0.99385
0.5	0.38590	0.00190	0.00000	0.00190	0.99355
1	0.38560	0.00220	0.00000	0.00220	0.99325
2	0.38525	0.00255	0.00000	0.00255	0.99290
4	0.38490	0.00290	0.00000	0.00290	0.99255
9	0.38455	0.00325	0.00000	0.00325	0.99220
16	0.38430	0.00350	0.00000	0.00350	0.99195
25	0.38415	0.00365	0.00000	0.00365	0.99180
30	0.38405	0.00375	0.00000	0.00375	0.99170
60	0.38380	0.00400	0.00000	0.00400	0.99145
120	0.38360	0.00420	0.00000	0.00420	0.99125
180	0.38335	0.00445	0.00000	0.00445	0.99100
905	0.38250	0.00530	0.00000	0.00530	0.99015



Project No. : 230230 Sample No.: ST-12
Boring No. : B-015-0-22 Depth: 31.0 - 33.0'

1.0 tsf Load

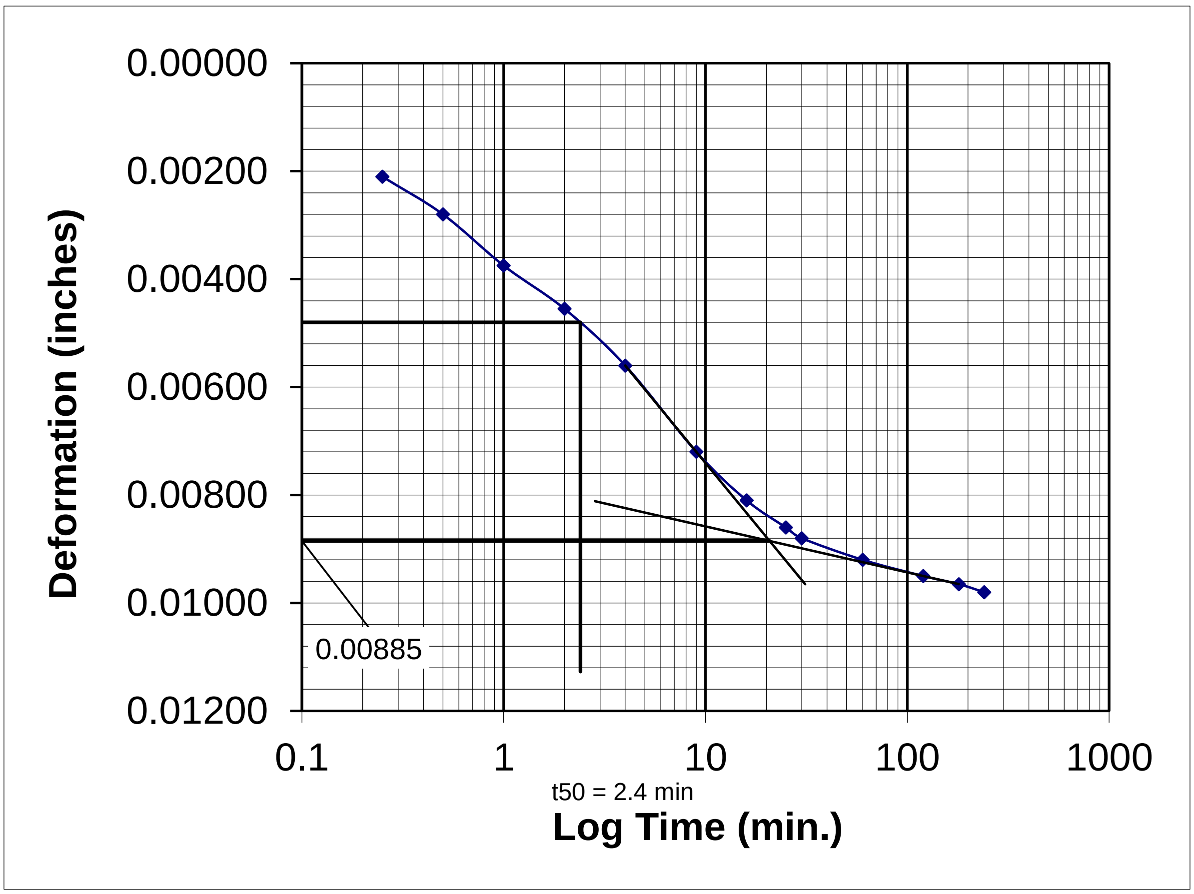
initial height= 0.99015 inches

Do= D1-(D2-D1)
1) 0.25 to 1.0: 0.00045
2) 0.5 to 2.0: 0.00105
3) 1.0 to 4.0: 0.00190
Do Avg 1&2: 0.00075
Do Avg 1-3: 0.00113

Use Do= 0.00075
D100= 0.00885
D50= **D100+0.5(Do-D100)**
D50= 0.00480

t50 = 2.4 min.

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.38250				
0.25	0.37790	0.00460	0.00250	0.00210	0.98805
0.5	0.37720	0.00530	0.00250	0.00280	0.98735
1	0.37625	0.00625	0.00250	0.00375	0.98640
2	0.37545	0.00705	0.00250	0.00455	0.98560
4	0.37440	0.00810	0.00250	0.00560	0.98455
9	0.37280	0.00970	0.00250	0.00720	0.98295
16	0.37190	0.01060	0.00250	0.00810	0.98205
25	0.37140	0.01110	0.00250	0.00860	0.98155
30	0.37120	0.01130	0.00250	0.00880	0.98135
60	0.37080	0.01170	0.00250	0.00920	0.98095
120	0.37050	0.01200	0.00250	0.00950	0.98065
180	0.37035	0.01215	0.00250	0.00965	0.98050
240	0.37020	0.01230	0.00250	0.00980	0.98035



Project No. : 230230 Sample No.: ST-12
Boring No. : B-015-0-22 Depth: 31.0 - 33.0'

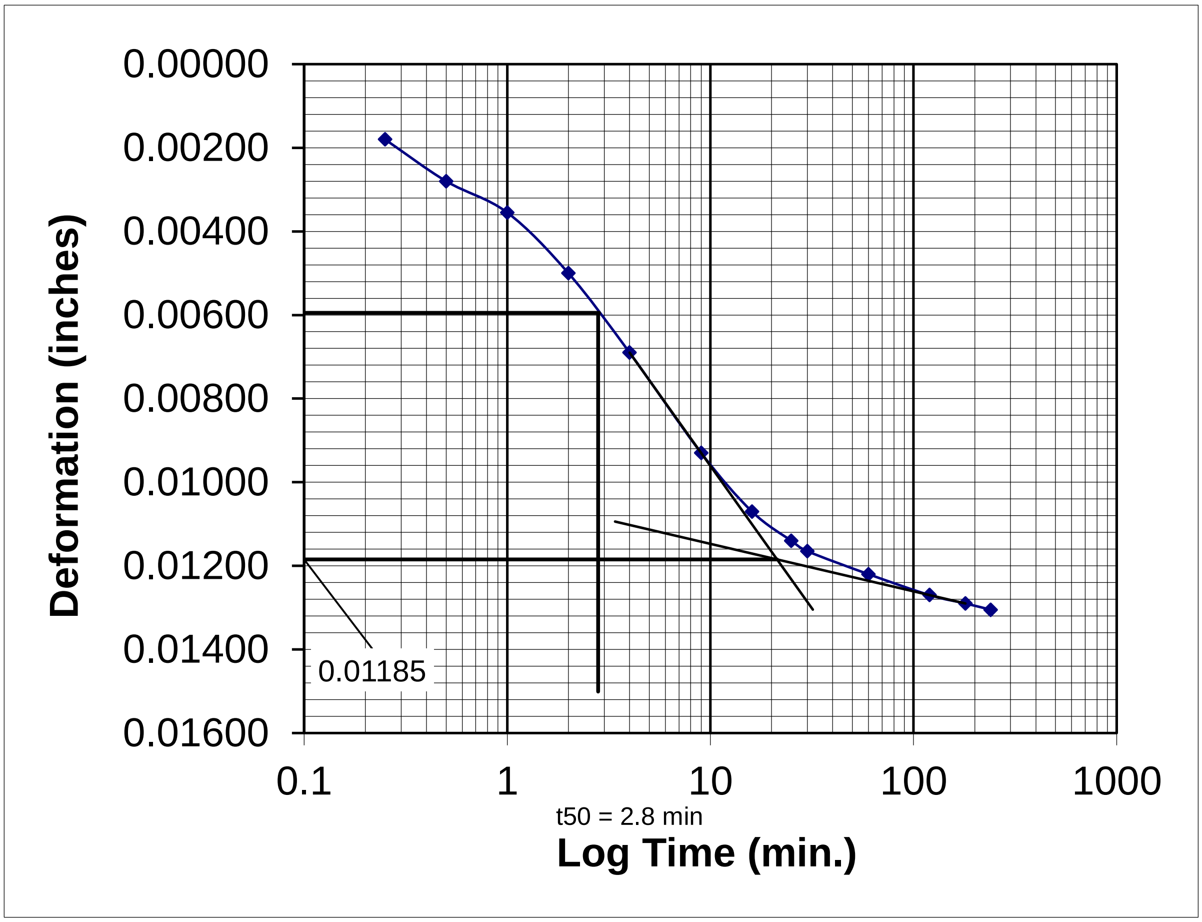
2.0 tsf Load

initial height= 0.98035 inches

Do= D1-(D2-D1)
1) 0.25 to 1.0: 0.00005
2) 0.5 to 2.0: 0.00060
3) 1.0 to 4.0: 0.00020
Do Avg 1&2: 0.00033
Do Avg 1-3: 0.00028
Use Do= 0.00005
D100= 0.01185
D50= D100+0.5(Do-D100)
D50= 0.00595

t50 = 2.8 min.

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.37020				
0.25	0.36550	0.00470	0.00290	0.00180	0.97855
0.5	0.36450	0.00570	0.00290	0.00280	0.97755
1	0.36375	0.00645	0.00290	0.00355	0.97680
2	0.36230	0.00790	0.00290	0.00500	0.97535
4	0.36040	0.00980	0.00290	0.00690	0.97345
9	0.35800	0.01220	0.00290	0.00930	0.97105
16	0.35660	0.01360	0.00290	0.01070	0.96965
25	0.35590	0.01430	0.00290	0.01140	0.96895
30	0.35565	0.01455	0.00290	0.01165	0.96870
60	0.35510	0.01510	0.00290	0.01220	0.96815
120	0.35460	0.01560	0.00290	0.01270	0.96765
180	0.35440	0.01580	0.00290	0.01290	0.96745
240	0.35425	0.01595	0.00290	0.01305	0.96730



Project No. : 230230 Sample No.: ST-12
Boring No. : B-015-0-22 Depth: 31.0 - 33.0'

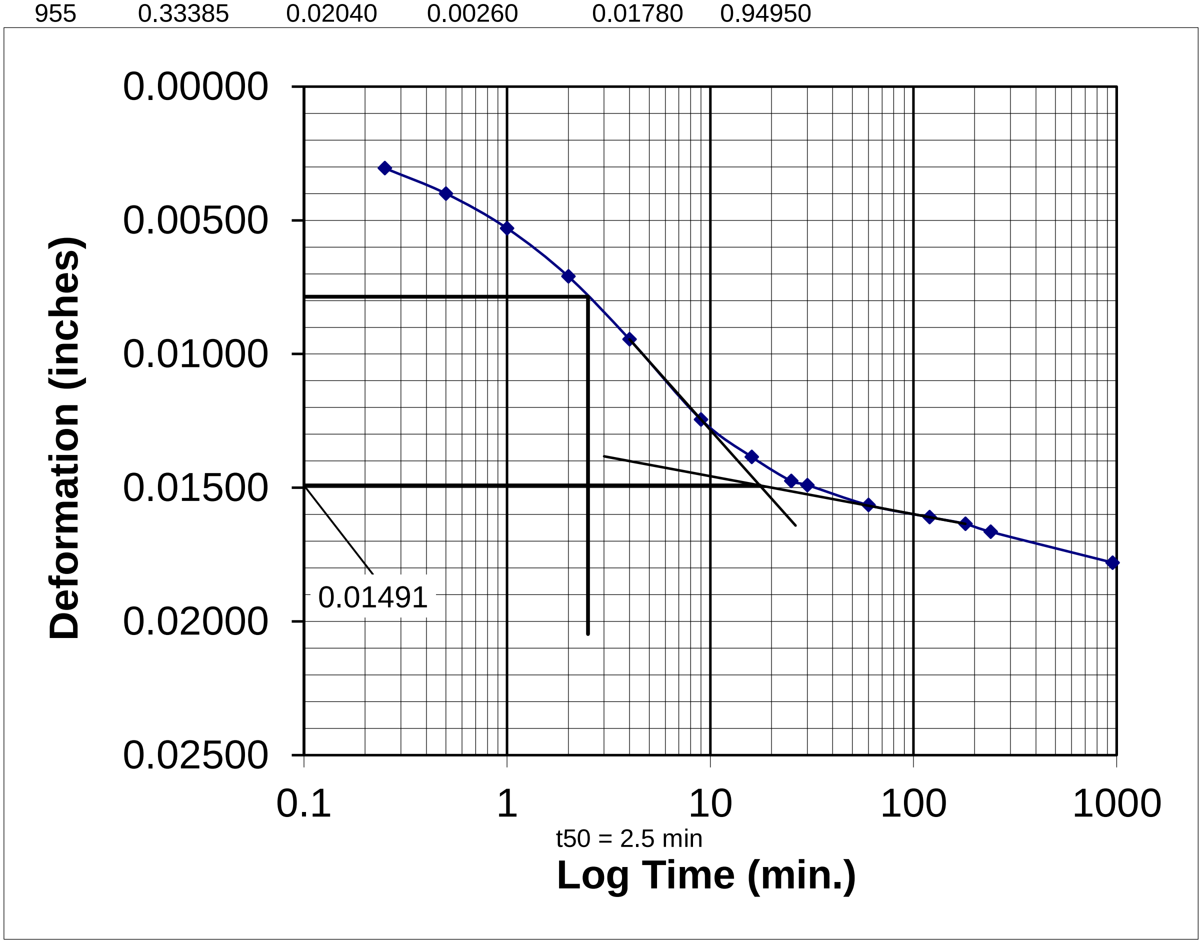
4.0 tsf Load

initial height= 0.9673 inches

Do= D1-(D2-D1)
1) 0.25 to 1.0: 0.00080
2) 0.5 to 2.0: 0.00090
3) 1.0 to 4.0: 0.00115
Do Avg 1&2: 0.00085
Do Avg 1-3: 0.00095
Use Do= 0.00080
D100= 0.01491
D50= D100+0.5(Do-D100)
D50= 0.00786

t50 = 2.5 min.

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.35425				
0.25	0.34860	0.00565	0.00260	0.00305	0.96425
0.5	0.34765	0.00660	0.00260	0.00400	0.96330
1	0.34635	0.00790	0.00260	0.00530	0.96200
2	0.34455	0.00970	0.00260	0.00710	0.96020
4	0.34220	0.01205	0.00260	0.00945	0.95785
9	0.33920	0.01505	0.00260	0.01245	0.95485
16	0.33780	0.01645	0.00260	0.01385	0.95345
25	0.33690	0.01735	0.00260	0.01475	0.95255
30	0.33675	0.01750	0.00260	0.01490	0.95240
60	0.33600	0.01825	0.00260	0.01565	0.95165
120	0.33555	0.01870	0.00260	0.01610	0.95120
180	0.33530	0.01895	0.00260	0.01635	0.95095
240	0.33500	0.01925	0.00260	0.01665	0.95065
955	0.33385	0.02040	0.00260	0.01780	0.94950



Project No. : 230230 Sample No.: ST-12
Boring No. : B-015-0-22 Depth: 31.0 - 33.0'

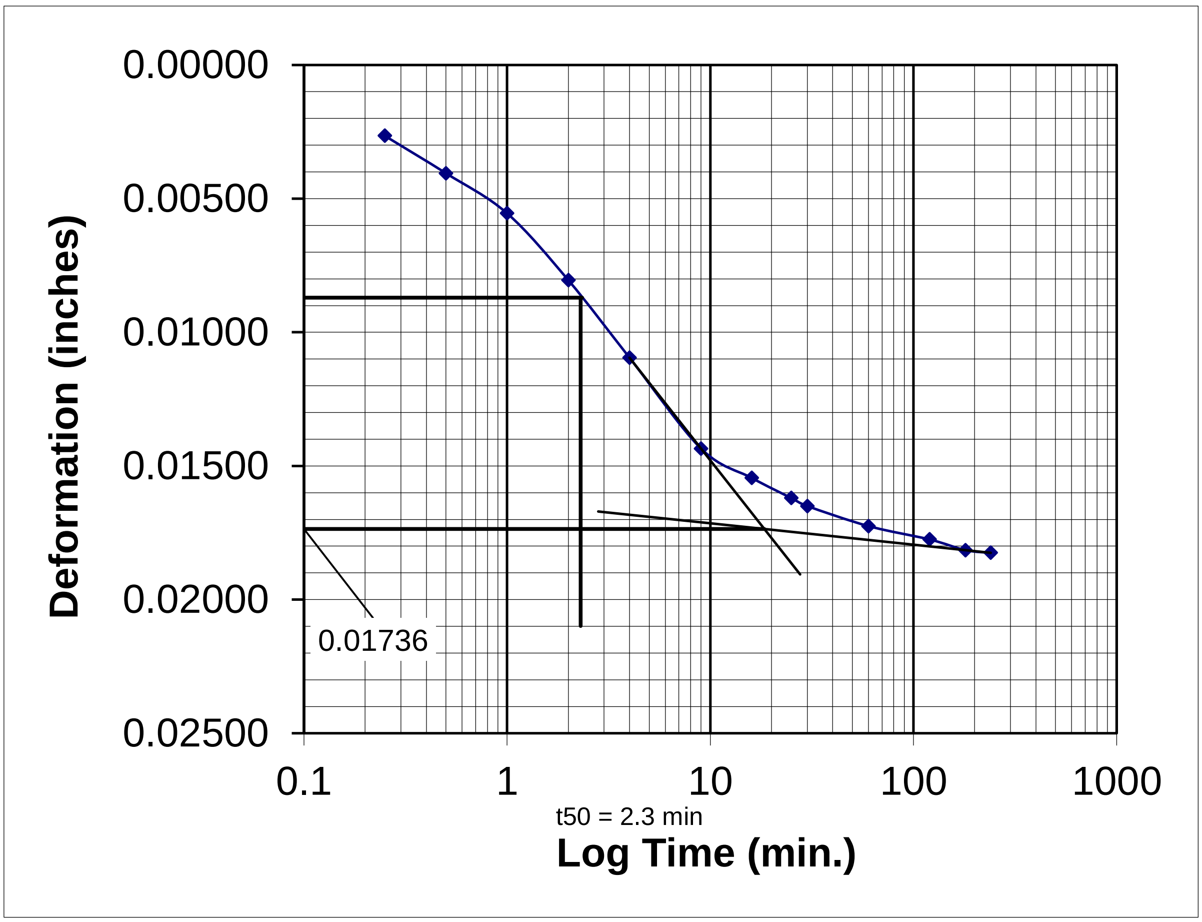
8.0 tsf Load

initial height= 0.94950 inches

Do= D1-(D2-D1)
1) 0.25 to 1.0: -0.00025
2) 0.5 to 2.0: 0.00005
3) 1.0 to 4.0: 0.00015
Do Avg 1&2: -0.00010
Do Avg 1-3: -0.00002
Use Do= 0.00005
D100= 0.01736
D50= D100+0.5(Do-D100)
D50= 0.00870

t50 = 2.3 min.

Interval Minutes	**Dial Reading**	**ΔH**	**Deformation Constant**	**TRUE ΔH**	**Height of Sample**
0	0.33385				
0.25	0.32900	0.00485	0.00220	0.00265	0.94685
0.5	0.32760	0.00625	0.00220	0.00405	0.94545
1	0.32610	0.00775	0.00220	0.00555	0.94395
2	0.32360	0.01025	0.00220	0.00805	0.94145
4	0.32070	0.01315	0.00220	0.01095	0.93855
9	0.31730	0.01655	0.00220	0.01435	0.93515
16	0.31620	0.01765	0.00220	0.01545	0.93405
25	0.31545	0.01840	0.00220	0.01620	0.93330
30	0.31515	0.01870	0.00220	0.01650	0.93300
60	0.31440	0.01945	0.00220	0.01725	0.93225
120	0.31390	0.01995	0.00220	0.01775	0.93175
180	0.31350	0.02035	0.00220	0.01815	0.93135
240	0.31340	0.02045	0.00220	0.01825	0.93125



Project No. : 230230
Boring No. : B-015-0-22

Sample No.: ST-12
Depth: 31.0 - 33.0'

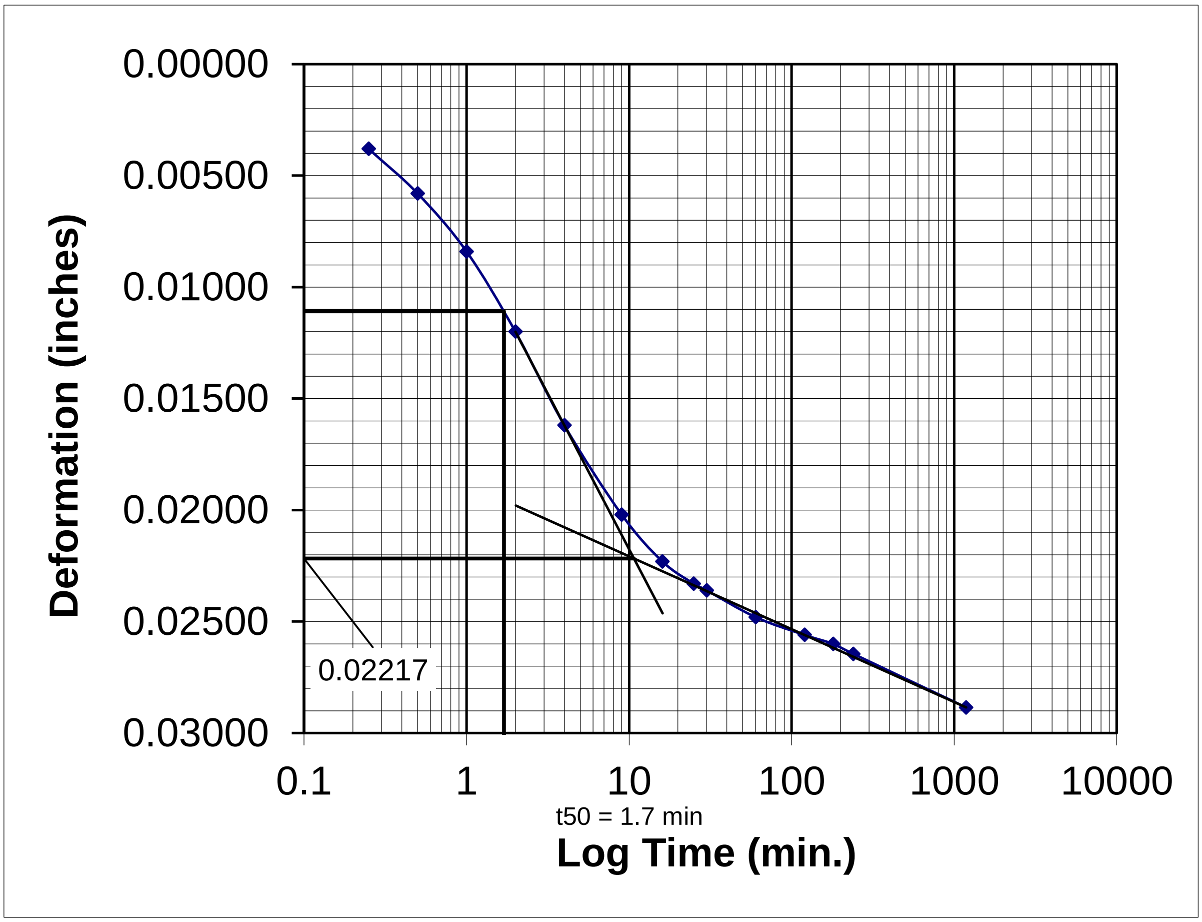
16 tsf Load

initial height= 0.93125 inches

Do= D1-(D2-D1)
1) 0.25 to 1.0: -0.00080
2) 0.5 to 2.0: -0.00040
3) 1.0 to 4.0: 0.00060
Do Avg 1&2: -0.00060
Do Avg 1-3: -0.00020
Use Do= 0.00000
D100= 0.02217
D50= D100+0.5(Do-D100)
D50= 0.01109

t50 = 1.7 min.

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.31340				
0.25	0.30770	0.00570	0.00190	0.00380	0.92745
0.5	0.30570	0.00770	0.00190	0.00580	0.92545
1	0.30310	0.01030	0.00190	0.00840	0.92285
2	0.29950	0.01390	0.00190	0.01200	0.91925
4	0.29530	0.01810	0.00190	0.01620	0.91505
9	0.29130	0.02210	0.00190	0.02020	0.91105
16	0.28920	0.02420	0.00190	0.02230	0.90895
25	0.28820	0.02520	0.00190	0.02330	0.90795
30	0.28790	0.02550	0.00190	0.02360	0.90765
60	0.28670	0.02670	0.00190	0.02480	0.90645
120	0.28590	0.02750	0.00190	0.02560	0.90565
180	0.28550	0.02790	0.00190	0.02600	0.90525
240	0.28505	0.02835	0.00190	0.02645	0.90480
1185	0.28265	0.03075	0.00190	0.02885	0.90240

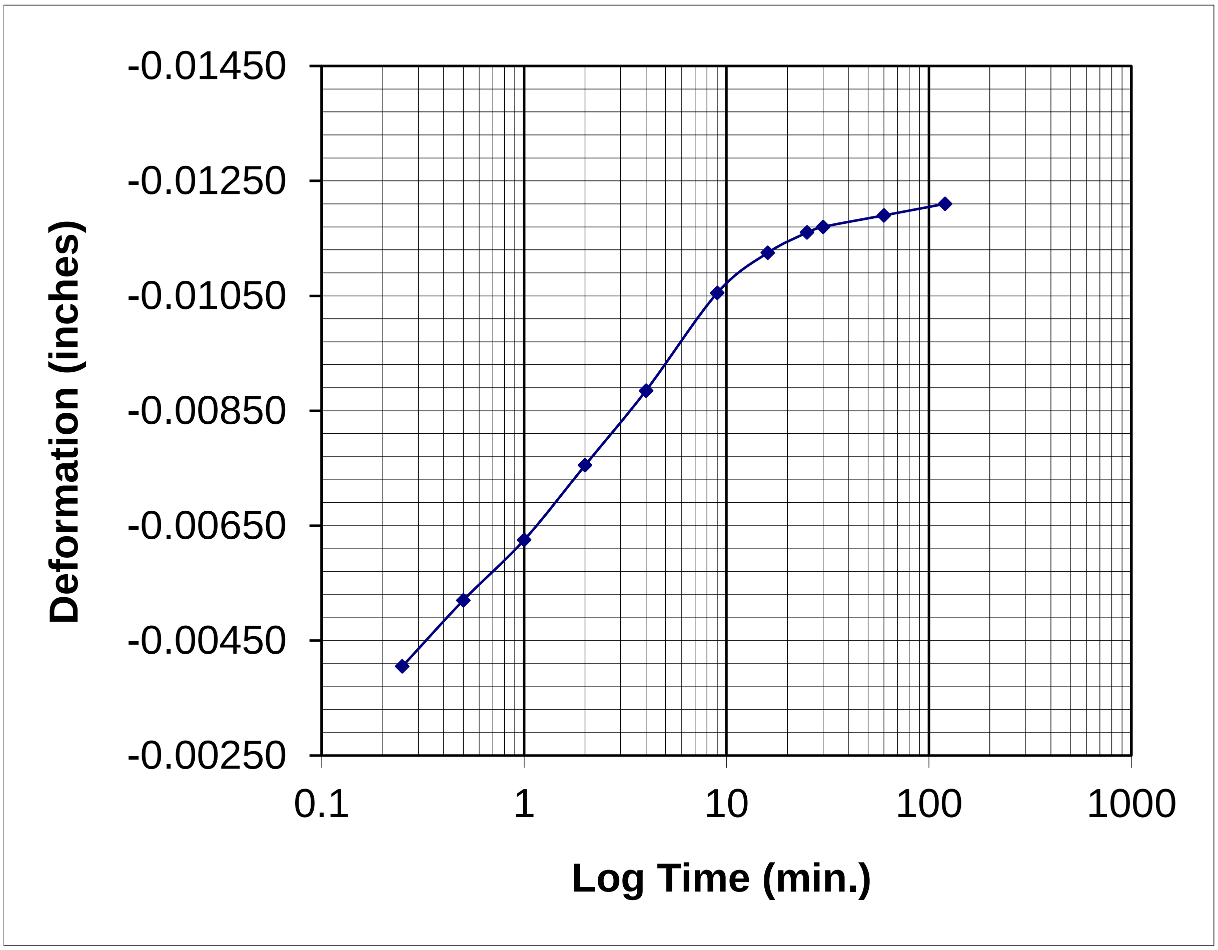


Project No. : 230230 Sample No.: ST-12
Boring No. : B-015-0-22 Depth: 31.0 - 33.0'

4.0 tsf Unload

initial height= 0.9024 inches

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.28265				
0.25	0.28800	-0.00535	-0.00130	-0.00405	0.90645
0.5	0.28915	-0.00650	-0.00130	-0.00520	0.90760
1	0.29020	-0.00755	-0.00130	-0.00625	0.90865
2	0.29150	-0.00885	-0.00130	-0.00755	0.90995
4	0.29280	-0.01015	-0.00130	-0.00885	0.91125
9	0.29450	-0.01185	-0.00130	-0.01055	0.91295
16	0.29520	-0.01255	-0.00130	-0.01125	0.91365
25	0.29555	-0.01290	-0.00130	-0.01160	0.91400
30	0.29565	-0.01300	-0.00130	-0.01170	0.91410
60	0.29585	-0.01320	-0.00130	-0.01190	0.91430
120	0.29605	-0.01340	-0.00130	-0.01210	0.91450

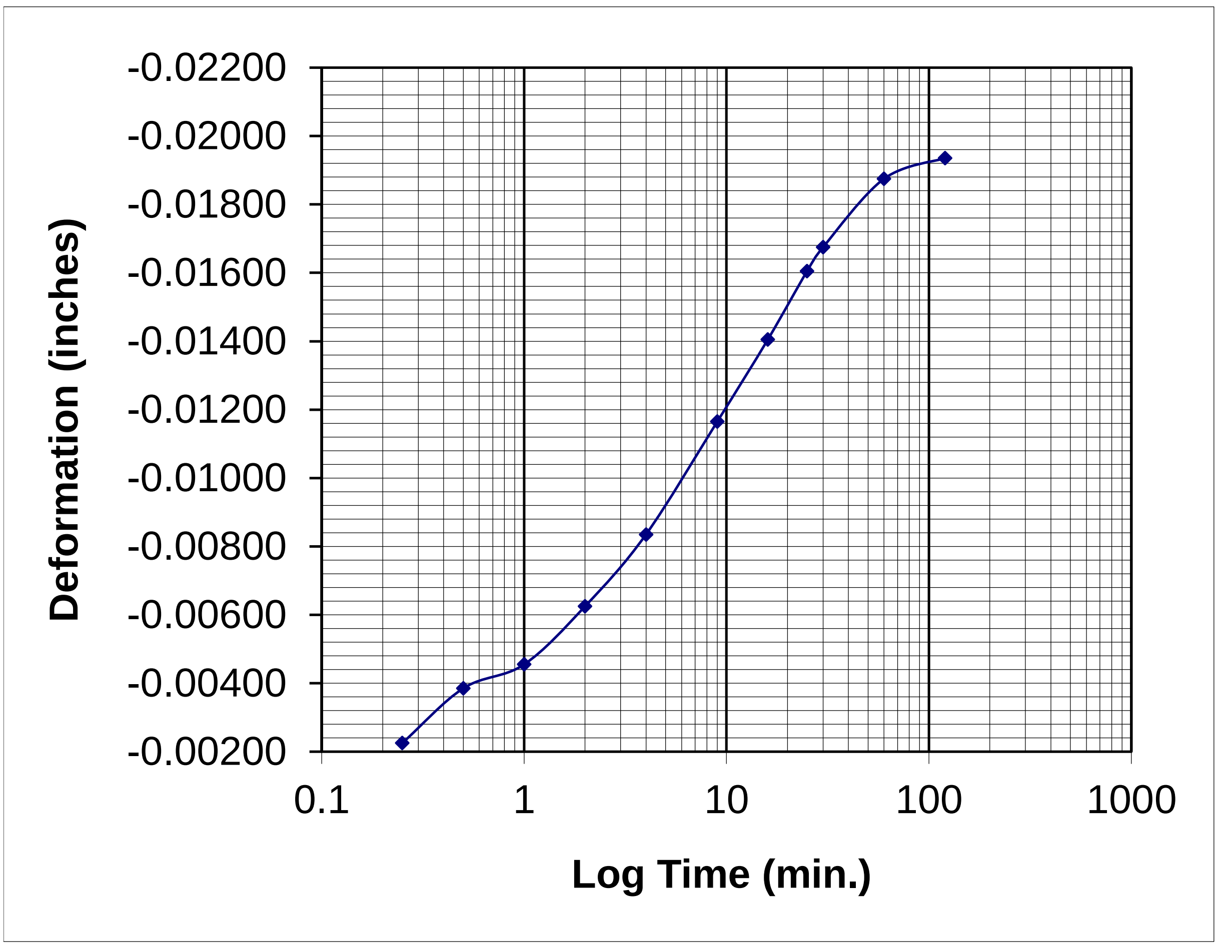


Project No. : 230230 Sample No.: ST-12
Boring No. : B-015-0-22 Depth: 31.0 - 33.0'

1.0 tsf Unload

initial height= 0.9145 inches

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.29605				
0.25	0.30020	-0.00415	-0.00190	-0.00225	0.91675
0.5	0.30180	-0.00575	-0.00190	-0.00385	0.91835
1	0.30250	-0.00645	-0.00190	-0.00455	0.91905
2	0.30420	-0.00815	-0.00190	-0.00625	0.92075
4	0.30630	-0.01025	-0.00190	-0.00835	0.92285
9	0.30960	-0.01355	-0.00190	-0.01165	0.92615
16	0.31200	-0.01595	-0.00190	-0.01405	0.92855
25	0.31400	-0.01795	-0.00190	-0.01605	0.93055
30	0.31470	-0.01865	-0.00190	-0.01675	0.93125
60	0.31670	-0.02065	-0.00190	-0.01875	0.93325
120	0.31730	-0.02125	-0.00190	-0.01935	0.93385

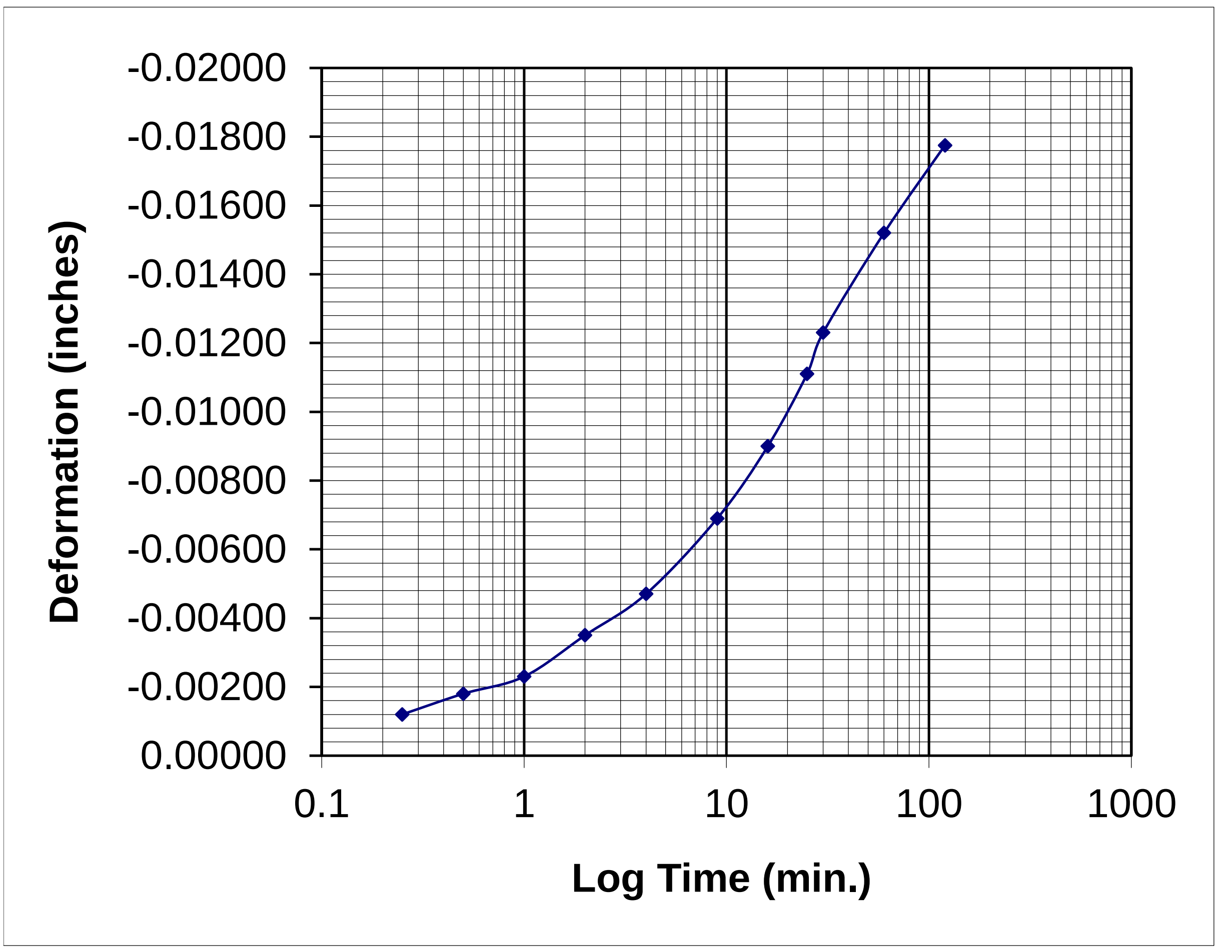


Project No. : 230230 Sample No.: ST-12
Boring No. : B-015-0-22 Depth: 31.0 - 33.0'

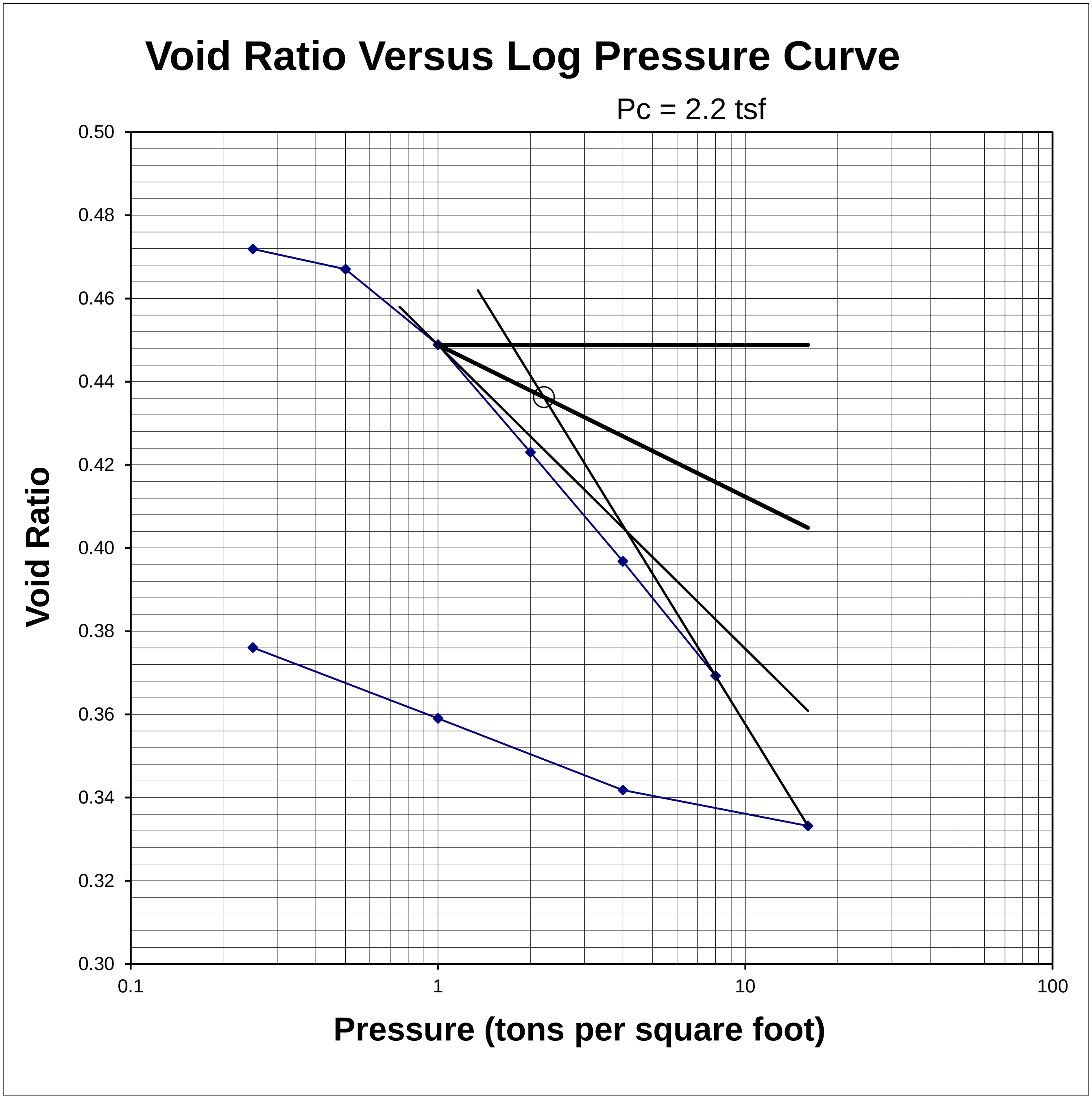
0.25 tsf Unload

initial height= 0.93385 inches

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.31730				
0.25	0.31850	-0.00120	0.00000	-0.00120	0.93505
0.5	0.31910	-0.00180	0.00000	-0.00180	0.93565
1	0.31960	-0.00230	0.00000	-0.00230	0.93615
2	0.32080	-0.00350	0.00000	-0.00350	0.93735
4	0.32200	-0.00470	0.00000	-0.00470	0.93855
9	0.32420	-0.00690	0.00000	-0.00690	0.94075
16	0.32630	-0.00900	0.00000	-0.00900	0.94285
25	0.32840	-0.01110	0.00000	-0.01110	0.94495
30	0.32960	-0.01230	0.00000	-0.01230	0.94615
60	0.33250	-0.01520	0.00000	-0.01520	0.94905
120	0.33505	-0.01775	0.00000	-0.01775	0.95160



Project No.: 230230
Date: 5/5/2023
Client: ODOT
Project: HEN-24/17D-00.43
Henry County, OH
Boring No.: B-018-0-22
Sample No.: ST-5
Depth: 11.0 - 13.0'



LEADING THROUGH the next 100 years

Project No.: 230230
Date: 5/5/2023
Client: ODOT
Project: HEN-24/17D-00.43
Henry County, OH
Boring No.: B-018-0-22
Sample No.: ST-5
Depth: 11.0 - 13.0'

Initial H= 1 inches

Pressure tsf	Final Height (in)	Initial Height (in)	DH	Average H (in)	e	t50 (min)	Ave P (tsf)	Cv (in2/s)	Cv (ft2/d)
0.25	0.99700	1.00000	0.00300	0.9985	0.472	0.7	0.125	0.001129	0.677
0.5	0.99370	0.99700	0.00630	0.9954	0.467	2.5	0.375	0.000323	0.194
1	0.98140	0.99370	0.01860	0.9876	0.449	1.8	0.75	0.000457	0.274
2	0.96390	0.98140	0.03610	0.9727	0.423	3.8	1.5	0.000204	0.123
4	0.94615	0.96390	0.05385	0.9550	0.397	4.1	3	0.000181	0.108
8	0.92750	0.94615	0.07250	0.9368	0.369	3.6	6	0.000198	0.119
16	0.90305	0.92750	0.09695	0.9153	0.333	4.1	12	0.000168	0.101
4	0.90890	0.90305	0.09110	0.9060	0.342		10		
1	0.92055	0.90890	0.07945	0.9147	0.359		2.5		
0.25	0.93210	0.92055	0.06790	0.9263	0.376		0.625		

Estimated Cc: 0.120
Estimated Cr: 0.024

Soil Description: Gray SILT and CLAY, Little Gravel, Little Sand A-6a (8)
Specific Gravity: 2.689
Liquid Limit: 30
Plastic Limit: 18
Plasticity Index: 12

Initial Water Content:	14.6 %	Final Water Content:	15.4 %
Inital Dry Density:	113.7 pcf	Final Dry Density:	122.0 pcf
Initial Void Ratio:	0.476	Final Void Ratio:	0.376
Initial Degree of Saturation:	82.1 %	Final Degree of Saturatior	109.9 %

Estimated Preconsolidation Pressure: 2.2 tsf

The sample for the test was trimmed from a Shelby tube sample using a cutting shoe. Test Method B was used with the specimen inundated during testing. Coefficients of consolidation were computed by log of time method.

LEADING THROUGH the next 100 years

Consolidation Laboratory Calculations

Consolidometer:	**1**
Method:	ASTM D 2435 Method B
Project No. :	230230
Client:	ODOT
Project:	HEN-24/17D-00.43
Location:	Henry County, OH
Boring No. :	B-018-0-22
Sample No.:	ST-5
Depth:	11.0 - 13.0'
Date of Test:	5/5/2023

Visual Description:	Gray SILT and CLAY, Little Gravel, Little Sand A-6a (8)
Liquid Limit:	30 %
Plastic Limit:	18 %
Plasticity Index:	12 %

Initial Sample Data

Initial Height	1.000 in.	
Ring Dia.	2.493 in.	
Area of Ring	4.8813 in^2	
Initial Volume	4.8813 in^3	0.00282 ft^3
Specific Gravity	2.689	
Initial wet mass soil & ring	313.2 g	
Mass of ring	146.3 g	
Initial wet mass soil	166.9 g	0.36795 lb

Final Sample Data

Final Height	0.932 in.	
Ring Dia.	2.493 in.	
Area of Ring	4.8813 in^2	
Final Volume	4.5498 in^3	0.00263 ft^3
Final wet mass soil, pan & ring	364.9 g	
Wt of Pan	50.5 g	
Final wet mass soil & ring	314.4	
Mass of ring	146.3 g	
Final dry mass of soil, pan & ring	342.5 g	
Final wet mass soil	168.1 g	0.37060 lb
Weight of water	22.4 g	0.04938 lb

Initial Water Content

Mass can & wet soil	617.7 g
Mass can & dry soil	553.9 g
Mass of can	51.5 g
Mass of water	63.8 g
Mass of soil	502.4 g
Initial water content	12.70 % (trimmings)

Initial water content	14.55 % (based on final dry weight)	
Initial dry density	113.7 pcf	
Initial void ratio (eo)	0.476	
Initial volume of voids (Vvo)	1.5749 in^3	0.00091 ft^3
Initial volume of water (Vwo)	1.2937 in^3	0.00075 ft^3
Initial degree of saturation (So)	82.14 %	

Final water content	15.37 % (based on final dry weight)	
Final weight of solids (Md)	145.7 g	0.32122 lb
Final dry density	122.0 pcf	
Final volume of solids (Vs)	3.3064 in^3	0.00191 ft^3
Final height of solids (Hs)	0.6774 in.	
Final void ratio (ef)	0.376	
Final volume of voids (Vvf)	1.2434 in^3	0.00072 ft^3
Final volume of water (Vwf)	1.3669 in^3	0.00079 ft^3
Final degree of saturation (Sf)	109.93 %	

Project No. : 230230 Sample No.: ST-5
Boring No. : B-018-0-22 Depth: 11.0 - 13.0'

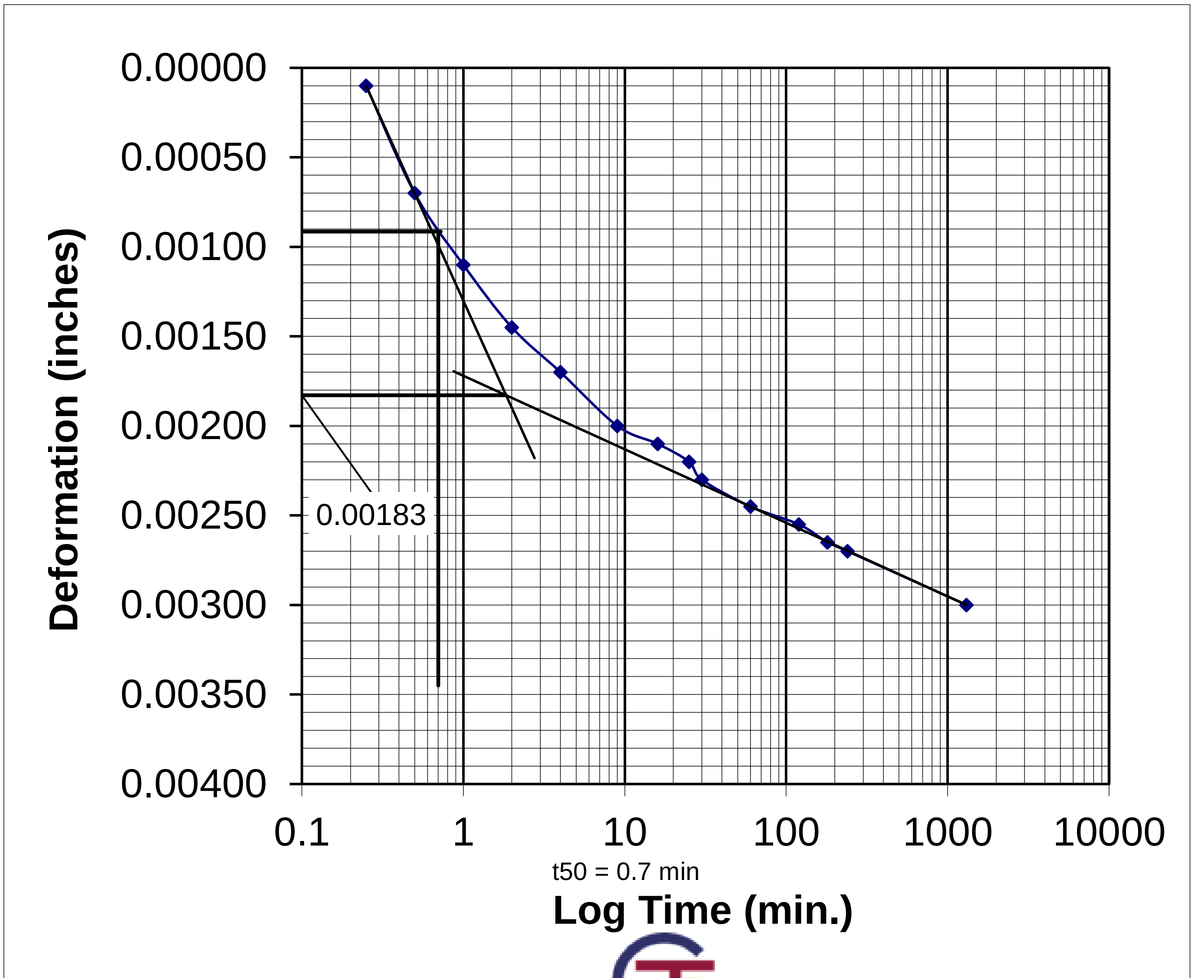
0.25 tsf Load

initial height= 1 inches

Do= D1-(D2-D1)
1) 0.25 to 1.0: -0.00090
2) 0.5 to 2.0: -0.00005
3) 1.0 to 4.0: 0.00050
Do Avg 1&2: -0.00048
Do Avg 1-3: -0.00015
Use Do= 0.00000
D100= 0.00183
D50= D100+0.5(Do-D100)
D50= 0.00091

t50 = 0.7 min.

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.40000				
0.25	0.39560	0.00440	0.00430	0.00010	0.99990
0.5	0.39500	0.00500	0.00430	0.00070	0.99930
1	0.39460	0.00540	0.00430	0.00110	0.99890
2	0.39425	0.00575	0.00430	0.00145	0.99855
4	0.39400	0.00600	0.00430	0.00170	0.99830
9	0.39370	0.00630	0.00430	0.00200	0.99800
16	0.39360	0.00640	0.00430	0.00210	0.99790
25	0.39350	0.00650	0.00430	0.00220	0.99780
30	0.39340	0.00660	0.00430	0.00230	0.99770
60	0.39325	0.00675	0.00430	0.00245	0.99755
120	0.39315	0.00685	0.00430	0.00255	0.99745
180	0.39305	0.00695	0.00430	0.00265	0.99735
240	0.39300	0.00700	0.00430	0.00270	0.99730
1310	0.39270	0.00730	0.00430	0.00300	0.99700



Project No. : 230230　　Sample No.: ST-5
Boring No. : B-018-0-22　　Depth: 11.0 - 13.0'

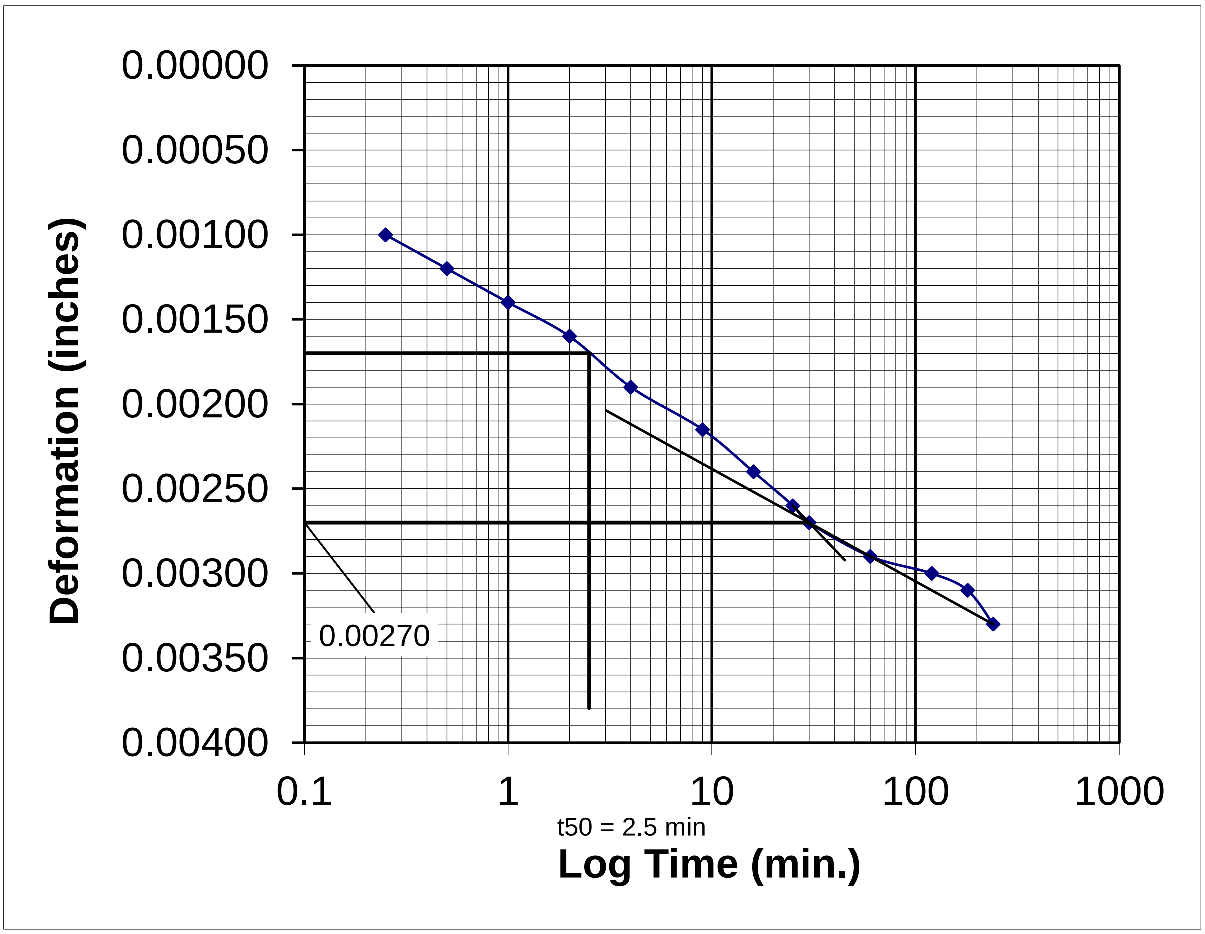
0.5 tsf Load

initial height= 0.997 inches

Do= D1-(D2-D1)
1) 0.25 to 1.0: 0.00060
2) 0.5 to 2.0: 0.00080
3) 1.0 to 4.0: 0.00090
Do Avg 1&2: 0.00070
Do Avg 1-3: 0.00077
Use Do= 0.00070
D100= 0.00270
D50= D100+0.5(Do-D100)
D50= 0.00170

t50 = 2.5 min.

Interval Minutes	**Dial Reading**	**ΔH**	**Deformation Constant**	**TRUE ΔH**	**Height of Sample**
0	0.39270				
0.25	0.39170	0.00100	0.00000	0.00100	0.99600
0.5	0.39150	0.00120	0.00000	0.00120	0.99580
1	0.39130	0.00140	0.00000	0.00140	0.99560
2	0.39110	0.00160	0.00000	0.00160	0.99540
4	0.39080	0.00190	0.00000	0.00190	0.99510
9	0.39055	0.00215	0.00000	0.00215	0.99485
16	0.39030	0.00240	0.00000	0.00240	0.99460
25	0.39010	0.00260	0.00000	0.00260	0.99440
30	0.39000	0.00270	0.00000	0.00270	0.99430
60	0.38980	0.00290	0.00000	0.00290	0.99410
120	0.38970	0.00300	0.00000	0.00300	0.99400
180	0.38960	0.00310	0.00000	0.00310	0.99390
240	0.38940	0.00330	0.00000	0.00330	0.99370



Project No. : 230230 Sample No.: ST-5
Boring No. : B-018-0-22 Depth: 11.0 - 13.0'

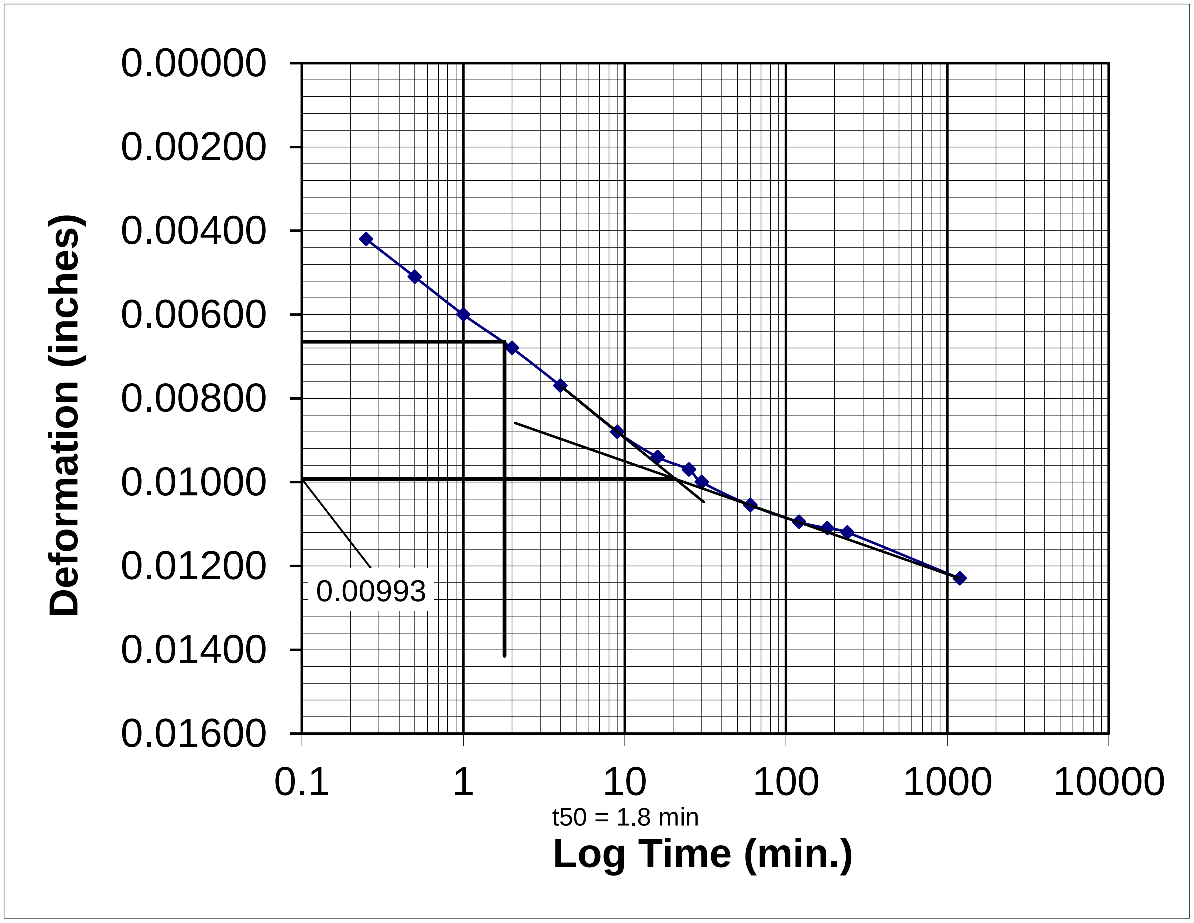
1.0 tsf Load

initial height= 0.9937 inches

Do= D1-(D2-D1)
1) 0.25 to 1.0: 0.00240
2) 0.5 to 2.0: 0.00340
3) 1.0 to 4.0: 0.00430
Do Avg 1&2: 0.00290
Do Avg 1-3: 0.00337
Use Do= 0.00337
D100= 0.00993
D50= D100+0.5(Do-D100)
D50= 0.00665

t50 = 1.8 min.

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.38940				
0.25	0.38270	0.00670	0.00250	0.00420	0.98950
0.5	0.38180	0.00760	0.00250	0.00510	0.98860
1	0.38090	0.00850	0.00250	0.00600	0.98770
2	0.38010	0.00930	0.00250	0.00680	0.98690
4	0.37920	0.01020	0.00250	0.00770	0.98600
9	0.37810	0.01130	0.00250	0.00880	0.98490
16	0.37750	0.01190	0.00250	0.00940	0.98430
25	0.37720	0.01220	0.00250	0.00970	0.98400
30	0.37690	0.01250	0.00250	0.01000	0.98370
60	0.37635	0.01305	0.00250	0.01055	0.98315
120	0.37595	0.01345	0.00250	0.01095	0.98275
180	0.37580	0.01360	0.00250	0.01110	0.98260
240	0.37570	0.01370	0.00250	0.01120	0.98250
1195	0.37460	0.01480	0.00250	0.01230	0.98140



Project No. : 230230 Sample No.: ST-5
Boring No. : B-018-0-22 Depth: 11.0 - 13.0'

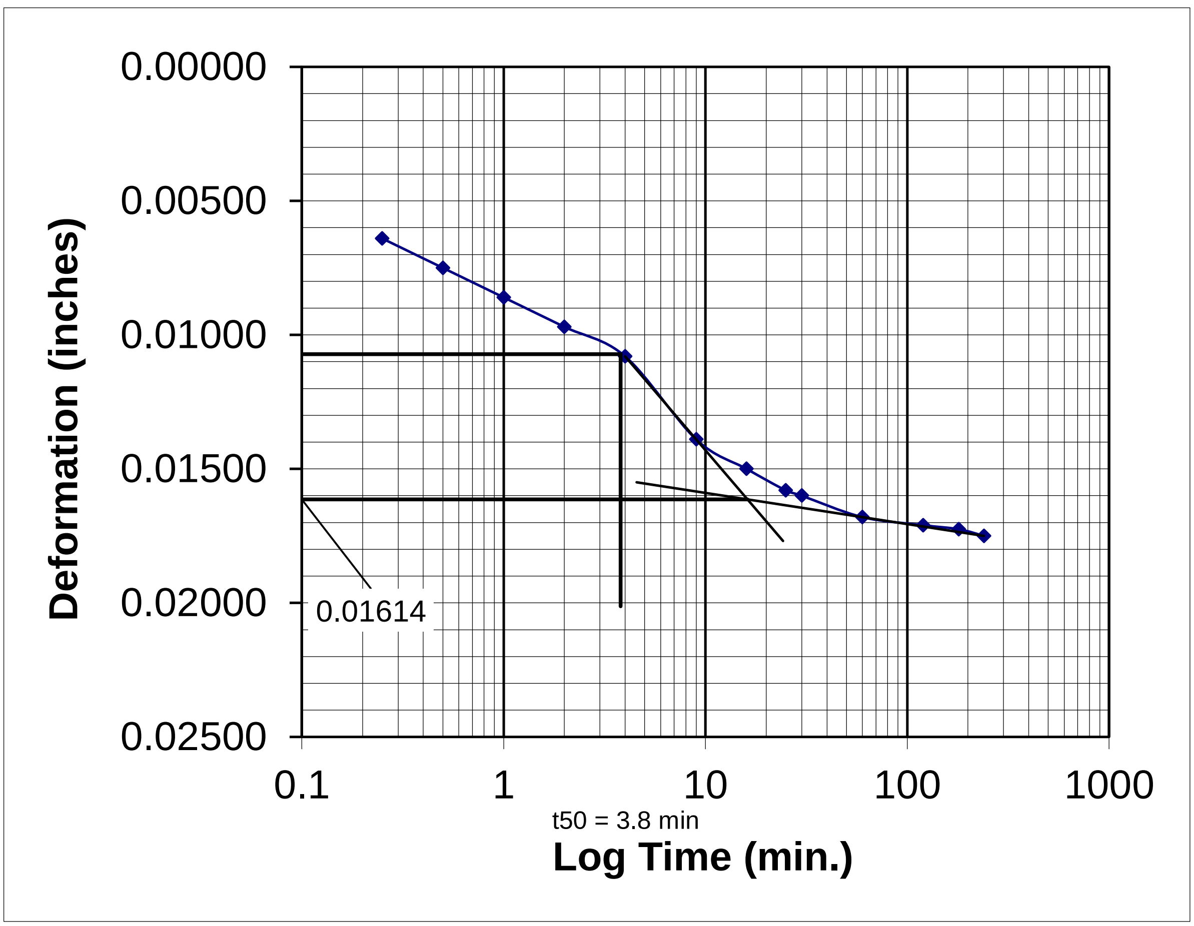
2.0 tsf Load

initial height= 0.9814 inches

Do= D1-(D2-D1)
1) 0.25 to 1.0: 0.00420
2) 0.5 to 2.0: 0.00530
3) 1.0 to 4.0: 0.00640
Do Avg 1&2: 0.00475
Do Avg 1-3: 0.00530
Use Do= 0.00530
D100= 0.01614
D50= D100+0.5(Do-D100)
D50= 0.01072

t50 = 3.8 min.

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.37460				
0.25	0.36530	0.00930	0.00290	0.00640	0.97500
0.5	0.36420	0.01040	0.00290	0.00750	0.97390
1	0.36310	0.01150	0.00290	0.00860	0.97280
2	0.36200	0.01260	0.00290	0.00970	0.97170
4	0.36090	0.01370	0.00290	0.01080	0.97060
9	0.35780	0.01680	0.00290	0.01390	0.96750
16	0.35670	0.01790	0.00290	0.01500	0.96640
25	0.35590	0.01870	0.00290	0.01580	0.96560
30	0.35570	0.01890	0.00290	0.01600	0.96540
60	0.35490	0.01970	0.00290	0.01680	0.96460
120	0.35460	0.02000	0.00290	0.01710	0.96430
180	0.35445	0.02015	0.00290	0.01725	0.96415
240	0.35420	0.02040	0.00290	0.01750	0.96390



Project No. : 230230 Sample No.: ST-5
Boring No. : B-018-0-22 Depth: 11.0 - 13.0'

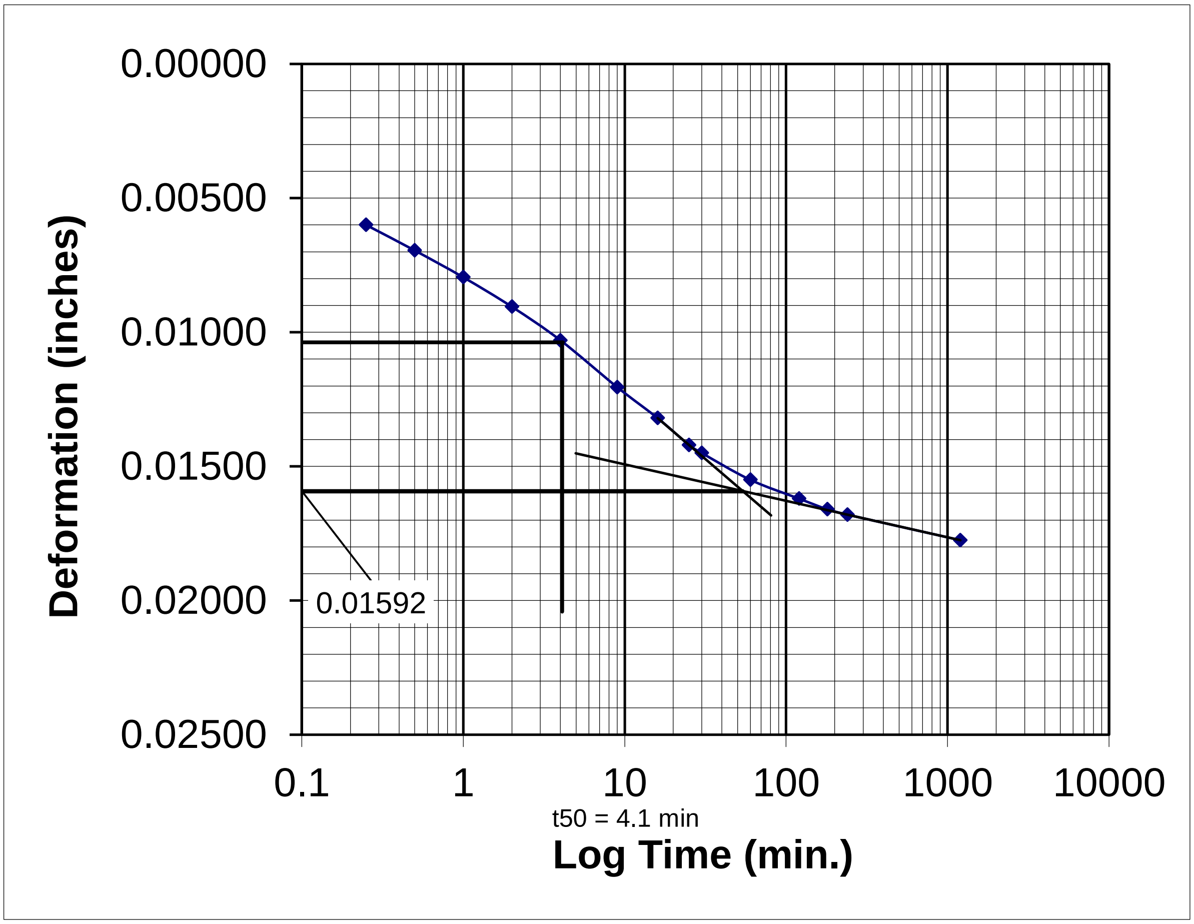
4.0 tsf Load

initial height= 0.9639 inches

Do= D1-(D2-D1)
1) 0.25 to 1.0: 0.00405
2) 0.5 to 2.0: 0.00485
3) 1.0 to 4.0: 0.00560
Do Avg 1&2: 0.00445
Do Avg 1-3: 0.00483
Use Do= 0.00483
D100= 0.01592
D50= **D100+0.5(Do-D100)**
D50= 0.01038

t50 = 4.1 min.

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.35420				
0.25	0.34560	0.00860	0.00260	0.00600	0.95790
0.5	0.34465	0.00955	0.00260	0.00695	0.95695
1	0.34365	0.01055	0.00260	0.00795	0.95595
2	0.34255	0.01165	0.00260	0.00905	0.95485
4	0.34130	0.01290	0.00260	0.01030	0.95360
9	0.33955	0.01465	0.00260	0.01205	0.95185
16	0.33840	0.01580	0.00260	0.01320	0.95070
25	0.33740	0.01680	0.00260	0.01420	0.94970
30	0.33710	0.01710	0.00260	0.01450	0.94940
60	0.33610	0.01810	0.00260	0.01550	0.94840
120	0.33540	0.01880	0.00260	0.01620	0.94770
180	0.33500	0.01920	0.00260	0.01660	0.94730
240	0.33480	0.01940	0.00260	0.01680	0.94710
1200	0.33385	0.02035	0.00260	0.01775	0.94615



Project No. : 230230
Boring No. : B-018-0-22

Sample No.: ST-5
Depth: 11.0 - 13.0'

8.0 tsf Load

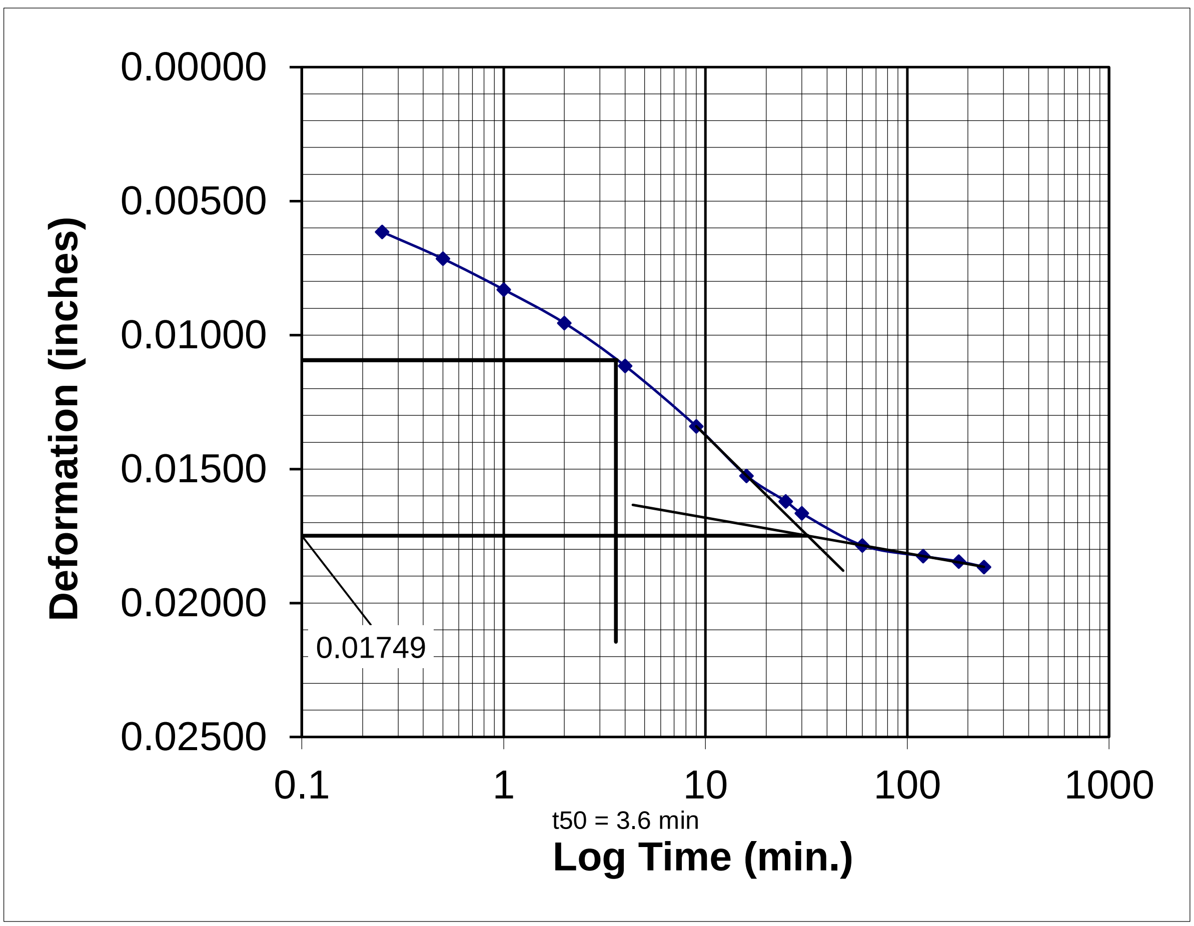
initial height= 0.94615 inches

Do= D1-(D2-D1)
1) 0.25 to 1.0: 0.00400
2) 0.5 to 2.0: 0.00475
3) 1.0 to 4.0: 0.00545
Do Avg 1&2: 0.00437
Do Avg 1-3: 0.00473

Use Do= 0.00437
D100= 0.01749
D50= **D100+0.5(Do-D100)**
D50= 0.01093

t50 = 3.6 min.

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.33385				
0.25	0.32550	0.00835	0.00220	0.00615	0.94000
0.5	0.32450	0.00935	0.00220	0.00715	0.93900
1	0.32335	0.01050	0.00220	0.00830	0.93785
2	0.32210	0.01175	0.00220	0.00955	0.93660
4	0.32050	0.01335	0.00220	0.01115	0.93500
9	0.31825	0.01560	0.00220	0.01340	0.93275
16	0.31640	0.01745	0.00220	0.01525	0.93090
25	0.31545	0.01840	0.00220	0.01620	0.92995
30	0.31500	0.01885	0.00220	0.01665	0.92950
60	0.31380	0.02005	0.00220	0.01785	0.92830
120	0.31340	0.02045	0.00220	0.01825	0.92790
180	0.31320	0.02065	0.00220	0.01845	0.92770
240	0.31300	0.02085	0.00220	0.01865	0.92750



Project No. : 230230
Boring No. : B-018-0-22

Sample No.: ST-5
Depth: 11.0 - 13.0'

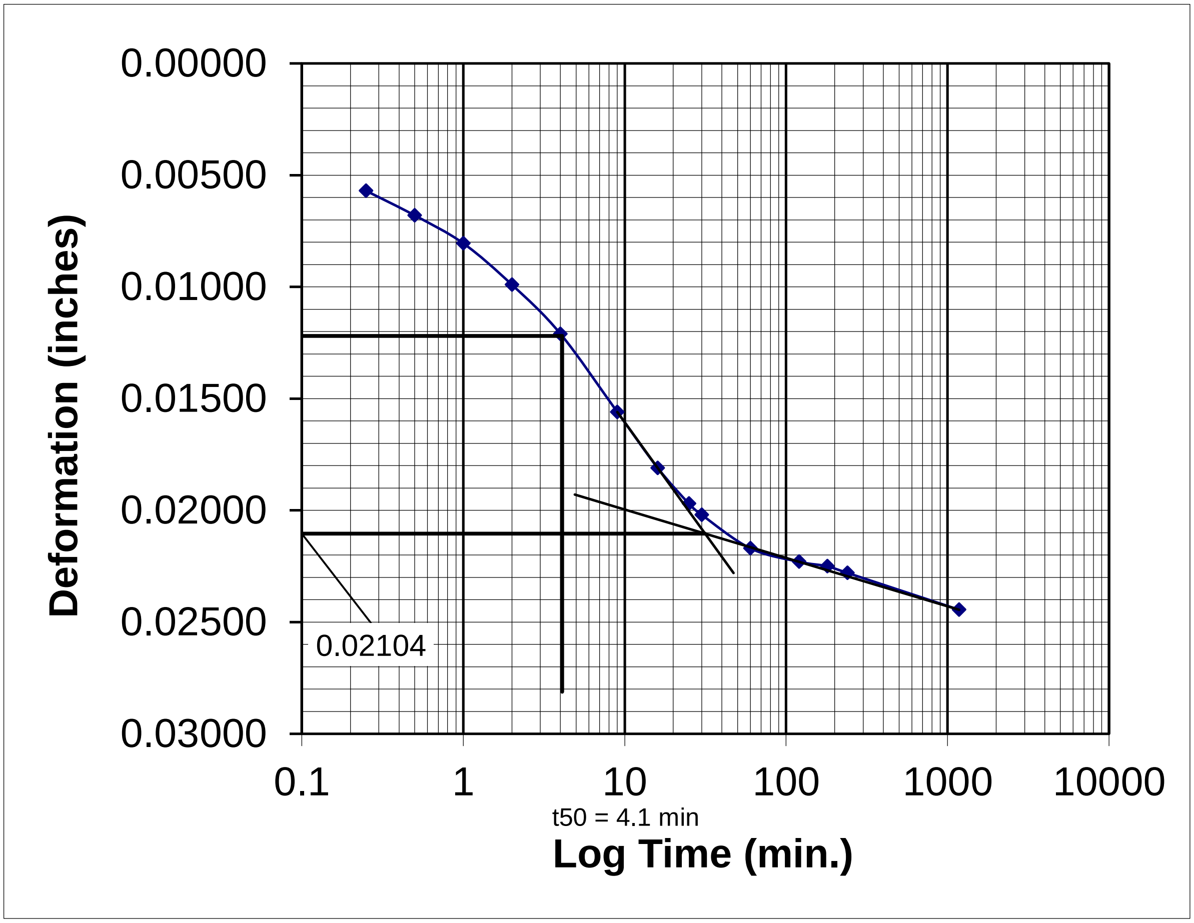
16 tsf Load

initial height= 0.9275 inches

Do= D1-(D2-D1)

1) 0.25 to 1.0:	0.00335
2) 0.5 to 2.0:	0.00370
3) 1.0 to 4.0:	0.00400
Do Avg 1&2:	0.00352
Do Avg 1-3:	0.00368
Use Do=	0.00335
D100=	0.02104
D50=	**D100+0.5(Do-D100)**
D50=	0.01220
t50 =	4.1 min.

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.31300				
0.25	0.30540	0.00760	0.00190	0.00570	0.92180
0.5	0.30430	0.00870	0.00190	0.00680	0.92070
1	0.30305	0.00995	0.00190	0.00805	0.91945
2	0.30120	0.01180	0.00190	0.00990	0.91760
4	0.29900	0.01400	0.00190	0.01210	0.91540
9	0.29550	0.01750	0.00190	0.01560	0.91190
16	0.29300	0.02000	0.00190	0.01810	0.90940
25	0.29140	0.02160	0.00190	0.01970	0.90780
30	0.29090	0.02210	0.00190	0.02020	0.90730
60	0.28940	0.02360	0.00190	0.02170	0.90580
120	0.28880	0.02420	0.00190	0.02230	0.90520
180	0.28860	0.02440	0.00190	0.02250	0.90500
240	0.28830	0.02470	0.00190	0.02280	0.90470
1180	0.28665	0.02635	0.00190	0.02445	0.90305



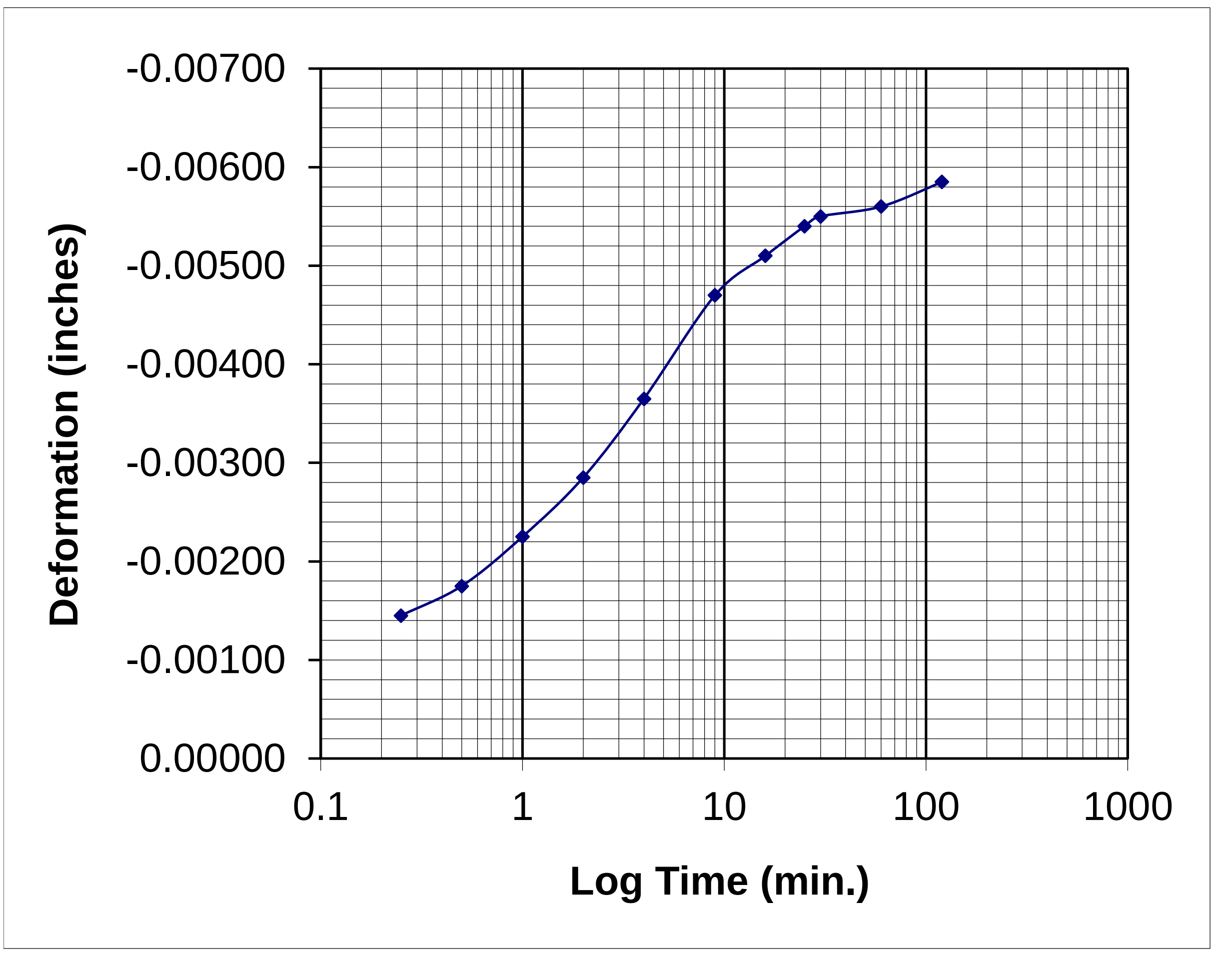
Project No. : 230230
Boring No. : B-018-0-22

Sample No.: ST-5
Depth: 11.0 - 13.0'

4.0 tsf Unload

initial height= 0.90305 inches

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.28665				
0.25	0.28940	-0.00275	-0.00130	-0.00145	0.90450
0.5	0.28970	-0.00305	-0.00130	-0.00175	0.90480
1	0.29020	-0.00355	-0.00130	-0.00225	0.90530
2	0.29080	-0.00415	-0.00130	-0.00285	0.90590
4	0.29160	-0.00495	-0.00130	-0.00365	0.90670
9	0.29265	-0.00600	-0.00130	-0.00470	0.90775
16	0.29305	-0.00640	-0.00130	-0.00510	0.90815
25	0.29335	-0.00670	-0.00130	-0.00540	0.90845
30	0.29345	-0.00680	-0.00130	-0.00550	0.90855
60	0.29355	-0.00690	-0.00130	-0.00560	0.90865
120	0.29380	-0.00715	-0.00130	-0.00585	0.90890

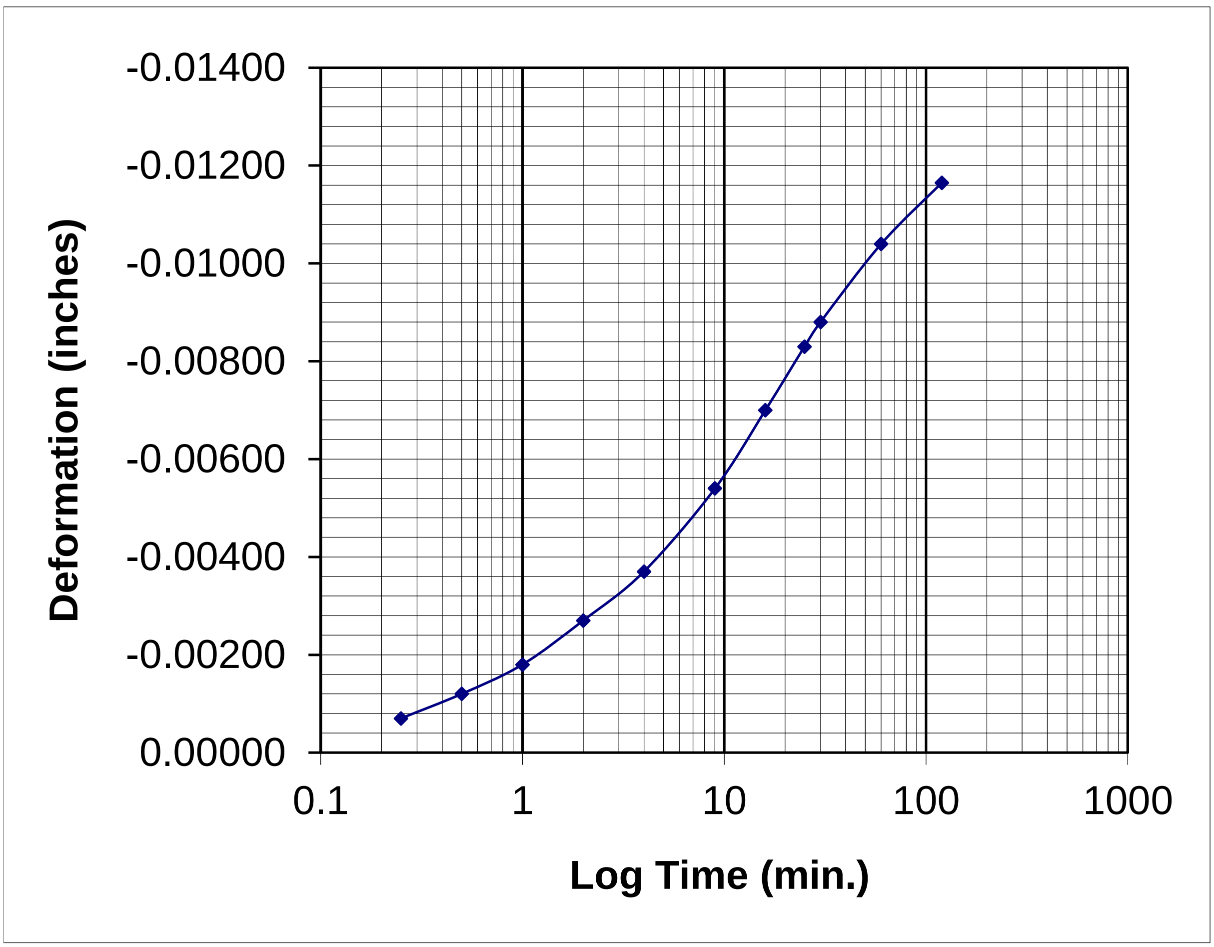


Project No. : 230230 Sample No.: ST-5
Boring No. : B-018-0-22 Depth: 11.0 - 13.0'

1.0 tsf Unload

initial height= 0.9089 inches

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.29380				
0.25	0.29640	-0.00260	-0.00190	-0.00070	0.90960
0.5	0.29690	-0.00310	-0.00190	-0.00120	0.91010
1	0.29750	-0.00370	-0.00190	-0.00180	0.91070
2	0.29840	-0.00460	-0.00190	-0.00270	0.91160
4	0.29940	-0.00560	-0.00190	-0.00370	0.91260
9	0.30110	-0.00730	-0.00190	-0.00540	0.91430
16	0.30270	-0.00890	-0.00190	-0.00700	0.91590
25	0.30400	-0.01020	-0.00190	-0.00830	0.91720
30	0.30450	-0.01070	-0.00190	-0.00880	0.91770
60	0.30610	-0.01230	-0.00190	-0.01040	0.91930
120	0.30735	-0.01355	-0.00190	-0.01165	0.92055

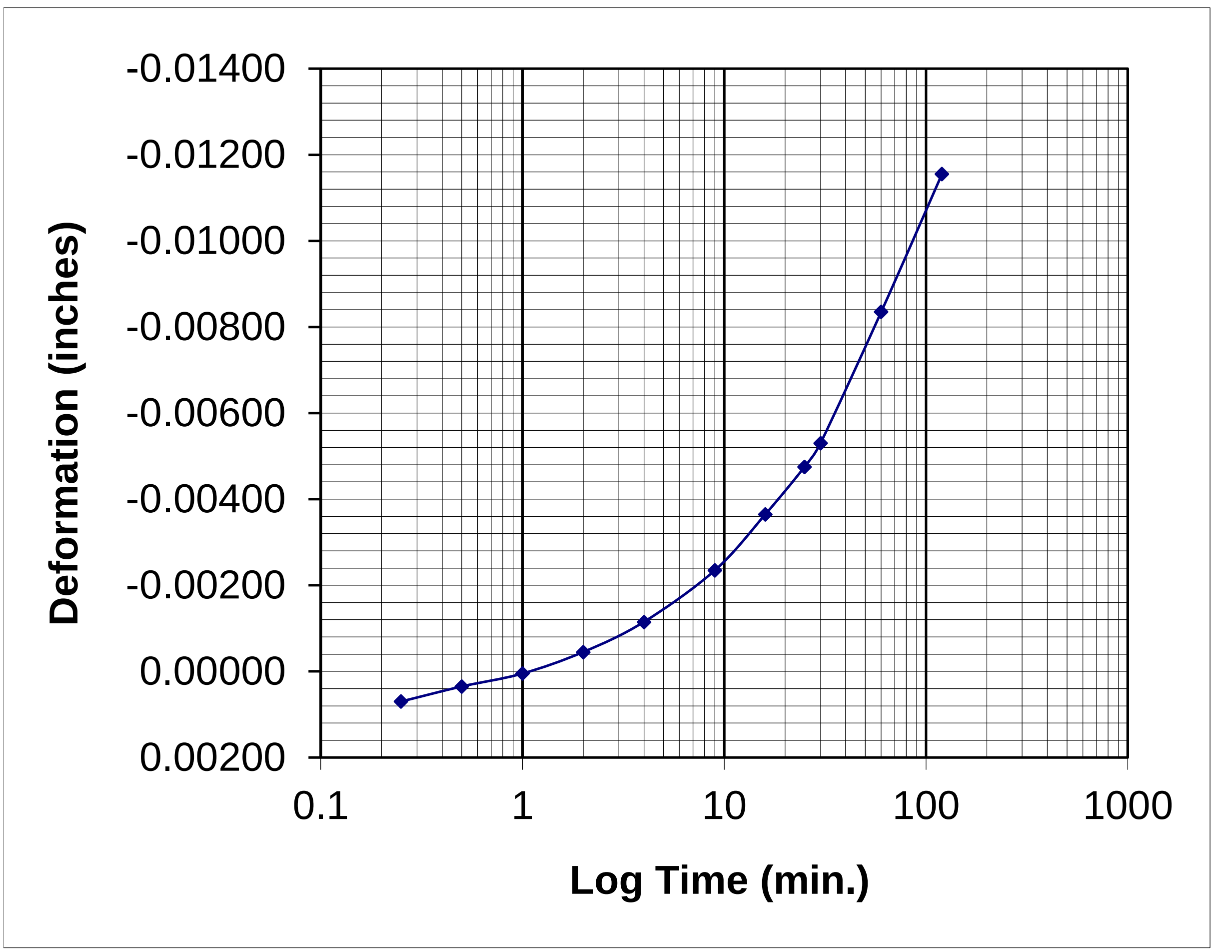


Project No. : 230230 Sample No.: ST-5
Boring No. : B-018-0-22 Depth: 11.0 - 13.0'

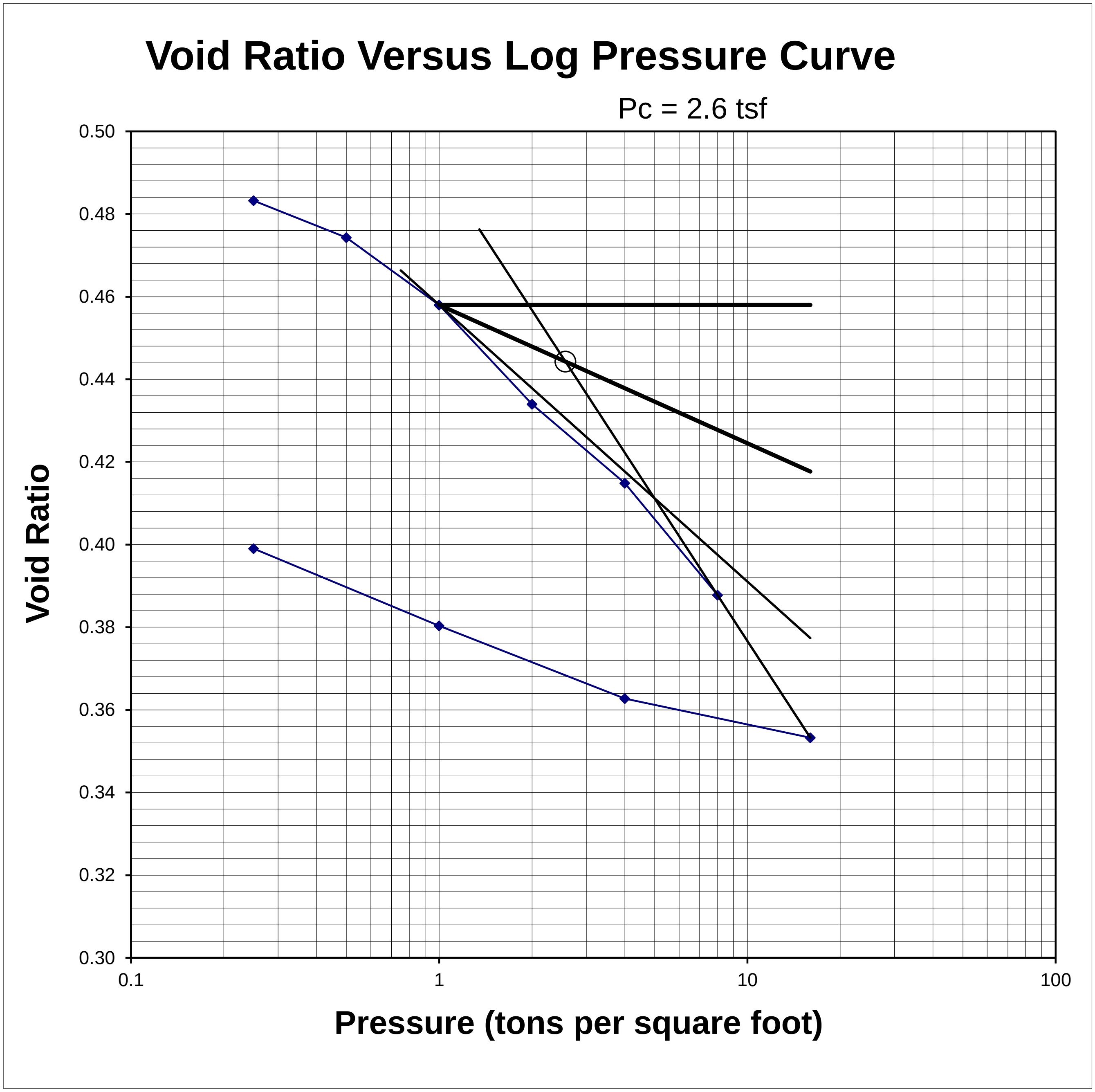
0.25 tsf Unload

initial height= 0.92055 inches

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.30735				
0.25	0.30865	-0.00130	-0.00200	0.00070	0.91985
0.5	0.30900	-0.00165	-0.00200	0.00035	0.92020
1	0.30930	-0.00195	-0.00200	0.00005	0.92050
2	0.30980	-0.00245	-0.00200	-0.00045	0.92100
4	0.31050	-0.00315	-0.00200	-0.00115	0.92170
9	0.31170	-0.00435	-0.00200	-0.00235	0.92290
16	0.31300	-0.00565	-0.00200	-0.00365	0.92420
25	0.31410	-0.00675	-0.00200	-0.00475	0.92530
30	0.31465	-0.00730	-0.00200	-0.00530	0.92585
60	0.31770	-0.01035	-0.00200	-0.00835	0.92890
120	0.32090	-0.01355	-0.00200	-0.01155	0.93210



Project No.: 230230
Date: 5/5/2023
Client: ODOT
Project: HEN-24/17D-00.43
Henry County, OH
Boring No.: B-020-0-22
Sample No.: ST-9
Depth: 21.0 - 23.0'



Project No.:	230230
Date:	5/5/2023
Client:	ODOT
Project:	HEN-24/17D-00.43
	Henry County, OH
Boring No.:	B-020-0-22
Sample No.:	ST-9
Depth:	21.0 - 23.0'

Initial H= 1 inches

Pressure tsf	Final Height (in)	Initial Height (in)	DH	Average H (in)	e	t50 (min)	Ave P (tsf)	Cv (in2/s)	Cv (ft2/d)
0.25	0.99350	1.00000	0.00650	0.9968	0.483	6.5	0.125	0.000126	0.075
0.5	0.98750	0.99350	0.01250	0.9905	0.474	3.2	0.375	0.000252	0.151
1	0.97660	0.98750	0.02340	0.9821	0.458	2.6	0.75	0.000306	0.184
2	0.96050	0.97660	0.03950	0.9686	0.434	3.2	1.5	0.000244	0.146
4	0.94770	0.96050	0.05230	0.9541	0.415	5.1	3	0.000145	0.087
8	0.92955	0.94770	0.07045	0.9386	0.388	3.6	6	0.000202	0.121
16	0.90645	0.92955	0.09355	0.9180	0.353	4.1	12	0.000167	0.100
4	0.91280	0.90645	0.08720	0.9096	0.363		10		
1	0.92460	0.91280	0.07540	0.9187	0.380		2.5		
0.25	0.93710	0.92460	0.06290	0.9309	0.399		0.625		

Estimated Cc: 0.115
Estimated Cr: 0.025

Soil Description:	Gray SILT and CLAY, Little Sand, Trace Gravel A-6a (9)
Specific Gravity:	2.723
Liquid Limit:	31
Plastic Limit:	19
Plasticity Index:	12

Initial Water Content:	16.2 %	Final Water Content:	15.8 %
Inital Dry Density:	113.9 pcf	Final Dry Density:	121.5 pcf
Initial Void Ratio:	0.493	Final Void Ratio:	0.399
Initial Degree of Saturation:	89.7 %	Final Degree of Saturation	107.6 %

Estimated Preconsolidation Pressure: 2.6 tsf

The sample for the test was trimmed from a Shelby tube sample using a cutting shoe. Test Method B was used with the specimen inundated during testing. Coefficients of consolidation were computed by log of time method.

Consolidation Laboratory Calculations

Consolidometer: **2**

Method:	ASTM D 2435 Method B
Project No. :	230230
Client:	ODOT
Project:	HEN-24/17D-00.43
Location:	Henry County, OH
Boring No. :	B-020-0-22
Sample No.:	ST-9
Depth:	21.0 - 23.0'
Date of Test:	5/5/2023

Visual Description:	Gray SILT and CLAY, Little Sand, Trace Gravel A-6a (9)
Liquid Limit:	31 %
Plastic Limit:	19 %
Plasticity Index:	12 %

Initial Sample Data

Initial Height	1.000 in.	
Ring Dia.	2.493 in.	
Area of Ring	4.8813 in^2	
Initial Volume	4.8813 in^3	0.00282 ft^3
Specific Gravity	2.723	
Initial wet mass soil & ring	314.3 g	
Mass of ring	144.7 g	
Initial wet mass soil	169.6 g	0.37391 lb

Final Sample Data

Final Height	0.937 in.	
Ring Dia.	2.493 in.	
Area of Ring	4.8813 in^2	
Final Volume	4.5743 in^3	0.00265 ft^3
Final wet mass soil, pan & ring	364.8 g	
Wt of Pan	51.2 g	
Final wet mass soil & ring	313.6	
Mass of ring	144.7 g	
Final dry mass of soil, pan & ring	341.8 g	
Final wet mass soil	168.9 g	0.37236 lb
Weight of water	23.0 g	0.05071 lb

Initial Water Content

Mass can & wet soil	657.7 g
Mass can & dry soil	570 g
Mass of can	50.1 g
Mass of water	87.7 g
Mass of soil	519.9 g
Initial water content	16.87 % (trimmings)

Initial water content	16.24 % (based on final dry weight)	
Initial dry density	113.9 pcf	
Initial void ratio (eo)	0.493	
Initial volume of voids (Vvo)	1.6117 in^3	0.00093 ft^3
Initial volume of water (Vwo)	1.4462 in^3	0.00084 ft^3
Initial degree of saturation (So)	89.73 %	

Final water content	15.76 % (based on final dry weight)	
Final weight of solids (Md)	145.9 g	0.32166 lb
Final dry density	121.5 pcf	
Final volume of solids (Vs)	3.2696 in^3	0.00189 ft^3
Final height of solids (Hs)	0.6698 in.	
Final void ratio (ef)	0.399	
Final volume of voids (Vvf)	1.3047 in^3	0.00076 ft^3
Final volume of water (Vwf)	1.4035 in^3	0.00081 ft^3
Final degree of saturation (Sf)	107.58 %	

LEADING THROUGH the next 100 years

Project No. : 230230 Sample No.: ST-9
Boring No. : B-020-0-22 Depth: 21.0 - 23.0'

Do= D1-(D2-D1)
1) 0.25 to 1.0: 0.00030
2) 0.5 to 2.0: 0.00065
3) 1.0 to 4.0: 0.00080
Do Avg 1&2: 0.00048
Do Avg 1-3: 0.00058

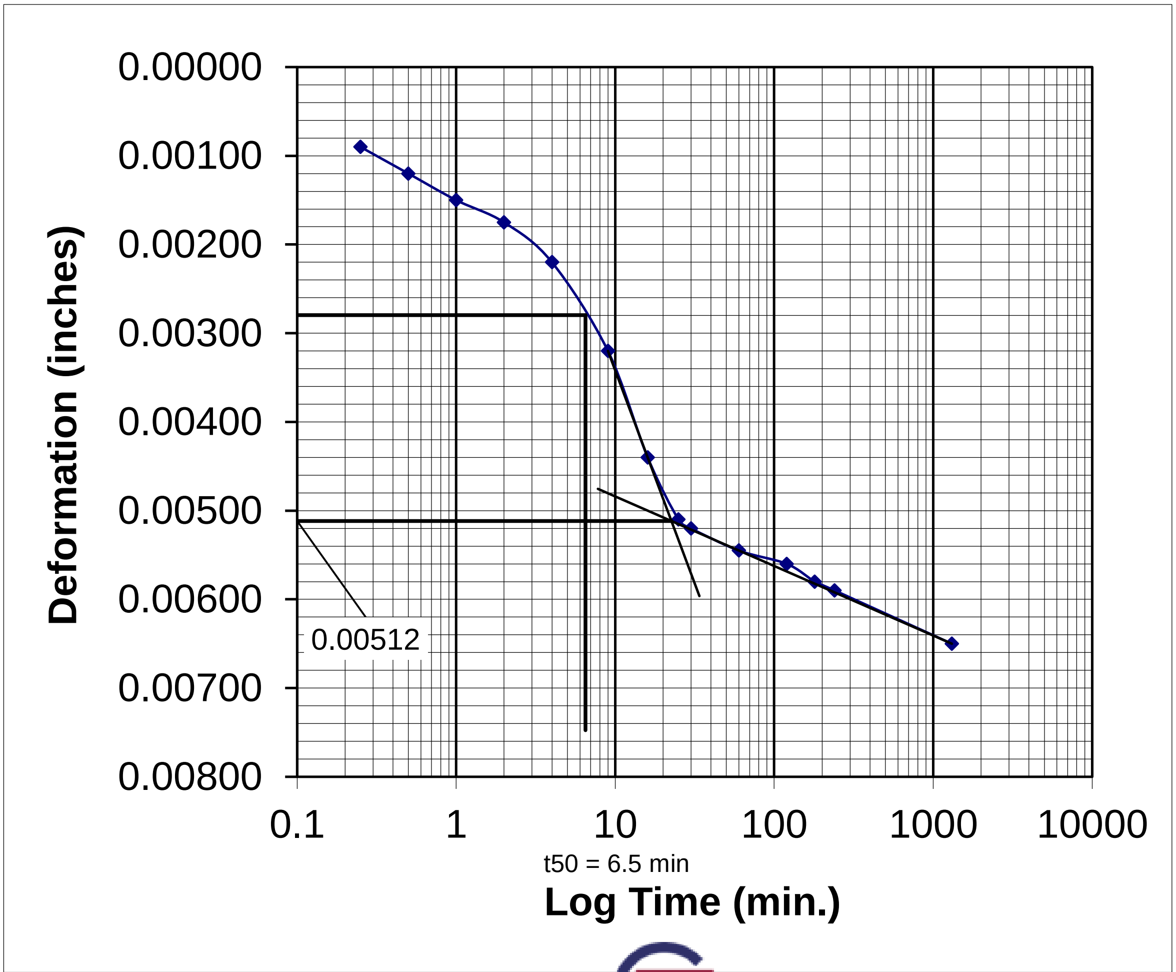
0.25 tsf Load

initial height= 1 inches

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.39860				
0.25	0.39670	0.00190	0.00100	0.00090	0.99910
0.5	0.39640	0.00220	0.00100	0.00120	0.99880
1	0.39610	0.00250	0.00100	0.00150	0.99850
2	0.39585	0.00275	0.00100	0.00175	0.99825
4	0.39540	0.00320	0.00100	0.00220	0.99780
9	0.39440	0.00420	0.00100	0.00320	0.99680
16	0.39320	0.00540	0.00100	0.00440	0.99560
25	0.39250	0.00610	0.00100	0.00510	0.99490
30	0.39240	0.00620	0.00100	0.00520	0.99480
60	0.39215	0.00645	0.00100	0.00545	0.99455
120	0.39200	0.00660	0.00100	0.00560	0.99440
180	0.39180	0.00680	0.00100	0.00580	0.99420
240	0.39170	0.00690	0.00100	0.00590	0.99410
1310	0.39110	0.00750	0.00100	0.00650	0.99350

Use Do= 0.00048
D100= 0.00512
D50= D100+0.5(Do-D100)
D50= 0.00280

t50 = 6.5 min.



Project No. : 230230　　Sample No.: ST-9
Boring No. : B-020-0-22　　Depth: 21.0 - 23.0'

0.5 tsf Load

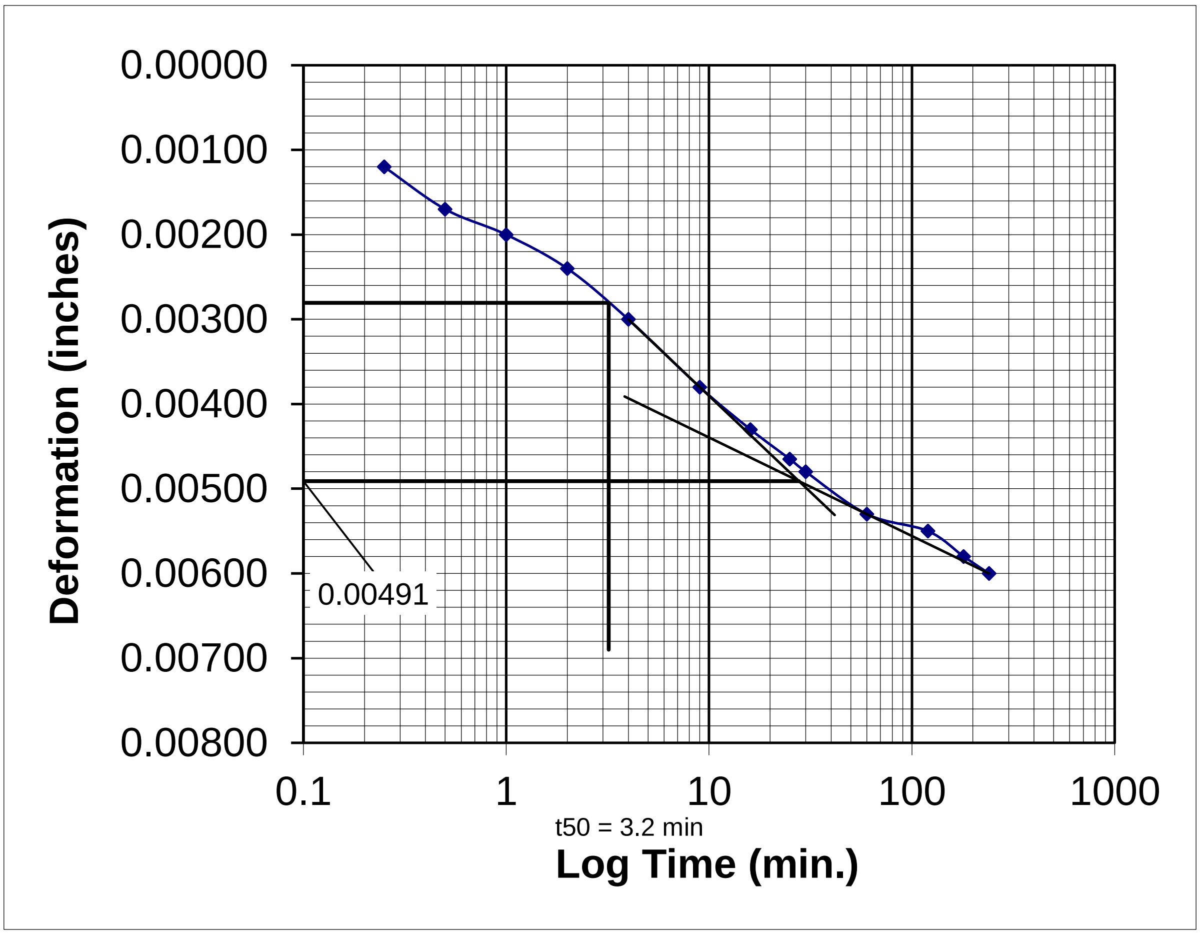
initial height= 0.9935 inches

Do= D1-(D2-D1)
1) 0.25 to 1.0: 0.00040
2) 0.5 to 2.0: 0.00100
3) 1.0 to 4.0: 0.00100
Do Avg 1&2: 0.00070
Do Avg 1-3: 0.00080

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.39110				
0.25	0.38850	0.00260	0.00140	0.00120	0.99230
0.5	0.38800	0.00310	0.00140	0.00170	0.99180
1	0.38770	0.00340	0.00140	0.00200	0.99150
2	0.38730	0.00380	0.00140	0.00240	0.99110
4	0.38670	0.00440	0.00140	0.00300	0.99050
9	0.38590	0.00520	0.00140	0.00380	0.98970
16	0.38540	0.00570	0.00140	0.00430	0.98920
25	0.38505	0.00605	0.00140	0.00465	0.98885
30	0.38490	0.00620	0.00140	0.00480	0.98870
60	0.38440	0.00670	0.00140	0.00530	0.98820
120	0.38420	0.00690	0.00140	0.00550	0.98800
180	0.38390	0.00720	0.00140	0.00580	0.98770
240	0.38370	0.00740	0.00140	0.00600	0.98750

Use Do= 0.00070
D100= 0.00491
D50= D100+0.5(Do-D100)
D50= 0.00281

t50 = 3.2 min.



Project No. : 230230 Sample No.: ST-9
Boring No. : B-020-0-22 Depth: 21.0 - 23.0'

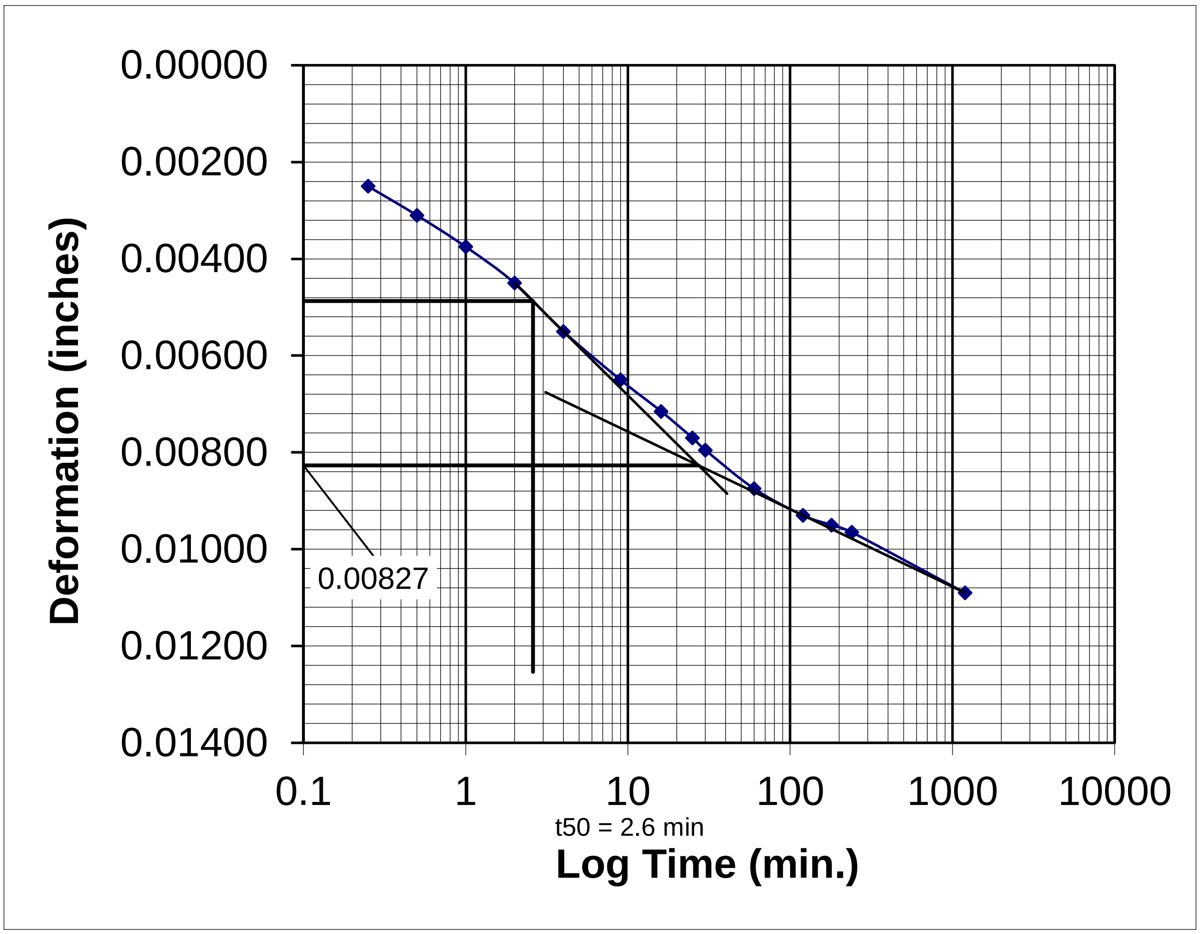
1.0 tsf Load

initial height= 0.9875 inches

Do= D1-(D2-D1)
1) 0.25 to 1.0: 0.00125
2) 0.5 to 2.0: 0.00170
3) 1.0 to 4.0: 0.00200
Do Avg 1&2: 0.00147
Do Avg 1-3: 0.00165
Use Do= 0.00147
D100= 0.00827
D50= D100+0.5(Do-D100)
D50= 0.00487

t50 = 2.6 min.

Interval Minutes	**Dial Reading**	**ΔH**	**Deformation Constant**	**TRUE ΔH**	**Height of Sample**
0	0.38370				
0.25	0.37950	0.00420	0.00170	0.00250	0.98500
0.5	0.37890	0.00480	0.00170	0.00310	0.98440
1	0.37825	0.00545	0.00170	0.00375	0.98375
2	0.37750	0.00620	0.00170	0.00450	0.98300
4	0.37650	0.00720	0.00170	0.00550	0.98200
9	0.37550	0.00820	0.00170	0.00650	0.98100
16	0.37485	0.00885	0.00170	0.00715	0.98035
25	0.37430	0.00940	0.00170	0.00770	0.97980
30	0.37405	0.00965	0.00170	0.00795	0.97955
60	0.37325	0.01045	0.00170	0.00875	0.97875
120	0.37270	0.01100	0.00170	0.00930	0.97820
180	0.37250	0.01120	0.00170	0.00950	0.97800
240	0.37235	0.01135	0.00170	0.00965	0.97785
1195	0.37110	0.01260	0.00170	0.01090	0.97660



Project No. : 230230 Sample No.: ST-9
Boring No. : B-020-0-22 Depth: 21.0 - 23.0'

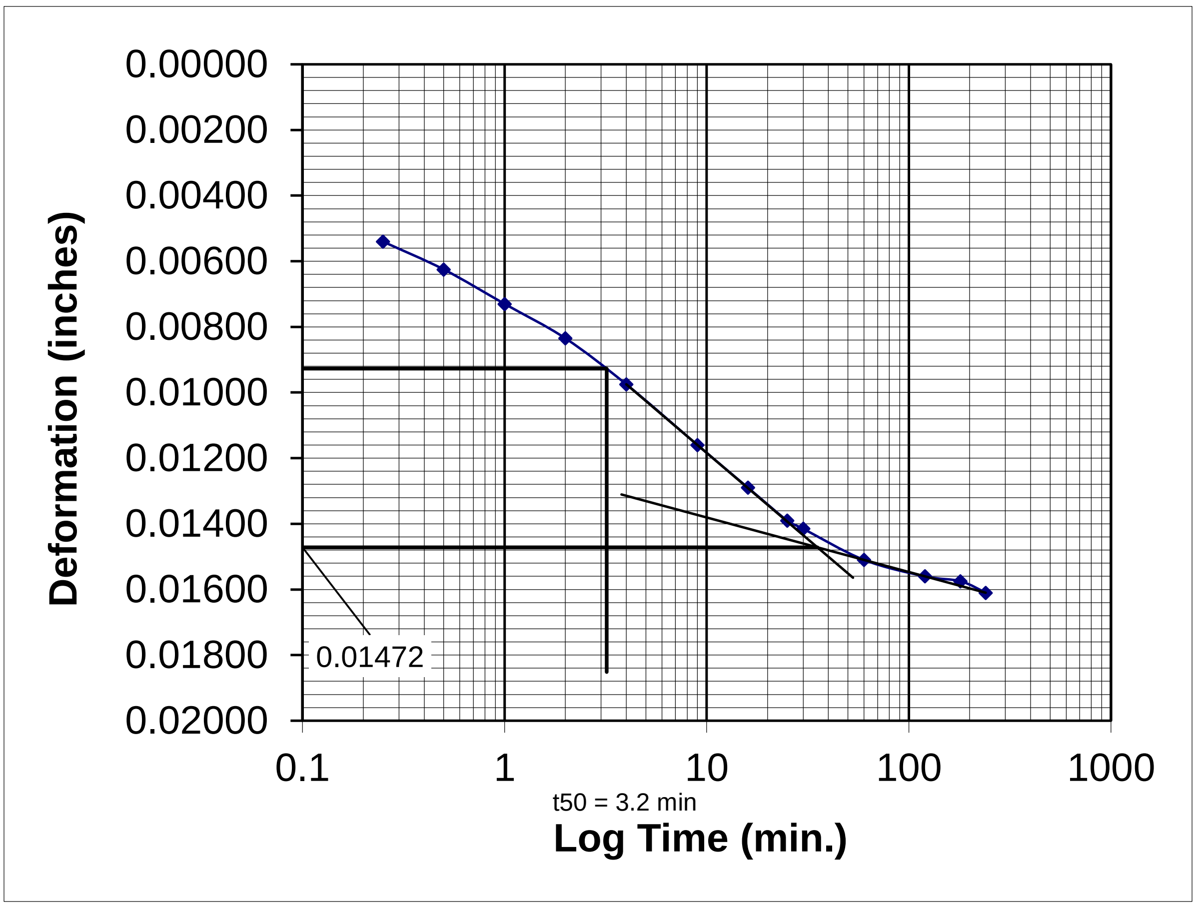
2.0 tsf Load

initial height= 0.9766 inches

Do= D1-(D2-D1)
1) 0.25 to 1.0: 0.00350
2) 0.5 to 2.0: 0.00415
3) 1.0 to 4.0: 0.00485
Do Avg 1&2: 0.00382
Do Avg 1-3: 0.00417
Use Do= 0.00382
D100= 0.01472
D50= D100+0.5(Do-D100)
D50= 0.00927

t50 = 3.2 min.

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.37110				
0.25	0.36300	0.00810	0.00270	0.00540	0.97120
0.5	0.36215	0.00895	0.00270	0.00625	0.97035
1	0.36110	0.01000	0.00270	0.00730	0.96930
2	0.36005	0.01105	0.00270	0.00835	0.96825
4	0.35865	0.01245	0.00270	0.00975	0.96685
9	0.35680	0.01430	0.00270	0.01160	0.96500
16	0.35550	0.01560	0.00270	0.01290	0.96370
25	0.35450	0.01660	0.00270	0.01390	0.96270
30	0.35425	0.01685	0.00270	0.01415	0.96245
60	0.35330	0.01780	0.00270	0.01510	0.96150
120	0.35280	0.01830	0.00270	0.01560	0.96100
180	0.35265	0.01845	0.00270	0.01575	0.96085
240	0.35230	0.01880	0.00270	0.01610	0.96050



Project No. : 230230
Boring No. : B-020-0-22

Sample No.: ST-9
Depth: 21.0 - 23.0'

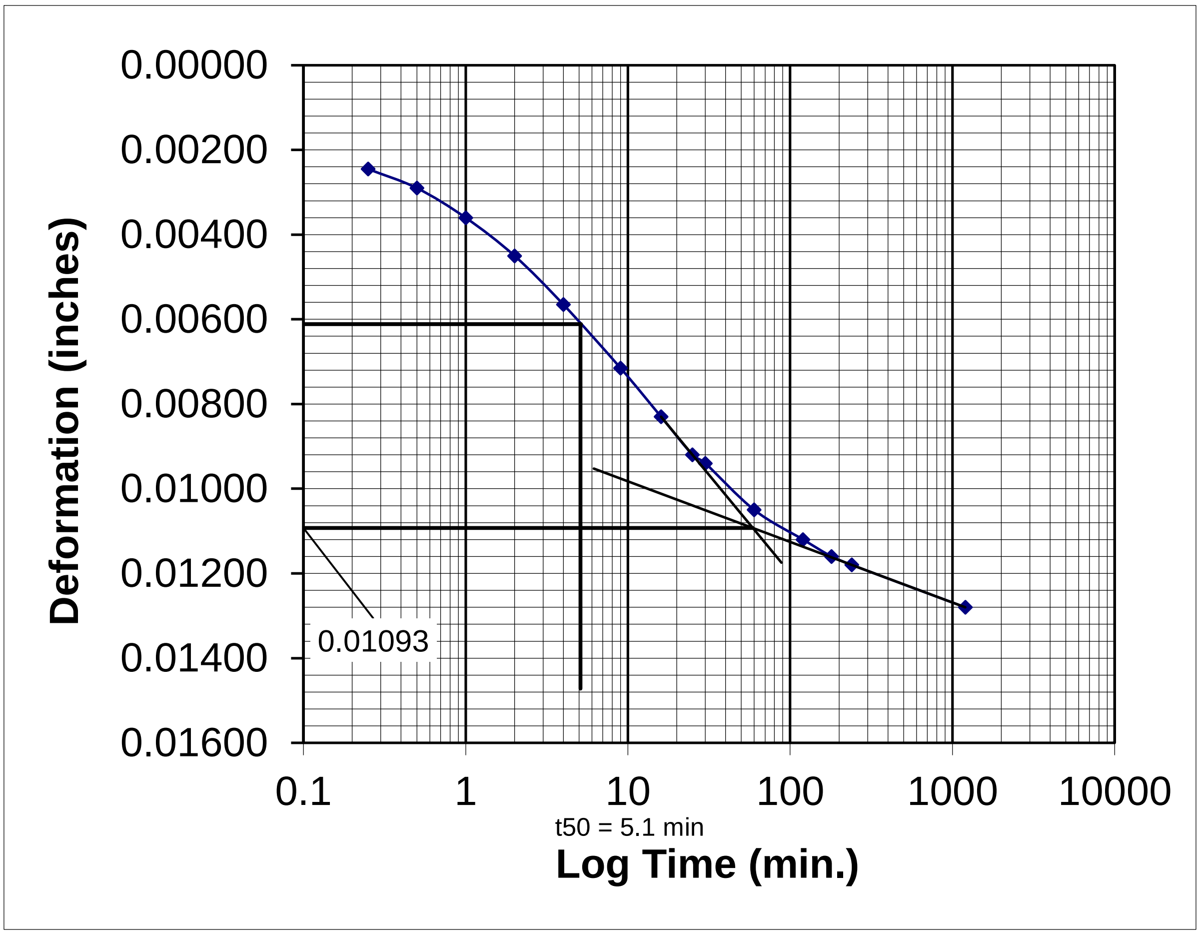
4.0 tsf Load

initial height= 0.9605 inches

Do= D1-(D2-D1)
1) 0.25 to 1.0: 0.00130
2) 0.5 to 2.0: 0.00130
3) 1.0 to 4.0: 0.00155
Do Avg 1&2: 0.00130
Do Avg 1-3: 0.00138
Use Do= 0.00130
D100= 0.01093
D50= D100+0.5(Do-D100)
D50= 0.00611

t50 = 5.1 min.

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.35230				
0.25	0.34835	0.00395	0.00150	0.00245	0.95805
0.5	0.34790	0.00440	0.00150	0.00290	0.95760
1	0.34720	0.00510	0.00150	0.00360	0.95690
2	0.34630	0.00600	0.00150	0.00450	0.95600
4	0.34515	0.00715	0.00150	0.00565	0.95485
9	0.34365	0.00865	0.00150	0.00715	0.95335
16	0.34250	0.00980	0.00150	0.00830	0.95220
25	0.34160	0.01070	0.00150	0.00920	0.95130
30	0.34140	0.01090	0.00150	0.00940	0.95110
60	0.34030	0.01200	0.00150	0.01050	0.95000
120	0.33960	0.01270	0.00150	0.01120	0.94930
180	0.33920	0.01310	0.00150	0.01160	0.94890
240	0.33900	0.01330	0.00150	0.01180	0.94870
1200	0.33800	0.01430	0.00150	0.01280	0.94770



Project No. : 230230 Sample No.: ST-9
Boring No. : B-020-0-22 Depth: 21.0 - 23.0'

8.0 tsf Load

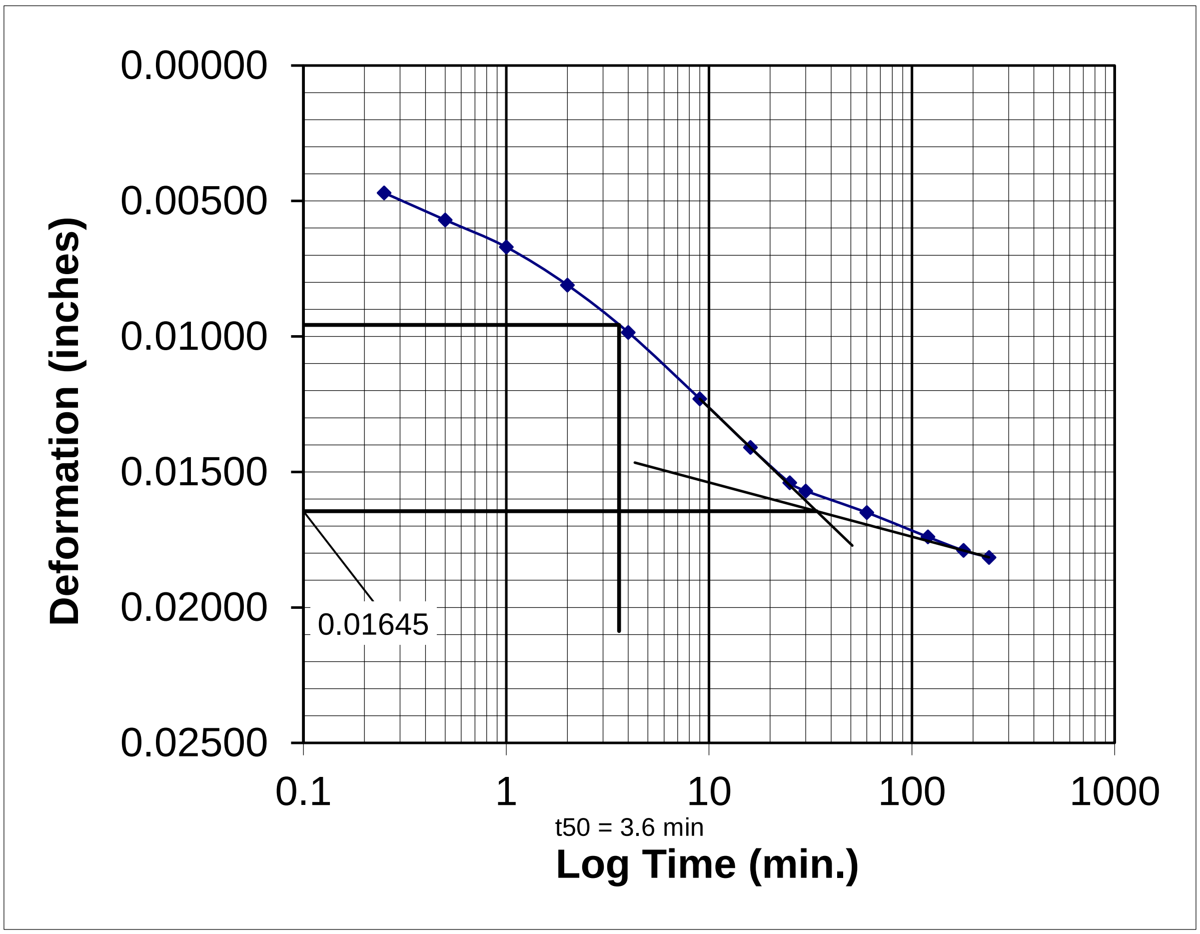
initial height= 0.94770 inches

Do= D1-(D2-D1)
1) 0.25 to 1.0: 0.00270
2) 0.5 to 2.0: 0.00330
3) 1.0 to 4.0: 0.00355
Do Avg 1&2: 0.00300
Do Avg 1-3: 0.00318

Use Do= 0.00270
D100= 0.01645
D50= D100+0.5(Do-D100)
D50= 0.00957

t50 = 3.6 min.

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.33800				
0.25	0.33150	0.00650	0.00180	0.00470	0.94300
0.5	0.33050	0.00750	0.00180	0.00570	0.94200
1	0.32950	0.00850	0.00180	0.00670	0.94100
2	0.32810	0.00990	0.00180	0.00810	0.93960
4	0.32635	0.01165	0.00180	0.00985	0.93785
9	0.32390	0.01410	0.00180	0.01230	0.93540
16	0.32210	0.01590	0.00180	0.01410	0.93360
25	0.32080	0.01720	0.00180	0.01540	0.93230
30	0.32050	0.01750	0.00180	0.01570	0.93200
60	0.31970	0.01830	0.00180	0.01650	0.93120
120	0.31880	0.01920	0.00180	0.01740	0.93030
180	0.31830	0.01970	0.00180	0.01790	0.92980
240	0.31805	0.01995	0.00180	0.01815	0.92955



Project No. : 230230 Sample No.: ST-9
Boring No. : B-020-0-22 Depth: 21.0 - 23.0'

16 tsf Load

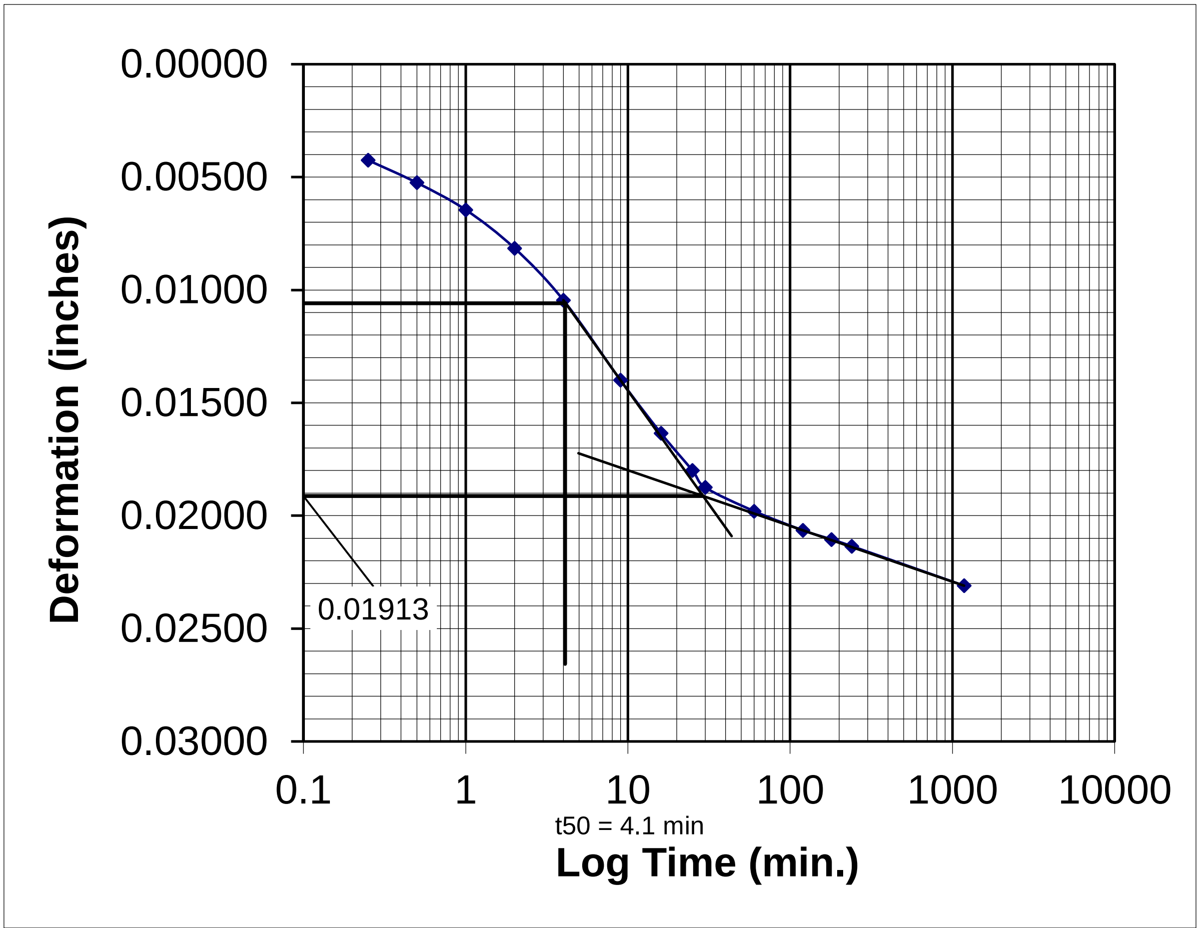
initial height= 0.92955 inches

Do= D1-(D2-D1)
1) 0.25 to 1.0: 0.00205
2) 0.5 to 2.0: 0.00235
3) 1.0 to 4.0: 0.00245
Do Avg 1&2: 0.00220
Do Avg 1-3: 0.00228

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.31805				
0.25	0.31200	0.00605	0.00180	0.00425	0.92530
0.5	0.31100	0.00705	0.00180	0.00525	0.92430
1	0.30980	0.00825	0.00180	0.00645	0.92310
2	0.30810	0.00995	0.00180	0.00815	0.92140
4	0.30580	0.01225	0.00180	0.01045	0.91910
9	0.30225	0.01580	0.00180	0.01400	0.91555
16	0.29990	0.01815	0.00180	0.01635	0.91320
25	0.29825	0.01980	0.00180	0.01800	0.91155
30	0.29750	0.02055	0.00180	0.01875	0.91080
60	0.29645	0.02160	0.00180	0.01980	0.90975
120	0.29560	0.02245	0.00180	0.02065	0.90890
180	0.29520	0.02285	0.00180	0.02105	0.90850
240	0.29490	0.02315	0.00180	0.02135	0.90820
1180	0.29315	0.02490	0.00180	0.02310	0.90645

Use Do= 0.00205
D100= 0.01913
D50= D100+0.5(Do-D100)
D50= 0.01059

t50 = 4.1 min.



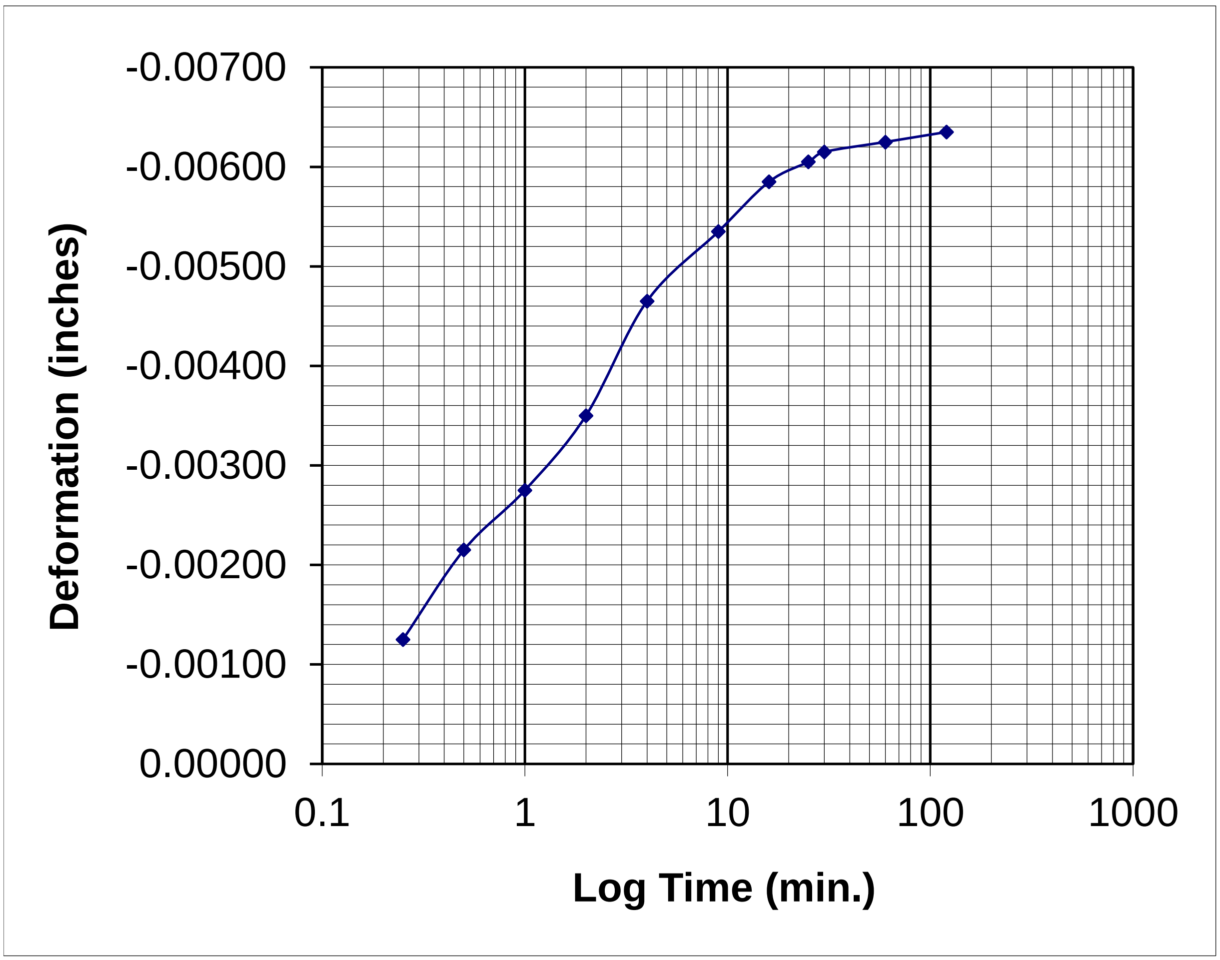
Project No. : 230230
Boring No. : B-020-0-22

Sample No.: ST-9
Depth: 21.0 - 23.0'

4.0 tsf Unload

initial height= 0.90645 inches

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.29315				
0.25	0.29550	-0.00235	-0.00110	-0.00125	0.90770
0.5	0.29640	-0.00325	-0.00110	-0.00215	0.90860
1	0.29700	-0.00385	-0.00110	-0.00275	0.90920
2	0.29775	-0.00460	-0.00110	-0.00350	0.90995
4	0.29890	-0.00575	-0.00110	-0.00465	0.91110
9	0.29960	-0.00645	-0.00110	-0.00535	0.91180
16	0.30010	-0.00695	-0.00110	-0.00585	0.91230
25	0.30030	-0.00715	-0.00110	-0.00605	0.91250
30	0.30040	-0.00725	-0.00110	-0.00615	0.91260
60	0.30050	-0.00735	-0.00110	-0.00625	0.91270
120	0.30060	-0.00745	-0.00110	-0.00635	0.91280



LEADING THROUGH the next 100 years

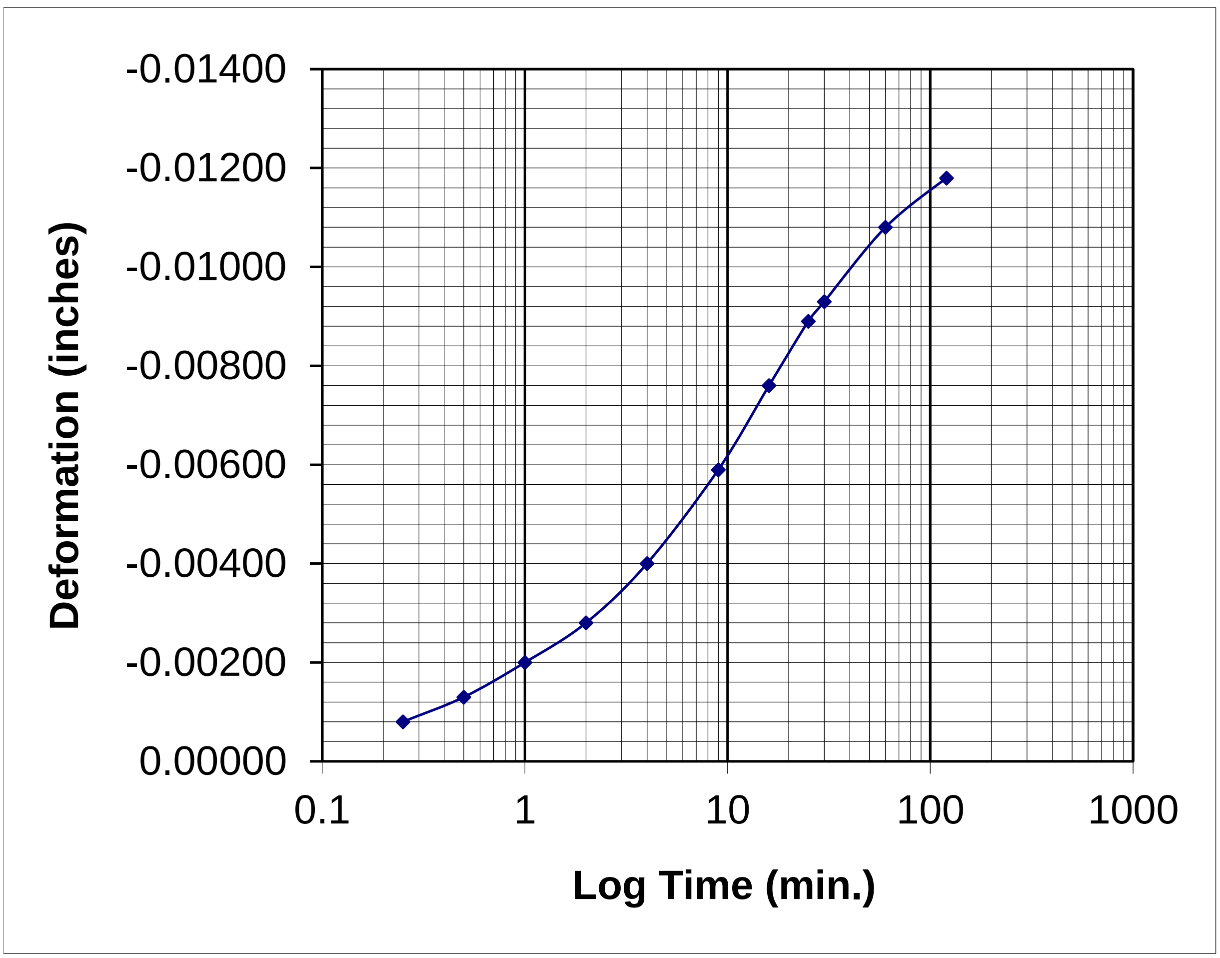
Project No. : 230230
Boring No. : B-020-0-22

Sample No.: ST-9
Depth: 21.0 - 23.0'

1.0 tsf Unload

initial height= 0.9128 inches

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.30060				
0.25	0.30300	-0.00240	-0.00160	-0.00080	0.91360
0.5	0.30350	-0.00290	-0.00160	-0.00130	0.91410
1	0.30420	-0.00360	-0.00160	-0.00200	0.91480
2	0.30500	-0.00440	-0.00160	-0.00280	0.91560
4	0.30620	-0.00560	-0.00160	-0.00400	0.91680
9	0.30810	-0.00750	-0.00160	-0.00590	0.91870
16	0.30980	-0.00920	-0.00160	-0.00760	0.92040
25	0.31110	-0.01050	-0.00160	-0.00890	0.92170
30	0.31150	-0.01090	-0.00160	-0.00930	0.92210
60	0.31300	-0.01240	-0.00160	-0.01080	0.92360
120	0.31400	-0.01340	-0.00160	-0.01180	0.92460



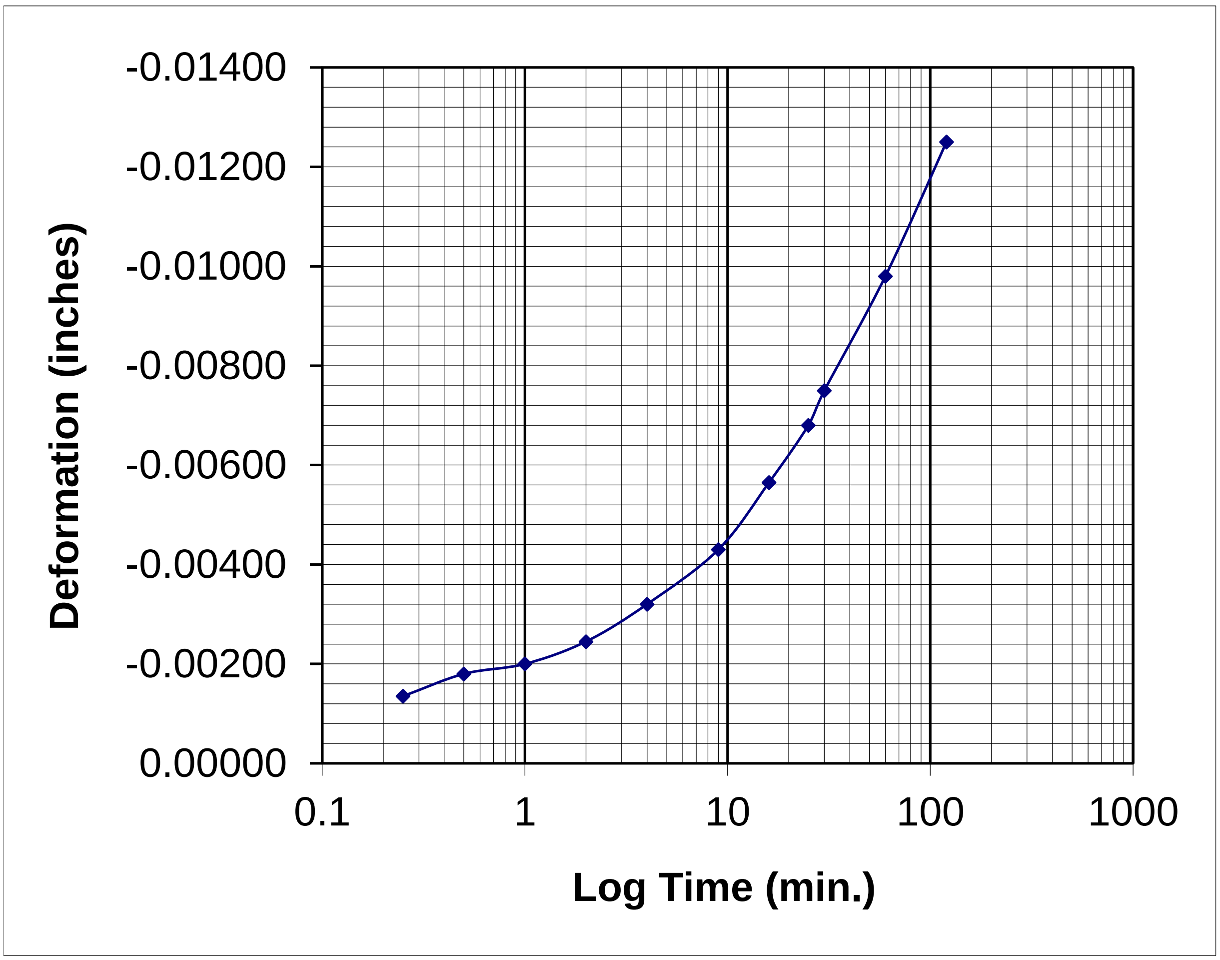
Project No. : 230230
Boring No. : B-020-0-22

Sample No.: ST-9
Depth: 21.0 - 23.0'

0.25 tsf Unload

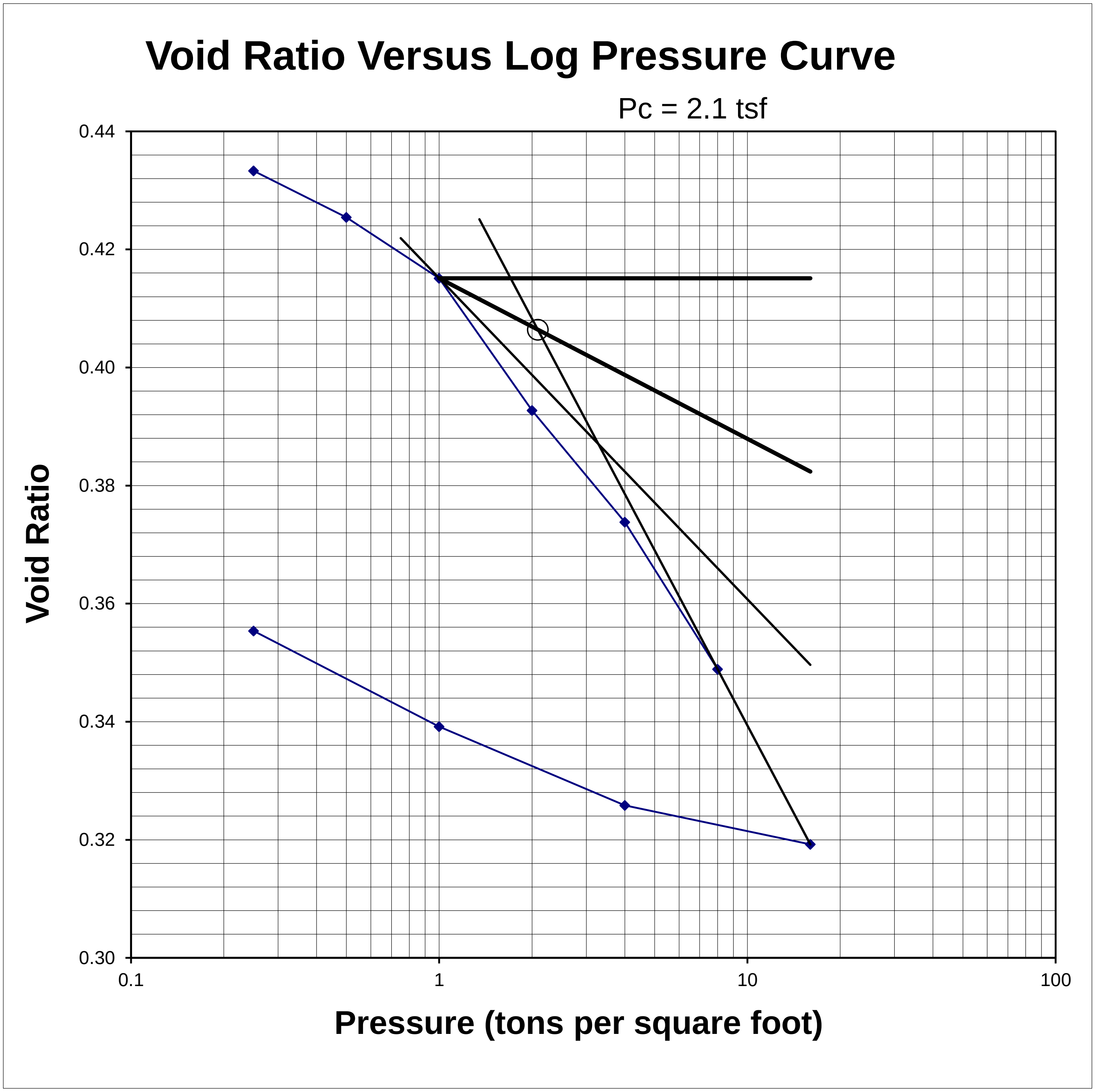
initial height= 0.9246 inches

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.31400				
0.25	0.31535	-0.00135	0.00000	-0.00135	0.92595
0.5	0.31580	-0.00180	0.00000	-0.00180	0.92640
1	0.31600	-0.00200	0.00000	-0.00200	0.92660
2	0.31645	-0.00245	0.00000	-0.00245	0.92705
4	0.31720	-0.00320	0.00000	-0.00320	0.92780
9	0.31830	-0.00430	0.00000	-0.00430	0.92890
16	0.31965	-0.00565	0.00000	-0.00565	0.93025
25	0.32080	-0.00680	0.00000	-0.00680	0.93140
30	0.32150	-0.00750	0.00000	-0.00750	0.93210
60	0.32380	-0.00980	0.00000	-0.00980	0.93440
120	0.32650	-0.01250	0.00000	-0.01250	0.93710



LEADING THROUGH the next 100 years

Project No.: 230230
Date: 5/11/2023
Client: ODOT
Project: HEN-24/17D-00.43
Henry County, OH
Boring No.: B-024-0-22
Sample No.: ST-13
Depth: 36.0 - 38.0'



Project No.:	230230
Date:	5/11/2023
Client:	ODOT
Project:	HEN-24/17D-00.43 Henry County, OH
Boring No.:	B-024-0-22
Sample No.:	ST-13
Depth:	36.0 - 38.0'

Initial H= 1 inches

Pressure tsf	Final Height (in)	Initial Height (in)	DH	Average H (in)	e	t50 (min)	Ave P (tsf)	Cv (in2/s)	Cv (ft2/d)
0.25	0.98500	1.00000	0.01500	0.9925	0.433	9.3	0.125	0.000087	0.052
0.5	0.97960	0.98500	0.02040	0.9823	0.425	5.4	0.375	0.000148	0.089
1	0.97250	0.97960	0.02750	0.9761	0.415	1.3	0.75	0.000622	0.373
2	0.95710	0.97250	0.04290	0.9648	0.393	2.1	1.5	0.000368	0.221
4	0.94410	0.95710	0.05590	0.9506	0.374	1.6	3	0.000472	0.283
8	0.92700	0.94410	0.07300	0.9356	0.349	1.5	6	0.000489	0.293
16	0.90660	0.92700	0.09340	0.9168	0.319	1.5	12	0.000469	0.282
4	0.91115	0.90660	0.08885	0.9089	0.326		10		
1	0.92030	0.91115	0.07970	0.9157	0.339		2.5		
0.25	0.93145	0.92030	0.06855	0.9259	0.355		0.625		

Estimated Cc:	0.099
Estimated Cr:	0.020

Soil Description:	Gray SILT and CLAY, Little Sand, Little Gravel A-6a (8)
Specific Gravity:	2.725
Liquid Limit:	28
Plastic Limit:	17
Plasticity Index:	11

Initial Water Content:	16.2 %	Final Water Content:	14.8 %
Inital Dry Density:	116.9 pcf	Final Dry Density:	125.5 pcf
Initial Void Ratio:	0.455	Final Void Ratio:	0.355
Initial Degree of Saturation:	96.7 %	Final Degree of Saturation	113.1 %

Estimated Preconsolidation Pressure: 2.1 tsf

The sample for the test was trimmed from a Shelby tube sample using a cutting shoe. Test Method B was used with the specimen inundated during testing. Coefficients of consolidation were computed by log of time method.

LEADING THROUGH the next 100 years

Consolidation Laboratory Calculations

Consolidometer: **2**

Method:	ASTM D 2435 Method B
Project No. :	230230
Client:	ODOT
Project:	HEN-24/17D-00.43
Location:	Henry County, OH
Boring No. :	B-024-0-22
Sample No.:	ST-13
Depth:	36.0 - 38.0'
Date of Test:	5/11/2023

Visual Description:	Gray SILT and CLAY, Little Sand, Little Gravel A-6a (8)	
Liquid Limit:	28	%
Plastic Limit:	17	%
Plasticity Index:	11	%

Initial Sample Data

Initial Height	1.000	in.		
Ring Dia.	2.493	in.		
Area of Ring	4.8813	in^2		
Initial Volume	4.8813	in^3	0.00282	ft^3
Specific Gravity	2.725			
Initial wet mass soil & ring	318.6	g		
Mass of ring	144.6	g		
Initial wet mass soil	174	g	0.38361	lb

Final Sample Data

Final Height	0.931	in.		
Ring Dia.	2.493	in.		
Area of Ring	4.8813	in^2		
Final Volume	4.5467	in^3	0.00263	ft^3
Final wet mass soil, pan & ring	367.3	g		
Wt of Pan	50.8	g		
Final wet mass soil & ring	316.5			
Mass of ring	144.6	g		
Final dry mass of soil, pan & ring	345.2	g		
Final wet mass soil	171.9	g	0.37898	lb
Weight of water	22.1	g	0.04872	lb

Initial Water Content

Mass can & wet soil	619	g
Mass can & dry soil	544.1	g
Mass of can	50.9	g
Mass of water	74.9	g
Mass of soil	493.2	g
Initial water content	15.19	% (trimmings)

Initial water content	16.15	% (based on final dry weight)
Final water content	14.75	% (based on final dry weight)

Initial dry density	116.9	pcf		
Initial void ratio (eo)	0.455			
Initial volume of voids (Vvo)	1.5268	in^3	0.00088	ft^3
Initial volume of water (Vwo)	1.4767	in^3	0.00085	ft^3
Initial degree of saturation (So)	96.72	%		

Final weight of solids (Md)	149.8	g	0.33025	lb
Final dry density	125.5	pcf		
Final volume of solids (Vs)	3.3545	in^3	0.00194	ft^3
Final height of solids (Hs)	0.6872	in.		
Final void ratio (ef)	0.355			
Final volume of voids (Vvf)	1.1921	in^3	0.00069	ft^3
Final volume of water (Vwf)	1.3486	in^3	0.00078	ft^3
Final degree of saturation (Sf)	113.12	%		

Checks:
Final DD >= Initial DD TRUE

100 YEARS
LEADING THROUGH the next 100 years

Project No. : 230230 Sample No.: ST-13
Boring No. : B-024-0-22 Depth: 36.0 - 38.0'

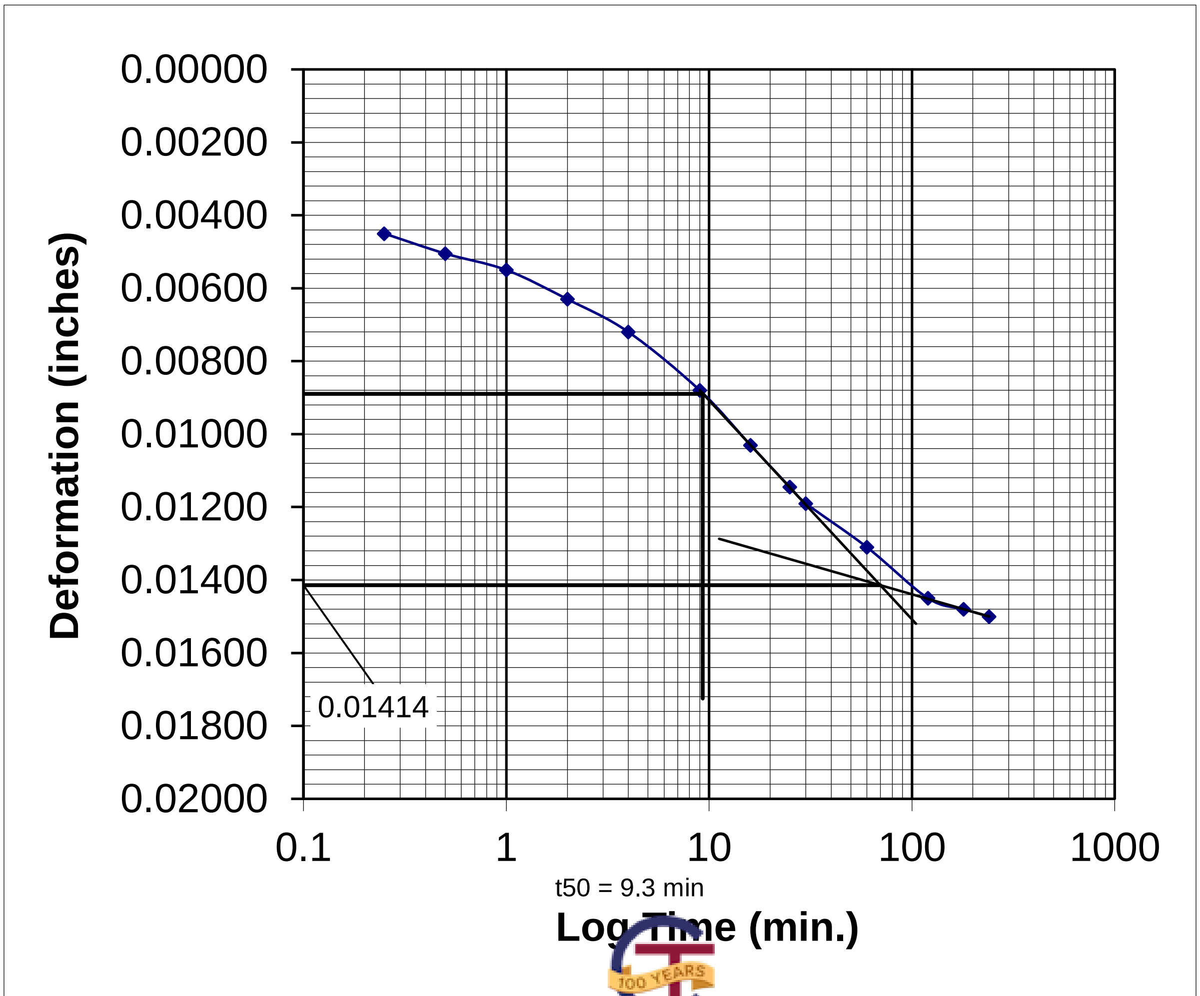
0.25 tsf Load

initial height= 1 inches

Do= D1-(D2-D1)
1) 0.25 to 1.0: 0.00350
2) 0.5 to 2.0: 0.00380
3) 1.0 to 4.0: 0.00380
Do Avg 1&2: 0.00365
Do Avg 1-3: 0.00370
Use Do= 0.00365
D100= 0.01414
D50= D100+0.5(Do-D100)
D50= 0.00890

t50 = 9.3 min.

Interval Minutes	**Dial Reading**	**ΔH**	**Deformation Constant**	**TRUE ΔH**	**Height of Sample**
0	0.40000				
0.25	0.39450	0.00550	0.00100	0.00450	0.99550
0.5	0.39395	0.00605	0.00100	0.00505	0.99495
1	0.39350	0.00650	0.00100	0.00550	0.99450
2	0.39270	0.00730	0.00100	0.00630	0.99370
4	0.39180	0.00820	0.00100	0.00720	0.99280
9	0.39020	0.00980	0.00100	0.00880	0.99120
16	0.38870	0.01130	0.00100	0.01030	0.98970
25	0.38755	0.01245	0.00100	0.01145	0.98855
30	0.38710	0.01290	0.00100	0.01190	0.98810
60	0.38590	0.01410	0.00100	0.01310	0.98690
120	0.38450	0.01550	0.00100	0.01450	0.98550
180	0.38420	0.01580	0.00100	0.01480	0.98520
240	0.38400	0.01600	0.00100	0.01500	0.98500



Project No. : 230230 Sample No.: ST-13
Boring No. : B-024-0-22 Depth: 36.0 - 38.0'

Do= D1-(D2-D1)
1) 0.25 to 1.0: -0.00050
2) 0.5 to 2.0: -0.00040
3) 1.0 to 4.0: -0.00020
Do Avg 1&2: -0.00045
Do Avg 1-3: -0.00037

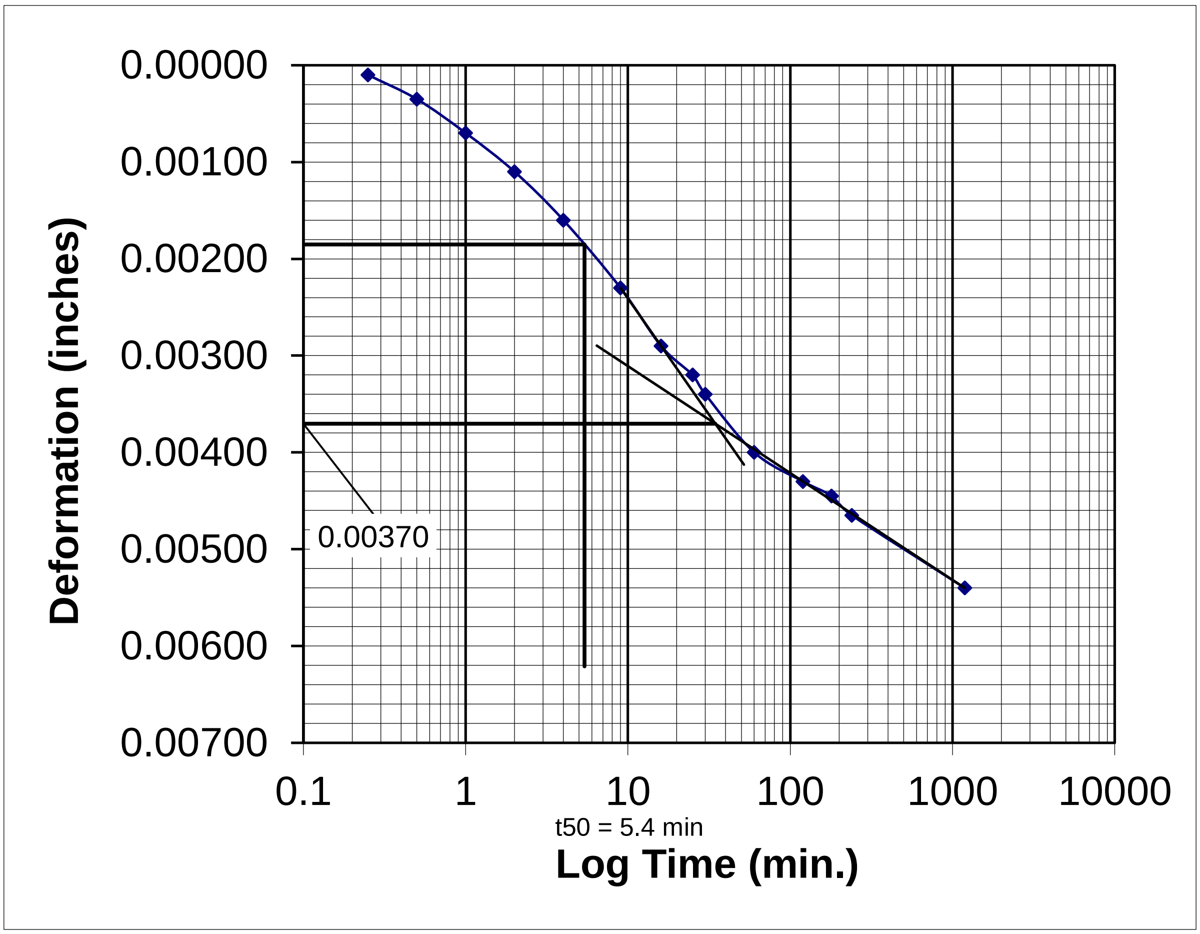
0.5 tsf Load

initial height= 0.985 inches

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.38400				
0.25	0.38250	0.00150	0.00140	0.00010	0.98490
0.5	0.38225	0.00175	0.00140	0.00035	0.98465
1	0.38190	0.00210	0.00140	0.00070	0.98430
2	0.38150	0.00250	0.00140	0.00110	0.98390
4	0.38100	0.00300	0.00140	0.00160	0.98340
9	0.38030	0.00370	0.00140	0.00230	0.98270
16	0.37970	0.00430	0.00140	0.00290	0.98210
25	0.37940	0.00460	0.00140	0.00320	0.98180
30	0.37920	0.00480	0.00140	0.00340	0.98160
60	0.37860	0.00540	0.00140	0.00400	0.98100
120	0.37830	0.00570	0.00140	0.00430	0.98070
180	0.37815	0.00585	0.00140	0.00445	0.98055
240	0.37795	0.00605	0.00140	0.00465	0.98035
1190	0.37720	0.00680	0.00140	0.00540	0.97960

Use Do= 0.00000
D100= 0.00370
D50= D100+0.5(Do-D100)
D50= 0.00185

t50 = 5.4 min.



Project No. : 230230
Boring No. : B-024-0-22

Sample No.: ST-13
Depth: 36.0 - 38.0'

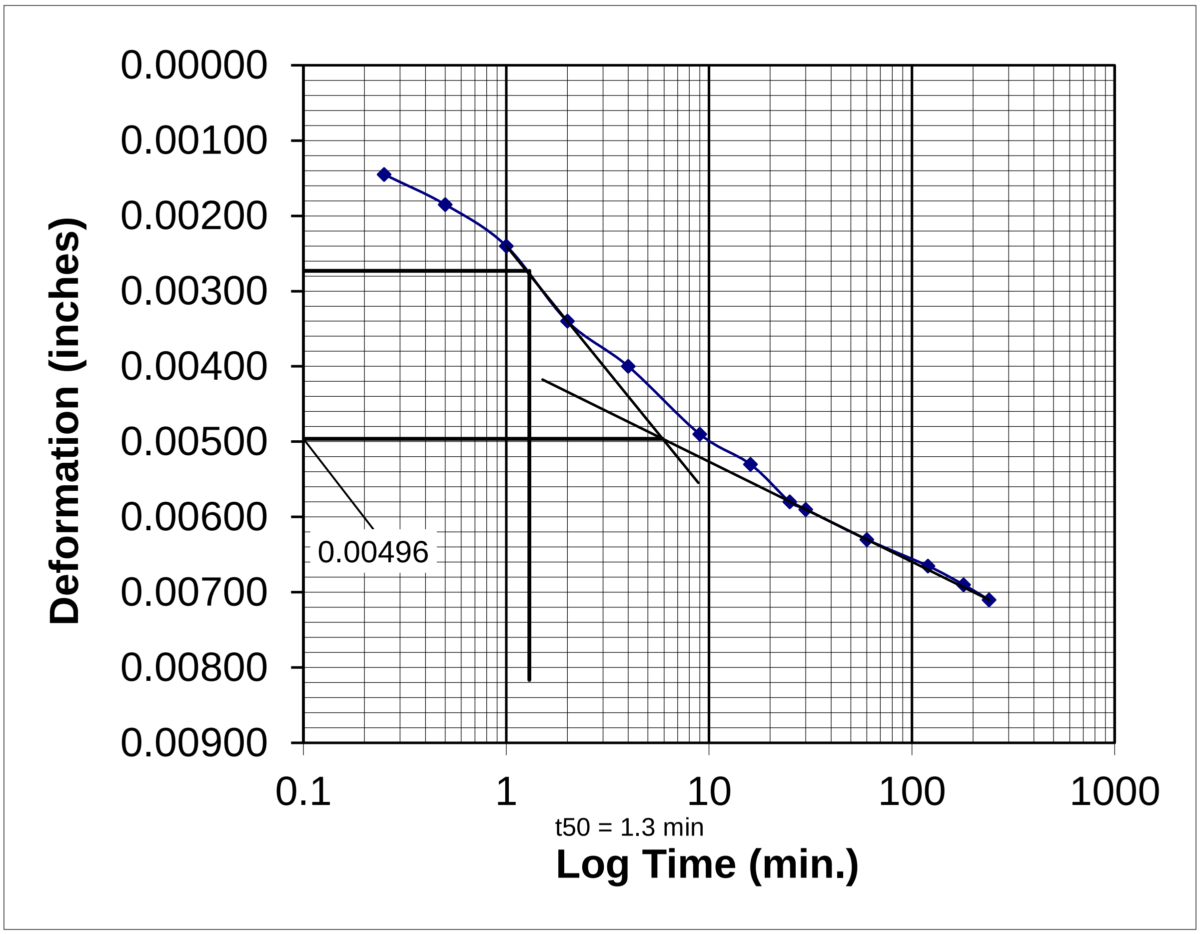
1.0 tsf Load

initial height= 0.9796 inches

Do= D1-(D2-D1)
1) 0.25 to 1.0: 0.00050
2) 0.5 to 2.0: 0.00030
3) 1.0 to 4.0: 0.00080
Do Avg 1&2: 0.00040
Do Avg 1-3: 0.00053
Use Do= 0.00050
D100= 0.00496
D50= D100+0.5(Do-D100)
D50= 0.00273

t50 = 1.3 min.

Interval Minutes	**Dial Reading**	**ΔH**	**Deformation Constant**	**TRUE ΔH**	**Height of Sample**
0	0.37720				
0.25	0.37405	0.00315	0.00170	0.00145	0.97815
0.5	0.37365	0.00355	0.00170	0.00185	0.97775
1	0.37310	0.00410	0.00170	0.00240	0.97720
2	0.37210	0.00510	0.00170	0.00340	0.97620
4	0.37150	0.00570	0.00170	0.00400	0.97560
9	0.37060	0.00660	0.00170	0.00490	0.97470
16	0.37020	0.00700	0.00170	0.00530	0.97430
25	0.36970	0.00750	0.00170	0.00580	0.97380
30	0.36960	0.00760	0.00170	0.00590	0.97370
60	0.36920	0.00800	0.00170	0.00630	0.97330
120	0.36885	0.00835	0.00170	0.00665	0.97295
180	0.36860	0.00860	0.00170	0.00690	0.97270
240	0.36840	0.00880	0.00170	0.00710	0.97250



LEADING THROUGH the next 100 years

Project No. : 230230 Sample No.: ST-13
Boring No. : B-024-0-22 Depth: 36.0 - 38.0'

2.0 tsf Load

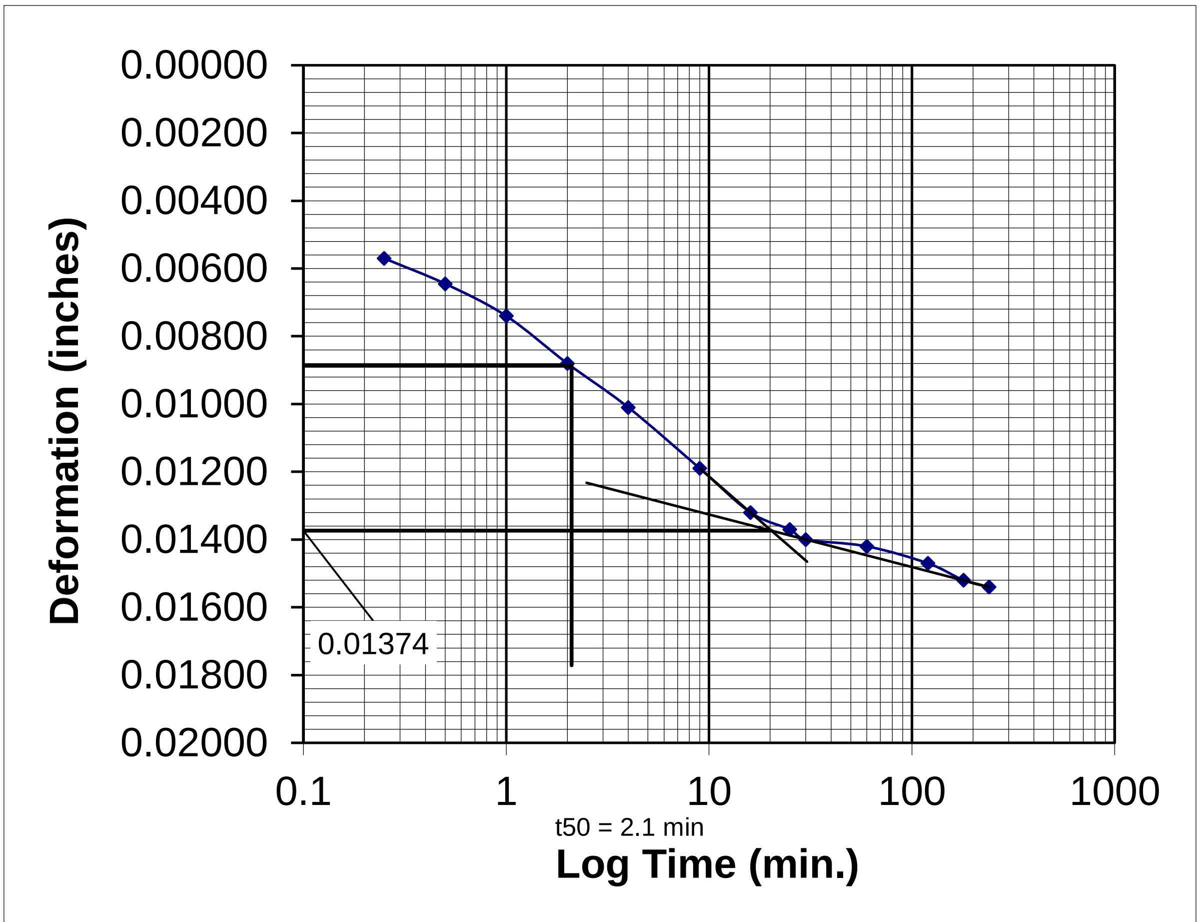
initial height= 0.9725 inches

Do= D1-(D2-D1)
1) 0.25 to 1.0: 0.00400
2) 0.5 to 2.0: 0.00410
3) 1.0 to 4.0: 0.00470
Do Avg 1&2: 0.00405
Do Avg 1-3: 0.00427

Interval Minutes	**Dial Reading**	**ΔH**	**Deformation Constant**	**TRUE ΔH**	**Height of Sample**
0	0.36840				
0.25	0.36000	0.00840	0.00270	0.00570	0.96680
0.5	0.35925	0.00915	0.00270	0.00645	0.96605
1	0.35830	0.01010	0.00270	0.00740	0.96510
2	0.35690	0.01150	0.00270	0.00880	0.96370
4	0.35560	0.01280	0.00270	0.01010	0.96240
9	0.35380	0.01460	0.00270	0.01190	0.96060
16	0.35250	0.01590	0.00270	0.01320	0.95930
25	0.35200	0.01640	0.00270	0.01370	0.95880
30	0.35170	0.01670	0.00270	0.01400	0.95850
60	0.35150	0.01690	0.00270	0.01420	0.95830
120	0.35100	0.01740	0.00270	0.01470	0.95780
180	0.35050	0.01790	0.00270	0.01520	0.95730
240	0.35030	0.01810	0.00270	0.01540	0.95710

Use Do= 0.00400
D100= 0.01374
D50= D100+0.5(Do-D100)
D50= 0.00887

t50 = 2.1 min.



Project No. : 230230 Sample No.: ST-13
Boring No. : B-024-0-22 Depth: 36.0 - 38.0'

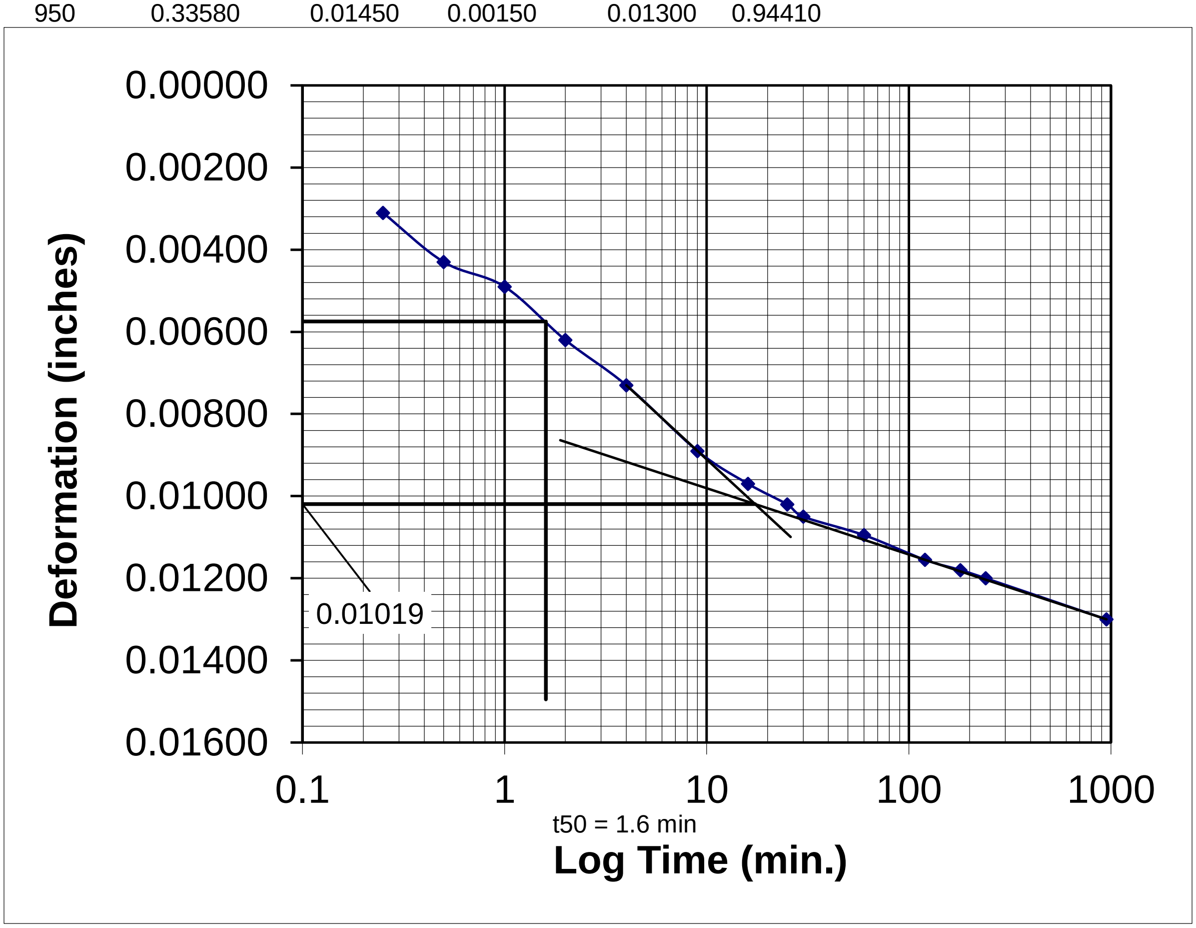
4.0 tsf Load

initial height= 0.9571 inches

Do= D1-(D2-D1)
1) 0.25 to 1.0: 0.00130
2) 0.5 to 2.0: 0.00240
3) 1.0 to 4.0: 0.00250
Do Avg 1&2: 0.00185
Do Avg 1-3: 0.00207
Use Do= 0.00130
D100= 0.01019
D50= D100+0.5(Do-D100)
D50= 0.00575

t50 = 1.6 min.

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.35030				
0.25	0.34570	0.00460	0.00150	0.00310	0.95400
0.5	0.34450	0.00580	0.00150	0.00430	0.95280
1	0.34390	0.00640	0.00150	0.00490	0.95220
2	0.34260	0.00770	0.00150	0.00620	0.95090
4	0.34150	0.00880	0.00150	0.00730	0.94980
9	0.33990	0.01040	0.00150	0.00890	0.94820
16	0.33910	0.01120	0.00150	0.00970	0.94740
25	0.33860	0.01170	0.00150	0.01020	0.94690
30	0.33830	0.01200	0.00150	0.01050	0.94660
60	0.33785	0.01245	0.00150	0.01095	0.94615
120	0.33725	0.01305	0.00150	0.01155	0.94555
180	0.33700	0.01330	0.00150	0.01180	0.94530
240	0.33680	0.01350	0.00150	0.01200	0.94510
950	0.33580	0.01450	0.00150	0.01300	0.94410



Project No. : 230230

Boring No. : B-024-0-22

Sample No.: ST-13

Depth: 36.0 - 38.0'

8.0 tsf Load

initial height= 0.94410 inches

Do= D1-(D2-D1)

1) 0.25 to 1.0: 0.00350

2) 0.5 to 2.0: 0.00385

3) 1.0 to 4.0: 0.00460

Do Avg 1&2: 0.00368

Do Avg 1-3: 0.00398

Use Do= 0.00350

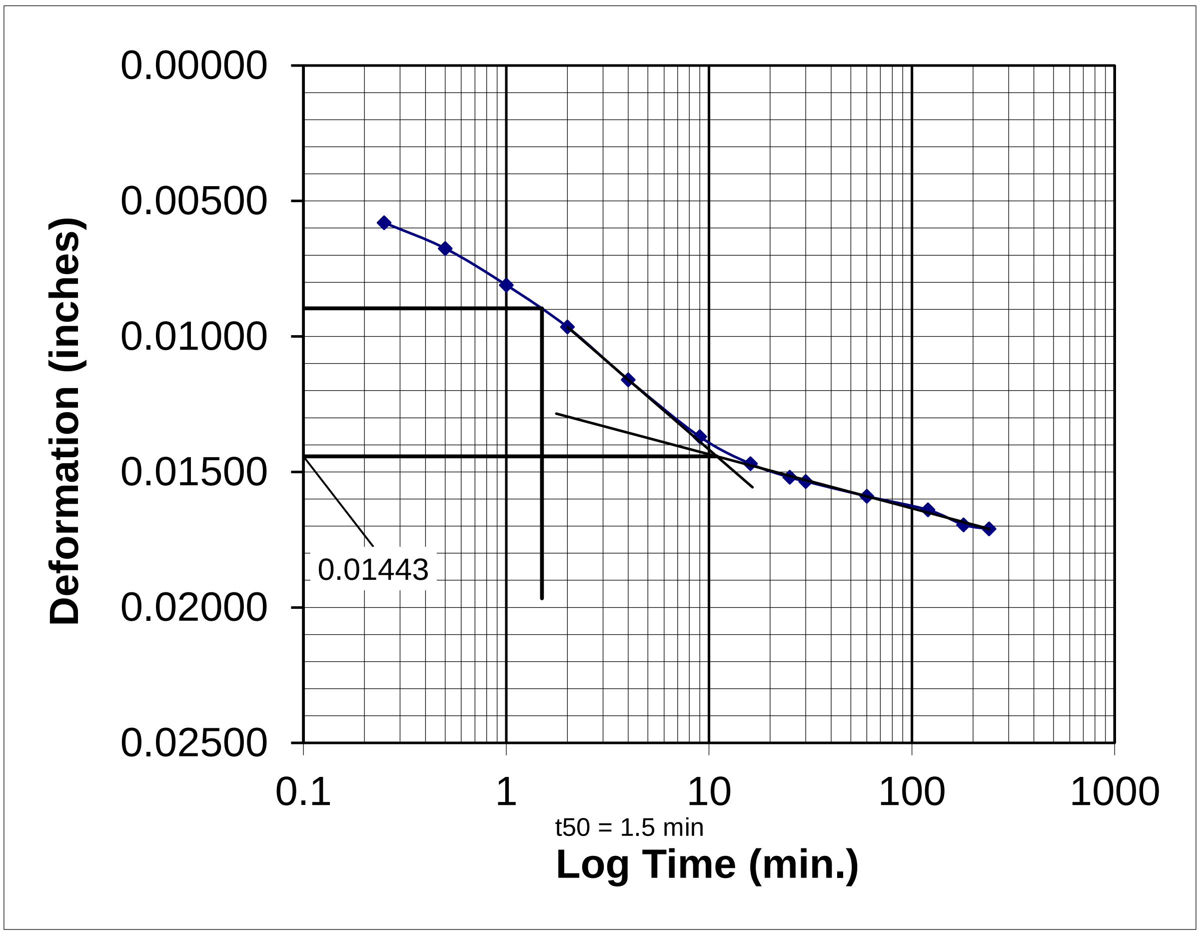
D100= 0.01443

D50= D100+0.5(Do-D100)

D50= 0.00896

t50 = 1.5 min.

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.33580				
0.25	0.32820	0.00760	0.00180	0.00580	0.93830
0.5	0.32725	0.00855	0.00180	0.00675	0.93735
1	0.32590	0.00990	0.00180	0.00810	0.93600
2	0.32435	0.01145	0.00180	0.00965	0.93445
4	0.32240	0.01340	0.00180	0.01160	0.93250
9	0.32030	0.01550	0.00180	0.01370	0.93040
16	0.31930	0.01650	0.00180	0.01470	0.92940
25	0.31880	0.01700	0.00180	0.01520	0.92890
30	0.31865	0.01715	0.00180	0.01535	0.92875
60	0.31810	0.01770	0.00180	0.01590	0.92820
120	0.31760	0.01820	0.00180	0.01640	0.92770
180	0.31705	0.01875	0.00180	0.01695	0.92715
240	0.31690	0.01890	0.00180	0.01710	0.92700



Project No. : 230230 Sample No.: ST-13
Boring No. : B-024-0-22 Depth: 36.0 - 38.0'

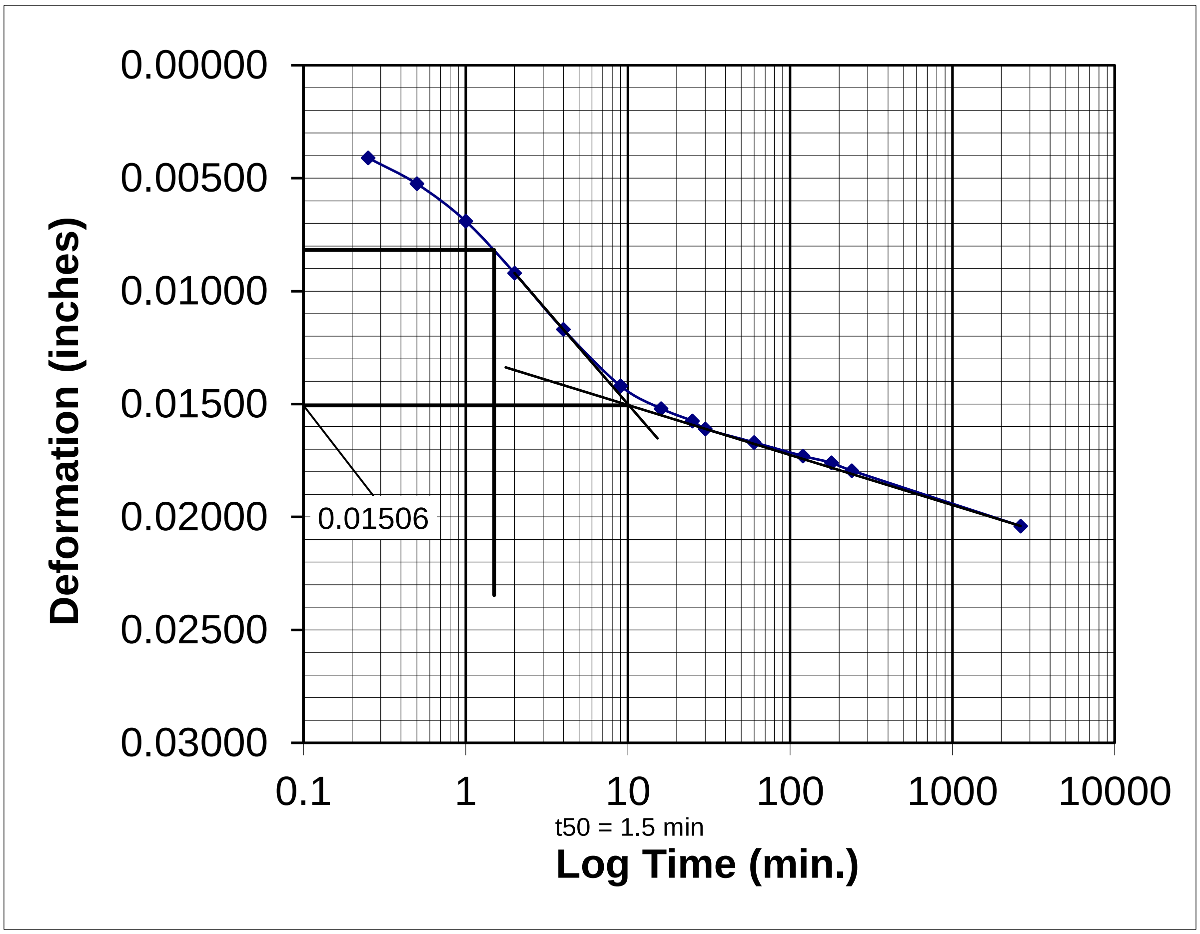
16 tsf Load

initial height= 0.927 inches

Do= D1-(D2-D1)
1) 0.25 to 1.0: 0.00130
2) 0.5 to 2.0: 0.00130
3) 1.0 to 4.0: 0.00210
Do Avg 1&2: 0.00130
Do Avg 1-3: 0.00157
Use Do= 0.00130
D100= 0.01506
D50= D100+0.5(Do-D100)
D50= 0.00818

t50 = 1.5 min.

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.31690				
0.25	0.31100	0.00590	0.00180	0.00410	0.92290
0.5	0.30985	0.00705	0.00180	0.00525	0.92175
1	0.30820	0.00870	0.00180	0.00690	0.92010
2	0.30590	0.01100	0.00180	0.00920	0.91780
4	0.30340	0.01350	0.00180	0.01170	0.91530
9	0.30090	0.01600	0.00180	0.01420	0.91280
16	0.29990	0.01700	0.00180	0.01520	0.91180
25	0.29935	0.01755	0.00180	0.01575	0.91125
30	0.29900	0.01790	0.00180	0.01610	0.91090
60	0.29840	0.01850	0.00180	0.01670	0.91030
120	0.29780	0.01910	0.00180	0.01730	0.90970
180	0.29750	0.01940	0.00180	0.01760	0.90940
240	0.29715	0.01975	0.00180	0.01795	0.90905
2630	0.29470	0.02220	0.00180	0.02040	0.90660

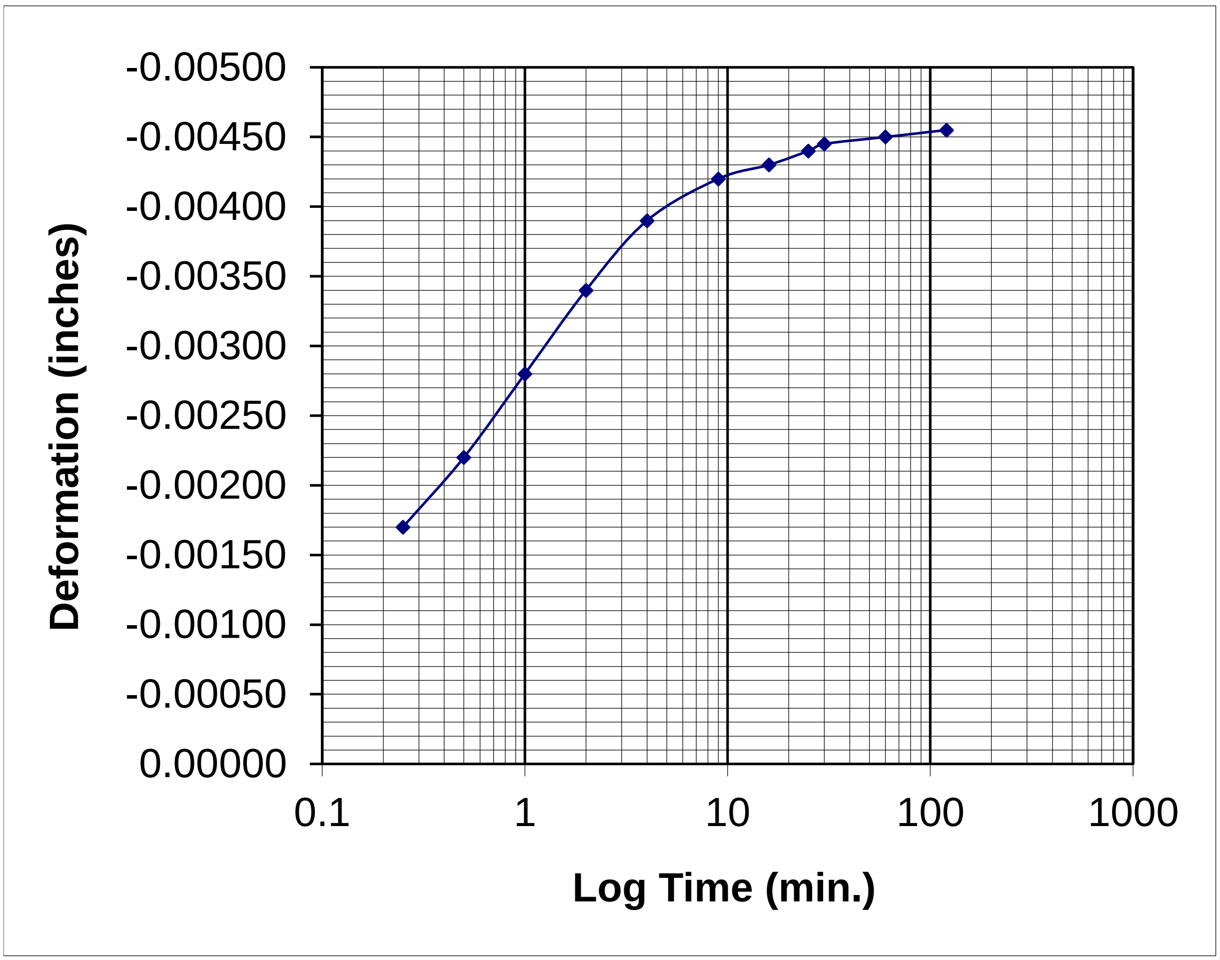


Project No. : 230230 Sample No.: ST-13
Boring No. : B-024-0-22 Depth: 36.0 - 38.0'

4.0 tsf Unload

initial height= 0.9066 inches

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.29470				
0.25	0.29750	-0.00280	-0.00110	-0.00170	0.90830
0.5	0.29800	-0.00330	-0.00110	-0.00220	0.90880
1	0.29860	-0.00390	-0.00110	-0.00280	0.90940
2	0.29920	-0.00450	-0.00110	-0.00340	0.91000
4	0.29970	-0.00500	-0.00110	-0.00390	0.91050
9	0.30000	-0.00530	-0.00110	-0.00420	0.91080
16	0.30010	-0.00540	-0.00110	-0.00430	0.91090
25	0.30020	-0.00550	-0.00110	-0.00440	0.91100
30	0.30025	-0.00555	-0.00110	-0.00445	0.91105
60	0.30030	-0.00560	-0.00110	-0.00450	0.91110
120	0.30035	-0.00565	-0.00110	-0.00455	0.91115



LEADING THROUGH the next 100 years

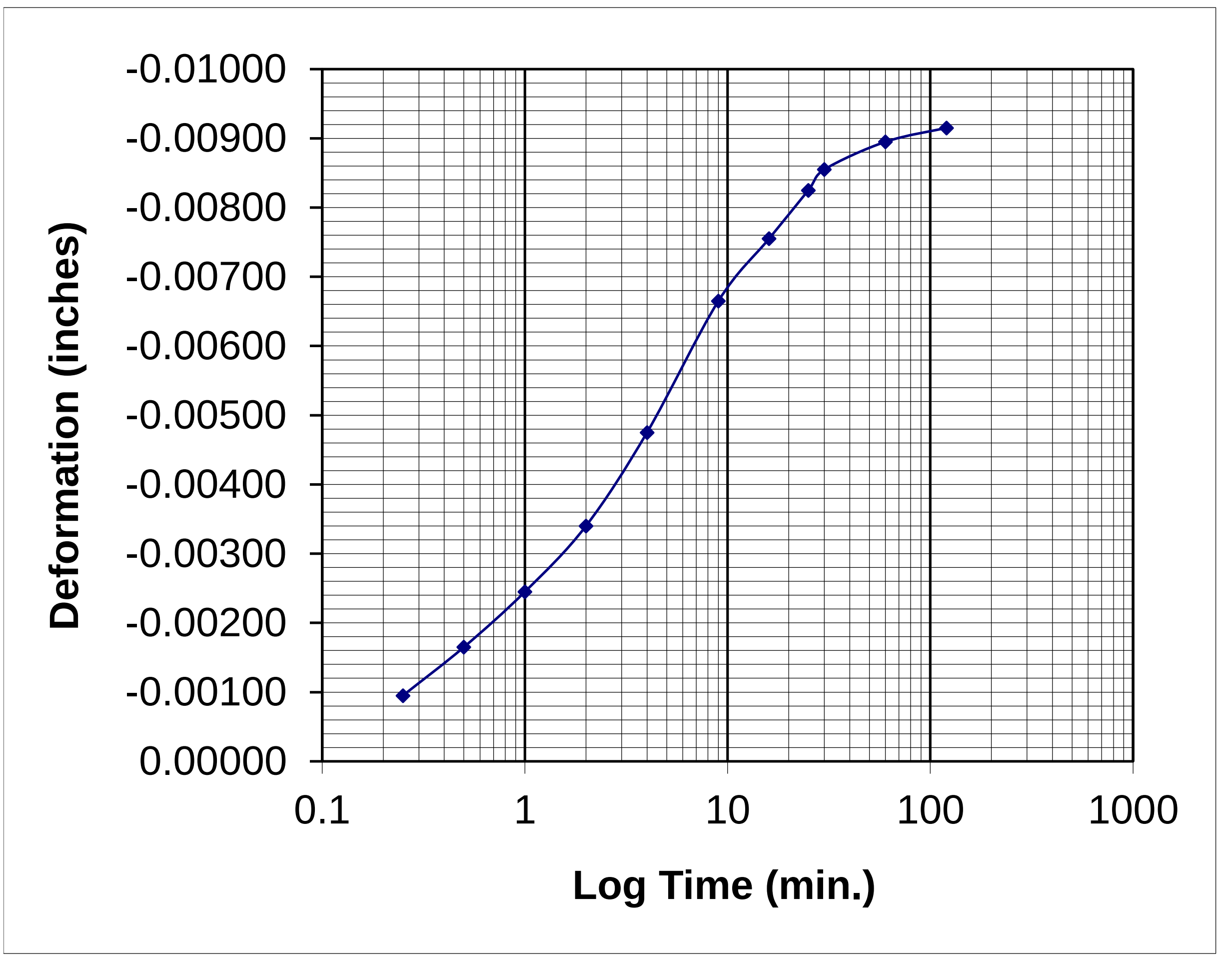
Project No. : 230230
Boring No. : B-024-0-22

Sample No.: ST-13
Depth: 36.0 - 38.0'

1.0 tsf Unload

initial height= 0.91115 inches

Interval Minutes	Dial Reading	DH	Deformation Constant	TRUE DH	Height of Sample
0	0.30035				
0.25	0.30290	-0.00255	-0.00160	-0.00095	0.91210
0.5	0.30360	-0.00325	-0.00160	-0.00165	0.91280
1	0.30440	-0.00405	-0.00160	-0.00245	0.91360
2	0.30535	-0.00500	-0.00160	-0.00340	0.91455
4	0.30670	-0.00635	-0.00160	-0.00475	0.91590
9	0.30860	-0.00825	-0.00160	-0.00665	0.91780
16	0.30950	-0.00915	-0.00160	-0.00755	0.91870
25	0.31020	-0.00985	-0.00160	-0.00825	0.91940
30	0.31050	-0.01015	-0.00160	-0.00855	0.91970
60	0.31090	-0.01055	-0.00160	-0.00895	0.92010
120	0.31110	-0.01075	-0.00160	-0.00915	0.92030

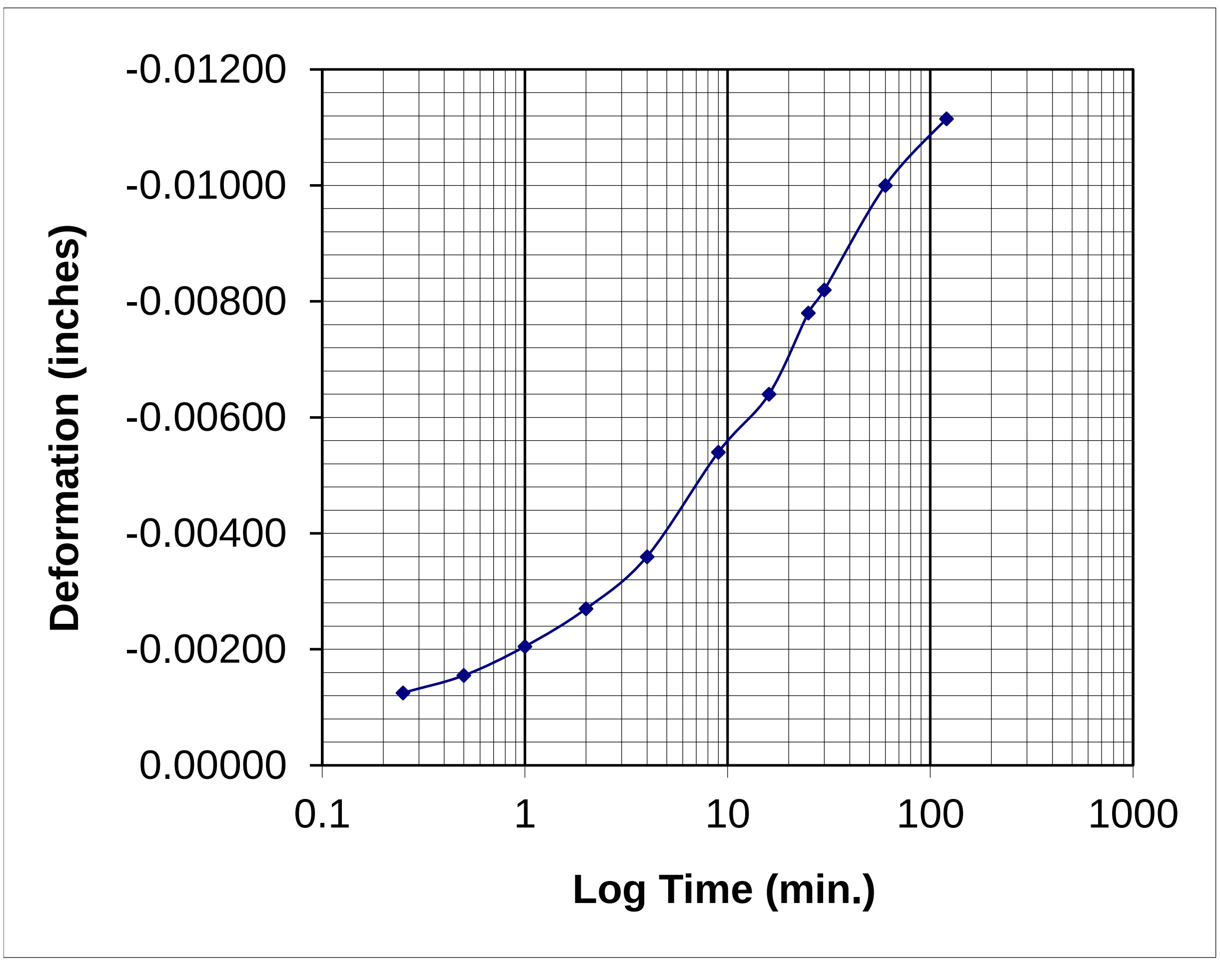


Project No. : 230230 Sample No.: ST-13
Boring No. : B-024-0-22 Depth: 36.0 - 38.0'

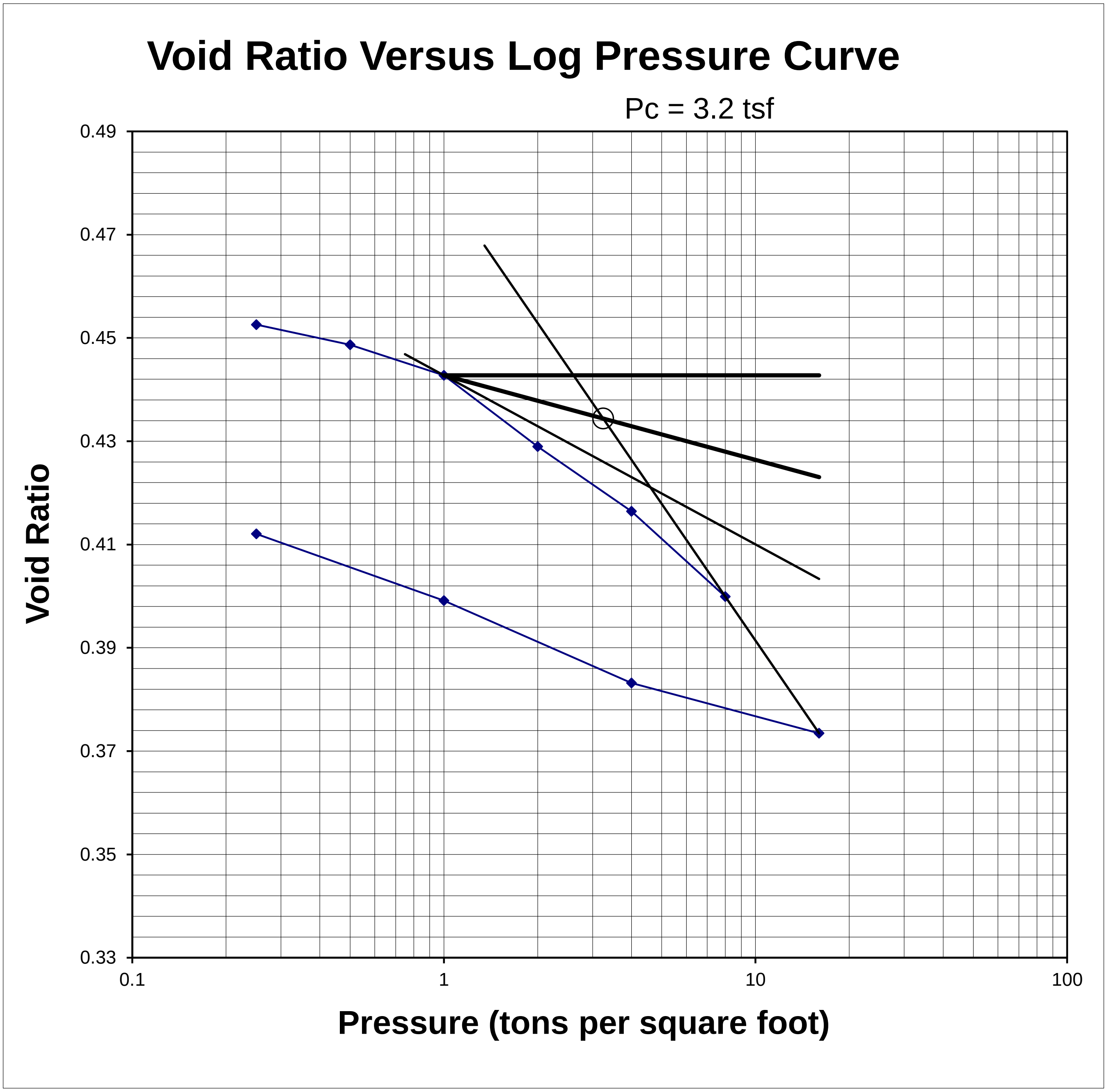
0.25 tsf Unload

initial height= 0.9203 inches

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.31110				
0.25	0.31235	-0.00125	0.00000	-0.00125	0.92155
0.5	0.31265	-0.00155	0.00000	-0.00155	0.92185
1	0.31315	-0.00205	0.00000	-0.00205	0.92235
2	0.31380	-0.00270	0.00000	-0.00270	0.92300
4	0.31470	-0.00360	0.00000	-0.00360	0.92390
9	0.31650	-0.00540	0.00000	-0.00540	0.92570
16	0.31750	-0.00640	0.00000	-0.00640	0.92670
25	0.31890	-0.00780	0.00000	-0.00780	0.92810
30	0.31930	-0.00820	0.00000	-0.00820	0.92850
60	0.32110	-0.01000	0.00000	-0.01000	0.93030
120	0.32225	-0.01115	0.00000	-0.01115	0.93145



Project No.: 230230
Date: 8/1/2023
Client: Burgess & Niple, Inc.
Project: HEN-24/17D-00.43, PID 117712
Henry County, OH
Boring No.: B-025-0-22
Sample No.: ST-3
Depth: 6.0 - 8.0'



Project No.: 230230
Date: 8/1/2023
Client: Burgess & Niple, Inc.
Project: HEN-24/17D-00.43, PID 117712
Henry County, OH
Boring No.: B-025-0-22
Sample No.: ST-3
Depth: 6.0 - 8.0'

Initial H= 1 inches

Pressure tsf	Final Height (in)	Initial Height (in)	DH	Average H (in)	e	t50 (min)	Ave P (tsf)	Cv (in2/s)	Cv (ft2/d)
0.25	0.99855	1.00000	0.00145	0.9993	0.453		0.125		
0.5	0.99585	0.99855	0.00415	0.9972	0.449		0.375		
1	0.99180	0.99585	0.00820	0.9938	0.443	0.8	0.75	0.001020	0.612
2	0.98230	0.99180	0.01770	0.9871	0.429	1.1	1.5	0.000730	0.438
4	0.97370	0.98230	0.02630	0.9780	0.416	0.5	3	0.001436	0.861
8	0.96235	0.97370	0.03765	0.9680	0.400	1.6	6	0.000494	0.297
16	0.94415	0.96235	0.05585	0.9533	0.373	1.3	12	0.000561	0.337
4	0.95085	0.94415	0.04915	0.9475	0.383		10		
1	0.96180	0.95085	0.03820	0.9563	0.399		2.5		
0.25	0.97070	0.96180	0.02930	0.9663	0.412		0.625		

Estimated Cc: 0.088
Estimated Cr: 0.021

Soil Description: Brown SILT and CLAY, Little Sand, Trace Gravel A-6a (10)
Specific Gravity: 2.706
Liquid Limit: 34
Plastic Limit: 20
Plasticity Index: 14

Initial Water Content:	15.6 %	Final Water Content:	17.4 %
Inital Dry Density:	116.1 pcf	Final Dry Density:	119.6 pcf
Initial Void Ratio:	0.455	Final Void Ratio:	0.412
Initial Degree of Saturation:	92.8 %	Final Degree of Saturation	114.3 %

Estimated Preconsolidation Pressure: 3.2 tsf

The sample for the test was trimmed from a Shelby tube sample using a cutting shoe. Test Method B was used with the specimen inundated during testing. Coefficients of consolidation were computed by log of time method.

LEADING THROUGH the next 100 years

Consolidation Laboratory Calculations

Consolidometer:	**2**
Method:	ASTM D 2435 Method B
Project No. :	230230
Client:	Burgess & Niple, Inc.
Project:	HEN-24/17D-00.43, PID 117712
Location:	Henry County, OH
Boring No. :	B-025-0-22
Sample No.:	ST-3
Depth:	6.0 - 8.0'
Date of Test:	8/1/2023

Visual Description:	Brown SILT and CLAY, Little Sand, Trace Gravel A-6a (10)
Liquid Limit:	34 %
Plastic Limit:	20 %
Plasticity Index:	14 %

Initial Sample Data

Initial Height	1.000 in.	
Ring Dia.	2.493 in.	
Area of Ring	4.8813 in^2	
Initial Volume	4.8813 in^3	0.00282 ft^3
Specific Gravity	2.706	
Initial wet mass soil & ring	318.3 g	
Mass of ring	146.3 g	
Initial wet mass soil	172 g	0.37920 lb

Final Sample Data

Final Height	0.971 in.	
Ring Dia.	2.493 in.	
Area of Ring	4.8813 in^2	
Final Volume	4.7383 in^3	0.00274 ft^3
Final wet mass soil, pan & ring	371.2 g	
Wt of Pan	50.2 g	
Final wet mass soil & ring	321.0	
Mass of ring	146.3 g	
Final dry mass of soil, pan & ring	345.3 g	
Final wet mass soil	174.7 g	0.38515 lb
Weight of water	25.9 g	0.05710 lb

Initial Water Content

Mass can & wet soil	496.7 g
Mass can & dry soil	436 g
Mass of can	50.8 g
Mass of water	60.7 g
Mass of soil	385.2 g
Initial water content	15.76 % (trimmings)

Initial water content	15.59 % (based on final dry weight)	
Initial dry density	116.1 pcf	
Initial void ratio (eo)	0.455	
Initial volume of voids (Vvo)	1.5258 in^3	0.00088 ft^3
Initial volume of water (Vwo)	1.4157 in^3	0.00082 ft^3
Initial degree of saturation (So)	92.79 %	

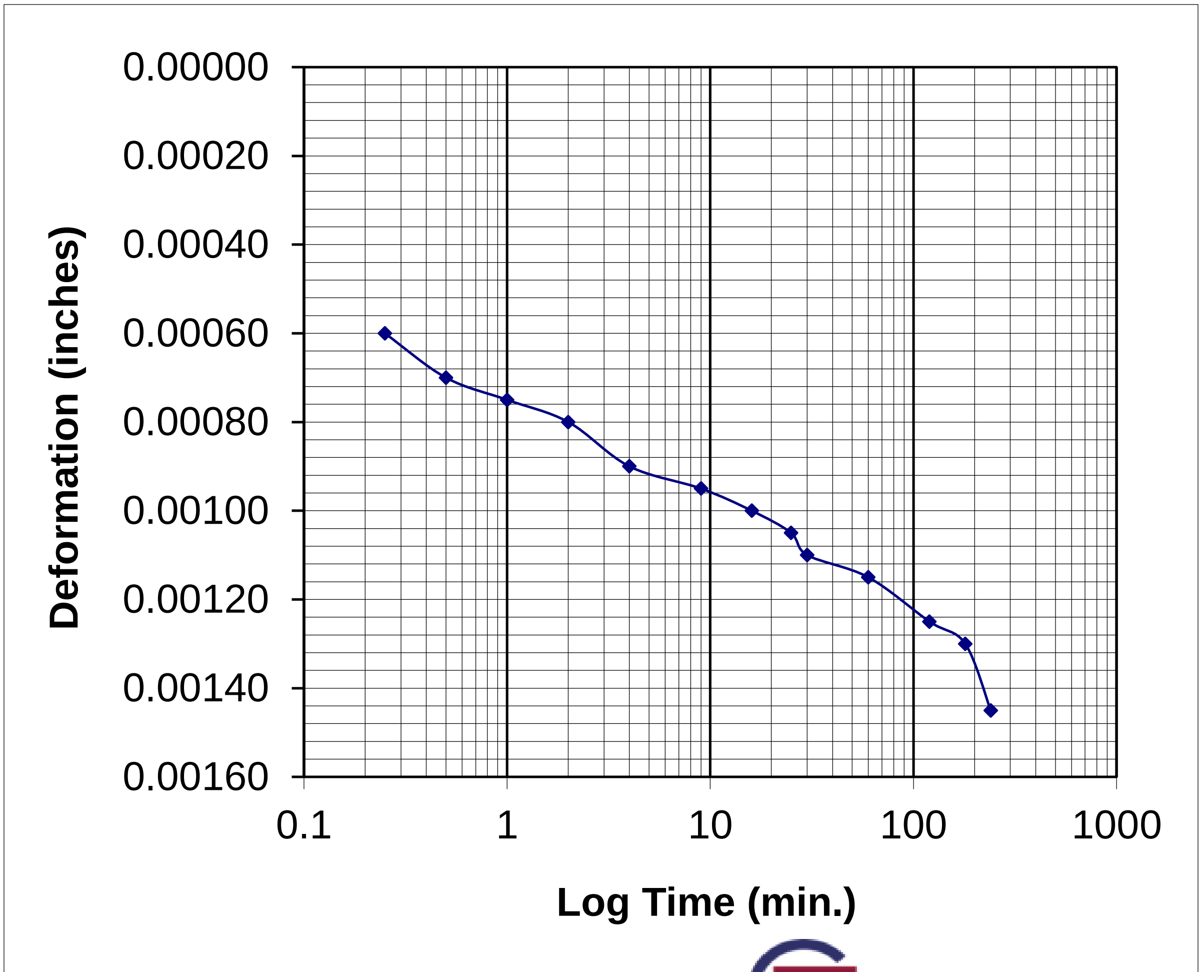
Final water content	17.41 % (based on final dry weight)	
Final weight of solids (Md)	148.8 g	0.32805 lb
Final dry density	119.6 pcf	
Final volume of solids (Vs)	3.3555 in^3	0.00194 ft^3
Final height of solids (Hs)	0.6874 in.	
Final void ratio (ef)	0.412	
Final volume of voids (Vvf)	1.3827 in^3	0.00080 ft^3
Final volume of water (Vwf)	1.5805 in^3	0.00091 ft^3
Final degree of saturation (Sf)	114.30 %	

Project No. : 230230 Sample No.: ST-3
Boring No. : B-025-0-22 Depth: 6.0 - 8.0'

0.25 tsf Load

initial height= 1 inches

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.39980				
0.25	0.39920	0.00060	0.00000	0.00060	0.99940
0.5	0.39910	0.00070	0.00000	0.00070	0.99930
1	0.39905	0.00075	0.00000	0.00075	0.99925
2	0.39900	0.00080	0.00000	0.00080	0.99920
4	0.39890	0.00090	0.00000	0.00090	0.99910
9	0.39885	0.00095	0.00000	0.00095	0.99905
16	0.39880	0.00100	0.00000	0.00100	0.99900
25	0.39875	0.00105	0.00000	0.00105	0.99895
30	0.39870	0.00110	0.00000	0.00110	0.99890
60	0.39865	0.00115	0.00000	0.00115	0.99885
120	0.39855	0.00125	0.00000	0.00125	0.99875
180	0.39850	0.00130	0.00000	0.00130	0.99870
240	0.39835	0.00145	0.00000	0.00145	0.99855

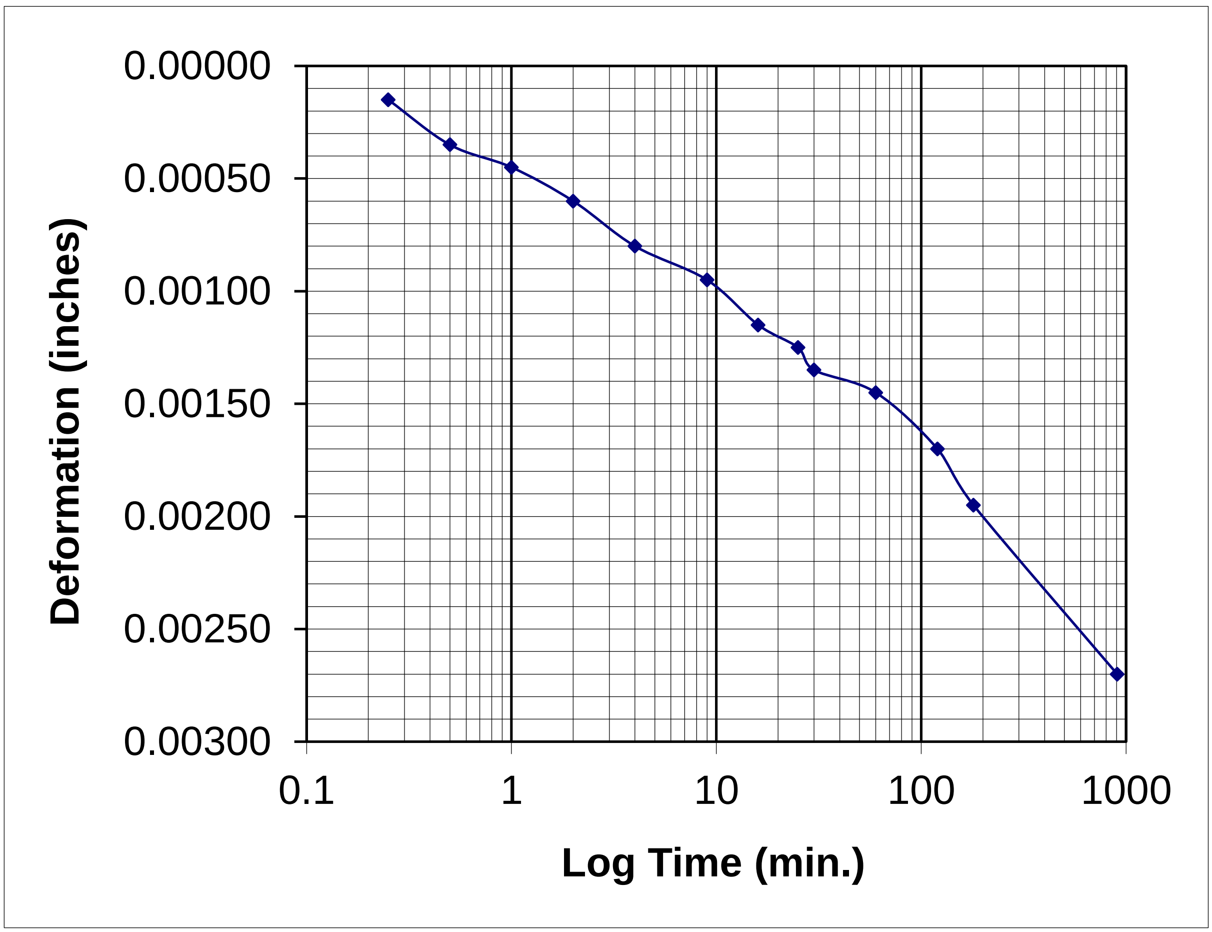


Project No. : 230230 Sample No.: ST-3
Boring No. : B-025-0-22 Depth: 6.0 - 8.0'

0.5 tsf Load

initial height= 0.99855 inches

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.39835				
0.25	0.39680	0.00155	0.00140	0.00015	0.99840
0.5	0.39660	0.00175	0.00140	0.00035	0.99820
1	0.39650	0.00185	0.00140	0.00045	0.99810
2	0.39635	0.00200	0.00140	0.00060	0.99795
4	0.39615	0.00220	0.00140	0.00080	0.99775
9	0.39600	0.00235	0.00140	0.00095	0.99760
16	0.39580	0.00255	0.00140	0.00115	0.99740
25	0.39570	0.00265	0.00140	0.00125	0.99730
30	0.39560	0.00275	0.00140	0.00135	0.99720
60	0.39550	0.00285	0.00140	0.00145	0.99710
120	0.39525	0.00310	0.00140	0.00170	0.99685
180	0.39500	0.00335	0.00140	0.00195	0.99660
905	0.39425	0.00410	0.00140	0.00270	0.99585



Project No. : 230230 Sample No.: ST-3
Boring No. : B-025-0-22 Depth: 6.0 - 8.0'

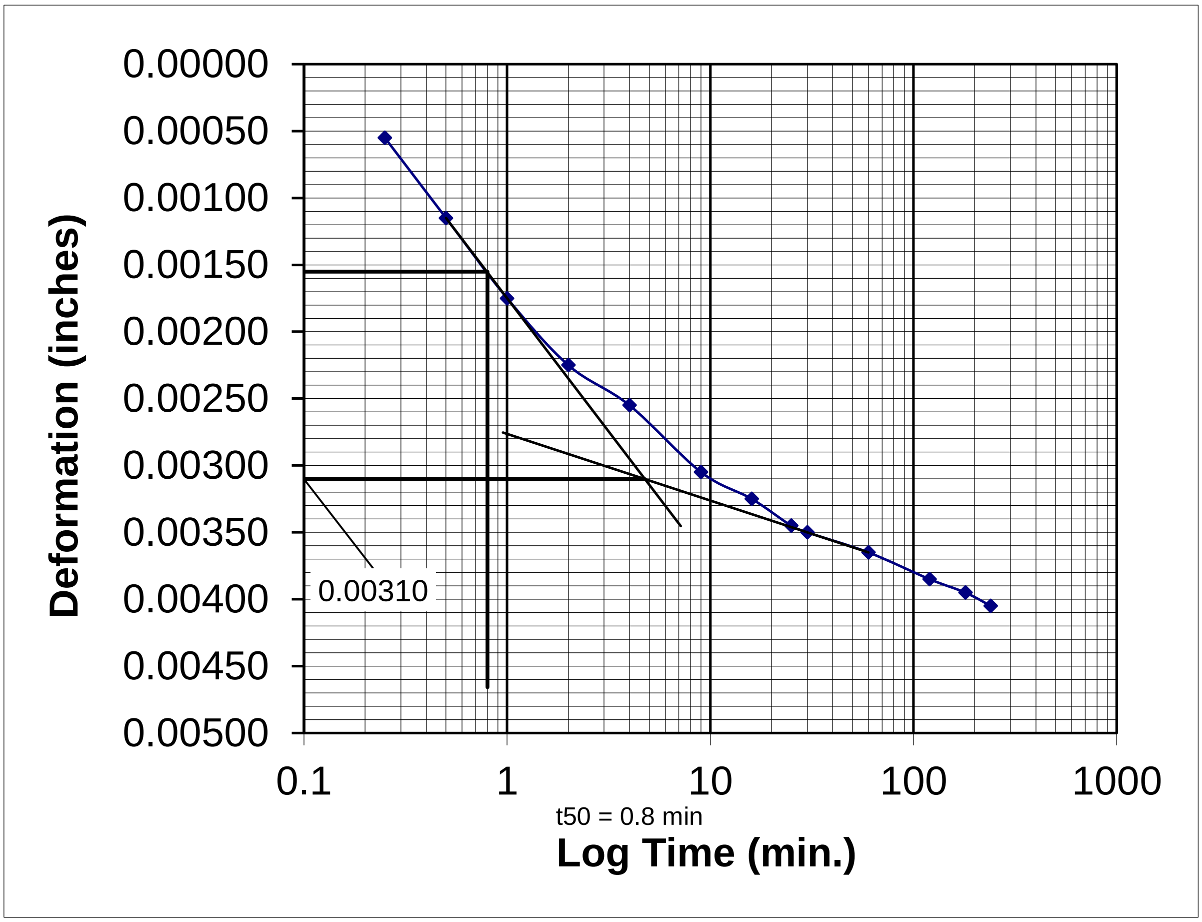
1.0 tsf Load

initial height= 0.99585 inches

Do= D1-(D2-D1)
1) 0.25 to 1.0: -0.00065
2) 0.5 to 2.0: 0.00005
3) 1.0 to 4.0: 0.00095
Do Avg 1&2: -0.00030
Do Avg 1-3: 0.00012
Use Do= 0.00000
D100= 0.00310
D50= D100+0.5(Do-D100)
D50= 0.00155

t50 = 0.8 min.

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.39425				
0.25	0.39200	0.00225	0.00170	0.00055	0.99530
0.5	0.39140	0.00285	0.00170	0.00115	0.99470
1	0.39080	0.00345	0.00170	0.00175	0.99410
2	0.39030	0.00395	0.00170	0.00225	0.99360
4	0.39000	0.00425	0.00170	0.00255	0.99330
9	0.38950	0.00475	0.00170	0.00305	0.99280
16	0.38930	0.00495	0.00170	0.00325	0.99260
25	0.38910	0.00515	0.00170	0.00345	0.99240
30	0.38905	0.00520	0.00170	0.00350	0.99235
60	0.38890	0.00535	0.00170	0.00365	0.99220
120	0.38870	0.00555	0.00170	0.00385	0.99200
180	0.38860	0.00565	0.00170	0.00395	0.99190
240	0.38850	0.00575	0.00170	0.00405	0.99180



LEADING THROUGH the next 100 years

Project No. : 230230 Sample No.: ST-3
Boring No. : B-025-0-22 Depth: 6.0 - 8.0'

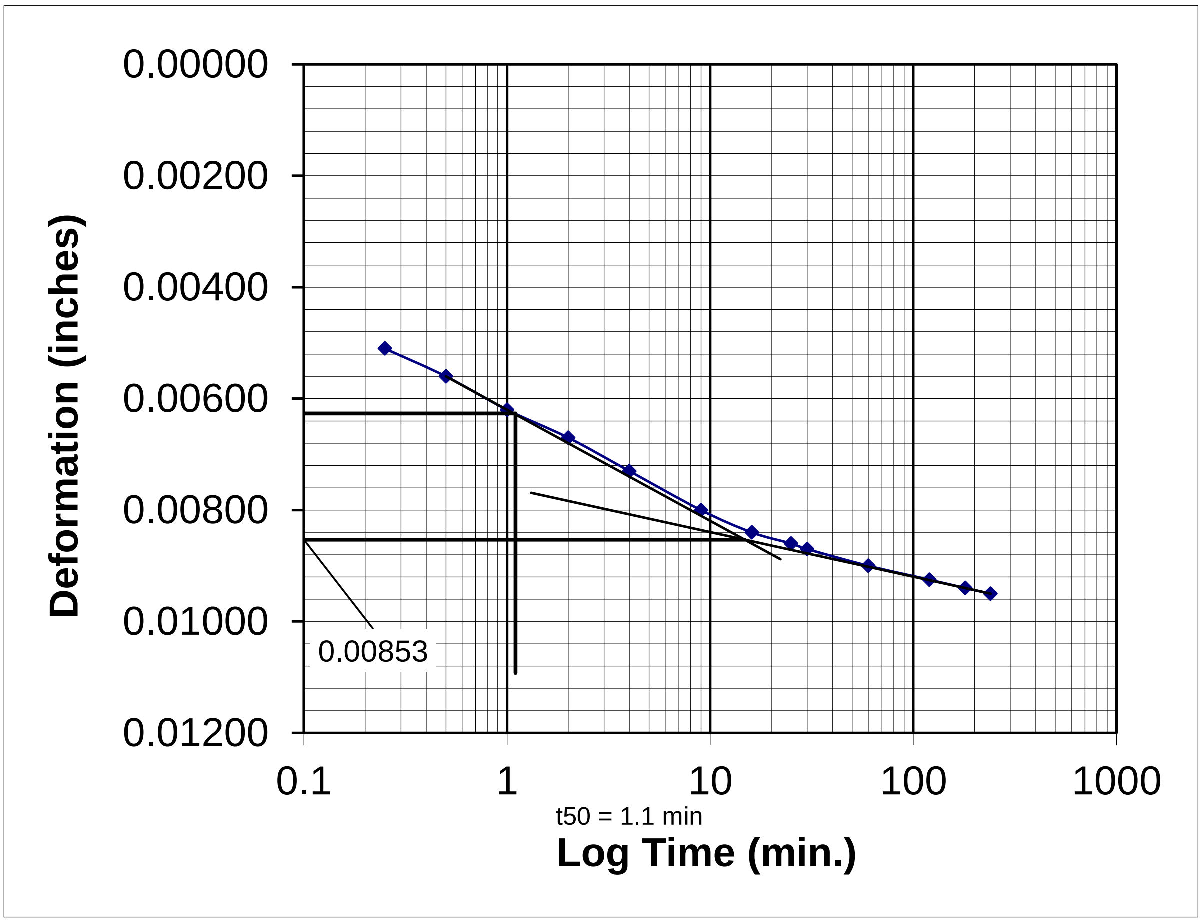
2.0 tsf Load

initial height= 0.9918 inches

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.38850				
0.25	0.38070	0.00780	0.00270	0.00510	0.98670
0.5	0.38020	0.00830	0.00270	0.00560	0.98620
1	0.37960	0.00890	0.00270	0.00620	0.98560
2	0.37910	0.00940	0.00270	0.00670	0.98510
4	0.37850	0.01000	0.00270	0.00730	0.98450
9	0.37780	0.01070	0.00270	0.00800	0.98380
16	0.37740	0.01110	0.00270	0.00840	0.98340
25	0.37720	0.01130	0.00270	0.00860	0.98320
30	0.37710	0.01140	0.00270	0.00870	0.98310
60	0.37680	0.01170	0.00270	0.00900	0.98280
120	0.37655	0.01195	0.00270	0.00925	0.98255
180	0.37640	0.01210	0.00270	0.00940	0.98240
240	0.37630	0.01220	0.00270	0.00950	0.98230

Do= D1-(D2-D1)
1) 0.25 to 1.0: 0.00400
2) 0.5 to 2.0: 0.00450
3) 1.0 to 4.0: 0.00510
Do Avg 1&2: 0.00425
Do Avg 1-3: 0.00453
Use Do= 0.00400
D100= 0.00853
D50= D100+0.5(Do-D100)
D50= 0.00627

t50 = 1.1 min.



Project No. : 230230
Boring No. : B-025-0-22

Sample No.: ST-3
Depth: 6.0 - 8.0'

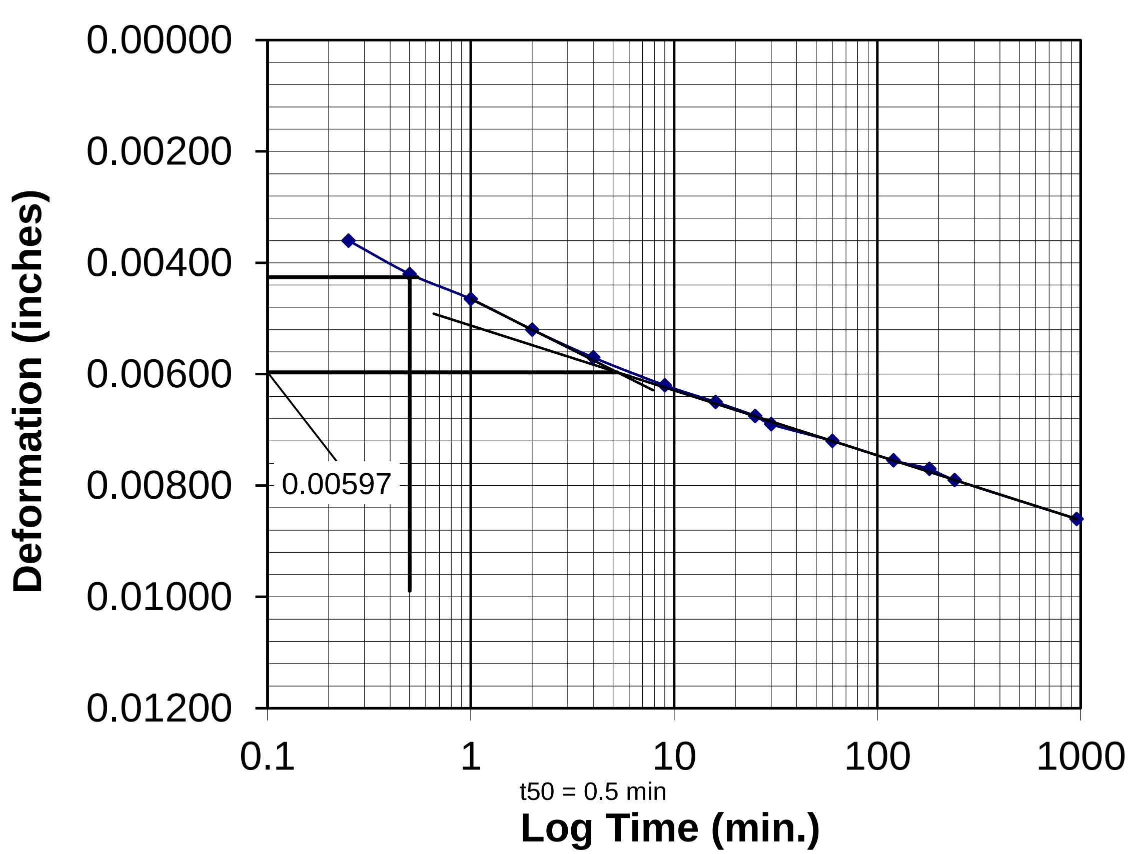
4.0 tsf Load

initial height= 0.9823 inches

Do= D1-(D2-D1)
1) 0.25 to 1.0: 0.00255
2) 0.5 to 2.0: 0.00320
3) 1.0 to 4.0: 0.00360
Do Avg 1&2: 0.00288
Do Avg 1-3: 0.00312
Use Do= 0.00255
D100= 0.00597
D50= D100+0.5(Do-D100)
D50= 0.00426

t50 = 0.5 min.

Interval Minutes	**Dial Reading**	**ΔH**	**Deformation Constant**	**TRUE ΔH**	**Height of Sample**
0	0.37630				
0.25	0.37120	0.00510	0.00150	0.00360	0.97870
0.5	0.37060	0.00570	0.00150	0.00420	0.97810
1	0.37015	0.00615	0.00150	0.00465	0.97765
2	0.36960	0.00670	0.00150	0.00520	0.97710
4	0.36910	0.00720	0.00150	0.00570	0.97660
9	0.36860	0.00770	0.00150	0.00620	0.97610
16	0.36830	0.00800	0.00150	0.00650	0.97580
25	0.36805	0.00825	0.00150	0.00675	0.97555
30	0.36790	0.00840	0.00150	0.00690	0.97540
60	0.36760	0.00870	0.00150	0.00720	0.97510
120	0.36725	0.00905	0.00150	0.00755	0.97475
180	0.36710	0.00920	0.00150	0.00770	0.97460
240	0.36690	0.00940	0.00150	0.00790	0.97440
955	0.36620	0.01010	0.00150	0.00860	0.97370



Project No. : 230230 Sample No.: ST-3
Boring No. : B-025-0-22 Depth: 6.0 - 8.0'

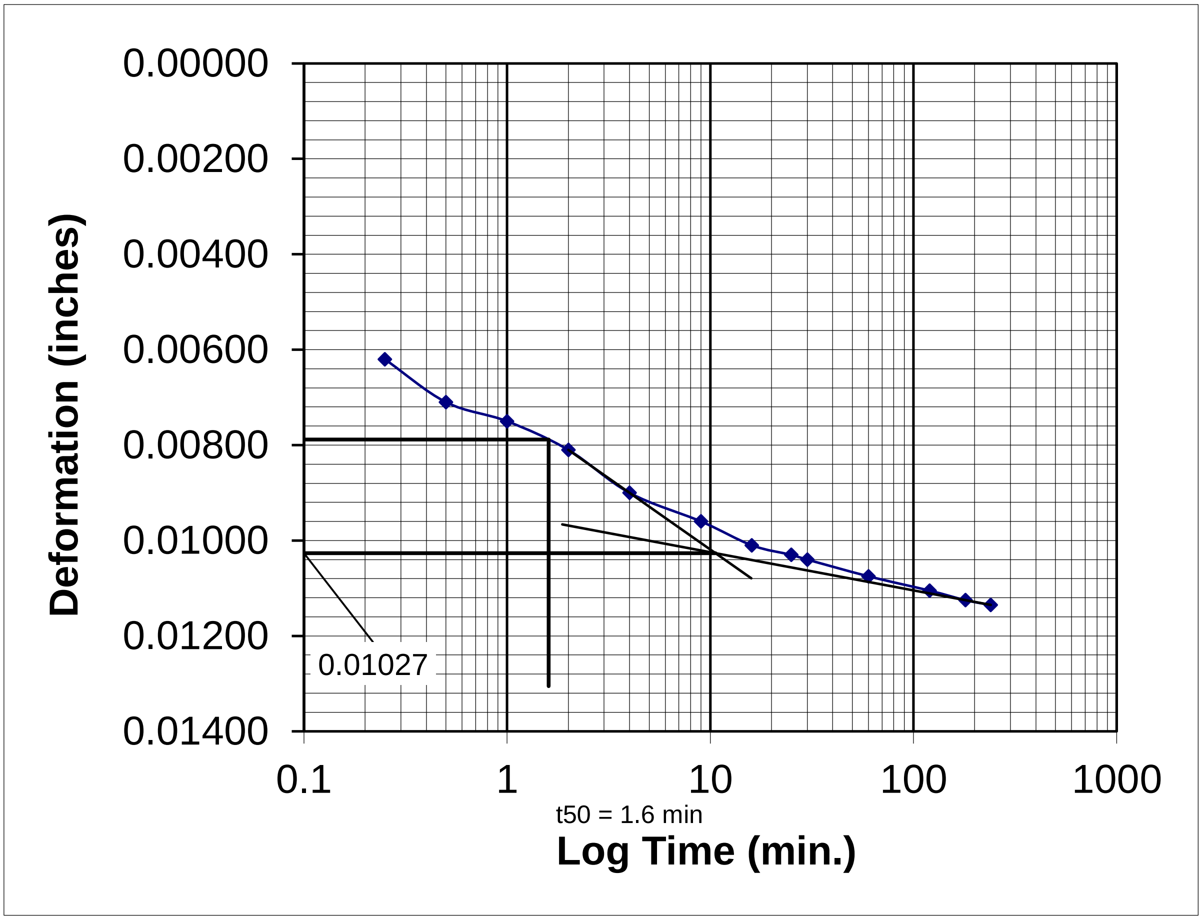
8.0 tsf Load

initial height= 0.97370 inches

Do= D1-(D2-D1)
1) 0.25 to 1.0: 0.00490
2) 0.5 to 2.0: 0.00610
3) 1.0 to 4.0: 0.00600
Do Avg 1&2: 0.00550
Do Avg 1-3: 0.00567
Use Do= 0.00550
D100= 0.01027
D50= D100+0.5(Do-D100)
D50= 0.00788

t50 = 1.6 min.

Interval Minutes	**Dial Reading**	**ΔH**	**Deformation Constant**	**TRUE ΔH**	**Height of Sample**
0	0.36620				
0.25	0.35820	0.00800	0.00180	0.00620	0.96750
0.5	0.35730	0.00890	0.00180	0.00710	0.96660
1	0.35690	0.00930	0.00180	0.00750	0.96620
2	0.35630	0.00990	0.00180	0.00810	0.96560
4	0.35540	0.01080	0.00180	0.00900	0.96470
9	0.35480	0.01140	0.00180	0.00960	0.96410
16	0.35430	0.01190	0.00180	0.01010	0.96360
25	0.35410	0.01210	0.00180	0.01030	0.96340
30	0.35400	0.01220	0.00180	0.01040	0.96330
60	0.35365	0.01255	0.00180	0.01075	0.96295
120	0.35335	0.01285	0.00180	0.01105	0.96265
180	0.35315	0.01305	0.00180	0.01125	0.96245
240	0.35305	0.01315	0.00180	0.01135	0.96235



Project No. : 230230 Sample No.: ST-3
Boring No. : B-025-0-22 Depth: 6.0 - 8.0'

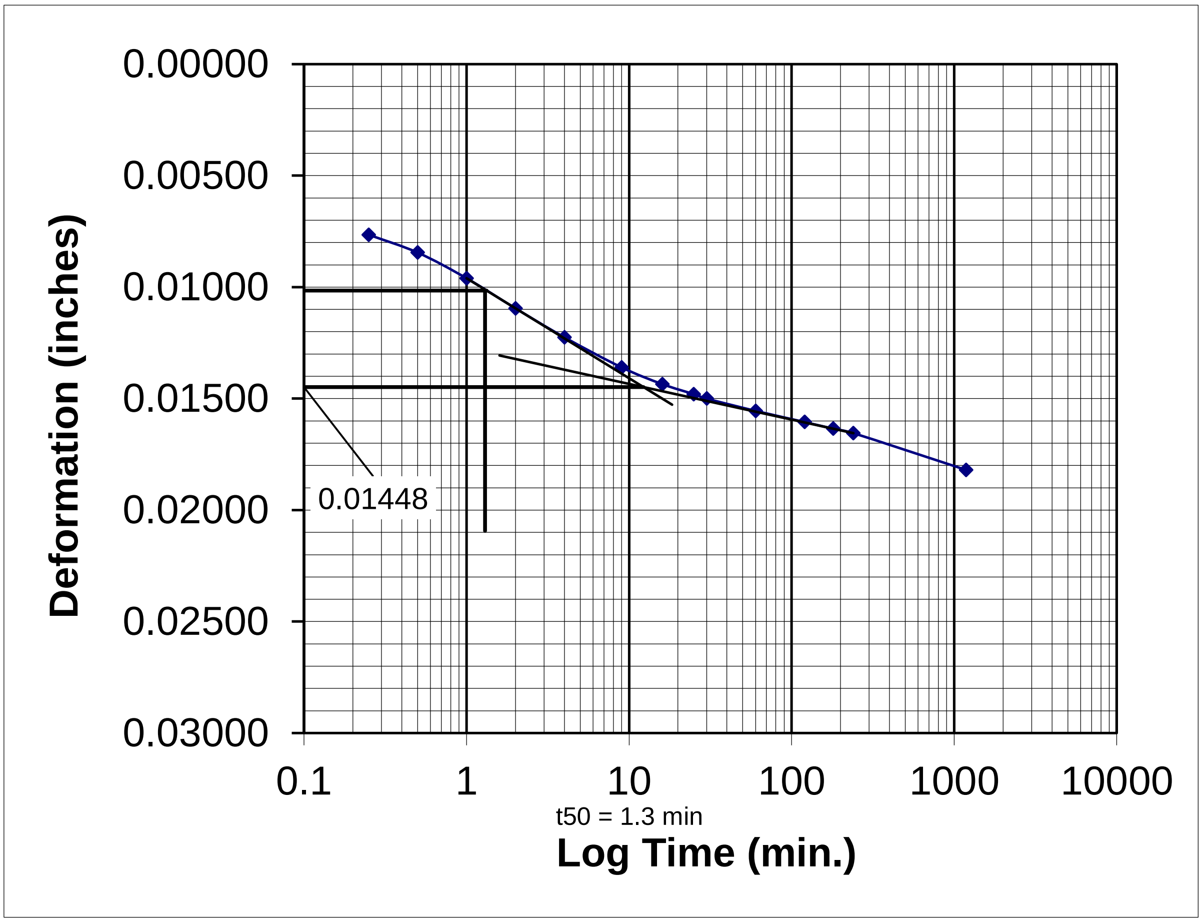
16 tsf Load

initial height= 0.96235 inches

Do= D1-(D2-D1)
1) 0.25 to 1.0: 0.00570
2) 0.5 to 2.0: 0.00595
3) 1.0 to 4.0: 0.00695
Do Avg 1&2: 0.00582
Do Avg 1-3: 0.00620
Use Do= 0.00582
D100= 0.01448
D50= D100+0.5(Do-D100)
D50= 0.01015

t50 = 1.3 min.

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.35305				
0.25	0.34360	0.00945	0.00180	0.00765	0.95470
0.5	0.34280	0.01025	0.00180	0.00845	0.95390
1	0.34165	0.01140	0.00180	0.00960	0.95275
2	0.34030	0.01275	0.00180	0.01095	0.95140
4	0.33900	0.01405	0.00180	0.01225	0.95010
9	0.33765	0.01540	0.00180	0.01360	0.94875
16	0.33690	0.01615	0.00180	0.01435	0.94800
25	0.33645	0.01660	0.00180	0.01480	0.94755
30	0.33625	0.01680	0.00180	0.01500	0.94735
60	0.33570	0.01735	0.00180	0.01555	0.94680
120	0.33520	0.01785	0.00180	0.01605	0.94630
180	0.33490	0.01815	0.00180	0.01635	0.94600
240	0.33470	0.01835	0.00180	0.01655	0.94580
1185	0.33305	0.02000	0.00180	0.01820	0.94415

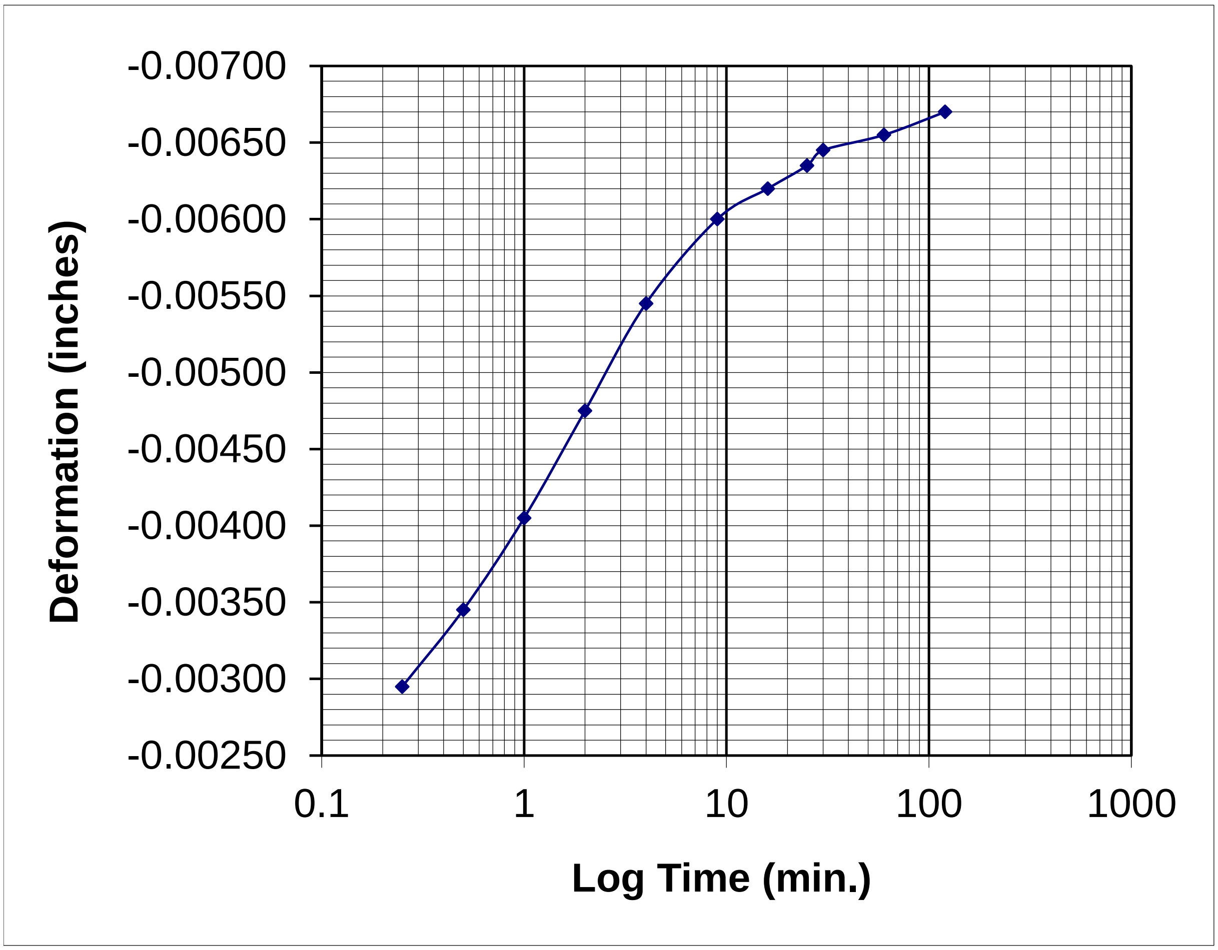


Project No. : 230230 Sample No.: ST-3
Boring No. : B-025-0-22 Depth: 6.0 - 8.0'

4.0 tsf Unload

initial height= 0.94415 inches

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.33305				
0.25	0.33710	-0.00405	-0.00110	-0.00295	0.94710
0.5	0.33760	-0.00455	-0.00110	-0.00345	0.94760
1	0.33820	-0.00515	-0.00110	-0.00405	0.94820
2	0.33890	-0.00585	-0.00110	-0.00475	0.94890
4	0.33960	-0.00655	-0.00110	-0.00545	0.94960
9	0.34015	-0.00710	-0.00110	-0.00600	0.95015
16	0.34035	-0.00730	-0.00110	-0.00620	0.95035
25	0.34050	-0.00745	-0.00110	-0.00635	0.95050
30	0.34060	-0.00755	-0.00110	-0.00645	0.95060
60	0.34070	-0.00765	-0.00110	-0.00655	0.95070
120	0.34085	-0.00780	-0.00110	-0.00670	0.95085



LEADING THROUGH the next 100 years

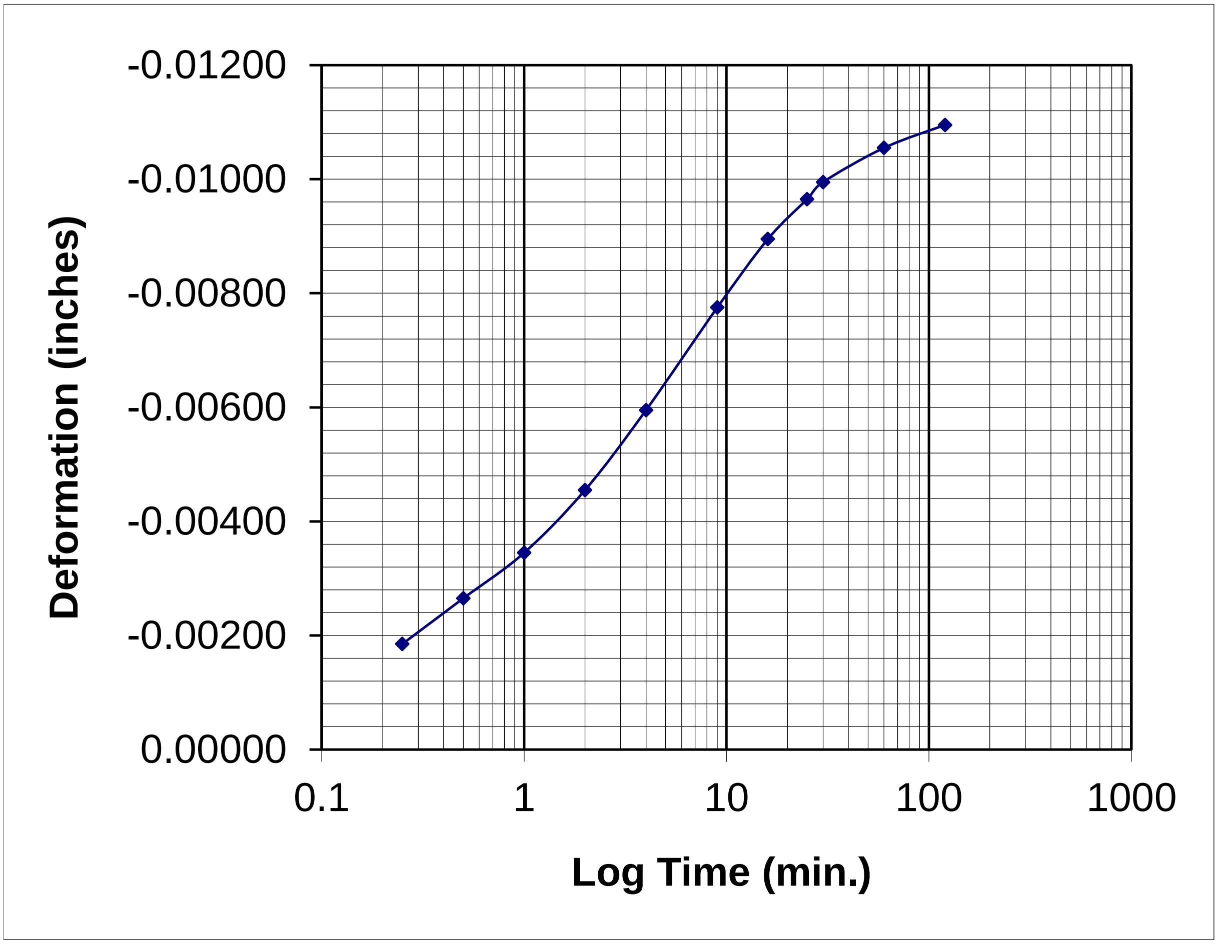
Project No. : 230230
Boring No. : B-025-0-22

Sample No.: ST-3
Depth: 6.0 - 8.0'

1.0 tsf Unload

initial height= 0.95085 inches

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.34085				
0.25	0.34430	-0.00345	-0.00160	-0.00185	0.95270
0.5	0.34510	-0.00425	-0.00160	-0.00265	0.95350
1	0.34590	-0.00505	-0.00160	-0.00345	0.95430
2	0.34700	-0.00615	-0.00160	-0.00455	0.95540
4	0.34840	-0.00755	-0.00160	-0.00595	0.95680
9	0.35020	-0.00935	-0.00160	-0.00775	0.95860
16	0.35140	-0.01055	-0.00160	-0.00895	0.95980
25	0.35210	-0.01125	-0.00160	-0.00965	0.96050
30	0.35240	-0.01155	-0.00160	-0.00995	0.96080
60	0.35300	-0.01215	-0.00160	-0.01055	0.96140
120	0.35340	-0.01255	-0.00160	-0.01095	0.96180

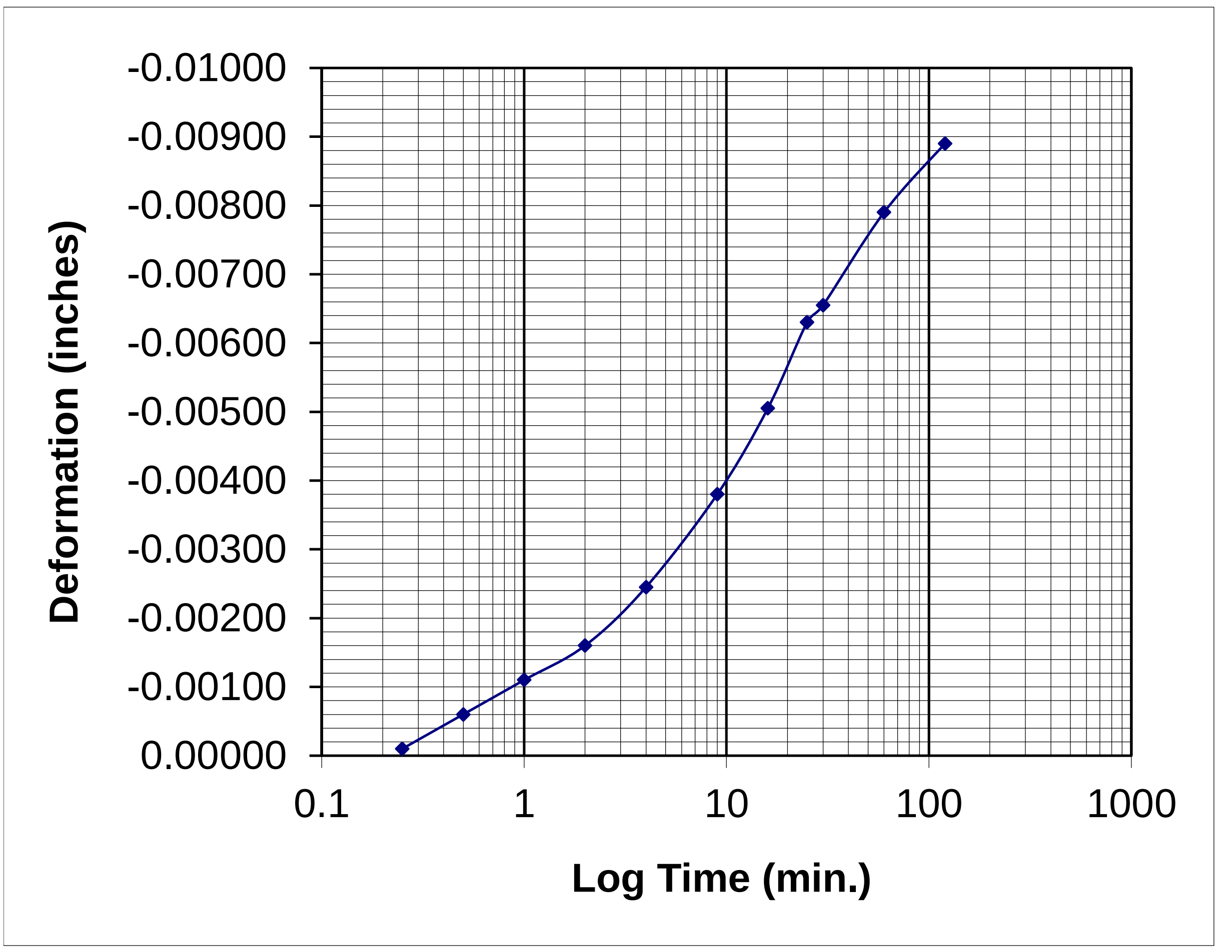


Project No. : 230230 Sample No.: ST-3
Boring No. : B-025-0-22 Depth: 6.0 - 8.0'

0.25 tsf Unload

initial height= 0.9618 inches

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.35340				
0.25	0.35490	-0.00150	-0.00140	-0.00010	0.96190
0.5	0.35540	-0.00200	-0.00140	-0.00060	0.96240
1	0.35590	-0.00250	-0.00140	-0.00110	0.96290
2	0.35640	-0.00300	-0.00140	-0.00160	0.96340
4	0.35725	-0.00385	-0.00140	-0.00245	0.96425
9	0.35860	-0.00520	-0.00140	-0.00380	0.96560
16	0.35985	-0.00645	-0.00140	-0.00505	0.96685
25	0.36110	-0.00770	-0.00140	-0.00630	0.96810
30	0.36135	-0.00795	-0.00140	-0.00655	0.96835
60	0.36270	-0.00930	-0.00140	-0.00790	0.96970
120	0.36370	-0.01030	-0.00140	-0.00890	0.97070



LEADING THROUGH the next 100 years

Compressive Strength of Rock ASTM D 7012, Method C

PROJECT	HEN-24/17D-00.43, PID 117712	CT PROJECT NUMBER	230230
LOCATION	Napoleon Township, Henry County, Ohio		
CLIENT	Burgess & Niple, Inc.		
BORING NUMBER	B-014-0-22	SAMPLE NUMBER	NQ2-2
SAMPLE DEPTH (FEET)	63.0 TO 68.0	SPECIMEN DEPTH (FEET)	63.0 TO 64.0

ROCK DESCRIPTION	SHALE, GRAY, MODERATELY WEATHERED, MODERATELY STRONG, JOINTED - MODERATELY FRACTURED TO SLIGHTLY FRACTURED, TIGHT

LENGTH (INCHES)	3.07	MASS (GRAMS)	400.20
DIAMETER (INCHES)	1.98	UNIT WEIGHT (LBS/CU. FT.)	161.3
LENGTH / DIAMETER	1.55		
CORRECTION FACTOR	1.0	MAXIMUM LOAD (LBS)	18,220
AREA (SQ. IN.)	3.08	COMPRESSIVE STRENGTH (PSI)	5,680

TEST SPECIMEN PHOTO

TEST SPECIMEN PHOTO

Compressive Strength of Rock ASTM D 7012, Method C

PROJECT	HEN-24/17D-00.43, PID 117712	CT PROJECT NUMBER	230230
LOCATION	Napoleon Township, Henry County, Ohio		
CLIENT	Burgess & Niple, Inc.		
BORING NUMBER	B-015-0-22	SAMPLE NUMBER	NQ2-2
SAMPLE DEPTH (FEET)	65.5 TO 75.5	SPECIMEN DEPTH (FEET)	65.6 TO 66.0

ROCK DESCRIPTION	SHALE, GRAY, MODERATELY WEATHERED, STRONG, JOINTED - FRACTURED TO MODERATLY FRACTURED, TIGHT

LENGTH (INCHES)	4.02	MASS (GRAMS)	510.80
DIAMETER (INCHES)	1.98	UNIT WEIGHT (LBS/CU. FT.)	157.2
LENGTH / DIAMETER	2.03		
CORRECTION FACTOR	1.0	MAXIMUM LOAD (LBS)	24,100
AREA (SQ. IN.)	3.08	COMPRESSIVE STRENGTH (PSI)	7,830

TEST SPECIMEN PHOTO

TEST SPECIMEN PHOTO

Compressive Strength of Rock ASTM D 7012, Method C

PROJECT	HEN-24/17D-00.43, PID 117712	CT PROJECT NUMBER	230230
LOCATION	Napoleon Township, Henry County, Ohio		
CLIENT	Burgess & Niple, Inc.		
BORING NUMBER	B-019-0-22	SAMPLE NUMBER	NQ2-1
SAMPLE DEPTH (FEET)	60.0 TO 65.0	SPECIMEN DEPTH (FEET)	63.5 TO 63.9

ROCK DESCRIPTION	SHALE, GRAY, SLIGHTLY WEATHERED, STRONG, JOINTED - FRACTURED TO MODERATELY FRACTURED, TIGHT

LENGTH (INCHES)	2.26	MASS (GRAMS)	290.20
DIAMETER (INCHES)	1.98	UNIT WEIGHT (LBS/CU. FT.)	158.9
LENGTH / DIAMETER	1.14		
CORRECTION FACTOR	0.9	MAXIMUM LOAD (LBS)	28,190
AREA (SQ. IN.)	3.08	COMPRESSIVE STRENGTH (PSI)	8,240

TEST SPECIMEN PHOTO

TEST SPECIMEN PHOTO

Compressive Strength of Rock ASTM D 7012, Method C

PROJECT	HEN-24/17D-00.43, PID 117712	CT PROJECT NUMBER	230230
LOCATION	Napoleon Township, Henry County, Ohio		
CLIENT	Burgess & Niple, Inc.		
BORING NUMBER	B-024-0-22	SAMPLE NUMBER	NQ2-1
SAMPLE DEPTH (FEET)	59.0 TO 64.0	SPECIMEN DEPTH (FEET)	61.0 TO 61.5

ROCK DESCRIPTION	SHALE, GRAY, SLIGHTLY WEATHERED, STRONG, JOINTED - MODERATELY FRACTURED TO SLIGHTLY FRACTURED, TIGHT

LENGTH (INCHES)	3.35	MASS (GRAMS)	429.90
DIAMETER (INCHES)	1.98	UNIT WEIGHT (LBS/CU. FT.)	158.8
LENGTH / DIAMETER	1.69		
CORRECTION FACTOR	1.0	MAXIMUM LOAD (LBS)	28,180
AREA (SQ. IN.)	3.08	COMPRESSIVE STRENGTH (PSI)	8,970

TEST SPECIMEN PHOTO

TEST SPECIMEN PHOTO

Compressive Strength of Rock ASTM D 7012, Method C

Project	HEN-24/17D-00.43, PID 117712	CT Project Number	230230
Location	Napoleon Township, Henry County, Ohio		
Client	Burgess & Niple, Inc.		
Boring Number	B-025-0-22	Sample Number	NQ2-1
Sample Depth (feet)	59.0 TO 64.0	Specimen Depth (feet)	61.7 TO 62.1

Rock Description	SHALE, GRAY, SLIGHTLY WEATHERED, MODERATELY STRONG, JOINTED - FRACTURED TO MODERATELY FRACTURED, TIGHT

Length (inches)	3.42	Mass (grams)	430.30
Diameter (inches)	1.98	Unit Weight (lbs/cu. ft.)	155.7
Length / Diameter	1.73		
Correction Factor	1.0	Maximum Load (lbs)	23,390
Area (sq. in.)	3.08	Compressive Strength (psi)	7,450

Test Specimen Photo

Test Specimen Photo

Appendix B
Rock Core Photographic Logs

Ohio Department of Transportation
Division of Engineering

Office of Geotechnical Engineering

B-014-0-22

Core Date: July 18, 2023					Ground Surface Elevation: 699.2’			
Run #:	Depth		Elevation		Recovery		RQD	
NQ2-1	58.0’	63.0’	641.2’	636.2’	54/60	90%	24/60	40%
NQ2-2	63.0’	68.0’	636.2’	631.2’	55/60	92%	55/60	92%
HEN-24/17D-00.43, PID 117712								

Prepared by

LEADING THROUGH the next 100 years

CT Project No.: 230230

Ohio Department of Transportation
Division of Engineering

Office of Geotechnical Engineering

B-015-0-22

Core Date: July 26,2023					Ground Surface Elevation: 700.7'			
Run #:	Depth		Elevation		Recovery		RQD	
NQ2-1	60.5'	65.5'	640.2'	635.2'	60/60	100%	41/60	68%
NQ2-2	65.5'	70.5'	635.2'	630.2'	60/60	100%	32/60	53%
HEN-24/17D-00.43, PID 117712								

Prepared by

CT Project No.: 230230

B-019-0-22

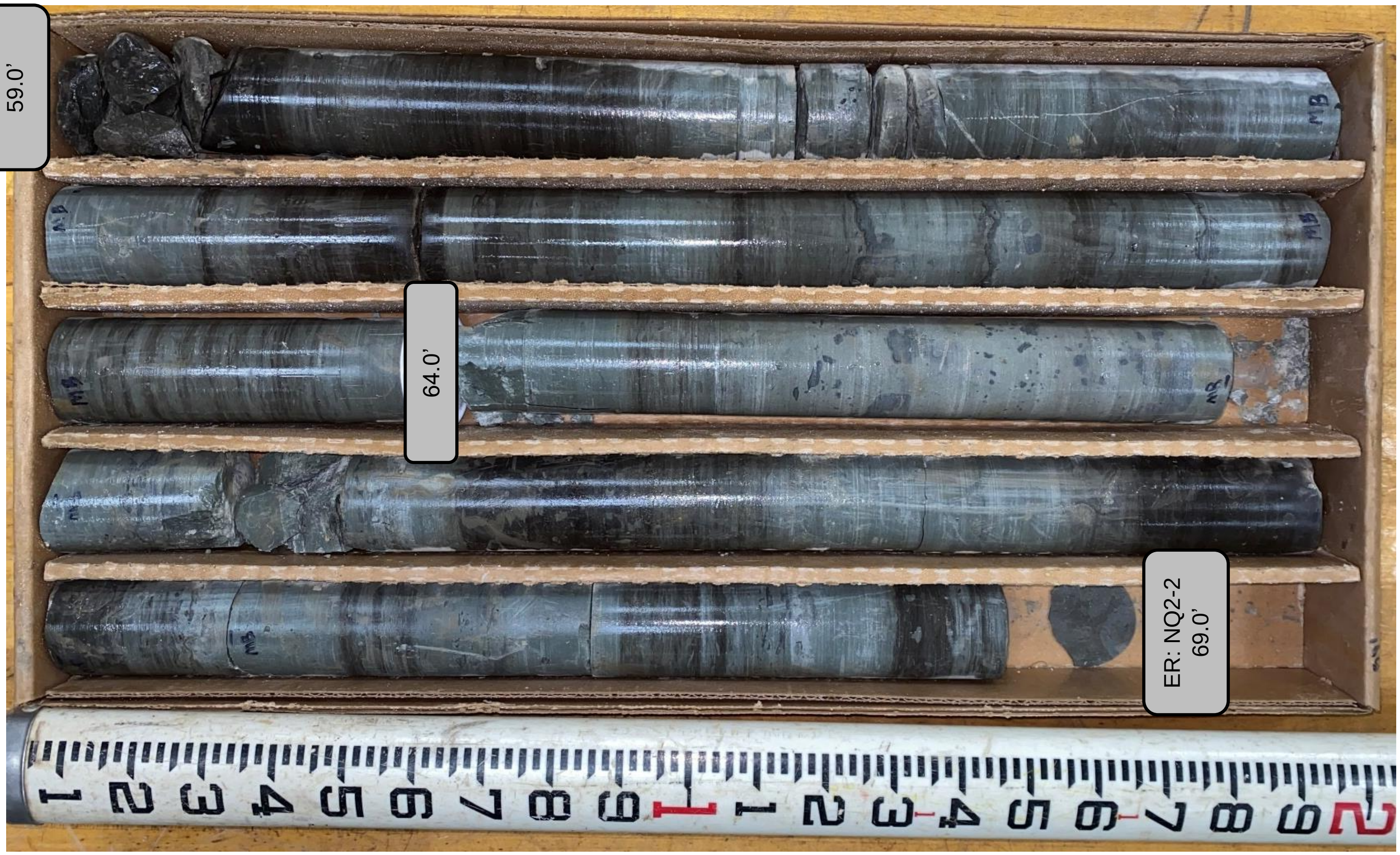
Core Date: June 30, 2023					Ground Surface Elevation: 701.7’			
Run #:	Depth		Elevation		Recovery		RQD	
NQ2-1	60.0’	65.0’	641.7’	636.7’	60/60	100%	23/60	38%
HEN-24/17D-00.43, PID 117712								

Prepared by

Ohio Department of Transportation
Division of Engineering

Office of Geotechnical Engineering

B-024-0-22



Core Date: May 10, 2023					Ground Surface Elevation: 700.2'			
Run #:	Depth		Elevation		Recovery		RQD	
NQ2-1	59.0'	64.0'	641.2'	636.2'	54/60	90%	48/60	80%
NQ2-2	64.0'	69.0'	636.2'	631.2'	55/60	92%	53/60	88%
HEN-24/17D-00.43, PID 117712								

Prepared by

CT Project No.: 230230

OHIO DEPARTMENT OF TRANSPORTATION
DIVISION OF ENGINEERING

Office of Geotechnical Engineering

B-025-0-22

Core Date: July 30, 2023					Ground Surface Elevation: 698.5’			
Run #:	Depth		Elevation		Recovery		RQD	
NQ2-1	59.0’	64.0’	639.5’	634.5’	54/60	90%	43/60	72%
NQ2-2	64.0’	69.0’	634.5’	629.5’	60/60	100%	32/60	53%
HEN-24/17D-00.43, PID 117712								

Prepared by

LEADING THROUGH the next 100 years

CT Project No.: 230230

Appendix C

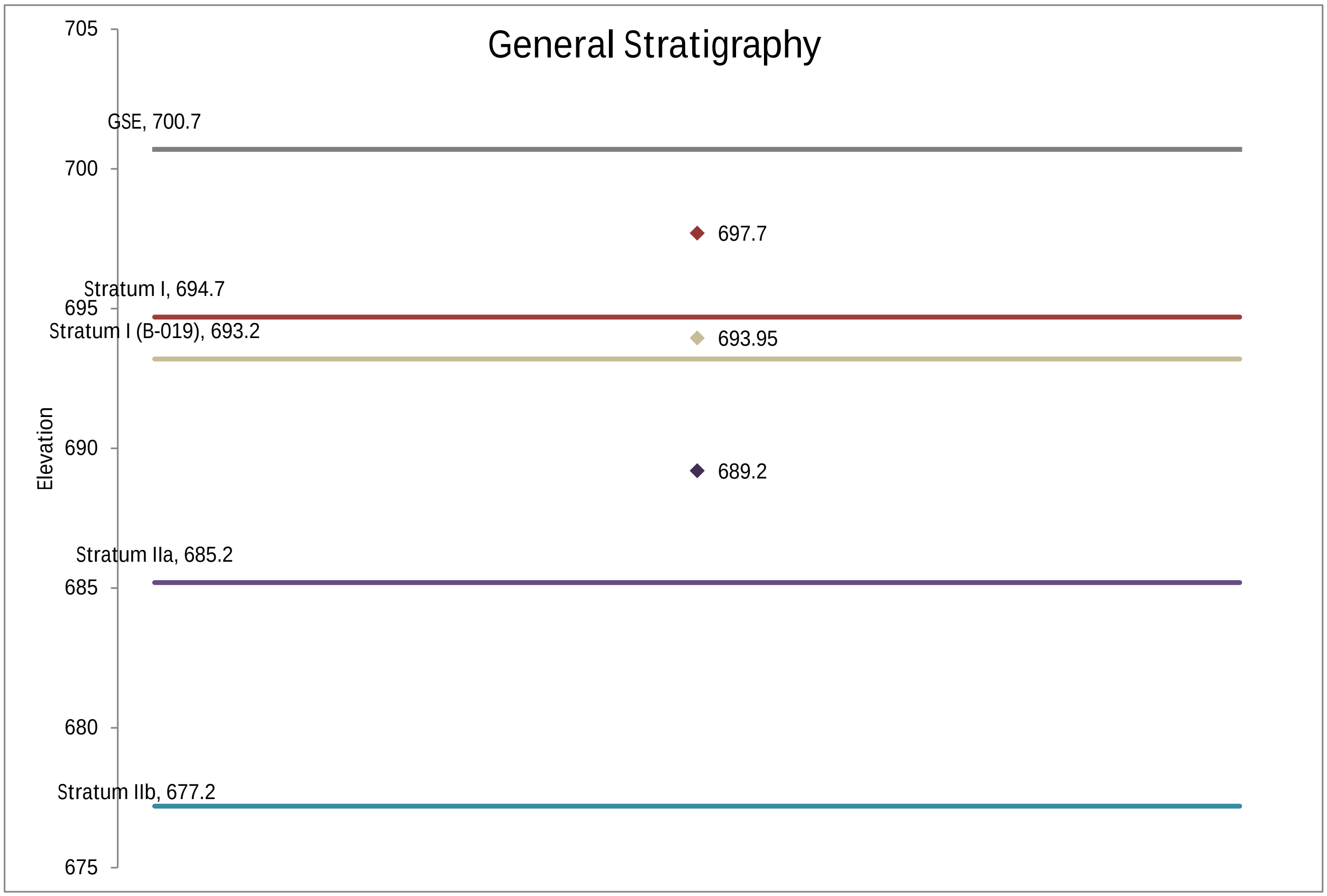
Embankment Evaluations and Calculations (Including Special Benching Diagrams)

LEADING THROUGH the next 100 years

Project Name: HEN-24/17D-00.43, PID 117712 Boring Number B-015 - Forward Abutment
Project Number: 230230 Analysis Type Embankment
Calculated by: KCH 3/26/2024

Settlement Analysis Results:

Layer	H (feet)	C_c or C_r	e_o	σ_v' (psf)	z (feet)	$I_{z,A}$	ΔP_A at P_A of 2875 psf	$I_{z,B}$	ΔP_B at P_B of 2875 psf	Total ΔP (psf)	ΔH (inches)
Stratum I	6	0.019	0.62	375	3	0.500	1,438	0.500	1,438	2,875	0.79
Stratum I (B-019)	1.5	0.019	0.62	844	6.75	0.500	1,438	0.500	1,438	2,875	0.14
Stratum IIa	8	0.027	0.51	1,458	11.5	0.492	1,415	0.492	1,415	2,829	0.80
Stratum IIb	8	0.027	0.51	2,061	19.5	0.472	1,357	0.472	1,357	2,714	0.63
Stratum III	14	0.033	0.57	2,839	30.5	0.460	1,323	0.460	1,323	2,645	1.01
Stratum IV	20.5	0.011	0.47	4,092	47.75	0.413	1,187	0.413	1,187	2,375	0.37



Sum ΔH (in.) below embankment	3.74
+15%	4.30
-15%	3.18

Settlement Under Self Weight (CL)	3.67

TOTAL SETTLEMENT	6.75 to 8 inches

Project Name:	HEN-24/17D-00.43, PID 117712	Boring Number	B-015 - Forward Abutment
Project Number:	230230	Analysis Type	Embankment
Calculated by:	KCH 3/26/2024		

Boring Properties & Settlement Analysis Inputs:

G	2.7
GSE	700.7
GWT	688.2
Bearing Elev	700.7

$B_{2,A}$	46 ft	$B_{1,A}$	27.5 ft
$B_{2,B}$	46 ft	$B_{1,B}$	27.5 ft
P_A	2,875 psf	H_A	23 ft
P_B	2,875 psf	H_B	23 ft

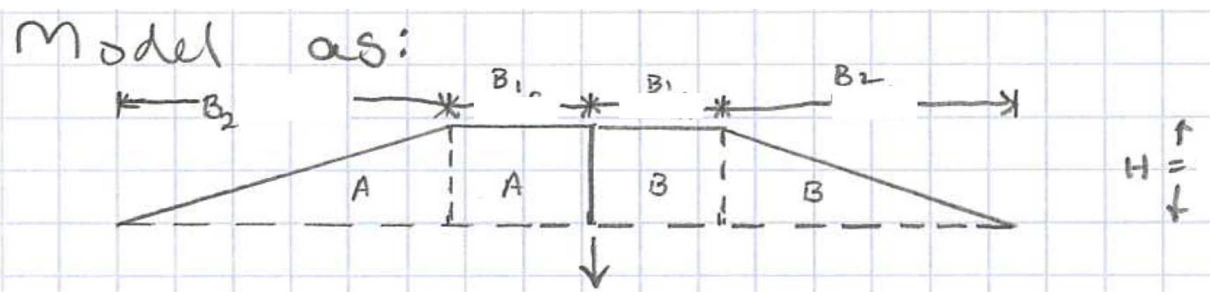
Project-Specific Consolidation Soil Properties:

Stratum	e_o	C_c	C_r	P_c (psf)	γ_T (pcf)	Basis
I	0.62	0.194	0.019	4,250	125	Estimated
II	0.512	0.118	0.027	5,500	130	Tested
III	0.565	0.13	0.033	6,200	135	Tested
IV	0.47	0.109	0.011	34,890	135	Estimated

note: Hardpan considered highly overconsolidated. Use Cr.

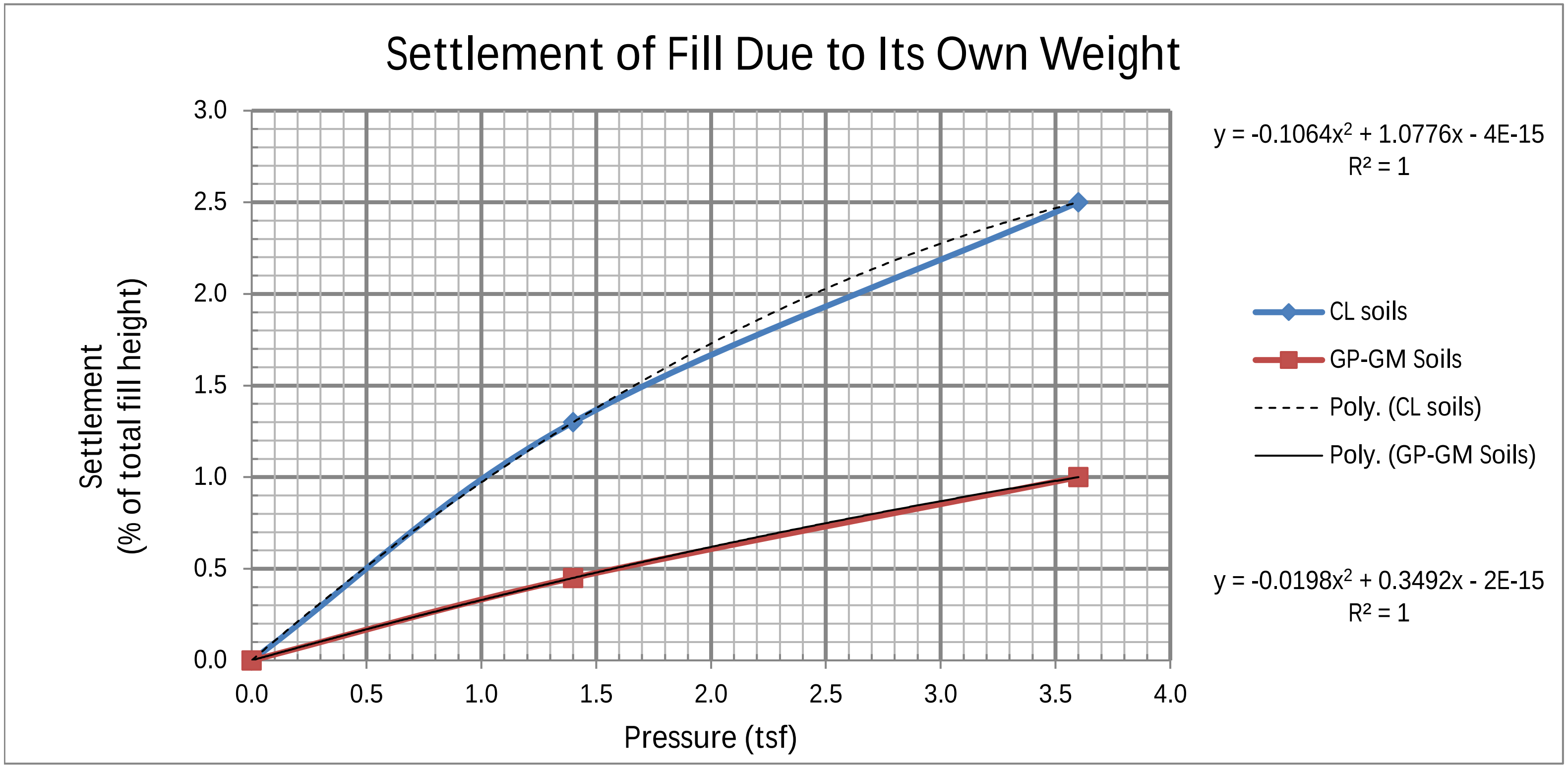
Layer Inputs based on Encountered Strata:

Encountered Layer	Bot. Elev.	Centroid (C) Elev.	H (ft)	z below footing	z below GSE	γ_T (pcf)	H_{GWT-C}	σ_v' (psf)	$\Delta P+\sigma_v'$ (psf)	Layer Pc (psf)	Use	Layer C_r	e_o	$B_{1,A}/z$	$B_{2,A}/z$	$I_{z,A}$	$B_{1,B}/z$	$B_{2,B}/z$	$I_{z,B}$
Stratum I	694.7	697.7	6	3	3	125	-9.5	375	3,250	4,250	Cr	0.019	0.62	9.2	15.3	0.500	9.2	15.3	0.500
Stratum I (B-019)	693.2	693.95	1.5	6.75	6.75	125	-5.75	844	3,719	4,250	Cr	0.019	0.62	4.1	6.8	0.500	4.1	6.8	0.500
Stratum IIa	685.2	689.2	8	11.5	11.5	130	-1	1,458	4,287	5,500	Cr	0.027	0.51	2.4	4.0	0.492	2.4	4.0	0.492
Stratum IIb	677.2	681.2	8	19.5	19.5	130	7	2,061	4,775	5,500	Cr	0.027	0.51	1.4	2.4	0.472	1.4	2.4	0.472
Stratum III	663.2	670.2	14	30.5	30.5	135	18	2,839	5,484	6,200	Cr	0.033	0.57	0.9	1.5	0.460	0.9	1.5	0.460
Stratum IV	642.7	652.95	20.5	47.75	47.75	135	35.25	4,092	6,466	34,890	Cr	0.011	0.47	0.6	1.0	0.413	0.6	1.0	0.413



clays of low to medium plasticity (CL)	
pressure	typical value of compression - (percent of total fill height)
0	0
1.4	1.3
3.6	2.5
Poorly Graded Gravel with sand and silt (GP-GM)	
pressure	typical value of compression - (percent of total fill height)
0	0
1.4	0.45
3.6	1

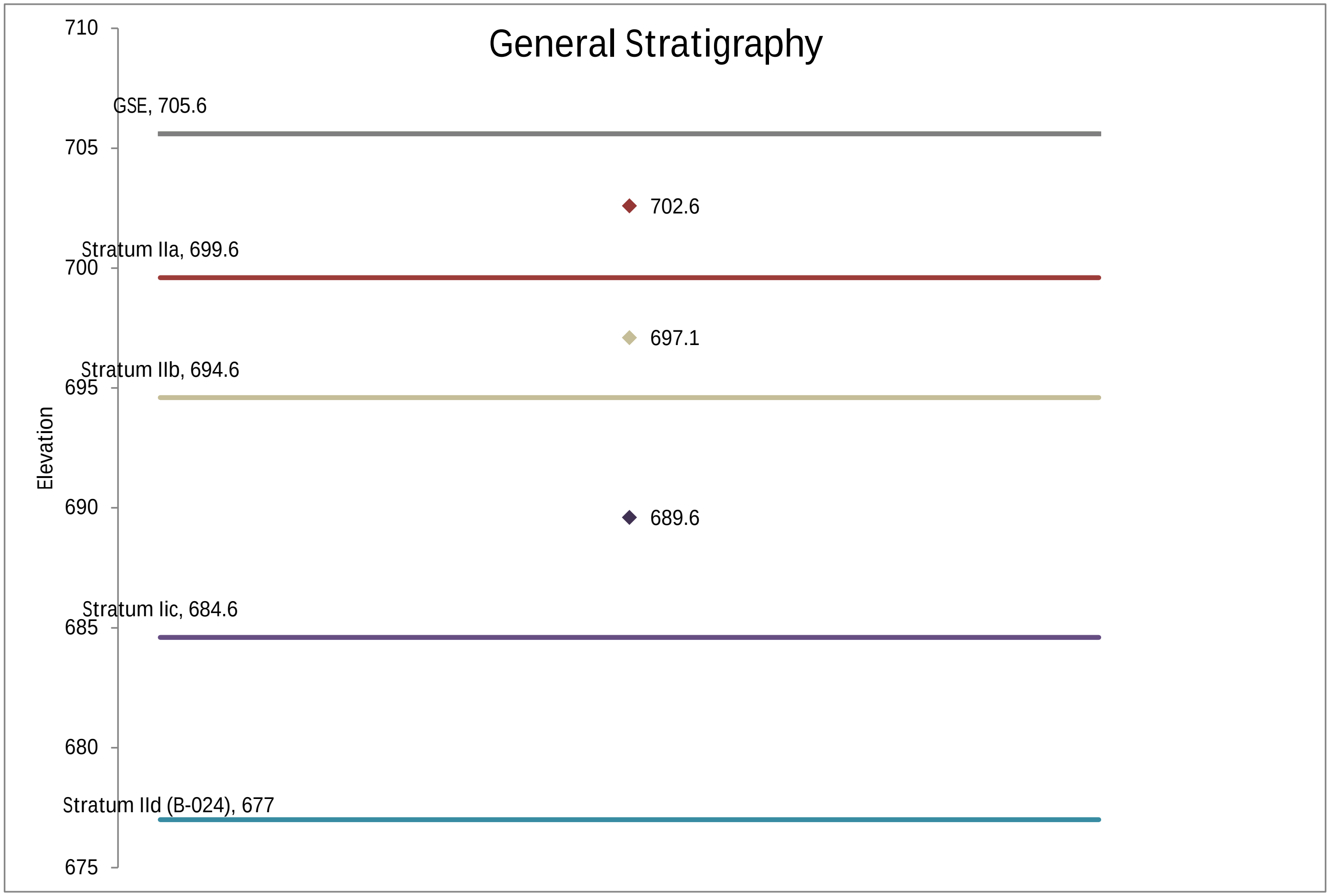
Max. Embankment Pressure =	2,875	psf
=	1.4375	tsf
Settlement CL	1.3	%
Max. Embankment Height =	23	ft
Settlement =	3.67	inches
Settlement GP-GM	0.5	%
Max. Embankment Height =	23	ft
Settlement =	1.27	inches



Project Name: HEN-24/17D-00.43, PID 117712 Boring Number B-018 - Ramp Intersection (Rear Side)
Project Number: 230230 Analysis Type Embankment
Calculated by: KCH 3/25/2024

Settlement Analysis Results:

Layer	H (feet)	C_c or C_r	e_o	σ_v' (psf)	z (feet)	$I_{z,A}$	ΔP_A at P_A of 1750 psf	$I_{z,B}$	ΔP_B at P_B of 1750 psf	Total ΔP (psf)	ΔH (inches)
Stratum IIa	6	0.027	0.51	390	3	0.500	875	0.500	875	1,750	0.95
Stratum IIb	5	0.027	0.51	1,105	8.5	0.498	872	0.498	872	1,743	0.44
Stratum Iic	10	0.027	0.51	1,768	16	0.490	858	0.490	858	1,715	0.63
Stratum IId (B-024)	7.6	0.027	0.51	2,363	24.8	0.465	814	0.465	814	1,628	0.37
Stratum III (B-024)	11	0.033	0.57	3,019	34.1	0.430	753	0.430	753	1,505	0.49
Stratum IV (B-024)	17.5	0.011	0.47	4,054	48.35	0.372	651	0.372	651	1,302	0.19



Sum ΔH (in.) below embankment	3.07
+15%	3.53
-15%	2.61

Settlement Under Self Weight (CL)	1.45

TOTAL SETTLEMENT	4 to 5 inches

Project Name:	HEN-24/17D-00.43, PID 117712	Boring Number	B-018 - Ramp Intersection (Rear Side)
Project Number:	230230	Analysis Type	Embankment
Calculated by:	KCH 3/25/2024		

Boring Properties & Settlement Analysis Inputs:

G	2.7			
GSE	705.6			
GWT	694.6			
Bearing Elev	705.6			
$B_{2,A}$	28 ft		$B_{1,A}$	27.5 ft
$B_{2,B}$	28 ft		$B_{1,B}$	27.5 ft
P_A	1,750 psf		H_A	14 ft
P_B	1,750 psf		H_B	14 ft

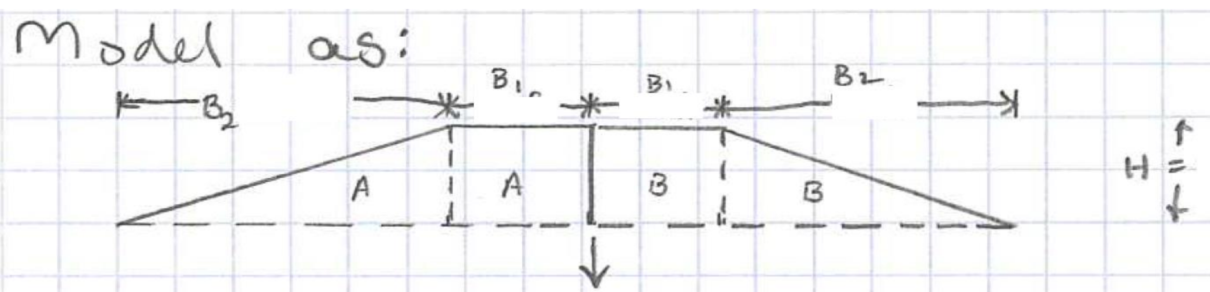
Project-Specific Consolidation Soil Properties:

Stratum	e_o	C_c	C_r	P_c (psf)	γ_T (pcf)	Basis
I	0.62	0.194	0.019	4,250	125	Estimated
II	0.512	0.118	0.027	5,500	130	Tested
III	0.565	0.13	0.033	6,200	135	Tested
IV	0.47	0.109	0.011	34,890	135	Estimated

note: Hardpan considered highly overconsolidated. Use Cr.

Layer Inputs based on Encountered Strata:

Encountered Layer	Bot. Elev.	Centroid (C) Elev.	H (ft)	z below footing	z below GSE	γ_T (pcf)	H_{GWT-C}	σ_v' (psf)	$\Delta P+\sigma_v'$ (psf)	Layer Pc (psf)	Use	Layer C_r	e_o	$B_{1,A}/z$	$B_{2,A}/z$	$I_{z,A}$	$B_{1,B}/z$	$B_{2,B}/z$	$I_{z,B}$
Stratum IIa	699.6	702.6	6	3	3	130	-8	390	2,140	4,250	Cr	0.027	0.51	9.2	9.3	0.500	9.2	9.3	0.500
Stratum IIb	694.6	697.1	5	8.5	8.5	130	-2.5	1,105	2,848	4,250	Cr	0.027	0.51	3.2	3.3	0.498	3.2	3.3	0.498
Stratum Iic	684.6	689.6	10	16	16	130	5	1,768	3,483	5,500	Cr	0.027	0.51	1.7	1.8	0.490	1.7	1.8	0.490
Stratum IId (B-024)	677	680.8	7.6	24.8	24.8	130	13.8	2,363	3,990	5,500	Cr	0.027	0.51	1.1	1.1	0.465	1.1	1.1	0.465
Stratum III (B-024)	666	671.5	11	34.1	34.1	135	23.1	3,019	4,524	6,200	Cr	0.033	0.57	0.81	0.82	0.430	0.8	0.8	0.430
Stratum IV (B-024)	648.5	657.25	17.5	48.35	48.35	135	37.35	4,054	5,356	34,890	Cr	0.011	0.47	0.57	0.58	0.372	0.6	0.6	0.372



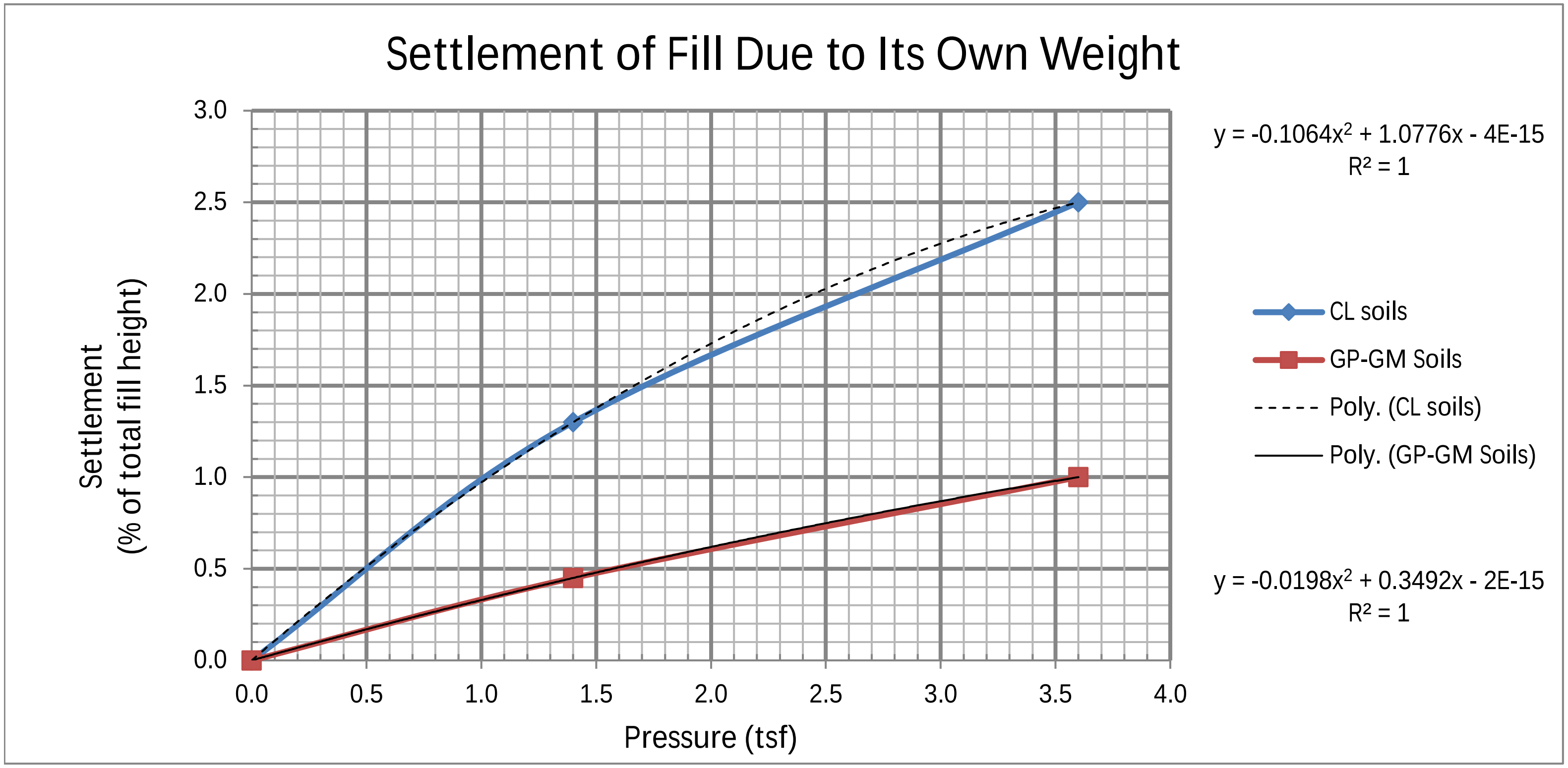
clays of low to medium plasticity (CL)

pressure	typical value of compression - (percent of total fill height)
0	0
1.4	1.3
3.6	2.5

Poorly Graded Gravel with sand and silt (GP-GM)

pressure	typical value of compression - (percent of total fill height)
0	0
1.4	0.45
3.6	1

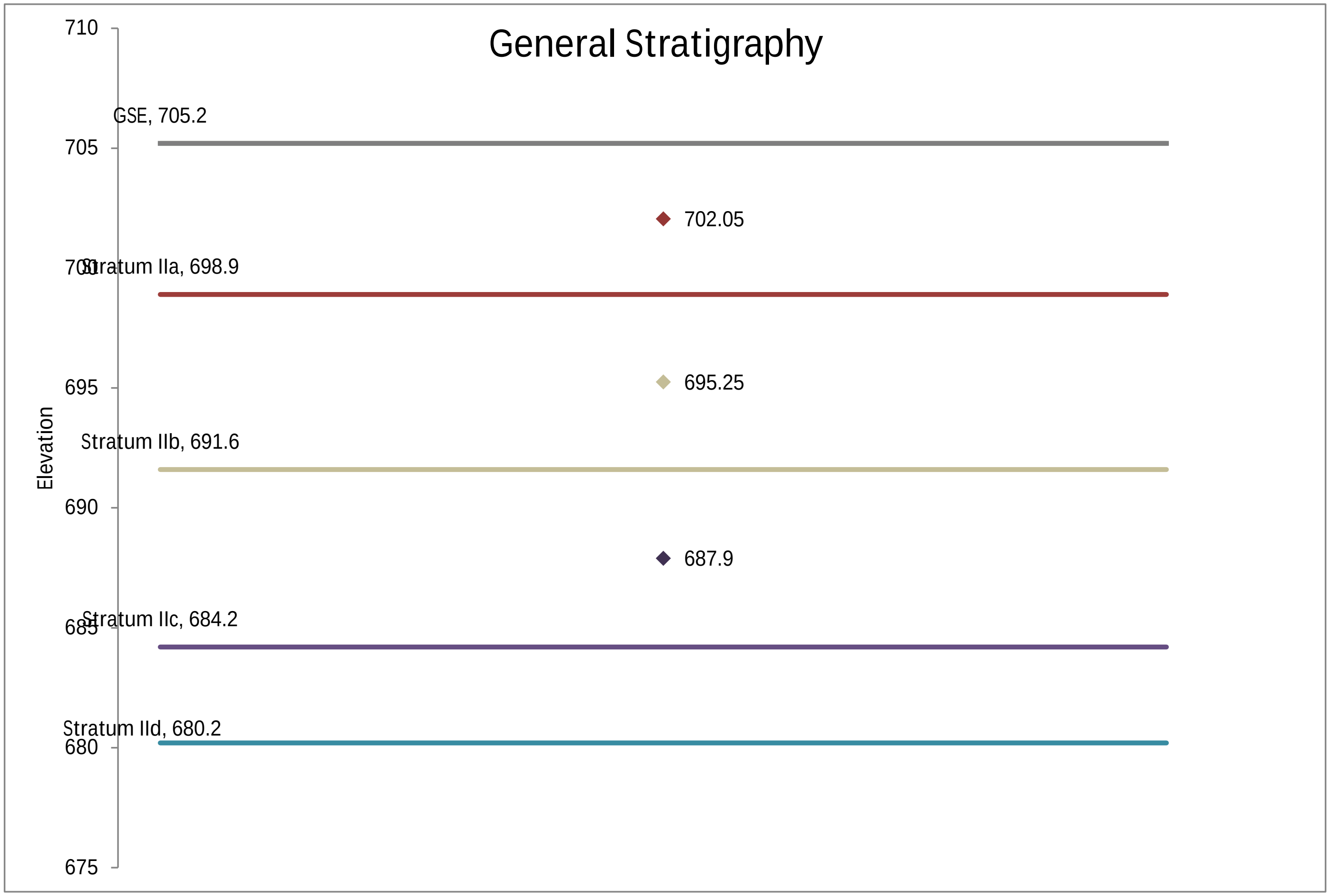
Max. Embankment Pressure =	1,750	psf
=	0.875	tsf
Settlement CL	0.9	%
Max. Embankment Height =	14	ft
Settlement =	1.45	inches
Settlement GP-GM	0.3	%
Max. Embankment Height =	14	ft
Settlement =	0.49	inches



Project Name:	HEN-24/17D-00.43, PID 117712	Boring Number	B-020 - Ramp Intersection (Forward Side)
Project Number:	230230	Analysis Type	Embankment
Calculated by:	KCH 3/25/2024		

Settlement Analysis Results:

Layer	H (feet)	C_c or C_r	e_o	σ_v' (psf)	z (feet)	$I_{z,A}$	ΔP_A at P_A of 2000 psf	$I_{z,B}$	ΔP_B at P_B of 2000 psf	Total ΔP (psf)	ΔH (inches)
Stratum IIa	6.3	0.027	0.51	409	3.15	0.500	1,000	0.500	1,000	2,000	1.04
Stratum IIb	7.3	0.027	0.51	1,294	9.95	0.493	986	0.493	986	1,972	0.63
Stratum IIc	7.4	0.027	0.51	1,843	17.3	0.489	978	0.489	978	1,956	0.50
Stratum IId	4	0.027	0.51	2,229	23	0.475	950	0.475	950	1,900	0.23
Stratum III (B-015)	13.2	0.033	0.57	2,843	31.6	0.446	892	0.446	892	1,784	0.71
Stratum IV (B-015)	20.5	0.011	0.47	4,066	48.45	0.380	760	0.380	760	1,520	0.25



Sum ΔH (in.) below embankment	3.36
+15%	3.86
-15%	2.85

Settlement Under Self Weight (CL)	1.86

TOTAL SETTLEMENT	4.75 to 5.75 inches

Project Name:	HEN-24/17D-00.43, PID 117712	Boring Number	B-020 - Ramp Intersection (Forward Side)
Project Number:	230230	Analysis Type	Embankment
Calculated by:	KCH 3/25/2024		

Boring Properties & Settlement Analysis Inputs:

G	2.7				
GSE	705.2				
GWT	694.4				
Bearing Elev	705.2				
$B_{2,A}$	32	ft	$B_{1,A}$	27.5	ft
$B_{2,B}$	32	ft	$B_{1,B}$	27.5	ft
P_A	2,000	psf	H_A	16	ft
P_B	2,000	psf	H_B	16	ft

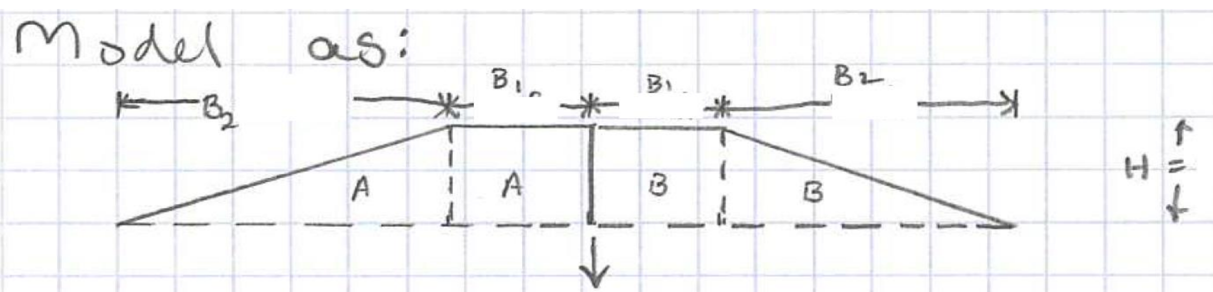
Project-Specific Consolidation Soil Properties:

Stratum	e_o	C_c	C_r	P_c (psf)	γ_T (pcf)	Basis
I	0.62	0.194	0.019	4,250	125	Estimated
II	0.512	0.118	0.027	5,500	130	Tested
III	0.565	0.13	0.033	6,200	135	Tested
IV	0.47	0.109	0.011	34,890	135	Estimated

note: Hardpan considered highly overconsolidated. Use Cr.

Layer Inputs based on Encountered Strata:

Encountered Layer	Bot. Elev.	Centroid (C) Elev.	H (ft)	z below footing	z below GSE	γ_T (pcf)	H_{GWT-C}	σ_v' (psf)	$\Delta P+\sigma_v'$ (psf)	Layer Pc (psf)	Use	Layer C_r	e_o	$B_{1,A}/z$	$B_{2,A}/z$	$I_{z,A}$	$B_{1,B}/z$	$B_{2,B}/z$	$I_{z,B}$
Stratum IIa	698.9	702.05	6.3	3.15	3.15	130	-7.65	409	2,410	4,250	Cr	0.027	0.51	8.7	10.2	0.500	8.7	10.2	0.500
Stratum IIb	691.6	695.25	7.3	9.95	9.95	130	-0.85	1,294	3,266	4,250	Cr	0.027	0.51	2.8	3.2	0.493	2.8	3.2	0.493
Stratum IIc	684.2	687.9	7.4	17.3	17.3	130	6.5	1,843	3,799	5,500	Cr	0.027	0.51	1.6	1.8	0.489	1.6	1.8	0.489
Stratum IId	680.2	682.2	4	23	23	130	12.2	2,229	4,129	5,500	Cr	0.027	0.51	1.2	1.4	0.475	1.2	1.4	0.475
Stratum III (B-015)	667	673.6	13.2	31.6	31.6	135	20.8	2,843	4,627	6,200	Cr	0.033	0.57	0.87	1.01	0.446	0.9	1.0	0.446
Stratum IV (B-015)	646.5	656.75	20.5	48.45	48.45	135	37.65	4,066	5,586	34,890	Cr	0.011	0.47	0.57	0.66	0.380	0.6	0.7	0.380



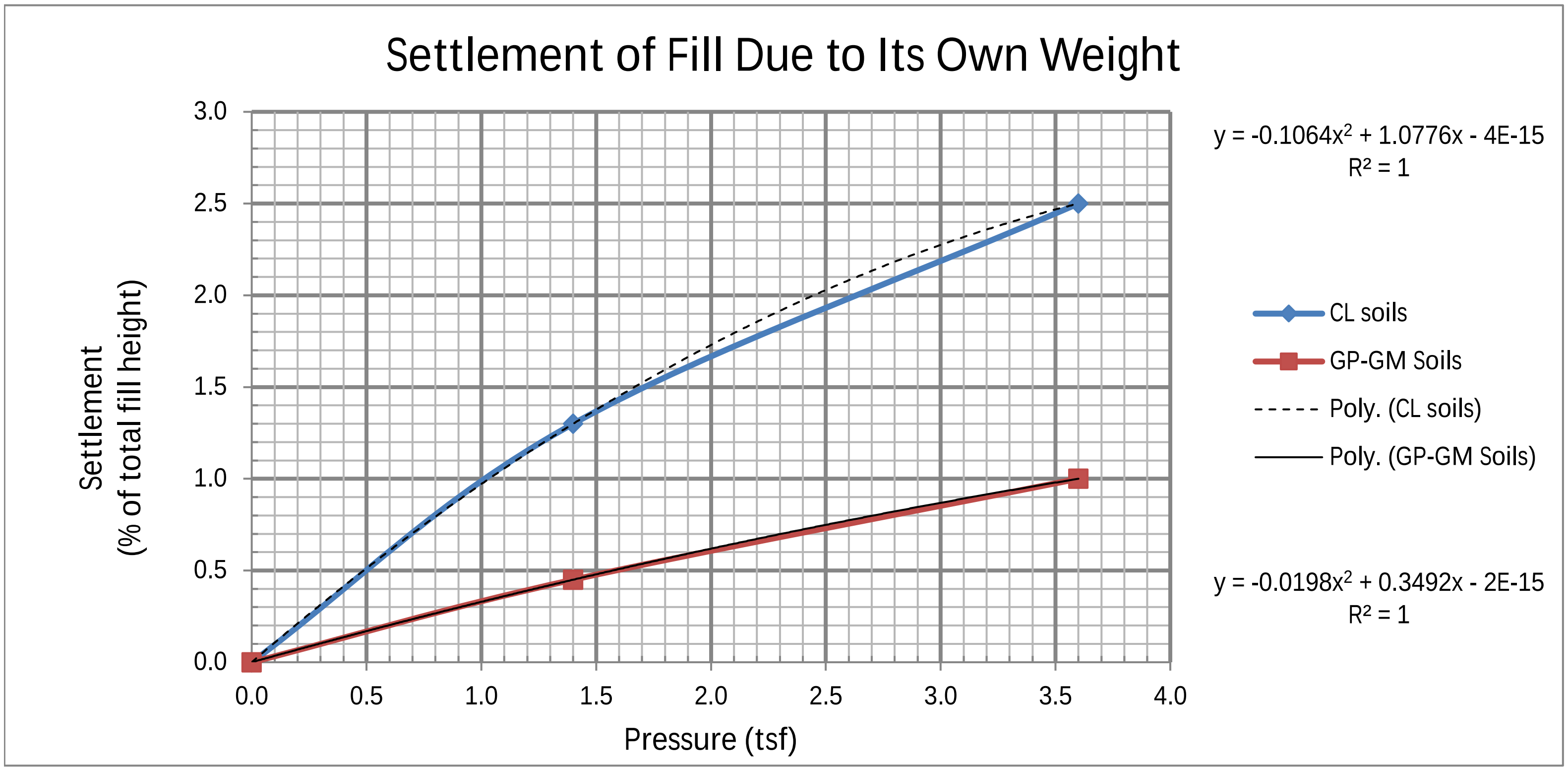
clays of low to medium plasticity (CL)

pressure	typical value of compression - (percent of total fill height)
0	0
1.4	1.3
3.6	2.5

Poorly Graded Gravel with sand and silt (GP-GM)

pressure	typical value of compression - (percent of total fill height)
0	0
1.4	0.45
3.6	1

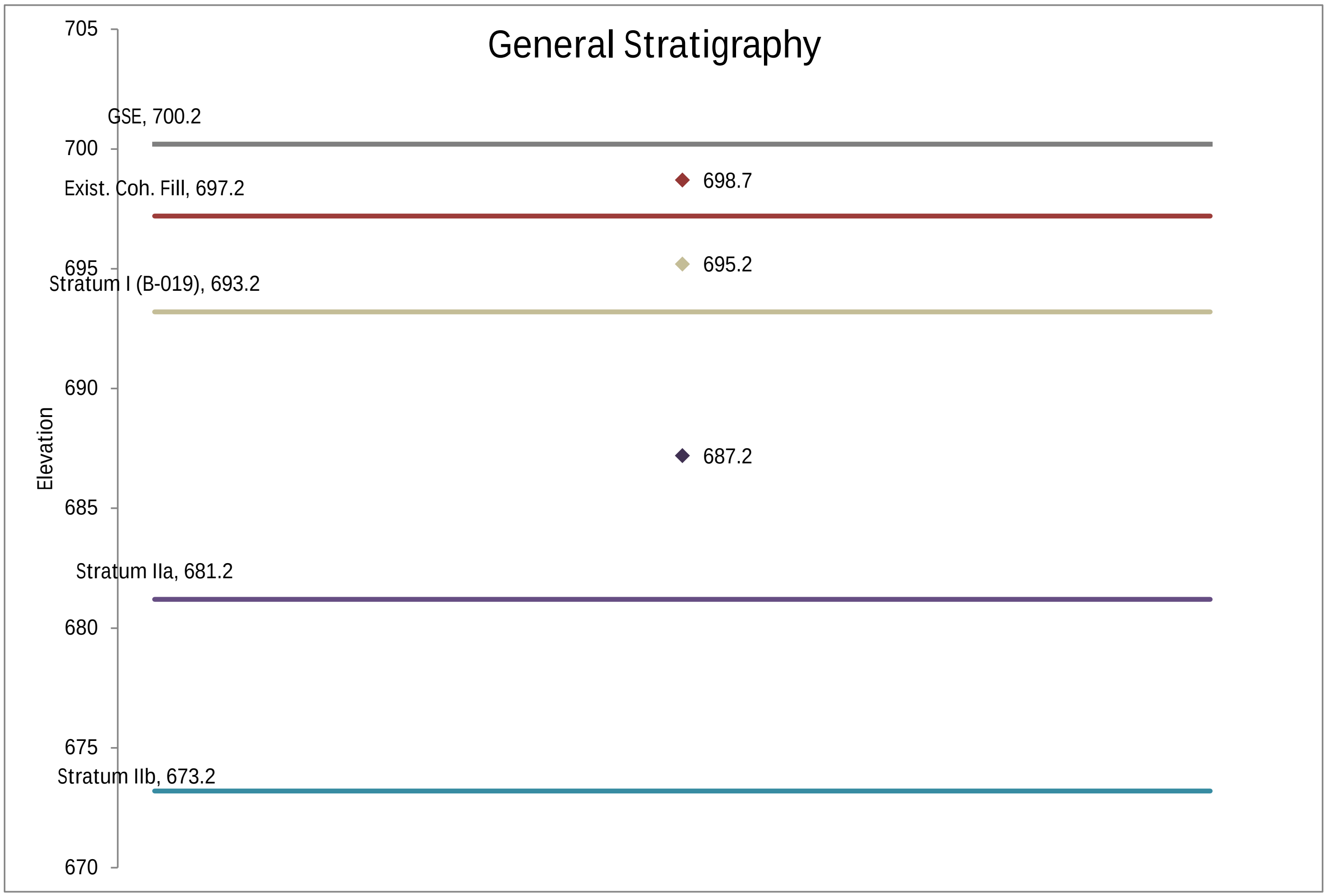
Max. Embankment Pressure =	2,000	psf
=	1	tsf
Settlement CL	1.0	%
Max. Embankment Height =	16	ft
Settlement =	1.86	inches
Settlement GP-GM	0.3	%
Max. Embankment Height =	16	ft
Settlement =	0.63	inches



Project Name:	HEN-24/17D-00.43, PID 117712	Boring Number	B-024 - Rear Abutment
Project Number:	230230	Analysis Type	Embankment
Calculated by:	KCH 3/26/2024		

Settlement Analysis Results:

Layer	H (feet)	C_c or C_r	e_o	σ_v' (psf)	z (feet)	$I_{z,A}$	ΔP_A at P_A of 2750 psf	$I_{z,B}$	ΔP_B at P_B of 2750 psf	Total ΔP (psf)	ΔH (inches)
Exist. Coh. Fill	3	*	-								0.47
Stratum I (B-019)	4	0.019	0.62	625	5	0.500	1,375	0.500	1,375	2,750	0.41
Stratum IIa	12	0.027	0.51	1,655	13	0.496	1,364	0.496	1,364	2,728	1.09
Stratum IIb	8	0.027	0.51	2,581	23	0.479	1,317	0.479	1,317	2,635	0.52
Stratum III	11	0.033	0.57	3,250	32.5	0.450	1,238	0.450	1,238	2,475	0.68
Stratum IV	17.5	0.011	0.47	4,285	46.75	0.408	1,122	0.408	1,122	2,244	0.29



Sum ΔH (in.) below embankment	3.46
+15%	3.98
-15%	2.94

Settlement Under Self Weight (CL)	3.38

TOTAL SETTLEMENT	6.25 to 7.25 inches

Project Name: HEN-24/17D-00.43, PID 117712 Boring Number B-024 - Rear Abutment
Project Number: 230230 Analysis Type Embankment
Calculated by: KCH 3/26/2024

Boring Properties & Settlement Analysis Inputs:

G	2.7	
GSE	700.2	
GWT	683.2	
Bearing Elev	700.2	

$B_{2,A}$	44	ft	$B_{1,A}$	27.5	ft
$B_{2,B}$	44	ft	$B_{1,B}$	27.5	ft
P_A	2,750	psf	H_A	22	ft
P_B	2,750	psf	H_B	22	ft

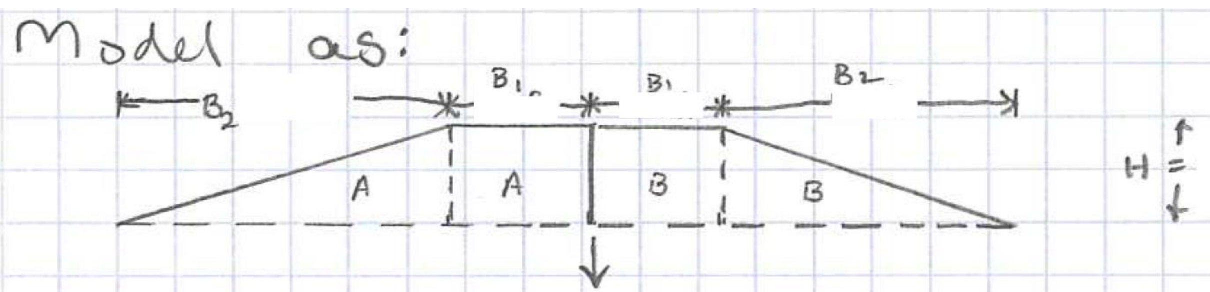
Project-Specific Consolidation Soil Properties:

Stratum	e_o	C_c	C_r	P_c (psf)	γ_T (pcf)	Basis
I	0.62	0.194	0.019	4,250	125	Estimated
II	0.512	0.118	0.027	5,500	130	Tested
III	0.565	0.13	0.033	6,200	135	Tested
IV	0.47	0.109	0.011	34,890	135	Estimated

note: Hardpan considered highly overconsolidated. Use Cr.

Layer Inputs based on Encountered Strata:

Encountered Layer	Bot. Elev.	Centroid (C) Elev.	H (ft)	z below footing	z below GSE	γ_T (pcf)	H_{GWT-C}	σ_v' (psf)	$\Delta P+\sigma_v'$ (psf)	Layer Pc (psf)	Use	Layer C_r	e_o	$B_{1,A}/z$	$B_{2,A}/z$	$I_{z,A}$	$B_{1,B}/z$	$B_{2,B}/z$	$I_{z,B}$
Exist. Coh. Fill	697.2	698.7	3	1.5	1.5	125	-15.5	188	188	4,250	1.30%	*	-	18.3	29.3	0.500	18.3	29.3	0.500
Stratum I (B-019)	693.2	695.2	4	5	5	125	-12	625	3,375	4,250	Cr	0.019	0.62	5.5	8.8	0.500	5.5	8.8	0.500
Stratum IIa	681.2	687.2	12	13	13	130	-4	1,655	4,383	5,500	Cr	0.027	0.51	2.1	3.4	0.496	2.1	3.4	0.496
Stratum IIb	673.2	677.2	8	23	23	130	6	2,581	5,215	5,500	Cr	0.027	0.51	1.2	1.9	0.479	1.2	1.9	0.479
Stratum III	662.2	667.7	11	32.5	32.5	135	15.5	3,250	5,725	6,200	Cr	0.033	0.57	0.8	1.4	0.450	0.8	1.4	0.450
Stratum IV	644.7	653.45	17.5	46.75	46.75	135	29.75	4,285	6,529	34,890	Cr	0.011	0.47	0.6	0.9	0.408	0.6	0.9	0.408



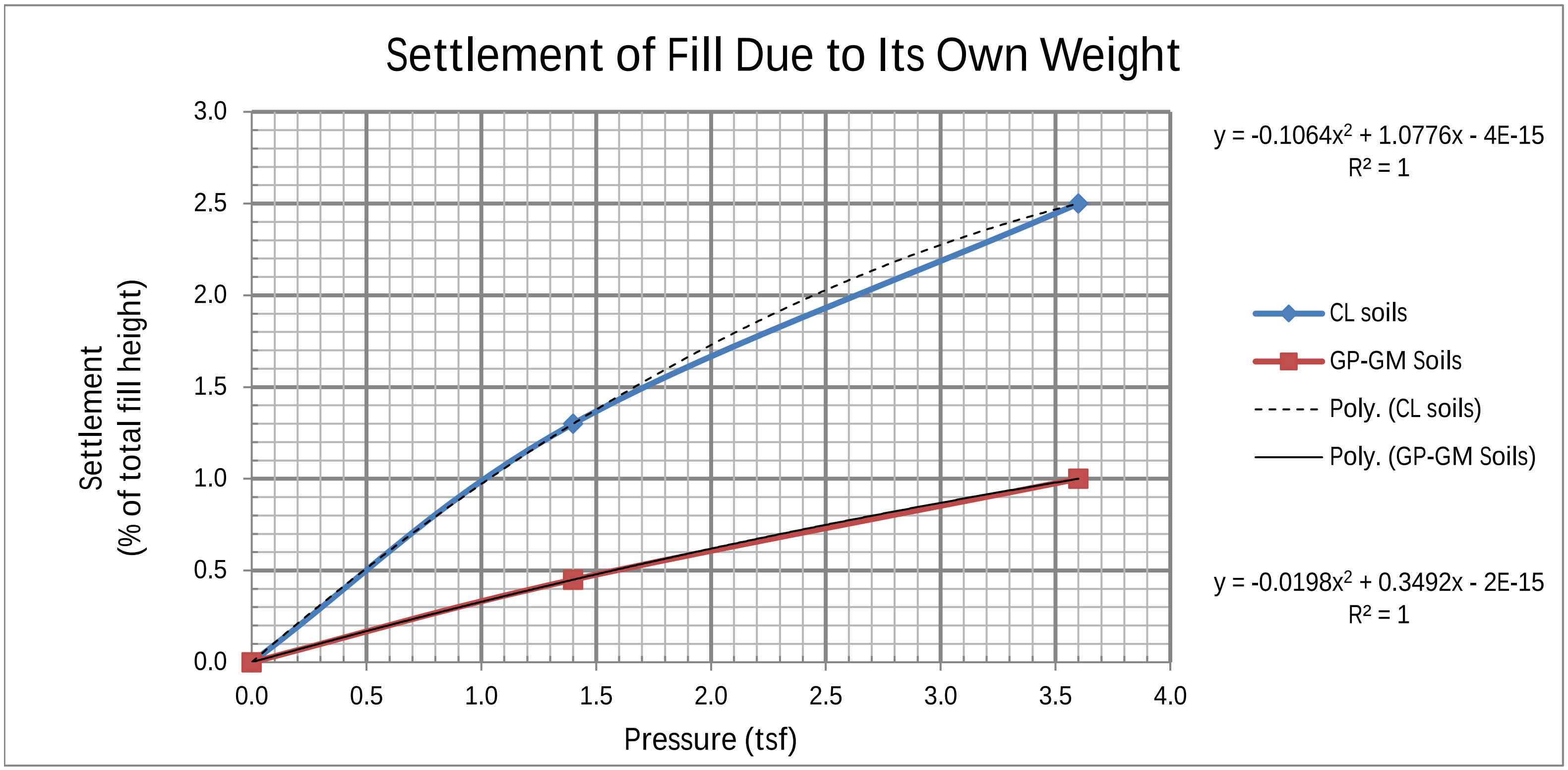
clays of low to medium plasticity (CL)

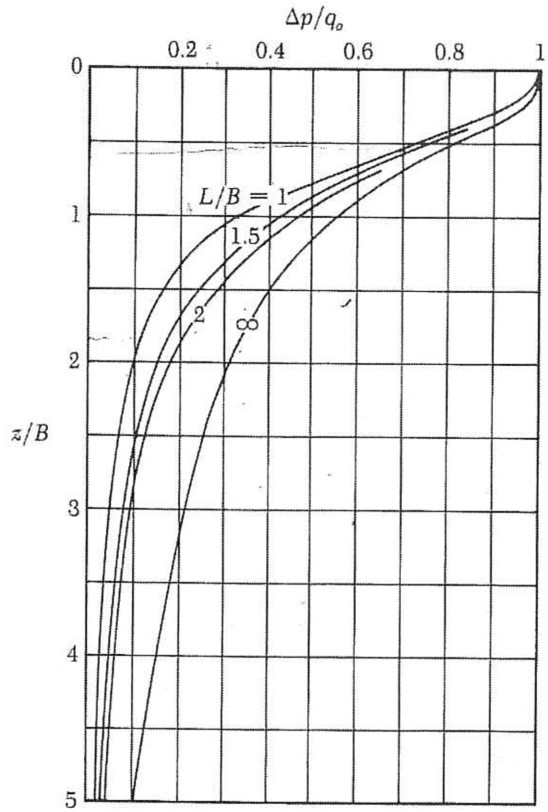
pressure	typical value of compression - (percent of total fill height)
0	0
1.4	1.3
3.6	2.5

Poorly Graded Gravel with sand and silt (GP-GM)

pressure	typical value of compression - (percent of total fill height)
0	0
1.4	0.45
3.6	1

Max. Embankment Pressure =	2,750	psf
=	1.375	tsf
Settlement CL	1.3	%
Max. Embankment Height =	22	ft
Settlement =	3.38	inches
Settlement GP-GM	0.4	%
Max. Embankment Height =	22	ft
Settlement =	1.17	inches





▼ **FIGURE 3.41** Increase of stress under the center of a flexible loaded rectangular area

method (Figure 3.42, page 200). According to this method, the increase of stress at depth z is

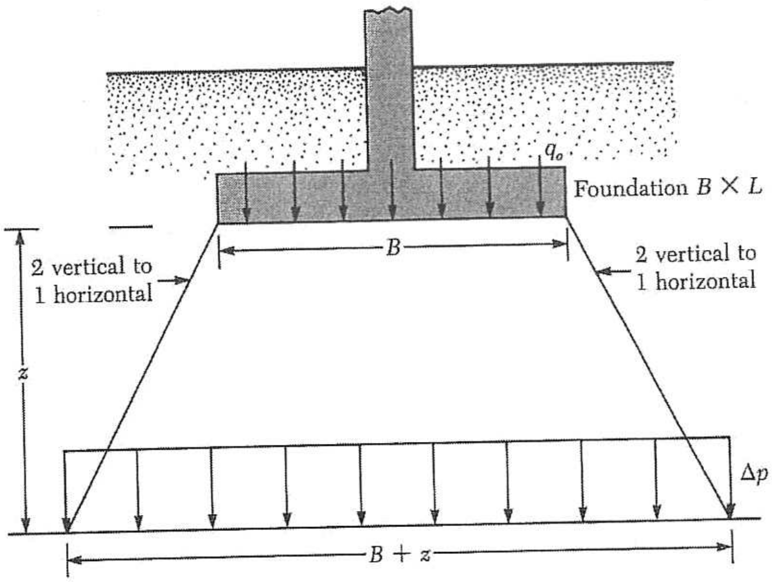
$$\Delta p = \frac{q_o \times B \times L}{(B + z)(L + z)} \tag{3.108}$$

Note that Eq. (3.108) is based on the assumption that the stress from the foundation spreads out along lines with a *2 vertical to 1 horizontal slope.*

Stress Increase Under an Embankment

Figure 3.43 shows the cross section of an embankment of height H. For this two-dimensional loading condition the vertical stress increase may be expressed as

$$\Delta p = \frac{q_o}{\pi}\left[\left(\frac{B_1 + B_2}{B_2}\right)(\alpha_1 + \alpha_2) - \frac{B_1}{B_2}(\alpha_2)\right] \tag{3.109}$$

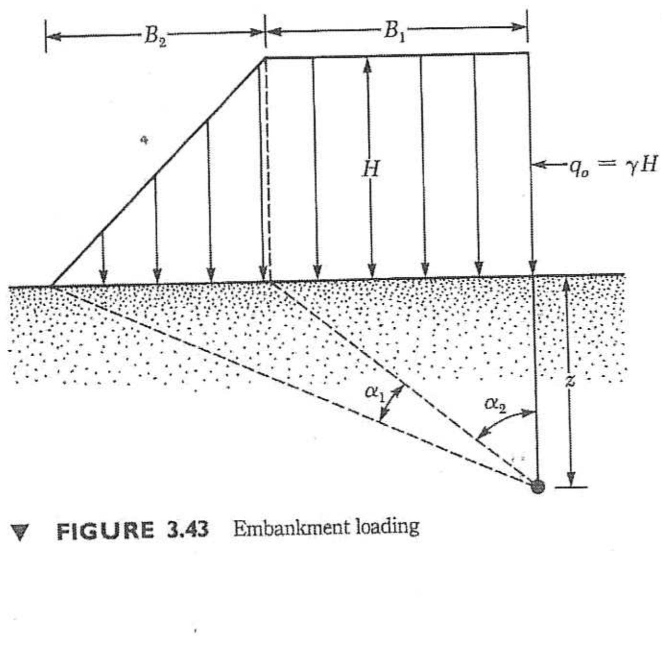


▼ **FIGURE 3.42** 2 : 1 method of finding stress increase under a foundation

where $q = \gamma H$
γ = unit weight of the embankment soil
H = height of the embankment

$$\alpha_1 \text{ (radians)} = \tan^{-1}\left(\frac{B_1 + B_2}{z}\right) - \tan^{-1}\left(\frac{B_1}{z}\right) \tag{3.110}$$

$$\alpha_2 = \tan^{-1}\left(\frac{B_1}{z}\right) \tag{3.111}$$



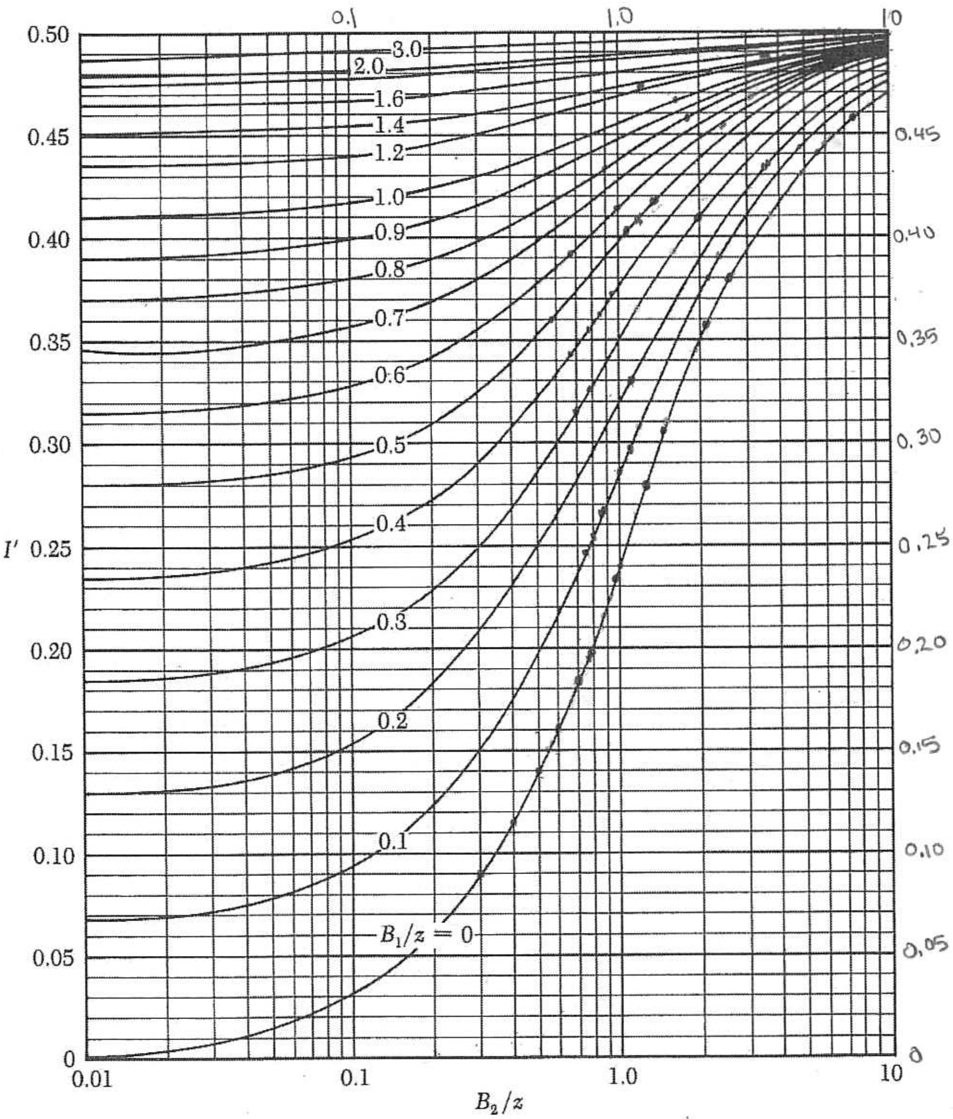
▼ **FIGURE 3.43** Embankment loading

For a detailed derivation of the equation, see Das (1983). A simplified form of Eq. (1.109) is

$$\Delta p = q_o I' \tag{3.112}$$

where I' = a function of B_1/z and B_2/z.

The variation of I' with B_1/z and B_2/z is shown in Figure 3.44. Application of this diagram is shown in Example 3.12 on page 204.



▼ **FIGURE 3.44** Influence value of I' for embankment loading (after Osterberg, 1957)

Principles of Foundation Engineering, Third Ed., Braja M. Das.

3.110)

3.111)

Project Name: HEN-24/17D-00.43, PID 117712
Project Number: 230230
Calculated by: KCH 3/25/2024

Embankment Parameters

Height		Pressure @ 125 pcf	
14	feet	1750 psf	0.875 tsf

Coefficient of Consolidation from NAVFAC Figure 4 (7.1-144)

Stratum	LL	Virgin Compression		Recompression		Average
		C_v (cm^2/sec)	C_v (ft^2/day)	C_v (cm^2/sec)	C_v (ft^2/day)	C_v (ft^2/day)
I (low end LL)	31	0.0	0.4	>0.3	>2	1.4
I (high end LL)	51	0.0	0.2	0.0	1	
I (average LL)	39	0.0	0.3	0.0	2	
II (low end LL)	27	>0.05	>0.5	>0.3	>2	1.6
II (high end LL)	55	0.0	0.1	0.0	0.5	
II (average LL)	35	0.0	0.4	0.0	2	
III (low end LL)	26	>0.05	>0.5	>0.3	>2	1.5
III (high end LL)	60	0.0	0.1	0.0	0.3	
III (average LL)	36	0.0	0.3	0.0	2	
IV (low end LL)	24	>0.05	>0.5	>0.3	>2	>2
IV (high end LL)	32	0.00	0.4	>0.3	>2	
IV (average LL)	28	>0.05	>0.5	>0.3	>2	

Coefficient of Consolidation from Tested Values

Stratum	Pressure (tsf)	Virgin Compression		Recompression		Cv for 0.875 tsf
		C_v (cm^2/sec)	C_v (ft^2/day)	C_v (cm^2/sec)	C_v (ft^2/day)	
B-014 (ST-2)	0.5	-		-	0.27	0.31
Stratum II	1.0	-		-	0.33	
B-015 (ST-12)	0.5	-		-	0.27	0.22
Stratum III	1.0	-		-	0.20	
B-018 (ST-5)	0.5	-		-	0.19	0.25
Stratum II	1.0	-		-	0.27	
B-020 (ST-9)	0.5	-		-	0.15	0.18
Stratum II	1.0	-		-	0.18	
B-024 (ST-13)	0.5	-		-	0.09	0.30
Stratum III	1.0	-		-	0.37	
					Average II	0.25
					Average III	0.26

Encountered Conditions

B-014, B-015, B-018, B-019, B-020, B-024, B-025	Low H (feet)	High H (feet)	Low H_{dr} (feet)	High H_{dr} (feet)
Stratum I layer thicknesses: 1.7 to 5 feet	1.7	5	0.85	2.5
Stratum II layer thicknesses: 2 to 16 feet	2	16	1	8
Stratum III layer thicknesses: 2.5 to 10 feet	2.5	10	1.25	5
Stratum IV layer thicknesses: 2.5 to 13.5	2.5	15	2.5	15

Assume double drainage between soil strata
Assume single drainage between Stratum IV & rock

Project Nar HEN-24/17D-00.43, PID 117712
Project Nui 230230
Calculated KCH 3/25/2024

Time for 60% Consolidation

$$t = \frac{T\,(H_{dr})^2}{C_v}$$

where T = 0.286 for 60% consolidation

Results Based on Low End H_{dr}

Stratum	From NAVFAC Cv Values		
	t (days)	t (weeks)	t (months)
I	0	0.0	0.0
II	0	0.0	0.0
III	0	0.0	0.0
IV	1	0.1	0.0

Stratum	From High Lab Cv Value			From Average Lab Cv Value			From Low Lab Cv Value		
	t (days)	t (weeks)	t (months)	t (days)	t (weeks)	t (months)	t (days)	t (weeks)	t (months)
II	0.9	0.1	0.0	1.2	0.2	0.0	1.6	0.2	0.1
III	1.5	0.2	0.0	1.7	0.2	0.1	2.0	0.3	0.1

Results Based on High End H_{dr}

Stratum	From NAVFAC Cv Values		
	t (days)	t (weeks)	t (months)
I	1	0.2	0.0
II	11	1.6	0.4
III	5	0.7	0.2
IV	32	4.6	1.1

Stratum	From High Lab Cv Value			From Average Lab Cv Value			From Low Lab Cv Value		
	t (days)	t (weeks)	t (months)	t (days)	t (weeks)	t (months)	t (days)	t (weeks)	t (months)
II	59	8.4	2.0	74	10.6	2.5	104	14.9	3.5
III	24	3.4	0.8	27	3.9	0.9	32	4.6	1.1

Final Conclusions

Expect up to approximately 3.5 months for 60% consolidation

Project Name: HEN-24/17D-00.43, PID 117712
Project Number: 230230
Calculated by: KCH 3/25/2024

Embankment Parameters

Height	Pressure @ 125 pcf	
14 feet	1750 psf	0.875 tsf

Coefficient of Consolidation from NAVFAC Figure 4 (7.1-144)

Stratum	LL	Virgin Compression		Recompression		Average
		C_v (cm^2/sec)	C_v (ft^2/day)	C_v (cm^2/sec)	C_v (ft^2/day)	C_v (ft^2/day)
I (low end LL)	31	0.0	0.4	>0.3	>2	1.4
I (high end LL)	51	0.0	0.2	0.0	1	
I (average LL)	39	0.0	0.3	0.0	2	
II (low end LL)	27	>0.05	>0.5	>0.3	>2	1.6
II (high end LL)	55	0.0	0.1	0.0	0.5	
II (average LL)	35	0.0	0.4	0.0	2	
III (low end LL)	26	>0.05	>0.5	>0.3	>2	1.5
III (high end LL)	60	0.0	0.1	0.0	0.3	
III (average LL)	36	0.0	0.3	0.0	2	
IV (low end LL)	24	>0.05	>0.5	>0.3	>2	>2
IV (high end LL)	32	0.00	0.4	>0.3	>2	
IV (average LL)	28	>0.05	>0.5	>0.3	>2	

Coefficient of Consolidation from Tested Values

Stratum	Pressure (tsf)	Virgin Compression		Recompression		Cv for 0.875 tsf
		C_v (cm^2/sec)	C_v (ft^2/day)	C_v (cm^2/sec)	C_v (ft^2/day)	
B-014 (ST-2)	0.5	-		-	0.27	0.31
Stratum II	1.0	-		-	0.33	
B-015 (ST-12)	0.5	-		-	0.27	0.22
Stratum III	1.0	-		-	0.20	
B-018 (ST-5)	0.5	-		-	0.19	0.25
Stratum II	1.0	-		-	0.27	
B-020 (ST-9)	0.5	-		-	0.15	0.18
Stratum II	1.0	-		-	0.18	
B-024 (ST-13)	0.5	-		-	0.09	0.30
Stratum III	1.0	-		-	0.37	

Average II 0.25
Average III 0.26

Encountered Conditions

B-014, B-015, B-018, B-019, B-020, B-024, B-025	Low H (feet)	High H (feet)	Low H_{dr} (feet)	High H_{dr} (feet)
Stratum I layer thicknesses: 1.7 to 5 feet	1.7	5	0.85	2.5
Stratum II layer thicknesses: 2 to 16 feet	2	16	1	8
Stratum III layer thicknesses: 2.5 to 10 feet	2.5	10	1.25	5
Stratum IV layer thicknesses: 2.5 to 13.5	2.5	15	2.5	15

Assume double drainage between soil strata
Assume single drainage between Stratum IV & rock

Project Nar HEN-24/17D-00.43, PID 117712
Project Nui 230230
Calculated KCH 3/25/2024

Time for 90% Consolidation

$$t = \frac{T\,(H_{dr})^2}{C_v}$$

where T = 0.848 for 90% consolidation

Results Based on Low End H_{dr}

Stratum	From NAVFAC Cv Values		
	t (days)	t (weeks)	t (months)
I	0	0.1	0.0
II	1	0.1	0.0
III	1	0.1	0.0
IV	3	0.4	0.1

Stratum	From High Lab Cv Value			From Average Lab Cv Value			From Low Lab Cv Value		
	t (days)	t (weeks)	t (months)	t (days)	t (weeks)	t (months)	t (days)	t (weeks)	t (months)
II	0.9	0.1	0.0	3.4	0.5	0.1	4.8	0.7	0.2
III	4.4	0.6	0.1	5.1	0.7	0.2	6.0	0.9	0.2

Results Based on High End H_{dr}

Stratum	From NAVFAC Cv Values		
	t (days)	t (weeks)	t (months)
I	4	0.5	0.1
II	34	4.9	1.1
III	14	2.1	0.5
IV	95	13.6	3.2

Stratum	From High Lab Cv Value			From Average Lab Cv Value			From Low Lab Cv Value		
	t (days)	t (weeks)	t (months)	t (days)	t (weeks)	t (months)	t (days)	t (weeks)	t (months)
II	59	8.4	2.0	219	31.3	7.3	309	44.2	10.3
III	70	10.0	2.3	81	11.6	2.7	96	13.8	3.2

Final Conclusions

Expect 1 to 6 months for 90% consolidation

Project Name:	HEN-24/17D-00.43, PID 117712
Project Number:	230230
Calculated by:	KCH 3/25/2024

Embankment Parameters

Height	Pressure @ 125 pcf	
16 feet	2000 psf	1.0 tsf

Coefficient of Consolidation from NAVFAC Figure 4 (7.1-144)

Stratum	LL	Virgin Compression		Recompression		Average
		C_v (cm^2/sec)	C_v (ft^2/day)	C_v (cm^2/sec)	C_v (ft^2/day)	C_v (ft^2/day)
I (low end LL)	31	0.0	0.4	>0.3	>2	1.4
I (high end LL)	51	0.0	0.2	0.0	1	
I (average LL)	39	0.0	0.3	0.0	2	
II (low end LL)	27	>0.05	>0.5	>0.3	>2	1.6
II (high end LL)	55	0.0	0.1	0.0	0.5	
II (average LL)	35	0.0	0.4	0.0	2	
III (low end LL)	26	>0.05	>0.5	>0.3	>2	1.5
III (high end LL)	60	0.0	0.1	0.0	0.3	
III (average LL)	36	0.0	0.3	0.0	2	
IV (low end LL)	24	>0.05	>0.5	>0.3	>2	>2
IV (high end LL)	32	0.00	0.4	>0.3	>2	
IV (average LL)	28	>0.05	>0.5	>0.3	>2	

Coefficient of Consolidation from Tested Values

Stratum	Pressure (tsf)	Virgin Compression		Recompression		Cv for 1 tsf
		C_v (cm^2/sec)	C_v (ft^2/day)	C_v (cm^2/sec)	C_v (ft^2/day)	
B-014 (ST-2)	0.5	-		-	0.27	0.33
Stratum II	1.0	-		-	0.33	
B-015 (ST-12)	0.5	-		-	0.27	0.20
Stratum III	1.0	-		-	0.20	
B-018 (ST-5)	0.5	-		-	0.19	0.27
Stratum II	1.0	-		-	0.27	
B-020 (ST-9)	0.5	-		-	0.15	0.18
Stratum II	1.0	-		-	0.18	
B-024 (ST-13)	0.5	-		-	0.09	0.37
Stratum III	1.0	-		-	0.37	
					Average II	0.26
					Average III	0.29

Encountered Conditions

B-014, B-015, B-018, B-019, B-020, B-024, B-025	Low H (feet)	High H (feet)	Low H_{dr} (feet)	High H_{dr} (feet)
Stratum I layer thicknesses: 1.7 to 5 feet	1.7	5	0.85	2.5
Stratum II layer thicknesses: 2 to 16 feet	2	16	1	8
Stratum III layer thicknesses: 2.5 to 10 feet	2.5	10	1.25	5
Stratum IV layer thicknesses: 2.5 to 13.5	2.5	15	2.5	15

Assume double drainage between soil strata
Assume single drainage between Stratum IV & rock

Project Nai HEN-24/17D-00.43, PID 117712
Project Nui 230230
Calculated KCH 3/25/2024

Time for 60% Consolidation

$$t = \frac{T\,(H_{dr})^2}{C_v}$$

where T = 0.286 for 60% consolidation

Results Based on Low End H_{dr}

Stratum	From NAVFAC Cv Values		
	t (days)	t (weeks)	t (months)
I	0	0.0	0.0
II	0	0.0	0.0
III	0	0.0	0.0
IV	1	0.1	0.0

Stratum	From High Lab Cv Value			From Average Lab Cv Value			From Low Lab Cv Value		
	t (days)	t (weeks)	t (months)	t (days)	t (weeks)	t (months)	t (days)	t (weeks)	t (months)
II	0.9	0.1	0.0	1.1	0.2	0.0	1.6	0.2	0.1
III	1.2	0.2	0.0	1.6	0.2	0.1	2.2	0.3	0.1

Results Based on High End H_{dr}

Stratum	From NAVFAC Cv Values		
	t (days)	t (weeks)	t (months)
I	1	0.2	0.0
II	11	1.6	0.4
III	5	0.7	0.2
IV	32	4.6	1.1

Stratum	From High Lab Cv Value			From Average Lab Cv Value			From Low Lab Cv Value		
	t (days)	t (weeks)	t (months)	t (days)	t (weeks)	t (months)	t (days)	t (weeks)	t (months)
II	56	8.0	1.9	70	10.0	2.3	100	14.2	3.3
III	19	2.7	0.6	25	3.5	0.8	35	5.0	1.2

Final Conclusions

Expect up to approximately 3.5 months for 60% consolidation

Project Name:	HEN-24/17D-00.43, PID 117712
Project Number:	230230
Calculated by:	KCH 3/25/2024

Embankment Parameters

Height	Pressure @ 125 pcf	
16 feet	2000 psf	1 tsf

Coefficient of Consolidation from NAVFAC Figure 4 (7.1-144)

Stratum	LL	Virgin Compression		Recompression		Average
		C_v (cm^2/sec)	C_v (ft^2/day)	C_v (cm^2/sec)	C_v (ft^2/day)	C_v (ft^2/day)
I (low end LL)	31	0.0	0.4	>0.3	>2	1.4
I (high end LL)	51	0.0	0.2	0.0	1	
I (average LL)	39	0.0	0.3	0.0	2	
II (low end LL)	27	>0.05	>0.5	>0.3	>2	1.6
II (high end LL)	55	0.0	0.1	0.0	0.5	
II (average LL)	35	0.0	0.4	0.0	2	
III (low end LL)	26	>0.05	>0.5	>0.3	>2	1.5
III (high end LL)	60	0.0	0.1	0.0	0.3	
III (average LL)	36	0.0	0.3	0.0	2	
IV (low end LL)	24	>0.05	>0.5	>0.3	>2	>2
IV (high end LL)	32	0.00	0.4	>0.3	>2	
IV (average LL)	28	>0.05	>0.5	>0.3	>2	

Coefficient of Consolidation from Tested Values

Stratum	Pressure (tsf)	Virgin Compression		Recompression		Cv for 1 tsf
		C_v (cm^2/sec)	C_v (ft^2/day)	C_v (cm^2/sec)	C_v (ft^2/day)	
B-014 (ST-2) Stratum II	0.5	-		-	0.27	0.33
	1.0	-		-	0.33	
B-015 (ST-12) Stratum III	0.5	-		-	0.27	0.20
	1.0	-		-	0.20	
B-018 (ST-5) Stratum II	0.5	-		-	0.19	0.27
	1.0	-		-	0.27	
B-020 (ST-9) Stratum II	0.5	-		-	0.15	0.18
	1.0	-		-	0.18	
B-024 (ST-13) Stratum III	0.5	-		-	0.09	0.37
	1.0	-		-	0.37	
					Average II	0.26
					Average III	0.29

Encountered Conditions

B-014, B-015, B-018, B-019, B-020, B-024, B-025	Low H (feet)	High H (feet)	Low H_{dr} (feet)	High H_{dr} (feet)
Stratum I layer thicknesses: 1.7 to 5 feet	1.7	5	0.85	2.5
Stratum II layer thicknesses: 2 to 16 feet	2	16	1	8
Stratum III layer thicknesses: 2.5 to 10 feet	2.5	10	1.25	5
Stratum IV layer thicknesses: 2.5 to 13.5	2.5	15	2.5	15

Assume double drainage between soil strata
Assume single drainage between Stratum IV & rock

Project Nar HEN-24/17D-00.43, PID 117712

Project Nui 230230

Calculated KCH 3/25/2024

Time for 90% Consolidation

$$t = \frac{T\,(H_{dr})^2}{C_v}$$

where T = 0.848 for 90% consolidation

Results Based on Low End H_{dr}

Stratum	From NAVFAC Cv Values		
	t (days)	t (weeks)	t (months)
I	0	0.1	0.0
II	1	0.1	0.0
III	1	0.1	0.0
IV	3	0.4	0.1

Stratum	From High Lab Cv Value			From Average Lab Cv Value			From Low Lab Cv Value		
	t (days)	t (weeks)	t (months)	t (days)	t (weeks)	t (months)	t (days)	t (weeks)	t (months)
II	0.9	0.1	0.0	3.2	0.5	0.1	4.6	0.7	0.2
III	3.6	0.5	0.1	4.6	0.7	0.2	6.5	0.9	0.2

Results Based on High End H_{dr}

Stratum	From NAVFAC Cv Values		
	t (days)	t (weeks)	t (months)
I	4	0.5	0.1
II	34	4.9	1.1
III	14	2.1	0.5
IV	95	13.6	3.2

Stratum	From High Lab Cv Value			From Average Lab Cv Value			From Low Lab Cv Value		
	t (days)	t (weeks)	t (months)	t (days)	t (weeks)	t (months)	t (days)	t (weeks)	t (months)
II	56	8.0	1.9	207	29.6	6.9	296	42.2	9.9
III	57	8.1	1.9	74	10.5	2.5	105	14.9	3.5

Final Conclusions

Expect 1 to 6 months for 90% consolidation

Project Name: HEN-24/17D-00.43, PID 117712
Project Number: 230230
Calculated by: KCH 8/10/2023

Embankment Parameters

Height		Pressure @ 125 pcf	
23	feet	2875 psf	1.4375 tsf

Coefficient of Consolidation from NAVFAC Figure 4 (7.1-144)

Stratum	LL	Virgin Compression		Recompression		Average
		C_v (cm^2/sec)	C_v (ft^2/day)	C_v (cm^2/sec)	C_v (ft^2/day)	C_v (ft^2/day)
I (low end LL)	31	0.0	0.4	>0.3	>2	1.4
I (high end LL)	51	0.0	0.2	0.0	1	
I (average LL)	39	0.0	0.3	0.0	2	
II (low end LL)	27	>0.05	>0.5	>0.3	>2	1.6
II (high end LL)	55	0.0	0.1	0.0	0.5	
II (average LL)	35	0.0	0.4	0.0	2	
III (low end LL)	26	>0.05	>0.5	>0.3	>2	1.5
III (high end LL)	60	0.0	0.1	0.0	0.3	
III (average LL)	36	0.0	0.3	0.0	2	
IV (low end LL)	24	>0.05	>0.5	>0.3	>2	>2
IV (high end LL)	32	0.00	0.4	>0.3	>2	
IV (average LL)	28	>0.05	>0.5	>0.3	>2	

Coefficient of Consolidation from Tested Values

Stratum	Pressure (tsf)	Virgin Compression		Recompression		Cv for 1.4375 tsf
		C_v (cm^2/sec)	C_v (ft^2/day)	C_v (cm^2/sec)	C_v (ft^2/day)	
B-014 (ST-2)	1.0	-		-	0.33	0.24
Stratum II	2.0	-		-	0.12	
B-015 (ST-12)	1.0	-		-	0.20	0.19
Stratum III	2.0	-		-	0.17	
B-018 (ST-5)	1.0	-		-	0.27	0.21
Stratum II	2.0	-		-	0.12	
B-020 (ST-9)	1.0	-		-	0.18	0.17
Stratum II	2.0	-		-	0.15	
B-024 (ST-13)	1.0	-		-	0.37	0.31
Stratum III	2.0	-		-	0.22	
B-025 (ST-3)	1.0	-		-	0.61	0.54
Stratum II	2.0	-		-	0.44	
					Average II	0.29
					Average III	0.25

Project Nar HEN-24/17D-00.43, PID 117712
Project Nui 230230
Calculated KCH 8/10/2023

Time for 60% Consolidation

$$t = \frac{T\,(H_{dr})^2}{C_v}$$

where T = 0.286 for 60% consolidation

Results Based on Low End H_{dr}

Stratum	From NAVFAC Cv Values		
	t (days)	t (weeks)	t (months)
I	0	0.0	0.0
II	0	0.0	0.0
III	0	0.0	0.0
IV	1	0.1	0.0

Stratum	From High Lab Cv Value			From Average Lab Cv Value			From Low Lab Cv Value		
	t (days)	t (weeks)	t (months)	t (days)	t (weeks)	t (months)	t (days)	t (weeks)	t (months)
II	0.8	0.1	0.0	1.6	0.2	0.1	2.7	0.4	0.1
III	1.5	0.2	0.0	1.8	0.3	0.1	2.4	0.3	0.1

Results Based on High End H_{dr}

Stratum	From NAVFAC Cv Values		
	t (days)	t (weeks)	t (months)
I	1	0.2	0.0
II	11	1.6	0.4
III	5	0.7	0.2
IV	32	4.6	1.1

Stratum	From High Lab Cv Value			From Average Lab Cv Value			From Low Lab Cv Value		
	t (days)	t (weeks)	t (months)	t (days)	t (weeks)	t (months)	t (days)	t (weeks)	t (months)
II	34	4.9	1.1	64	9.1	2.1	109	15.6	3.6
III	23	3.3	0.8	29	4.1	1.0	38	5.5	1.3

Final Conclusions

Expect up to approximately 3.5 months for 60% consolidation to limit settlement
<0.4 inch for all soil layers

Project Name: HEN-24/17D-00.43, PID 117712
Project Number: 230230
Calculated by: KCH 8/10/2023

Embankment Parameters

Height		Pressure @ 125 pcf	
23	feet	2875 psf	1.4375 tsf

Coefficient of Consolidation from NAVFAC Figure 4 (7.1-144)

Stratum	LL	Virgin Compression		Recompression		Average
		C_v (cm^2/sec)	C_v (ft^2/day)	C_v (cm^2/sec)	C_v (ft^2/day)	C_v (ft^2/day)
I (low end LL)	31	0.0	0.4	>0.3	>2	
I (high end LL)	51	0.0	0.2	0.0	1	1.4
I (average LL)	39	0.0	0.3	0.0	2	
II (low end LL)	27	>0.05	>0.5	>0.3	>2	
II (high end LL)	55	0.0	0.1	0.0	0.5	1.6
II (average LL)	35	0.0	0.4	0.0	2	
III (low end LL)	26	>0.05	>0.5	>0.3	>2	
III (high end LL)	60	0.0	0.1	0.0	0.3	1.5
III (average LL)	36	0.0	0.3	0.0	2	
IV (low end LL)	24	>0.05	>0.5	>0.3	>2	
IV (high end LL)	32	0.00	0.4	>0.3	>2	>2
IV (average LL)	28	>0.05	>0.5	>0.3	>2	

Coefficient of Consolidation from Tested Values

Stratum	Pressure (tsf)	Virgin Compression		Recompression		Cv for 1.4375 tsf
		C_v (cm^2/sec)	C_v (ft^2/day)	C_v (cm^2/sec)	C_v (ft^2/day)	
B-014 (ST-2)	1.0	-		-	0.33	0.24
Stratum II	2.0	-		-	0.12	
B-015 (ST-12)	1.0	-		-	0.20	0.19
Stratum III	2.0	-		-	0.17	
B-018 (ST-5)	1.0	-		-	0.27	0.21
Stratum II	2.0	-		-	0.12	
B-020 (ST-9)	1.0	-		-	0.18	0.17
Stratum II	2.0	-		-	0.15	
B-024 (ST-13)	1.0	-		-	0.37	0.31
Stratum III	2.0	-		-	0.22	
B-025 (ST-3)	1.0	-		-	0.61	0.54

Project Nar HEN-24/17D-00.43, PID 117712
Project Nui 230230
Calculated KCH 8/10/2023

Time for 90% Consolidation

$$t = \frac{T\,(H_{dr})^2}{C_v}$$

where T = 0.848 for 90% consolidation

Results Based on Low End H_{dr}

Stratum	From NAVFAC Cv Values		
	t (days)	t (weeks)	t (months)
I	0	0.1	0.0
II	1	0.1	0.0
III	1	0.1	0.0
IV	3	0.4	0.1

Stratum	From High Lab Cv Value			From Average Lab Cv Value			From Low Lab Cv Value		
	t (days)	t (weeks)	t (months)	t (days)	t (weeks)	t (months)	t (days)	t (weeks)	t (months)
II	2.5	0.4	0.1	4.6	0.7	0.2	7.9	1.1	0.3
III	4.3	0.6	0.1	5.4	0.8	0.2	7.1	1.0	0.2

Results Based on High End H_{dr}

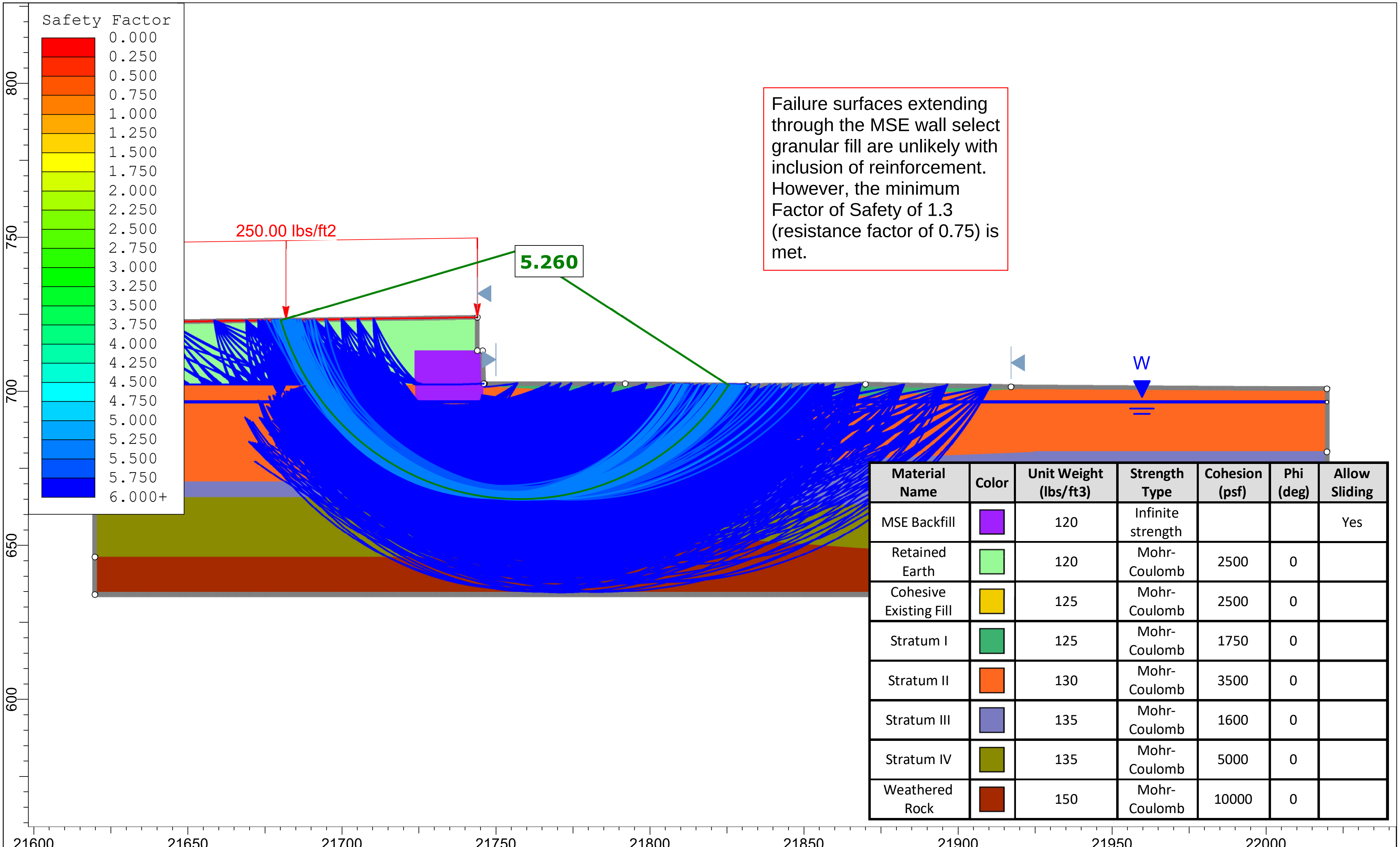
Stratum	From NAVFAC Cv Values		
	t (days)	t (weeks)	t (months)
I	4	0.5	0.1
II	34	4.9	1.1
III	14	2.1	0.5
IV	95	13.6	3.2

Stratum	From High Lab Cv Value			From Average Lab Cv Value			From Low Lab Cv Value		
	t (days)	t (weeks)	t (months)	t (days)	t (weeks)	t (months)	t (days)	t (weeks)	t (months)
II	101	14.5	3.4	189	27.0	6.3	324	46.3	10.8
III	69	9.9	2.3	86	12.3	2.9	114	16.3	3.8

Final Conclusions

Expect 1 to 6 months for 90% consolidation

Appendix D
MSE Retaining Walls Evaluations and Calculations



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Allow Sliding
MSE Backfill		120	Infinite strength			Yes
Retained Earth		120	Mohr-Coulomb	2500	0	
Cohesive Existing Fill		125	Mohr-Coulomb	2500	0	
Stratum I		125	Mohr-Coulomb	1750	0	
Stratum II		130	Mohr-Coulomb	3500	0	
Stratum III		135	Mohr-Coulomb	1600	0	
Stratum IV		135	Mohr-Coulomb	5000	0	
Weathered Rock		150	Mohr-Coulomb	10000	0	

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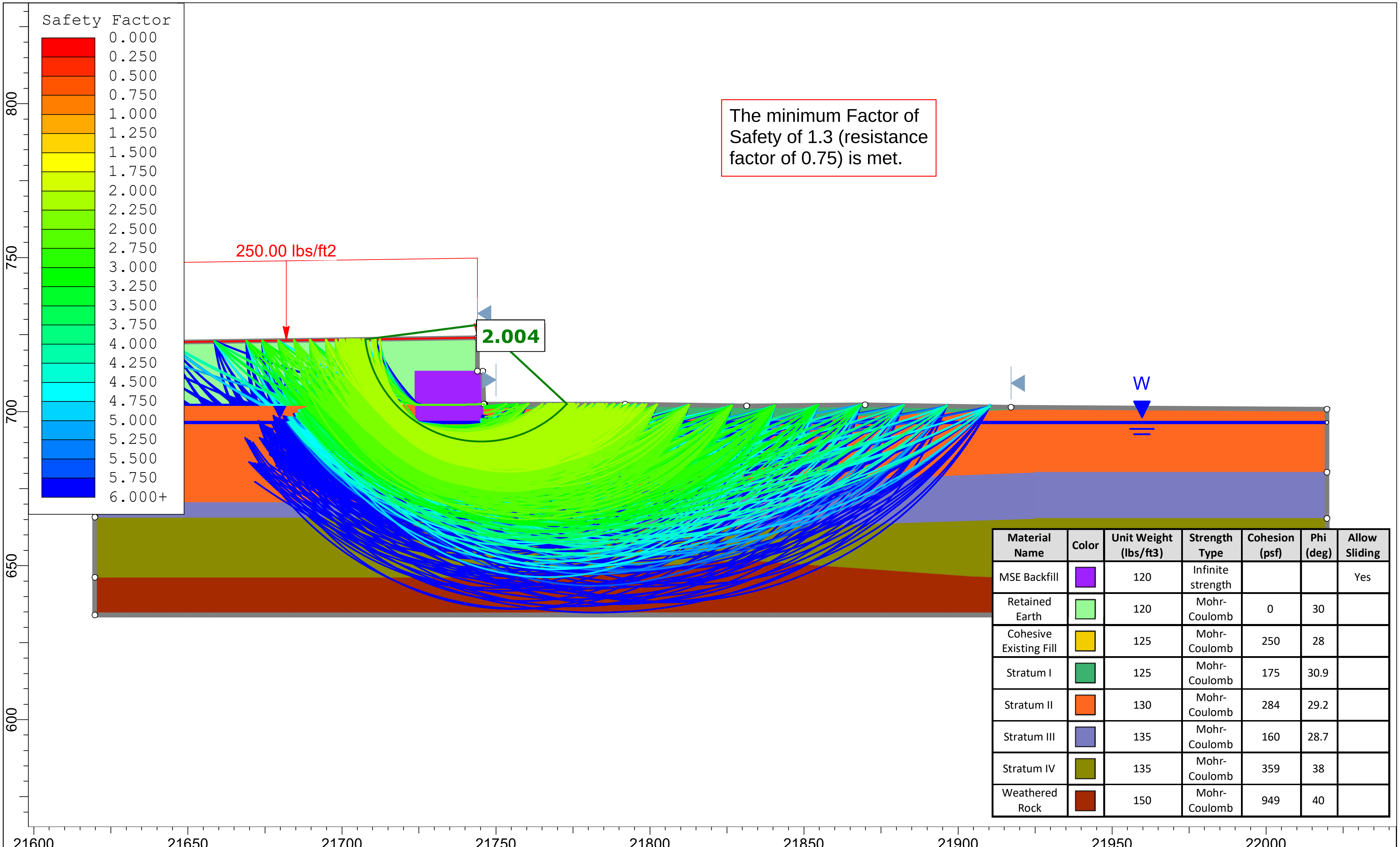
Project	HEN-24/17D-00.43, PID 117712		
Group	Group 1	*Analysis*	TSSP Rear Abutment
Drawn By	K. Hennicken	*Company*	CT Consultants, Inc.
Date	8/11/2023, 7:44:41 PM	*File Name*	TSSP Rear Abutment.slmd



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Allow Sliding
MSE Backfill		120	Infinite strength			Yes
Retained Earth		120	Mohr-Coulomb	0	30	
Cohesive Existing Fill		125	Mohr-Coulomb	250	28	
Stratum I		125	Mohr-Coulomb	175	30.9	
Stratum II		130	Mohr-Coulomb	284	29.2	
Stratum III		135	Mohr-Coulomb	160	28.7	
Stratum IV		135	Mohr-Coulomb	359	38	
Weathered Rock		150	Mohr-Coulomb	949	40	

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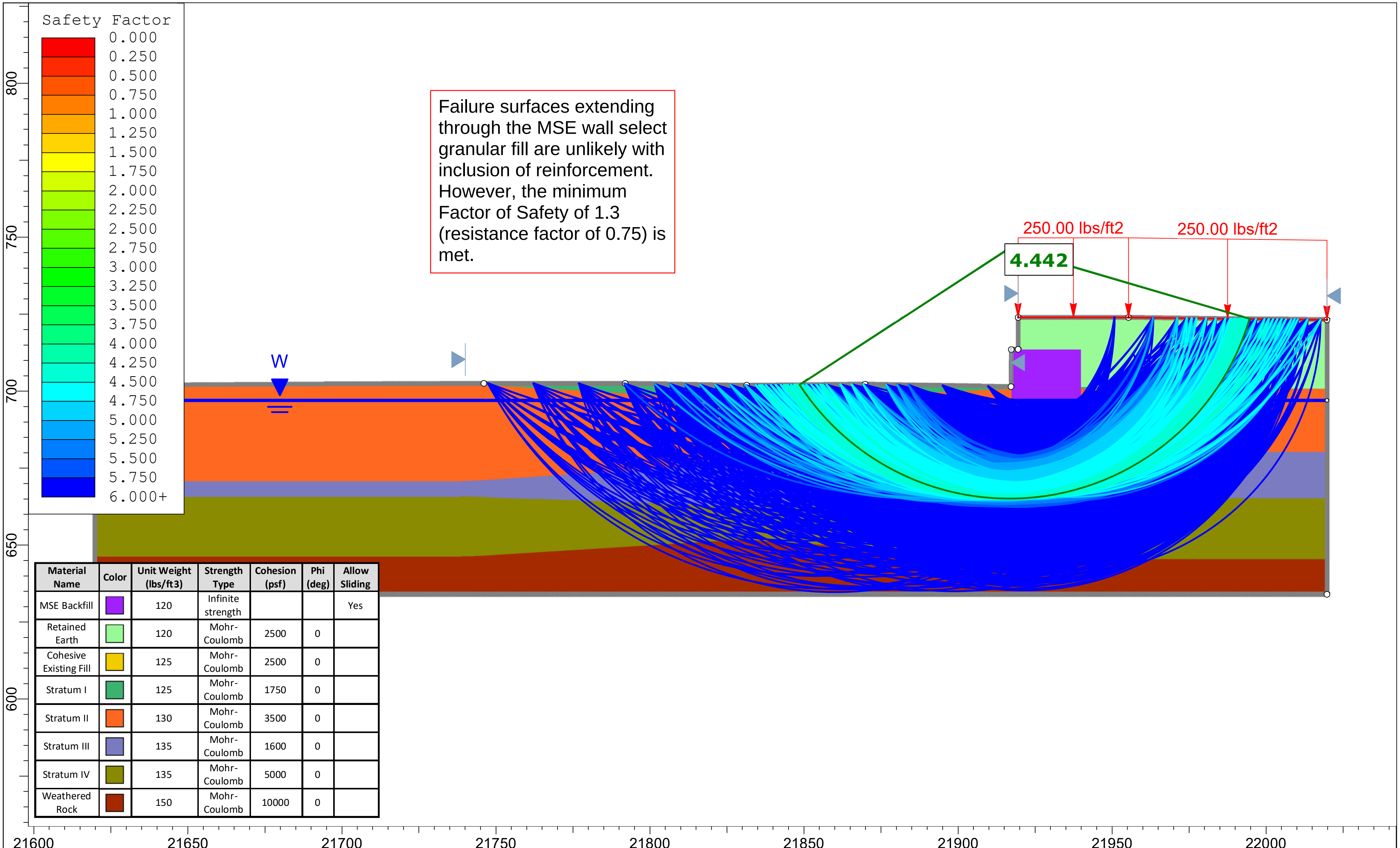
Project	HEN-24/17D-00.43, PID 117712		
Group	Group 1	*Analysis*	ESSP Rear Abutment
Drawn By	K. Hennicken	*Company*	CT Consultants, Inc.
Date	8/11/2023, 7:44:41 PM	*File Name*	ESSP Rear Abutment.slmd



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Allow Sliding
MSE Backfill		120	Infinite strength			Yes
Retained Earth		120	Mohr-Coulomb	2500	0	
Cohesive Existing Fill		125	Mohr-Coulomb	2500	0	
Stratum I		125	Mohr-Coulomb	1750	0	
Stratum II		130	Mohr-Coulomb	3500	0	
Stratum III		135	Mohr-Coulomb	1600	0	
Stratum IV		135	Mohr-Coulomb	5000	0	
Weathered Rock		150	Mohr-Coulomb	10000	0	

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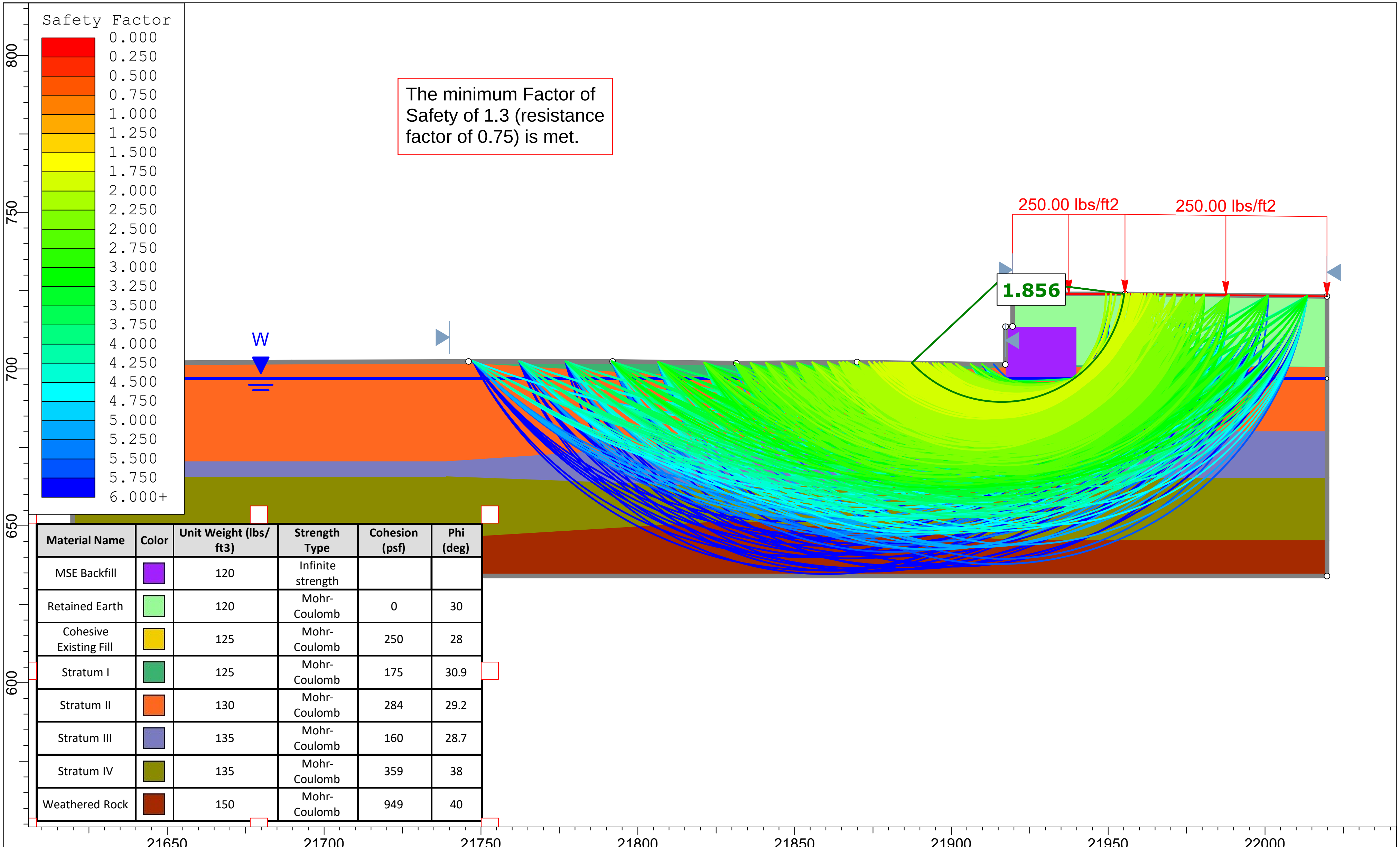
Project	HEN-24/17D-00.43, PID 117712		
Group	Group 1	*Analysis*	TSSP Forward Abutment
Drawn By	K. Hennicken	*Company*	CT Consultants, Inc.
Date	8/11/2023, 7:44:41 PM	*File Name*	TSSP Forward Abutment.slmd



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
MSE Backfill		120	Infinite strength		
Retained Earth		120	Mohr-Coulomb	0	30
Cohesive Existing Fill		125	Mohr-Coulomb	250	28
Stratum I		125	Mohr-Coulomb	175	30.9
Stratum II		130	Mohr-Coulomb	284	29.2
Stratum III		135	Mohr-Coulomb	160	28.7
Stratum IV		135	Mohr-Coulomb	359	38
Weathered Rock		150	Mohr-Coulomb	949	40

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Project	HEN-24/17D-00.43, PID 117712		
Group	Group 1	*Analysis*	ESSP Forward Abutment
Drawn By	K. Hennicken	*Company*	CT Consultants, Inc.
Date	8/11/2023, 7:44:41 PM	*File Name*	ESSP Forward Abutment.slmd

Mechanically Stabilized Earth Walls
Required Parameters

Unit Weight of Reinforced Earth	*120*	pcf
Friction Angle of Reinforced Earth	*34*	degrees
Unit Weight of Retained Earth	*120*	pcf
Friction Angle of Retained Earth	*30*	degrees
Minimum Ratio of Reinforcement Length [Composite Superimposed Wall(s)]	*0.7*	Overall Height (H_i)
Minimum Ratio of Reinforcement Length (Independent Wall)	*0.7*	H1
Minimum Reinforcement Length	*8*	ft
Foundation Soil Type	C	

	Rear Abutment	
Geometry		
Effective Backslope Angle β (degrees)	0.00	
Wall Top/Gutter Elev (ft)	712.70	
Ground Elev (ft)	702.17	
Wall Height to Ground (ft)	10.53	
Embedment Depth (ft)	5.67	
Profile Grade Elev. (ft)	722.93	
Leveling Pad Elev. (ft)	696.50	
Total Wall Height H (ft)	26.43	
Height to Effective Backslope h (ft)	26.43	
[Reserved]		
[Reserved]		
Reinforcement		
Minimum Reinforcement Length (ft)	18.50	
Reinforcement Length (ft)	22.00	
Width - Reinforcement Length (ft)		
Active Zone Distance Behind Wall Face (ft)	37.26	
External Loads		
Live Load Surcharge		
Surcharge Live Load (psf)	250.00	
1st Distance from Wall Face (nearest) (ft)	0.00	
2nd Distance from Wall Face (nearest) (ft)	100.00	
Width of Strip in Active Zone (ft)	37.26	
Effective Height of Surcharge (ft)	26.43	
Dead Load Surcharge (Tiered Wall)		
Surcharge Dead Load (psf)		
1st Distance from Wall Face (nearest) (ft)		
Eccentricity		
Rankine Active Earth Pressure Coefficient Ka	0.33	
Horizontal Forces		
Fill Thrust		
Fill Thrust F1b (lb/ft)	41912.69	
Fill Active Thrust F1b (lb/ft)	13970.90	LRFD PEH
F1b Point of Application Above Base (h/3) (ft)	8.81	
Live Load Surcharge		
Surcharge Load Thrust F3	2202.50	
Surcharge Load Active Thrust F3 (lb/ft)	2202.50	LRFD PLSH
F3 Assumed Point of Application Above Base (h/2) (ft)	13.22	
Dead Load Surcharge (Tiered Wall)		
Surcharge Load Thrust F4	0.00	
Surcharge Load Active Thrust F4 (lb/ft)	0.00	
F4 Assumed Point of Application Above Base (h/2) (ft)	13.22	

	Rear Abutment	
Vertical Forces		
Wall Weight		
Weight of Reinforced Earth (lb/ft)	69775.20	LRFD PEV
W2		
Weight of Sloping Fill	0.00	
Point of Application (L/6) (ft)	3.67	
Fill Thrust		
Vertical Component of Fill Active Thrust (lb/ft)	0.00	
Point of Application (ft)	11.00	
Live Load Surcharge		
Surcharge Live Load (lb/ft)	5500.00	LRFD PLSV
Dead Load Surcharge (Tiered Wall)		
Surcharge Dead Load (lb/ft)	0.00	
Point of Application (ft)	0.00	
R1		
Vertical Resultant (Dead Load) (lb/ft)	69775.20	
$\Sigma I M_{CL}$		
Sum of Moments About Center of Reinforced Earth Mass (lb-ft/ft)	152189.65	
e1		
Eccentricity (Dead Load) e (ft)	2.18	
Allowable Eccentricity (ft)	3.67	
Actual < Allowable e	TRUE	
R2		
Vertical Resultant (Live Load) (lb/ft)	75275.20	
Adjusted Bearing Width		
B' = L -2e (ft)	17.64	
Bearing Pressure		
Gross Pressure at Base (Live Load) (psf)	3421.60	
Adjusted Pressure at Base (Meyerhof) (psf)	4267.85	
q max	5456.96	
q min	1386.24	
Sliding		
Coefficient of Friction	0.35	
Resisting Force (lb/ft)	24421.32	
Driving Force (lb/ft)	16173.40	
FS Sliding	1.51	
FS > 1.5	TRUE	
Overturning		
Resisting Moments About Toe of Reinforced Earth Mass (lb-ft/ft)	767527.20	
Driving Moments About Toe of Reinforced Earth Mass (lb-ft/ft)	152189.65	
FS Overturning	5.04	
FS > 2.0	TRUE	
Reinforcement Ratio	0.83	

	Rear Abutment	
Geometry		
Effective Backslope Angle β (degrees)	0.00	
Wall Top/Gutter Elev (ft)	712.70	
Ground Elev (ft)	702.17	
Wall Height to Ground (ft)	10.53	
Embedment Depth (ft)	5.67	
Profile Grade Elev. (ft)	722.93	
Levelling Pad Elev (ft)	696.50	
Total Wall Height H (ft)	26.43	
Height to Effective Backslope h (ft)	26.43	
[Reserved]		
[Reserved]		
Reinforcement		
Minimum Reinforcement Length (ft)	18.50	
Reinforcement Length (ft)	22.00	
Width - Reinforcement Length (ft)		
Active Zone Distance Behind Wall Face (ft)	37.26	
External Loads		
Live Load Surcharge		
Surcharge Live Load (psf)	250.00	
1st Distance from Wall Face (nearest) (ft)	0.00	
2nd Distance from Wall Face (nearest) (ft)	100.00	
Width of Strip in Active Zone (ft)	37.26	
Effective Height of Surcharge (ft)	26.43	
Dead Load Surcharge (Tiered Wall)		
Surcharge Dead Load (psf)		
1st Distance from Wall Face (nearest) (ft)		
Eccentricity		
Rankine Active Earth Pressure Coefficient Ka	0.33	
Horizontal Forces		
Fill Thrust		
Fill Thrust F1b (lb/ft)	41912.69	
Fill Active Thrust F1b (lb/ft)	13970.90	LRFD PEH
F1b Point of Application Above Base (h/3) (ft)	8.81	
Live Load Surcharge		
Surcharge Load Thrust F3	2202.50	
Surcharge Load Active Thrust F3 (lb/ft)	2202.50	LRFD PLSH
F3 Assumed Point of Application Above Base (h/2) (ft)	13.22	
Dead Load Surcharge (Tiered Wall)		
Surcharge Load Thrust F4	0.00	
Surcharge Load Active Thrust F4 (lb/ft)	0.00	
F4 Assumed Point of Application Above Base (h/2) (ft)	13.22	

	Rear Abutment	
Vertical Forces		
Wall Weight		
Weight of Reinforced Earth (lb/ft)	69775.20	LRFD PEV
W2		
Weight of Sloping Fill	0.00	
Point of Application (L/6) (ft)	3.67	
Fill Thrust		
Vertical Component of Fill Active Thrust (lb/ft)	0.00	
Point of Application (ft)	11.00	
Live Load Surcharge		
Surcharge Live Load (lb/ft)	5500.00	LRFD PLSV
Dead Load Surcharge (Tiered Wall)		
Surcharge Dead Load (lb/ft)	0.00	
Point of Application (ft)	0.00	
R1		
Vertical Resultant (Dead Load) (lb/ft)	69775.20	
ΣM_{CL}		
Sum of Moments About Center of Reinforced Earth Mass (lb-ft/ft)	152189.65	
e1		
Eccentricity (Dead Load) e (ft)	2.18	
Allowable Eccentricity (ft)	3.67	
Actual < Allowable e	TRUE	
R2		
Vertical Resultant (Live Load) (lb/ft)	75275.20	
Adjusted Bearing Width		
B' = L -2e (ft)	17.64	
Bearing Pressure		
Gross Pressure at Base (Live Load) (psf)	3421.60	
Adjusted Pressure at Base (Meyerhof) (psf)	4267.85	
q max	5456.96	
q min	1386.24	
Sliding		
Coefficient of Friction	0.35	
Resisting Force (lb/ft)	24421.32	
Driving Force (lb/ft)	16173.40	
FS Sliding	1.51	
FS > 1.5	TRUE	
Overturning		
Resisting Moments About Toe of Reinforced Earth Mass (lb-ft/ft)	767527.20	
Driving Moments About Toe of Reinforced Earth Mass (lb-ft/ft)	152189.65	
FS Overturning	5.04	
FS > 2.0	TRUE	
Reinforcement Ratio	0.83	

		Rear Abutment				
Overturning & Sliding						
Reinf L (ft)	22.00					
H' (ft)	26.43					
Load Factors	γEV	γEH	γLS			
Strength 1-a	1.00	1.50	1.75			
(Sliding & Eccentricity)						
Strength 1-b	1.35	1.50	1.75			
(Bearing Resistance)						
Service 1	1.00	1.00	1.00			
Unfactored Loads						
Vertical Loads						
PEV (k/ft)	**69.8**					
Moment Arm [L/2] (ft)	11.0					
MEV (k-ft/ft)	**767.5**					
PLSV (k/ft)	**5.5**	(No vertical load immediately over wall)				
MLSV (k-ft/ft)	**0.0**					
Horizontal Loads						
PEH (k/ft)	**14.0**					
Moment Arm [H'/3] (ft)	8.8					
MEH (k-ft/ft)	**123.1**					
PLSH (k/ft)	**2.2**					
Moment Arm [H'/2] (ft)	13.2					
MLSH (k-ft/ft)	**29.1**					
Factored Loads						
Vertical Loads						
	PEV (k/ft)	PLSV (k/ft)	V Total (k/ft)			
Strength 1-a	69.78	9.63	79.40			
Service 1	69.78	5.50	75.28			
Horizontal Loads						
	PEH (k/ft)	PLSH (k/ft)	H Total (k/ft)			
Strength 1-a	20.96	3.85	24.81			
Service 1	13.97	2.20	16.17			
Eccentricity Check	PEV (k/ft)	MEV (k-ft/ft)	MHTOT (k-ft/ft)	xo (ft)	eB (ft)	quniform (ksf)
Strength 1-a	69.78	767.53	235.56	7.62	3.38	4.58
Service 1	69.78	767.53	152.19	8.82	2.18	3.96
				max eB=	3.38	
Location of resultant must be in middle 2/3 of base.						
		emax (ft)	7.33			
		eB<emax	**TRUE**			
Sliding Check						
$R_R=\phi_\tau R_\tau+\phi_{ep}R_{ep}$						
Neglect passive resistance: φepRep=0						
φτ	1.0					
Granular			Cohesive			
Rτ(k/ft)=Vtanδ	38.20		Lesser of:			
(See Parameters Below)			R_τ(k/ft)=cL	56.10		
			or			
			Rt(k/ft)=0.5*V	34.89		
V (k/ft)=PEV	69.78	(Strength 1-a)				
tanδ=tanφmin	0.55					
φmin (deg)	28.7					
c (ksf)	2.55					
RR(k/ft)	34.89					
RR>H Total	**TRUE**					

	Rear Abutment					
Bearing Resistance						
Analyze wall at Abutment		26.43	ft			
Reinf L (ft)	22.00					
H' (ft)	26.43					
Live Load offset						
from wall face [a] (ft)	0.00					
Load Factors	γEV	γEH	γLS			
Strength 1-a	1.00	1.50	1.75			
(Sliding & Eccentricity)						
Strength 1-b	1.35	1.50	1.75			
(Bearing Resistance)						
Service 1	1.00	1.00	1.00			
Unfactored Loads						
Vertical Loads						
PEV (k/ft)	**69.8**					
Moment Arm [L/2] (ft)	11.0					
MEV (k-ft/ft)	**767.5**					
PLSV (k/ft)	**5.5**					
Moment Arm						
[a+0.5(L-a)] (ft)	**11.0**					
MLSV (k-ft/ft)	**60.5**					
Horizontal Loads						
PEH (k/ft)	**14.0**					
Moment Arm [H'/3] (ft)	8.8					
MEH (k-ft/ft)	**123.1**					
PLSH (k/ft)	**2.2**					
Moment Arm [H'/2] (ft)	13.2					
MLSH (k-ft/ft)	**29.1**					
Factored Loads						
Vertical Loads						
	PEV (k/ft)	PLSV (k/ft)	V Total (k/ft)			
Strength 1-b	94.20	9.63	103.82			
Service 1	69.78	5.50	75.28			
Horizontal Loads						
	PEH (k/ft)	PLSH (k/ft)	H Total (k/ft)			
Strength 1-b	20.96	3.85	24.81			
Service 1	13.97	2.20	16.17			

Bearing Resistance Check						
Undrained Case						
Soil angle of friction, ϕ (deg)	0					
Nc	5.14	AASHTO Table 10.6.3.1.2a-1				
Nq	1.0					
Nγ	0.0					
cohesion, c (ksf)	2.55					
soil unit weight, γ (kcf)	0.13					
Df (ft)	5.67					
q (ksf)	0.7371					
B' (ft)	17.64					
Cwq	0.5	AASHTO Table 10.6.3.1.2a-2				
Cwγ	0.5	AASHTO Table 10.6.3.1.2a-2				
qn (ksf) =						
[cNc+qNqCwq+0.5B'γNγCwγ]	13.47555					
qR (ksf) = ϕqn	8.76					
ϕ	0.65					
	V Total	Mv Total	MH Total	xo	eB	q uniform
Group	(k/ft)	(k-ft/ft)	(k-ft/ft)	(ft)	(ft)	(ksf)
Strength 1-b	103.82	1142.04	235.56	8.73	2.27	5.95
Service 1	75.28	828.03	152.19	8.98	2.02	4.19
					max q uniform=	5.95
max q uniform<qR	**TRUE**					
Undrained bearing resistance is adequate.						
Limit Pore Pressures to (ksf)	8.76					
Limit Pore Pressures to (psi)	60.8					
Bearing Pressure up to Top of Wall (ksf)	1.944					
Bearing Pressure <qR?	TRUE					
Drained Case						
Soil angle of friction, ϕ (deg)	28.7					
Nc	25.8	AASHTO Table 10.6.3.1.2a-1				
Nq	14.7					
Nγ	16.7					
cohesion, c (ksf)	0					
soil unit weight, γ (kcf)	0.13					
Df (ft)	5.67					
q (ksf)	0.7371					
B' (ft)	17.64					
Cwq	1.0	AASHTO Table 10.6.3.1.2a-2				
Cwγ	0.5	AASHTO Table 10.6.3.1.2a-2				
qn (ksf) =						
[cNc+qNqCwq+0.5B'γNγCwγ]	20.41					
qR (ksf) = ϕqn	13.27					
ϕ	0.65					
max q uniform<qR	**TRUE**					
Drained bearing resistance is adequate.						

Mechanically Stabilized Earth Walls
Required Parameters

Unit Weight of Reinforced Earth	*120*	pcf
Friction Angle of Reinforced Earth	*34*	degrees
Unit Weight of Retained Earth	*120*	pcf
Friction Angle of Retained Earth	*30*	degrees
Minimum Ratio of Reinforcement Length [Composite Superimposed Wall(s)]	*0.7*	Overall Height (H_i)
Minimum Ratio of Reinforcement Length (Independent Wall)	*0.7*	H1
Minimum Reinforcement Length	*8*	ft
Foundation Soil Type	C	

	Forward Abutment	
Geometry		
Effective Backslope Angle β (degrees)	0.00	
Wall Top/Gutter Elev (ft)	712.95	
Ground Elev (ft)	701.30	
Wall Height to Ground (ft)	11.65	
Embedment Depth (ft)	4.30	
Profile Grade Elev. (ft)	722.94	
Leveling Pad Elev. (ft)	697.00	
Total Wall Height H (ft)	25.94	
Height to Effective Backslope h (ft)	25.94	
[Reserved]		
[Reserved]		
Reinforcement		
Minimum Reinforcement Length (ft)	18.16	
Reinforcement Length (ft)	22.00	
Width - Reinforcement Length (ft)		
Active Zone Distance Behind Wall Face (ft)	36.98	
External Loads		
Live Load Surcharge		
Surcharge Live Load (psf)	250.00	
1st Distance from Wall Face (nearest) (ft)	0.00	
2nd Distance from Wall Face (nearest) (ft)	100.00	
Width of Strip in Active Zone (ft)	36.98	
Effective Height of Surcharge (ft)	25.94	
Dead Load Surcharge (Tiered Wall)		
Surcharge Dead Load (psf)		
1st Distance from Wall Face (nearest) (ft)		
Eccentricity		
Rankine Active Earth Pressure Coefficient Ka	0.33	
Horizontal Forces		
Fill Thrust		
Fill Thrust F1b (lb/ft)	40373.02	
Fill Active Thrust F1b (lb/ft)	13457.67	LRFD PEH
F1b Point of Application Above Base (h/3) (ft)	8.65	
Live Load Surcharge		
Surcharge Load Thrust F3	2161.67	
Surcharge Load Active Thrust F3 (lb/ft)	2161.67	LRFD PLSH
F3 Assumed Point of Application Above Base (h/2) (ft)	12.97	
Dead Load Surcharge (Tiered Wall)		
Surcharge Load Thrust F4	0.00	
Surcharge Load Active Thrust F4 (lb/ft)	0.00	
F4 Assumed Point of Application Above Base (h/2) (ft)	12.97	

	Forward Abutment	
Vertical Forces		
Wall Weight		
Weight of Reinforced Earth (lb/ft)	68481.60	LRFD PEV
W2		
Weight of Sloping Fill	0.00	
Point of Application (L/6) (ft)	3.67	
Fill Thrust		
Vertical Component of Fill Active Thrust (lb/ft)	0.00	
Point of Application (ft)	11.00	
Live Load Surcharge		
Surcharge Live Load (lb/ft)	5500.00	LRFD PLSV
Dead Load Surcharge (Tiered Wall)		
Surcharge Dead Load (lb/ft)	0.00	
Point of Application (ft)	0.00	
R1		
Vertical Resultant (Dead Load) (lb/ft)	68481.60	
$\Sigma I M_{CL}$		
Sum of Moments About Center of Reinforced Earth Mass (lb-ft/ft)	144400.82	
e1		
Eccentricity (Dead Load) e (ft)	2.11	
Allowable Eccentricity (ft)	3.67	
Actual < Allowable e	TRUE	
R2		
Vertical Resultant (Live Load) (lb/ft)	73981.60	
Adjusted Bearing Width		
B' = L -2e (ft)	17.78	
Bearing Pressure		
Gross Pressure at Base (Live Load) (psf)	3362.80	
Adjusted Pressure at Base (Meyerhof) (psf)	4160.29	
q max	5296.66	
q min	1428.94	
Sliding		
Coefficient of Friction	0.35	
Resisting Force (lb/ft)	23968.56	
Driving Force (lb/ft)	15619.34	
FS Sliding	1.53	
FS > 1.5	TRUE	
Overturning		
Resisting Moments About Toe of Reinforced Earth Mass (lb-ft/ft)	753297.60	
Driving Moments About Toe of Reinforced Earth Mass (lb-ft/ft)	144400.82	
FS Overturning	5.22	
FS > 2.0	TRUE	
Reinforcement Ratio	0.85	

	Forward Abutment	
Geometry		
Effective Backslope Angle β (degrees)	0.00	
Wall Top/Gutter Elev (ft)	712.95	
Ground Elev (ft)	701.30	
Wall Height to Ground (ft)	11.65	
Embedment Depth (ft)	4.30	
Profile Grade Elev. (ft)	722.94	
Levelling Pad Elev (ft)	697.00	
Total Wall Height H (ft)	25.94	
Height to Effective Backslope h (ft)	25.94	
[Reserved]		
[Reserved]		
Reinforcement		
Minimum Reinforcement Length (ft)	18.16	
Reinforcement Length (ft)	22.00	
Width - Reinforcement Length (ft)		
Active Zone Distance Behind Wall Face (ft)	36.98	
External Loads		
Live Load Surcharge		
Surcharge Live Load (psf)	250.00	
1st Distance from Wall Face (nearest) (ft)	0.00	
2nd Distance from Wall Face (nearest) (ft)	100.00	
Width of Strip in Active Zone (ft)	36.98	
Effective Height of Surcharge (ft)	25.94	
Dead Load Surcharge (Tiered Wall)		
Surcharge Dead Load (psf)		
1st Distance from Wall Face (nearest) (ft)		
Eccentricity		
Rankine Active Earth Pressure Coefficient Ka	0.33	
Horizontal Forces		
Fill Thrust		
Fill Thrust F1b (lb/ft)	40373.02	
Fill Active Thrust F1b (lb/ft)	13457.67	LRFD PEH
F1b Point of Application Above Base (h/3) (ft)	8.65	
Live Load Surcharge		
Surcharge Load Thrust F3	2161.67	
Surcharge Load Active Thrust F3 (lb/ft)	2161.67	LRFD PLSH
F3 Assumed Point of Application Above Base (h/2) (ft)	12.97	
Dead Load Surcharge (Tiered Wall)		
Surcharge Load Thrust F4	0.00	
Surcharge Load Active Thrust F4 (lb/ft)	0.00	
F4 Assumed Point of Application Above Base (h/2) (ft)	12.97	

	Forward Abutment	
Vertical Forces		
Wall Weight		
Weight of Reinforced Earth (lb/ft)	68481.60	LRFD PEV
W2		
Weight of Sloping Fill	0.00	
Point of Application (L/6) (ft)	3.67	
Fill Thrust		
Vertical Component of Fill Active Thrust (lb/ft)	0.00	
Point of Application (ft)	11.00	
Live Load Surcharge		
Surcharge Live Load (lb/ft)	5500.00	LRFD PLSV
Dead Load Surcharge (Tiered Wall)		
Surcharge Dead Load (lb/ft)	0.00	
Point of Application (ft)	0.00	
R1		
Vertical Resultant (Dead Load) (lb/ft)	68481.60	
$\Sigma I M_{CL}$		
Sum of Moments About Center of Reinforced Earth Mass (lb-ft/ft)	144400.82	
e1		
Eccentricity (Dead Load) e (ft)	2.11	
Allowable Eccentricity (ft)	3.67	
Actual < Allowable e	TRUE	
R2		
Vertical Resultant (Live Load) (lb/ft)	73981.60	
Adjusted Bearing Width		
B' = L -2e (ft)	17.78	
Bearing Pressure		
Gross Pressure at Base (Live Load) (psf)	3362.80	
Adjusted Pressure at Base (Meyerhof) (psf)	4160.29	
q max	5296.66	
q min	1428.94	
Sliding		
Coefficient of Friction	0.35	
Resisting Force (lb/ft)	23968.56	
Driving Force (lb/ft)	15619.34	
FS Sliding	1.53	
FS > 1.5	TRUE	
Overturning		
Resisting Moments About Toe of Reinforced Earth Mass (lb-ft/ft)	753297.60	
Driving Moments About Toe of Reinforced Earth Mass (lb-ft/ft)	144400.82	
FS Overturning	5.22	
FS > 2.0	TRUE	
Reinforcement Ratio	0.85	

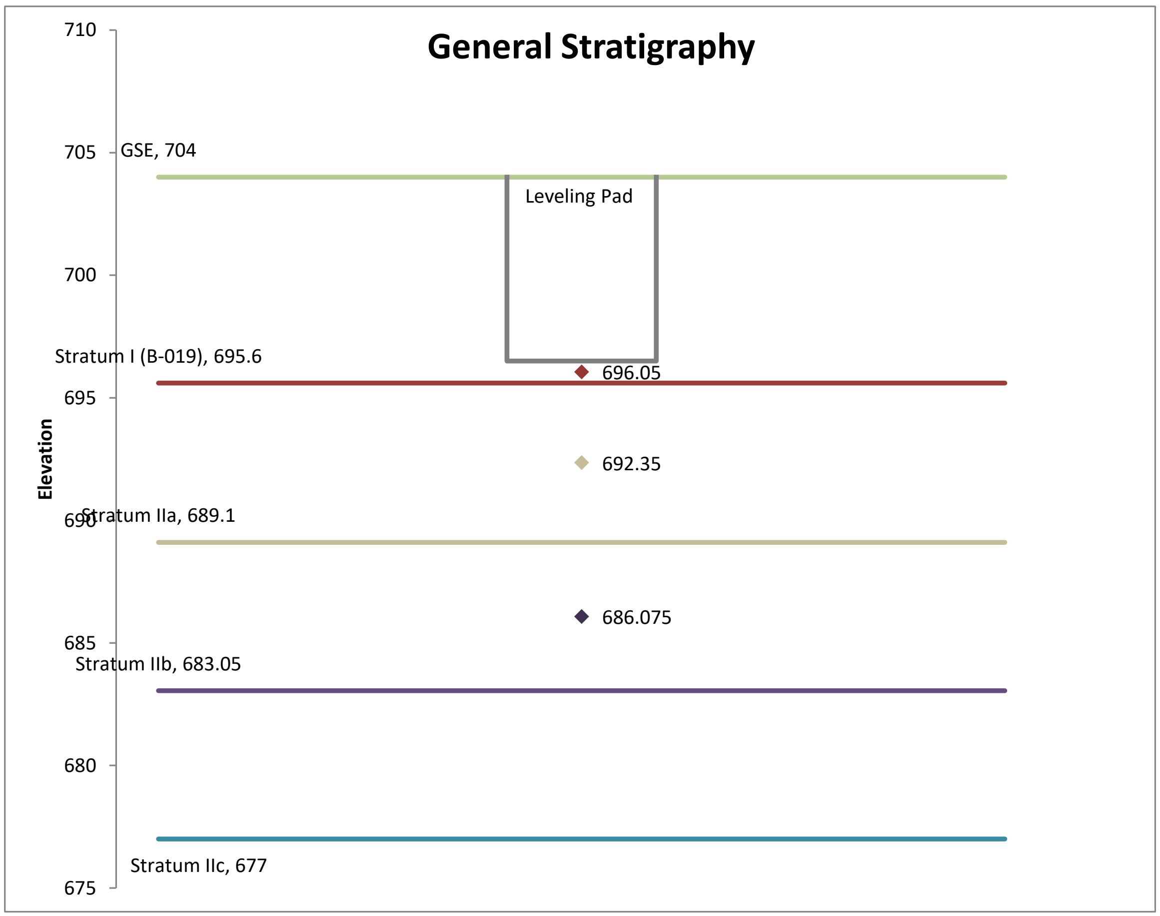
	Forward Abutment					
Overturning & Sliding						
Reinf L (ft)	22.00					
H' (ft)	25.94					
Load Factors	γEV	γEH	γLS			
Strength 1-a	1.00	1.50	1.75			
(Sliding & Eccentricity)						
Strength 1-b	1.35	1.50	1.75			
(Bearing Resistance)						
Service 1	1.00	1.00	1.00			
Unfactored Loads						
Vertical Loads						
PEV (k/ft)	**68.5**					
Moment Arm [L/2] (ft)	11.0					
MEV (k-ft/ft)	**753.3**					
PLSV (k/ft)	**5.5**	(No vertical load immediately over wall)				
MLSV (k-ft/ft)	**0.0**					
Horizontal Loads						
PEH (k/ft)	**13.5**					
Moment Arm [H'/3] (ft)	8.6					
MEH (k-ft/ft)	**116.4**					
PLSH (k/ft)	**2.2**					
Moment Arm [H'/2] (ft)	13.0					
MLSH (k-ft/ft)	**28.0**					
Factored Loads						
Vertical Loads						
	PEV (k/ft)	PLSV (k/ft)	V Total (k/ft)			
Strength 1-a	68.48	9.63	78.11			
Service 1	68.48	5.50	73.98			
Horizontal Loads						
	PEH (k/ft)	PLSH (k/ft)	H Total (k/ft)			
Strength 1-a	20.19	3.78	23.97			
Service 1	13.46	2.16	15.62			
Eccentricity Check	PEV (k/ft)	MEV (k-ft/ft)	MHTOT (k-ft/ft)	xo (ft)	eB (ft)	quniform (ksf)
Strength 1-a	68.48	753.30	223.61	7.73	3.27	4.43
Service 1	68.48	753.30	144.40	8.89	2.11	3.85
				max eB=	3.27	
Location of resultant must be in middle 2/3 of base.						
		emax (ft)	7.33			
		eB<emax	**TRUE**			
Sliding Check						
$R_R=\phi_\tau R_\tau+\phi_{ep}R_{ep}$						
Neglect passive resistance: ϕepRep=0						
$\phi\tau$	1.0					
Granular			Cohesive			
Rτ(k/ft)=Vtanδ	37.49		Lesser of:			
(See Parameters Below)			R_τ(k/ft)=cL	56.10		
			or			
			Rt(k/ft)=0.5*V	34.24		
V (k/ft)=PEV	68.48	(Strength 1-a)				
tanδ=tanϕmin	0.55					
ϕmin (deg)	28.7					
c (ksf)	2.55					
RR(k/ft)	34.24					
RR>H Total	**TRUE**					

	Forward Abutment					
Bearing Resistance						
Analyze wall at Abutment		25.94	ft			
Reinf L (ft)	22.00					
H' (ft)	25.94					
Live Load offset						
from wall face [a] (ft)	0.00					
Load Factors	γEV	γEH	γLS			
Strength 1-a	1.00	1.50	1.75			
(Sliding & Eccentricity)						
Strength 1-b	1.35	1.50	1.75			
(Bearing Resistance)						
Service 1	1.00	1.00	1.00			
Unfactored Loads						
Vertical Loads						
PEV (k/ft)	**68.5**					
Moment Arm [L/2] (ft)	11.0					
MEV (k-ft/ft)	**753.3**					
PLSV (k/ft)	**5.5**					
Moment Arm						
[a+0.5(L-a)] (ft)	**11.0**					
MLSV (k-ft/ft)	**60.5**					
Horizontal Loads						
PEH (k/ft)	**13.5**					
Moment Arm [H'/3] (ft)	8.6					
MEH (k-ft/ft)	**116.4**					
PLSH (k/ft)	**2.2**					
Moment Arm [H'/2] (ft)	13.0					
MLSH (k-ft/ft)	**28.0**					
Factored Loads						
Vertical Loads						
	PEV (k/ft)	PLSV (k/ft)	V Total (k/ft)			
Strength 1-b	92.45	9.63	102.08			
Service 1	68.48	5.50	73.98			
Horizontal Loads						
	PEH (k/ft)	PLSH (k/ft)	H Total (k/ft)			
Strength 1-b	20.19	3.78	23.97			
Service 1	13.46	2.16	15.62			

Bearing Resistance Check						
Undrained Case						
Soil angle of friction, ϕ (deg)	0					
Nc	5.14	AASHTO Table 10.6.3.1.2a-1				
Nq	1.0					
Nγ	0.0					
cohesion, c (ksf)	2.55					
soil unit weight, γ (kcf)	0.13					
Df (ft)	4.30					
q (ksf)	0.559					
B' (ft)	17.78					
Cwq	0.5	AASHTO Table 10.6.3.1.2a-2				
Cwγ	0.5	AASHTO Table 10.6.3.1.2a-2				
qn (ksf) =						
[cNc+qNqCwq+0.5B'γNγCwγ]	13.3865					
qR (ksf) = ϕqn	8.70					
ϕ	0.65					
	V Total	Mv Total	MH Total	xo	eB	q uniform
Group	(k/ft)	(k-ft/ft)	(k-ft/ft)	(ft)	(ft)	(ksf)
Strength 1-b	102.08	1122.83	223.61	8.81	2.19	5.79
Service 1	73.98	813.80	144.40	9.05	1.95	4.09
					max q uniform=	5.79
max q uniform<qR	**TRUE**					
Undrained bearing resistance is adequate.						
Limit Pore Pressures to (ksf)	8.70					
Limit Pore Pressures to (psi)	60.4					
Bearing Pressure up to Top of Wall (ksf)	1.914					
Bearing Pressure <qR?	TRUE					
Drained Case						
Soil angle of friction, ϕ (deg)	28.7					
Nc	25.8	AASHTO Table 10.6.3.1.2a-1				
Nq	14.7					
Nγ	16.7					
cohesion, c (ksf)	0					
soil unit weight, γ (kcf)	0.13					
Df (ft)	4.30					
q (ksf)	0.559					
B' (ft)	17.78					
Cwq	1.0	AASHTO Table 10.6.3.1.2a-2				
Cwγ	0.5	AASHTO Table 10.6.3.1.2a-2				
qn (ksf) =						
[cNc+qNqCwq+0.5B'γNγCwγ]	17.87					
qR (ksf) = ϕqn	11.61					
ϕ	0.65					
max q uniform<qR	**TRUE**					
Drained bearing resistance is adequate.						

Project Name:	HEN-24/17D-00.43, PID 117712	Boring Number	B-024 - Rear Abutment
Project Number:	230230	Analysis Type	Boussinesq Continuous
Calculated by:	KCH 8/10/2023		

Layer	H (feet)	C_c or C_r	e_o	σ_v' (psf)	z (feet)	b (feet)	(z-Df) / b	I_z	delta p@	3331 psf	(check) sigma v+ΔP	delta H (inches)		
Stratum I (B-019)	0.9	0.019	0.62	994	0.45	17.64	0.0	1	3330.5		4324	0.08		
Stratum IIa	6.5	0.027	0.51	1473	4.15	17.64	0.2	1	3330.5		4803	0.72		
Stratum IIb	6.05	0.027	0.51	2231	10.425	17.64	0.6	0.8	2664.4		4895	0.44		
Stratum IIc	6.05	0.027	0.51	2640	16.475	17.64	0.9	0.6	1998.3		4638	0.32		
Stratum III	11	0.033	0.57	3243	25	17.64	1.4	0.4	1332.2		4576	0.42		
Stratum IV	17.5	0.011	0.47	4278	39.25	17.64	2.2	0.3	999.15		5277	0.14		
											Total delta H (in.)	2.12		
											+15%	2.43		
											-15%	1.80		



Differential Settlement along Wall

Max 2.43 inches over 1/2 length of wall
0.5*142.3 ft*12"/ft
= 853.8 inches
= 2.43 inches / = 853.8 inches
0.28% < 1% ok

MSE Wall settlement - rear abutment

Project Name:	HEN-24/17D-00.43, PID 117712	Boring Number	B-024 - Rear Abutment
Project Number:	230230	Analysis Type	Boussinesq Continuou
Calculated by:	KCH 8/10/2023		(Homogeneous)

G	2.7		
GSE	704		
GWT	687		
Bearing Elev	696.5		leveling pad
D_f	7.5	ft	
B'	17.64	ft	
q	4268	psf	
$\gamma * D_f$	937.5	psf	
q'	3330.5	psf	

Project-Specific Consolidation Soil Properties:

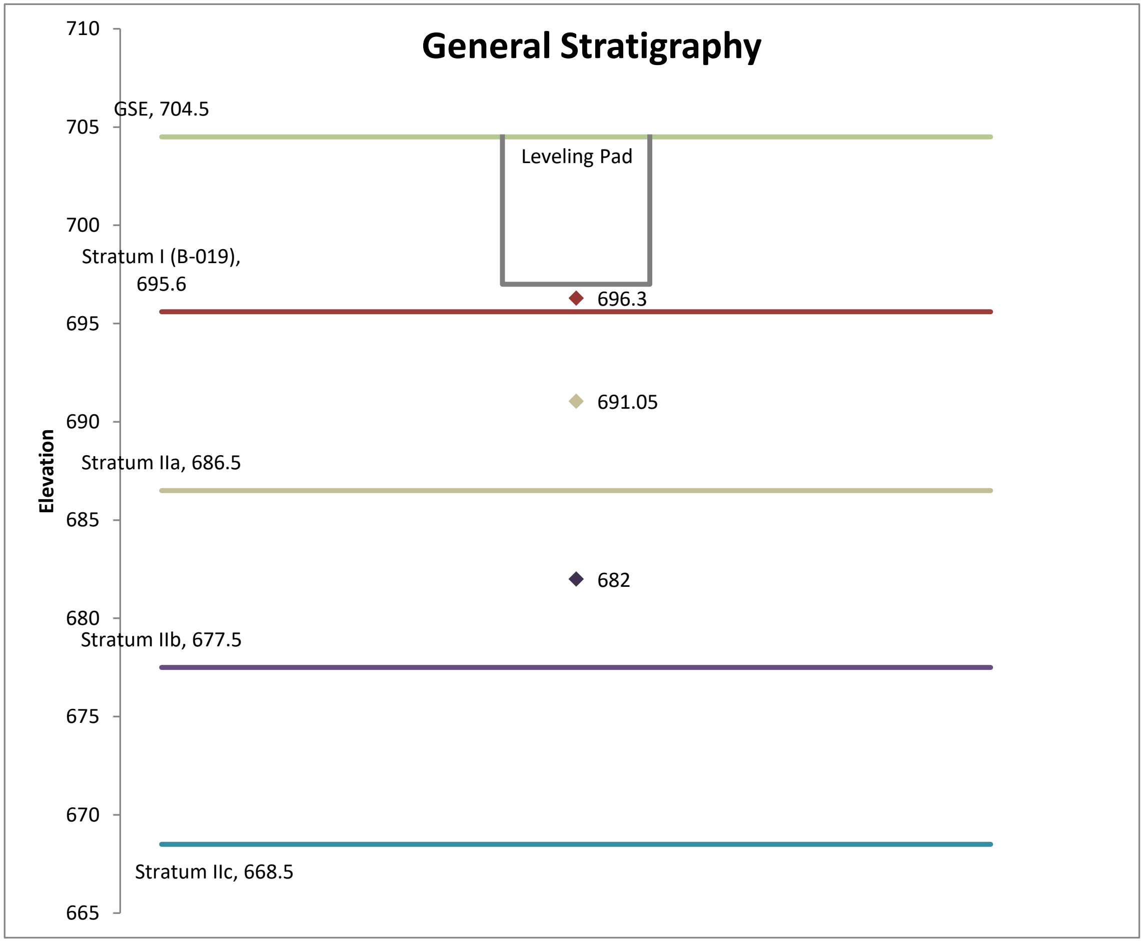
Stratum	e_o	C_c	C_r	P_c (psf)	γ_T (pcf)	Basis
I	0.62	0.194	0.019	4,250	125	Estimated
II	0.512	0.118	0.027	5,500	130	Tested
III	0.565	0.13	0.033	6,200	135	Tested
IV	0.47	0.109	0.011	34,890	135	Estimated

note: Hardpan considered highly overconsolidated. Use Cr.

Encountered Layer	Bot. Elev.	Centroid (C) Elev.	H (ft)	z below footing	z below GSE	γ_T (pcf)	H_{GWT-C}	σ_v' (psf)	$\Delta P+\sigma_v'$ (psf)	Layer Pc (psf)	Use	Layer Cr	eo	Depth of Influence = $(z-D_f)/B$	I_z
Stratum I (B-019)	695.6	696.1	0.9	0.45	7.95	125	-9.05	994	3315	4250	Cr	0.019	0.62	0.0	1.0
Stratum IIa	689.1	692.4	6.5	4.15	11.65	130	-5.35	1,473	3705	4250	Cr	0.027	0.51	0.2	1.0
Stratum IIb	683.1	686.1	6.1	10.425	17.925	130	0.925	2,231	4011	5500	Cr	0.027	0.51	0.6	0.8
Stratum IIc	677.0	680.0	6.0	16.475	23.975	130	6.975	2,640	4011	5500	Cr	0.027	0.51	0.9	0.6
Stratum III	666.0	671.5	11.0	25	32.5	135	15.5	3,243	4011	6200	Cr	0.033	0.57	1.4	0.4

Project Name: HEN-24/17D-00.43, PID 117712 Boring Number B-015 - Forward Abutment
Project Number: 230230 Analysis Type Boussinesq Continuous
Calculated by: KCH 8/10/2023

Layer	H (feet)	C_c or C_r	e_o	σ_v' (psf)	z (feet)	b (feet)	(z-Df) / b	I_z	delta p@	3224 psf	(check) sigma v+ΔP	delta H (inches)			
ratum I (B-01	1.4	0.019	0.62	1025	0.7	17.78	0.0	1	3223.5		4249	0.12			
Stratum IIa	9.1	0.027	0.51	1645	5.95	17.78	0.3	0.9	2901.15		4546	0.86			
Stratum IIb	9	0.027	0.51	2257	15	17.78	0.8	0.6	1934.1		4191	0.52			
Stratum IIc	9	0.027	0.51	2865	24	17.78	1.3	0.4	1289.4		4154	0.31			
Stratum III	14	0.033	0.57	3677	35.5	17.78	2.0	0.3	967.05		4644	0.36			
Stratum IV	20.5	0.011	0.47	4930	52.75	17.78	3.0	0.2	644.7		5574	0.10			
											Total delta H (in.)	2.27			
											+15%	2.61			
											-15%	1.93			



Differential Settlement along Wall

Max 2.61 inches over 1/2 length of wall
0.5*137.8 ft*12"/ft
= 826.8 inches
= 2.61 inches / = 826.8 inches
0.32% < 1% ok

MSE Wall settlement - forward abutment

Project Name:	HEN-24/17D-00.43, PID 117712	Boring Number	B-015 - Forward Abutment
Project Number:	230230	Analysis Type	Boussinesq Continuou
Calculated by:	KCH 8/10/2023		(Homogeneous)

G	2.7		
GSE	704.5		
GWT	692		
Bearing Elev	697		leveling pad
D_f	7.5	ft	
B'	17.78	ft	
q	4161	psf	
$\gamma * D_f$	937.5	psf	
q'	3223.5	psf	

Project-Specific Consolidation Soil Properties:

Stratum	e_o	C_c	C_r	P_c (psf)	γ_T (pcf)	Basis
I	0.62	0.194	0.019	4,250	125	Estimated
II	0.512	0.118	0.027	5,500	130	Tested
III	0.565	0.13	0.033	6,200	135	Tested
IV	0.47	0.109	0.011	34,890	135	Estimated

note: Hardpan considered highly overconsolidated. Use Cr.

Encountered Layer	Bot. Elev.	Centroid (C) Elev.	H (ft)	z below footing	z below GSE	γ_T (pcf)	H_{GWT-C}	σ_v' (psf)	$\Delta P+\sigma_v'$ (psf)	Layer Pc (psf)	Use	Layer Cr	eo	Depth of Influence = $(z-D_f)/B$	I_z
Stratum I (B-019)	695.6	696.3	1.4	0.7	8.2	125	-4.3	1,025	3315	4250	Cr	0.019	0.62	0.0	1.0
Stratum IIa	686.5	691.1	9.1	5.95	13.45	130	0.95	1,645	3705	4250	Cr	0.027	0.51	0.3	0.9
Stratum IIb	677.5	682.0	9.0	15	22.5	130	10	2,257	4011	5500	Cr	0.027	0.51	0.8	0.6
Stratum IIc	668.5	673.0	9.0	24	31.5	130	19	2,865	4011	5500	Cr	0.027	0.51	1.3	0.4
Stratum III	654.5	661.5	14.0	35.5	43	135	30.5	3,677	4011	6200	Cr	0.033	0.57	2.0	0.3

Project Name:	HEN-24/17D-00.43, PID 117712
Project Number:	230230
Calculated by:	KCH 8/12/2023

Embankment Parameters

Height	Pressure @ 125 pcf	
17.5 feet	2187.5 psf	1.09375 tsf

Coefficient of Consolidation from NAVFAC Figure 4 (7.1-144)

Stratum	LL	Virgin Compression		Recompression		Average
		C_v (cm^2/sec)	C_v (ft^2/day)	C_v (cm^2/sec)	C_v (ft^2/day)	C_v (ft^2/day)
I (low end LL)	31	0.0	0.4	>0.3	>2	1.4
I (high end LL)	51	0.0	0.2	0.0	1	
I (average LL)	39	0.0	0.3	0.0	2	
II (low end LL)	27	>0.05	>0.5	>0.3	>2	1.6
II (high end LL)	55	0.0	0.1	0.0	0.5	
II (average LL)	35	0.0	0.4	0.0	2	
III (low end LL)	26	>0.05	>0.5	>0.3	>2	1.5
III (high end LL)	60	0.0	0.1	0.0	0.3	
III (average LL)	36	0.0	0.3	0.0	2	
IV (low end LL)	24	>0.05	>0.5	>0.3	>2	>2
IV (high end LL)	32	0.00	0.4	>0.3	>2	
IV (average LL)	28	>0.05	>0.5	>0.3	>2	

Coefficient of Consolidation from Tested Values

Stratum	Pressure (tsf)	Virgin Compression		Recompression		Cv for 1.09375 tsf
		C_v (cm^2/sec)	C_v (ft^2/day)	C_v (cm^2/sec)	C_v (ft^2/day)	
B-014 (ST-2) Stratum II	1.0	-		-	0.33	0.31
	2.0	-		-	0.12	
B-015 (ST-12) Stratum III	1.0	-		-	0.20	0.20
	2.0	-		-	0.17	
B-018 (ST-5) Stratum II	1.0	-		-	0.27	0.26
	2.0	-		-	0.12	
B-020 (ST-9) Stratum II	1.0	-		-	0.18	0.18
	2.0	-		-	0.15	
B-024 (ST-13) Stratum III	1.0	-		-	0.37	0.36
	2.0	-		-	0.22	
B-025 (ST-3) Stratum II	1.0	-		-	0.61	0.60
	2.0	-		-	0.44	
					Average II	0.34
					Average III	0.28

Encountered Conditions

B-014, B-015, B-019, B-024, B-025	Low H (feet)	High H (feet)	Low H_{dr} (feet)	High H_{dr} (feet)
Stratum I layer thicknesses: 1.7 to 5 feet	1.7	5	0.85	2.5
Stratum II layer thicknesses: 2.5 to 16 feet	2.5	16	1.25	8
Stratum III layer thicknesses: 2.5 to 10 feet	2.5	10	1.25	5
Stratum IV layer thicknesses: 2.5 to 13.5	2.5	15	2.5	15

Assume double drainage between soil strata
Assume single drainage between Stratum IV & rock

Project Na HEN-24/17D-00.43, PID 117712
Project Nu 230230
Calculated KCH 8/12/2023

Time for 90% Consolidation

$$t = \frac{T\,(H_{dr})^2}{C_v}$$

where T = 0.848 for 90% consolidation

Results Based on Low End H_{dr}

Stratum	From NAVFAC Cv Values		
	t (days)	t (weeks)	t (months)
I	0	0.1	0.0
II	1	0.1	0.0
III	1	0.1	0.0
IV	3	0.4	0.1

Stratum	From High Lab Cv Value			From Average Lab Cv Value			From Low Lab Cv Value		
	t (days)	t (weeks)	t (months)	t (days)	t (weeks)	t (months)	t (days)	t (weeks)	t (months)
II	2.2	0.3	0.1	3.9	0.6	0.1	7.4	1.1	0.2
III	3.7	0.5	0.1	4.8	0.7	0.2	6.7	1.0	0.2

Results Based on High End H_{dr}

Stratum	From NAVFAC Cv Values		
	t (days)	t (weeks)	t (months)
I	4	0.5	0.1
II	34	4.9	1.1
III	14	2.1	0.5
IV	95	13.6	3.2

Stratum	From High Lab Cv Value			From Average Lab Cv Value			From Low Lab Cv Value		
	t (days)	t (weeks)	t (months)	t (days)	t (weeks)	t (months)	t (days)	t (weeks)	t (months)
II	91	13.0	3.0	162	23.1	5.4	301	43.0	10.0
III	59	8.4	2.0	76	10.9	2.5	106	15.2	3.5

Final Conclusions

Expect 1 to 6 months for 90% consolidation

Appendix E
Bridge Foundation Evaluations and Calculations

LEADING THROUGH
the next 100 years

DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: T:\GEOTECH\DRIVEN\230230\B-014.DVN
Project Name: HEN-24/17D-00.43, PID 11 Project Date: 08/07/2023
Project Client: Burgess _Niple
Computed By: KCH
Project Manager: KCH

PILE INFORMATION

Pile Type: Pipe Pile - Closed End
Top of Pile: 0.00 ft ← Bottom of Pile Sleeve at Elev. 699.5
Diameter of Pile: 14.00 in

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	13.50 ft
	- Driving/Restrike	13.50 ft
	- Ultimate:	13.50 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesive	2.00 ft	0.00%	125.00 pcf	2500.00 psf	T-79 Steel
2	Cohesive	31.50 ft	0.00%	130.00 pcf	3500.00 psf	T-79 Steel
3	Cohesive	5.00 ft	0.00%	135.00 pcf	1600.00 psf	T-79 Steel
4	Cohesionless	19.50 ft	0.00%	135.00 pcf	38.0/38.0	Nordlund

RESTRIKE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	1000.00 psf	0.04 Kips
1.99 ft	Cohesive	N/A	N/A	1000.00 psf	7.29 Kips
2.01 ft	Cohesive	N/A	N/A	770.00 psf	7.36 Kips
11.01 ft	Cohesive	N/A	N/A	770.00 psf	32.76 Kips
20.01 ft	Cohesive	N/A	N/A	886.81 psf	65.87 Kips
29.01 ft	Cohesive	N/A	N/A	1012.81 psf	107.59 Kips
33.49 ft	Cohesive	N/A	N/A	1075.53 psf	131.46 Kips
33.51 ft	Cohesive	N/A	N/A	1252.26 psf	131.57 Kips
38.49 ft	Cohesive	N/A	N/A	1289.26 psf	155.10 Kips
38.51 ft	Cohesionless	3460.36 psf	25.33	N/A	155.26 Kips
47.51 ft	Cohesionless	3787.06 psf	25.33	N/A	260.68 Kips
56.51 ft	Cohesionless	4113.76 psf	25.33	N/A	384.30 Kips
57.99 ft	Cohesionless	4167.49 psf	25.33	N/A	406.37 Kips

RESTRIKE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	24.05 Kips
1.99 ft	Cohesive	N/A	N/A	N/A	24.05 Kips
2.01 ft	Cohesive	N/A	N/A	N/A	33.67 Kips
11.01 ft	Cohesive	N/A	N/A	N/A	33.67 Kips
20.01 ft	Cohesive	N/A	N/A	N/A	33.67 Kips
29.01 ft	Cohesive	N/A	N/A	N/A	33.67 Kips
33.49 ft	Cohesive	N/A	N/A	N/A	33.67 Kips
33.51 ft	Cohesive	N/A	N/A	N/A	15.39 Kips
38.49 ft	Cohesive	N/A	N/A	N/A	15.39 Kips
38.51 ft	Cohesionless	3460.73 psf	110.40	287.14 Kips	287.14 Kips
47.51 ft	Cohesionless	4114.13 psf	110.40	287.14 Kips	287.14 Kips
56.51 ft	Cohesionless	4767.53 psf	110.40	287.14 Kips	287.14 Kips
57.99 ft	Cohesionless	4874.97 psf	110.40	287.14 Kips	287.14 Kips

RESTRIKE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.04 Kips	24.05 Kips	24.09 Kips
1.99 ft	7.29 Kips	24.05 Kips	31.35 Kips
2.01 ft	7.36 Kips	33.67 Kips	41.03 Kips
11.01 ft	32.76 Kips	33.67 Kips	66.43 Kips
20.01 ft	65.87 Kips	33.67 Kips	99.54 Kips
29.01 ft	107.59 Kips	33.67 Kips	141.27 Kips
33.49 ft	131.46 Kips	33.67 Kips	165.14 Kips
33.51 ft	131.57 Kips	15.39 Kips	146.96 Kips
38.49 ft	155.10 Kips	15.39 Kips	170.49 Kips
38.51 ft	155.26 Kips	287.14 Kips	442.39 Kips
47.51 ft	260.68 Kips	287.14 Kips	547.82 Kips
56.51 ft	384.30 Kips	287.14 Kips	671.44 Kips
57.99 ft	406.37 Kips	287.14 Kips	693.51 Kips

DRIVING - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	1000.00 psf	0.04 Kips
1.99 ft	Cohesive	N/A	N/A	1000.00 psf	7.29 Kips
2.01 ft	Cohesive	N/A	N/A	770.00 psf	7.36 Kips
11.01 ft	Cohesive	N/A	N/A	770.00 psf	32.76 Kips
20.01 ft	Cohesive	N/A	N/A	886.81 psf	65.87 Kips
29.01 ft	Cohesive	N/A	N/A	1012.81 psf	107.59 Kips
33.49 ft	Cohesive	N/A	N/A	1075.53 psf	131.46 Kips
33.51 ft	Cohesive	N/A	N/A	1252.26 psf	131.57 Kips
38.49 ft	Cohesive	N/A	N/A	1289.26 psf	155.10 Kips
38.51 ft	Cohesionless	3460.36 psf	25.33	N/A	155.26 Kips
47.51 ft	Cohesionless	3787.06 psf	25.33	N/A	260.68 Kips
56.51 ft	Cohesionless	4113.76 psf	25.33	N/A	384.30 Kips
57.99 ft	Cohesionless	4167.49 psf	25.33	N/A	406.37 Kips

DRIVING - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	24.05 Kips
1.99 ft	Cohesive	N/A	N/A	N/A	24.05 Kips
2.01 ft	Cohesive	N/A	N/A	N/A	33.67 Kips
11.01 ft	Cohesive	N/A	N/A	N/A	33.67 Kips
20.01 ft	Cohesive	N/A	N/A	N/A	33.67 Kips
29.01 ft	Cohesive	N/A	N/A	N/A	33.67 Kips
33.49 ft	Cohesive	N/A	N/A	N/A	33.67 Kips
33.51 ft	Cohesive	N/A	N/A	N/A	15.39 Kips
38.49 ft	Cohesive	N/A	N/A	N/A	15.39 Kips
38.51 ft	Cohesionless	3460.73 psf	110.40	287.14 Kips	287.14 Kips
47.51 ft	Cohesionless	4114.13 psf	110.40	287.14 Kips	287.14 Kips
56.51 ft	Cohesionless	4767.53 psf	110.40	287.14 Kips	287.14 Kips
57.99 ft	Cohesionless	4874.97 psf	110.40	287.14 Kips	287.14 Kips

DRIVING - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.04 Kips	24.05 Kips	24.09 Kips
1.99 ft	7.29 Kips	24.05 Kips	31.35 Kips
2.01 ft	7.36 Kips	33.67 Kips	41.03 Kips
11.01 ft	32.76 Kips	33.67 Kips	66.43 Kips
20.01 ft	65.87 Kips	33.67 Kips	99.54 Kips
29.01 ft	107.59 Kips	33.67 Kips	141.27 Kips
33.49 ft	131.46 Kips	33.67 Kips	165.14 Kips
33.51 ft	131.57 Kips	15.39 Kips	146.96 Kips
38.49 ft	155.10 Kips	15.39 Kips	170.49 Kips
38.51 ft	155.26 Kips	287.14 Kips	442.39 Kips
47.51 ft	260.68 Kips	287.14 Kips	547.82 Kips
56.51 ft	384.30 Kips	287.14 Kips	671.44 Kips
57.99 ft	406.37 Kips	287.14 Kips	693.51 Kips

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	1000.00 psf	0.04 Kips
1.99 ft	Cohesive	N/A	N/A	1000.00 psf	7.29 Kips
2.01 ft	Cohesive	N/A	N/A	770.00 psf	7.36 Kips
11.01 ft	Cohesive	N/A	N/A	770.00 psf	32.76 Kips
20.01 ft	Cohesive	N/A	N/A	886.81 psf	65.87 Kips
29.01 ft	Cohesive	N/A	N/A	1012.81 psf	107.59 Kips
33.49 ft	Cohesive	N/A	N/A	1075.53 psf	131.46 Kips
33.51 ft	Cohesive	N/A	N/A	1252.26 psf	131.57 Kips
38.49 ft	Cohesive	N/A	N/A	1289.26 psf	155.10 Kips
38.51 ft	Cohesionless	3460.36 psf	25.33	N/A	155.26 Kips
47.51 ft	Cohesionless	3787.06 psf	25.33	N/A	260.68 Kips
56.51 ft	Cohesionless	4113.76 psf	25.33	N/A	384.30 Kips
57.99 ft	Cohesionless	4167.49 psf	25.33	N/A	406.37 Kips

ULTIMATE - END BEARING

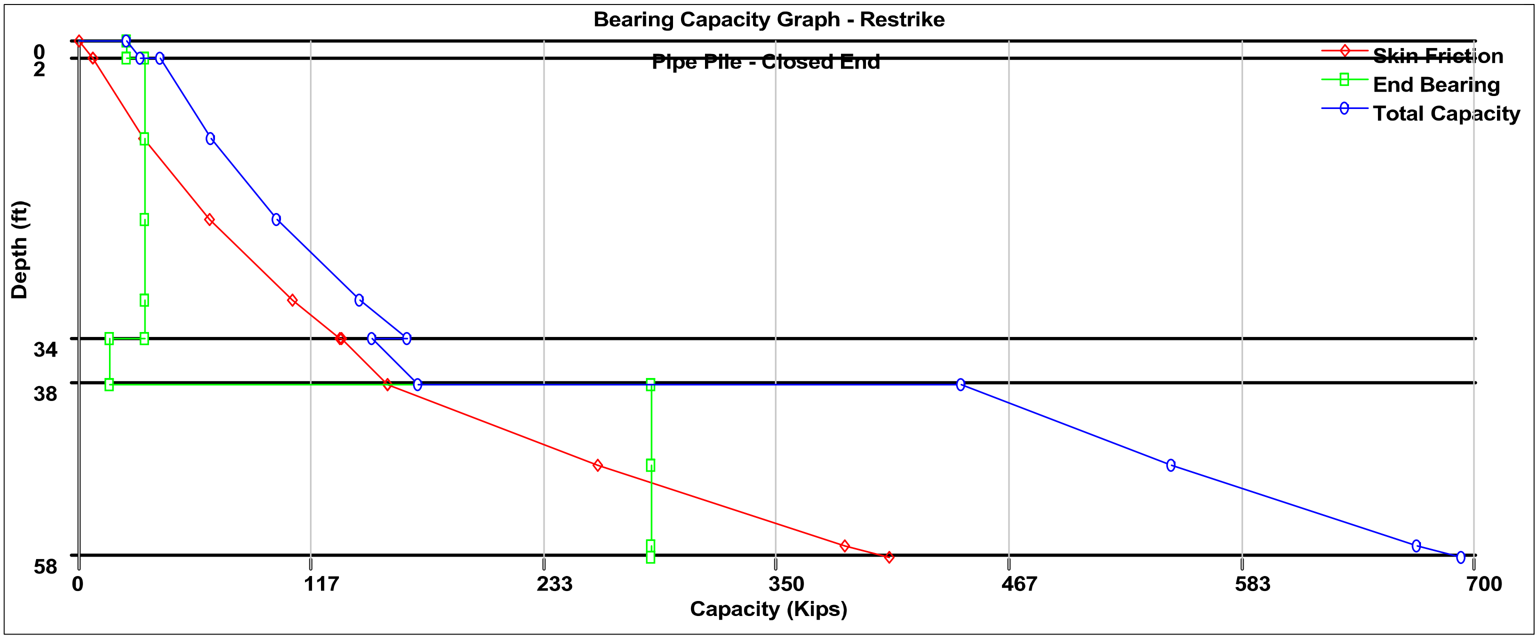
Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	24.05 Kips
1.99 ft	Cohesive	N/A	N/A	N/A	24.05 Kips
2.01 ft	Cohesive	N/A	N/A	N/A	33.67 Kips
11.01 ft	Cohesive	N/A	N/A	N/A	33.67 Kips
20.01 ft	Cohesive	N/A	N/A	N/A	33.67 Kips
29.01 ft	Cohesive	N/A	N/A	N/A	33.67 Kips
33.49 ft	Cohesive	N/A	N/A	N/A	33.67 Kips
33.51 ft	Cohesive	N/A	N/A	N/A	15.39 Kips
38.49 ft	Cohesive	N/A	N/A	N/A	15.39 Kips
38.51 ft	Cohesionless	3460.73 psf	110.40	287.14 Kips	287.14 Kips
47.51 ft	Cohesionless	4114.13 psf	110.40	287.14 Kips	287.14 Kips
56.51 ft	Cohesionless	4767.53 psf	110.40	287.14 Kips	287.14 Kips
57.99 ft	Cohesionless	4874.97 psf	110.40	287.14 Kips	287.14 Kips

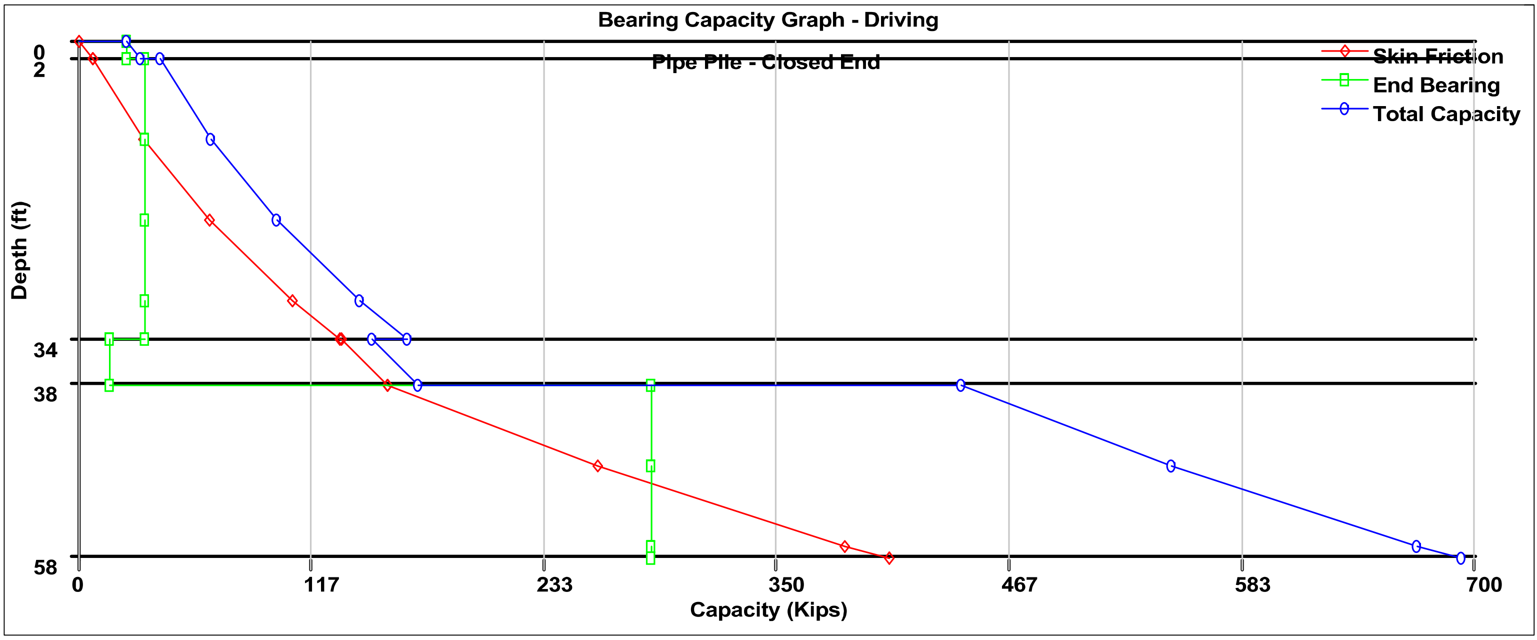
HEN-24/17D-00.43, PID 117712
14" CIP
Rear Abutment - B-014

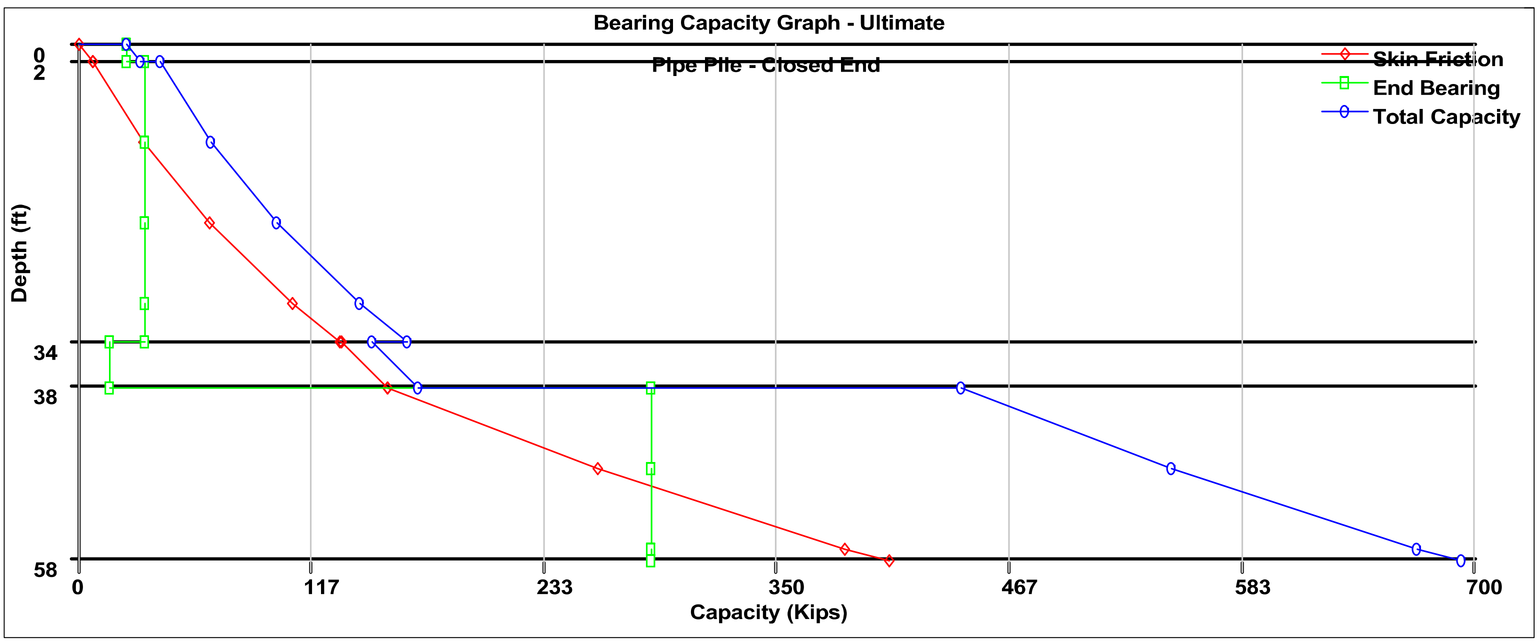
ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.04 Kips	24.05 Kips	24.09 Kips
1.99 ft	7.29 Kips	24.05 Kips	31.35 Kips
2.01 ft	7.36 Kips	33.67 Kips	41.03 Kips
11.01 ft	32.76 Kips	33.67 Kips	66.43 Kips
20.01 ft	65.87 Kips	33.67 Kips	99.54 Kips
29.01 ft	107.59 Kips	33.67 Kips	141.27 Kips
33.49 ft	131.46 Kips	33.67 Kips	165.14 Kips
33.51 ft	131.57 Kips	15.39 Kips	146.96 Kips
38.49 ft	155.10 Kips	15.39 Kips	170.49 Kips
38.51 ft	155.26 Kips	287.14 Kips	442.39 Kips
47.51 ft	260.68 Kips	287.14 Kips	547.82 Kips
56.51 ft	384.30 Kips	287.14 Kips	671.44 Kips
57.99 ft	406.37 Kips	287.14 Kips	693.51 Kips

Rndr = 244 kips at 38.5 feet







HEN-24/17D-00.43, PID 117712
14" CIP
Rear Abutment - B-014

Filename: T:\GEOTECH\DRIVEN\230230\B-014.DVN

HEN-24/17D-00.43, PID 117712
14" CIP
Rear Abutment - B-014

Soil Profile

DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: H:\2023\230230\DRIVEN\B-019.DVN
Project Name: HEN-24/17D-00.43, PID 11 Project Date: 03/25/2024
Project Client: Burgess _Niple
Computed By: KCH
Project Manager: KCH

PILE INFORMATION

Pile Type: Pipe Pile - Closed End
Top of Pile: 6.20 ft
Bottom of Pile Cap at Elev. 695.5
Diameter of Pile: 14.00 in

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	13.00 ft
	- Driving/Restrike	13.00 ft
	- Ultimate:	13.00 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesive	8.50 ft	0.00%	125.00 pcf	1750.00 psf	T-79 Steel
2	Cohesive	20.00 ft	0.00%	130.00 pcf	3500.00 psf	T-79 Steel
3	Cohesive	14.50 ft	0.00%	135.00 pcf	1600.00 psf	T-79 Steel
4	Cohesionless	10.50 ft	0.00%	135.00 pcf	38.0/38.0	Nordlund

RESTRIKE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
6.19 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
6.20 ft	Cohesive	N/A	N/A	1140.00 psf	0.00 Kips
8.49 ft	Cohesive	N/A	N/A	1140.00 psf	9.57 Kips
8.51 ft	Cohesive	N/A	N/A	770.00 psf	9.64 Kips
17.51 ft	Cohesive	N/A	N/A	851.81 psf	37.74 Kips
26.51 ft	Cohesive	N/A	N/A	977.81 psf	74.16 Kips
28.49 ft	Cohesive	N/A	N/A	1005.53 psf	83.28 Kips
28.51 ft	Cohesive	N/A	N/A	1215.12 psf	83.37 Kips
37.51 ft	Cohesive	N/A	N/A	1281.98 psf	125.66 Kips
42.99 ft	Cohesive	N/A	N/A	1322.69 psf	153.58 Kips
43.01 ft	Cohesionless	3748.36 psf	25.33	N/A	153.74 Kips
52.01 ft	Cohesionless	4075.06 psf	25.33	N/A	267.19 Kips
53.49 ft	Cohesionless	4128.79 psf	25.33	N/A	287.59 Kips

RESTRIKE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
6.19 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
6.20 ft	Cohesive	N/A	N/A	N/A	16.84 Kips
8.49 ft	Cohesive	N/A	N/A	N/A	16.84 Kips
8.51 ft	Cohesive	N/A	N/A	N/A	33.67 Kips
17.51 ft	Cohesive	N/A	N/A	N/A	33.67 Kips
26.51 ft	Cohesive	N/A	N/A	N/A	33.67 Kips
28.49 ft	Cohesive	N/A	N/A	N/A	33.67 Kips
28.51 ft	Cohesive	N/A	N/A	N/A	15.39 Kips
37.51 ft	Cohesive	N/A	N/A	N/A	15.39 Kips
42.99 ft	Cohesive	N/A	N/A	N/A	15.39 Kips
43.01 ft	Cohesionless	3748.73 psf	110.40	287.14 Kips	287.14 Kips
52.01 ft	Cohesionless	4402.13 psf	110.40	287.14 Kips	287.14 Kips
53.49 ft	Cohesionless	4509.57 psf	110.40	287.14 Kips	287.14 Kips

RESTRIKE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
6.19 ft	0.00 Kips	0.00 Kips	0.00 Kips
6.20 ft	0.00 Kips	16.84 Kips	16.84 Kips
8.49 ft	9.57 Kips	16.84 Kips	26.41 Kips
8.51 ft	9.64 Kips	33.67 Kips	43.31 Kips
17.51 ft	37.74 Kips	33.67 Kips	71.41 Kips
26.51 ft	74.16 Kips	33.67 Kips	107.83 Kips
28.49 ft	83.28 Kips	33.67 Kips	116.96 Kips
28.51 ft	83.37 Kips	15.39 Kips	98.77 Kips
37.51 ft	125.66 Kips	15.39 Kips	141.06 Kips
42.99 ft	153.58 Kips	15.39 Kips	168.97 Kips
43.01 ft	153.74 Kips	287.14 Kips	440.88 Kips
52.01 ft	267.19 Kips	287.14 Kips	554.33 Kips
53.49 ft	287.59 Kips	287.14 Kips	574.72 Kips

DRIVING - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
6.19 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
6.20 ft	Cohesive	N/A	N/A	1140.00 psf	0.00 Kips
8.49 ft	Cohesive	N/A	N/A	1140.00 psf	9.57 Kips
8.51 ft	Cohesive	N/A	N/A	770.00 psf	9.64 Kips
17.51 ft	Cohesive	N/A	N/A	851.81 psf	37.74 Kips
26.51 ft	Cohesive	N/A	N/A	977.81 psf	74.16 Kips
28.49 ft	Cohesive	N/A	N/A	1005.53 psf	83.28 Kips
28.51 ft	Cohesive	N/A	N/A	1215.12 psf	83.37 Kips
37.51 ft	Cohesive	N/A	N/A	1281.98 psf	125.66 Kips
42.99 ft	Cohesive	N/A	N/A	1322.69 psf	153.58 Kips
43.01 ft	Cohesionless	3748.36 psf	25.33	N/A	153.74 Kips
52.01 ft	Cohesionless	4075.06 psf	25.33	N/A	267.19 Kips
53.49 ft	Cohesionless	4128.79 psf	25.33	N/A	287.59 Kips

DRIVING - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
6.19 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
6.20 ft	Cohesive	N/A	N/A	N/A	16.84 Kips
8.49 ft	Cohesive	N/A	N/A	N/A	16.84 Kips
8.51 ft	Cohesive	N/A	N/A	N/A	33.67 Kips
17.51 ft	Cohesive	N/A	N/A	N/A	33.67 Kips
26.51 ft	Cohesive	N/A	N/A	N/A	33.67 Kips
28.49 ft	Cohesive	N/A	N/A	N/A	33.67 Kips
28.51 ft	Cohesive	N/A	N/A	N/A	15.39 Kips
37.51 ft	Cohesive	N/A	N/A	N/A	15.39 Kips
42.99 ft	Cohesive	N/A	N/A	N/A	15.39 Kips
43.01 ft	Cohesionless	3748.73 psf	110.40	287.14 Kips	287.14 Kips
52.01 ft	Cohesionless	4402.13 psf	110.40	287.14 Kips	287.14 Kips
53.49 ft	Cohesionless	4509.57 psf	110.40	287.14 Kips	287.14 Kips

DRIVING - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
6.19 ft	0.00 Kips	0.00 Kips	0.00 Kips
6.20 ft	0.00 Kips	16.84 Kips	16.84 Kips
8.49 ft	9.57 Kips	16.84 Kips	26.41 Kips
8.51 ft	9.64 Kips	33.67 Kips	43.31 Kips
17.51 ft	37.74 Kips	33.67 Kips	71.41 Kips
26.51 ft	74.16 Kips	33.67 Kips	107.83 Kips
28.49 ft	83.28 Kips	33.67 Kips	116.96 Kips
28.51 ft	83.37 Kips	15.39 Kips	98.77 Kips
37.51 ft	125.66 Kips	15.39 Kips	141.06 Kips
42.99 ft	153.58 Kips	15.39 Kips	168.97 Kips
43.01 ft	153.74 Kips	287.14 Kips	440.88 Kips
52.01 ft	267.19 Kips	287.14 Kips	554.33 Kips
53.49 ft	287.59 Kips	287.14 Kips	574.72 Kips

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
6.19 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
6.20 ft	Cohesive	N/A	N/A	1140.00 psf	0.00 Kips
8.49 ft	Cohesive	N/A	N/A	1140.00 psf	9.57 Kips
8.51 ft	Cohesive	N/A	N/A	770.00 psf	9.64 Kips
17.51 ft	Cohesive	N/A	N/A	851.81 psf	37.74 Kips
26.51 ft	Cohesive	N/A	N/A	977.81 psf	74.16 Kips
28.49 ft	Cohesive	N/A	N/A	1005.53 psf	83.28 Kips
28.51 ft	Cohesive	N/A	N/A	1215.12 psf	83.37 Kips
37.51 ft	Cohesive	N/A	N/A	1281.98 psf	125.66 Kips
42.99 ft	Cohesive	N/A	N/A	1322.69 psf	153.58 Kips
43.01 ft	Cohesionless	3748.36 psf	25.33	N/A	153.74 Kips
52.01 ft	Cohesionless	4075.06 psf	25.33	N/A	267.19 Kips
53.49 ft	Cohesionless	4128.79 psf	25.33	N/A	287.59 Kips

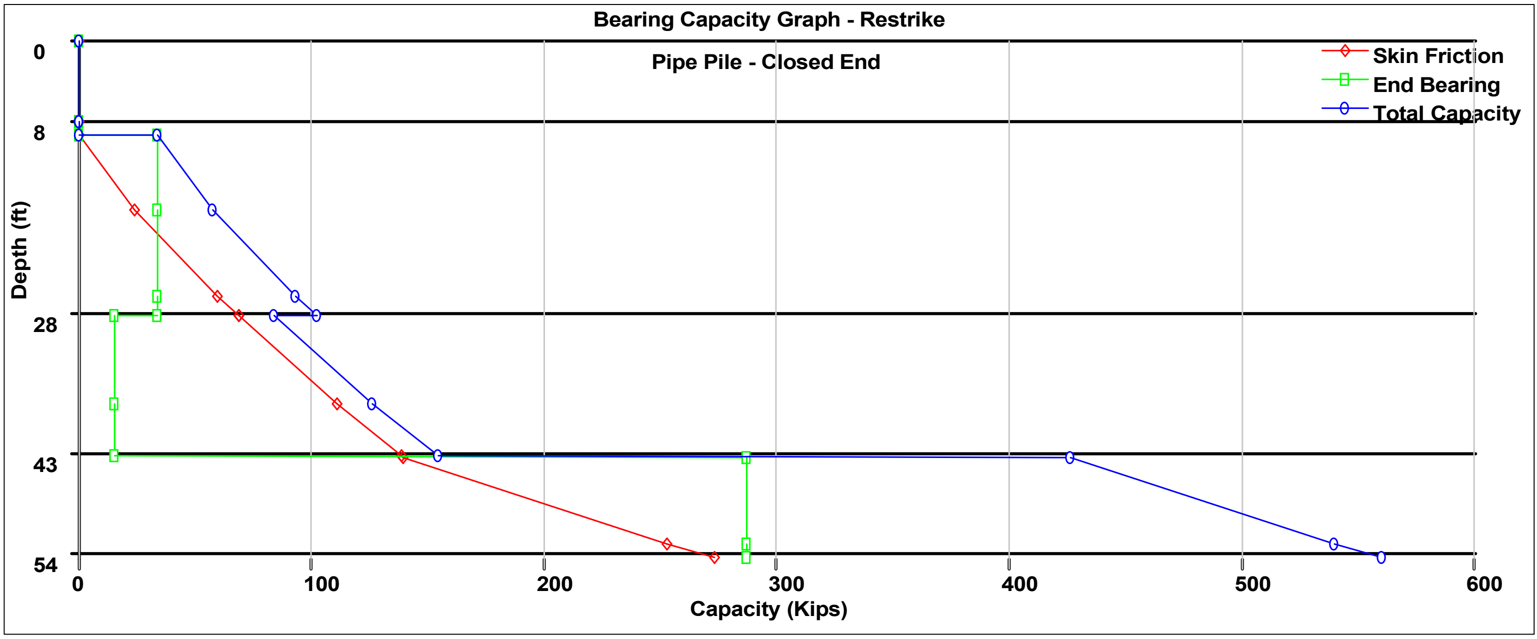
ULTIMATE - END BEARING

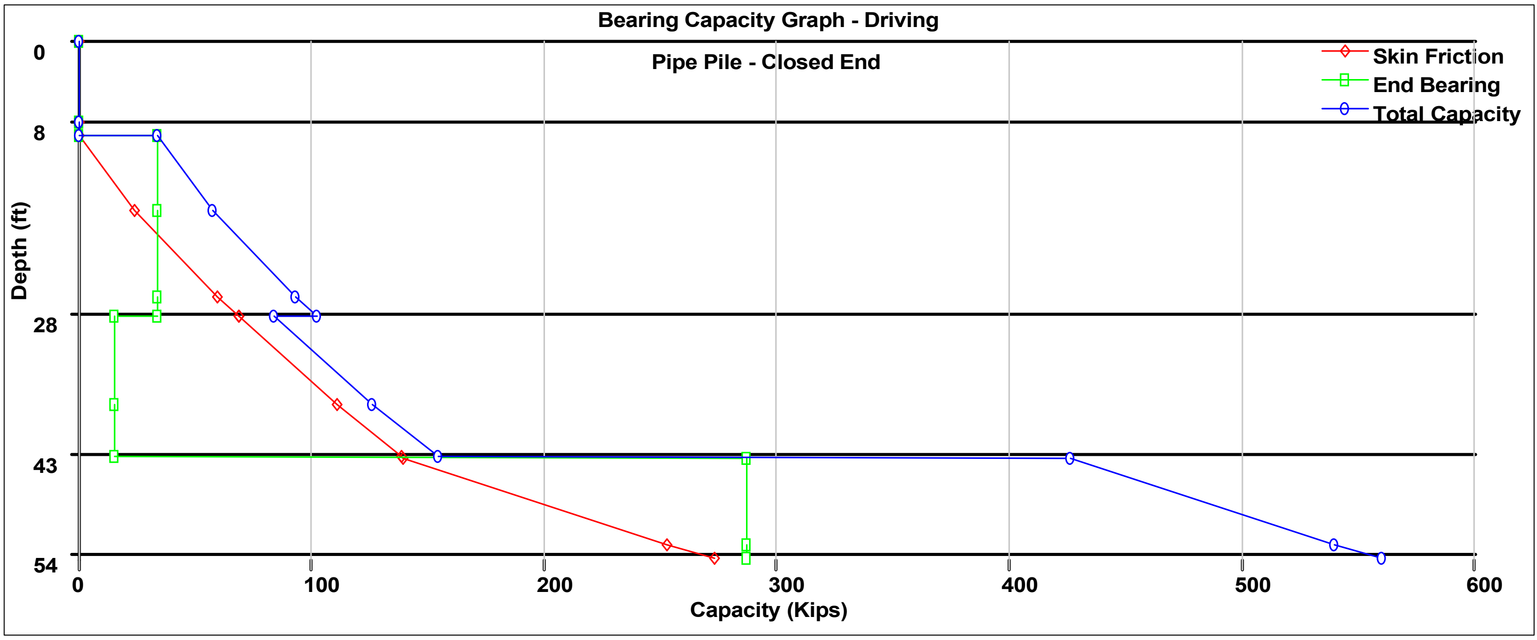
Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
6.19 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
6.20 ft	Cohesive	N/A	N/A	N/A	16.84 Kips
8.49 ft	Cohesive	N/A	N/A	N/A	16.84 Kips
8.51 ft	Cohesive	N/A	N/A	N/A	33.67 Kips
17.51 ft	Cohesive	N/A	N/A	N/A	33.67 Kips
26.51 ft	Cohesive	N/A	N/A	N/A	33.67 Kips
28.49 ft	Cohesive	N/A	N/A	N/A	33.67 Kips
28.51 ft	Cohesive	N/A	N/A	N/A	15.39 Kips
37.51 ft	Cohesive	N/A	N/A	N/A	15.39 Kips
42.99 ft	Cohesive	N/A	N/A	N/A	15.39 Kips
43.01 ft	Cohesionless	3748.73 psf	110.40	287.14 Kips	287.14 Kips
52.01 ft	Cohesionless	4402.13 psf	110.40	287.14 Kips	287.14 Kips
53.49 ft	Cohesionless	4509.57 psf	110.40	287.14 Kips	287.14 Kips

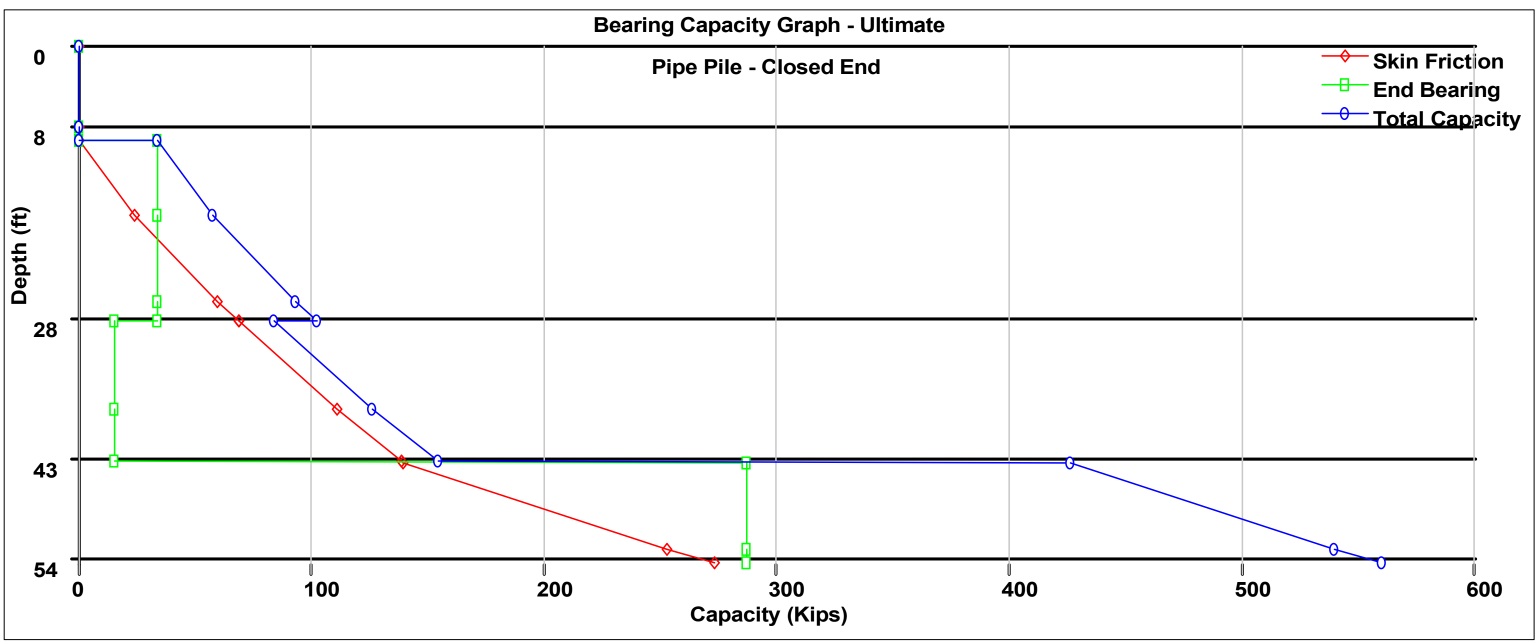
ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
6.19 ft	0.00 Kips	0.00 Kips	0.00 Kips
6.20 ft	0.00 Kips	16.84 Kips	16.84 Kips
8.49 ft	9.57 Kips	16.84 Kips	26.41 Kips
8.51 ft	9.64 Kips	33.67 Kips	43.31 Kips
17.51 ft	37.74 Kips	33.67 Kips	71.41 Kips
26.51 ft	74.16 Kips	33.67 Kips	107.83 Kips
28.49 ft	83.28 Kips	33.67 Kips	116.96 Kips
28.51 ft	83.37 Kips	15.39 Kips	98.77 Kips
37.51 ft	125.66 Kips	15.39 Kips	141.06 Kips
42.99 ft	153.58 Kips	15.39 Kips	168.97 Kips
43.01 ft	153.74 Kips	287.14 Kips	440.88 Kips
52.01 ft	267.19 Kips	287.14 Kips	554.33 Kips
53.49 ft	287.59 Kips	287.14 Kips	574.72 Kips

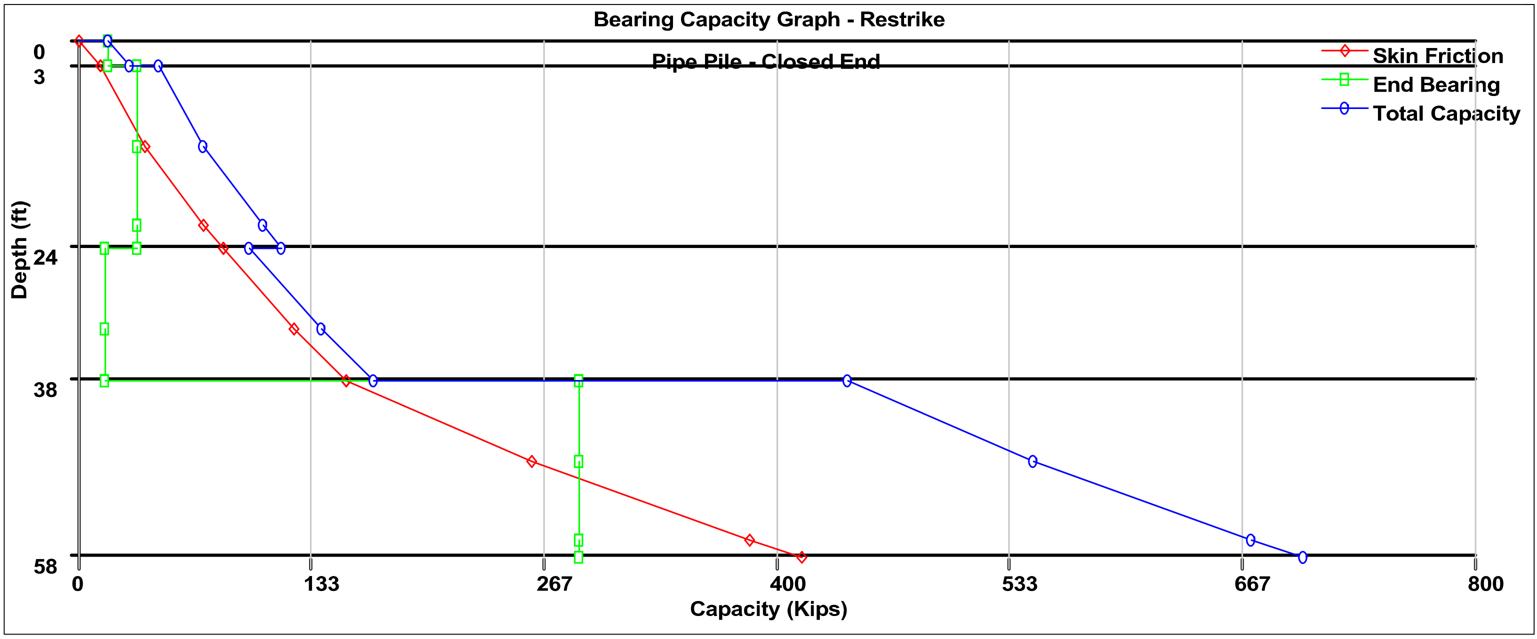
Rndr = 277 kips
at 43.0 feet

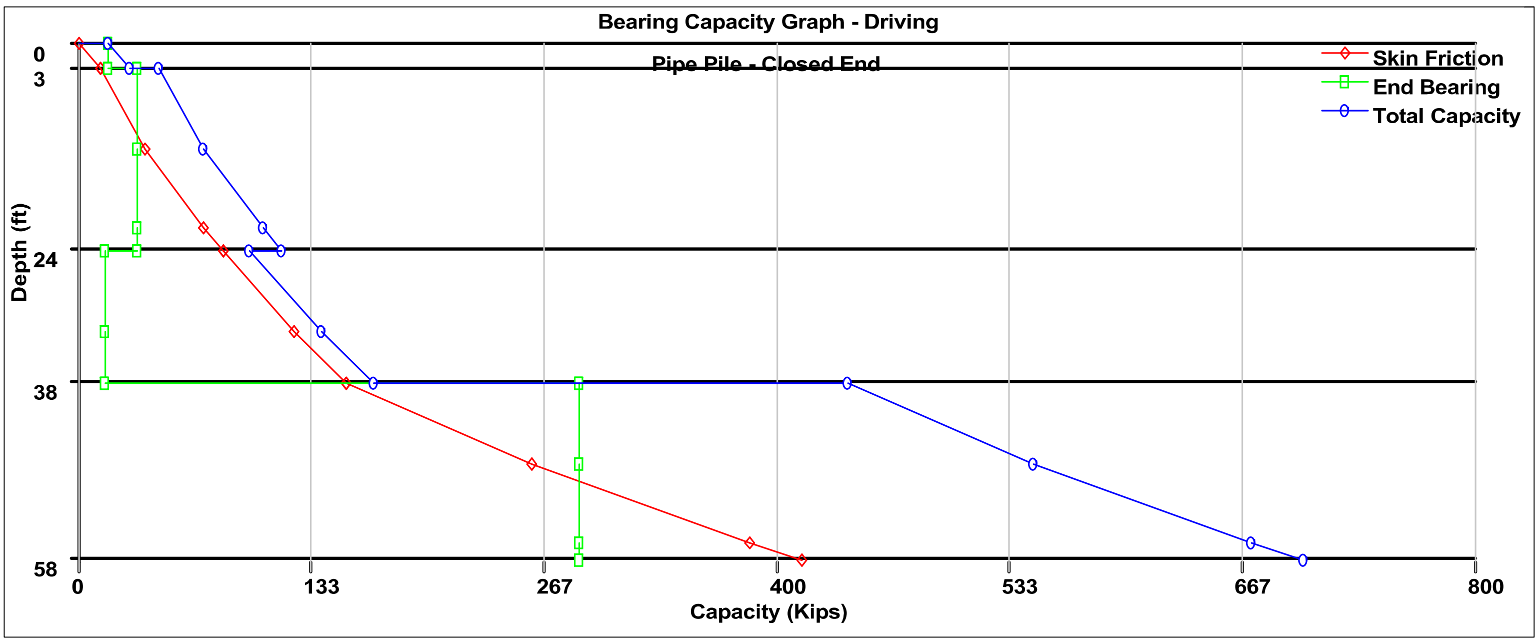


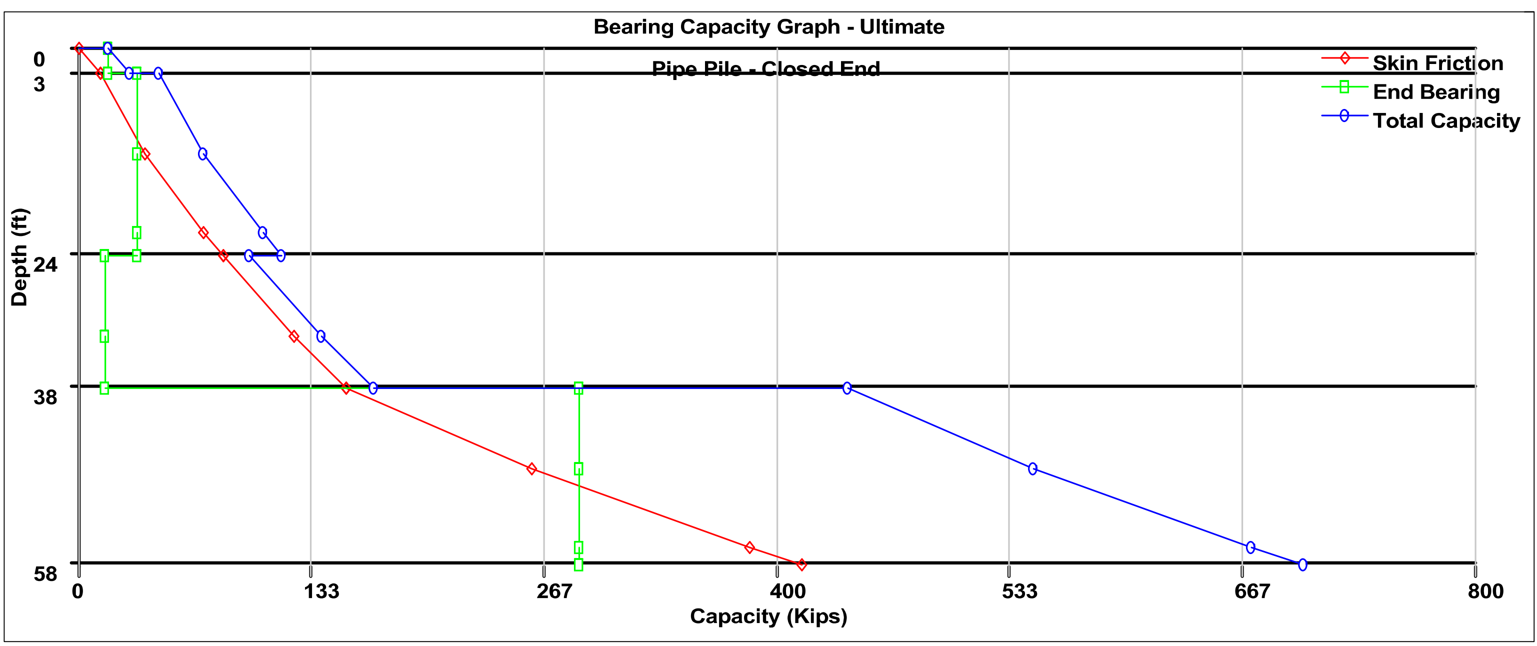




HEN-24/17D-00.43, PID 117712
14" CIP
Pier - B-019



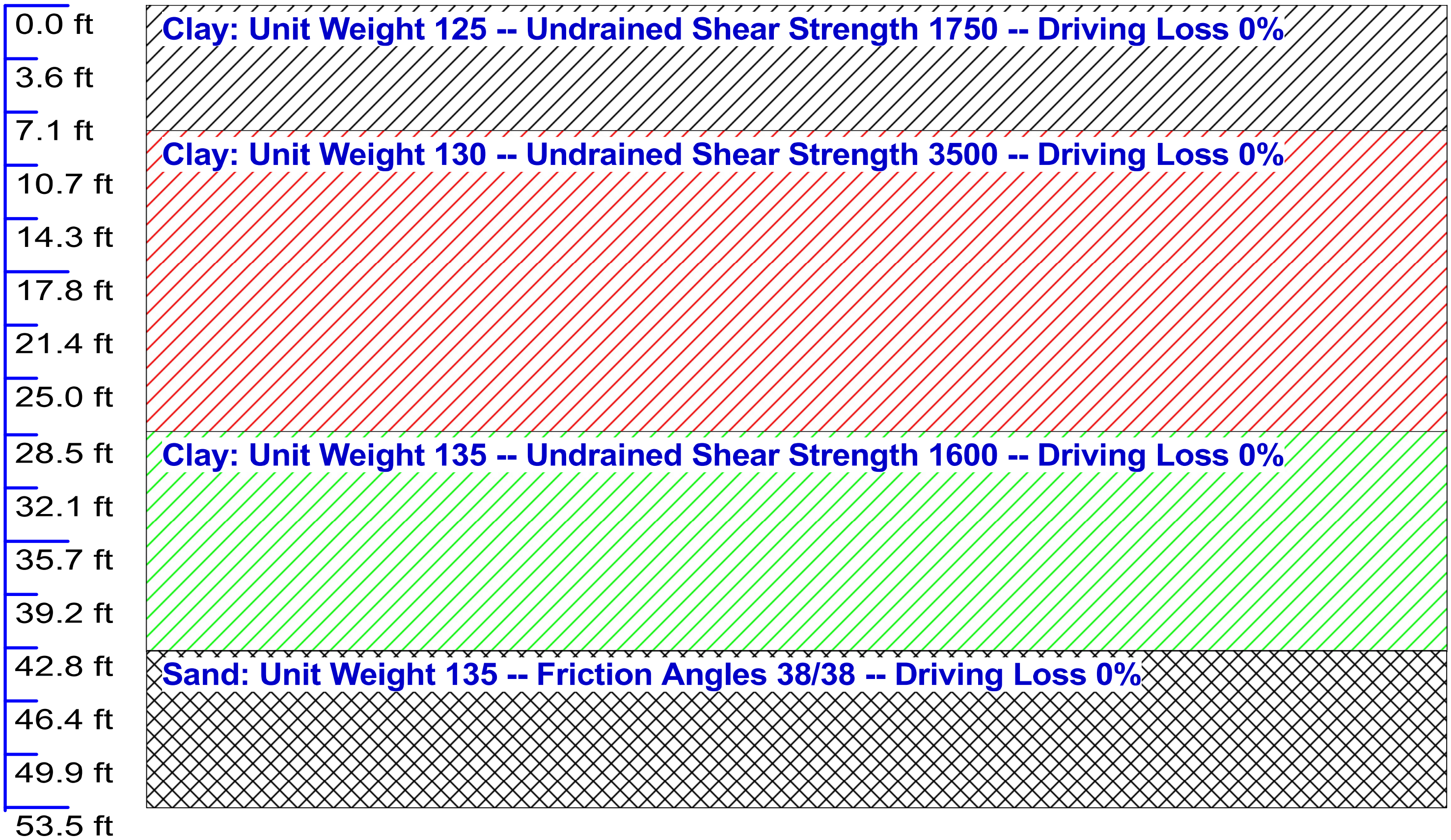




HEN-24/17D-00.43, PID 117712
14" CIP
Forward Abutment - B-025

Filename: T:\GEOTECH\DRIVEN\230230\B-019.DVN

Soil Profile



DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: T:\GEOTECH\DRIVEN\230230\B-25.DVN
Project Name: HEN-24/17D-00.43, PID 11 Project Date: 08/07/2023
Project Client: Burgess _Niple
Computed By: KCH
Project Manager: KCH

PILE INFORMATION

Pile Type: Pipe Pile - Closed End
Top of Pile: 0.00 ft
Diameter of Pile: 14.00 in

Bottom of Pile Sleeve at Elev. 698.5

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	13.30 ft
	- Driving/Restrike	13.30 ft
	- Ultimate:	13.30 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesive	3.00 ft	0.00%	125.00 pcf	1750.00 psf	T-79 Steel
2	Cohesive	20.50 ft	0.00%	130.00 pcf	3500.00 psf	T-79 Steel
3	Cohesive	15.00 ft	0.00%	135.00 pcf	1600.00 psf	T-79 Steel
4	Cohesionless	20.00 ft	0.00%	135.00 pcf	38.0/38.0	Nordlund

RESTRIKE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	1140.00 psf	0.04 Kips
2.99 ft	Cohesive	N/A	N/A	1140.00 psf	12.49 Kips
3.01 ft	Cohesive	N/A	N/A	770.00 psf	12.56 Kips
12.01 ft	Cohesive	N/A	N/A	774.81 psf	38.12 Kips
21.01 ft	Cohesive	N/A	N/A	900.81 psf	72.00 Kips
23.49 ft	Cohesive	N/A	N/A	935.53 psf	82.79 Kips
23.51 ft	Cohesive	N/A	N/A	1177.98 psf	82.88 Kips
32.51 ft	Cohesive	N/A	N/A	1244.84 psf	123.95 Kips
38.49 ft	Cohesive	N/A	N/A	1289.26 psf	153.67 Kips
38.51 ft	Cohesionless	3492.88 psf	25.33	N/A	153.83 Kips
47.51 ft	Cohesionless	3819.58 psf	25.33	N/A	260.16 Kips
56.51 ft	Cohesionless	4146.28 psf	25.33	N/A	384.68 Kips
58.49 ft	Cohesionless	4218.16 psf	25.33	N/A	414.52 Kips

RESTRIKE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	16.84 Kips
2.99 ft	Cohesive	N/A	N/A	N/A	16.84 Kips
3.01 ft	Cohesive	N/A	N/A	N/A	33.67 Kips
12.01 ft	Cohesive	N/A	N/A	N/A	33.67 Kips
21.01 ft	Cohesive	N/A	N/A	N/A	33.67 Kips
23.49 ft	Cohesive	N/A	N/A	N/A	33.67 Kips
23.51 ft	Cohesive	N/A	N/A	N/A	15.39 Kips
32.51 ft	Cohesive	N/A	N/A	N/A	15.39 Kips
38.49 ft	Cohesive	N/A	N/A	N/A	15.39 Kips
38.51 ft	Cohesionless	3493.25 psf	110.40	287.14 Kips	287.14 Kips
47.51 ft	Cohesionless	4146.65 psf	110.40	287.14 Kips	287.14 Kips
56.51 ft	Cohesionless	4800.05 psf	110.40	287.14 Kips	287.14 Kips
58.49 ft	Cohesionless	4943.79 psf	110.40	287.14 Kips	287.14 Kips

RESTRIKE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.04 Kips	16.84 Kips	16.88 Kips
2.99 ft	12.49 Kips	16.84 Kips	29.33 Kips
3.01 ft	12.56 Kips	33.67 Kips	46.24 Kips
12.01 ft	38.12 Kips	33.67 Kips	71.80 Kips
21.01 ft	72.00 Kips	33.67 Kips	105.67 Kips
23.49 ft	82.79 Kips	33.67 Kips	116.47 Kips
23.51 ft	82.88 Kips	15.39 Kips	98.27 Kips
32.51 ft	123.95 Kips	15.39 Kips	139.34 Kips
38.49 ft	153.67 Kips	15.39 Kips	169.06 Kips
38.51 ft	153.83 Kips	287.14 Kips	440.97 Kips
47.51 ft	260.16 Kips	287.14 Kips	547.30 Kips
56.51 ft	384.68 Kips	287.14 Kips	671.82 Kips
58.49 ft	414.52 Kips	287.14 Kips	701.66 Kips

DRIVING - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	1140.00 psf	0.04 Kips
2.99 ft	Cohesive	N/A	N/A	1140.00 psf	12.49 Kips
3.01 ft	Cohesive	N/A	N/A	770.00 psf	12.56 Kips
12.01 ft	Cohesive	N/A	N/A	774.81 psf	38.12 Kips
21.01 ft	Cohesive	N/A	N/A	900.81 psf	72.00 Kips
23.49 ft	Cohesive	N/A	N/A	935.53 psf	82.79 Kips
23.51 ft	Cohesive	N/A	N/A	1177.98 psf	82.88 Kips
32.51 ft	Cohesive	N/A	N/A	1244.84 psf	123.95 Kips
38.49 ft	Cohesive	N/A	N/A	1289.26 psf	153.67 Kips
38.51 ft	Cohesionless	3492.88 psf	25.33	N/A	153.83 Kips
47.51 ft	Cohesionless	3819.58 psf	25.33	N/A	260.16 Kips
56.51 ft	Cohesionless	4146.28 psf	25.33	N/A	384.68 Kips
58.49 ft	Cohesionless	4218.16 psf	25.33	N/A	414.52 Kips

DRIVING - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	16.84 Kips
2.99 ft	Cohesive	N/A	N/A	N/A	16.84 Kips
3.01 ft	Cohesive	N/A	N/A	N/A	33.67 Kips
12.01 ft	Cohesive	N/A	N/A	N/A	33.67 Kips
21.01 ft	Cohesive	N/A	N/A	N/A	33.67 Kips
23.49 ft	Cohesive	N/A	N/A	N/A	33.67 Kips
23.51 ft	Cohesive	N/A	N/A	N/A	15.39 Kips
32.51 ft	Cohesive	N/A	N/A	N/A	15.39 Kips
38.49 ft	Cohesive	N/A	N/A	N/A	15.39 Kips
38.51 ft	Cohesionless	3493.25 psf	110.40	287.14 Kips	287.14 Kips
47.51 ft	Cohesionless	4146.65 psf	110.40	287.14 Kips	287.14 Kips
56.51 ft	Cohesionless	4800.05 psf	110.40	287.14 Kips	287.14 Kips
58.49 ft	Cohesionless	4943.79 psf	110.40	287.14 Kips	287.14 Kips

DRIVING - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.04 Kips	16.84 Kips	16.88 Kips
2.99 ft	12.49 Kips	16.84 Kips	29.33 Kips
3.01 ft	12.56 Kips	33.67 Kips	46.24 Kips
12.01 ft	38.12 Kips	33.67 Kips	71.80 Kips
21.01 ft	72.00 Kips	33.67 Kips	105.67 Kips
23.49 ft	82.79 Kips	33.67 Kips	116.47 Kips
23.51 ft	82.88 Kips	15.39 Kips	98.27 Kips
32.51 ft	123.95 Kips	15.39 Kips	139.34 Kips
38.49 ft	153.67 Kips	15.39 Kips	169.06 Kips
38.51 ft	153.83 Kips	287.14 Kips	440.97 Kips
47.51 ft	260.16 Kips	287.14 Kips	547.30 Kips
56.51 ft	384.68 Kips	287.14 Kips	671.82 Kips
58.49 ft	414.52 Kips	287.14 Kips	701.66 Kips

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	1140.00 psf	0.04 Kips
2.99 ft	Cohesive	N/A	N/A	1140.00 psf	12.49 Kips
3.01 ft	Cohesive	N/A	N/A	770.00 psf	12.56 Kips
12.01 ft	Cohesive	N/A	N/A	774.81 psf	38.12 Kips
21.01 ft	Cohesive	N/A	N/A	900.81 psf	72.00 Kips
23.49 ft	Cohesive	N/A	N/A	935.53 psf	82.79 Kips
23.51 ft	Cohesive	N/A	N/A	1177.98 psf	82.88 Kips
32.51 ft	Cohesive	N/A	N/A	1244.84 psf	123.95 Kips
38.49 ft	Cohesive	N/A	N/A	1289.26 psf	153.67 Kips
38.51 ft	Cohesionless	3492.88 psf	25.33	N/A	153.83 Kips
47.51 ft	Cohesionless	3819.58 psf	25.33	N/A	260.16 Kips
56.51 ft	Cohesionless	4146.28 psf	25.33	N/A	384.68 Kips
58.49 ft	Cohesionless	4218.16 psf	25.33	N/A	414.52 Kips

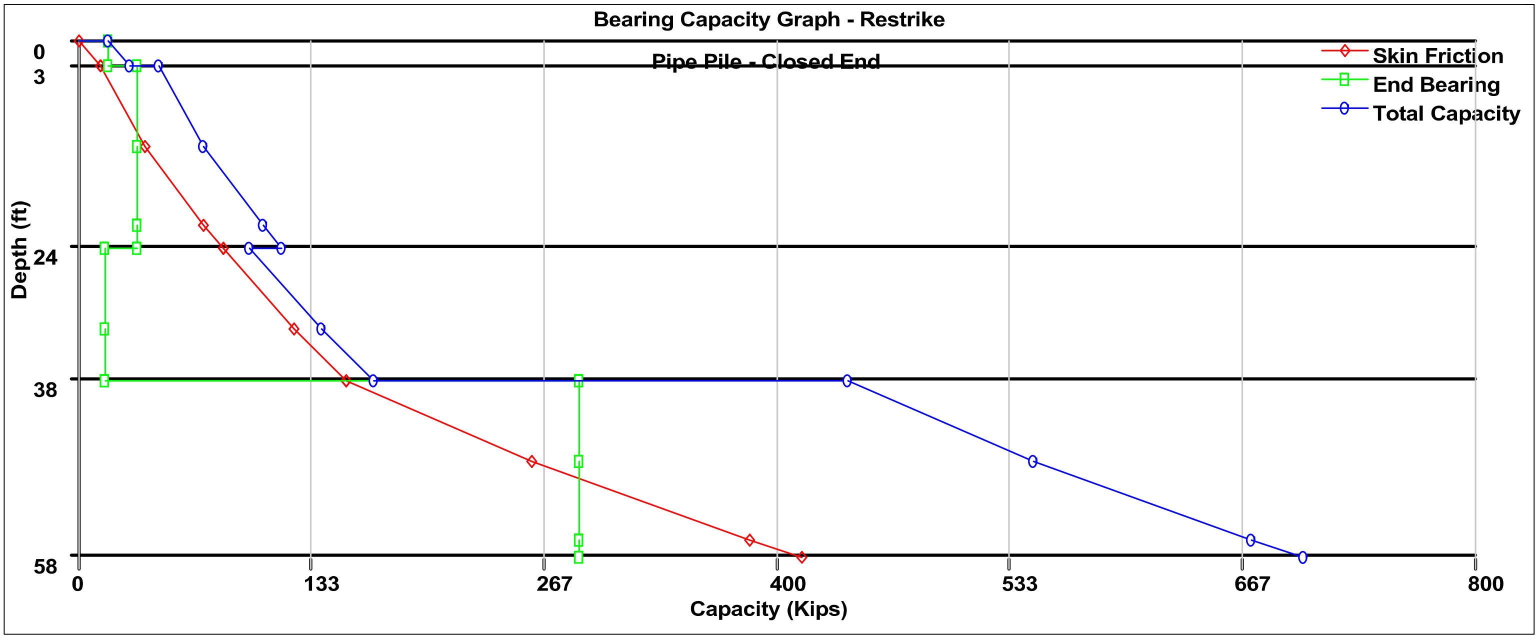
ULTIMATE - END BEARING

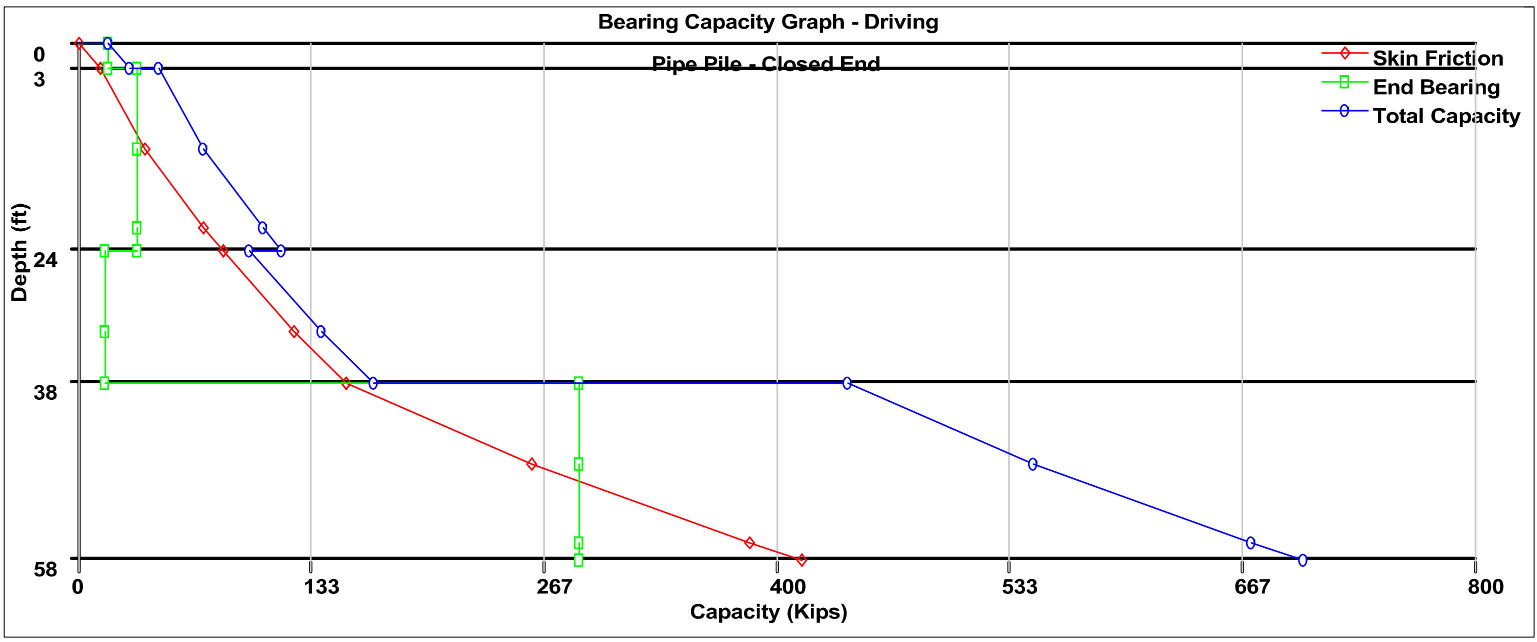
Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	16.84 Kips
2.99 ft	Cohesive	N/A	N/A	N/A	16.84 Kips
3.01 ft	Cohesive	N/A	N/A	N/A	33.67 Kips
12.01 ft	Cohesive	N/A	N/A	N/A	33.67 Kips
21.01 ft	Cohesive	N/A	N/A	N/A	33.67 Kips
23.49 ft	Cohesive	N/A	N/A	N/A	33.67 Kips
23.51 ft	Cohesive	N/A	N/A	N/A	15.39 Kips
32.51 ft	Cohesive	N/A	N/A	N/A	15.39 Kips
38.49 ft	Cohesive	N/A	N/A	N/A	15.39 Kips
38.51 ft	Cohesionless	3493.25 psf	110.40	287.14 Kips	287.14 Kips
47.51 ft	Cohesionless	4146.65 psf	110.40	287.14 Kips	287.14 Kips
56.51 ft	Cohesionless	4800.05 psf	110.40	287.14 Kips	287.14 Kips
58.49 ft	Cohesionless	4943.79 psf	110.40	287.14 Kips	287.14 Kips

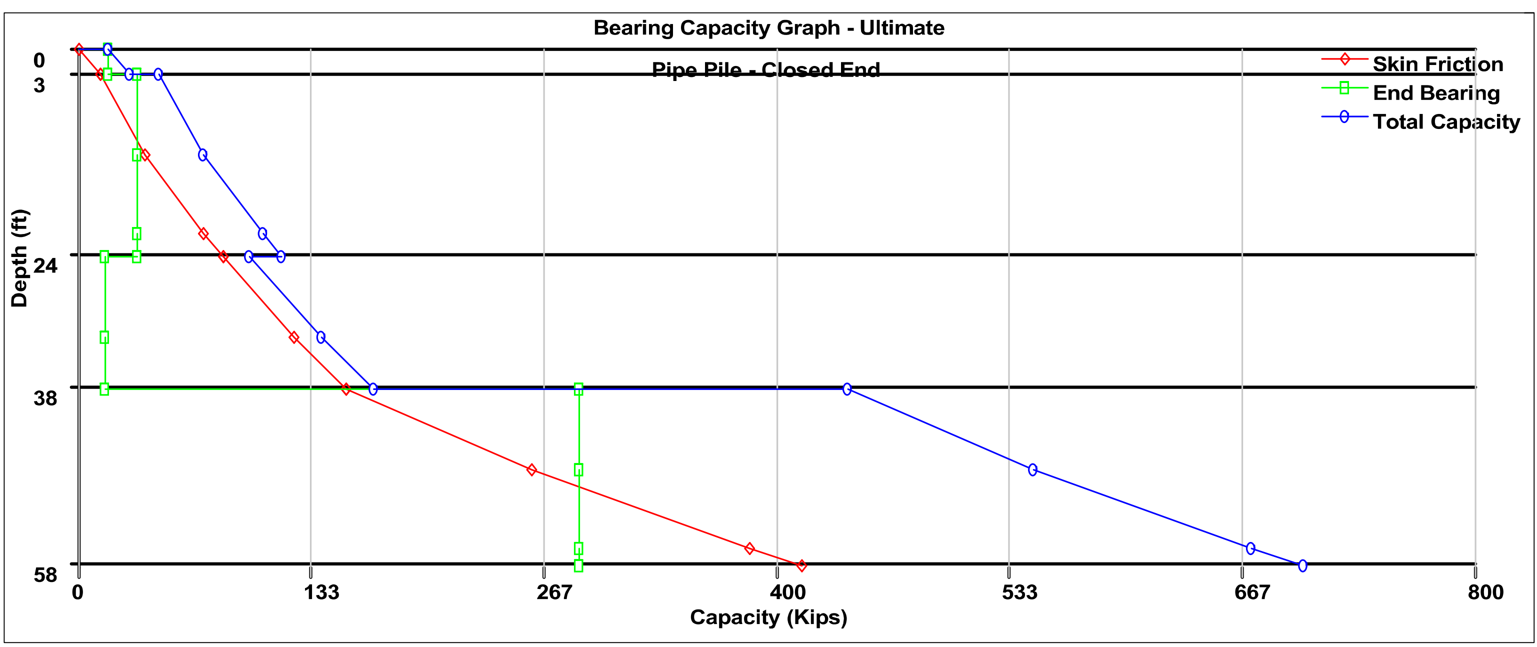
ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.04 Kips	16.84 Kips	16.88 Kips
2.99 ft	12.49 Kips	16.84 Kips	29.33 Kips
3.01 ft	12.56 Kips	33.67 Kips	46.24 Kips
12.01 ft	38.12 Kips	33.67 Kips	71.80 Kips
21.01 ft	72.00 Kips	33.67 Kips	105.67 Kips
23.49 ft	82.79 Kips	33.67 Kips	116.47 Kips
23.51 ft	82.88 Kips	15.39 Kips	98.27 Kips
32.51 ft	123.95 Kips	15.39 Kips	139.34 Kips
38.49 ft	153.67 Kips	15.39 Kips	169.06 Kips
38.51 ft	153.83 Kips	287.14 Kips	440.97 Kips
47.51 ft	260.16 Kips	287.14 Kips	547.30 Kips
56.51 ft	384.68 Kips	287.14 Kips	671.82 Kips
58.49 ft	414.52 Kips	287.14 Kips	701.66 Kips

Rndr = 244 kips
at 38.5 feet


Bearing Capacity Graph - Restrike
Pipe Pile - Closed End
Skin Friction
End Bearing
Total Capacity
Depth (ft)
0
3
24
38
58
0
133
267
400
533
667
800
Capacity (Kips)


Bearing Capacity Graph - Driving
Pipe Pile - Closed End
Skin Friction
End Bearing
Total Capacity
Depth (ft)
0
3
24
38
58
0
133
267
400
533
667
800
Capacity (Kips)


Bearing Capacity Graph - Ultimate
Pipe Pile - Closed End
Skin Friction
End Bearing
Total Capacity
Depth (ft)
0
3
24
38
58
0
133
267
400
533
667
800
Capacity (Kips)

Filename: T:\GEOTECH\DRIVEN\230230\B-25.DVN

HEN-24/17D-00.43, PID 117712
14" CIP
Forward Abutment - B-025

Soil Profile

Project Name:	HEN-24/17D-00.43, PID 117712
Project Number:	230230
Calculated by:	KCH 3/25/2024
Subject:	Driveability Analysis

Pile type: 14" CIP

Prebore through Embankment? No

Sleeved through Embankment Yes Ignore skin friction for driveability through sleeve per BDM 305.3.5.7

Required Inputs:

Pile Diameter =	14	inches
Pile Tip Area =	153.9	square inches
Pile Perimeter =	3.665	ft
Pile Size =	14	inches
Elastic Modulus =	30,000	ksi, per GDM 1304.2.2
Spec Weight =	492	pcf, per GDM 1304.2.2
Wall Thickness =	0.125	inches, smallest available

Boring Number	Location	Pile Length* (feet)	GSE (feet)	Footing Elev. (feet)	Tip Elev. (feet)	Penetration** (feet)	GWT (feet)	Overburden Pressure (psf)
B-014	Rear Abutment	60	699.5	712.7	661	38.58	13.5	0
B-019	Pier	45	701.7	697.15	658.7	38.53	13	569
B-025	Forward Abutment	60	698.5	712.95	660	38.58	13.3	0

*GRLWEAP input is named "Pile Length." ODOT GDM 1304.2.2 specifies to use Order Length.

**Model driving 1" into end-bearing material

Stratum	Top Depth (feet)	Bottom Depth (feet)	c (psf)	SPT N60	D/Qt (GDM Table 1300-2)	Qt	ODOT Soil Class	Skin Damping, Js (GDM Table 1300-3)	Set-up Time, SU T (GDM Table 1300-4) (hours)	Setup Factor, f_{su} (BDM Table 305-2)	DRIVEN % Driving Strength Loss (BDM Table 305-2)	Shaft Gain/Loss Factor
Cohesive Fill	0	2	2500	12	92.8	0.151	A-6b	0.2	168	1.75	43	0.57
I	2	2	1750	14	96.2	0.146	-	-	-	-	-	-
II	2	33.5	3500	29	114.0	0.123	A-4a, A-6a, A-6b	0.15 - 0.2	168	1.75	43	0.57
III	33.5	38.5	1600	13	94.5	0.148	A-6b	0.2	168	1.75	43	0.57
IV	38.5	53.5	phi = 42 deg	71	120	0.117	A-4a, A-6a	0.15 - 0.2	168	1.5	33	0.67

Shaft Gain/Loss	Toe Gain/Loss
0.57	1.0
0	0
0	0
0	0
0	0

Stratum	Top Depth (feet)	Bottom Depth (feet)	c (psf)	SPT N60	D/Qt (GDM Table 1300-2)	Qt	ODOT Soil Class	Skin Damping, Js (GDM Table 1300-3)	Set-up Time, SU T (GDM Table 1300-4) (hours)	Setup Factor, f_{su} (BDM Table 305-2)	DRIVEN % Driving Strength Loss (BDM Table 305-2)	Shaft Gain/Loss Factor
Cohesive Fill	0	0	2500	12	92.8	0.151	-	-	-	-	-	-
I	0	8.5	1750	14	96.2	0.146	A-6b	0.2	168	1.75	43	0.57
II	8.5	28.5	3500	29	114.0	0.123	A-4a, A-6a, A-6b	0.15 - 0.2	168	1.75	43	0.57
III	28.5	43	1600	13	94.5	0.148	A-6b	0.2	168	1.75	43	0.57
IV	43	53.5	phi = 42 deg	71	120	0.117	A-4a	0.15	168	1.2	17	0.83

Shaft Gain/Loss	Toe Gain/Loss
0.57	1.0
0	0
0	0
0	0
0	0

Stratum	Top Depth (feet)	Bottom Depth (feet)	c (psf)	SPT N60	D/Qt (GDM Table 1300-2)	Qt	ODOT Soil Class	Skin Damping, Js (GDM Table 1300-3)	Set-up Time, SU T (GDM Table 1300-4) (hours)	Setup Factor, f_{su} (BDM Table 305-2)	DRIVEN % Driving Strength Loss (BDM Table 305-2)	Shaft Gain/Loss Factor
Cohesive Fill	0	0	2500	12	92.8	0.151	-	-	-	-	-	-
I	0	3	1750	14	96.2	0.146	A-6b	0.2	168	1.75	43	0.57
II	3	23.5	3500	29	114.0	0.123	A-6a, A-6b	0.15 - 0.2	168	1.75	43	0.57
III	23.5	38.5	1600	13	94.5	0.148	A-6b	0.2	168	1.75	43	0.57
IV	38.5	58.5	phi = 42 deg	71	120	0.117	A-4a, A-6b	0.15 - 0.2	168	1.75	43	0.57

Shaft Gain/Loss	Toe Gain/Loss
0.57	1.0
0	0
0	0
0	0
0	0

GRLWEAP - Version 2005
WAVE EQUATION ANALYSIS OF PILE FOUNDATIONS

written by GRL Engineers, Inc. (formerly Goble Rausche Likins and Associates, Inc.) with cooperation from Pile Dynamics, Inc.

ABOUT THE WAVE EQUATION ANALYSIS RESULTS

The GRLWEAP program simulates the behavior of a preformed pile driven by either an impact hammer or a vibratory hammer. The program is based on mathematical models, which describe motion and forces of hammer, driving system, pile and soil under the hammer action. Under certain conditions, the models only crudely approximate, often complex, dynamic situations.

A wave equation analysis generally relies on input data, which represents normal situations. In particular, the hammer data file supplied with the program assumes that the hammer is in good working order. All of the input data selected by the user may be the best available information at the time when the analysis is performed. However, input data and therefore results may significantly differ from actual field conditions.

Therefore, the program authors recommend prudent use of the GRLWEAP results. Soil response and hammer performance should be verified by static and/or dynamic testing and measurements. Estimates of bending or other local non-axial stresses and prestress effects must also be accounted for by the user.

The calculated capacity - blow count relationship, i.e. the bearing graph, should be used in conjunction with observed blow counts for the capacity assessment of a driven pile. Soil setup occurring after pile installation may produce bearing capacity values that differ substantially from those expected from a wave equation analysis due to soil setup or relaxation. This is particularly true for pile driven with vibratory hammers. The GRLWEAP user must estimate such effects and should also use proper care when applying blow counts from restrike because of the variability of hammer energy, soil resistance and blow count during early restriking.

Finally, the GRLWEAP capacities are ultimate values. They MUST be reduced by means of an appropriate factor of safety to yield a design or working load. The selection of a factor of safety should consider the quality of the construction control, the variability of the site conditions, uncertainties in the loads, the importance of building and other factors.

Input File: T:\GEOTECH\DRIVEN\230230\B-014.GWI
Hammer File: C:\Program Files (x86)\PDI\GRLWEAP 2005\HAMMER2003.GW
Hammer File Version: 2003 (8/28/2009)

```
                      Input File Contents
    HEN-24/17D-00.43, PID 117712
 OUT OSG HAM STR FUL PEL  N SPL N-U P-D %SK ISM  0 PHI RSA ITR H-D MXT     DEx
-100   0  41   0   0   0  0   0   0   1   0   0  0   0   0   0   0   0   0.000
   Pile g  Hammer g  Toe Area Pile Size           Pile Type
   32.170    32.170   153.940    14.000                Pipe
     W Cp      A Cp      E Cp      T Cp       CoR      ROut      StCp
    1.900   227.000     530.0     2.000     0.800     0.010       0.0
     A Cu      E Cu      T Cu       CoR      ROut      StCu
    0.000       0.0     0.000     0.000     0.000       0.0
     LPle      APle      EPle      WPle      Peri      Strg       CoR      ROut
   55.000    10.800 30000.000   492.000     3.665     0.000     0.850     0.010
 Manufac  Hmr Name  HmrType No Seg-s
 DELMAG   D 19-42         1        5
   Ram Wt     Ram L   Ram Dia   MaxStrk   RtdStrk    Efficy
     4.00    129.10     12.60     11.86     10.81      0.80
   IB. Wt     IB. L    IB.Dia    IB CoR     IB RO
     0.75     25.30     12.60     0.900     0.010
  CompStrk A Chamber V Chamber   C Delay  C Duratn Exp Coeff VolCStart  Vol CEnd
    16.65    124.70    157.70     0.002     0.002     1.250      0.00      0.00
    P atm        P1        P2        P3        P4        P5
    14.70   1520.00   1368.00   1231.00   1108.00      0.00
   Stroke    Effic.  Pressure  R-Weight   T-Delay Exp-Coeff   Eps-Str  Total-AW
  10.8100    0.8000 1520.0000    0.0000    0.0000    0.0000    0.0100    0.0000
       Qs        Qt        Js        Jt        Qx        Jx      Rati      Dept
    0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000
  Research Soil Model: Atoe, Plug,  Gap, Q-fac
    0.000     0.000     0.000     0.000
  Research Soil Model: RD-skn: m, d, toe: m, d
    0.000     0.000     0.000     0.000
  Res. Distribution
   Dpth    Rskn     Rtoe       Qs       Qt       Js       Jt     SU F     LimD     SU T
   0.01    1.00    24.05     0.10     0.15     0.20     0.15     1.75     6.00   148.00
   1.99    1.00    24.05     0.10     0.15     0.20     0.15     1.75     6.00   148.00
   2.01    0.77    33.67     0.10     0.12     0.20     0.15     1.75     6.00   148.00
  11.01    0.77    33.67     0.10     0.12     0.20     0.15     1.75     6.00   148.00
  20.01    0.89    33.67     0.10     0.12     0.20     0.15     1.75     6.00   148.00
  29.01    1.01    33.67     0.10     0.12     0.20     0.15     1.75     6.00   148.00
  33.49    1.08    33.67     0.10     0.12     0.20     0.15     1.75     6.00   148.00
  33.51    1.25    15.39     0.10     0.15     0.20     0.15     1.75     6.00   148.00
  38.49    1.29    15.39     0.10     0.15     0.20     0.15     1.75     6.00   148.00
  38.51    2.92   287.14     0.10     0.12     0.20     0.15     1.50     6.00   148.00
  55.00    2.92   287.14     0.10     0.12     0.20     0.15     1.50     6.00   148.00
  Gain/Loss factors: shaft and toe
  0.57000   0.00000   0.00000   0.00000   0.00000
  1.00000   0.00000   0.00000   0.00000   0.00000
     Dpth         L      Wait      Strk      Pmx%      Eff.      Stff       CoR
     1.98      0.00      0.00     0.000     0.000     0.000     0.000     0.000
     2.02      0.00      0.00     0.000     0.000     0.000     0.000     0.000
```

17.75	0.00	0.00	0.000	0.000	0.000	0.000	0.000
33.48	0.00	0.00	0.000	0.000	0.000	0.000	0.000
33.52	0.00	0.00	0.000	0.000	0.000	0.000	0.000
35.99	0.00	0.00	0.000	0.000	0.000	0.000	0.000
38.58	0.00	0.00	0.000	0.000	0.000	0.000	0.000
0.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000

Diameter	COGHammer	WHammer	ABatter	Depth Sup	Flag
0.000	0.000	0.000	0.000	0.000	0

GRLWEAP: WAVE EQUATION ANALYSIS OF PILE FOUNDATIONS
Version 2005
English Units

HEN-24/17D-00.43, PID 117712

Hammer Model: D 19-42 Made by: DELMAG

No.	Weight kips	Stiffn k/inch	CoR	C-Slk ft	Dampg k/ft/s
1	0.800				
2	0.800	140046.7	1.000	0.0100	
3	0.800	140046.7	1.000	0.0100	
4	0.800	140046.7	1.000	0.0100	
5	0.800	140046.7	1.000	0.0100	
Imp Block	0.753	70735.6	0.900	0.0100	
Helmet	1.900	60155.0	0.800	0.0100	5.8
Combined Pile Top		8345.5			

HAMMER OPTIONS:

Hammer File ID No.	41	Hammer Type	OE Diesel
Stroke Option	FxdP-VarS	Stroke Convergence Crit.	0.010
Fuel Pump Setting	Maximum		

HAMMER DATA:

Ram Weight	(kips)	4.00	Ram Length	(inch)	129.10
Maximum Stroke	(ft)	11.86			
Rated Stroke	(ft)	10.81	Efficiency		0.800
Maximum Pressure	(psi)	1520.00	Actual Pressure	(psi)	1520.00
Compression Exponent		1.350	Expansion Exponent		1.250
Ram Diameter	(inch)	12.60			
Combustion Delay	(s)	0.00200	Ignition Duration	(s)	0.00200

The Hammer Data Includes Estimated (NON-MEASURED) Quantities

HAMMER CUSHION			PILE CUSHION		
Cross Sect. Area	(in2)	227.00	Cross Sect. Area	(in2)	0.00

```
 Elastic-Modulus      (ksi)     530.0  Elastic-Modulus      (ksi)       0.0
 Thickness           (inch)      2.00  Thickness           (inch)      0.00
 Coeff of Restitution             0.8  Coeff of Restitution             1.0
 RoundOut              (ft)       0.0  RoundOut              (ft)       0.0
 Stiffness        (kips/in)   60155.0  Stiffness        (kips/in)       0.0
```

```
HEN-24/17D-00.43, PID 117712                                     08/22/2023
TTL Associates Inc                               GRLWEAP(TM) Version 2005

 Depth                 (ft)       2.0
 Shaft Gain/Loss Factor         0.570  Toe Gain/Loss Factor           1.000

 PILE PROFILE:
 Toe Area             (in2)   153.940  Pile Type                       Pipe
 Pile Size           (inch)    14.000

  L b Top     Area    E-Mod  Spec Wt    Perim Strength  Wave Sp      EA/c
       ft      in2      ksi   lb/ft3       ft      ksi     ft/s    k/ft/s
      0.0    10.80   30000.    492.0      3.7    0.000   16807.      19.3
     55.0    10.80   30000.    492.0      3.7    0.000   16807.      19.3

 Wave Travel Time 2L/c (ms)     6.545

        Pile and Soil Model            Total Capacity Rut  (kips)      28.2
No. Weight  Stiffn C-Slk T-Slk  CoR  Soil-S  Soil-D Quake   LbTop Perim  Area
      kips    k/in    ft    ft         kips    s/ft  inch      ft    ft   in2
  1  0.119   8345. 0.010 0.000 0.85     0.0   0.000 0.100    3.24   3.7  10.8
  2  0.119   8345. 0.000 0.000 1.00     0.0   0.000 0.100    6.47   3.7  10.8
 17  0.119   8345. 0.000 0.000 1.00     4.1   0.200 0.100   55.00   3.7  10.8
Toe                                    24.0   0.150 0.151

    2.030 kips total unreduced pile weight (g= 32.17 ft/s2)
    2.030 kips total reduced pile weight   (g= 32.17 ft/s2)

 PILE, SOIL, ANALYSIS OPTIONS:
 Uniform pile                          Pile Segments: Automatic
 No. of Slacks/Splices              0  Pile Damping            (%)        1
 Pile Penetration (ft)          24.05  Pile Damping Fact.(k/ft/s)     0.386
 Driveability Analysis
 Soil Damping Option            Smith
 Max No Analysis Iterations         0  Time Increment/Critical          160
 Output Time Interval               1  Analysis Time-Input   (ms)         0
 Output Level: Normal
 Gravity Mass, Pile, Hammer:   32.170    32.170    32.170
 Output Segment Generation: Automatic

    Depth     Stroke  Pressure    Efficy
       ft         ft     Ratio
     1.98      10.81      1.00     0.800
```

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↑
HEN-24/17D-00.43, PID 117712                                  08/22/2023
TTL Associates Inc                                GRLWEAP(TM) Version 2005

    Rut    Bl Ct    Stroke (ft) Ten Str   i   t Comp Str   i   t ENTHRU   Bl Rt
   kips    b/ft    down      up     ksi              ksi         kip-ft   b/min
   28.2     2.6    4.06    4.10    0.00   1   0    14.84   1   2   22.7    58.5
↑
HEN-24/17D-00.43, PID 117712                                  08/22/2023
TTL Associates Inc                                GRLWEAP(TM) Version 2005

 Depth                  (ft)       2.0
 Shaft Gain/Loss Factor          0.570  Toe Gain/Loss Factor          1.000

 PILE PROFILE:
 Toe Area              (in2)   153.940  Pile Type                      Pipe
 Pile Size            (inch)    14.000

  L b Top     Area     E-Mod  Spec Wt    Perim Strength  Wave Sp      EA/c
       ft      in2       ksi   lb/ft3       ft      ksi     ft/s    k/ft/s
      0.0    10.80   30000.    492.0      3.7    0.000   16807.      19.3
     55.0    10.80   30000.    492.0      3.7    0.000   16807.      19.3

 Wave Travel Time 2L/c (ms)     6.545

        Pile and Soil Model            Total Capacity Rut  (kips)      37.9
No. Weight  Stiffn C-Slk T-Slk  CoR  Soil-S  Soil-D Quake   LbTop Perim  Area
      kips    k/in    ft    ft         kips    s/ft  inch      ft    ft   in2
  1  0.119   8345. 0.010 0.000 0.85     0.0   0.000 0.100    3.24   3.7  10.8
  2  0.119   8345. 0.000 0.000 1.00     0.0   0.000 0.100    6.47   3.7  10.8
 17  0.119   8345. 0.000 0.000 1.00     4.2   0.200 0.100   55.00   3.7  10.8
Toe                                    33.7   0.150 0.123

     2.030 kips total unreduced pile weight (g= 32.17 ft/s2)
     2.030 kips total reduced pile weight   (g= 32.17 ft/s2)


    Depth    Stroke  Pressure    Efficy
       ft        ft     Ratio
     2.02     10.81      1.00     0.800
↑
HEN-24/17D-00.43, PID 117712                                  08/22/2023
TTL Associates Inc                                GRLWEAP(TM) Version 2005

    Rut    Bl Ct    Stroke (ft) Ten Str   i   t Comp Str   i   t ENTHRU   Bl Rt
   kips    b/ft    down      up     ksi              ksi         kip-ft   b/min
   37.9     3.7    4.47    4.46    0.00   1   0    18.22   5   3   21.6    56.0
↑
HEN-24/17D-00.43, PID 117712                                  08/22/2023
TTL Associates Inc                                GRLWEAP(TM) Version 2005
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```
 Depth                 (ft)      17.8
 Shaft Gain/Loss Factor         0.570  Toe Gain/Loss Factor          1.000

 PILE PROFILE:
 Toe Area             (in2)   153.940  Pile Type                      Pipe
 Pile Size           (inch)    14.000

  L b Top     Area     E-Mod  Spec Wt    Perim Strength  Wave Sp      EA/c
      ft       in2       ksi   lb/ft3       ft      ksi     ft/s    k/ft/s
     0.0     10.80   30000.    492.0      3.7    0.000   16807.      19.3
    55.0     10.80   30000.    492.0      3.7    0.000   16807.      19.3

 Wave Travel Time 2L/c (ms)     6.545

        Pile and Soil Model            Total Capacity Rut  (kips)      63.8
No. Weight  Stiffn C-Slk T-Slk  CoR  Soil-S  Soil-D Quake   LbTop Perim  Area
      kips    k/in    ft    ft         kips    s/ft  inch      ft    ft   in2
  1  0.119   8345. 0.010 0.000 0.85     0.0   0.000 0.100    3.24   3.7  10.8
  2  0.119   8345. 0.000 0.000 1.00     0.0   0.000 0.100    6.47   3.7  10.8
 12  0.119   8345. 0.000 0.000 1.00     3.3   0.200 0.100   38.82   3.7  10.8
 13  0.119   8345. 0.000 0.000 1.00     5.4   0.200 0.100   42.06   3.7  10.8
 14  0.119   8345. 0.000 0.000 1.00     5.2   0.200 0.100   45.29   3.7  10.8
 16  0.119   8345. 0.000 0.000 1.00     5.4   0.200 0.100   51.76   3.7  10.8
 17  0.119   8345. 0.000 0.000 1.00     5.7   0.200 0.100   55.00   3.7  10.8
Toe                                    33.7   0.150 0.123

    2.030 kips total unreduced pile weight (g= 32.17 ft/s2)
    2.030 kips total reduced pile weight   (g= 32.17 ft/s2)


   Depth    Stroke  Pressure    Efficy
      ft        ft     Ratio
   17.75     10.81      1.00     0.800
```

HEN-24/17D-00.43, PID 117712 08/22/2023
TTL Associates Inc GRLWEAP(TM) Version 2005

```
   Rut   Bl Ct   Stroke (ft) Ten Str   i   t Comp Str   i    t ENTHRU   Bl Rt
  kips    b/ft   down     up     ksi              ksi          kip-ft   b/min
  63.8     7.4   5.32   5.30   -0.81  12  50    23.94  12    4   19.3    51.0
```

HEN-24/17D-00.43, PID 117712 08/22/2023
TTL Associates Inc GRLWEAP(TM) Version 2005

```
 Depth                 (ft)      33.5
 Shaft Gain/Loss Factor         0.570  Toe Gain/Loss Factor          1.000

 PILE PROFILE:
 Toe Area             (in2)   153.940  Pile Type                      Pipe
```

Pile Size (inch) 14.000

L b Top	Area	E-Mod	Spec Wt	Perim	Strength	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft	ksi	ft/s	k/ft/s
0.0	10.80	30000.	492.0	3.7	0.000	16807.	19.3
55.0	10.80	30000.	492.0	3.7	0.000	16807.	19.3

Wave Travel Time 2L/c (ms) 6.545

Pile and Soil Model — Total Capacity Rut (kips) 95.5

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.119	8345.	0.010	0.000	0.85	0.0	0.000	0.100	3.24	3.7	10.8
2	0.119	8345.	0.000	0.000	1.00	0.0	0.000	0.100	6.47	3.7	10.8
7	0.119	8345.	0.000	0.000	1.00	2.3	0.200	0.100	22.65	3.7	10.8
8	0.119	8345.	0.000	0.000	1.00	5.6	0.200	0.100	25.88	3.7	10.8
9	0.119	8345.	0.000	0.000	1.00	5.2	0.200	0.100	29.12	3.7	10.8
11	0.119	8345.	0.000	0.000	1.00	5.3	0.200	0.100	35.59	3.7	10.8
12	0.119	8345.	0.000	0.000	1.00	5.6	0.200	0.100	38.82	3.7	10.8
13	0.119	8345.	0.000	0.000	1.00	5.9	0.200	0.100	42.06	3.7	10.8
14	0.119	8345.	0.000	0.000	1.00	6.2	0.200	0.100	45.29	3.7	10.8
15	0.119	8345.	0.000	0.000	1.00	6.5	0.200	0.100	48.53	3.7	10.8
16	0.119	8345.	0.000	0.000	1.00	6.8	0.200	0.100	51.76	3.7	10.8
17	0.119	8345.	0.000	0.000	1.00	7.1	0.200	0.100	55.00	3.7	10.8
Toe						33.7	0.150	0.123			

2.030 kips total unreduced pile weight (g= 32.17 ft/s2)
2.030 kips total reduced pile weight (g= 32.17 ft/s2)

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
33.48	10.81	1.00	0.800

HEN-24/17D-00.43, PID 117712 08/22/2023
TTL Associates Inc GRLWEAP(TM) Version 2005

Rut	Bl Ct	Stroke (ft)		Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
95.5	12.8	6.07	6.08	-0.20	7	39	26.83	7	3	17.7	47.7

HEN-24/17D-00.43, PID 117712 08/22/2023
TTL Associates Inc GRLWEAP(TM) Version 2005

Depth (ft) 33.5
Shaft Gain/Loss Factor 0.570 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 153.940 Pile Type Pipe
Pile Size (inch) 14.000

L b Top	Area	E-Mod	Spec Wt	Perim	Strength	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft	ksi	ft/s	k/ft/s
0.0	10.80	30000.	492.0	3.7	0.000	16807.	19.3
55.0	10.80	30000.	492.0	3.7	0.000	16807.	19.3

Wave Travel Time 2L/c (ms) 6.545

Pile and Soil Model — Total Capacity Rut (kips) 77.3

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.119	8345.	0.010	0.000	0.85	0.0	0.000	0.100	3.24	3.7	10.8
2	0.119	8345.	0.000	0.000	1.00	0.0	0.000	0.100	6.47	3.7	10.8
7	0.119	8345.	0.000	0.000	1.00	2.4	0.200	0.100	22.65	3.7	10.8
8	0.119	8345.	0.000	0.000	1.00	5.6	0.200	0.100	25.88	3.7	10.8
9	0.119	8345.	0.000	0.000	1.00	5.2	0.200	0.100	29.12	3.7	10.8
11	0.119	8345.	0.000	0.000	1.00	5.3	0.200	0.100	35.59	3.7	10.8
12	0.119	8345.	0.000	0.000	1.00	5.6	0.200	0.100	38.82	3.7	10.8
13	0.119	8345.	0.000	0.000	1.00	5.9	0.200	0.100	42.06	3.7	10.8
14	0.119	8345.	0.000	0.000	1.00	6.2	0.200	0.100	45.29	3.7	10.8
15	0.119	8345.	0.000	0.000	1.00	6.5	0.200	0.100	48.53	3.7	10.8
16	0.119	8345.	0.000	0.000	1.00	6.8	0.200	0.100	51.76	3.7	10.8
17	0.119	8345.	0.000	0.000	1.00	7.1	0.200	0.100	55.00	3.7	10.8
Toe						15.4	0.150	0.148			

2.030 kips total unreduced pile weight (g= 32.17 ft/s2)
2.030 kips total reduced pile weight (g= 32.17 ft/s2)

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
33.52	10.81	1.00	0.800

↑
HEN-24/17D-00.43, PID 117712 08/22/2023
TTL Associates Inc GRLWEAP(TM) Version 2005

Rut	Bl Ct	Stroke (ft)		Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
77.3	10.0	5.73	5.76	-0.37	7	44	25.55	7	3	18.2	49.1

↑
HEN-24/17D-00.43, PID 117712 08/22/2023
TTL Associates Inc GRLWEAP(TM) Version 2005

Depth (ft) 36.0
Shaft Gain/Loss Factor 0.570 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 153.940 Pile Type Pipe
Pile Size (inch) 14.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	Strength ksi	Wave Sp ft/s	EA/c k/ft/s
0.0	10.80	30000.	492.0	3.7	0.000	16807.	19.3
55.0	10.80	30000.	492.0	3.7	0.000	16807.	19.3

Wave Travel Time 2L/c (ms) 6.545

Pile and Soil Model — Total Capacity Rut (kips) 83.8

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.119	8345.	0.010	0.000	0.85	0.0	0.000	0.100	3.24	3.7	10.8
2	0.119	8345.	0.000	0.000	1.00	0.0	0.000	0.100	6.47	3.7	10.8
6	0.119	8345.	0.000	0.000	1.00	0.8	0.200	0.100	19.41	3.7	10.8
7	0.119	8345.	0.000	0.000	1.00	6.0	0.200	0.100	22.65	3.7	10.8
8	0.119	8345.	0.000	0.000	1.00	5.2	0.200	0.100	25.88	3.7	10.8
10	0.119	8345.	0.000	0.000	1.00	5.3	0.200	0.100	32.35	3.7	10.8
11	0.119	8345.	0.000	0.000	1.00	5.6	0.200	0.100	35.59	3.7	10.8
12	0.119	8345.	0.000	0.000	1.00	5.8	0.200	0.100	38.82	3.7	10.8
13	0.119	8345.	0.000	0.000	1.00	6.1	0.200	0.100	42.06	3.7	10.8
14	0.119	8345.	0.000	0.000	1.00	6.4	0.200	0.100	45.29	3.7	10.8
15	0.119	8345.	0.000	0.000	1.00	6.7	0.200	0.100	48.53	3.7	10.8
16	0.119	8345.	0.000	0.000	1.00	7.0	0.200	0.100	51.76	3.7	10.8
17	0.119	8345.	0.000	0.000	1.00	8.2	0.200	0.100	55.00	3.7	10.8
Toe						15.4	0.150	0.148			

2.030 kips total unreduced pile weight (g= 32.17 ft/s2)
2.030 kips total reduced pile weight (g= 32.17 ft/s2)

Depth ft	Stroke ft	Pressure Ratio	Efficy
35.99	10.81	1.00	0.800

HEN-24/17D-00.43, PID 117712 08/22/2023
TTL Associates Inc GRLWEAP(TM) Version 2005

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
83.8	11.1	5.88	5.91	-0.07	6	42	26.39	7	3	17.9	48.5

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TTL Associates Inc GRLWEAP(TM) Version 2005

Depth (ft) 38.6
Shaft Gain/Loss Factor 0.570 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 153.940 Pile Type Pipe
Pile Size (inch) 14.000

L b Top	Area	E-Mod	Spec Wt	Perim	Strength	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft	ksi	ft/s	k/ft/s
0.0	10.80	30000.	492.0	3.7	0.000	16807.	19.3
55.0	10.80	30000.	492.0	3.7	0.000	16807.	19.3

Wave Travel Time 2L/c (ms) 6.545

Pile and Soil Model — Total Capacity Rut (kips) 362.9

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.119	8345.	0.010	0.000	0.85	0.0	0.000	0.100	3.24	3.7	10.8
2	0.119	8345.	0.000	0.000	1.00	0.0	0.000	0.100	6.47	3.7	10.8
6	0.119	8345.	0.000	0.000	1.00	5.8	0.200	0.100	19.41	3.7	10.8
7	0.119	8345.	0.000	0.000	1.00	5.2	0.200	0.100	22.65	3.7	10.8
9	0.119	8345.	0.000	0.000	1.00	5.2	0.200	0.100	29.12	3.7	10.8
10	0.119	8345.	0.000	0.000	1.00	5.5	0.200	0.100	32.35	3.7	10.8
11	0.119	8345.	0.000	0.000	1.00	5.8	0.200	0.100	35.59	3.7	10.8
12	0.119	8345.	0.000	0.000	1.00	6.1	0.200	0.100	38.82	3.7	10.8
13	0.119	8345.	0.000	0.000	1.00	6.4	0.200	0.100	42.06	3.7	10.8
14	0.119	8345.	0.000	0.000	1.00	6.7	0.200	0.100	45.29	3.7	10.8
15	0.119	8345.	0.000	0.000	1.00	7.0	0.200	0.100	48.53	3.7	10.8
16	0.119	8345.	0.000	0.000	1.00	7.9	0.200	0.100	51.76	3.7	10.8
17	0.119	8345.	0.000	0.000	1.00	9.0	0.200	0.100	55.00	3.7	10.8
Toe						287.1	0.150	0.117			

2.030 kips total unreduced pile weight (g= 32.17 ft/s2)
2.030 kips total reduced pile weight (g= 32.17 ft/s2)

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
38.58	10.81	1.00	0.800

HEN-24/17D-00.43, PID 117712 08/22/2023
TTL Associates Inc GRLWEAP(TM) Version 2005

Rut	Bl Ct	Stroke (ft)		Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
362.9	135.9	9.01	8.99	-3.17	6	47	40.67	2	9	21.7	39.4

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TTL Associates Inc GRLWEAP(TM) Version 2005

SUMMARY OVER DEPTHS

G/L at Shaft and Toe: 0.570 1.000

Depth	Rut	Frictn	End Bg	Bl Ct	Com Str	Ten Str	Stroke	ENTHRU
ft	kips	kips	kips	bl/ft	ksi	ksi	ft	kip-ft
2.0	28.2	4.1	24.0	2.6	14.839	0.000	4.06	22.7
2.0	37.9	4.2	33.7	3.7	18.217	0.000	4.47	21.6

17.8	63.8	30.1	33.7	7.4	23.944	-0.805	5.32	19.3
33.5	95.5	61.9	33.7	12.8	26.829	-0.197	6.07	17.7
33.5	77.3	61.9	15.4	10.0	25.552	-0.373	5.73	18.2
36.0	83.8	68.5	15.4	11.1	26.395	-0.067	5.88	17.9
38.6	362.9	75.7	287.1	135.9	40.675	-3.165	9.01	21.7

Total Driving Time 10 minutes; Total No. of Blows 466

HEN-24/17D-00.43, PID 117712 08/22/2023
TTL Associates Inc GRLWEAP(TM) Version 2005

Table of Depths Analyzed with Driving System Modifiers

Depth ft	Temp. Length ft	Wait Time hr	Equivalent Stroke ft	Pressure Ratio	Efficy.	Stiffn. Factor	Cushion CoR
1.98	55.00	0.00	10.81	1.00	0.80	1.00	1.00
2.02	55.00	0.00	10.81	1.00	0.80	1.00	1.00
17.75	55.00	0.00	10.81	1.00	0.80	1.00	1.00
33.48	55.00	0.00	10.81	1.00	0.80	1.00	1.00
33.52	55.00	0.00	10.81	1.00	0.80	1.00	1.00
35.99	55.00	0.00	10.81	1.00	0.80	1.00	1.00
38.58	55.00	0.00	10.81	1.00	0.80	1.00	1.00

Soil Layer Resistance Values

Depth ft	Shaft Res. k/ft2	End Bearing kips	Shaft Quake inch	Toe Quake inch	Shaft Damping s/ft	Toe Damping s/ft	Soil Setup Normlzd	Limit Distance ft	Setup Time hrs
0.01	1.00	24.05	0.100	0.151	0.200	0.150	1.000	6.000	148.000
1.99	1.00	24.05	0.100	0.151	0.200	0.150	1.000	6.000	148.000
2.01	0.77	33.67	0.100	0.123	0.200	0.150	1.000	6.000	148.000
11.01	0.77	33.67	0.100	0.123	0.200	0.150	1.000	6.000	148.000
20.01	0.89	33.67	0.100	0.123	0.200	0.150	1.000	6.000	148.000
29.01	1.01	33.67	0.100	0.123	0.200	0.150	1.000	6.000	148.000
33.49	1.08	33.67	0.100	0.123	0.200	0.150	1.000	6.000	148.000
33.51	1.25	15.39	0.100	0.148	0.200	0.150	1.000	6.000	148.000
38.49	1.29	15.39	0.100	0.148	0.200	0.150	1.000	6.000	148.000
38.51	2.92	287.14	0.100	0.117	0.200	0.150	0.778	6.000	148.000
55.00	2.92	287.14	0.100	0.117	0.200	0.150	0.778	6.000	148.000

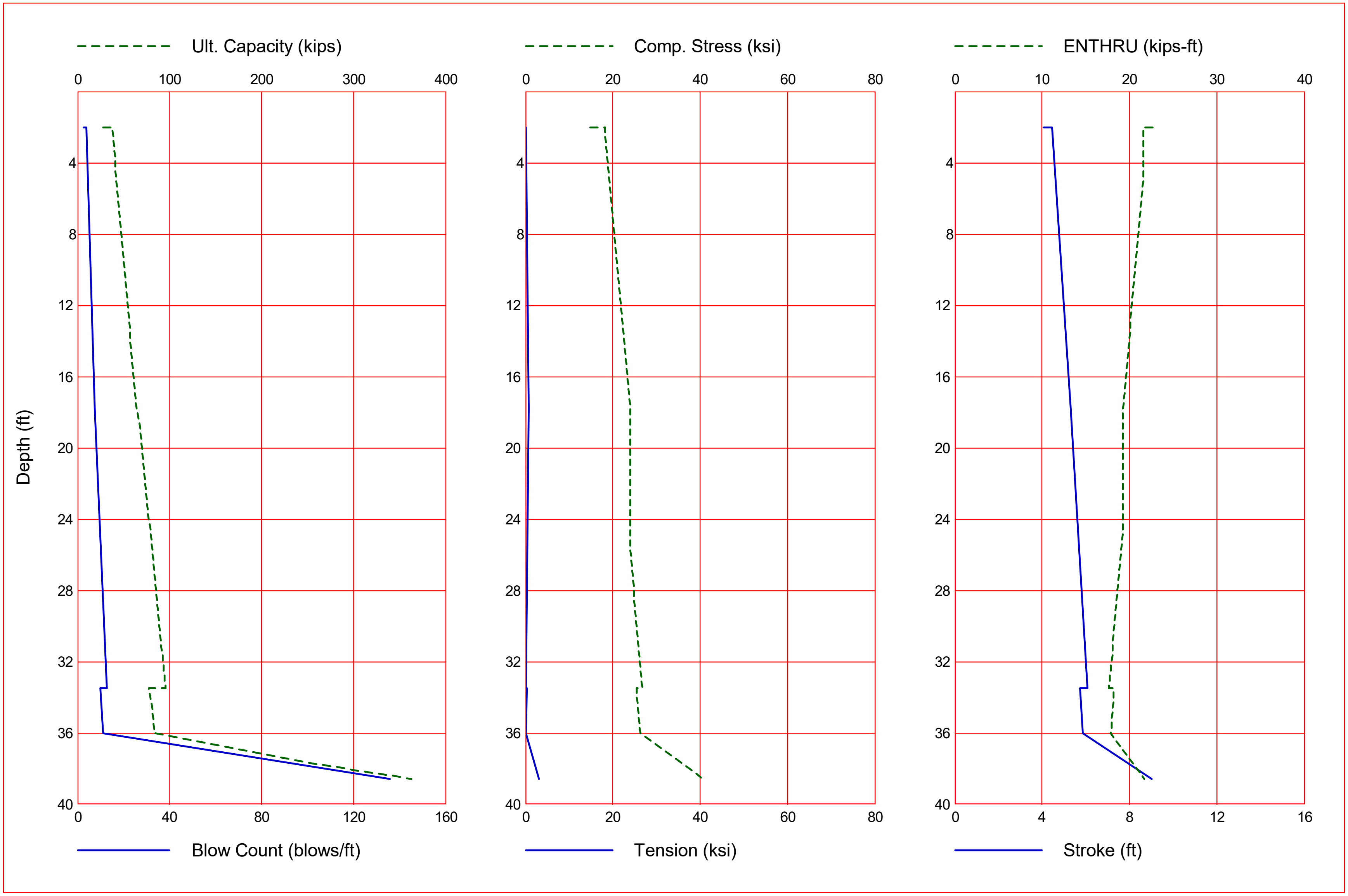
TTL Associates Inc

Aug 22 2023

HEN-24/17D-00.43, PID 117712

Gain/Loss 1 at Shaft and Toe 0.570 / 1.000

GRLWEAP(TM) Version 2005



TTL Associates Inc
HEN-24/17D-00.43, PID 117712

Aug 22 2023
GRLWEAP(TM) Version 2005

Gain/Loss 1 at Shaft and Toe 0.570 / 1.000

Depth ft	Ultimate Capacity kips	Friction kips	End Bearing kips	Blow Count blows/ft	Comp. Stress ksi	Tension Stress ksi	Stroke ft	ENTHRU kips-ft
2.0	28.2	4.1	24.0	2.6	14.839	0.000	4.06	22.7
2.0	37.9	4.2	33.7	3.7	18.217	0.000	4.47	21.6
17.8	63.8	30.1	33.7	7.4	23.944	-0.805	5.32	19.3
33.5	95.5	61.9	33.7	12.8	26.829	-0.197	6.07	17.7
33.5	77.3	61.9	15.4	10.0	25.552	-0.373	5.73	18.2
36.0	83.8	68.5	15.4	11.1	26.395	-0.067	5.88	17.9
38.6	362.9	75.7	287.1	135.9	40.675	-3.165	9.01	21.7

Total Continuous Driving Time 10.00 minutes; Total Number of Blows 466

GRLWEAP - Version 2005
WAVE EQUATION ANALYSIS OF PILE FOUNDATIONS

written by GRL Engineers, Inc. (formerly Goble Rausche Likins and Associates, Inc.) with cooperation from Pile Dynamics, Inc.

ABOUT THE WAVE EQUATION ANALYSIS RESULTS

The GRLWEAP program simulates the behavior of a preformed pile driven by either an impact hammer or a vibratory hammer. The program is based on mathematical models, which describe motion and forces of hammer, driving system, pile and soil under the hammer action. Under certain conditions, the models only crudely approximate, often complex, dynamic situations.

A wave equation analysis generally relies on input data, which represents normal situations. In particular, the hammer data file supplied with the program assumes that the hammer is in good working order. All of the input data selected by the user may be the best available information at the time when the analysis is performed. However, input data and therefore results may significantly differ from actual field conditions.

Therefore, the program authors recommend prudent use of the GRLWEAP results. Soil response and hammer performance should be verified by static and/or dynamic testing and measurements. Estimates of bending or other local non-axial stresses and prestress effects must also be accounted for by the user.

The calculated capacity - blow count relationship, i.e. the bearing graph, should be used in conjunction with observed blow counts for the capacity assessment of a driven pile. Soil setup occurring after pile installation may produce bearing capacity values that differ substantially from those expected from a wave equation analysis due to soil setup or relaxation. This is particularly true for pile driven with vibratory hammers. The GRLWEAP user must estimate such effects and should also use proper care when applying blow counts from restrike because of the variability of hammer energy, soil resistance and blow count during early restriking.

Finally, the GRLWEAP capacities are ultimate values. They MUST be reduced by means of an appropriate factor of safety to yield a design or working load. The selection of a factor of safety should consider the quality of the construction control, the variability of the site conditions, uncertainties in the loads, the importance of building and other factors.

```
 Input  File: H:\2023\230230\DRIVEN\B-019NEW.GWI
 Hammer File: C:\Program Files (x86)\PDI\GRLWEAP 2005
\HAMMER2003.GW
 Hammer File Version:  2003 (8/28/2009)

                             Input File Contents
     HEN-24/17D-00.43, PID 11 : 03/25/2024 :
 OUT OSG HAM STR FUL PEL  N SPL N-U P-D %SK ISM  0 PHI RSA ITR
H-D MXT     DEx
-100   0  41   0   0   0  0   0   0   1   0   0  0   0   0   0
0   0   0.000
    Pile g  Hammer g  Toe Area Pile Size           Pile Type
    32.170    32.170   153.940    14.000                Pipe
      W Cp      A Cp      E Cp      T Cp       CoR      ROut
StCp
     1.900   227.000     530.0     2.000     0.800     0.010
0.0
      A Cu      E Cu      T Cu       CoR      ROut      StCu
     0.000       0.0     0.000     0.000     0.000       0.0
      LPle      APle      EPle      WPle      Peri      Strg
CoR      ROut
    45.000    10.800 30000.000   492.000     3.665    36.000
0.850     0.010
 Manufac  Hmr Name  HmrType No Seg-s
 DELMAG   D 19-42          1        5
    Ram Wt     Ram L   Ram Dia   MaxStrk   RtdStrk    Efficy
      4.00    129.10     12.60     11.86     10.81      0.80
    IB. Wt     IB. L    IB.Dia    IB CoR     IB RO
      0.75     25.30     12.60     0.900     0.010
  CompStrk A Chamber V Chamber   C Delay  C Duratn Exp Coeff
VolCStart  Vol CEnd
     16.65    124.70    157.70     0.002     0.002     1.250
0.00      0.00
     P atm        P1        P2        P3        P4        P5
     14.70   1520.00   1368.00   1231.00   1108.00      0.00
    Stroke    Effic.  Pressure  R-Weight   T-Delay Exp-Coeff
Eps-Str  Total-AW
   10.8100    0.8000 1520.0000    0.0000    0.0000    0.0000
0.0100    0.0000
        Qs        Qt        Js        Jt        Qx        Jx
Rati      Dept
     0.000     0.000     0.000     0.000     0.000     0.000
0.000     0.000
  Research Soil Model: Atoe, Plug,  Gap, Q-fac
     0.000     0.000     0.000     0.000
  Research Soil Model: RD-skn: m, d, toe: m, d
     0.000     0.000     0.000     0.000
  Res. Distribution
    Dpth    Rskn    Rtoe      Qs      Qt      Js      Jt    SU F
LimD    SU T
    0.01    0.00    0.00    0.10    0.12    0.20    0.15    1.75
6.00  168.00
    6.19    0.00    0.00    0.10    0.12    0.20    0.15    1.75
```

```
6.00  168.00
    6.20    1.14   16.84    0.10    0.12    0.20    0.15    1.75
6.00  168.00
    8.49    1.14   16.84    0.10    0.12    0.20    0.15    1.75
6.00  168.00
    8.51    0.77   33.67    0.10    0.12    0.20    0.15    1.75
6.00  168.00
   17.51    0.85   33.67    0.10    0.12    0.20    0.15    1.75
6.00  168.00
   26.51    0.98   33.67    0.10    0.12    0.20    0.15    1.75
6.00  168.00
   28.49    1.01   33.67    0.10    0.12    0.20    0.15    1.75
6.00  168.00
   28.51    1.22   15.39    0.10    0.12    0.20    0.15    1.75
6.00  168.00
   37.51    1.28   15.39    0.10    0.12    0.20    0.15    1.75
6.00  168.00
   42.99    1.32   15.39    0.10    0.12    0.20    0.15    1.75
6.00  168.00
   43.01    3.16  287.14    0.10    0.12    0.05    0.15    1.75
6.00  168.00
   45.00    3.16  287.14    0.10    0.12    0.05    0.15    1.75
6.00  168.00
  Gain/Loss factors: shaft and toe
   0.57000   0.00000   0.00000   0.00000   0.00000
   1.00000   1.00000   1.00000   1.00000   1.00000
      Dpth         L      Wait      Strk      Pmx%      Eff.
Stff       CoR
      0.10      0.00      0.00     0.000     0.000     0.000
0.000     0.000
      8.49      0.00      0.00     0.000     0.000     0.000
0.000     0.000
      8.51      0.00      0.00     0.000     0.000     0.000
0.000     0.000
      9.81      0.00      0.00     0.000     0.000     0.000
0.000     0.000
      9.82      0.00      0.00     0.000     0.000     0.000
0.000     0.000
     17.51      0.00      0.00     0.000     0.000     0.000
0.000     0.000
     26.51      0.00      0.00     0.000     0.000     0.000
0.000     0.000
     28.49      0.00      0.00     0.000     0.000     0.000
0.000     0.000
     28.51      0.00      0.00     0.000     0.000     0.000
0.000     0.000
     37.51      0.00      0.00     0.000     0.000     0.000
0.000     0.000
     42.99      0.00      0.00     0.000     0.000     0.000
0.000     0.000
     43.01      0.00      0.00     0.000     0.000     0.000
0.000     0.000
      0.00      0.00      0.00     0.000     0.000     0.000
0.000     0.000
```

Diameter	COGHammer	WHammer	ABatter	Depth Sup	Flag
0.000	0.000	0.000	0.000	0.000	0

GRLWEAP: WAVE EQUATION ANALYSIS OF PILE FOUNDATIONS
Version 2005
English Units

HEN-24/17D-00.43, PID 11 : 03/25/2024 :

Hammer Model: D 19-42 Made by: DELMAG

No.	Weight kips	Stiffn k/inch	CoR	C-Slk ft	Dampg k/ft/s
1	0.800				
2	0.800	140046.7	1.000	0.0100	
3	0.800	140046.7	1.000	0.0100	
4	0.800	140046.7	1.000	0.0100	
5	0.800	140046.7	1.000	0.0100	
Imp Block	0.753	70735.6	0.900	0.0100	
Helmet	1.900	60155.0	0.800	0.0100	5.8
Combined Pile Top		8400.0			

HAMMER OPTIONS:
Hammer File ID No. 41 Hammer Type OE Diesel
Stroke Option FxdP-VarS Stroke Convergence Crit. 0.010
Fuel Pump Setting Maximum

HAMMER DATA:
Ram Weight (kips) 4.00 Ram Length (inch) 129.10
Maximum Stroke (ft) 11.86
Rated Stroke (ft) 10.81 Efficiency 0.800

Maximum Pressure (psi) 1520.00 Actual Pressure (psi) 1520.00
Compression Exponent 1.350 Expansion Exponent 1.250
Ram Diameter (inch) 12.60
Combustion Delay (s) 0.00200 Ignition Duration (s) 0.00200

The Hammer Data Includes Estimated (NON-MEASURED) Quantities

HAMMER CUSHION PILE CUSHION

```
  Cross Sect. Area     (in2)    227.00  Cross Sect. Area
(in2)      0.00
  Elastic-Modulus      (ksi)     530.0  Elastic-Modulus
(ksi)       0.0
  Thickness          (inch)       2.00  Thickness
(inch)      0.00
  Coeff of Restitution             0.8  Coeff of Restitution
1.0
  RoundOut              (ft)       0.0  RoundOut
(ft)       0.0
  Stiffness        (kips/in)   60155.0  Stiffness
(kips/in)       0.0
```

```
 HEN-24/17D-00.43, PID 11 : 03/25/2024 :
03/27/2024
 TTL Associates Inc
GRLWEAP(TM) Version 2005

  Depth                    (ft)       0.1
  Shaft Gain/Loss Factor          0.570  Toe Gain/Loss Factor
1.000

  PILE PROFILE:
  Toe Area              (in2)   153.940  Pile Type
Pipe
  Pile Size            (inch)    14.000

   L b Top     Area    E-Mod  Spec Wt    Perim Strength  Wave Sp
EA/c
        ft      in2      ksi   lb/ft3       ft      ksi     ft/s
k/ft/s
       0.0    10.80   30000.    492.0      3.7   36.000
16807.     19.3
      45.0    10.80   30000.    492.0      3.7   36.000
16807.     19.3

  Wave Travel Time 2L/c (ms)      5.355

         Pile and Soil Model            Total Capacity Rut
(kips)       0.0
 No. Weight  Stiffn C-Slk T-Slk  CoR  Soil-S  Soil-D Quake
LbTop Perim  Area
       kips    k/in    ft    ft         kips    s/ft  inch
ft    ft   in2
   1  0.119   8400. 0.010 0.000 0.85     0.0   0.000 0.100
3.21   3.7  10.8
   2  0.119   8400. 0.000 0.000 1.00     0.0   0.000 0.100
6.43   3.7  10.8
  14  0.119   8400. 0.000 0.000 1.00     0.0   0.200 0.100
45.00   3.7  10.8
 Toe                                     0.0   0.150 0.117

      1.660 kips total unreduced pile weight (g= 32.17 ft/s2)
      1.660 kips total reduced pile weight   (g= 32.17 ft/s2)

  PILE, SOIL, ANALYSIS OPTIONS:
  Uniform pile                            Pile Segments: Automatic
  No. of Slacks/Splices                0  Pile Damping
(%)        1
                                          Pile Damping
Fact.(k/ft/s)     0.386
  Driveability Analysis
  Soil Damping Option             Smith
  Max No Analysis Iterations           0  Time Increment/Critical
160
  Output Time Interval                 1  Analysis Time-Input
```

```
(ms)          0
  Output Level: Normal
  Gravity Mass, Pile, Hammer:   32.170    32.170    32.170
  Output Segment Generation: Automatic

     Depth    Stroke  Pressure    Efficy
        ft        ft     Ratio
      0.10     10.81      1.00     0.800


 INITIAL STATIC ANALYSIS: Total Wt, Sum(R)      4.3     0.0
  Hammer+Pile Weight > Rult: Pile Runs
```

```
 HEN-24/17D-00.43, PID 11 : 03/25/2024 :
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 TTL Associates Inc
GRLWEAP(TM) Version 2005

     Rut   Bl Ct   Stroke (ft) Ten Str   i   t Comp Str   i   t
ENTHRU   Bl Rt
    kips    b/ft   down     up     ksi              ksi
kip-ft   b/min
```

```
 HEN-24/17D-00.43, PID 11 : 03/25/2024 :
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 TTL Associates Inc
GRLWEAP(TM) Version 2005

  Depth                    (ft)       8.5
  Shaft Gain/Loss Factor          0.570  Toe Gain/Loss Factor
1.000

  PILE PROFILE:
  Toe Area               (in2)   153.940  Pile Type
Pipe
  Pile Size             (inch)    14.000

   L b Top     Area    E-Mod  Spec Wt    Perim Strength  Wave Sp
EA/c
        ft      in2      ksi   lb/ft3       ft      ksi     ft/s
k/ft/s
       0.0    10.80   30000.    492.0      3.7   36.000
16807.     19.3
      45.0    10.80   30000.    492.0      3.7   36.000
16807.     19.3

  Wave Travel Time 2L/c (ms)      5.355

         Pile and Soil Model            Total Capacity Rut
(kips)      22.3
 No. Weight  Stiffn C-Slk T-Slk  CoR  Soil-S  Soil-D Quake
LbTop Perim  Area
       kips    k/in    ft    ft         kips    s/ft  inch
ft     ft   in2
   1  0.119   8400. 0.010 0.000 0.85     0.0   0.000 0.100
3.21   3.7  10.8
   2  0.119   8400. 0.000 0.000 1.00     0.0   0.000 0.100
6.43   3.7  10.8
  12  0.119   8400. 0.000 0.000 1.00     0.0   0.200 0.100
38.57   3.7  10.8
  14  0.119   8400. 0.000 0.000 1.00     5.5   0.200 0.100
45.00   3.7  10.8
 Toe                                    16.8   0.150 0.117

      1.660 kips total unreduced pile weight (g= 32.17 ft/s2)
      1.660 kips total reduced pile weight   (g= 32.17 ft/s2)


     Depth    Stroke  Pressure    Efficy
        ft        ft     Ratio
      8.49     10.81      1.00     0.800
```

HEN-24/17D-00.43, PID 11 : 03/25/2024 :
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TTL Associates Inc
GRLWEAP(TM) Version 2005

Rut	Bl Ct	Stroke (ft)		Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
22.3	2.1	3.80	3.78	0.00	1	0	11.99	1	2	24.0	60.7

```
 HEN-24/17D-00.43, PID 11 : 03/25/2024 :
03/27/2024
 TTL Associates Inc
GRLWEAP(TM) Version 2005

  Depth                  (ft)       8.5
  Shaft Gain/Loss Factor         0.570  Toe Gain/Loss Factor
1.000

  PILE PROFILE:
  Toe Area             (in2)   153.940  Pile Type
Pipe
  Pile Size           (inch)    14.000

   L b Top     Area    E-Mod  Spec Wt    Perim Strength  Wave Sp
EA/c
        ft      in2      ksi   lb/ft3       ft      ksi     ft/s
k/ft/s
       0.0    10.80   30000.    492.0      3.7   36.000
16807.     19.3
      45.0    10.80   30000.    492.0      3.7   36.000
16807.     19.3

  Wave Travel Time 2L/c (ms)      5.355

         Pile and Soil Model            Total Capacity Rut
(kips)      39.2
 No. Weight  Stiffn C-Slk T-Slk  CoR  Soil-S  Soil-D Quake
LbTop Perim  Area
       kips    k/in    ft    ft         kips    s/ft  inch
ft    ft   in2
   1  0.119   8400. 0.010 0.000 0.85     0.0   0.000 0.100
3.21   3.7  10.8
   2  0.119   8400. 0.000 0.000 1.00     0.0   0.000 0.100
6.43   3.7  10.8
  12  0.119   8400. 0.000 0.000 1.00     0.0   0.200 0.100
38.57   3.7  10.8
  14  0.119   8400. 0.000 0.000 1.00     5.5   0.200 0.100
45.00   3.7  10.8
 Toe                                    33.7   0.150 0.117

      1.660 kips total unreduced pile weight (g= 32.17 ft/s2)
      1.660 kips total reduced pile weight   (g= 32.17 ft/s2)


     Depth     Stroke  Pressure    Efficy
        ft         ft     Ratio
      8.51     10.81      1.00     0.800
```

HEN-24/17D-00.43, PID 11 : 03/25/2024 :
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TTL Associates Inc
GRLWEAP(TM) Version 2005

Rut	Bl Ct	Stroke (ft)		Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
39.2	3.9	4.48	4.46	0.00	1	0	18.45	3	3	21.5	55.9

```
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 TTL Associates Inc
GRLWEAP(TM) Version 2005

  Depth                  (ft)       9.8
  Shaft Gain/Loss Factor         0.570  Toe Gain/Loss Factor
1.000

  PILE PROFILE:
  Toe Area             (in2)   153.940  Pile Type
Pipe
  Pile Size           (inch)    14.000

   L b Top     Area    E-Mod  Spec Wt    Perim Strength  Wave Sp
EA/c
       ft       in2      ksi   lb/ft3       ft      ksi     ft/s
k/ft/s
       0.0    10.80   30000.    492.0      3.7   36.000
16807.     19.3
      45.0    10.80   30000.    492.0      3.7   36.000
16807.     19.3

  Wave Travel Time 2L/c (ms)      5.355

         Pile and Soil Model            Total Capacity Rut
(kips)      41.3
 No. Weight  Stiffn C-Slk T-Slk  CoR  Soil-S  Soil-D Quake
LbTop Perim  Area
       kips    k/in    ft    ft         kips    s/ft  inch
ft    ft   in2
   1  0.119   8400. 0.010 0.000 0.85     0.0   0.000 0.100
3.21   3.7  10.8
   2  0.119   8400. 0.000 0.000 1.00     0.0   0.000 0.100
6.43   3.7  10.8
  11  0.119   8400. 0.000 0.000 1.00     0.0   0.200 0.100
35.36   3.7  10.8
  13  0.119   8400. 0.000 0.000 1.00     1.0   0.200 0.100
41.79   3.7  10.8
  14  0.119   8400. 0.000 0.000 1.00     6.7   0.200 0.100
45.00   3.7  10.8
 Toe                                    33.7   0.150 0.117

      1.660 kips total unreduced pile weight (g= 32.17 ft/s2)
      1.660 kips total reduced pile weight   (g= 32.17 ft/s2)


     Depth     Stroke  Pressure    Efficy
        ft         ft     Ratio
      9.81      10.81      1.00     0.800
```

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TTL Associates Inc
GRLWEAP(TM) Version 2005

Rut	Bl Ct	Stroke (ft)		Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
41.3	4.2	4.56	4.54	0.00	1	0	19.00	5	3	21.2	55.3

```
 HEN-24/17D-00.43, PID 11 : 03/25/2024 :
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 TTL Associates Inc
GRLWEAP(TM) Version 2005

  Depth                  (ft)       9.8
  Shaft Gain/Loss Factor         0.570  Toe Gain/Loss Factor
1.000

  PILE PROFILE:
  Toe Area              (in2)   153.940  Pile Type
Pipe
  Pile Size            (inch)    14.000

   L b Top     Area    E-Mod  Spec Wt    Perim Strength  Wave Sp
EA/c
        ft      in2      ksi   lb/ft3       ft      ksi     ft/s
k/ft/s
       0.0    10.80   30000.    492.0      3.7   36.000
16807.     19.3
      45.0    10.80   30000.    492.0      3.7   36.000
16807.     19.3

  Wave Travel Time 2L/c (ms)      5.355

         Pile and Soil Model            Total Capacity Rut
(kips)      41.3
 No. Weight  Stiffn C-Slk T-Slk  CoR  Soil-S  Soil-D Quake
LbTop Perim  Area
       kips    k/in    ft    ft         kips    s/ft  inch
ft    ft   in2
   1  0.119   8400. 0.010 0.000 0.85     0.0   0.000 0.100
3.21   3.7  10.8
   2  0.119   8400. 0.000 0.000 1.00     0.0   0.000 0.100
6.43   3.7  10.8
  11  0.119   8400. 0.000 0.000 1.00     0.0   0.200 0.100
35.36   3.7  10.8
  13  0.119   8400. 0.000 0.000 1.00     1.0   0.200 0.100
41.79   3.7  10.8
  14  0.119   8400. 0.000 0.000 1.00     6.7   0.200 0.100
45.00   3.7  10.8
 Toe                                    33.7   0.150 0.117

      1.660 kips total unreduced pile weight (g= 32.17 ft/s2)
      1.660 kips total reduced pile weight   (g= 32.17 ft/s2)


     Depth    Stroke  Pressure    Efficy
        ft        ft     Ratio
      9.82     10.81      1.00     0.800
```

HEN-24/17D-00.43, PID 11 : 03/25/2024 :
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TTL Associates Inc
GRLWEAP(TM) Version 2005

```
     Rut   Bl Ct   Stroke (ft) Ten Str   i   t Comp Str   i   t
ENTHRU   Bl Rt
    kips    b/ft   down     up     ksi             ksi
kip-ft   b/min
    41.3     4.2   4.56   4.54    0.00   1   0    18.97   5   3
21.2    55.3
```

```
 HEN-24/17D-00.43, PID 11 : 03/25/2024 :
03/27/2024
 TTL Associates Inc
GRLWEAP(TM) Version 2005

  Depth                  (ft)      17.5
  Shaft Gain/Loss Factor         0.570  Toe Gain/Loss Factor
1.000

  PILE PROFILE:
  Toe Area              (in2)   153.940  Pile Type
Pipe
  Pile Size            (inch)    14.000

   L b Top     Area    E-Mod  Spec Wt    Perim Strength  Wave Sp
EA/c
       ft      in2      ksi   lb/ft3       ft      ksi     ft/s
k/ft/s
       0.0    10.80   30000.    492.0      3.7   36.000
16807.     19.3
      45.0    10.80   30000.    492.0      3.7   36.000
16807.     19.3

  Wave Travel Time 2L/c (ms)      5.355

         Pile and Soil Model            Total Capacity Rut
(kips)      54.4
 No. Weight  Stiffn C-Slk T-Slk  CoR  Soil-S  Soil-D Quake
LbTop Perim  Area
       kips    k/in    ft    ft         kips    s/ft  inch
ft     ft   in2
   1  0.119   8400. 0.010 0.000 0.85     0.0   0.000 0.100
3.21   3.7  10.8
   2  0.119   8400. 0.000 0.000 1.00     0.0   0.000 0.100
6.43   3.7  10.8
   9  0.119   8400. 0.000 0.000 1.00     0.0   0.200 0.100
28.93   3.7  10.8
  11  0.119   8400. 0.000 0.000 1.00     4.0   0.200 0.100
35.36   3.7  10.8
  12  0.119   8400. 0.000 0.000 1.00     5.7   0.200 0.100
38.57   3.7  10.8
  13  0.119   8400. 0.000 0.000 1.00     5.4   0.200 0.100
41.79   3.7  10.8
  14  0.119   8400. 0.000 0.000 1.00     5.6   0.200 0.100
45.00   3.7  10.8
 Toe                                    33.7   0.150 0.117

      1.660 kips total unreduced pile weight (g= 32.17 ft/s2)
      1.660 kips total reduced pile weight   (g= 32.17 ft/s2)


     Depth     Stroke  Pressure    Efficy
        ft         ft     Ratio
```

17.51	10.81	1.00	0.800

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Rut	Bl Ct	Stroke (ft)		Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
54.4	6.1	5.03	5.00	-0.11	11	50	22.38	11	4	20.0	52.5

```
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  Depth                  (ft)      26.5
  Shaft Gain/Loss Factor         0.570  Toe Gain/Loss Factor
1.000

  PILE PROFILE:
  Toe Area              (in2)   153.940  Pile Type
Pipe
  Pile Size            (inch)    14.000

   L b Top     Area    E-Mod  Spec Wt    Perim Strength  Wave Sp
EA/c
        ft      in2      ksi   lb/ft3       ft      ksi     ft/s
k/ft/s
       0.0    10.80   30000.    492.0      3.7   36.000
16807.     19.3
      45.0    10.80   30000.    492.0      3.7   36.000
16807.     19.3

  Wave Travel Time 2L/c (ms)      5.355

         Pile and Soil Model            Total Capacity Rut
(kips)      71.6
 No. Weight  Stiffn C-Slk T-Slk  CoR  Soil-S  Soil-D Quake
LbTop Perim  Area
       kips    k/in    ft    ft          kips    s/ft  inch
ft    ft   in2
   1  0.119   8400. 0.010 0.000 0.85     0.0   0.000 0.100
3.21   3.7  10.8
   2  0.119   8400. 0.000 0.000 1.00     0.0   0.000 0.100
6.43   3.7  10.8
   6  0.119   8400. 0.000 0.000 1.00     0.0   0.200 0.100
19.29   3.7  10.8
   8  0.119   8400. 0.000 0.000 1.00     2.5   0.200 0.100
25.71   3.7  10.8
   9  0.119   8400. 0.000 0.000 1.00     6.2   0.200 0.100
28.93   3.7  10.8
  10  0.119   8400. 0.000 0.000 1.00     5.4   0.200 0.100
32.14   3.7  10.8
  11  0.119   8400. 0.000 0.000 1.00     5.6   0.200 0.100
35.36   3.7  10.8
  12  0.119   8400. 0.000 0.000 1.00     5.8   0.200 0.100
38.57   3.7  10.8
  13  0.119   8400. 0.000 0.000 1.00     6.1   0.200 0.100
41.79   3.7  10.8
  14  0.119   8400. 0.000 0.000 1.00     6.4   0.200 0.100
45.00   3.7  10.8
 Toe                                    33.7   0.150 0.117
```

1.660 kips total unreduced pile weight (g= 32.17 ft/s2)
1.660 kips total reduced pile weight (g= 32.17 ft/s2)

Depth ft	Stroke ft	Pressure Ratio	Efficy
26.51	10.81	1.00	0.800

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Rut	Bl Ct	Stroke (ft)		Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
71.6	8.7	5.49	5.54	-0.42	8	45	24.71	8	3	18.6	50.1

```
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  Depth                   (ft)      28.5
  Shaft Gain/Loss Factor          0.570  Toe Gain/Loss Factor
1.000

  PILE PROFILE:
  Toe Area              (in2)   153.940  Pile Type
Pipe
  Pile Size            (inch)    14.000

   L b Top     Area    E-Mod  Spec Wt    Perim Strength  Wave Sp
EA/c
        ft      in2      ksi   lb/ft3       ft      ksi     ft/s
k/ft/s
       0.0    10.80   30000.    492.0      3.7   36.000
16807.     19.3
      45.0    10.80   30000.    492.0      3.7   36.000
16807.     19.3

  Wave Travel Time 2L/c (ms)      5.355

         Pile and Soil Model           Total Capacity Rut
(kips)      75.7
 No. Weight  Stiffn C-Slk T-Slk  CoR  Soil-S  Soil-D Quake
LbTop Perim  Area
       kips    k/in    ft    ft         kips    s/ft  inch
ft    ft   in2
   1  0.119   8400. 0.010 0.000 0.85     0.0   0.000 0.100
3.21   3.7  10.8
   2  0.119   8400. 0.000 0.000 1.00     0.0   0.000 0.100
6.43   3.7  10.8
   6  0.119   8400. 0.000 0.000 1.00     0.0   0.200 0.100
19.29   3.7  10.8
   8  0.119   8400. 0.000 0.000 1.00     6.6   0.200 0.100
25.71   3.7  10.8
   9  0.119   8400. 0.000 0.000 1.00     5.3   0.200 0.100
28.93   3.7  10.8
  10  0.119   8400. 0.000 0.000 1.00     5.5   0.200 0.100
32.14   3.7  10.8
  11  0.119   8400. 0.000 0.000 1.00     5.7   0.200 0.100
35.36   3.7  10.8
  12  0.119   8400. 0.000 0.000 1.00     6.0   0.200 0.100
38.57   3.7  10.8
  13  0.119   8400. 0.000 0.000 1.00     6.3   0.200 0.100
41.79   3.7  10.8
  14  0.119   8400. 0.000 0.000 1.00     6.6   0.200 0.100
45.00   3.7  10.8
 Toe                                    33.7   0.150 0.117
```

1.660 kips total unreduced pile weight (g= 32.17 ft/s2)
1.660 kips total reduced pile weight (g= 32.17 ft/s2)

Depth ft	Stroke ft	Pressure Ratio	Efficy
28.49	10.81	1.00	0.800

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Rut	Bl Ct	Stroke (ft)		Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
75.7	9.4	5.60	5.64	-0.42	8	43	25.58	8	3	18.5	49.6

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 TTL Associates Inc
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  Depth                    (ft)      28.5
  Shaft Gain/Loss Factor         0.570  Toe Gain/Loss Factor
1.000

  PILE PROFILE:
  Toe Area              (in2)   153.940  Pile Type
Pipe
  Pile Size           (inch)    14.000

   L b Top     Area    E-Mod  Spec Wt    Perim Strength  Wave Sp
EA/c
       ft       in2      ksi   lb/ft3       ft      ksi     ft/s
k/ft/s
       0.0    10.80   30000.    492.0      3.7   36.000
16807.     19.3
      45.0    10.80   30000.    492.0      3.7   36.000
16807.     19.3

  Wave Travel Time 2L/c (ms)      5.355

         Pile and Soil Model            Total Capacity Rut
(kips)      57.5
 No. Weight  Stiffn C-Slk T-Slk  CoR  Soil-S  Soil-D Quake
LbTop Perim  Area
       kips    k/in    ft    ft         kips    s/ft  inch
ft    ft   in2
   1  0.119   8400. 0.010 0.000 0.85     0.0   0.000 0.100
3.21   3.7  10.8
   2  0.119   8400. 0.000 0.000 1.00     0.0   0.000 0.100
6.43   3.7  10.8
   6  0.119   8400. 0.000 0.000 1.00     0.0   0.200 0.100
19.29   3.7  10.8
   8  0.119   8400. 0.000 0.000 1.00     6.7   0.200 0.100
25.71   3.7  10.8
   9  0.119   8400. 0.000 0.000 1.00     5.3   0.200 0.100
28.93   3.7  10.8
  10  0.119   8400. 0.000 0.000 1.00     5.5   0.200 0.100
32.14   3.7  10.8
  11  0.119   8400. 0.000 0.000 1.00     5.7   0.200 0.100
35.36   3.7  10.8
  12  0.119   8400. 0.000 0.000 1.00     6.0   0.200 0.100
38.57   3.7  10.8
  13  0.119   8400. 0.000 0.000 1.00     6.3   0.200 0.100
41.79   3.7  10.8
  14  0.119   8400. 0.000 0.000 1.00     6.6   0.200 0.100
45.00   3.7  10.8
 Toe                                    15.4   0.150 0.117
```

```
 1.660 kips total unreduced pile weight (g= 32.17 ft/s2)
 1.660 kips total reduced pile weight   (g= 32.17 ft/s2)
```

Depth ft	Stroke ft	Pressure Ratio	Efficy
28.51	10.81	1.00	0.800

HEN-24/17D-00.43, PID 11 : 03/25/2024 : 03/27/2024
TTL Associates Inc
GRLWEAP(TM) Version 2005

Rut	Bl Ct	Stroke (ft)		Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
57.5	6.9	5.22	5.20	-0.44	8	50	23.81	8	3	19.5	51.5

HEN-24/17D-00.43, PID 11 : 03/25/2024 : 03/27/2024
TTL Associates Inc
GRLWEAP(TM) Version 2005

Depth (ft) 37.5
Shaft Gain/Loss Factor 0.570 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 153.940 Pile Type Pipe
Pile Size (inch) 14.000

L b Top	Area	E-Mod	Spec Wt	Perim	Strength	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft	ksi	ft/s	k/ft/s
0.0	10.80	30000.	492.0	3.7	36.000	16807.	19.3
45.0	10.80	30000.	492.0	3.7	36.000	16807.	19.3

Wave Travel Time 2L/c (ms) 5.355

Pile and Soil Model Total Capacity Rut (kips) 81.0

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.119	8400.	0.010	0.000	0.85	0.0	0.000	0.100	3.21	3.7	10.8
2	0.119	8400.	0.000	0.000	1.00	0.0	0.000	0.100	6.43	3.7	10.8
3	0.119	8400.	0.000	0.000	1.00	0.0	0.200	0.100	9.64	3.7	10.8
5	0.119	8400.	0.000	0.000	1.00	5.6	0.200	0.100	16.07	3.7	10.8
6	0.119	8400.	0.000	0.000	1.00	5.3	0.200	0.100	19.29	3.7	10.8
7	0.119	8400.	0.000	0.000	1.00	5.5	0.200	0.100	22.50	3.7	10.8
8	0.119	8400.	0.000	0.000	1.00	5.7	0.200	0.100	25.71	3.7	10.8
9	0.119	8400.	0.000	0.000	1.00	5.9	0.200	0.100	28.93	3.7	10.8
10	0.119	8400.	0.000	0.000	1.00	6.2	0.200	0.100	32.14	3.7	10.8
11	0.119	8400.	0.000	0.000	1.00	6.5	0.200	0.100	35.36	3.7	10.8
12	0.119	8400.	0.000	0.000	1.00	7.9	0.200	0.100	38.57	3.7	10.8

```
  13  0.119   8400. 0.000 0.000 1.00     8.4   0.200 0.100
41.79   3.7  10.8
  14  0.119   8400. 0.000 0.000 1.00     8.5   0.200 0.100
45.00   3.7  10.8
 Toe                                    15.4   0.150 0.117

     1.660 kips total unreduced pile weight (g= 32.17 ft/s2)
     1.660 kips total reduced pile weight   (g= 32.17 ft/s2)


    Depth    Stroke  Pressure    Efficy
       ft        ft     Ratio
    37.51     10.81      1.00     0.800
```

HEN-24/17D-00.43, PID 11 : 03/25/2024 : 03/27/2024
TTL Associates Inc
GRLWEAP(TM) Version 2005

Rut	Bl Ct	Stroke (ft)		Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
81.0	10.7	5.83	5.85	-0.11	5	42	26.44	5	3	18.0	48.7

```
 HEN-24/17D-00.43, PID 11 : 03/25/2024 :
03/27/2024
 TTL Associates Inc
GRLWEAP(TM) Version 2005

  Depth                  (ft)      43.0
  Shaft Gain/Loss Factor         0.570  Toe Gain/Loss Factor
1.000

  PILE PROFILE:
  Toe Area              (in2)   153.940  Pile Type
Pipe
  Pile Size           (inch)    14.000

   L b Top     Area    E-Mod  Spec Wt    Perim Strength  Wave Sp
EA/c
       ft       in2      ksi   lb/ft3       ft       ksi      ft/s
k/ft/s
       0.0    10.80   30000.    492.0      3.7   36.000
16807.     19.3
      45.0    10.80   30000.    492.0      3.7   36.000
16807.     19.3

  Wave Travel Time 2L/c (ms)      5.355

         Pile and Soil Model            Total Capacity Rut
(kips)      95.9
 No. Weight  Stiffn C-Slk T-Slk  CoR  Soil-S  Soil-D Quake
LbTop Perim  Area
       kips    k/in    ft    ft         kips    s/ft  inch
ft    ft   in2
   1  0.119   8400. 0.010 0.000 0.85     0.0   0.200 0.100
3.21   3.7  10.8
   2  0.119   8400. 0.000 0.000 1.00     0.0   0.200 0.100
6.43   3.7  10.8
   3  0.119   8400. 0.000 0.000 1.00     3.4   0.200 0.100
9.64   3.7  10.8
   4  0.119   8400. 0.000 0.000 1.00     5.9   0.200 0.100
12.86   3.7  10.8
   5  0.119   8400. 0.000 0.000 1.00     5.4   0.200 0.100
16.07   3.7  10.8
   6  0.119   8400. 0.000 0.000 1.00     5.6   0.200 0.100
19.29   3.7  10.8
   7  0.119   8400. 0.000 0.000 1.00     5.9   0.200 0.100
22.50   3.7  10.8
   8  0.119   8400. 0.000 0.000 1.00     6.2   0.200 0.100
25.71   3.7  10.8
   9  0.119   8400. 0.000 0.000 1.00     6.5   0.200 0.100
28.93   3.7  10.8
  10  0.119   8400. 0.000 0.000 1.00     7.5   0.200 0.100
32.14   3.7  10.8
  11  0.119   8400. 0.000 0.000 1.00     8.3   0.200 0.100
35.36   3.7  10.8
```

```
  12  0.119   8400. 0.000 0.000 1.00     8.5   0.200 0.100
38.57   3.7  10.8
  13  0.119   8400. 0.000 0.000 1.00     8.6   0.200 0.100
41.79   3.7  10.8
  14  0.119   8400. 0.000 0.000 1.00     8.8   0.200 0.100
45.00   3.7  10.8
 Toe                                    15.4   0.150 0.117

      1.660 kips total unreduced pile weight (g= 32.17 ft/s2)
      1.660 kips total reduced pile weight   (g= 32.17 ft/s2)


     Depth     Stroke  Pressure    Efficy
        ft         ft     Ratio
     42.99      10.81      1.00     0.800
```

HEN-24/17D-00.43, PID 11 : 03/25/2024 : 03/27/2024
TTL Associates Inc
GRLWEAP(TM) Version 2005

Rut	Bl Ct	Stroke (ft)		Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
95.9	13.4	6.19	6.20	0.00	1	0	27.78	3	3	17.3	47.3

```
 HEN-24/17D-00.43, PID 11 : 03/25/2024 :
03/27/2024
 TTL Associates Inc
GRLWEAP(TM) Version 2005

  Depth                  (ft)      43.0
  Shaft Gain/Loss Factor         0.570  Toe Gain/Loss Factor
1.000

  PILE PROFILE:
  Toe Area              (in2)   153.940  Pile Type
Pipe
  Pile Size            (inch)    14.000

   L b Top     Area    E-Mod  Spec Wt    Perim Strength  Wave Sp
EA/c
        ft      in2      ksi   lb/ft3       ft      ksi      ft/s
k/ft/s
       0.0    10.80   30000.    492.0      3.7   36.000
16807.     19.3
      45.0    10.80   30000.    492.0      3.7   36.000
16807.     19.3

  Wave Travel Time 2L/c (ms)      5.355

         Pile and Soil Model            Total Capacity Rut
(kips)     367.7
 No. Weight  Stiffn C-Slk T-Slk  CoR  Soil-S  Soil-D Quake
LbTop Perim  Area
       kips    k/in    ft    ft         kips    s/ft  inch
ft    ft   in2
   1  0.119   8400. 0.010 0.000 0.85     0.0   0.200 0.100
3.21   3.7  10.8
   2  0.119   8400. 0.000 0.000 1.00     0.0   0.200 0.100
6.43   3.7  10.8
   3  0.119   8400. 0.000 0.000 1.00     3.5   0.200 0.100
9.64   3.7  10.8
   4  0.119   8400. 0.000 0.000 1.00     5.9   0.200 0.100
12.86   3.7  10.8
   5  0.119   8400. 0.000 0.000 1.00     5.4   0.200 0.100
16.07   3.7  10.8
   6  0.119   8400. 0.000 0.000 1.00     5.6   0.200 0.100
19.29   3.7  10.8
   7  0.119   8400. 0.000 0.000 1.00     5.9   0.200 0.100
22.50   3.7  10.8
   8  0.119   8400. 0.000 0.000 1.00     6.2   0.200 0.100
25.71   3.7  10.8
   9  0.119   8400. 0.000 0.000 1.00     6.5   0.200 0.100
28.93   3.7  10.8
  10  0.119   8400. 0.000 0.000 1.00     7.5   0.200 0.100
32.14   3.7  10.8
  11  0.119   8400. 0.000 0.000 1.00     8.3   0.200 0.100
35.36   3.7  10.8
```

```
  12  0.119   8400. 0.000 0.000 1.00     8.5   0.200 0.100
38.57   3.7  10.8
  13  0.119   8400. 0.000 0.000 1.00     8.6   0.200 0.100
41.79   3.7  10.8
  14  0.119   8400. 0.000 0.000 1.00     8.8   0.199 0.100
45.00   3.7  10.8
 Toe                                   287.1   0.150 0.117

      1.660 kips total unreduced pile weight (g= 32.17 ft/s2)
      1.660 kips total reduced pile weight   (g= 32.17 ft/s2)


     Depth    Stroke  Pressure    Efficy
        ft        ft     Ratio
     43.01     10.81      1.00     0.800
```

```
 HEN-24/17D-00.43, PID 11 : 03/25/2024 :
03/27/2024
 TTL Associates Inc
GRLWEAP(TM) Version 2005

     Rut   Bl Ct   Stroke (ft) Ten Str   i   t Comp Str   i   t
ENTHRU   Bl Rt
    kips    b/ft   down     up     ksi             ksi
kip-ft   b/min
   367.7   130.2   8.98   8.98   -1.50   4  39    41.41   2   8
20.4    39.4
```

HEN-24/17D-00.43, PID 11 : 03/25/2024 : 03/27/2024
TTL Associates Inc
GRLWEAP(TM) Version 2005

SUMMARY OVER DEPTHS

G/L at Shaft and Toe: 0.570 1.000

Depth ft	Rut kips	Frictn kips	End Bg kips	Bl Ct bl/ft	Com Str ksi	Ten Str ksi	Stroke ft	ENTHRU kip-ft
0.1	0.0	0.0	0.0	0.0	0.000	0.000	10.81	0.0
8.5	22.3	5.5	16.8	2.1	11.992	0.000	3.80	24.0
8.5	39.2	5.5	33.7	3.9	18.454	0.000	4.48	21.5
9.8	41.3	7.6	33.7	4.2	19.001	0.000	4.56	21.2
9.8	41.3	7.6	33.7	4.2	18.974	0.000	4.56	21.2
17.5	54.4	20.8	33.7	6.1	22.383	-0.113	5.03	20.0
26.5	71.6	38.0	33.7	8.7	24.705	-0.424	5.49	18.6
28.5	75.7	42.1	33.7	9.4	25.579	-0.424	5.60	18.5
28.5	57.5	42.1	15.4	6.9	23.809	-0.436	5.22	19.5
37.5	81.0	65.6	15.4	10.7	26.435	-0.109	5.83	18.0
43.0	95.9	80.5	15.4	13.4	27.776	0.000	6.19	17.3
43.0	367.7	80.6	287.1	130.2	41.413	-1.499	8.98	20.4

Total Driving Time 6 minutes; Total No. of Blows 284

HEN-24/17D-00.43, PID 11 : 03/25/2024 : 03/27/2024
TTL Associates Inc
GRLWEAP(TM) Version 2005

Table of Depths Analyzed with Driving System Modifiers

Depth ft	Temp. Length ft	Wait Time hr	Equivalent Stroke ft	Pressure Ratio	Efficy.	Stiffn. Factor	Cushion CoR
0.10	45.00	0.00	10.81	1.00	0.80	1.00	1.00
8.49	45.00	0.00	10.81	1.00	0.80	1.00	1.00
8.51	45.00	0.00	10.81	1.00	0.80	1.00	1.00
9.81	45.00	0.00	10.81	1.00	0.80	1.00	1.00
9.82	45.00	0.00	10.81	1.00	0.80	1.00	1.00
17.51	45.00	0.00	10.81	1.00	0.80	1.00	1.00
26.51	45.00	0.00	10.81	1.00	0.80	1.00	1.00
28.49	45.00	0.00	10.81	1.00	0.80	1.00	1.00
28.51	45.00	0.00	10.81	1.00	0.80	1.00	1.00
37.51	45.00	0.00	10.81	1.00	0.80	1.00	1.00
42.99	45.00	0.00	10.81	1.00	0.80	1.00	1.00
43.01	45.00	0.00	10.81	1.00	0.80	1.00	1.00

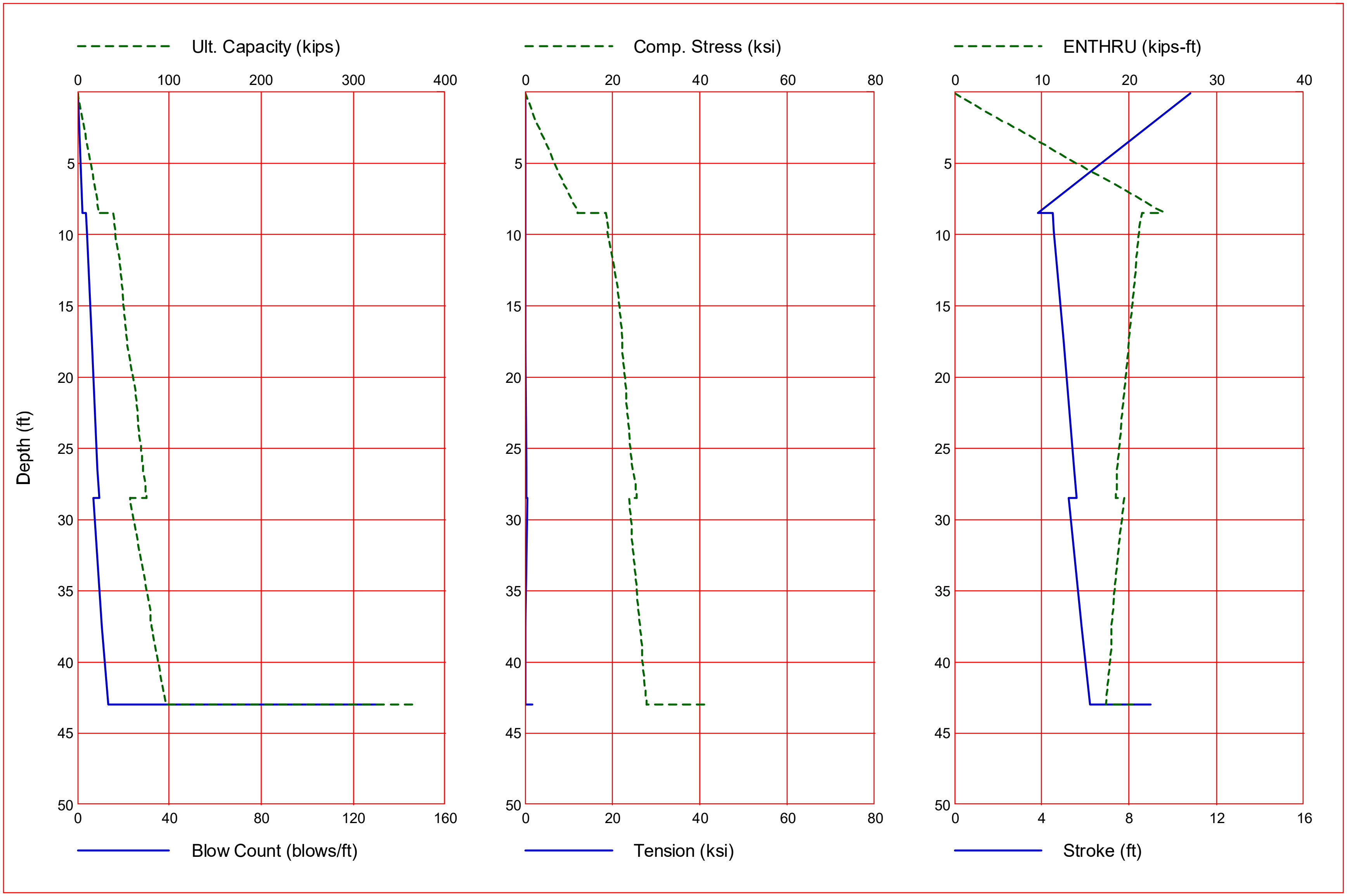
Soil Layer Resistance Values

Depth ft	Shaft Res. k/ft2	End Bearing kips	Shaft Quake inch	Toe Quake inch	Shaft Damping s/ft	Toe Damping s/ft	Soil Setup Normlzd	Limit Distance ft	Setup Time hrs
0.01	0.00	0.00	0.100	0.117	0.200	0.150	1.000	6.000	168.000
6.19	0.00	0.00	0.100	0.117	0.200	0.150	1.000	6.000	168.000
6.20	1.14	16.84	0.100	0.117	0.200	0.150	1.000	6.000	168.000

```
   8.49    1.14   16.84   0.100   0.117   0.200   0.150   1.000
6.000 168.000
   8.51    0.77   33.67   0.100   0.117   0.200   0.150   1.000
6.000 168.000
  17.51    0.85   33.67   0.100   0.117   0.200   0.150   1.000
6.000 168.000
  26.51    0.98   33.67   0.100   0.117   0.200   0.150   1.000
6.000 168.000
  28.49    1.01   33.67   0.100   0.117   0.200   0.150   1.000
6.000 168.000
  28.51    1.22   15.39   0.100   0.117   0.200   0.150   1.000
6.000 168.000
  37.51    1.28   15.39   0.100   0.117   0.200   0.150   1.000
6.000 168.000
  42.99    1.32   15.39   0.100   0.117   0.200   0.150   1.000
6.000 168.000
  43.01    3.16  287.14   0.100   0.117   0.050   0.150   1.000
6.000 168.000
  45.00    3.16  287.14   0.100   0.117   0.050   0.150   1.000
6.000 168.000
```

TTL Associates Inc — Mar 27 2024

HEN-24/17D-00.43, PID 11 : 03/25/2024 : Gain/Loss 1 at Shaft and Toe 0.570 / 1.000 GRLWEAP(TM) Version 2005



TTL Associates Inc — Mar 27 2024
HEN-24/17D-00.43, PID 11 : 03/25/2024 : — GRLWEAP(TM) Version 2005

Gain/Loss 1 at Shaft and Toe 0.570 / 1.000

Depth ft	Ultimate Capacity kips	Friction kips	End Bearing kips	Blow Count blows/ft	Comp. Stress ksi	Tension Stress ksi	Stroke ft	ENTHRU kips-ft
0.1	0.0	0.0	0.0	0.0	0.000	0.000	10.81	0.0
8.5	22.3	5.5	16.8	2.1	11.992	0.000	3.80	24.0
8.5	39.2	5.5	33.7	3.9	18.454	0.000	4.48	21.5
9.8	41.3	7.6	33.7	4.2	19.001	0.000	4.56	21.2
9.8	41.3	7.6	33.7	4.2	18.974	0.000	4.56	21.2
17.5	54.4	20.8	33.7	6.1	22.383	-0.113	5.03	20.0
26.5	71.6	38.0	33.7	8.7	24.705	-0.424	5.49	18.6
28.5	75.7	42.1	33.7	9.4	25.579	-0.424	5.60	18.5
28.5	57.5	42.1	15.4	6.9	23.809	-0.436	5.22	19.5
37.5	81.0	65.6	15.4	10.7	26.435	-0.109	5.83	18.0
43.0	95.9	80.5	15.4	13.4	27.776	0.000	6.19	17.3
43.0	367.7	80.6	287.1	130.2	41.413	-1.499	8.98	20.4

Total Continuous Driving Time 6.00 minutes; Total Number of Blows 284

GRLWEAP - Version 2005
WAVE EQUATION ANALYSIS OF PILE FOUNDATIONS

written by GRL Engineers, Inc. (formerly Goble Rausche Likins and Associates, Inc.) with cooperation from Pile Dynamics, Inc.

ABOUT THE WAVE EQUATION ANALYSIS RESULTS

The GRLWEAP program simulates the behavior of a preformed pile driven by either an impact hammer or a vibratory hammer. The program is based on mathematical models, which describe motion and forces of hammer, driving system, pile and soil under the hammer action. Under certain conditions, the models only crudely approximate, often complex, dynamic situations.

A wave equation analysis generally relies on input data, which represents normal situations. In particular, the hammer data file supplied with the program assumes that the hammer is in good working order. All of the input data selected by the user may be the best available information at the time when the analysis is performed. However, input data and therefore results may significantly differ from actual field conditions.

Therefore, the program authors recommend prudent use of the GRLWEAP results. Soil response and hammer performance should be verified by static and/or dynamic testing and measurements. Estimates of bending or other local non-axial stresses and prestress effects must also be accounted for by the user.

The calculated capacity - blow count relationship, i.e. the bearing graph, should be used in conjunction with observed blow counts for the capacity assessment of a driven pile. Soil setup occurring after pile installation may produce bearing capacity values that differ substantially from those expected from a wave equation analysis due to soil setup or relaxation. This is particularly true for pile driven with vibratory hammers. The GRLWEAP user must estimate such effects and should also use proper care when applying blow counts from restrike because of the variability of hammer energy, soil resistance and blow count during early restriking.

Finally, the GRLWEAP capacities are ultimate values. They MUST be reduced by means of an appropriate factor of safety to yield a design or working load. The selection of a factor of safety should consider the quality of the construction control, the variability of the site conditions, uncertainties in the loads, the importance of building and other factors.

Input File: T:\GEOTECH\DRIVEN\230230\B-025.GWI
Hammer File: C:\Program Files (x86)\PDI\GRLWEAP 2005\HAMMER2003.GW
Hammer File Version: 2003 (8/28/2009)

```
                        Input File Contents
     HEN-24/17D-00.43, PID 117712
 OUT OSG HAM STR FUL PEL  N SPL N-U P-D %SK ISM  0 PHI RSA ITR H-D MXT     DEx
-100   0  41   0   0   0  0   0   0   1   0   0  0   0   0   0   0   0   0.000
    Pile g  Hammer g  Toe Area Pile Size           Pile Type
    32.170    32.170   153.940    14.000                Pipe
      W Cp      A Cp      E Cp      T Cp       CoR      ROut      StCp
     1.900   227.000     530.0     2.000     0.800     0.010       0.0
      A Cu      E Cu      T Cu       CoR      ROut      StCu
     0.000       0.0     0.000     0.000     0.000       0.0
      LPle      APle      EPle      WPle      Peri      Strg       CoR      ROut
    55.000    10.800 30000.000   492.000     3.665     0.000     0.850     0.010
 Manufac  Hmr Name  HmrType No Seg-s
 DELMAG   D 19-42         1       5
    Ram Wt     Ram L   Ram Dia   MaxStrk   RtdStrk    Efficy
      4.00    129.10     12.60     11.86     10.81      0.80
    IB. Wt     IB. L    IB.Dia    IB CoR     IB RO
      0.75     25.30     12.60     0.900     0.010
  CompStrk A Chamber V Chamber   C Delay  C Duratn Exp Coeff VolCStart  Vol CEnd
     16.65    124.70    157.70     0.002     0.002     1.250      0.00      0.00
     P atm        P1        P2        P3        P4        P5
     14.70   1520.00   1368.00   1231.00   1108.00      0.00
    Stroke    Effic.  Pressure  R-Weight   T-Delay Exp-Coeff   Eps-Str  Total-AW
   10.8100    0.8000 1520.0000    0.0000    0.0000    0.0000    0.0100    0.0000
        Qs        Qt        Js        Jt        Qx        Jx      Rati      Dept
     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000
  Research Soil Model: Atoe, Plug,  Gap, Q-fac
     0.000     0.000     0.000     0.000
  Research Soil Model: RD-skn: m, d, toe: m, d
     0.000     0.000     0.000     0.000
  Res. Distribution
    Dpth    Rskn    Rtoe      Qs      Qt      Js      Jt    SU F    LimD    SU T
    0.01    1.14   16.84    0.10    0.15    0.20    0.15    1.75    6.00  148.00
    2.99    1.14   16.84    0.10    0.15    0.20    0.15    1.75    6.00  148.00
    3.01    0.77   33.67    0.10    0.12    0.20    0.15    1.75    6.00  148.00
   12.01    0.77   33.67    0.10    0.12    0.20    0.15    1.75    6.00  148.00
   21.01    0.90   33.67    0.10    0.12    0.20    0.15    1.75    6.00  148.00
   23.49    0.94   33.67    0.10    0.12    0.20    0.15    1.75    6.00  148.00
   23.51    1.18   15.39    0.10    0.15    0.20    0.15    1.75    6.00  148.00
   32.51    1.25   15.39    0.10    0.15    0.20    0.15    1.75    6.00  148.00
   38.49    1.29   15.39    0.10    0.15    0.20    0.15    1.75    6.00  148.00
   38.51    2.95  287.14    0.10    0.12    0.20    0.15    1.75    6.00  148.00
   55.00    2.95  287.14    0.10    0.12    0.20    0.15    1.75    6.00  148.00
  Gain/Loss factors: shaft and toe
   0.57000   0.00000   0.00000   0.00000   0.00000
   1.00000   0.00000   0.00000   0.00000   0.00000
      Dpth         L      Wait      Strk      Pmx%      Eff.      Stff       CoR
      2.98      0.00      0.00     0.000     0.000     0.000     0.000     0.000
      3.02      0.00      0.00     0.000     0.000     0.000     0.000     0.000
```

13.25	0.00	0.00	0.000	0.000	0.000	0.000	0.000
23.48	0.00	0.00	0.000	0.000	0.000	0.000	0.000
23.52	0.00	0.00	0.000	0.000	0.000	0.000	0.000
30.99	0.00	0.00	0.000	0.000	0.000	0.000	0.000
38.28	0.00	0.00	0.000	0.000	0.000	0.000	0.000
0.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000

Diameter	COGHammer	WHammer	ABatter	Depth Sup	Flag
0.000	0.000	0.000	0.000	0.000	0

GRLWEAP: WAVE EQUATION ANALYSIS OF PILE FOUNDATIONS
Version 2005
English Units

HEN-24/17D-00.43, PID 117712

Hammer Model: D 19-42 Made by: DELMAG

No.	Weight kips	Stiffn k/inch	CoR	C-Slk ft	Dampg k/ft/s
1	0.800				
2	0.800	140046.7	1.000	0.0100	
3	0.800	140046.7	1.000	0.0100	
4	0.800	140046.7	1.000	0.0100	
5	0.800	140046.7	1.000	0.0100	
Imp Block	0.753	70735.6	0.900	0.0100	
Helmet	1.900	60155.0	0.800	0.0100	5.8
Combined Pile Top		8345.5			

HAMMER OPTIONS:

Hammer File ID No.	41	Hammer Type	OE Diesel
Stroke Option	FxdP-VarS	Stroke Convergence Crit.	0.010
Fuel Pump Setting	Maximum		

HAMMER DATA:

Ram Weight	(kips)	4.00	Ram Length	(inch)	129.10
Maximum Stroke	(ft)	11.86			
Rated Stroke	(ft)	10.81	Efficiency		0.800
Maximum Pressure	(psi)	1520.00	Actual Pressure	(psi)	1520.00
Compression Exponent		1.350	Expansion Exponent		1.250
Ram Diameter	(inch)	12.60			
Combustion Delay	(s)	0.00200	Ignition Duration	(s)	0.00200

The Hammer Data Includes Estimated (NON-MEASURED) Quantities

HAMMER CUSHION			PILE CUSHION		
Cross Sect. Area	(in2)	227.00	Cross Sect. Area	(in2)	0.00

Elastic-Modulus	(ksi)	530.0	Elastic-Modulus	(ksi)	0.0
Thickness	(inch)	2.00	Thickness	(inch)	0.00
Coeff of Restitution		0.8	Coeff of Restitution		1.0
RoundOut	(ft)	0.0	RoundOut	(ft)	0.0
Stiffness	(kips/in)	60155.0	Stiffness	(kips/in)	0.0

HEN-24/17D-00.43, PID 117712 08/22/2023
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Depth	(ft)	3.0		
Shaft Gain/Loss Factor		0.570	Toe Gain/Loss Factor	1.000

PILE PROFILE:

Toe Area	(in2)	153.940	Pile Type	Pipe
Pile Size	(inch)	14.000		

L b Top	Area	E-Mod	Spec Wt	Perim	Strength	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft	ksi	ft/s	k/ft/s
0.0	10.80	30000.	492.0	3.7	0.000	16807.	19.3
55.0	10.80	30000.	492.0	3.7	0.000	16807.	19.3

Wave Travel Time 2L/c (ms) 6.545

Pile and Soil Model — Total Capacity Rut (kips) 23.9

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.119	8345.	0.010	0.000	0.85	0.0	0.000	0.100	3.24	3.7	10.8
2	0.119	8345.	0.000	0.000	1.00	0.0	0.000	0.100	6.47	3.7	10.8
17	0.119	8345.	0.000	0.000	1.00	7.1	0.200	0.100	55.00	3.7	10.8
Toe						16.8	0.150	0.146			

2.030 kips total unreduced pile weight (g= 32.17 ft/s2)
2.030 kips total reduced pile weight (g= 32.17 ft/s2)

PILE, SOIL, ANALYSIS OPTIONS:

Uniform pile		Pile Segments: Automatic	
No. of Slacks/Splices	0	Pile Damping (%)	1
Pile Penetration (ft)	16.84	Pile Damping Fact.(k/ft/s)	0.386
Driveability Analysis			
Soil Damping Option	Smith		
Max No Analysis Iterations	0	Time Increment/Critical	160
Output Time Interval	1	Analysis Time-Input (ms)	0
Output Level: Normal			

Gravity Mass, Pile, Hammer: 32.170 32.170 32.170
Output Segment Generation: Automatic

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
2.98	10.81	1.00	0.800

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↑
HEN-24/17D-00.43, PID 117712                                    08/22/2023
TTL Associates Inc                                     GRLWEAP(TM) Version 2005

    Rut    Bl Ct    Stroke (ft) Ten Str    i    t Comp Str    i    t ENTHRU    Bl Rt
   kips     b/ft    down      up     ksi                 ksi          kip-ft    b/min
   23.9      2.2    3.91    3.94    0.00    1    0    13.22    1    2    23.4     59.7
↑
HEN-24/17D-00.43, PID 117712                                    08/22/2023
TTL Associates Inc                                     GRLWEAP(TM) Version 2005

 Depth                  (ft)        3.0
 Shaft Gain/Loss Factor          0.570  Toe Gain/Loss Factor           1.000

 PILE PROFILE:
 Toe Area              (in2)   153.940  Pile Type                        Pipe
 Pile Size            (inch)    14.000

  L b Top     Area     E-Mod  Spec Wt    Perim Strength  Wave Sp      EA/c
       ft      in2       ksi   lb/ft3       ft      ksi     ft/s    k/ft/s
      0.0    10.80    30000.    492.0      3.7    0.000   16807.      19.3
     55.0    10.80    30000.    492.0      3.7    0.000   16807.      19.3

 Wave Travel Time 2L/c (ms)     6.545

       Pile and Soil Model            Total Capacity Rut  (kips)      40.8
No. Weight  Stiffn C-Slk T-Slk  CoR  Soil-S  Soil-D Quake   LbTop Perim  Area
      kips    k/in    ft    ft         kips    s/ft  inch      ft    ft   in2
  1  0.119   8345. 0.010 0.000 0.85     0.0   0.000 0.100    3.24   3.7  10.8
  2  0.119   8345. 0.000 0.000 1.00     0.0   0.000 0.100    6.47   3.7  10.8
 17  0.119   8345. 0.000 0.000 1.00     7.2   0.200 0.100   55.00   3.7  10.8
Toe                                    33.7   0.150 0.123

     2.030 kips total unreduced pile weight (g= 32.17 ft/s2)
     2.030 kips total reduced pile weight   (g= 32.17 ft/s2)


    Depth    Stroke  Pressure    Efficy
       ft        ft     Ratio
     3.02     10.81      1.00     0.800
↑
HEN-24/17D-00.43, PID 117712                                    08/22/2023
TTL Associates Inc                                     GRLWEAP(TM) Version 2005

    Rut    Bl Ct    Stroke (ft) Ten Str    i    t Comp Str    i    t ENTHRU    Bl Rt
   kips     b/ft    down      up     ksi                 ksi          kip-ft    b/min
   40.8      4.1    4.59    4.56    0.00    1    0    19.01    8    3    21.2     55.2
↑
HEN-24/17D-00.43, PID 117712                                    08/22/2023
TTL Associates Inc                                     GRLWEAP(TM) Version 2005
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 Depth                  (ft)      13.2
 Shaft Gain/Loss Factor         0.570  Toe Gain/Loss Factor           1.000

 PILE PROFILE:
 Toe Area              (in2)   153.940  Pile Type                       Pipe
 Pile Size            (inch)    14.000

  L b Top     Area     E-Mod  Spec Wt    Perim Strength  Wave Sp      EA/c
       ft      in2       ksi   lb/ft3       ft      ksi     ft/s    k/ft/s
      0.0    10.80   30000.    492.0      3.7    0.000    16807.     19.3
     55.0    10.80   30000.    492.0      3.7    0.000    16807.     19.3

 Wave Travel Time 2L/c (ms)     6.545

        Pile and Soil Model            Total Capacity Rut  (kips)      57.4
No. Weight  Stiffn C-Slk T-Slk  CoR  Soil-S  Soil-D Quake   LbTop Perim  Area
      kips    k/in    ft    ft         kips    s/ft  inch      ft    ft   in2
  1  0.119   8345. 0.010 0.000 0.85     0.0   0.000 0.100    3.24   3.7  10.8
  2  0.119   8345. 0.000 0.000 1.00     0.0   0.000 0.100    6.47   3.7  10.8
 13  0.119   8345. 0.000 0.000 1.00     0.7   0.200 0.100   42.06   3.7  10.8
 14  0.119   8345. 0.000 0.000 1.00     7.3   0.200 0.100   45.29   3.7  10.8
 15  0.119   8345. 0.000 0.000 1.00     5.2   0.200 0.100   48.53   3.7  10.8
 16  0.119   8345. 0.000 0.000 1.00     5.2   0.200 0.100   51.76   3.7  10.8
 17  0.119   8345. 0.000 0.000 1.00     5.3   0.200 0.100   55.00   3.7  10.8
Toe                                    33.7   0.150 0.123

    2.030 kips total unreduced pile weight (g= 32.17 ft/s2)
    2.030 kips total reduced pile weight   (g= 32.17 ft/s2)


   Depth    Stroke  Pressure    Efficy
      ft        ft     Ratio
   13.25     10.81      1.00     0.800
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HEN-24/17D-00.43, PID 117712                                       08/22/2023
TTL Associates Inc                                   GRLWEAP(TM) Version 2005

   Rut   Bl Ct   Stroke (ft) Ten Str   i   t Comp Str   i   t ENTHRU   Bl Rt
  kips    b/ft   down     up     ksi             ksi          kip-ft   b/min
  57.4     6.4   5.14   5.11   -0.11  14  50    22.94  14   5   19.8    52.0
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HEN-24/17D-00.43, PID 117712                                       08/22/2023
TTL Associates Inc                                   GRLWEAP(TM) Version 2005

 Depth                  (ft)      23.5
 Shaft Gain/Loss Factor         0.570  Toe Gain/Loss Factor           1.000

 PILE PROFILE:
 Toe Area              (in2)   153.940  Pile Type                       Pipe
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Pile Size (inch) 14.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	Strength ksi	Wave Sp ft/s	EA/c k/ft/s
0.0	10.80	30000.	492.0	3.7	0.000	16807.	19.3
55.0	10.80	30000.	492.0	3.7	0.000	16807.	19.3

Wave Travel Time 2L/c (ms) 6.545

Pile and Soil Model — Total Capacity Rut (kips) 75.8

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.119	8345.	0.010	0.000	0.85	0.0	0.000	0.100	3.24	3.7	10.8
2	0.119	8345.	0.000	0.000	1.00	0.0	0.000	0.100	6.47	3.7	10.8
10	0.119	8345.	0.000	0.000	1.00	2.0	0.200	0.100	32.35	3.7	10.8
11	0.119	8345.	0.000	0.000	1.00	6.9	0.200	0.100	35.59	3.7	10.8
12	0.119	8345.	0.000	0.000	1.00	5.2	0.200	0.100	38.82	3.7	10.8
13	0.119	8345.	0.000	0.000	1.00	5.2	0.200	0.100	42.06	3.7	10.8
14	0.119	8345.	0.000	0.000	1.00	5.3	0.200	0.100	45.29	3.7	10.8
15	0.119	8345.	0.000	0.000	1.00	5.6	0.200	0.100	48.53	3.7	10.8
16	0.119	8345.	0.000	0.000	1.00	5.9	0.200	0.100	51.76	3.7	10.8
17	0.119	8345.	0.000	0.000	1.00	6.2	0.200	0.100	55.00	3.7	10.8
Toe						33.7	0.150	0.123			

2.030 kips total unreduced pile weight (g= 32.17 ft/s2)
2.030 kips total reduced pile weight (g= 32.17 ft/s2)

Depth ft	Stroke ft	Pressure Ratio	Efficy
23.48	10.81	1.00	0.800

↑
HEN-24/17D-00.43, PID 117712 08/22/2023
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Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
75.8	9.4	5.60	5.64	-0.69	10	45	25.20	11	4	18.5	49.6

↑
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TTL Associates Inc GRLWEAP(TM) Version 2005

Depth (ft) 23.5
Shaft Gain/Loss Factor 0.570 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 153.940 Pile Type Pipe
Pile Size (inch) 14.000

L b Top Area E-Mod Spec Wt Perim Strength Wave Sp EA/c

ft	in2	ksi	lb/ft3	ft	ksi	ft/s	k/ft/s
0.0	10.80	30000.	492.0	3.7	0.000	16807.	19.3
55.0	10.80	30000.	492.0	3.7	0.000	16807.	19.3

Wave Travel Time 2L/c (ms) 6.545

Pile and Soil Model   Total Capacity Rut (kips) 57.6

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.119	8345.	0.010	0.000	0.85	0.0	0.000	0.100	3.24	3.7	10.8
2	0.119	8345.	0.000	0.000	1.00	0.0	0.000	0.100	6.47	3.7	10.8
10	0.119	8345.	0.000	0.000	1.00	2.1	0.200	0.100	32.35	3.7	10.8
11	0.119	8345.	0.000	0.000	1.00	6.8	0.200	0.100	35.59	3.7	10.8
12	0.119	8345.	0.000	0.000	1.00	5.2	0.200	0.100	38.82	3.7	10.8
13	0.119	8345.	0.000	0.000	1.00	5.2	0.200	0.100	42.06	3.7	10.8
14	0.119	8345.	0.000	0.000	1.00	5.3	0.200	0.100	45.29	3.7	10.8
15	0.119	8345.	0.000	0.000	1.00	5.6	0.200	0.100	48.53	3.7	10.8
16	0.119	8345.	0.000	0.000	1.00	5.9	0.200	0.100	51.76	3.7	10.8
17	0.119	8345.	0.000	0.000	1.00	6.2	0.200	0.100	55.00	3.7	10.8
Toe						15.4	0.150	0.148			

2.030 kips total unreduced pile weight (g= 32.17 ft/s2)
2.030 kips total reduced pile weight (g= 32.17 ft/s2)

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
23.52	10.81	1.00	0.800

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TTL Associates Inc GRLWEAP(TM) Version 2005

Rut	Bl Ct	Stroke (ft) down	up	Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
57.6	6.8	5.23	5.21	-0.28	10	50	23.40	10	4	19.5	51.5

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TTL Associates Inc GRLWEAP(TM) Version 2005

Depth (ft) 31.0
Shaft Gain/Loss Factor 0.570 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 153.940 Pile Type Pipe
Pile Size (inch) 14.000

L b Top	Area	E-Mod	Spec Wt	Perim	Strength	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft	ksi	ft/s	k/ft/s
0.0	10.80	30000.	492.0	3.7	0.000	16807.	19.3
55.0	10.80	30000.	492.0	3.7	0.000	16807.	19.3

Wave Travel Time 2L/c (ms) 6.545

Pile and Soil Model — Total Capacity Rut (kips) 76.5

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.119	8345.	0.010	0.000	0.85	0.0	0.000	0.100	3.24	3.7	10.8
2	0.119	8345.	0.000	0.000	1.00	0.0	0.000	0.100	6.47	3.7	10.8
8	0.119	8345.	0.000	0.000	1.00	4.4	0.200	0.100	25.88	3.7	10.8
9	0.119	8345.	0.000	0.000	1.00	6.1	0.200	0.100	29.12	3.7	10.8
10	0.119	8345.	0.000	0.000	1.00	5.2	0.200	0.100	32.35	3.7	10.8
11	0.119	8345.	0.000	0.000	1.00	5.2	0.200	0.100	35.59	3.7	10.8
12	0.119	8345.	0.000	0.000	1.00	5.4	0.200	0.100	38.82	3.7	10.8
13	0.119	8345.	0.000	0.000	1.00	5.7	0.200	0.100	42.06	3.7	10.8
14	0.119	8345.	0.000	0.000	1.00	6.0	0.200	0.100	45.29	3.7	10.8
15	0.119	8345.	0.000	0.000	1.00	6.8	0.200	0.100	48.53	3.7	10.8
16	0.119	8345.	0.000	0.000	1.00	8.1	0.200	0.100	51.76	3.7	10.8
17	0.119	8345.	0.000	0.000	1.00	8.3	0.200	0.100	55.00	3.7	10.8
Toe						15.4	0.150	0.148			

2.030 kips total unreduced pile weight (g= 32.17 ft/s2)
2.030 kips total reduced pile weight (g= 32.17 ft/s2)

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
30.99	10.81	1.00	0.800

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Rut	Bl Ct	Stroke (ft) down	Stroke (ft) up	Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft			ksi			ksi			kip-ft	b/min
76.5	9.9	5.71	5.73	-0.46	8	45	25.74	8	3	18.3	49.2

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Depth (ft) 38.3
Shaft Gain/Loss Factor 0.570 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 153.940 Pile Type Pipe
Pile Size (inch) 14.000

L b Top	Area	E-Mod	Spec Wt	Perim	Strength	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft	ksi	ft/s	k/ft/s
0.0	10.80	30000.	492.0	3.7	0.000	16807.	19.3
55.0	10.80	30000.	492.0	3.7	0.000	16807.	19.3

Wave Travel Time 2L/c (ms) 6.545

Pile and Soil Model — Total Capacity Rut (kips) 95.7

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.119	8345.	0.010	0.000	0.85	0.0	0.000	0.100	3.24	3.7	10.8
2	0.119	8345.	0.000	0.000	1.00	0.0	0.000	0.100	6.47	3.7	10.8
6	0.119	8345.	0.000	0.000	1.00	6.4	0.200	0.100	19.41	3.7	10.8
7	0.119	8345.	0.000	0.000	1.00	5.4	0.200	0.100	22.65	3.7	10.8
8	0.119	8345.	0.000	0.000	1.00	5.2	0.200	0.100	25.88	3.7	10.8
9	0.119	8345.	0.000	0.000	1.00	5.2	0.200	0.100	29.12	3.7	10.8
10	0.119	8345.	0.000	0.000	1.00	5.4	0.200	0.100	32.35	3.7	10.8
11	0.119	8345.	0.000	0.000	1.00	5.7	0.200	0.100	35.59	3.7	10.8
12	0.119	8345.	0.000	0.000	1.00	6.0	0.200	0.100	38.82	3.7	10.8
13	0.119	8345.	0.000	0.000	1.00	7.3	0.200	0.100	42.06	3.7	10.8
14	0.119	8345.	0.000	0.000	1.00	8.1	0.200	0.100	45.29	3.7	10.8
15	0.119	8345.	0.000	0.000	1.00	8.3	0.200	0.100	48.53	3.7	10.8
16	0.119	8345.	0.000	0.000	1.00	8.5	0.200	0.100	51.76	3.7	10.8
17	0.119	8345.	0.000	0.000	1.00	8.6	0.200	0.100	55.00	3.7	10.8
Toe						15.4	0.150	0.148			

2.030 kips total unreduced pile weight (g= 32.17 ft/s2)
2.030 kips total reduced pile weight (g= 32.17 ft/s2)

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
38.28	10.81	1.00	0.800

HEN-24/17D-00.43, PID 117712 08/22/2023
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Rut	Bl Ct	Stroke (ft)		Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
95.7	13.3	6.14	6.16	0.00	1	0	27.62	6	3	17.5	47.5

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SUMMARY OVER DEPTHS

G/L at Shaft and Toe: 0.570 1.000

Depth	Rut	Frictn	End Bg	Bl Ct	Com Str	Ten Str	Stroke	ENTHRU
ft	kips	kips	kips	bl/ft	ksi	ksi	ft	kip-ft
3.0	23.9	7.1	16.8	2.2	13.218	0.000	3.91	23.4
3.0	40.8	7.2	33.7	4.1	19.007	0.000	4.59	21.2
13.2	57.4	23.7	33.7	6.4	22.941	-0.106	5.14	19.8
23.5	75.8	42.2	33.7	9.4	25.199	-0.689	5.60	18.5
23.5	57.6	42.3	15.4	6.8	23.396	-0.276	5.23	19.5
31.0	76.5	61.1	15.4	9.9	25.739	-0.459	5.71	18.3

38.3	95.7	80.3	15.4	13.3	27.615	0.000	6.14	17.5

Total Driving Time 6 minutes; Total No. of Blows 285

HEN-24/17D-00.43, PID 117712 08/22/2023
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Table of Depths Analyzed with Driving System Modifiers

Depth ft	Temp. Length ft	Wait Time hr	Equivalent Stroke ft	Pressure Ratio	Efficy.	Stiffn. Factor	Cushion CoR
2.98	55.00	0.00	10.81	1.00	0.80	1.00	1.00
3.02	55.00	0.00	10.81	1.00	0.80	1.00	1.00
13.25	55.00	0.00	10.81	1.00	0.80	1.00	1.00
23.48	55.00	0.00	10.81	1.00	0.80	1.00	1.00
23.52	55.00	0.00	10.81	1.00	0.80	1.00	1.00
30.99	55.00	0.00	10.81	1.00	0.80	1.00	1.00
38.28	55.00	0.00	10.81	1.00	0.80	1.00	1.00

Soil Layer Resistance Values

Depth ft	Shaft Res. k/ft2	End Bearing kips	Shaft Quake inch	Toe Quake inch	Shaft Damping s/ft	Toe Damping s/ft	Soil Setup Normlzd	Limit Distance ft	Setup Time hrs
0.01	1.14	16.84	0.100	0.146	0.200	0.150	1.000	6.000	148.000
2.99	1.14	16.84	0.100	0.146	0.200	0.150	1.000	6.000	148.000
3.01	0.77	33.67	0.100	0.123	0.200	0.150	1.000	6.000	148.000
12.01	0.77	33.67	0.100	0.123	0.200	0.150	1.000	6.000	148.000
21.01	0.90	33.67	0.100	0.123	0.200	0.150	1.000	6.000	148.000
23.49	0.94	33.67	0.100	0.123	0.200	0.150	1.000	6.000	148.000
23.51	1.18	15.39	0.100	0.148	0.200	0.150	1.000	6.000	148.000
32.51	1.25	15.39	0.100	0.148	0.200	0.150	1.000	6.000	148.000
38.49	1.29	15.39	0.100	0.148	0.200	0.150	1.000	6.000	148.000
38.51	2.95	287.14	0.100	0.117	0.200	0.150	1.000	6.000	148.000
55.00	2.95	287.14	0.100	0.117	0.200	0.150	1.000	6.000	148.000

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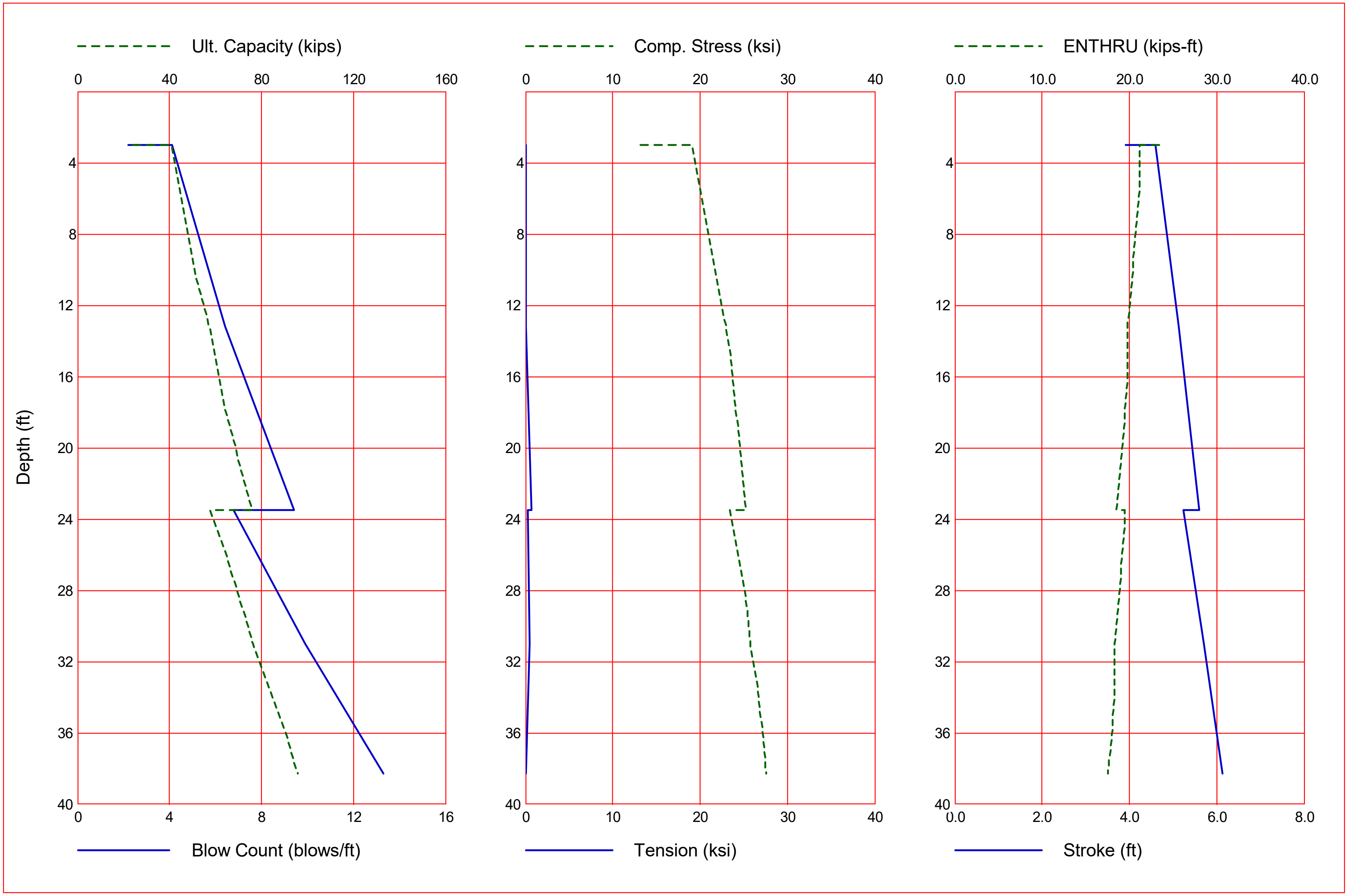
HEN-24/17D-00.43, PID 117712 | Gain/Loss 1 at Shaft and Toe 0.570 / 1.000 | GRLWEAP(TM) Version 2005



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HEN-24/17D-00.43, PID 117712

Aug 22 2023
GRLWEAP(TM) Version 2005

Gain/Loss 1 at Shaft and Toe 0.570 / 1.000

Depth ft	Ultimate Capacity kips	Friction kips	End Bearing kips	Blow Count blows/ft	Comp. Stress ksi	Tension Stress ksi	Stroke ft	ENTHRU kips-ft
3.0	23.9	7.1	16.8	2.2	13.218	0.000	3.91	23.4
3.0	40.8	7.2	33.7	4.1	19.007	0.000	4.59	21.2
13.2	57.4	23.7	33.7	6.4	22.941	-0.106	5.14	19.8
23.5	75.8	42.2	33.7	9.4	25.199	-0.689	5.60	18.5
23.5	57.6	42.3	15.4	6.8	23.396	-0.276	5.23	19.5
31.0	76.5	61.1	15.4	9.9	25.739	-0.459	5.71	18.3
38.3	95.7	80.3	15.4	13.3	27.615	0.000	6.14	17.5

Total Continuous Driving Time 6.00 minutes; Total Number of Blows 285

By: KCH Date: 3/26/2024 Checked: CER Date: 3/27/2024

GENERAL FOUNDATION INFORMATION:

The culvert below Ramp C is planned to be approximately 53 feet long, with inverts on the order of Elev. 693. The headwalls are planned to be full-height headwalls, bearing at approximate Elev. 690.

Consider the headwall footing for the inlet, which is a smaller footprint, and therefore the conservative one to use for evaluations of bearing capacity.

L = 43.9 feet (46.1 feet at outlet)
B = 7 feet

GENERAL SOIL INFORMATION:

Boring B-011 was used to evaluate the foundations. Similar conditions were encountered in B-009.

Boring	Existing GSE at Boring
B-011	698.4

At Elev. 690, the foundations are expected to bear in:
Stratum II very stiff to hard cohesive soils

USE c = 3.500 ksf for this analysis

Groundwater

Model groundwater in ditch above foundatation bearing elevation.

STRENTH LIMIT STATE:

$q_R = \varphi_b * q_n$ (AASTHO LRFD 10.6.3.1.1-1)

$q_R =$ factored resistance at strength limit state (ksf)

$\varphi_b =$ resistance factor (Article 10.5.5.2.2)

$q_n = cN_{cm} + q_n =$ nominal bearing resistance (ksf) (AASTHO LRFD 10.6.3.1.2a-1)

$N_{cm} = N_c s_c i_c$ (AASTHO LRFD 10.6.3.1.2a-2)

$N_{qm} = N_q s_q d_q i_q$ (AASTHO LRFD 10.6.3.1.2a-3)

$N_{\gamma m} = N_\gamma s_\gamma i_\gamma$ (AASTHO LRFD 10.6.3.1.2a-4)

$c =$ cohesion, undrained shear strength (ksf)

$N_c =$ cohesion term (Table 10.6.3.1.2a-1)

$N_q =$ surcharge term (Table 10.6.3.1.2a-1)

$N_g =$ unit weight term (Table 10.6.3.1.2a-1)

$\gamma =$ total (moist) unit weight (kcf)

$D_f =$ footing embedment depth (ft)

$B =$ footing width (ft)

C_{wq} , $C_{w\gamma} =$ groundwater correction factors (Table 10.6.3.1.2a-2)

s_c , s_γ , $s_q =$ shape correction factors (Table 10.6.3.1.2a-3)

$d_q =$ shear resistance thought cohesionless material correction factor (Table 10.6.3.1.2a-4)

i_c , i_γ , $i_q =$ inclination correction factors

Setup

Bearing in Very Stiff to Hard cohesive soils

$c =$	3.500	ksf			
$\phi_f =$	0	degrees	assumed zero in cohesive soil		
$N_c =$	5.14	*units*			
$N_q =$	1.0	*units*	for soil with a $\phi_f =$ 0 Degrees		
$N_\gamma =$	0.0	*units*			
$\gamma =$	0.068	kcf	(0.130 soil - 0.062 water)		
$D_f =$	3	ft	(693 invert - 690 bearing)		
$B =$	7.00	ft	Width		
$L =$	43.9	ft	Length	$1.5B + D_f =$	13.5
$D_w =$	0	ft	highest anticipated groundwater depth		
$C_{wq} =$	0.5	*units*	where $D_w = 0.0$		$s_c = 1 + (B/(5L))(Nq/Nc)$
$C_{w\gamma} =$	0.5	*units*	(above $D_{f)}$	for $\phi_f > 0$	$s_g = 1 - 0.4(B/L)$
$s_c =$	1.03	*units*	$s_c = 1 + (B/(5L))$		$s_q = 1 + ((B/L)\tan(\phi_f))$
$s_g =$	1.00	*units*	for $\phi_f = 0$ $s_\gamma = 1$	$D_f / B =$	0.428571
$s_q =$	1.00	*units*	$s_q = 1$		
$d_q =$	1.0	*units*	taken as 1 since cohesive soil		
calculation i_c , i_γ , i_q =	1.0	*units*	Assumed loaded without inclination		

$N_{cm} = N_c s_c i_c$ = 5.14 * 1.032 * 1 = 5.304

$N_{qm} = N_q s_q d_q i_q$ = 1 * 1 * 1 * 1 = 1

$N_{\gamma m} = N_\gamma s_\gamma i_\gamma$ = 0 * 1 * 1 = 0

$cN_{cm} =$ 18.564

$\gamma D_f N_{qm} C_{wq} =$ 0.101

$0.5\gamma B N_{\gamma m} C_{w\gamma} =$ 0

$q_n = cN_{cm} + \gamma D_f N_{qm} C_{wq} + 0.5\gamma B N_{\gamma m} C_{w\gamma}$

= (3.5*5.304) + (0.0676*3*1*0.5) + (0.5*7*0*0.5) =

= (18.564) + (0.101) + (0) =

$q_n =$ 18.665 ksf

$\varphi_b =$ 0.5 based on theoretical method (Munfakh et al., 2001), in clay

$q_R = \varphi_b * q_n$ = 0.5 * 18.665 = 9.3325 ksf

Factored resistance at the strength limit state for the proposed headwall is equal to 9.3 ksf

By: KCH Date: 3/26/2024 Checked: Date:

SERVICE LIMIT STATE:

Based on : (Table C10.6.2.6.1-1)

"Presumptive Bearing Resistance for Spread Footing Foundations at the Service Limit State" Table

Stratum II very stiff to hard cohesive soils

within applicable borings and depths:

Consistency	Soil Type	Bearing Resistance (ksf)	
		Ordinary Range	Recommended Value of Use*
"Medium Dense to Dense"	Lean Clay (CL)	2-6	4
"Very Dense"	Lean Clay (CL)	6-12	8

* recomented value based on Table C10.6.2.6.1-1

φ_b = 1

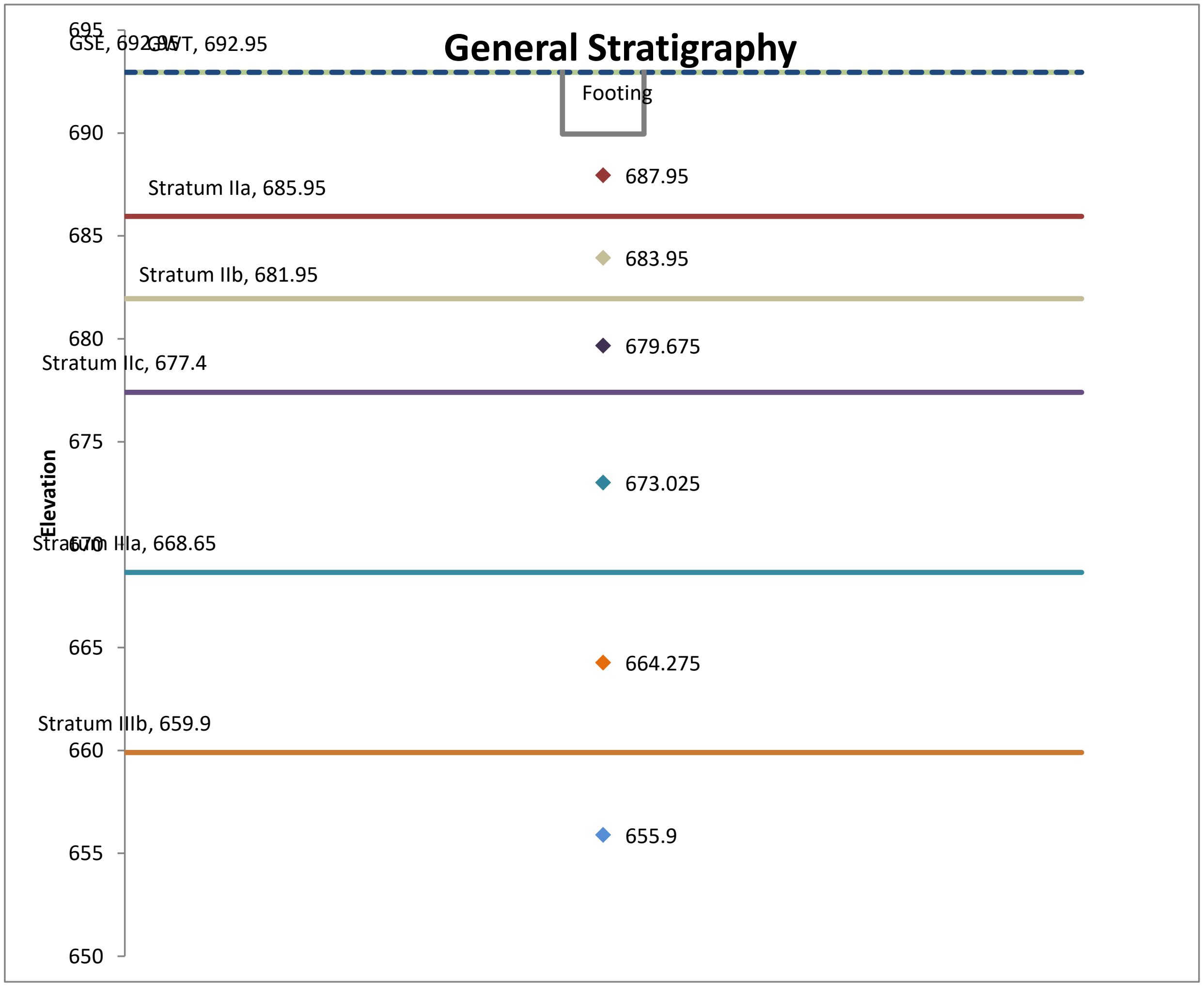
Factored bearing resistance = 6 ksf, for dense to very dense CL

Limit to 2.84 ksf based on design and settlement considerations (see attached *Settlement Calculation*)

Project Name: HEN-24/17D-00.43, PID 117712 Boring Number B-011
Project Number: 230230 Analysis Type Rectangular
Calculated by: KCH 3/26/2024

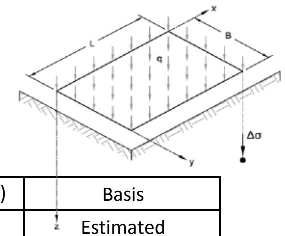
Layer	H (feet)	C_r	e_o	sigma v (psf)	z (feet)	b (feet)	(z-Df) / b	I_z	delta p@	2840 psf	(check) sigma v+ΔP	delta H (inches)
Stratum IIa	4	0.027	0.51	338	2	7	0.3	0.236	2680		3018	0.81
Stratum IIb	4	0.027	0.51	608	6	7	0.9	0.153	1738		2347	0.50
Stratum IIc	4.55	0.027	0.51	897	10.275	7	1.5	0.100	1132		2029	0.35
Stratum IIIa	8.75	0.027	0.51	1347	16.925	7	2.4	0.061	688		2035	0.34
Stratum IIIb	8.75	0.033	0.57	1960	25.675	7	3.7	0.037	415		2375	0.18
Stratum IV	8	0.011	0.47	2568	34.05	7	4.9	0.024	278		2846	0.03

Total delta H (in.)	2.25
+15%	2.59
-15%	1.91



Project Name:	HEN-24/17D-00.43, PID 117712	Boring Number	B-011
Project Number:	230230	Analysis Type	Rectangular
Calculated by:	KCH 3/26/2024		

G (assumed)	2.7	
GSE	692.95	Ditch Bottom
GWT	692.95	At or above Ditch Bottom
Bearing Elev	689.95	
D_f	3	ft
Footing Width, B	7	ft
Length, L	46.1	ft
P	2840	psf



$$\Delta\sigma = q I_B$$

$$I_B = \frac{1}{4\pi}\left[\frac{2|mn|\sqrt{V}}{V+V_1} \times \frac{V+1}{V} + \tan^{-1}\left(\frac{2|mn|\sqrt{V}}{V-V_1}\right) + \beta\right]$$

$$V = m^2 + n^2 + 1$$

$$V_1 = (mn)^2$$

$$\beta \left(\text{when } \tan^{-1}\left(\frac{2|mn|\sqrt{V}}{V-V_1}\right) \le 0\right) = \pi$$

$$\beta \left(\text{when } \tan^{-1}\left(\frac{2|mn|\sqrt{V}}{V-V_1}\right) > 0\right) = 0$$

$$m = \frac{B}{z}$$

$$n = \frac{L}{z}$$

Project-Specific Consolidation Soil Properties:

Stratum	e_o	C_c	C_r	P_c (psf)	γ_T (pcf)	Basis
I	0.62	0.194	0.019	4,250	125	Estimated
II	0.512	0.118	0.027	5,500	130	Tested
III	0.565	0.13	0.033	6,200	135	Tested
IV	0.47	0.109	0.011	34,890	135	Estimated

note: Hardpan considered highly overconsolidated. Use Cr.

	Bot. Elev.	Centroid (C) Elev.	H (ft)	z below footing	z below GSE	γ_T (pcf)	γ_d (pcf)	H_{GWT-C}	Cr	e_o	Depth of Influence = $(z-D_f)/B$	m = 0.5*B/z	n = 0.5*L/z	I_z*	σ_v' (psf)	V	V1	$\tan^{-1}\left(\frac{2\lvert mn\rvert\sqrt{V}}{V-V_1}\right)$	Beta
Stratum IIa	686	688	4	2	5	130		5	0.027	0.512	0.29	1.8	11.5	0.236	338	137	407	-1.05	3.14
Stratum IIb	682	684	4	6	9	130		9	0.027	0.512	0.9	0.6	3.8	0.153	608	16	5	1.02	0.00
Stratum IIc	677	679.7	5	10.275	13.275	130		13.28	0.027	0.512	1.5	0.3	2.2	0.100	897	6.1	0.6	0.60	0.00
Stratum IIIa	669	673.0	9	16.925	19.925	130		19.93	0.027	0.512	2.4	0.2	1.4	0.061	1347	2.9	0.1	0.33	0.00
Stratum IIIb	659.9	664.275	9	25.675	28.675	135		28.68	0.033	0.565	3.7	0.1	0.9	0.037	1960	1.8	0.01	0.18	0.00
Stratum IV	651.9	655.9	8	34.05	37.05	135		37.05	0.011	0.47	4.9	0.10	0.7	0.024	2568	1.5	0.00	0.11	0.00

*Note: Influence factors are multiplied by 4 in calculation of delta p

By: KCH Date: 3/26/2024 Checked: Date:

GENERAL FOUNDATION INFORMATION:

The culvert below Ramp B is planned to be approximately 53 feet long, with inverts on the order of Elev. 692. The headwalls are planned to be full-height headwalls, bearing at approximate Elev. 689.

Consider the headwall footing for the inlet, which is a smaller footprint, and therefore the conservative one to use for evaluations of bearing capacity.

Width of headwall = 6'

Length of headwall = 44.1' or 44.3'

GENERAL SOIL INFORMATION:

Boring B-028 was used to evaluate the foundations. Similar conditions were encountered in B-030, with 6 more inches to the change from Stratum II to Stratum III.

Boring	Existing GSE at Boring
B-028	698.2

At Elev. 689, the foundations are expected to bear in:

Stratum II very stiff to hard cohesive soils; approx. 18 feet to Stratum III stiff to very stiff soils

Briefly consider 2-layer analysis.

USE c =	3.500	ksf for Stratum II
USE c =	1.600	ksf for Stratum III

Groundwater

Model groundwater in ditch above foundatation bearing elevation.

STRENTH LIMIT STATE:

$q_R = \varphi_b * q_n$ (AASTHO LRFD 10.6.3.1.1-1)

q_R = factored resistance at strength limit state (ksf)
φ_b = resistance factor (Article 10.5.5.2.2)
q_n = nominal bearing resistance (ksf)

$q_n = cN_{cm} + gD_fN_{qm}C_{wq} + 0.5gBN_{\gamma m}C_{w\gamma}$ (AASTHO LRFD 10.6.3.1.2a-1)
$N_{cm} = N_cs_ci_c$ (AASTHO LRFD 10.6.3.1.2a-2)
$N_{qm} = N_qs_qd_qi_q$ (AASTHO LRFD 10.6.3.1.2a-3)
$N_{\gamma m} = N_\gamma s_\gamma i_\gamma$ (AASTHO LRFD 10.6.3.1.2a-4)

c = cohesion, undrained shear strength (ksf)
N_c = cohesion term (Table 10.6.3.1.2a-1)
N_q = surcharge term (Table 10.6.3.1.2a-1)
N_g = unit weight term (Table 10.6.3.1.2a-1)
γ = total (moist) unit weight (kcf)
D_f = footing embedment depth (ft)
B = footing width (ft)
C_{wq} , $C_{w\gamma}$= groundwater correction factors (Table 10.6.3.1.2a-2)
s_c , s_γ , s_q = shape correction factors (Table 10.6.3.1.2a-3)
d_q = shear resistance thought cohesionless material correction factor (Table 10.6.3.1.2a-4)
i_c , i_γ , i_q = inclination correction factors

Bearing in Stratum II very stiff to hard cohesive soils; approx. 18 feet to Stratum III stiff to very stiff soil

Setup	$c =$	3.5	ksf			
	$\phi_f =$	0	degrees	assumed zero in cohesive soil		
	$N_c =$	5.14	*units*			
	$N_q =$	1.0	*units*	for soil with a $\phi_f =$ 0 Degrees		
	$N_\gamma =$	0.0	*units*			
	$\gamma =$	0.068	kcf	(0.130 soil - 0.062 water)		
	$D_f =$	3	ft	(692 invert - 689 bearing)		
	$B =$	6.00	ft	Width		
	$L =$	44.1	ft	Length		
	$D_w =$	0	ft	highest anticipated groundwater depth		
	$C_{wq} =$	0.5	*units*	where $D_w = 0.0$	$1.5B + D_f =$ 12	
	$C_{w\gamma} =$	0.5	*units*	(above D_f)		
	$s_c =$	1.03	*units*	$s_c = 1 + (B/(5L))$		$s_c = 1 + (B/(5L))(Nq/Nc)$
	$s_g =$	1.00	*units*	for $\phi_f = 0$ $s_\gamma = 1$	for $\phi_f > 0$	$s_g = 1 - 0.4(B/L)$
	$s_q =$	1.00	*units*	$s_q = 1$		$s_q = 1 + ((B/L)\tan(\phi_f))$
	$d_q =$	1.0	*units*	taken as 1 since cohesive soil		$D_f / B =$ 0.5
	$i_c , i_\gamma , i_q =$	1.0	*units*	Assumed loaded without inclination		

calculation	$N_{cm} = N_c s_c i_c$	= 5.14 * 1.027 * 1 =	5.279
	$N_{qm} = N_q s_q d_q i_q$	= 1 * 1 * 1 * 1 =	1
	$N_{\gamma m} = N_\gamma s_\gamma i_\gamma$	= 0 * 1 * 1 =	0

$q_n = cN_{cm} + \gamma D_f N_{qm} C_{wq} + 0.5\gamma B N_{\gamma m} C_{w\gamma}$ — $cN_{cm} =$ 18.477

= (3.5*5.279) + (0.0676*3*1*0.5) + (0.5*6*0*0.5) = — $\gamma D_f N_{qm} C_{wq} =$ 0.101

= (18.477) + (0.101) + (0) = — $0.5\gamma B N_{\gamma m} C_{w\gamma} =$ 0

$q_n =$ 18.578 ksf

$\varphi_b =$ 0.5 — based on theoretical method (Munfakh et al., 2001), in clay

$q_R = \varphi_b * q_n$ = 0.5 * 18.578 = 9.289 ksf in Stratum II

2-layer considerations

For Stratum III,

$q_n = cN_{cm} + \gamma D_f N_{qm} C_{wq} + 0.5\gamma B N_{\gamma m} C_{w\gamma}$ — $cN_{cm} =$ 8.446

= (1.6*5.279) + (0.0676*3*1*0.5) + (0.5*6*0*0.5) = — $\gamma D_f N_{qm} C_{wq} =$ 0.101

= (8.446) + (0.101) + (0) = — $0.5\gamma B N_{\gamma m} C_{w\gamma} =$ 0

$q_n =$ 8.547 ksf

$\varphi_b =$ 0.5 — based on theoretical method (Munfakh et al., 2001), in clay

$q_R = \varphi_b * q_n$ = 0.5 * 8.547 = 4.2735 ksf in Stratum III

$$H_{crit} = \frac{(3B)\ \ln\left(\frac{q_1}{q_2}\right)}{2\left(1+\frac{B}{L}\right)}$$ (10.6.3.1.2d-1)

H_{crit} = 6.151

Stratum III 18 feet below footing. Hcrit < 18 feet. Therefore, do not need 2-layer analysis.

Factored resistance at the strength limit state for the proposed headwall is equal to 9.3 ksf

SERVICE LIMIT STATE:

Based on : (Table C10.6.2.6.1-1)

"Presumptive Bearing Resistance for Spread Footing Foundations at the Service Limit State" Table

Stratum II stiff to very stiff cohesive soils
Consider "medium stiff" based on selected c = 0.835 ksf
within applicable borings and depths:

Consistency	Soil Type	Bearing Resistance (ksf)	
		Ordinary Range	Recommended Value of Use*
"Medium Dense to Dense"	Lean Clay (CL)	2-6	4
"Very Dense"	Lean Clay (CL)	6-12	8

* recomented value based on Table C10.6.2.6.1-1

φ_b = 1

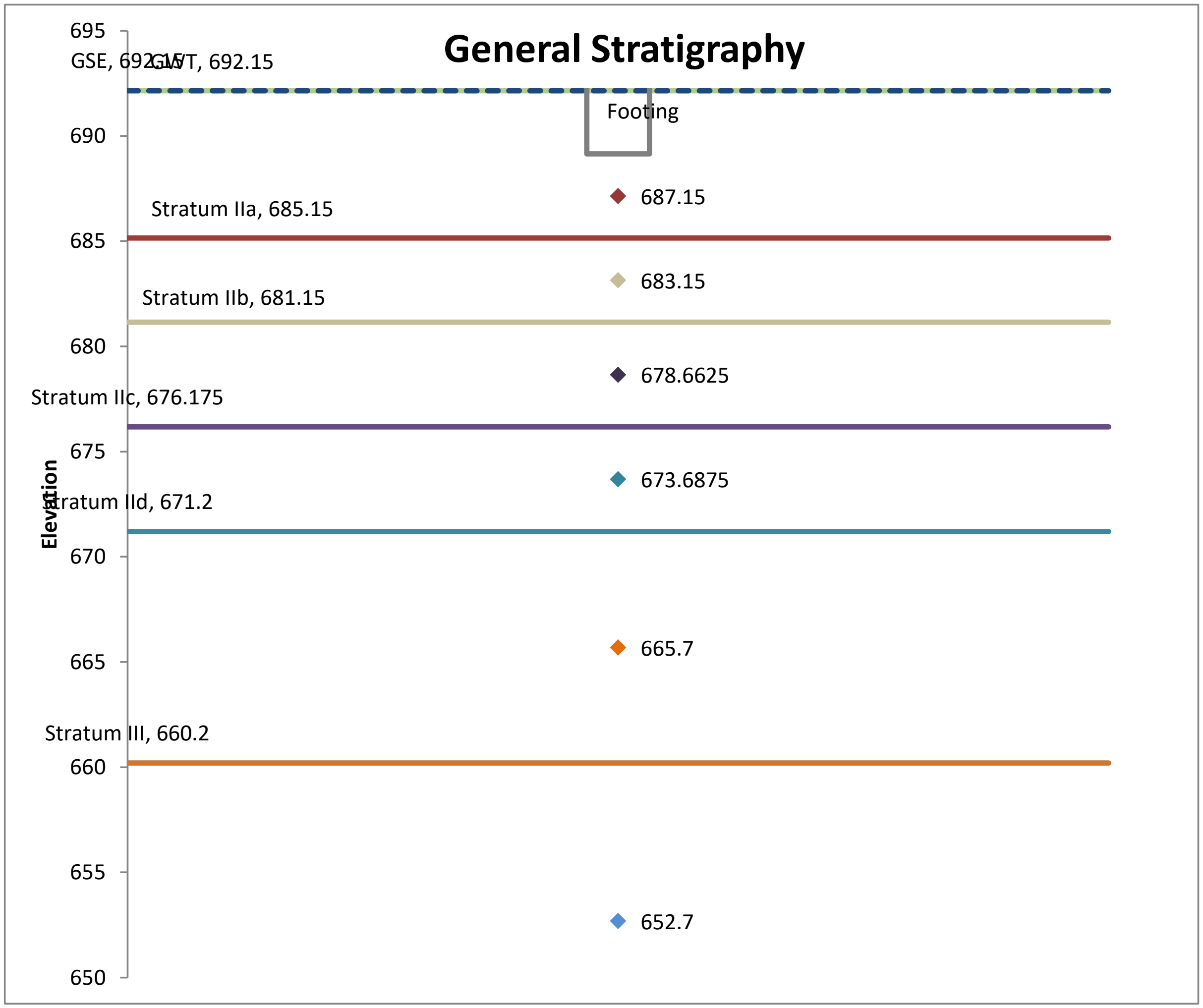
Factored bearing resistance = 6 ksf, for dense to very dense CL

Limit to 2.59 ksf based on design and settlement considerations (see attached *Settlement Calculation*)

Project Name:	HEN-24/17D-00.43, PID 117712	Boring Number	B-028
Project Number:	230230	Analysis Type	Rectangular
Calculated by:	KCH 3/26/2024		

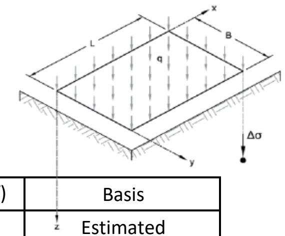
Layer	H (feet)	C_r	e_o	sigma v (psf)	z (feet)	b (feet)	$\frac{(z-Df)}{b}$	I_z	delta p@	2590 psf	(check) sigma v+ΔP	delta H (inches)
Stratum IIa	4	0.027	0.51	338	2	6	0.3	0.230	2381		2719	0.78
Stratum IIb	4	0.027	0.51	608	6	6	1.0	0.137	1421		2029	0.45
Stratum IIc	4.975	0.027	0.51	912	10.4875	6	1.7	0.085	883		1795	0.31
Stratum IId	4.975	0.027	0.51	1248	15.4625	6	2.6	0.057	595		1843	0.18
Stratum III	11	0.033	0.57	1816	23.45	6	3.9	0.035	362		2177	0.22
Stratum IV	15	0.011	0.47	2759	36.45	6	6.1	0.018	191		2951	0.04

Total delta H (in.)	2.02
+15%	2.32
-15%	1.72



Project Name:	HEN-24/17D-00.43, PID 117712	Boring Number	B-028
Project Number:	230230	Analysis Type	Rectangular
Calculated by:	KCH 3/26/2024		

G (assumed)	2.7	
GSE	692.15	Ditch Bottom
GWT	692.15	At or above Ditch Bottom
Bearing Elev	689.15	
D_f	3	ft
Footing Width, B	6	ft
Length, L	44.3	ft
P	2590	psf



$\Delta\sigma$ .... $= qI_B$

I_B .... $= \frac{1}{4\pi}\left[\frac{2|mn|\sqrt{V}}{V+V_1} \times \frac{V+1}{V} + \tan^{-1}\left(\frac{2|mn|\sqrt{V}}{V-V_1}\right) + \beta\right]$

V .... $= m^2 + n^2 + 1$

V_1 .... $= (mn)^2$

$\beta \left(\text{when } \tan^{-1}\left(\frac{2|mn|\sqrt{V}}{V-V_1}\right) \leq 0\right)$ .... $= \pi$

$\beta \left(\text{when } \tan^{-1}\left(\frac{2|mn|\sqrt{V}}{V-V_1}\right) > 0\right)$ .... $= 0$

m .... $= \frac{B}{z}$

n .... $= \frac{L}{z}$

Project-Specific Consolidation Soil Properties:

Stratum	e_o	C_c	C_r	P_c (psf)	γ_T (pcf)	Basis
I	0.62	0.194	0.019	4,250	125	Estimated
II	0.512	0.118	0.027	5,500	130	Tested
III	0.565	0.13	0.033	6,200	135	Tested
IV	0.47	0.109	0.011	34,890	135	Estimated

note: Hardpan considered highly overconsolidated. Use Cr.

	Bot. Elev.	Centroid (C) Elev.	H (ft)	z below footing	z below GSE	γ_T (pcf)	γ_d (pcf)	H_{GWT-C}	Cr	e_o	Depth of Influence = $(z-D_f)/B$	m = 0.5*B/z	n = 0.5*L/z	I_z*	σ_v' (psf)	V	V1	$\tan^{-1}\left(\frac{2\|mn\|\sqrt{V}}{V-V_1}\right)$	Beta
Stratum IIa	685.2	687.15	4	2	5	130		5	0.027	0.512	0.33	1.5	11.1	0.230	338	126	276	-1.19	3.14
Stratum IIb	681.2	683.15	4	6	9	130		9	0.027	0.512	1.0	0.5	3.7	0.137	608	15	3	0.89	0.00
Stratum IIc	676.2	678.6625	4.98	10.4875	13.4875	130		13.49	0.027	0.512	1.7	0.3	2.1	0.085	912	5.5	0.4	0.50	0.00
Stratum IId	671.2	673.6875	4.97	15.4625	18.4625	130		18.46	0.027	0.512	2.6	0.2	1.4	0.057	1248	3.1	0.1	0.31	0.00
Stratum III	660.2	665.7	11	23.45	26.45	135		26.45	0.033	0.565	3.9	0.1	0.9	0.035	1816	1.9	0.01	0.17	0.00
Stratum IV	645.2	652.7	15	36.45	39.45	135		39.45	0.011	0.47	6.1	0.08	0.6	0.018	2759	1.4	0.00	0.09	0.00

*Note: Influence factors are multiplied by 4 in calculation of delta p

Appendix F

Subgrade Evaluations and Calculations
(Including Subgrade Analysis Spreadsheets)

LEADING THROUGH
the next 100 years

OHIO DEPARTMENT OF TRANSPORTATION

OFFICE OF GEOTECHNICAL ENGINEERING

PLAN SUBGRADES
Geotechnical Design Manual Section 600

Instructions: Enter data in the shaded cells only.
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HEN-24/17D-00.43
117712

Proposed Diamond Interchange - County Road 17D

CT Consultants, Inc.

Prepared By: Katherine C. Hennicken
Date prepared: Wednesday, March 27, 2024

Katherine C. Hennicken
CT Consultants, Inc.
1915 North 12th Street
Toledo, Ohio 43604
419-214-5026
khennicken@ctconsultants.com

NO. OF BORINGS: 5

#	Boring ID	Alignment	Station	Offset	Dir	Drill Rig	ER	Boring EL.	Proposed Subgrade EL	Cut Fill
1	B-016-0-22	County Road 17D	20834			CME 75 Truck 844 \04	73	702.1	701.1	1.0 C
2	B-017-0-22	County Road 17D	21090			CME 75 Truck 844 \04	73	702.4	706.2	3.8 F
3	B-021-0-22	County Road 17D	22559			CME 75 Truck 844 \04	73	700.9	708.5	7.6 F
4	B-022-0-22	County Road 17D	22865			CME 75 Truck 844 \04	73	702.5	702.8	0.3 F
5	B-023-0-22	County Road 17D	22965			CME 75 Truck 844 \04	73	701.8	702.4	0.6 F

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.6 2/11/2022

#	Boring	Sample	Sample Depth		Subgrade Depth		Standard Penetration		HP (tsf)	Physical Characteristics						Moisture		Ohio DOT		Sulfate Content (ppm)	Problem		Excavate and Replace (Item 204)		Recommendation (Enter depth in inches)
			From	To	From	To	N_{60}	N_{60L}		LL	PL	PI	% Silt	% Clay	P200	M_C	M_{OPT}	Class	GI		Unsuitable	Unstable	Unsuitable	Unstable	
1	B	SS-1	1.3	2.2	0.3	1.2	16		>4.5	35	20	15	20	56	76	16	15	A-6a	10	250					NO UNDERCUT
	016-0	SS-2	2.2	6.4	1.2	5.4	12		4.25	37	19	18	19	60	79	18	16	A-6b	11						
	22	SS-3	6.4	8.5	5.4	7.5	29		>4.5							16	16	A-6b							
		SS-4	8.5	10.0	7.5	9.0	45	12	>4.5							15	16	A-6b							
2	B	SS-1	1.2	3.0	5.0	6.9	13		4.5	35	20	15	20	67	87	20	15	A-6a							NO UNDERCUT
	017-0	SS-2	3.0	6.3	6.9	10.2	11		4							21	16	A-6b							
	22	SS-3	6.3	8.0	10.2	11.9	24		>4.5							16	16	A-6b							
		ST-4	8.0	11.0	11.9	14.9	ST	13	>4.5	38	19	19	17	51	68	15	16	A-6b							
3	B	SS-1	1.3	3.0	8.9	10.6	15		>4.5							18	16	A-6b							NO UNDERCUT
	021-0	SS-2	3.0	6.2	10.6	13.8	15		4.25							21	16	A-6b							
	22	SS-3	6.2	8.5	13.8	16.1	38		>4.5	31	19	12	25	48	73	16	14	A-6a							
		SS-4	8.5	11.0	16.1	18.6	29		>4.5							15	16	A-6b							
4	B	SS-1	1.3	2.6	1.6	2.9	30		3.5							21	16	A-6b	16	240		Mc			NO UNDERCUT
	022-0	SS-2	2.6	6.0	2.9	6.3	12		1.25							23	16	A-6b	16						
	22	SS-3	6.0	8.3	6.3	8.6	26		1	36	20	16	26	46	72	26	16	A-6b							
		SS-4	8.3	11.8	8.6	12.1	41	12	>4.5	37	19	18	25	54	79	16	16	A-6b							
5	B	SS-1	1.4	2.4	2.0	3.0	19									24	18	A-7-6	16			Mc			NO UNDERCUT
	023-0	SS-2	2.4	6.0	3.0	6.6	10		2.5	44	22	22	27	51	78	23	19	A-7-6	14	250					
	22	SS-3	6.0	8.0	6.6	8.6	17		2	43	22	21	25	56	81	27	19	A-7-6							
		SS-4	8.0	10.0	8.6	10.6	33	10	>4.5							16	16	A-6b							

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.6 2/11/2022

PID: 117712

County-Route-Section: HEN-24/17D-00.43
No. of Borings: 5

Geotechnical Consultant: CT Consultants, Inc.
Prepared By: Katherine C. Hennicken
Date prepared: 3/27/2024

Chemical Stabilization Options		
320	Rubblize & Roll	No
206	Cement Stabilization	Option
	Lime Stabilization	Option
206	Depth	12"

Excavate and Replace Stabilization Options	
Global Geotextile Average(N60L): Average(HP):	12" 0"
Global Geogrid Average(N60L): Average(HP):	0" 0"

Design CBR	5

% Samples within 6 feet of subgrade			
$N_{60} \leq 5$	0%	HP ≤ 0.5	0%
$N_{60} < 12$	13%	0.5 < HP ≤ 1	0%
$12 \leq N_{60} < 15$	38%	1 < HP ≤ 2	13%
$N_{60} \geq 20$	25%	HP > 2	50%
M+	25%		
Rock	0%		
Unsuitable	0%		

Excavate and Replace at Surface	
Average	
Maximum	0"
Minimum	0"

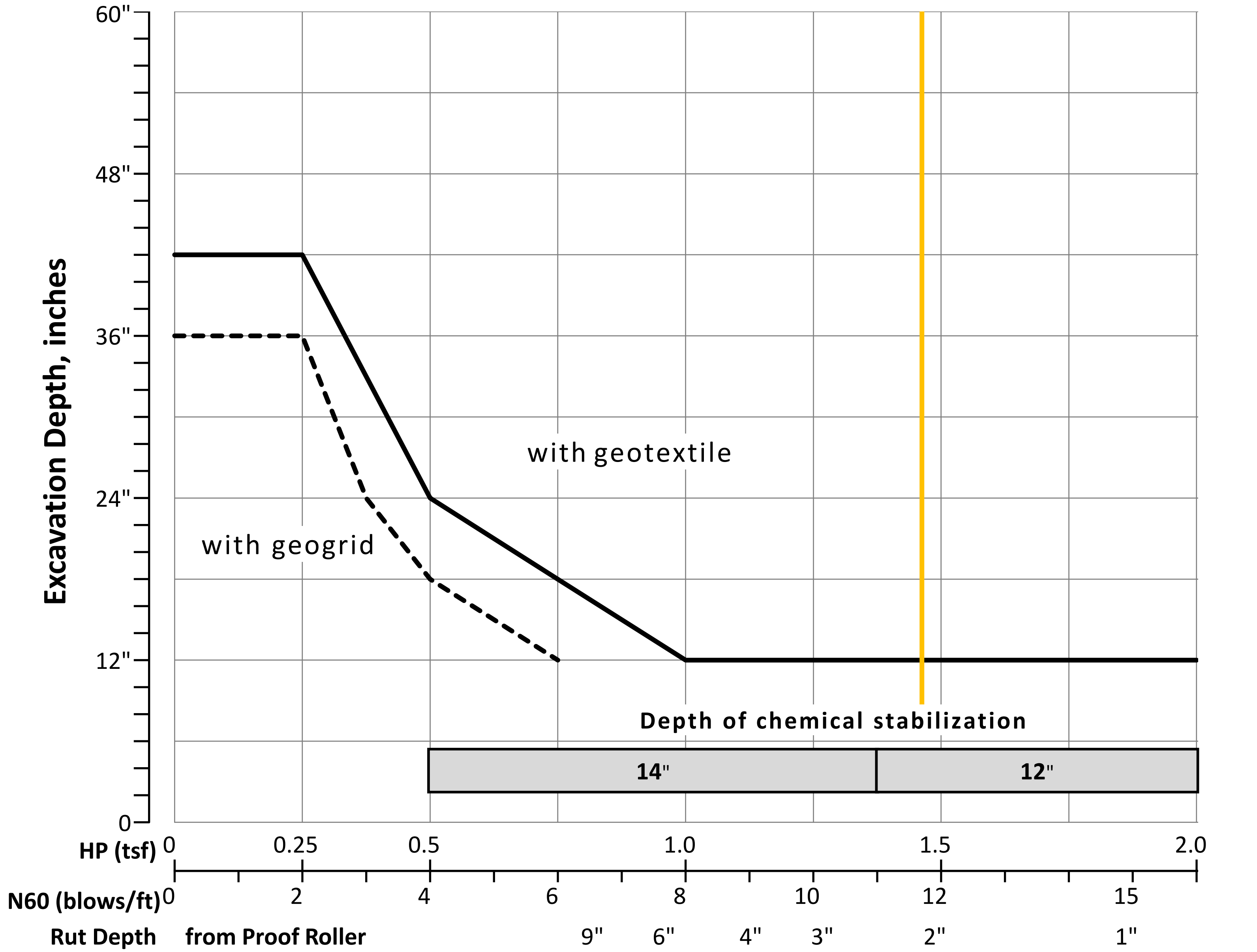
% Proposed Subgrade Surface	
Unstable & Unsuitable	50%
Unstable	50%
Unsuitable	0%

	N_{60}	N_{60L}	HP	LL	PL	PI	Silt	Clay	P 200	M_C	M_{OPT}	GI
Average	23	12	3.03	37	20	17	23	54	77	19	16	14
Maximum	45	13	4.50	44	22	22	27	67	87	27	19	16
Minimum	10	10	1.00	31	19	12	17	46	68	15	14	10

Classification Counts by Sample

ODOT Class	Rock	A-1-a	A-1-b	A-2-4	A-2-5	A-2-6	A-2-7	A-3	A-3a	A-4a	A-4b	A-5	A-6a	A-6b	A-7-5	A-7-6	A-8a	A-8b	Totals
Count	0	0	0	0	0	0	0	0	0	0	0	0	3	14	0	3	0	0	20
Percent	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	15%	70%	0%	15%	0%	0%	100%
% Rock|Granular|Cohesive	0%	0%									100%								100%
Surface Class Count	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	1	0	0	4
Surface Class Percent	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	25%	50%	0%	25%	0%	0%	100%

Fig. 600-1 – Subgrade Stabilization



OVERRIDE TABLE

Calculated Average	New Values	Check to Override
3.03		☐ HP
11.75		☐ N60L

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PLAN SUBGRADES
Geotechnical Design Manual Section 600

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HEN-24/17D-00.43
117712

Proposed Diamond Interchange - Ramp A

CT Consultants, Inc.

Prepared By: Katherine C. Hennicken
Date prepared: Wednesday, March 27, 2024

Katherine C. Hennicken
CT Consultants, Inc.
1915 North 12th Street
Toledo, Ohio 43604
419-214-5026
khennicken@ctconsultants.com

NO. OF BORINGS: 4

#	Boring ID	Alignment	Station	Offset	Dir	Drill Rig	ER	Boring EL.	Proposed Subgrade EL	Cut Fill
1	B-003-0-22	US 24	12816			CME 75 Truck 844 \04	73	705.5	703.6	1.9 C
2	B-005-0-22	Ramp A	40233			Geoprobe 7822DT \03	90*	701.6	702.8	1.2 F
3	B-007-0-22	Ramp A	40628			Geoprobe 7822DT \03	90*	700.5	698.8	1.7 C
4	B-010-0-22	Ramp A	41012			Diedrich D70 Track \01	90	701.6	704.9	3.3 F

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.6 2/11/2022

#	Boring	Sample	Sample Depth		Subgrade Depth		Standard Penetration		HP (tsf)	Physical Characteristics						Moisture		Ohio DOT		Sulfate Content (ppm)	Problem		Excavate and Replace (Item 204)		Recommendation (Enter depth in inches)
			From	To	From	To	N_{60}	N_{60L}		LL	PL	PI	% Silt	% Clay	P200	M_C	M_{OPT}	Class	GI		Unsuitable	Unstable	Unsuitable	Unstable	
1	B	SS-1	1.4	3.8	-0.5	1.9	7		>4.5	34	18	16	23	26	49	17	16	A-6b	5	240		N_{60}		15"	15"
	003-0	SS-2	3.8	4.8	1.9	2.9	10		3.75	38	19	19	24	34	58	23	16	A-6b	8			N_{60} & Mc			204 Geotextile
	22	SS-3	4.8	6.2	2.9	4.3	15		3							20	16	A-6b	16						
		SS-4	6.2	7.5	4.3	5.6	26	7	>4.5							18	16	A-6b	16						
2	B	SS-1	0.3	2.0	1.5	3.2	18		>4.5	46	26	20	28	28	56	17	23	A-7-6	9	240					NO UNDERCUT
	005-0	SS-2	2.0	3.3	3.2	4.5	12		>4.5							19	18	A-7-6	16						
	22	SS-3	3.3	4.5	4.5	5.7	8		3.5	43	21	22	25	53	78	22	18	A-7-6	13						
		SS-4	4.5	6.0	5.7	7.2	14	8	4							19	16	A-6b							
3	B	SS-1	0.3	3.0	-1.4	1.3	14		>4.5	44	24	20	23	56	79	19	21	A-7-6	13	240					NO UNDERCUT
	007-0	SS-2	3.0	6.0	1.3	4.3	11		>4.5							19	16	A-6b	16						
	22	SS-3	6.0	8.0	4.3	6.3	27		>4.5	32	20	12	23	47	70	16	15	A-6a	8						
		SS-4	8.0	10.0	6.3	8.3	45	11	>4.5							15	14	A-6a							
4	B	SS-1	0.8	3.0	4.1	6.3	14		4.5	38	21	17	20	64	84	16	16	A-6b	11						NO UNDERCUT
	010-0	SS-2	3.0	6.0	6.3	9.3	26		4.5							15	16	A-6b							
	22	SS-3	6.0	8.5	9.3	11.8	60		4.5	37	18	19	19	65	84	16	16	A-6b							
		SS-4	8.5	11.0	11.8	14.3	39	14	4.5	36	19	17	19	67	86	16	16	A-6b							

PID: 117712

County-Route-Section: HEN-24/17D-00.43
No. of Borings: 4

Geotechnical Consultant: CT Consultants, Inc.
Prepared By: Katherine C. Hennicken
Date prepared: 3/27/2024

Chemical Stabilization Options		
320	Rubblize & Roll	No
206	Cement Stabilization	Option
	Lime Stabilization	Option
206	Depth	14"

Excavate and Replace Stabilization Options	
Global Geotextile Average(N60L): Average(HP):	12" 0"
Global Geogrid Average(N60L): Average(HP):	0" 0"

Design CBR	5

% Samples within 6 feet of subgrade			
$N_{60} \leq 5$	0%	HP ≤ 0.5	0%
$N_{60} < 12$	33%	0.5 < HP ≤ 1	0%
$12 \leq N_{60} < 15$	33%	1 < HP ≤ 2	0%
$N_{60} \geq 20$	17%	HP > 2	42%
M+	8%		
Rock	0%		
Unsuitable	0%		

Excavate and Replace at Surface	
Average	15"
Maximum	15"
Minimum	15"

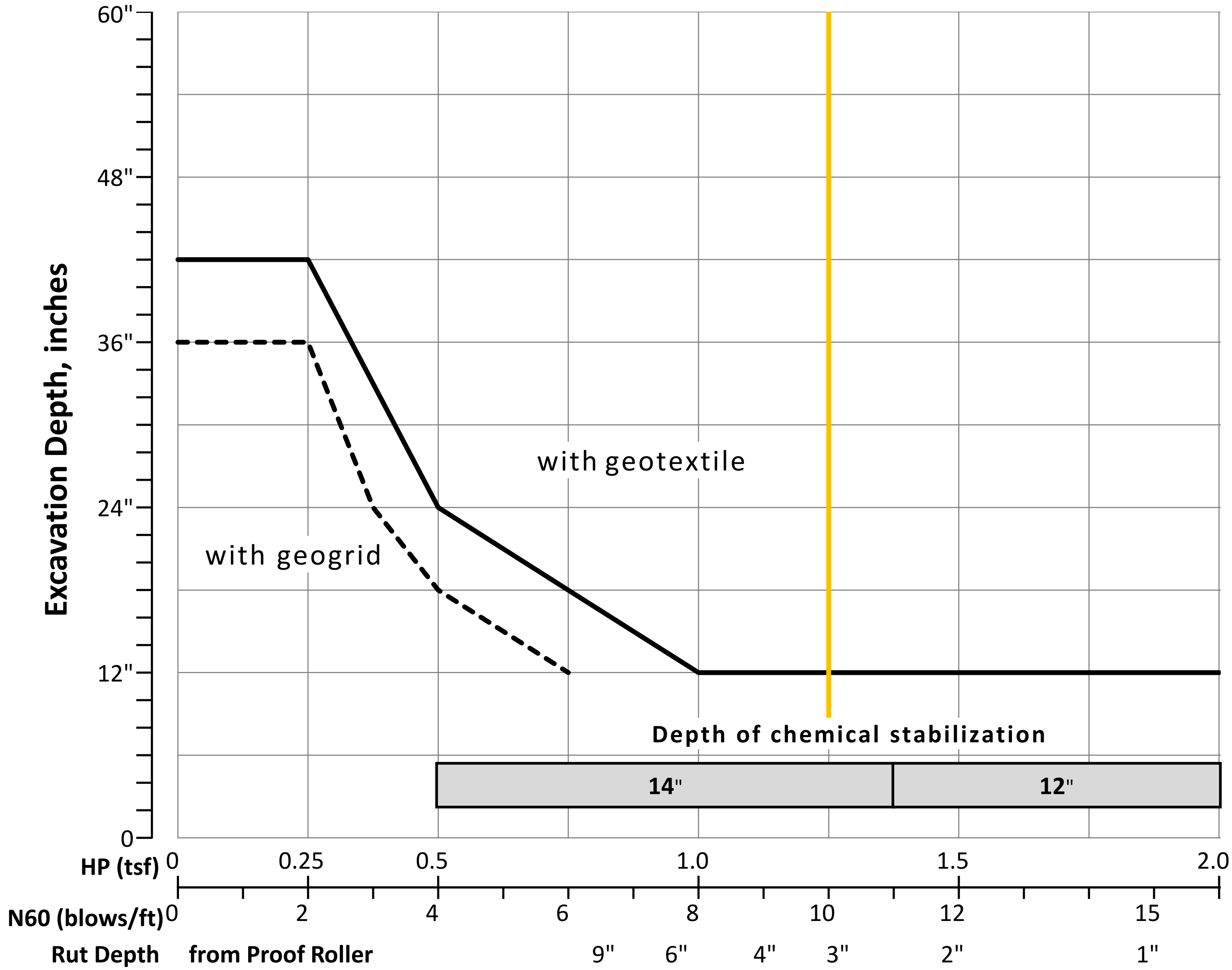
% Proposed Subgrade Surface	
Unstable & Unsuitable	40%
Unstable	40%
Unsuitable	0%

	N_{60}	N_{60L}	HP	LL	PL	PI	Silt	Clay	P 200	M_C	M_{OPT}	GI
Average	22	10	4.03	39	21	18	23	49	72	18	17	12
Maximum	60	14	4.50	46	26	22	28	67	86	23	23	16
Minimum	7	7	3.00	32	18	12	19	26	49	15	14	5

Classification Counts by Sample

ODOT Class	Rock	A-1-a	A-1-b	A-2-4	A-2-5	A-2-6	A-2-7	A-3	A-3a	A-4a	A-4b	A-5	A-6a	A-6b	A-7-5	A-7-6	A-8a	A-8b	Totals
Count	0	0	0	0	0	0	0	0	0	0	0	0	2	10	0	4	0	0	16
Percent	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	13%	63%	0%	25%	0%	0%	100%
% Rock|Granular|Cohesive	0%	0%									100%								100%
Surface Class Count	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	2	0	0	5
Surface Class Percent	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	60%	0%	40%	0%	0%	100%

Fig. 600-1 – Subgrade Stabilization



OVERRIDE TABLE

Calculated Average	New Values	Check to Override
4.03		☐ HP
10.00		☐ N60L

Average HP

Average N_{60L}

OHIO DEPARTMENT OF TRANSPORTATION

OFFICE OF GEOTECHNICAL ENGINEERING

PLAN SUBGRADES
Geotechnical Design Manual Section 600

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HEN-24/17D-00.43
117712

Proposed Diamond Interchange - Ramp B

CT Consultants, Inc.

Prepared By: Katherine C. Hennicken
Date prepared: Wednesday, March 27, 2024

Katherine C. Hennicken
CT Consultants, Inc.
1915 North 12th Street
Toledo, Ohio 43604
419-214-5026
khennicken@ctconsultants.com

NO. OF BORINGS: 7

#	Boring ID	Alignment	Station	Offset	Dir	Drill Rig	ER	Boring EL.	Proposed Subgrade EL	Cut Fill
1	B-028-0-22	Ramp B	50649			Diedrich D70 Track \01	90	698.2	703.5	5.3 F
2	B-030-0-22	Ramp B	50773			Diedrich D70 Track \01	90	697.7	701.5	3.8 F
3	B-031-0-22	Ramp B	51109			Diedrich D70 Track \01	90	696.2	699.5	3.3 F
4	B-033-0-22	US 24	15933			Hand Auger	60	700.0	698.7	1.3 C
5	B-035-0-22	US 24	16324			CME 75 Truck 844 \04	73	702.1	700.8	1.3 C
6	B-037-0-22	US 24	16724			CME 75 Truck 844 \04	73	701.0	699.7	1.3 C
7	B-038-0-22	US 24	17105			CME 75 Truck 844 \04	73	702.7	701.4	1.3 C

#	Boring	Sample	Sample Depth		Subgrade Depth		Standard Penetration		HP (tsf)	Physical Characteristics						Moisture		Ohio DOT		Sulfate Content (ppm)	Problem		Excavate and Replace (Item 204)		Recommendation (Enter depth in inches)
			From	To	From	To	N_{60}	N_{60L}		LL	PL	PI	% Silt	% Clay	P200	M_C	M_{OPT}	Class	GI		Unsuitable	Unstable	Unsuitable	Unstable	
1	B	SS-1	0.7	3.5	6.0	8.8	14		4.5	39	20	19	26	55	81	16	16	A-6b							**NO UNDERCUT**
	028-0	SS-2	3.5	6.0	8.8	11.3	27		4.5							16	16	A-6b							
	22	SS-3	6.0	8.0	11.3	13.3	36		4.5	37	19	18	18	57	75	14	16	A-6b							
		SS-4	8.0	11.0	13.3	16.3	56		4.5							15	14	A-6a							
2	B	SS-1	0.4	3.0	4.2	6.8	9		2	36	19	17	26	53	79	18	16	A-6b	11						**NO UNDERCUT**
	030-0	SS-2	3.0	6.0	6.8	9.8	21		4.5							14	14	A-6a							
	22	SS-3	6.0	8.5	9.8	12.3	39		4.5							15	14	A-6a							
		SS-4	8.5	10.0	12.3	13.8	45	9	4.5	32	18	14	26	47	73	15	14	A-6a							
3	B	SS-1	0.8	3.0	4.1	6.4	9		1.5	37	20	17	27	53	80	24	16	A-6b	11						**NO UNDERCUT**
	031-0	SS-2	3.0	6.0	6.4	9.4	21		3							16	14	A-6a							
	22	SS-3	6.0	8.5	9.4	11.9	47		4.5	29	21	8	43	32	75	15	16	A-4a							
		SS-4	8.5	12.0	11.9	15.4	42	9	4.5							15	10	A-4a							
4	B	SS-1	0.5	1.5	-0.8	0.2	5		3	38	21	17	24	42	66	24	16	A-6b	9	240		N_{60} & Mc		21"	**21"**
	033-0	SS-2	1.5	3.0	0.2	1.7	8		3.75							21	16	A-6b	16			N_{60} & Mc		12"	**204 Geotextile**
	22	SS-3	3.0	4.5	1.7	3.2	5		4							22	16	A-6b	16			N_{60} & Mc			
		SS-4	4.5	6.0	3.2	4.7	10	5	4.5	36	19	17	23	51	74	16	14	A-4a	8						
5	B	SS-1	1.7	4.0	0.4	2.7	7			NP	NP	NP	16	2	18	8	6	A-1-b	0	<100					**NO UNDERCUT**
	035-0	SS-2	4.0	5.0	2.7	3.7	10		3	39	23	16	25	48	73	25	18	A-6b	10						
	22	SS-3	5.0	6.2	3.7	4.9	16		4							19	16	A-6b	16						
		SS-4	6.2	7.5	4.9	6.2	23	7	3.5							18	16	A-6b	16						
6	B	SS-1	0.6	1.0	-0.7	-0.3	10			44	24	20	29	22	51	13	21	A-7-6	7	240					**12"**
	037-0	SS-2	1.0	3.0	-0.3	1.7	16		>4.5							17	16	A-6b	16						**204 Geotextile**
	22	SS-3	3.0	5.0	1.7	3.7	9		3.5	39	22	17	23	57	80	21	17	A-6b	11						
		SS-4	5.0	6.0	3.7	4.7	16	9	4							22	16	A-6b	16						
7	B	SS-1	1.8	3.5	0.5	2.2	6		>4.5	44	22	22	20	32	52	19	19	A-7-6	8	230		N_{60}		18"	**18"**
	038-0	SS-2	3.0	5.0	1.7	3.7	12		2.75	38	20	18	26	41	67	21	16	A-6b	10						**204 Geotextile**
	22	SS-3	5.0	6.5	3.7	5.2	15		3.5							19	16	A-6b	16						
		SS-4	6.5	7.5	5.2	6.2	17	6								19	8	A-3a							

PID: 117712

County-Route-Section: HEN-24/17D-00.43
No. of Borings: 7

Geotechnical Consultant: CT Consultants, Inc.
Prepared By: Katherine C. Hennicken
Date prepared: 3/27/2024

Chemical Stabilization Options		
320	Rubblize & Roll	No
206	Cement Stabilization	Option
	Lime Stabilization	Option
206	Depth	14"

Excavate and Replace Stabilization Options	
Global Geotextile Average(N60L): Average(HP):	15" 0"
Global Geogrid Average(N60L): Average(HP):	0" 0"

Design CBR	5

% Samples within 6 feet of subgrade			
$N_{60} \leq 5$	11%	HP ≤ 0.5	0%
$N_{60} < 12$	56%	0.5 < HP ≤ 1	0%
$12 \leq N_{60} < 15$	11%	1 < HP ≤ 2	11%
$N_{60} \geq 20$	6%	HP > 2	67%
M+	17%		
Rock	0%		
Unsuitable	0%		

Excavate and Replace at Surface	
Average	17"
Maximum	21"
Minimum	12"

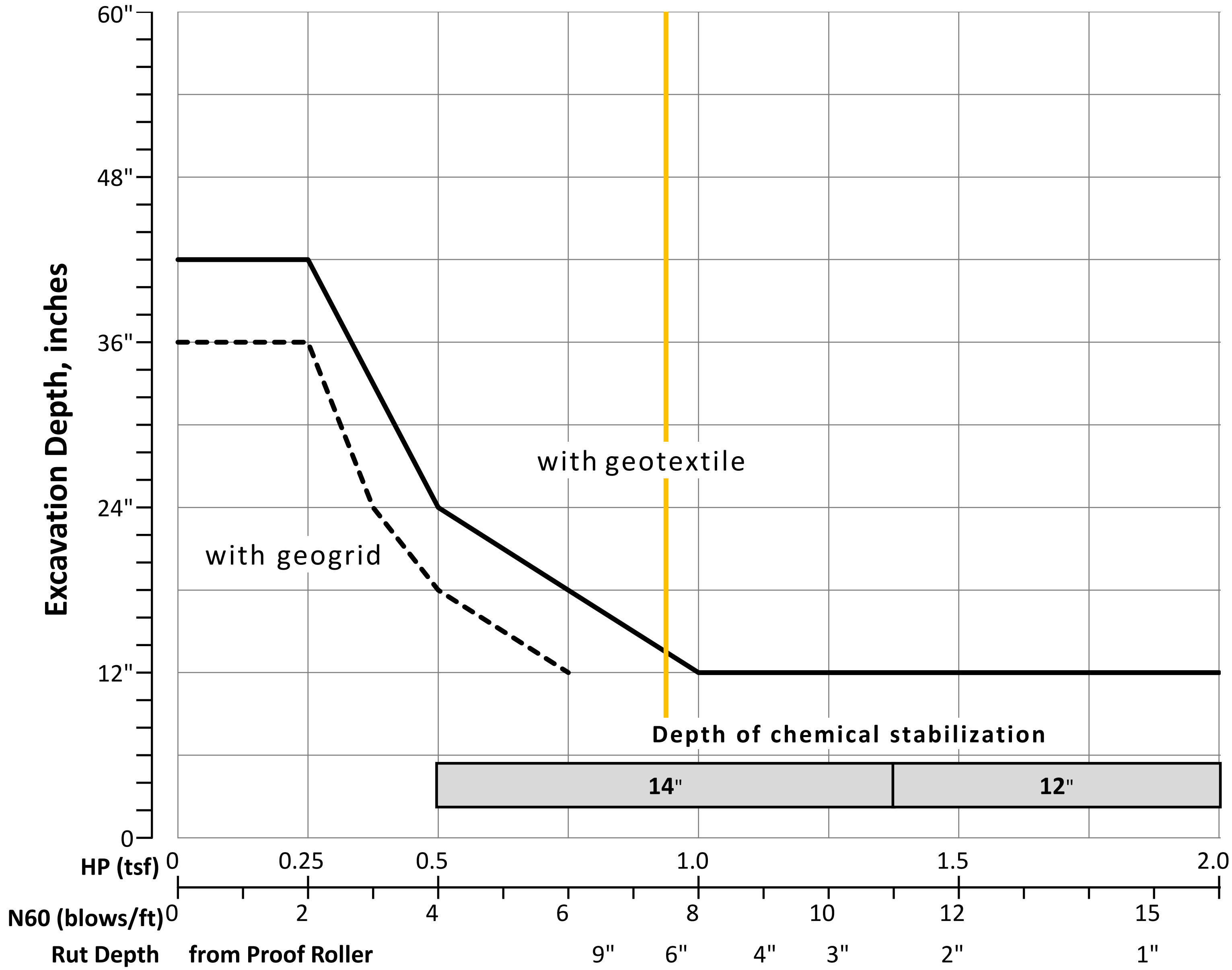
% Proposed Subgrade Surface	
Unstable & Unsuitable	40%
Unstable	40%
Unsuitable	0%

	N_{60}	N_{60L}	HP	LL	PL	PI	Silt	Clay	P 200	M_C	M_{OPT}	GI
Average	20	8	3.76	37	20	17	25	44	69	18	15	12
Maximum	56	9	4.50	44	24	22	43	57	81	25	21	16
Minimum	5	5	1.50	29	18	8	16	2	18	8	6	0

Classification Counts by Sample

ODOT Class	Rock	A-1-a	A-1-b	A-2-4	A-2-5	A-2-6	A-2-7	A-3	A-3a	A-4a	A-4b	A-5	A-6a	A-6b	A-7-5	A-7-6	A-8a	A-8b	Totals
Count	0	0	1	0	0	0	0	0	1	3	0	0	5	16	0	1	0	0	27
Percent	0%	0%	4%	0%	0%	0%	0%	0%	4%	11%	0%	0%	19%	59%	0%	4%	0%	0%	100%
% Rock|Granular|Cohesive	0%	19%									81%								100%
Surface Class Count	0	0	1	0	0	0	0	0	0	0	0	0	0	7	0	2	0	0	10
Surface Class Percent	0%	0%	10%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	70%	0%	20%	0%	0%	100%

Fig. 600-1 – Subgrade Stabilization



OVERRIDE TABLE

Calculated Average	New Values	Check to Override
3.76		☐ HP
7.50		☐ N60L

Average HP

Average N_{60L}

OHIO DEPARTMENT OF TRANSPORTATION

OFFICE OF GEOTECHNICAL ENGINEERING

PLAN SUBGRADES
Geotechnical Design Manual Section 600

Instructions: Enter data in the shaded cells only.
(Enter state route number, project description,county, consultant's name, prepared by name, and date prepared. This information will be transferred to all other sheets. The date prepared must be entered in the appropriate cell on this sheet to remove these instructions prior to printing.)

HEN-24/17D-00.43
117712

Proposed Diamond Interchange - Ramp C

CT Consultants, Inc.

Prepared By: Katherine C. Hennicken
Date prepared: Wednesday, March 27, 2024

Katherine C. Hennicken
CT Consultants, Inc.
1915 North 12th Street
Toledo, Ohio 43604
419-214-5026
khennicken@ctconsultants.com

NO. OF BORINGS: 7

#	Boring ID	Alignment	Station	Offset	Dir	Drill Rig	ER	Boring EL.	Proposed Subgrade EL	Cut Fill
1	B-001-0-22	US 24	12182			CME 75 Truck 844 \04	73	707.4	706.1	1.3 C
2	B-002-0-22	US 24	12597			Geoprobe 7822DT \03	90*	705.8	704.5	1.3 C
3	B-004-0-22	US 24	13011			CME 75 Truck 844 \04	73	705.3	704.0	1.3 C
4	B-006-0-22	Ramp C	60427			CME 75 Truck 844 \04	73	702.5	701.2	1.3 C
5	B-008-0-22	Ramp C	60797			Geoprobe 7822DT \03	90*	701.3	701.0	0.3 C
6	B-009-0-22	Ramp C	61102			CME 550x ATV \08	75	699.2	704.0	4.8 F
7	B-011-0-22	Ramp C	61183			CME 550x ATV \08	75	698.4	705.3	6.9 F

#	Boring	Sample	Sample Depth		Subgrade Depth		Standard Penetration		HP (tsf)	Physical Characteristics						Moisture		Ohio DOT		Sulfate Content (ppm)	Problem		Excavate and Replace (Item 204)		Recommendation (Enter depth in inches)
			From	To	From	To	N_{60}	N_{60L}		LL	PL	PI	% Silt	% Clay	P200	M_C	M_{OPT}	Class	GI		Unsuitable	Unstable	Unsuitable	Unstable	
1	B	SS-1	1.7	4.0	0.4	2.7	2/50/4"									20	16	A-6b	16			Mc			NO UNDERCUT
	001-0	SS-2	4.0	5.0	2.7	3.7	11		>4.5	38	21	17	20	58	78	23	16	A-6b	11	250					
	22	SS-3	5.0	6.0	3.7	4.7	29		4							30	16	A-6b	16						
		SS-4	6.0	7.5	4.7	6.2	30	11	>4.5	39	20	19	21	51	72	18	16	A-6b	11						
2	B	SS-1	1.3	1.5	0.0	0.2	9		3.5							21	16	A-6b	16			N_{60} & Mc		12"	12"
	002-0	SS-2	1.5	3.0	0.2	1.7	27		>4.5	44	22	22	24	58	82	21	19	A-7-6	14	230					204 Geotextile
	22	SS-3	3.0	4.5	1.7	3.2	27		4							21	18	A-7-6	16			Mc			
		SS-4	4.5	6.0	3.2	4.7	24	9	>4.5	39	21	18	26	45	71	20	16	A-6b	10						
3	B	SS-1	1.7	3.0	0.4	1.7	22			43	24	19	20	8	28	25	10	A-2-7	1	230		Mc			NO UNDERCUT
	004-0	SS-2	3.0	4.8	1.7	3.5	18		>4.5	39	22	17	23	19	42	22	17	A-6b	3						
	22	SS-3	4.8	6.0	3.5	4.7	22		4							22	16	A-6b	16						
		SS-4	6.0	7.5	4.7	6.2	29	18	>4.5							17	16	A-6b	16						
4	B	SS-1	0.6	1.5	-0.7	0.2	10		>4.5							12	16	A-6b	16			N_{60}		12"	12"
	006-0	SS-2	1.5	3.0	0.2	1.7	11		>4.5	42	24	18	25	48	73	22	21	A-7-6	11	240		N_{60}		12"	204 Geotextile
	22	SS-3	3.0	4.5	1.7	3.2	11		4.25							22	18	A-7-6	16			N_{60} & Mc			
		SS-4	4.5	6.0	3.2	4.7	17	10	3.25	51	24	27	25	55	80	22	21	A-7-6	17						
5	B	SS-1	1.0	3.5	0.7	3.2	24		>4.5	44	22	22	27	53	80	16	19	A-7-6	14	230					NO UNDERCUT
	008-0	SS-2	3.5	6.0	3.2	5.7	14		3.5	44	21	23	25	49	74	23	18	A-7-6	14						
	22	SS-3	6.0	8.5	5.7	8.2	48		>4.5							16	16	A-6b							
		SS-4	8.5	11.0	8.2	10.7	42	14	>4.5	34	20	14	26	44	70	16	15	A-6a							
6	B	SS-1	0.6	3.5	5.4	8.3	13		4.5	42	22	20	26	55	81	20	19	A-7-6							NO UNDERCUT
	009-0	SS-2	3.5	6.0	8.3	10.8	18		4.5							17	16	A-6b							
	22	SS-3	6.0	9.5	10.8	14.3	55		4.5	32	15	17	25	49	74	15	16	A-6b							
		SS-4	9.5	10.0	14.3	14.8	23	13	4.5							15	16	A-6b							
7	B	SS-1	0.7	3.5	7.6	10.4	10		3	40	19	21	24	68	92	22	16	A-6b							NO UNDERCUT
	011-0	SS-2	3.5	6.0	10.4	12.9	23		4.5	32	12	20	24	52	76	15	16	A-6b							
	22	SS-3	6.0	9.0	12.9	15.9	44		4.5	33	15	18	24	51	75	16	16	A-6b							
		SS-4	9.0	11.0	15.9	17.9	23		4.5							15	14	A-6a							

PID: 117712

County-Route-Section: HEN-24/17D-00.43
No. of Borings: 7

Geotechnical Consultant: CT Consultants, Inc.
Prepared By: Katherine C. Hennicken
Date prepared: 3/27/2024

Chemical Stabilization Options		
320	Rubblize & Roll	Option
206	Cement Stabilization	Option
	Lime Stabilization	Option
206	Depth	12"

Excavate and Replace Stabilization Options	
Global Geotextile Average(N60L): Average(HP):	12" 0"
Global Geogrid Average(N60L): Average(HP):	0" 0"

Design CBR	5

% Samples within 6 feet of subgrade			
$N_{60} \leq 5$	0%	HP ≤ 0.5	0%
$N_{60} < 12$	25%	0.5 < HP ≤ 1	0%
$12 \leq N_{60} < 15$	10%	1 < HP ≤ 2	0%
$N_{60} \geq 20$	50%	HP > 2	40%
M+	25%		
Rock	0%		
Unsuitable	4%		

Excavate and Replace at Surface	
Average	12"
Maximum	12"
Minimum	12"

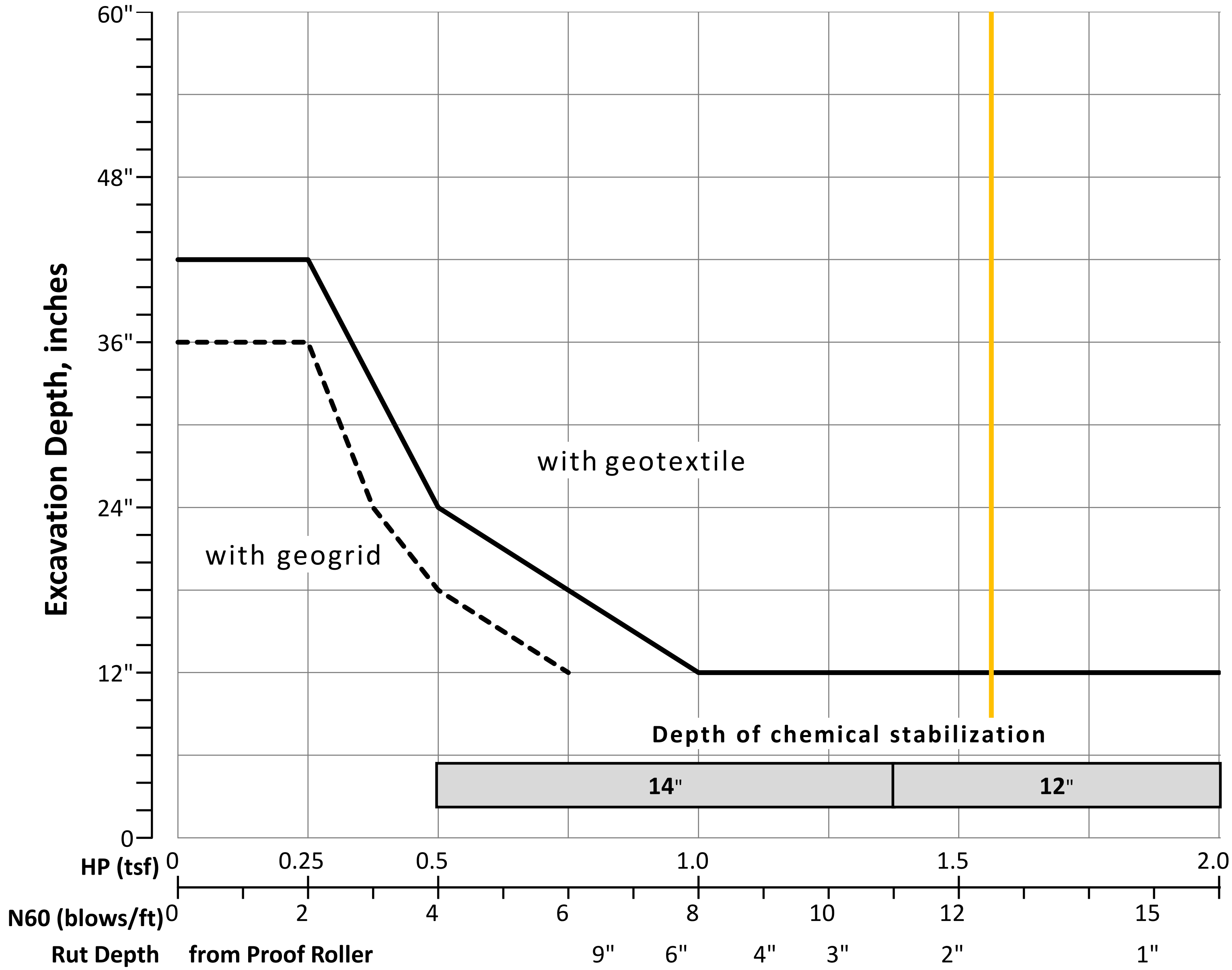
% Proposed Subgrade Surface	
Unstable & Unsuitable	64%
Unstable	64%
Unsuitable	0%

	N_{60}	N_{60L}	HP	LL	PL	PI	Silt	Clay	P 200	M_C	M_{OPT}	GI
Average	23	13	4.07	40	20	20	24	48	72	19	17	13
Maximum	55	18	4.50	51	24	27	27	68	92	30	21	17
Minimum	9	9	3.00	32	12	14	20	8	28	12	10	1

Classification Counts by Sample

ODOT Class	Rock	A-1-a	A-1-b	A-2-4	A-2-5	A-2-6	A-2-7	A-3	A-3a	A-4a	A-4b	A-5	A-6a	A-6b	A-7-5	A-7-6	A-8a	A-8b	Totals
Count	0	0	0	0	0	0	1	0	0	0	0	0	2	17	0	8	0	0	28
Percent	0%	0%	0%	0%	0%	0%	4%	0%	0%	0%	0%	0%	7%	61%	0%	29%	0%	0%	100%
% Rock|Granular|Cohesive	0%	4%									96%								100%
Surface Class Count	0	0	0	0	0	0	1	0	0	0	0	0	0	5	0	5	0	0	11
Surface Class Percent	0%	0%	0%	0%	0%	0%	9%	0%	0%	0%	0%	0%	0%	45%	0%	45%	0%	0%	100%

Fig. 600-1 – Subgrade Stabilization



OVERRIDE TABLE

Calculated Average	New Values	Check to Override
4.07		☐ HP
12.50		☐ N60L

Average HP

Average N_{60L}

OHIO DEPARTMENT OF TRANSPORTATION

OFFICE OF GEOTECHNICAL ENGINEERING

PLAN SUBGRADES
Geotechnical Design Manual Section 600

Instructions: Enter data in the shaded cells only.
(Enter state route number, project description,county, consultant's name, prepared by name, and date prepared. This information will be transferred to all other sheets. The date prepared must be entered in the appropriate cell on this sheet to remove these instructions prior to printing.)

HEN-24/17D-00.43
117712

Proposed Diamond Interchange - Ramp D

CT Consultants, Inc.

Prepared By: Katherine C. Hennicken
Date prepared: Wednesday, March 27, 2024

Katherine C. Hennicken
CT Consultants, Inc.
1915 North 12th Street
Toledo, Ohio 43604
419-214-5026
khennicken@ctconsultants.com

NO. OF BORINGS: 4

#	Boring ID	Alignment	Station	Offset	Dir	Drill Rig	ER	Boring EL.	Proposed Subgrade EL	Cut Fill
1	B-029-0-22	Ramp D	70662			Geoprobe 7822DT \03	90*	699.9	706.1	6.2 F
2	B-032-0-22	Ramp D	71083			CME 75 Truck 844 \04	73	701.3	700.6	0.7 C
3	B-034-0-22	Ramp D	71487			CME 75 Truck 844 \04	73	701.6	700.5	1.1 C
4	B-036-0-22	US 24	16475			CME 75 Truck 844 \04	73	702.3	701.0	1.3 C

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.6 2/11/2022

#	Boring	Sample	Sample Depth		Subgrade Depth		Standard Penetration		HP (tsf)	Physical Characteristics						Moisture		Ohio DOT		Sulfate Content (ppm)	Problem		Excavate and Replace (Item 204)		Recommendation (Enter depth in inches)
			From	To	From	To	N_{60}	N_{60L}		LL	PL	PI	% Silt	% Clay	P200	M_C	M_{OPT}	Class	GI		Unsuitable	Unstable	Unsuitable	Unstable	
1	B	SS-1	0.6	3.5	6.8	9.7	12		4							20	16	A-6b							NO UNDERCUT
	029-0	SS-2	3.5	6.0	9.7	12.2	15		3							19	14	A-6a							
	22	SS-3	6.0	8.5	12.2	14.7	38		4.5	32	19	13	24	58	82	16	14	A-6a							
		SS-4	8.5	11.5	14.7	17.7	33		4.5	30	20	10	36	47	83	16	15	A-4a							
2	B	SS-1	0.4	3.5	-0.3	2.8	15		>4.5							15	16	A-6b	16						NO UNDERCUT
	032-0	SS-2	3.5	6.0	2.8	5.3	21		3.75	41	20	21	25	49	74	19	18	A-7-6	12						
	22	SS-3	6.0	8.5	5.3	7.8	34		>4.5							16	18	A-7-6							
		SS-4	8.5	10.0	7.8	9.3	34	15	>4.5	33	17	16	23	48	71	16	16	A-6b							
3	B	SS-1	0.5	1.5	-0.6	0.4	17			41	22	19	25	42	67	13	19	A-7-6	10	230					12'' 204 Geotextile
	034-0	SS-2	1.5	3.0	0.4	1.9	13		>4.5							22	16	A-6b	16			N_{60} & Mc		12''	
	22	SS-3	3.0	4.5	1.9	3.4	18		>4.5							21	16	A-6b	16			Mc			
		SS-4	4.5	6.0	3.4	4.9	17	13	3.5	44	22	22	23	54	77	22	19	A-7-6	14						
4	B	SS-1	1.7	3.0	0.4	1.7	3/50/5"			NP	NP	NP	20	4	24	21	6	A-1-b	0	<100					NO UNDERCUT
	036-0	SS-2	3.0	4.0	1.7	2.7	13		4.25	45	24	21	26	39	65	26	21	A-7-6	11			N_{60} & Mc			
	22	SS-3	4.5	5.0	3.2	3.7	22		>4.5							23	16	A-6b	16						
		SS-4	5.0	7.5	3.7	6.2	29	13	>4.5							22	16	A-6b	16						

PID: 117712

County-Route-Section: HEN-24/17D-00.43
No. of Borings: 4

Geotechnical Consultant: CT Consultants, Inc.
Prepared By: Katherine C. Hennicken
Date prepared: 3/27/2024

Chemical Stabilization Options		
320	Rubblize & Roll	Option
206	Cement Stabilization	Option
	Lime Stabilization	Option
206	Depth	12"

Excavate and Replace Stabilization Options	
Global Geotextile	
Average(N60L):	12"
Average(HP):	0"
Global Geogrid	
Average(N60L):	0"
Average(HP):	0"

Design CBR	5

% Samples within 6 feet of subgrade			
$N_{60} \leq 5$	0%	$HP \leq 0.5$	0%
$N_{60} < 12$	0%	$0.5 < HP \leq 1$	0%
$12 \leq N_{60} < 15$	18%	$1 < HP \leq 2$	0%
$N_{60} \geq 20$	36%	$HP > 2$	27%
M+	27%		
Rock	0%		
Unsuitable	0%		

Excavate and Replace at Surface	
Average	12"
Maximum	12"
Minimum	12"

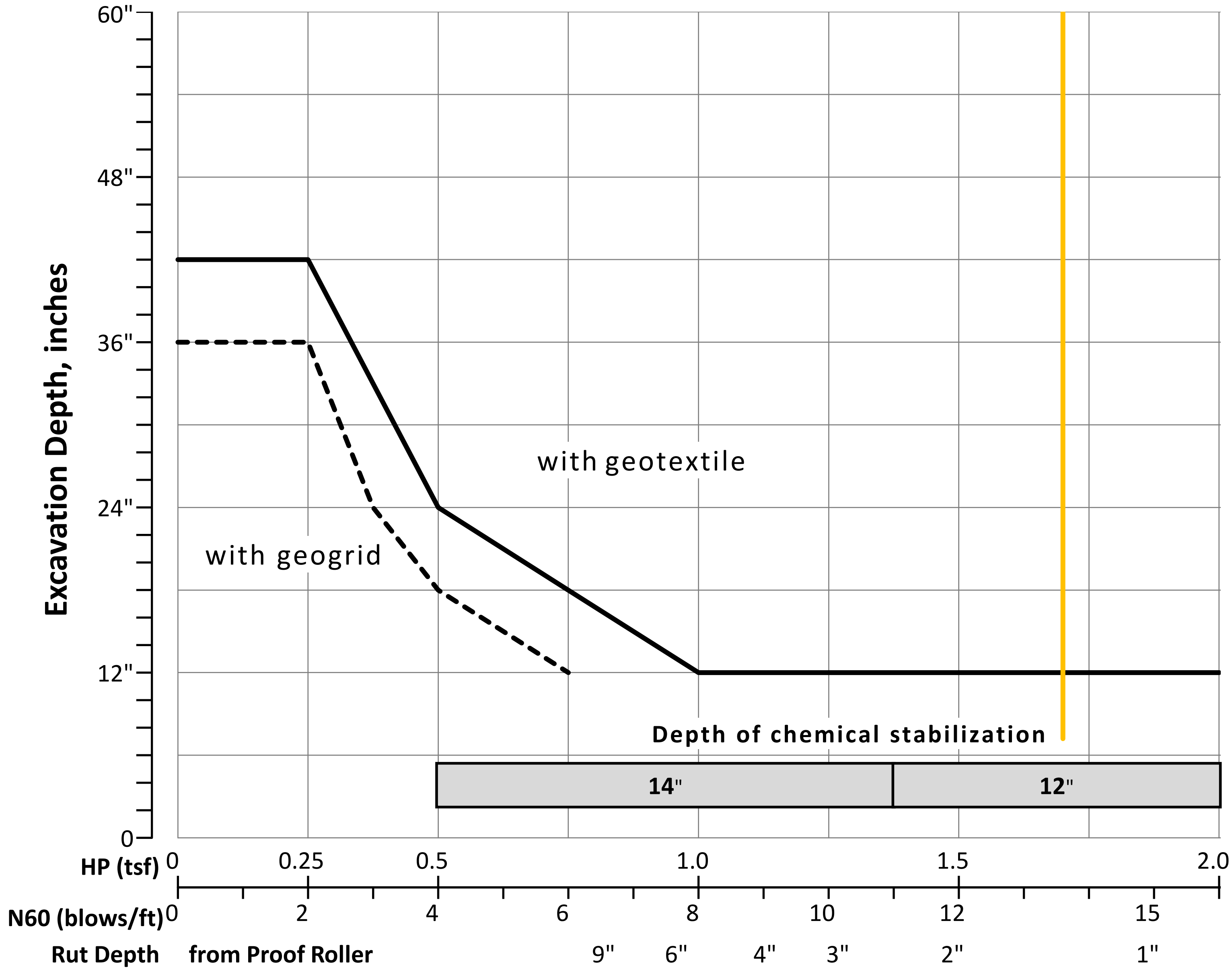
% Proposed Subgrade Surface	
Unstable & Unsuitable	43%
Unstable	43%
Unsuitable	0%

	N_{60}	N_{60L}	HP	LL	PL	PI	Silt	Clay	P 200	M_C	M_{OPT}	GI
Average	22	14	3.93	38	21	17	25	43	68	19	16	13
Maximum	38	15	4.50	45	24	22	36	58	83	26	21	16
Minimum	12	13	3.00	30	17	10	20	4	24	13	6	0

Classification Counts by Sample

ODOT Class	Rock	A-1-a	A-1-b	A-2-4	A-2-5	A-2-6	A-2-7	A-3	A-3a	A-4a	A-4b	A-5	A-6a	A-6b	A-7-5	A-7-6	A-8a	A-8b	Totals
Count	0	0	1	0	0	0	0	0	0	1	0	0	2	7	0	5	0	0	16
Percent	0%	0%	6%	0%	0%	0%	0%	0%	0%	6%	0%	0%	13%	44%	0%	31%	0%	0%	100%
% Rock|Granular|Cohesive	0%	13%									88%								100%
Surface Class Count	0	0	1	0	0	0	0	0	0	0	0	0	0	3	0	3	0	0	7
Surface Class Percent	0%	0%	14%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	43%	0%	43%	0%	0%	100%

Fig. 600-1 – Subgrade Stabilization



OVERRIDE TABLE

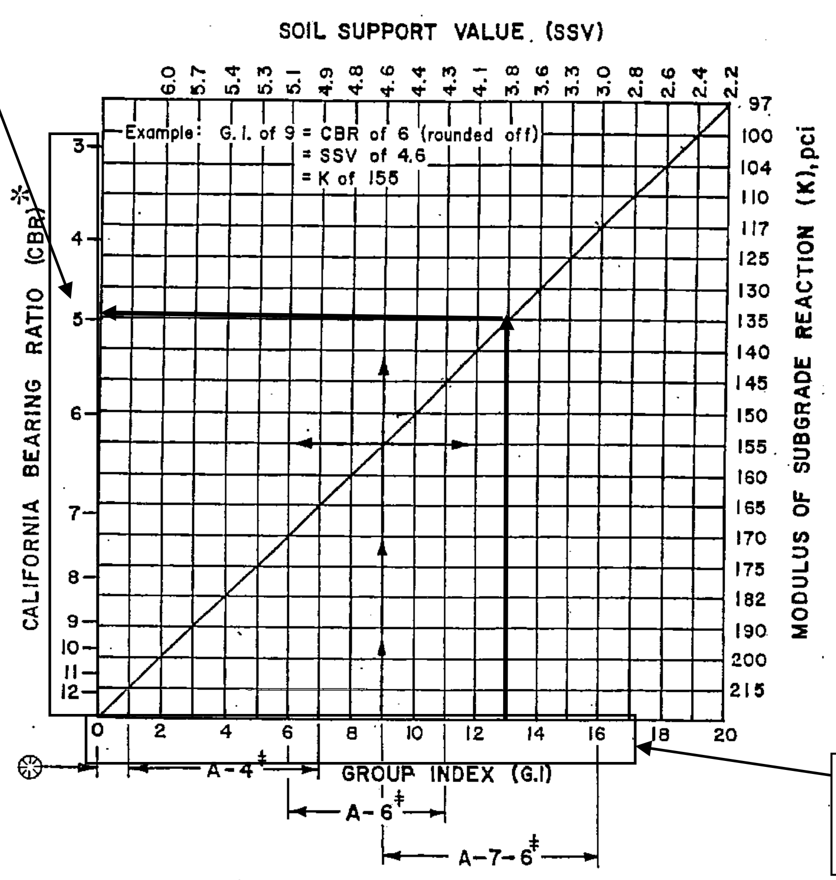
Calculated Average	New Values	Check to Override
3.93		☐ HP
13.67		☐ N60L

Average HP

Average N_{60L}

Range of GI from 0 to 17 for pavement subgrade samples corresponds to CBR values ranging from 3 to 12 percent. Average GI of 13 corresponds with CBR of 5 percent.

Fig.1301-3
Feb.1978



Range of GI for pavement subgrade samples: 0 to 17 for A-1-b, A-2-7, A-3a, A-4a, A-6a, A-6b, A-7-6 soils. Average GI was 13.

⊛ AASHTO Classes A-1, A-2 & A-3 lie below 0. SSV=6-10; K=200+.

‡ Usual range of AASHTO Classes.

✳ 5-1/2 Lb. hammer, 12" drop, 4 layers, 45 blows per layer, compacted at optimum moisture as determined by AASHTO T-99.

CORRELATION CHART FOR SUBGRADE STRENGTHS

Based on the subgrade analysis, a design CBR value of 5 percent was determined for each of the segments of the project. It should be noted that the CBR determination by the subgrade analysis spreadsheet is based on the **average** Group Index of all the evaluated samples, which was 13. Group indices for the tested samples ranged from 0 to 17, which would correlate with a CBR value of 3 to 12 percent. Based on the average design value calculations from the subgrade analysis spreadsheet, it does not appear to be unconservative to use the spreadsheet design CBR value of 5 percent for new pavement sections throughout the project area.

Appendix G
Geotechnical Engineering Design Checklists

I. Geotechnical Design Checklists	
Project: HEN-24/17D-00.43	**PDP Path:**
PID: 117712	**Review Stage:**

Checklist	Included in This Submission
II. Reconnaissance and Planning	✓
III. A. Centerline Cuts	
III. B. Embankments	✓
III. C. Subgrade	✓
IV. A. Foundations of Structures	✓
IV. B. Retaining Wall	✓
V. A. Landslide Remediation	
V. B. Rockfall Remediation	
V. C. Wetland or Peat Remediation	
V. D. Underground Mine Remediation	
V. E. Surface Mine Remediation	
V. F. Karst Remediation	
VI. A. Geotechnical Profile	
VI. D. Geotechnical Reports	✓

II. Reconnaissance and Planning Checklist

C-R-S: HEN-24/17D-00.43	PID: 117712	Reviewer: KCH	Date: 3/27/2024

		(Y/N/X)	Notes:
Reconnaissance		(Y/N/X)	Notes:
1	Based on Section 302.1 in the SGE, have the necessary plans been developed in the following areas prior to the commencement of the subsurface exploration reconnaissance:	Y	
	Roadway plans	✓	
	Structures plans	✓	
	Geohazards plans		
2	Have the resources listed in Section 302.2.1 of the SGE been reviewed as part of the office reconnaissance?	Y	
3	Have all the features listed in Section 302.3 of the SGE been observed and evaluated during the field reconnaissance?	Y	
4	If notable features were discovered in the field reconnaissance, were the GPS coordinates of these features recorded?	X	
Planning - General		(Y/N/X)	Notes:
5	In planning the geotechnical exploration program for the project, have the specific geologic conditions, the proposed work, and historic subsurface exploration work been considered?	Y	
6	Has the ODOT Transportation Information Mapping System (TIMS) been accessed to find all available historic boring information and inventoried geohazards?	Y	
7	Have the borings been located to develop the maximum subsurface information while using a minimum number of borings, utilizing historic geotechnical explorations to the fullest extent possible?	Y	
8	Have the topography, geologic origin of materials, surface manifestation of soil conditions, and any other special design considerations been utilized in determining the spacing and depth of borings?	Y	
9	Have the borings been located so as to provide adequate overhead clearance for the equipment, clearance of underground utilities, minimize damage to private property, and minimize disruption of traffic, without compromising the quality of the exploration?	Y	

II. Reconnaissance and Planning Checklist

Planning - General		(Y/N/X)	Notes:
10	Have the scaled boring plans, showing all project and historic borings, and a schedule of borings in tabular format, been submitted to the District Geotechnical Engineer?	Y	
	The schedule of borings should present the following information for each boring:		
a.	exploration identification number	Y	
b.	location by station and offset	N	
c.	estimated amount of rock and soil, including the total for each for the entire program.	Y	
Planning – Exploration Number		(Y/N/X)	Notes:
11	Have the coordinates, stations and offsets of all explorations (borings, soundings, test pits, etc.) been identified?	Y	
12	Has each exploration been assigned a unique identification number, in the following format X-ZZZ-W-YY, as per Section 303.2 of the SGE?	Y	
13	When referring to historic explorations that did not use the identification scheme in 12 above, have the historic explorations been assigned identification numbers according to Section 303.2 of the SGE?	Y	

II. Reconnaissance and Planning Checklist

Planning – Boring Types		(Y/N/X)	Notes:
14	Based on Sections 303.3 to 303.7.6 of the SGE, have the location, depth, and sampling requirements for the following boring types been determined for the project?	Y	
	Check all boring types utilized for this project:		
	Existing Subgrades (Type A)	✓	
	Roadway Borings (Type B)	✓	
	Embankment Foundations (Type B1)	✓	
	Cut Sections (Type B2)		
	Sidehill Cut Sections (Type B3)		
	Sidehill Cut-Fill Sections (Type B4)		
	Sidehill Fill Sections on Unstable Slopes (Type B5)		
	Geohazard Borings (Type C)		
	Lakes, Ponds, and Low-Lying Areas (Type C1)		
	Peat Deposits, Compressible Soils, and Low Strength Soils (Type C2)		
	Uncontrolled Fills, Waste Pits, and Reclaimed Surface Mines (Type C3)		
	Underground Mines (C4)		
	Landslides (Type C5)		
	Rock Slope (Type C6)		
	Karst (Type C7)		
	Proposed Underground Utilities (Type D)		
	Structure Borings (Type E)		
	Bridges (Type E1)	✓	
	Culverts (Type E2 a,b,c)	✓	
	Retaining Walls (Type E3 a and b)	✓	
	Noise Barrier (Type E4)		
	CCTV & High Mast Lighting Towers (Type E5)		
	Buildings and Salt Domes (Type E6)		

III.B. Embankments Checklist

C-R-S: HEN-24/17D-00.43	PID: 117712	Reviewer: KCH	Date: 3/27/2024

Use this checklist in conjunction with the Embankment Design Guidance in GDM Section 500
If you do not have an embankment on the project, you do not have to fill out this checklist.

Settlement		(Y/N/X)	Notes:
1	If soil conditions and project requirements warrant, have settlement issues been addressed? If not applicable (X), go to Question 14	Y	
2	Have consolidation properties of the foundation soils been determined?	Y	
	Check methods used:		
	laboratory consolidation tests	✓	
	empirical correlations with moisture content and Atterberg values	✓	
	other (describe other methods)		
3	Have calculations been performed to estimate the total expected embankment settlement and the time of consolidation? Indicate method used.	Y	Hand calculations
4	If differing foundation soil and/or loading conditions occur throughout the embankment area, have sufficient analyses been completed to evaluate consolidation at locations representative of the most critical conditions?	Y	
5	Have the total settlement and the time of consolidation analyses indicated acceptable values at all locations for the scope of the embankment work?	Y	
6	If total settlement or time of consolidation is unacceptable, have the stations and lateral extent of the problem areas been defined?	X	
7	Has a method been chosen as a solution to the settlement issues?	N	
	Check the method(s) used:		
	waiting periods with monitoring	✓	
	drainage blanket and wick drains	✓	
	surcharge (preloading)	✓	
	removal and replacement of weak soil		
	lowering proposed grade / change alignment		
	lightweight fill		
	other (describe other methods)		

III.B. Embankments Checklist

Settlement		(Y/N/X)	Notes:
8	Based on accepted design practices, and where applicable, adhering to published guidelines and design recommendations from FHWA, have calculations been performed to evaluate the effectiveness of the chosen solution(s)?	Y	
9	Has an economic analysis been performed to evaluate the cost benefits of the recommended solution compared to others?	N	
10	Have all necessary notes, specifications, and details for the chosen solution been determined?	N	
11	Have the need, locations, type, plan notes, and reading schedule for settlement platforms or cells been determined?	N	
12	Have the effects of the predicted settlement and the chosen solution been determined and accounted for on the construction schedule?	N	
13	Has the effect of any foundation soil consolidation (including differential settlement) been evaluated with regard to adjacent structures (e.g., bridges, buildings, culverts, utilities) which will also undergo settlement and be subject to stresses induced by the consolidation of the surrounding soil?	N	
Stability		(Y/N/X)	Notes:
14	If soil conditions and project requirements warrant, have stability issues been addressed? If not applicable (X), go to Question 29	X	
15	Has the total (short term) and effective (long term) shear strength of the foundation soils been determined?		
	Check method used:		
	laboratory shear tests		
	estimation from SPT or field tests		
16	Have the values of shear strength for proposed embankment fill material, as determined from GDM Section 500, been used in the stability analyses?		

III.B. Embankments Checklist

Stability		(Y/N/X)	Notes:
17	Have calculations been performed to determine the F.S. for stability? Indicate which program and which analysis method (Spencer, Bishop, etc) was used.		
18	Have the following F.S. been met or exceeded, as determined by the calculations, for the given stability conditions:		
a.	1.30 for short term (undrained) condition		
b.	1.30 for long term (drained) condition		
c.	1.10 for rapid drawdown, flood condition		
d.	1.50 for embankment containing or supporting a structural element		
19	When differing soil or loading conditions occur throughout the embankment area, have sufficient analyses been completed to evaluate the stability at locations representative of the most critical conditions?		
20	If the F.S. was not met or exceeded, have the stations and lateral extent of the problem areas been defined?		
21	Has a method been chosen as a solution to the stability issues?		
	Check the method(s) used:		
	flattening slopes		
	counterberm		
	lightweight embankment		
	reinforced soil slope		
	soil nailing		
	drainage blanket and wick drains		
	removal of soft soil, adding shear key		
	reduced grade / change alignment		
	staged construction		
	controlled rate of fill placement		
	drilled shaft slope stabilization		
	other (describe other methods)		
22	Based on accepted design practices, and where applicable, adhering to published guidelines and design recommendations from FHWA, have calculations been performed to evaluate the effectiveness of the chosen solution(s)?		
23	Has an economic analysis been performed to evaluate the cost benefits of the recommended solution compared to others?		

III.B. Embankments Checklist

Stability		(Y/N/X)	Notes:
24	Have all necessary notes, specifications, and details for the chosen solution been determined?		
25	Have the need, location, type, plan notes, and reading schedule for piezometers and inclinometers been determined?		
26	If piezometers will be used, has the critical pressure value been determined and the appropriate information included in the plans?		
27	Have the effects of the stability solution been determined and accounted for on the construction schedule?		
28	Has the effect of the stability solution been evaluated with regard to structures (e.g., bridges, buildings, culverts, utilities) which may be subject to unusual stresses or require special construction considerations?		
Sidehill Fills		(Y/N/X)	Notes:
29	If soil conditions and project requirements warrant, have sidehill fill issues been addressed? If not applicable (X), go to Question 34	Y	
30	In accordance with GDM Section 800, have sidehill fills been evaluated to determine if special benching or shear keys are needed?	Y	
31	In accordance with GDM Section 800, if special benching or shear keys are required,		
a.	has Plan Note G109 from L&D3 been included in the General Notes?	X	Plans to be prepared by others
b.	have quantities for both excavation and embankment been calculated for the benched areas and added to the plan General Quantities?	X	Plans to be prepared by others
c.	have the special benching or shear keys been indicated on the appropriate cross sections?	X	Plans to be prepared by others
32	Have water bearing zones been identified and their impact addressed?	X	
33	Have subsurface drainage controls been adequately addressed?	X	

III.B. Embankments Checklist

Special		(Y/N/X)	Notes:
34	Have all of the environmental factors, including wetlands, stream mitigation, and landfills, been considered and incorporated prior to design and analysis of embankment settlement and stability, including EPA or other government agencies' involvement, mitigation, or special design or construction considerations?	X	
35	If an embankment is to be placed through standing water or over weak, wet soils (with or without a fabric separator), the fill should be placed by the method of end dumping to a given height above the standing water or until compaction is achievable over the soft soil. If end dumping is to be specified,	X	
a.	has the material type for the fill to be end dumped been specified?		
b.	has the need for a fabric separator or filter layer been determined?		
c.	has the height of fill to be end dumped been determined?		
d.	have all notes and specifications for end dumping been developed?		

IV.B. Retaining Wall Checklist

C-R-S:	HEN-24/17D-00.43	PID:	117712	Reviewer:	KCH	Date:	3/27/2024

If you do not have a retaining wall on the project, you do not have to fill out this checklist.

Soil Data and Preliminary Calculations		(Y/N/X)	Notes:
1	Has a justification study been performed to determine the necessity of a wall as opposed to ROW purchase or other project alternatives?	X	
2	Have the necessary soil strength parameters and unit weights been determined?	Y	
	Check method used:		
	laboratory shear tests	✓	
	estimation from SPT or field tests	✓	
3	Has the groundwater elevation been determined?	Y	
4	Have the proper loading conditions been determined?	Y	
a.	If yes, check which loading conditions apply:		
	Backfill (Active Earth Pressure Loading):	✓	
	Backfill (Apparent Earth Pressure (AEP) Loading for Ground Anchors):		
	Backfill (At-Rest Earth Pressure Loading):	✓	
	Backfill (Flat, No Slope):	✓	
	Backfill (Infinite Slope):		
	Backfill (Broken Back Slope):		
	Earth Surcharge:	✓	
	Live Load Surcharge:	✓	
	Other (describe):		
5	Have the correct Load Factors, Load Combinations, and Limit States been considered, per AASHTO LRFD 9th Ed. Articles 3.4.1, 10.5, and 11.5?	Y	
6	Are earth pressure loads inclined at the soil-structure interaction friction angle, δ and has δ been determined per BDM 307.1.1?	Y	
7	Have the correct Resistance Factors been considered, per AASHTO LRFD 9th Ed. Articles 10.5 and 11.5?	Y	
8	If applicable, has the influence of groundwater been taken into account with regards to soil unit weights and active pressures?	X	
9	Has the Coulomb method been utilized to determine the lateral earth pressure?	Y	

IV.B. Retaining Wall Checklist

Design		(Y/N/X)	Notes:
10	For preliminary wall design, have the design criteria and wall type selection process been followed as instructed in BDM 201.1.2.5?	Y	
11	Was an economic analysis performed to evaluate the cost benefits of the chosen wall type compared to others?	X	
12	Were representative sections analyzed for the entire length of the retaining wall for the following:		
a.	bearing resistance?	Y	
b.	sliding resistance?	Y	
c.	limiting eccentricity and overturning resistance? Analyze moment equilibrium about toe for non-gravity cantilever walls.	Y	
d.	total and differential settlement?	Y	
e.	overall (global) stability?	Y	
13	If poor foundation soils are present, has a solution been determined with respect to the following:		
a.	excessive settlement?	Y	
b.	inadequate bearing resistance?	X	
c.	inadequate sliding resistance?	X	
d.	overall (global) instability?	X	
14	For non-proprietary walls, each wall type has design recommendations which need to be determined. For the wall type being evaluated, have the following design recommendations been determined by accepted design methods or, where applicable, FHWA design guidelines:		
a.	Rigid Gravity and Semigravity -- footing width and elevation, maximum factored Service and Strength Limit State bearing pressures, factored bearing resistance (BDM 307.1.5 & 307.2)	X	
b.	Drilled Shafts - diameter, spacing, embedment, arrangement and percent reinforcement, maximum moment and lateral shear, maximum deflection (see BDM 307.6)	X	
c.	Soldier Pile -pile size and type, drilled hole diameter, embedment, spacing, lagging design, facing, maximum moment and lateral shear, section modulus, maximum deflection	X	

IV.B. Retaining Wall Checklist

Design		(Y/N/X)	Notes:
d.	Sheet Pile - pile size, embedment, maximum moment and lateral shear, section modulus, maximum deflection (BDM 307.7.1)	X	
e.	Cellular - type, maximum factored Service and Strength Limit State bearing pressures, factored bearing resistance, fill material (BDM 307.7.2)	X	
f.	Soil Anchor - load per anchor, number of rows, wale design, anchor inclination and minimum length, type of anchor, pile size, type, spacing, and embedment, maximum moment and lateral shear, section modulus, lagging design, facing (BDM 307.8)	X	
g.	Soil Nail - nail size, spacing, inclination, and length, loading per nail, facing (BDM 307.9)	X	
15	Has the need for load testing of the retaining wall elements been evaluated?	X	
a.	If needed, have details and plan notes for load testing been included in the plans?		
16	Proprietary wall designs require a special process for detail design, as outlined in BDM 307.3 and 307.4. Has this procedure been followed for this project?	Y	
17	Temporary walls - have the same design requirements as permanent walls of the same type been followed, except the design service life is no more than three years (BDM 307.10)?	X	
18	The presence and quality of water behind the wall structure and in the backfill can be a major source of overloading and failure.		
a.	Has the quality / chemistry of the groundwater been accounted for in the drainage system?	X	
b.	Has an adequate drainage system been included in the detail wall design?	X	
c.	If there is a water source behind the wall, has additional drainage been added to control the effect of this water source on the wall?	X	
19	Have the effects of the wall design and construction procedure been determined and accounted for on the construction schedule?	X	

IV.B. Retaining Wall Checklist

Design		(Y/N/X)	Notes:
20	Has the effect of the wall design and construction been evaluated with regard to structures (e.g., bridges, culverts, buildings, utilities), which may be subject to unusual stresses or require special design or construction considerations?	Y	
Plans and Contract Documents		(Y/N/X)	Notes:
21	Have all the necessary notes, specifications, special provisions, and details for the construction of the wall system been included in the plans?	X	Plans to be prepared by others
22	Have the need, location, type, plan notes, and reading schedule for any instrumentation been determined and included in the plans?	Y	
	Check the types of instrumentation specified:		
	settlement cells		
	settlement platforms	✓	
	inclinometers		
	monitoring wells / piezometers	✓	
	load cells		
	strain gages		
	other (describe other types)		

III.C. Subgrade Checklist

C-R-S: HEN-24/17D-00.43	PID: 117712	Reviewer: KCH	Date: 3/27/2024

Use this Checklist in conjunction with the Subgrade design guidance in GDM Section 600
If you do not have any subgrade work on the project, you do not have to fill out this checklist.

Subgrade		(Y/N/X)	Notes:
1	Has the subsurface exploration adequately characterized the soil or rock according to GDM Section 600?	Y	
a.	Has each sample been visually classified and inspected for the presence of gypsum? Has a moisture content been performed on each sample?	Y	
b.	Has mechanical classification (Plastic Limit (PL), Liquid Limit (LL), and gradation testing) been done on at least two samples from each boring within six feet of the proposed subgrade?	Y	
c.	Has the sulfate content of at least one sample from each boring within 3 feet of the proposed subgrade been determined, per Supplement 1122, Determining Sulfate Content in Soils?	Y	
d.	Has the sulfate content of all samples that exhibit gypsum crystals been determined?	X	
e.	Have A-2-5, A-4b, A-5, A-7-5, A-8a, or A-8b soils within the top 3 feet of the proposed subgrade been mechanically classified?	X	
2	If soils classified as A-2-5, A-4b, A-5, A-7-5, A-8a, or A-8b, or having a LL>65, are present at the proposed subgrade (geotechnical profile), do the plans specify that these materials need to be removed and replaced or chemically stabilized?	X	
a.	If these materials are to be removed and replaced, have the station limits, depth, and lateral limits for the planned removal been provided?	X	
3	If there is any rock, shale, or coal present at the proposed subgrade (C&MS 204.05), do the plans specify the removal of the material?	X	
a.	If removal of any rock, shale, or coal is required, have the station limits, depth, and lateral limits for the planned removal of the material at proposed subgrade been provided?	X	

III.C. Subgrade Checklist

Subgrade		(Y/N/X)	Notes:
4	In accordance with GDM Section 600, do the SPT (N_{60})/HP values and existing moisture contents for the proposed subgrade soils indicate the need for subgrade stabilization?	N	
a.	If removal and replacement is applicable, has the detail of subgrade removal been shown on the plans, including depth of removal, station limits, lateral extent, replacement material, and plan notes (Item 204 - Subgrade Compaction and Proof Rolling)?	X	
b.	If chemical stabilization is applicable, has the detail of this treatment been shown on the plans, including depth, percentage of chemical, station limits, lateral extent, and plan notes?	X	
	Indicate type of chemcial stabilization specified:		
	cement stabilization	✓	
	lime stabilization	✓	
5	If removal and replacement has been specified, do the plans include Plan Note G121 from L&D3?	X	Plans to be prepared by others
6	If drainage or groundwater is an issue with the proposed subgrade, has an appropriate drainage system (e.g., pipe, underdrains) been provided?	X	
7	Has an appropriate quantity of Proof Rolling (C&MS 204.06) and has Plan Note G111 from L&D3 been included in the plans?	X	Plans to be prepared by others
8	Has a design CBR value been provided?	Y	

IV.A Foundations of Structures Checklist

C-R-S: HEN-24/17D-00.43	PID: 117712	Reviewer: KCH	Date: 3/27/2024

Use this Checklist in conjunction with the bridge foundation design guidance in GDM Section 1300
If you do not have such a foundation or structure on the project, you do not have to fill out this checklist.

	Soil and Bedrock Strength Data	(Y/N/X)	Notes:
1	Has the shear strength of the foundation soils been determined?	Y	
	Check method used:		
	laboratory shear tests	✓	
	estimation from SPT or field tests	✓	
2	Have sufficient soil shear strength, consolidation, and other parameters been determined so that the required allowable loads for the foundation/structure can be designed?	Y	
3	Has the shear strength of the foundation bedrock been determined?	X	
	Check method used:		
	laboratory shear tests		
	other (describe other methods)		
	Spread Footings	(Y/N/X)	Notes:
4	Are there spread footings on the project? If no, go to Question 11	N	
5	Have the recommended bottom of footing elevation and reason for this recommendation been provided?		
a.	Has the recommended bottom of footing elevation taken scour from streams or other water flow into account?		
6	Were representative sections analyzed for the entire length of the structure for the following:		
a.	factored bearing resistance?		
b.	factored sliding resistance?		
c.	eccentric load limitations (overturning)?		
d.	predicted settlement?		
e.	overall (global) stability?		
7	Has the need for a shear key been evaluated?		
a.	If needed, have the details been included in the plans?		
8	If special conditions exist (e.g. geometry, sloping rock, varying soil conditions), was the bottom of footing “stepped” to accommodate them?		
9	Have the Service I and Maximum Strength Limit States for bearing pressure on soil or rock been provided?		

IV.A Foundations of Structures Checklist

Spread Footings		(Y/N/X)	Notes:
10	If weak soil is present at the proposed foundation level, has the removal / treatment of this soil been developed and included in the plans?		
a.	Have the procedure and quantities related to this removal / treatment been included in the plans?		
Pile Structures		(Y/N/X)	Notes:
11	Are there piles on the project? If no, go to Question 17	Y	
12	Has an appropriate pile type been selected?		
	Check the type selected:		
	H-pile (driven)	✓	
	H-pile (prebored)		
	Cast In-place Reinforced Concrete Pipe		
	Micropile		
	Continuous Flight Auger (CFA)		
	other (describe other types)		
13	Have the estimated pile length or tip elevation and section (diameter) based on either the Ultimate Bearing Value (UBV) or the depth to top of bedrock been specified? Indicate method used.	Y	
14	If scour is predicted, has pile resistance in the scour zone been neglected?	X	
15	Has a wave equation drivability analysis been performed as per BDM 305.3.1.2 to determine whether the pile can be driven to either the UBV, the pile tip elevation, or refusal on bedrock without overstressing the pile?	Y	
16	If required for design, have sufficient soil parameters been provided and calculations performed to evaluate the:	Y	
a.	Nominal unit tip resistance and maximum settlement of the piles?	Y	
b.	Nominal unit side resistance for each contributing soil layer and maximum deflection of the piles?	X	
c.	Downdrag load on piles driven through new embankment or compressible soil layers, as per BDM 305.3.2.2?	X	
d.	Potential for and impact of lateral squeeze from soft foundation soils?	X	

IV.A Foundations of Structures Checklist

Pile Structures		(Y/N/X)	Notes:
17	If piles are to be driven to strong bedrock (Q_u >7.5 ksi) or through very dense granular soils or overburden containing boulders, have "pile points" been recommended in order to protect the tips of the steel piling, as per BDM 305.3.5.6?	X	
18	If subsurface obstacles exist, has preboring been recommended to avoid these obstructions?	X	
19	If piles will be driven through 15 feet or more of new embankment, has preboring been specified as per BDM 305.3.5.7?	X	

IV.A Foundations of Structures Checklist

Drilled Shafts		(Y/N/X)	Notes:
20	Are there drilled shafts on the project? If no, go to the next checklist.	N	
21	Have the drilled shaft diameter and embedment length been specified?		
22	Have the recommended drilled shaft diameter and embedment been developed based on the nominal unit side resistance and nominal unit tip resistance for vertical loading situations?		
23	For shafts undergoing lateral loading, have the following been determined:		
a.	total factored lateral shear?		
b.	total factored bending moment?		
c.	maximum deflection?		
d.	reinforcement design?		
24	If a bedrock socket is required, has a minimum rock socket length equal to 1.5 times the rock socket diameter been used, as per BDM 305.4.2?		
25	Generally, bedrock sockets are 6" smaller in diameter than the soil embedment section of the drilled shaft. Has this factor been accounted for in the drilled shaft design?		
26	If scour is predicted, has shaft resistance in the scour zone been neglected?		
27	Has the site been assessed for groundwater influence?		
a.	If yes, and if artesian flow is a potential concern, does the design address control of groundwater flow during construction?		
28	Have all the proper items been included in the plans for integrity testing?		
29	If special construction features (e.g., slurry, casing, load tests) are required, have all the proper items been included in the plans?		
30	If necessary, have wet construction methods been specified?		
General		(Y/N/X)	Notes:
31	Has the need for load testing of the foundations been evaluated?	Y	
a.	If needed, have details and plan notes for load testing been included in the plans?	X	

VI.B. Geotechnical Reports

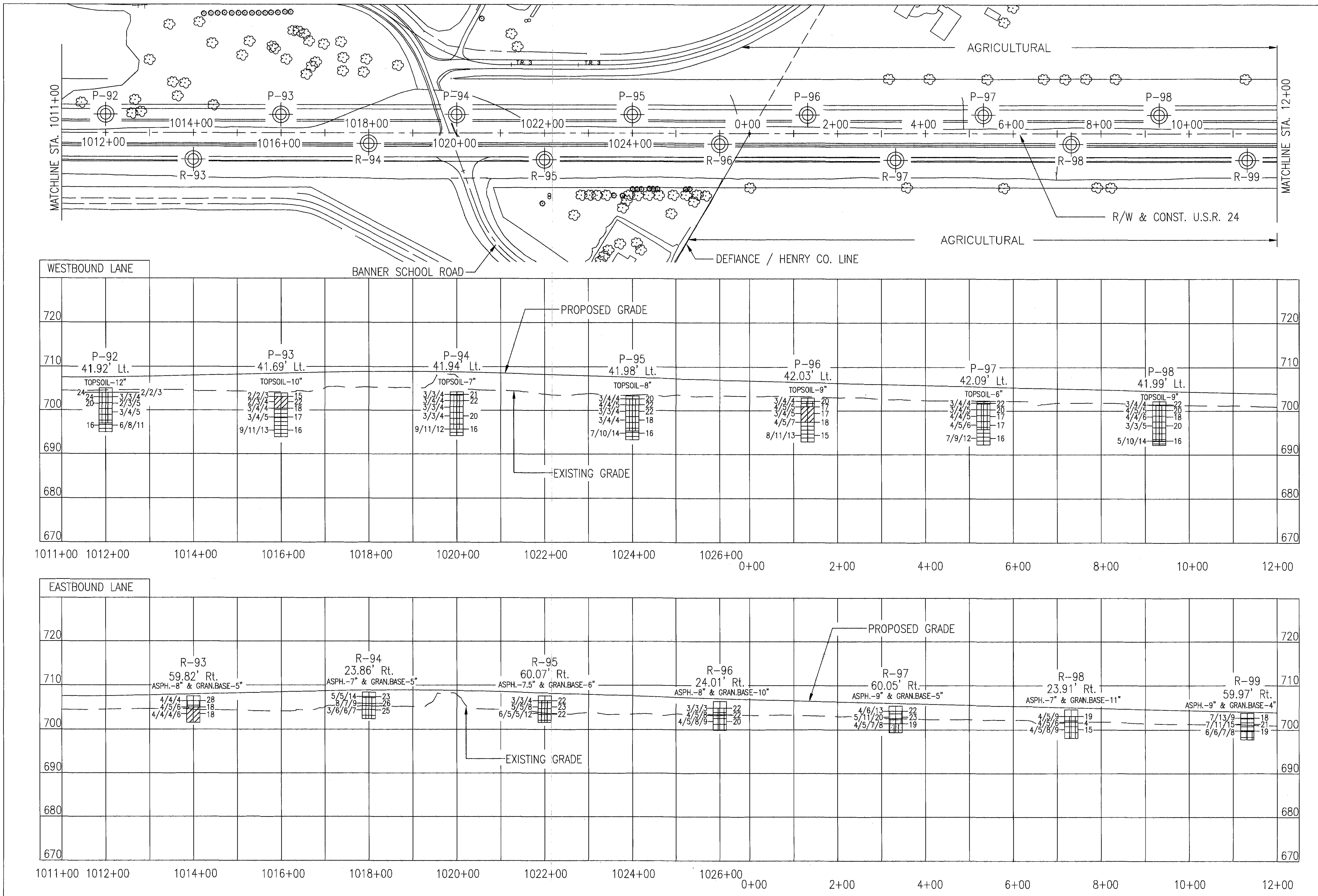
C-R-S: HEN-24/17D-00.43	PID: 117712	Reviewer: KCH	Date: 3/27/2024

General	(Y/N/X)	Notes:
1 Has an electronic copy of all geotechnical submissions been provided to the District Geotechnical Engineer (DGE)?	Y	
2 Has the first complete version of a geotechnical report being submitted been labeled as ‘Draft’?	Y	
3 Subsequent to ODOT’s review and approval, has the complete version of the revised geotechnical report being submitted been labeled ‘Final’?	Y	This is the Final Version of the report.
4 Has the boring data been submitted in a native format that is DIGGS (Data Interchange for Geotechnical and Geoenvironmental) compatable? gINT files meet this demand?	Y	
5 Does the report cover format follow ODOT's Brand and Identity Guidelines Report Standards found at http://www.dot.state.oh.us/brand/Pages/default.aspx ?	Y	
6 Have all geotechnical reports being submitted been titled correctly as prescribed in Section 706.1 of the SGE?	Y	
Report Body	(Y/N/X)	Notes:
7 Do all geotechnical reports being submitted contain the following:		
a. an Executive Summary as described in Section 706.2 of the SGE?	Y	
b. an Introduction as described in Section 706.3 of the SGE?	Y	
c. a section titled "Geology and Observations of the Project," as described in Section 706.4 of the SGE?	Y	
d. a section titled "Exploration," as described in Section 706.5 of the SGE?	Y	
e. a section titled "Findings," as described in Section 706.6 of the SGE?	Y	
f. a section titled "Analyses and Recommendations," as described in Section 706.7 of the SGE?	Y	
Appendices	(Y/N/X)	Notes:
8 Do all geotechnical reports being submitted contain all applicable Appendices as described in Section 706.8 of the SGE?	Y	
9 Do the Appendices present a site Boring Plan showing all boring locations as described in Section 706.8.1 of the SGE?	Y	

VI.B. Geotechnical Reports

Appendices		(Y/N/X)	Notes:
10	Do the Appendices include boring logs and color pictures of rock, if applicable, as described in Section 706.8.2 of the SGE?	Y	
11	Do the Appendices include reports of undisturbed test data as described in Section 706.8.3 of the SGE?	Y	
12	Do the Appendices include calculations in a logical format to support recommendations as described in Section 706.8.4 of the SGE?	Y	

Appendix H
Historic Borings



HORIZONTAL SCALE IN FEET 0 100 150 200

CALCULATED | CHECKED

DATE 02/21/04

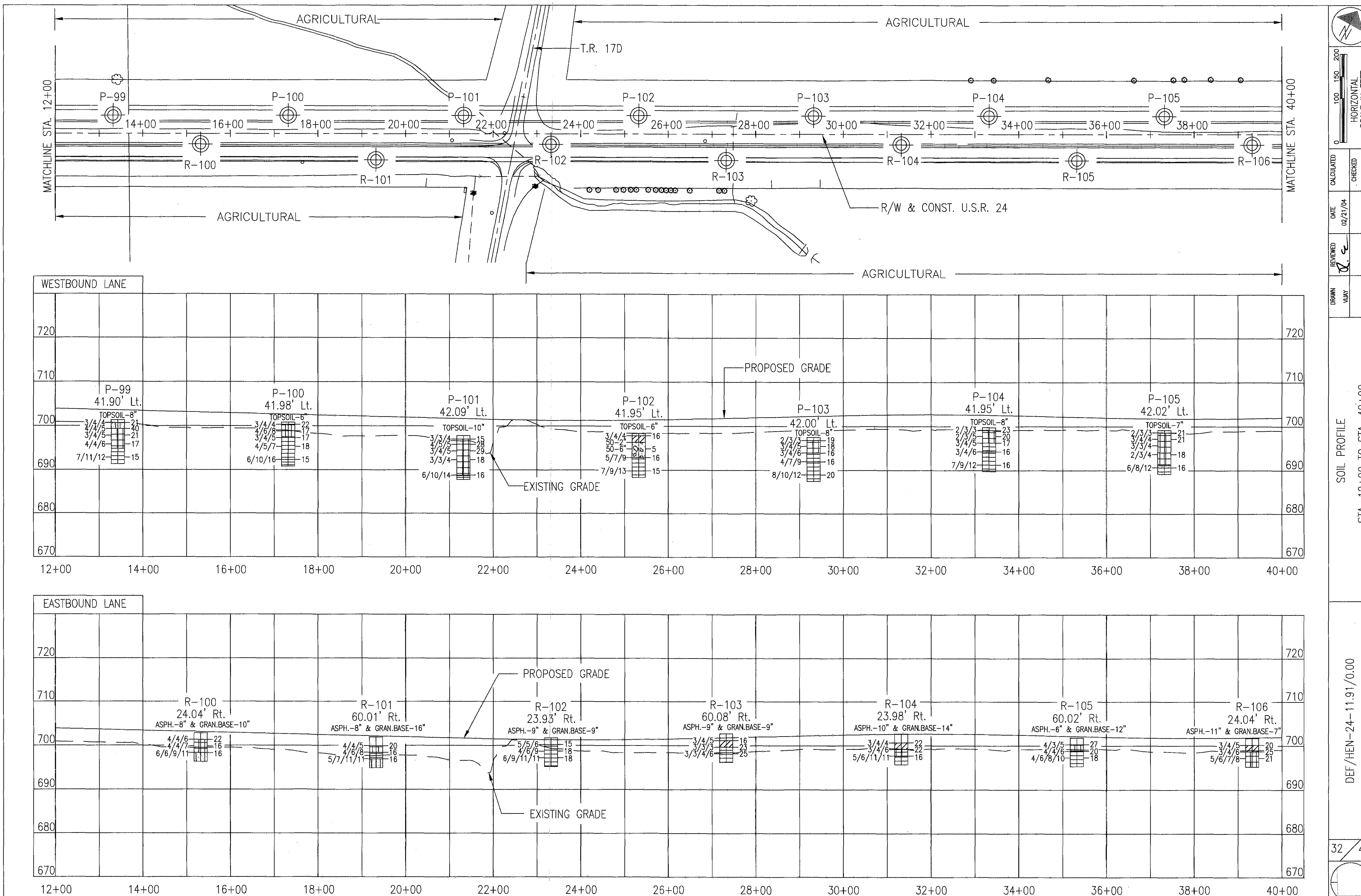
REVIEWED

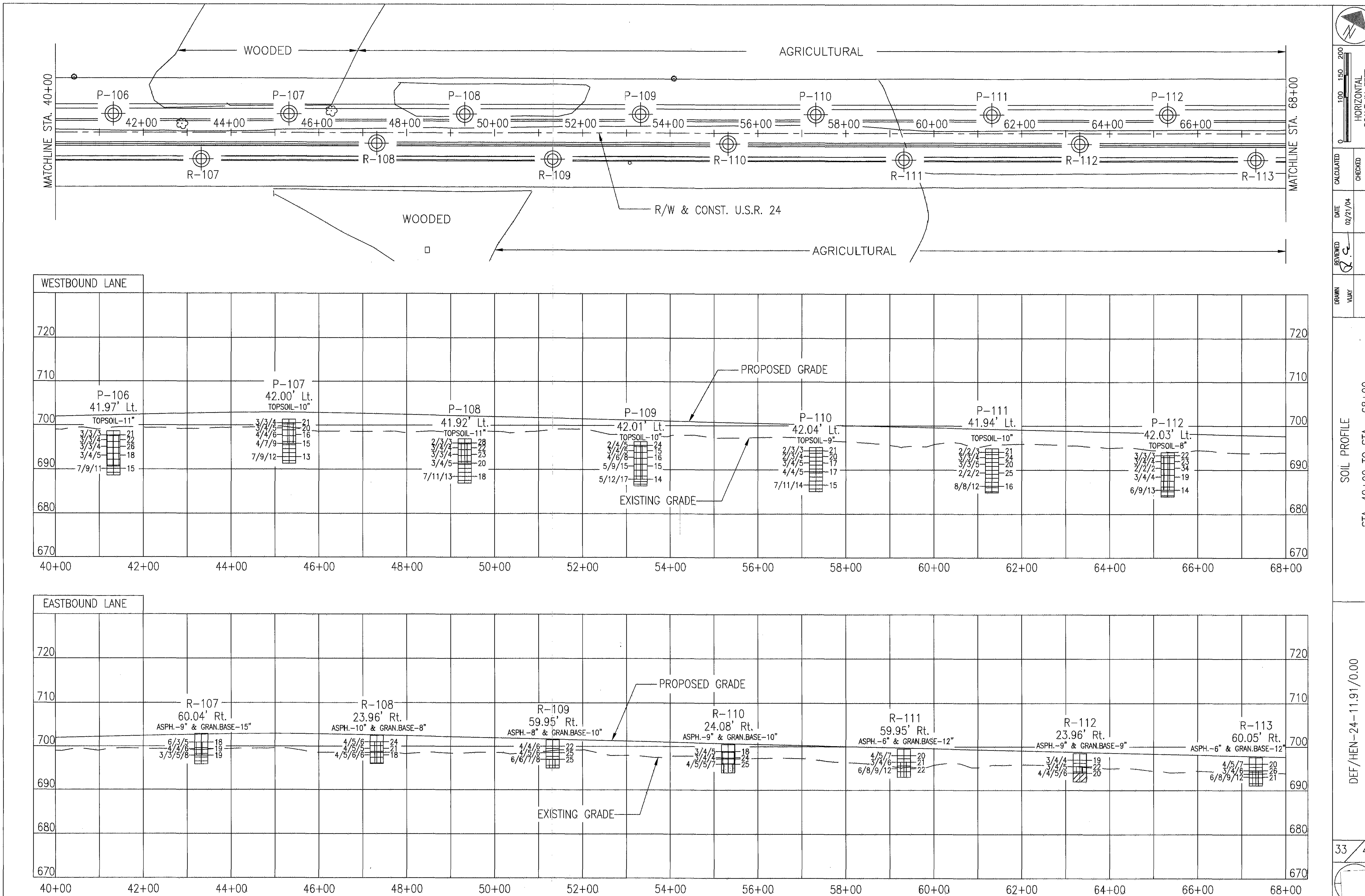
DRAWN VIJAY

SOIL PROFILE
STA.1011+00 TO STA. 12+00

DEF/HEN-24-11.91/0.00

31/40


AGRICULTURAL
T.R. 17D
MATCHLINE STA. 12+00
MATCHLINE STA. 40+00
P-99
P-100
P-101
P-102
P-103
P-104
P-105
R-100
R-101
R-102
R-103
R-104
R-105
R-106
R/W & CONST. U.S.R. 24
WESTBOUND LANE
P-99 41.90' Lt.
P-100 41.98' Lt.
P-101 42.09' Lt.
P-102 41.95' Lt.
P-103 42.00' Lt.
P-104 41.95' Lt.
P-105 42.02' Lt.
PROPOSED GRADE
EXISTING GRADE
EASTBOUND LANE
R-100 24.04' Rt.
ASPH.-8" & GRAN.BASE-10"
R-101 60.01' Rt.
ASPH.-8" & GRAN.BASE-16"
R-102 23.93' Rt.
ASPH.-9" & GRAN.BASE-9"
R-103 60.08' Rt.
ASPH.-9" & GRAN.BASE-9"
R-104 23.98' Rt.
ASPH.-10" & GRAN.BASE-14"
R-105 60.02' Rt.
ASPH.-6" & GRAN.BASE-12"
R-106 24.04' Rt.
ASPH.-11" & GRAN.BASE-7"
PROPOSED GRADE
EXISTING GRADE
HORIZONTAL SCALE IN FEET
CALCULATED
CHECKED
DATE 02/21/04
REVIEWED
DRAWN VIJAY
SOIL PROFILE
STA. 12+00 TO STA. 40+00
DEF/HEN-24-11.91/0.00
32/40



WOODED
AGRICULTURAL
MATCHLINE STA. 40+00
MATCHLINE STA. 68+00
P-106
P-107
P-108
P-109
P-110
P-111
P-112
R-107
R-108
R-109
R-110
R-111
R-112
R-113
42+00
44+00
46+00
48+00
50+00
52+00
54+00
56+00
58+00
60+00
62+00
64+00
66+00
R/W & CONST. U.S.R. 24
WOODED
AGRICULTURAL
WESTBOUND LANE
P-106 41.97' Lt. TOPSOIL-11"
P-107 42.00' Lt. TOPSOIL-10"
P-108 41.92' Lt. TOPSOIL-11"
P-109 42.01' Lt. TOPSOIL-10"
P-110 42.04' Lt. TOPSOIL-9"
P-111 41.94' Lt. TOPSOIL-10"
P-112 42.03' Lt. TOPSOIL-8"
PROPOSED GRADE
EXISTING GRADE
720
710
700
690
680
670
40+00
68+00
EASTBOUND LANE
R-107 60.04' Rt. ASPH.-9" & GRAN.BASE-15"
R-108 23.96' Rt. ASPH.-10" & GRAN.BASE-8"
R-109 59.95' Rt. ASPH.-8" & GRAN.BASE-10"
R-110 24.08' Rt. ASPH.-9" & GRAN.BASE-10"
R-111 59.95' Rt. ASPH.-6" & GRAN.BASE-12"
R-112 23.96' Rt. ASPH.-9" & GRAN.BASE-9"
R-113 60.05' Rt. ASPH.-6" & GRAN.BASE-12"
PROPOSED GRADE
EXISTING GRADE
HORIZONTAL SCALE IN FEET
0 100 150 200
CALCULATED
CHECKED
DATE 02/21/04
REVIEWED
DRAWN VIJAY
SOIL PROFILE
STA. 40+00 TO STA. 68+00
DEF/HEN-24-11.91/0.00
33/40

TR17D intersection over Unnamed Stream

LOG OF BORING

Date Started 6/21/05 Sampler: Type SS Dia. 1.375"
Date Completed 6/21/05 Casing: Length 30ft Dia. 3.25"

Project Identification: Ohio Department of Trasportation Dist. 1
05050110COL
DEF/HEN-24-11.91-/0.00

Boring No. C-3 Station & Offset 20+98.0, 91.0' Lt. *

Water Elev. Dry
Surface Elev. 698.8ft

Elev. (ft)	Depth (ft)	Std. Pen./ RQD	Rec. (ft)	Loss (ft)	Description	Sample No.	Physical Characteristics % Agg	% C.S.	% F.S.	% Silt	% Clay	L.L.	P.I.	W.C.	ODOT Class
698.8	0														
698.8 698.6 697.3		4/5/6			TOPSOIL (2") (FILL) 0.2' BROWN SILTY CLAY	1								13	VIS
	2	6/5/4			BROWN SILTY CLAY	2	1	3	16	38	42	34	17	16	A-6b
695.8	4	6/6/7			BROWN SILTY CLAY	3	1	4	17	30	48	38	20	16	A-6b
694.3		6/8/16			BROWN SILTY CLAY	4								15	VIS
692.8	6	8/8/17			BROWN SILTY CLAY	5								15	VIS
691.3	8	8/8/11			BROWN SILTY CLAY	6	2	5	13	30	50	33	16	14	A-6b
689.8	10	11/15/22			BROWN SILTY CLAY	7								15	VIS
687.3	12	12/16/21			BROWN SILTY CLAY 13.5'	8								16	VIS
685.3 684.8	14	5/11/14			GRAY SILT AND CLAY	9	2	4	11	30	53	31	15	16	A-6a
	16														
682.3	18	7/12/16			GRAY SILT AND CLAY	10								17	VIS
679.8	20	7/10/10			GRAY SILT AND CLAY	11	5	5	12	27	51	29	13	16	A-6a
	22														
675.3	24	11/15/16			GRAY SILT AND CLAY	12								15	VIS
	26														
	28														
670.3		12/15/15			GRAY SILT AND CLAY	13								17	VIS
668.8	30				30.0' BOTTOM OF BORING										

Particle Sizes: Agg => 2.00mm, Coarse Sand = 2.00-0.42mm, Fine Sand = 0.42-0.074mm, Silt = 0.074-0.005mm, Clay =< 0.005mm.


17D
C-003-0-05
C-004-0-05
Hwy 24
Hwy 24
17D
24
24
N
Google Earth

TR 17D Intersection over Unnamed Stream LOG OF BORING

Date Started 6/21/05 Sampler: Type SS Dia. 1.375" Project Identification: Ohio Department of Trasportation Dist. 1

Date Completed 6/21/05 Casing: Length 30ft Dia. 3.25" 05050110COL

Water Elev. Dry DEF/HEN-24-11.91-/0.00

Boring No. C-4 Station & Offset 23+14.0, 91.0' Rt. * Surface Elev. 700.4ft

Elev. (ft)	Depth (ft)	Std. Pen./ RQD	Rec. (ft)	Loss (ft)	Description	Sample No.	% Agg	% C.S.	% F.S.	% Silt	% Clay	L.L.	P.I.	W.C.	ODOT Class
700.4	0														
700.4 700.2 698.9		4/4/4			TOPSOIL (2") (FILL) 0.2' BROWN CLAY	1	0	3	16	37	44	41	19	14	A-7-6
	2	6/7/13			BROWN CLAY	2								13	VIS
697.4		9/10/12			BROWN CLAY	3	1	2	12	26	59	44	23	15	A-7-6
695.9	4				4.5'										
		6/8/14			BROWN AND GRAY SILT AND CLAY	4								17	VIS
694.4	6	2/9/13			BROWN AND GRAY SILT AND CLAY	5	2	5	12	31	50	32	15	14	A-6a
692.9					7.5'										
	8	9/12/14			BROWN SILTY AND CLAY	6								15	VIS
691.4	10	10/13/15			BROWN SILTY AND CLAY	7								12	VIS
688.9	12	13/14/15			BROWN SILTY AND CLAY	8								16	VIS
686.9 686.4	14				13.5'										
		4/5/9			GRAY SILT AND CLAY	9	3	5	12	28	52	29	14	15	A-6a
683.9	16	5/5/11			GRAY SILT AND CLAY	10								16	VIS
681.4	18 20	10/10/11			GRAY SILT AND CLAY	11								17	VIS
	22														
676.9	24	6/7/14			GRAY SILT AND CLAY	12								15	VIS
674.4	26				26.0'										
672.4	28	6/8/10			GRAY CLAY	13	0	0	0	7	93	53	29	35	A-7-6
670.4	30				30.0' BOTTOM OF BORING										

Particle Sizes: Agg => 2.00mm, Coarse Sand = 2.00-0.42mm, Fine Sand = 0.42-0.074mm, Silt = 0.074-0.005mm, Clay =< 0.005mm.