STRUCTURE FOUNDATION EXPLORATION

Proposed Culvert Replacement

WIL-6-11.07, PID 107612

US Highway 6 between CR 12C and CR 12

Bryan, Williams County, Ohio

Submitted to ODOT District 2

Date ***February 2024***

Prepared by

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OHIO DEPARTMENT OF TRANSPORTATION

Proposed Culvert Replacement

WIL-6-11.07
PID 107612
Bryan, Williams Co, Ohio

Structure Foundation Exploration

ODOT District 2
Bowling Green, Ohio

February 29, 2024

CT Project No. 232133

100th Anniversary
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100Th Anniversary
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February 29, 2024 **CT Project No. 232133**

Ms. Jorey Summersett, P.E.
Contract Manager, District 2
ODOT District 2
317 East Poe Road
Bowling Green, Ohio 43402

Final Report
Structure Foundation Exploration
Proposed Culvert Replacement
WIL-6-11.07, PID 107612
Bryan, Williams County, Ohio

Dear Ms. Summersett,

CT Consultants, Inc. (CT), has prepared the report of our geotechnical subsurface investigation at the site of the referenced project. This study was performed in accordance with CT Proposal No. P232133, dated September 27, 2023, and was authorized by you via an authorization letter dated October 11, 2023, which referenced Agreement No. 37607 and Encumbrance number 741820.

This report contains the results of our study, our engineering interpretation of the results with respect to the project characteristics, as well as our recommendations for headwall support and slope stability.

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

Sincerely,

CT Consultants, Inc.

STATE OF OHIO
CURTIS E. ROUPE
Reg # 59857
REGISTERED PROFESSIONAL ENGINEER

Luke G. Holmes
Geotechnical Staff

Curtis E. Roupe, P.E.
Vice President

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GEOTECHNICAL SUBSURFACE INVESTIGATION
PROPOSED CULVERT REPLACEMENT
WIL-6-11.07, PID 107612
BRYAN, WILLIAMS COUNTY, OHIO

FOR

ODOT DISTRICT 2
317 EAST POE ROAD
BOWLING GREEN, OHIO 43402

SUBMITTED

FEBRUARY 29, 2024
CT PROJECT NO. 232133

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EXECUTIVE SUMMARY

This Structure Foundation Exploration report has been prepared for the proposed culvert replacement (SFN 8600511) for the WIL-6-11.07, PID 107612 project in near Bryan, Williams County, Ohio. This exploration included two test borings for the evaluation of headwall support and slope stability. A summary of the conclusions and recommendations of this study are as follows:

1. The surface materials in Borings B-001 and B-002 encountered pavement materials consisting of asphalt on the order of 15 inches in thickness, underlain by an aggregate base with a thickness of 13 inches and 21 inches, respectively.
2. Based on the results of our field and laboratory tests, the subsoils encountered in the borings underlying the surface materials and existing fill materials can be generally described as two strata of cohesive soils underlain by two strata of granular soils, each with varying strength and moisture characteristics. **Stratum I** consisted of predominantly stiff to very stiff cohesive soils/materials encountered underlying the pavement materials to a depth of 18 feet and 16.8 feet below exiting grades in Borings B-001 and B-002, respectively (Elev. 757± and 759±, respectively). A **Zone** of loose granular soils, consisting of coarse and fine sand (A-3a) with little silt and traces of gravel and clay, was encountered within the Stratum I cohesive soils in Boring B-001 from a depth of 9 feet to a depth of 16 feet (From Elev. 766± to Elev. 759±). **Stratum II** consisted of predominantly hard cohesive soils encountered underlying Stratum I in Boring B-002 to a depth of 23 feet (Elev. 753±). **Stratum III** consisted of predominantly medium dense granular soils encountered Stratum I in Borings B-001 to a depth of 21 feet (Elev. 754±) and underlying Stratum II in Boring B-002 to a depth of 26 feet (Elev. 750±). **Stratum IV** consisted of predominantly dense to very dense granular soils encountered underlying Stratum IV to termination in both borings at a depth of 40 feet (Elev. 733±).
3. It is our opinion that the “normal” groundwater level can generally be expected to coincide or be just above the water levels in the creek. As such, groundwater elevations will fluctuate with seasonal and climatic influences. Therefore, groundwater conditions may vary at different times of the year from those encountered during this exploration.
4. A special design for headwalls is **not** required at this site.
5. The calculated factor of safety for both short-term and long-term analyses for 2½H:1V slopes for existing soils/materials as well as new embankment fill were greater than the minimum required factor of safety of 1.3. **Evaluations for the existing embankment materials indicated a factor of safety <u>lower</u> than 1.1 for the rapid drawdown case when using 2½H:1V slopes.** Evaluations for new embankment materials indicated suitable factors of safety greater than 1.1 for the rapid drawdown case.

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 geotechnical investigation report has been prepared for the proposed replacement of the culvert (SFN 8600511) along US Highway 6 (US 6) between County Road (CR) 12C and CR 12 near Bryan, in Williams County, Ohio, designated as WIL-6-11.07, PID 107612. The site is located approximately 3 miles southwest of Bryan, Ohio, approximately 475 feet east of the intersection of US 6 and CR 12C (*approximate latitude and longitude of site center: 41.441431, -84.595694*). The general location of the site is shown on the attached Site Location Map (Plate 1.0).

This study was performed in accordance with CT Proposal No. P232133, dated September 27, 2023, and was authorized by Ms. Jorey Summersett of ODOT District 2 via an authorization letter dated October 11, 2023, which referenced Agreement No. 37607 and Encumbrance number 741820.

1.1 Purpose and Scope of Exploration

The purpose of this exploration was to evaluate the subsurface conditions relative to installation and support of a culvert at the referenced location. To accomplish this, two (2) test borings, field and laboratory soil testing, and review of available geologic and soils data for the project area were performed.

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 includes a description of the existing surface materials, subsurface soils, and groundwater conditions encountered in the borings.

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

The scope of this study did not include an environmental assessment of the surface or subsurface materials at this site.

1.2 Proposed Construction

It is our understanding that the project will replace the existing twin reinforced concrete pipe culverts with precast reinforced box culvert sections, with planned dimensions of 10 feet span, 9 feet rise, and 132 feet in length. It was indicated that the culvert will have full-height headwalls. Headwall footings were indicated to bear at approximate Elevations of 754.4 feet and 754.8 feet for the outlet and inlet of the culvert, respectively. Additionally, final side slopes are proposed to be on the order 2.5 horizontal to 1vertical (2.5H:1V).

2.0 GEOLOGY AND OBSERVATIONS OF THE PROJECT

2.1 General Geology and Hydrogeology

Published geologic maps from the Ohio Department of Natural Resources (ODNR) indicate that the project site is located within the Maumee Lake Plains Region of the Huron-Erie Lake Plains District. Within this region, the geologic deposits are indicated to consist of Pleistocene-age silts and clays, and wave-planed clay till. However, the area was also mapped as containing lacustrine sands and beach sands.

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 left in the till soil matrix. Additionally, seams of granular soils may also be encountered within glacial tills. These granular seams may or may not be water bearing.

The lacustrine soils consist of predominantly lean clays and sands, 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.

Bedrock in the project area is broadly mapped on the "Geologic Map of Ohio" as Mississippian-age Waverly and Maxville (shales, sandstones, and limestones). Specific to the project site, the uppermost rock formation is mapped as Antrim Shale. Approximate bedrock Elevations are mapped as ranging from 580 to 560 feet, approximately 200 feet below grades at boring locations.

Review of the ODNR "Ohio Karst Areas" map indicated that the site is not in an area of probable karst.

The USDA Natural Resources Conservation Service (NRCS) Web Soil Survey indicates that the soils at the site are predominantly mapped as Cohoctah Loam (Ch) soils. The Ch soils consist of loamy alluvium (*soil deposited by rivers/running water*) formed on flood plains, and are considered to be poorly drained with a high permeability.

Web Soil Survey indicates that the soils around the on-site Cohoctah Loam (Ch) soils consist of Millgrove Loam (Mh) soils to the south, St. Clair Silty Clay Loam (SbD2) soils to the east, Tuscola Variant Fine Sandy Loam (TuC) soils to the west, and Udorthents (Ud) soils to the northwest and northeast. The Mh soils consist of outwash (*soil deposited by glacial meltwater*) formed on flats, and are considered to be very poorly drained with a moderately high to high permeability. The SbD2 soils consist of till (*soil deposited directly by glaciers)* formed on lake plains, end moraines, as well as ground moraines, and are considered to be moderately well drained with a low to moderately high permeability. The TuC soils consist of lacustrine (*soil deposited at the bottom of lakes*) deposits formed on deltas, lake plains, and are considered to be moderately well drained with a moderately high to high permeability. The Ud soils indicate were soils were removed or re-graded during previous development.

2.2 Site Reconnaissance

CT performed site reconnaissance on November 18, 2023. At the time of our reconnaissance, the areas to the north, northwest, and northeast are predominantly grassy land. A small fenced in facility, appearing to be for water treatment, was observed to the north, past the grassy area. A rural residential or rural business was observed to the northeast, past the grassy area. The areas to the south and to the southwest are predominantly wooded land. The area to the southeast appears to be a rural residential lot.

In the immediate area of the culvert, pavement along both US 6 was observed to generally be in fair condition, with a moderately weathered surface. Pavement distresses were generally limited to a few transverse cracks either side of the culvert, and continues longitudinal cracking along northern shoulder/westbound lane boundary as well as the center divider/eastbound lane boundary. The observed cracks were generally sealed.

The existing culvert appeared to be made of two, side by side, reinforced concrete pipes, each circular in cross-sectional shape. The pipe culverts' dimensions were approximately 7.7 feet in internal diameter and the pipes were spaced approximately 1½ feet apart from each other. At each end of the culvert, a wall, half the height of the culvert, was observed between the two pipes and extending a few feet to either side. The culvert was constructed in multiple sections for a total length of approximately 120 feet. Most joints between sections appeared to have been grouted, however, the grout was in poor condition or completely missing in many joints. Concrete spalling along the pipe inverts was observed at several joints, or in some cases over entire pipe sections. This was the case for both pipes, however observed more often in the eastern pipe. The spalling was often deep enough to expose the steel reinforcement cages. The exposed rebar was generally heavily rusted and completely rusted through in some locations. Despite the poor condition of some of the joints, none were observed to be open. The inlet was to the north.

Within the site area, grades along US 6 generally sloped down to the area of the culvert. Apart from two exceptions, signs of erosion, slumping, or other forms of noteworthy soil movement along the slopes were generally not observed at this site. Of the two exceptions, one was the light eruption observed at the base of several road signs along the slope. The other was more significant erosion of the slope between the two pipes at the inlet side. Unlike the outlet side, that had soil between the pipes and the half height wall, the inlet had a large void immediately behind the half height wall and between the pipes.

Both the inlet and outlet of the culvert were not level with the creek bottom, and were approximately 1½ to 2 feet above the creek bottom. Water was not flowing through the eastern pipe. The western pipe did have water flowing though it but was less than an inch in depth. At the inlet, water was on the order of 18 to 21 inches in depth. At the outlet, water was on the order of 8 to 10 inches in depth. The water at each end of the culvert appeared to be nearly stagnant, with aquatic plants floating on the waters surface to the north of the culverts and a "film" on the water's surface, appearing oily in some areas, to the south. Based on the presence of floating aquatic plants, this creek likely does not experience significant flow for much of the year.

Review of the Ohio Department of Natural Resources (ODNR) Map of Mines indicated no historic mining activity in the immediate vicinity of the site. The closest mining activity was mapped as historic surface mining located approximately 1½ miles north by northwest of the site.

3.0 EXPLORATION

3.1 Historic Borings

Review of the available ODOT records from the Transportation Information Mapping System (TIMS) indicated that several historic auger borings had been performed along US Route 6 in 1944 for WIL-6-3.63 and in 1950 WIL-384-(0.10-2.44). The historic data was reviewed for the four of closest auger borings to the culvert (two on either side), located up to approximately 425 feet west and east of the culvert, between County Road 12C (CR 12C) and CR 12. The cover sheet, laboratory data, and the plan-and-profile drawing from the historic projects are included in Appendix C of this report. Additionally, the approximate locations of the historic auger borings are shown on the Test Boring Location Plan (Plate 2.0).

The historic borings were not enumerated. For designation within this report, these borings were numerated as B-CCC-D-EE as follows:

- B = Boring.
- CCC = Whole historic station number (404 for Sta. 404+68, etc.).
- D = Number of times offset from original boring location (0 since none were offset).
- EE = Date which the borings were performed (44 for 1944).

Borings B-404, B-003, and B-006 were performed to a depth on the order of 5 feet and indicated ground surface elevations generally consistent with current elevations. Boring B-404, located approximately 400 feet west of the culvert, described the soils as clay and silt (A-7), underlain by sandy silt (A-4), further underlain by sandy silt and clay (A-4). Boring B-003, located approximately 175 feet west, described the soils as sandy silt and clay (A-6), underlain by sandy silt (A-4), further underlain by gravel, sand, and silt (A-1-b). Boring B-006, located approximately 125 feet east, described the soils as being the same as B-003 with the exception of not encountering the A-1-b soils.

Boring B-009, located approximately 425 feet east of the culvert, was performed to a depth of approximately 10 feet and indicated ground surface elevations being approximately 4 to 6 feet higher that current grades. Soils were indicated to consist of sand (A-2-4) underlain by sandy silt and clay (A-6).

The soil classifications described above are based on the soil profiles and legend keys from the historic plans. It should be noted that the soils classifications shown and described in the legend keys did not always align to the current soil classifications used by ODOT. Based on the historic borings being over 100 feet away from the culvert, outside of what CT expects to be the excavation area for the culvert replacement, CT has not attempted to update/reclassify the historic classifications to be consistent with the modern ODOT classification system. Additionally, based on the distance from the intersection and lack of testing to correlate soil strength (*SPT N-values and hand penetrometer values*), these historic boring have been omitted from the calculations for Section 5.1 “Soil Parameters for Headwall Support” and Section 5.2 “Slope Stability Analysis”.

It has been 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, 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

Two (2) test borings, designated as Borings B-001-1-23 and B-002-0-23 were performed for this exploration. The reason for the offset of Boring B-001-1-23 is described in Section 4.1. The borings were drilled by CT on November 20 and 21, 2023. These borings are fully designated as Borings B-001-1-23 and B-002-0-23 in accordance with ODOT protocol, but the “-0-23” portion of the nomenclature is generally omitted in the discussions within this report. Borings B-001 and B-002 were located in the paved shoulders either side of the culvert, drilled near the outlet and inlet, respectively. The existing site features and approximate locations of the borings are presented on the Test Boring Location Plan (Plate 1.0).

Stationing, offsets, and ground surface elevations were approximated based on plans provided by ODOT District 2. Latitude and Longitude coordinates were surveyed by CT via a hand-held GPS. The accuracy from the handheld GPS device was generally found to be approximately 2 to 12 inches horizontal, and approximately 4 to 24 inches vertical. These data are presented on the logs of test borings, and are summarized in the following table.

It should be noted that ground surface elevations were also surveyed by CT with the hand-held GPS. At the four points surveyed at the top of each culvert end (CT surveyed Elevations

666.0± to 667.1±), the resulting elevations generally matched well to the elevations on the provided plans. However, the points surveyed at the boring locations (CT surveyed Elevations, B-001 at 773.7± and B-002 at 773.4±) did not match well to the elevations on the provided plans, approximately 1¾ to 2 feet lower than expected based on the plans. As such, this report uses ground surface elevations approximated from the provided plans.

Table 3.2 General Boring Location Information						
Boring Number	**Location**	**Approximate US 6 Centerline Station**	**Approx. Offset (feet)**	**Approximate Ground Surface Elevation (feet)**	**Latitude (Degrees)**	**Longitude (Degrees)**
B-001-1-23	EB Shoulder	584+24	22 RT	775.4	41.441361	-84.595770
B-002-0-23	WB Shoulder	584+68	27 LT	775.5	41.441493	-84.595608

EB/WB = East/West Bound

The borings were performed as Type E2b structure borings per geotechnical investigative procedures outlined in Ohio Department of Transportation (ODOT) "Specifications for Geotechnical Explorations" (SGE).

Borings B-001 and B-002 were terminated at the planned depth of 40 feet below existing grades.

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 engineering 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 in the paved shoulders during this exploration were drilled with a track-mounted Diedrich D-70 drill rig utilizing 3¼-inch inside diameter hollow-stem augers. During auger advancement of the test borings, split-spoon drive samples were generally taken at 2½-foot intervals to auger refusal. The samples were sealed in jars and transported to our laboratory for further classification and testing.

Split-spoon (SS) soil samples were obtained by the Standard Penetration Test Method (ASTM D 1586). 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 ratio for the Diedrich D70 track-mounted drill rig was 90 percent, and was last calibrated on April 13, 2022. This energy ratio is at the upper bound of 90 percent for the purposes of analyses and reporting in accordance with the ODOT Specification for Geotechnical Explorations (SGE). The N_{60}-values are presented on the attached Logs of Test Borings and Summary of Soil Test Data sheet.

Shelby tube samples, designated ST on the Log of Test Boring, were obtained from Borings B-001-1-23 (8 to 10 feet) and B-002-0-23 (11 to 13 feet and 18 to 20 feet). The Shelby tube samples were obtained by hydraulically advancing a 3-inch diameter, thin-walled sampler approximately 24 inches beyond the hollow-stem auger into 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.

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 samples were visually or manually classified in accordance with the ODOT Soil Classification System. 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 select intact cohesive split-spoon samples as well as Shelby tube samples. Unconfined compressive strength estimates were obtained for the remaining intact cohesive samples using a calibrated hand penetrometer. Atterberg limits tests (ASTM D 4318) and particle size analyses (ASTM D 422) were performed on select samples to determine soil classification and index properties. These test results are presented on the Logs of Test Borings, Summary of Soil Test Data, Grain Size Distribution, and Shelby Tube Unconfined Compression Testing Results Sheets.

4.0 FINDINGS

4.1 General Site Conditions

The surface materials in Borings B-001 and B-002 encountered pavement materials consisting of asphalt on the order of 15 inches in thickness, underlain by an aggregate base with a thickness of 13 inches and 21 inches, respectively.

As indicated in Section 3.2, Boring B-001-1-23 was offset from the originally planned location in the middle of the shoulder, approximately 3 feet west and 3 feet south to the edge of the shoulder pavement. The original location encountered split-spoon refusal (SSR, 50 or more blows for 6 inches or less penetration) within the first sampling interval. The driller visually described the obstructions as a black colored plastic; however, a sample was not recovered to confirm this. CT contacted the Ohio utility protection service (OUPS) for utility markings and clearances prior to drilling. The results of which indicated that public utilities were generally not in the area of the culvert, with the closest utility being a gas line to the south, along the tree line or further.

With the exception of the miscellaneous debris encountered in the upper soils/materials near B-001, non-soil materials were not encountered in any of the recovered samples for this exploration. As such, the entire soil profile is described in Section 4.2, below. However, it is likely that most or all of the Stratum I soils consist of fill materials.

4.2 General Soil Conditions

Based on the results of our field and laboratory tests, the subsoils encountered in the borings underlying the surface materials and existing fill materials can be generally described as two strata of cohesive soils underlain by two strata of granular soils, each with varying strength and moisture characteristics.

Stratum I consisted of predominantly stiff to very stiff cohesive soils/materials encountered underlying the pavement materials to a depth of 18 feet and 16.8 feet below exiting grades in Borings B-001 and B-002, respectively (Elev. 757± and 759±, respectively). The cohesive soils consisted of silt and clay (ODOT A-6a) and silty clay (A-6b) soils, each with varying amounts of sand and traces of gravel. SPT N_{60}-values in the generally ranged from 11 to 15 blows per foot (bpf). Unconfined compressive strengths determined by the rate of strain method ranged from 3,440 to 4,955 pounds per square foot (psf). Unconfined compressive strengths determined with a calibrated hand penetrometer ranged from 4,000 pounds per square foot (psf) to greater than 9,000 psf (maximum reading obtainable using a hand penetrometer). The upper portion of this range, with relatively high apparent strengths may have been affected by desiccation, or may be indicative of transition to the underlying hard soils. Moisture contents generally ranged from 17 to 20 percent.

A **Zone** of **loose** granular soils, consisting of coarse and fine sand (A-3a) with little silt and traces of gravel and clay, was encountered within the Stratum I cohesive soils in Boring B-001 from a depth of 9 feet to a depth of 16 feet (From Elev. 766± to Elev. 759±). For the two standard penetration tests performed/samples recovered form this zone, N_{60}-values from were on the order of 6 bpf and moisture contents were 13 percent and 20 percent.

Stratum II consisted of predominantly hard cohesive soils encountered underlying Stratum I in Boring B-002 to a depth of 23 feet (Elev. 753±). The cohesive soils consisted of silt and clay (A-6a) with varying amounts of sand and gravel. The two SPT N_{60}-values from this stratum were 32 bpf and 48 bpf. Unconfined compressive strength hand penetrometer estimated were determined to be greater than 9,000 psf. The one sample from this stratum tested for unconfined compressive strength by the rate of strain method was determined to be approximately 19,625 psf. Moisture contents ranged from 11 to 15 percent.

Stratum III consisted of predominantly medium dense granular soils encountered Stratum I in Borings B-001 to a depth of 21 feet (Elev. 754±) and underlying Stratum II in Boring B-002 to a depth of 26 feet (Elev. 750±). The granular soils consisted of non-plastic silt (A-4b) with sand and traces of clay as well as fine sand (A-3) with traces of silt and clay. The two SPT N_{60}-values from this stratum were 20 bpf and 23 bpf. Moisture contents were 18 percent and 19 percent.

Stratum IV consisted of predominantly dense to very dense granular soils encountered underlying Stratum IV to termination in both borings at a depth of 40 feet (Elev. 733±). The granular soils consisted of gravel and stone fragments with sand (A-1-b) and traces of silt and clay as well as coarse and fine sand (A-3a) with a little silt, varying amounts of gravel, and traces of clay. SPT N_{60}-values ranged from 48 to over 100 bpf. Additionally, several standard penetration tests in Boring B-002 resulted in split-spoon refusal (SSR, 50 or more blows for

6 inches or less penetration). Moisture contents in Boring B-001 ranged from 7 to 11 percent. Moisture contents in Boring B-002 ranged from 13 to 17 percent.

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

4.3 Groundwater Conditions

During our site reconnaissance on November 18, 2023, generally 8 to 21 inches of nearly stagnant water was present in the creek, and the creek bottom was approximately 16 feet below the road grade, corresponding to an approximate elevation of the water at 761 to 760 feet. During this exploration, groundwater was initially encountered during drilling at depths of approximately 14 feet and 21¾ feet (Elev. 761± and 754±) in Borings B-001 and B-002, respectively. Groundwater was observed upon completion of drilling in both borings at a depth on the order of 14½ (Elev. 761±). It should be noted that the boreholes were drilled and backfilled within the same day, and stabilized water levels may not have occurred over this limited time period.

It is our opinion that the "normal" groundwater level can generally be expected to coincide or be just above the water levels in the creek. As such, groundwater elevations will fluctuate with seasonal and climatic influences. Therefore, groundwater conditions may vary at different times of the year from those encountered during this exploration.

5.0 ANALYSES AND RECOMMENDATIONS

The following analysis 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 Soil Parameters for Headwall Support

It was indicated that full-height headwalls will be utilized for the proposed precast box culvert. Headwall footings were indicated to bear at approximate Elevations of 754.4 feet and 754.8 feet for the outlet and inlet of the culvert, respectively.

Based on the conditions encountered in the borings, the soils at the anticipated headwall foundation bearing elevations may encounter Stratum II hard cohesive soils at the outlet headwall (B-001) and Stratum III medium dense granular soils at the inlet headwall (B-002). However, due to the elevations of the strata in proximity to the headwall foundation bearing elevations and differences in soil conditions between borings locations, any of the four strata described in Section 4.2 may be encountered at bearing elevation. In any case, the soils at the bearing elevations are anticipated to consisted of stiff to hard cohesive soils and/or medium dense to dense granular soils. All of these soils are considered generally suitable for support of the proposed headwall foundations.

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 values for the Stratum I stiff to very stiff soils and Stratum II hard cohesive bearing soils are 1,750 pounds per square foot (psf) and 6,000 psf, respectively. Both of which meet the minimum design requirement.

The standard concrete headwalls are indicated to be based on design using a minimum internal angle of friction (ϕ) of 28 degrees when the walls are bearing on granular soils. The design ϕ values for the Stratum III medium dense and Stratum IV very dense granular bearing soils are 32 degrees and 39 degrees, respectively. Both of which meet the minimum design requirement.

A special design for headwalls is **not** required at this site.

5.2 Slope Stability Analysis

A global slope stability analyses was performed using the 2-D Limit Equilibrium Slope Stability Program Slide 6.0 by Rocscience to evaluate the anticipated 2½H:1V new embankment slope extending north and south of the culvert replacement area. This analysis was performed to evaluate whether the permanent embankment slope designs have a factor of safety of 1.3 or greater for static conditions and a factor of safety of 1.1 or greater for rapid drawdown conditions. 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 a portion of the roadway.

We analyzed five cases for a typical embankment cross-section based on the plans provided and a traffic surcharge of 250 psf was applied at the top of the slope for traffic along US 6. The cases simulated are as follows:

- Long-term conditions using effective stress soil parameters (ESSP) for existing soils/materials and the provided ordinary high-water mark of 758.56 feet.
- ESSP for existing soils/materials and rapid drawdown from the provided 100-year high-water mark 762.56 feet.
- Short-term conditions using total stress soil parameters (TSSP) for new clay (A-7-6) embankment fill and the provided ordinary high-water mark 758.56 feet.
- ESSP for new clay (A-7-6) embankment fill and the provided ordinary high-water mark 758.56 feet.

- ESSP for new clay (A-7-6) embankment fill and rapid drawdown from the provided 100-year high-water mark 762.56 feet.

Soil strengths were evaluated based on unconfined compressive strength test results, hand penetrometer readings, as well as SPT N-values, moisture content, unit weight (density), and soil plasticity data of the encountered soils. Correlations with published data were also utilized to estimate soil properties.

It should be noted that the properties of the soil strata vary with layer and depth. The soil parameters utilized for analysis of the slope are presented in the following tables.

Table 5.2.A Design Soil Properties

Stratum	Total Unit Weight (pcf)	Short-Term, Undrained Case (End-of-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)	Residual cohesion, c' (psf)
New Embankment Fill (A-7-6)	125	0	2000	26	200
Stratum I: Stiff to Very Stiff Cohesive	130	0	1750	31	0
Zone in Stratum I: Loose Granular	120	29	0	29	0
Stratum II: Hard Cohesive	135	0	6000	32	0
Stratum III: Medium Dense Granular	120	32	0	32	0
Stratum IV: Dense to Very Dense Granular	130	39	0	39	0

(1) This value represents a limiting value for design. Higher strength may be appropriate when considering resistance to installation of steel sheetpiling.

Embankment fill materials were assumed to be cohesive, and strengths were estimated based of Geotechnical Design Manual (GDM) Section 502, Table 500-2. The borrow source soil class was conservatively selected as clay (A-7-6).

Global stability factors of safety determined using Bishop's method with 2½H:1V slopes for existing soils/materials as well as new embankment fill. Results of the slope stability analysis are presented in the following table.

Table 5.2.B Global Stability Evaluation Results		
Analyzed Cases	**Factor of Safety**	
	Short-Term, Undrained Case (End-of-Construction)	**Long-Term, Drained Case (Post-Construction)**
Existing Soils with Ordinary High-Water Mark: 758.56 Feet	-	1.42
Existing Soils with Rapid Drawdown from 100 Year High-Water Mark: 762.56 Feet	-	0.66
New Clay (A-7-6) Embankment Fill with Ordinary High-Water Mark: 758.56 Feet	3.19	1.81
New Clay (A-7-6) Embankment Fill with Rapid Drawdown from 100 Year High Water Mark: 762.56 Feet	-	1.55

The calculated factor of safety for both short-term and long-term analyses for 2½H:1V slopes for existing soils/materials as well as new embankment fill were greater than the minimum required factor of safety of 1.3. **Evaluations for the existing embankment materials indicated a factor of safety lower than 1.1 for the rapid drawdown case when using 2½H:1V slopes.** Evaluations for new embankment materials indicated suitable factors of safety greater than 1.1 for the rapid drawdown case.

Graphical output from each global stability analysis is attached to this report.

6.0 QUALIFICATION OF RECOMMENDATIONS

Our evaluation of design and construction conditions for the proposed culvert replacement has been based on our understanding of the site and project information and the data obtained during our field exploration. 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 or specifications.

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

BASE AERIAL OBTAINED FROM GOOGLE EARTH IMAGE DATED OCTOBER 25, 2015.

LEGEND

APPROXIMATE SITE LOCATION

N

APPROXIMATE SCALE – FEET

0 2,000 4,000

PLATE 1.0
SITE LOCATION MAP

PROPOSED CULVERT REPLACEMENT
WIL-6-11.07, PID 107612
NEAR BRYAN, WILLIAMS COUNTY, OHIO

PREPARED FOR

ODOT DISTRICT 2

DRAWN	LGH / 02–07–2024	CHECKED	CER / 02–12–2024
REVISED		APPROVED	
JOB NO.	232133		
DRAWING NUMBER	232133–01G		

100Th Anniversary
LEADING THROUGH THE NEXT 100 YEARS
www.ctconsultants.com

LEGEND

B-001-0-23 — APPROXIMATE TEST BORING LOCATION

B-405-0-44 — APPROXIMATE HISTORIC AUGER BORING LOCATION (WIL-6-3.63, 1944 & WIL-384-(0.10-2.44), 1950)

APPROXIMATE SCALE - FEET

0 100 120

PLATE 2.0

TEST BORING LOCATION PLAN

PROPOSED CULVERT REPLACEMENT

WIL-6-11.07, PID 107612

NEAR BRYAN, WILLIAMS COUNTY, OHIO

PREPARED FOR

ODOT DISTRICT 2

DRAWN LGH / 02–07–2024	CHECKED CER / 02–12–2024
REVISED	APPROVED
JOB NO. 232133	
DRAWING NUMBER 232133–02G	

100th Anniversary
LEADING THROUGH THE NEXT 100 YEARS
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BASE AERIAL OBTAINED FROM GOOGLE EARTH IMAGE DATED OCTOBER 25, 2015.

FIGURES

PROJECT: WIL-6-11.07	DRILLING FIRM / OPERATOR: CT / TB	DRILL RIG: DIEDRICH D70 TRACK	STATION / OFFSET: 584+24, 22' RT.	EXPLORATION ID B-001-1-23
TYPE: CULVERT	SAMPLING FIRM / LOGGER: CT / KKC	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: US 6 CENTERLINE	
PID: 107612 SFN: 8600511	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 4/13/22	ELEVATION: 775.4 (NAVD88) EOB: 40.0 ft.	PAGE
START: 11/21/23 END: 11/21/23	SAMPLING METHOD: SPT / ST	ENERGY RATIO (%): 90	LAT / LONG: 41.441361, -84.595770	1 OF 2

MATERIAL DESCRIPTION AND NOTES	ELEV. 775.4	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
ASPHALT - 15 INCHES	774.1	1																
AGGREGATE BASE - 13 INCHES	773.1	2	11 4 50	81	94	SS-1A	-	-	-	-	-	-	-	-	-	-	A-2-4 (V)	
HARD, GRAY/BROWN, **SILTY CLAY**, LITTLE SAND, TRACE CRUSHED STONE, DAMP FILL	772.4					SS-1B	>4.5	-	-	-	-	-	-	-	-	16	A-6b (V)	
STIFF TO VERY STIFF, BROWN, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, MOIST		3 4 5	2 4 6	15	100	SS-2	>4.5	-	-	-	-	-	-	-	-	18	A-6b (V)	
		6 7	4 4 5	14	89	SS-3	3.00	-	-	-	-	-	-	-	-	20	A-6b (V)	
		8				ST-4A	>4.5	-	-	-	-	-	-	-	-	-	A-6b (V)	
@8.5': SOME SAND, DAMP, Qu = 34.4 PSI = 4,955 PSF	766.4				100	ST-4B	>4.5	8	5	17	26	44	36	17	19	16	A-6b (11)	
LOOSE, BROWN, **GRAVEL AND STONE FRAGMENTS WITH SAND**, LITTLE SILT, TRACE CLAY, MOIST		9				ST-4C	-	26	28	30	13	3	NP	NP	NP	7	A-1-b (0)	
	765.4	10				ST-4D	-	-	-	-	-	-	-	-	-	-	A-1-b (V)	
LOOSE, GRAY, **COARSE AND FINE SAND**, LITTLE SILT, TRACE GRAVEL, TRACE CLAY, MOIST		11 12	4 2 2	6	22	SS-5	-	-	-	-	-	-	-	-	-	13	A-3a (V)	
@14': MOIST TO WET, (FREE WATER NOTED)		13 W 761.4 14 15	1 2 2	6	89	SS-6	-	-	-	-	-	-	-	-	-	20	A-3a (V)	
	759.4	16																
STIFF TO VERY STIFF, GRAY, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP Qu = 24.6 PSI = 3,540 PSF	757.4	17	6 7 12	29	100	SS-7	4.00	-	-	-	-	-	-	-	-	14	A-6a (V)	
MEDIUM DENSE, GRAY, **SILT**, "AND" SAND, TRACE CLAY, MOIST TO WET (FREE WATER NOTED)	754.4	18 19 20	9 11 4	23	83	SS-8	-	0	3	41	51	5	NP	NP	NP	19	A-4b (4)	

PID: 107612	SFN: 8600511	PROJECT: WIL-6-11.07	STATION / OFFSET: 584+24, 22' RT.	START: 11/21/23	END: 11/21/23	PG 2 OF 2	B-001-1-23

MATERIAL DESCRIPTION AND NOTES	ELEV. 754.4	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
DENSE, GRAY, **GRAVEL AND STONE FRAGMENTS WITH SAND**, TRACE SILT, TRACE CLAY, MOIST TO WET (FREE WATER NOTED)	752.4	22 – 23	18 14 18	48	72	SS-9	-	-	-	-	-	-	-	-	-	7	A-1-b (V)	
DENSE TO VERY DENSE, GRAY, **COARSE AND FINE SAND**, LITTLE SILT, LITTLE GRAVEL, TRACE CLAY, MOIST TO WET		24 – 25	4 8 23	47	89	SS-10	-	-	-	-	-	-	-	-	-	8	A-3a (V)	
@26': (FREE WATER NOTED)		26 – 27	8 16 22	57	100	SS-11	-	-	-	-	-	-	-	-	-	9	A-3a (V)	
		28 – 29	12 16 22	57	72	SS-12	-	-	-	-	-	-	-	-	-	7	A-3a (V)	
@31': (FREE WATER NOTED)		30 – 32	8 12 26	57	28	SS-13	-	-	-	-	-	-	-	-	-	11	A-3a (V)	
@33.5': (FREE WATER NOTED)		33 – 34	8 16 18	51	28	SS-14	-	-	-	-	-	-	-	-	-	11	A-3a (V)	
@36': (FREE WATER NOTED)		35 – 37	12 17 22	59	44	SS-15	-	-	-	-	-	-	-	-	-	10	A-3a (V)	
@38.5': (FREE WATER NOTED)	735.4	38 – 40, EOB	10 17 19	54	83	SS-16	-	-	-	-	-	-	-	-	-	9	A-3a (V)	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.5 BAG ASPHALT PATCH; AUGER CUTTINGS MIXED WITH 2 BAGS BENTONITE CHIPS

PROJECT: WIL-6-11.07 TYPE: CULVERT PID: 107612 SFN: 8600511 START: 11/20/23 END: 11/20/23	DRILLING FIRM / OPERATOR: CT / TB SAMPLING FIRM / LOGGER: CT / 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: 584+68, 27' LT. ALIGNMENT: US 6 CENTERLINE ELEVATION: 775.5 (NAVD88) EOB: 40.0 ft. LAT / LONG: 41.441493, -84.595608	EXPLORATION ID B-002-0-23 PAGE 1 OF 2

MATERIAL DESCRIPTION AND NOTES	ELEV. 775.5	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
ASPHALT - 15 INCHES	774.2																	
AGGREGATE BASE - 21 INCHES *(SOME SAND, SILT)*	772.5	1–2	8 6 5	17	78	SS-1	-	-	-	-	-	-	-	-	-	6	A-2-4 (V)	
STIFF TO VERY STIFF, BROWN, **SILTY CLAY**, SOME SAND, TRACE GRAVEL, MOIST Qu = 23.9 PSI = 3,440 PSF		4–5	2 3 4	11	100	SS-2	3.25	6	6	18	22	48	36	16	20	19	A-6b (11)	
		6–7	4 3 5	12	100	SS-3	3.00	-	-	-	-	-	-	-	-	20	A-6b (V)	
		9–10	2 2 3	8	100	SS-4	3.50	-	-	-	-	-	-	-	-	18	A-6b (V)	
	762.5	11–13			75	ST-5	-	-	-	-	-	-	-	-	-	-	A-6b (V)	
STIFF, GRAY, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, MOIST		14–15 (water level ▼ ~14.5)	3 4 3	11	89	SS-6	2.00	-	-	-	-	-	-	-	-	17	A-6a (V)	
	758.7	16–17	3 9 12	32	100	SS-7	>4.5	-	-	-	-	-	-	-	-	14	A-6a (V)	
HARD, GRAY, **SILT AND CLAY**, LITTLE SAND, DAMP TO MOIST @18': Qu = 136.3 PSI = 19,625 PSF		18–20			75	ST-8	>4.5	0	2	11	26	61	30	15	15	15	A-6a (10)	

PID: 107612	SFN: 8600511	PROJECT: WIL-6-11.07	STATION / OFFSET: 584+68, 27' LT.	START: 11/20/23	END: 11/20/23	PG 2 OF 2	B-002-0-23

MATERIAL DESCRIPTION AND NOTES	ELEV. 754.5	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
HARD, GRAY, **SILT AND CLAY**, LITTLE SAND, DAMP TO MOIST *(continued)* @21.8': TRACE GRAVEL	752.5	W 753.7; 22	9 18 14	48	100	SS-9	>4.5	-	-	-	-	-	-	-	-	11	A-6a (V)	
MEDIUM DENSE, GRAY, **FINE SAND**, TRACE SILT, TRACE CLAY, MOIST TO WET (FREE WATER NOTED)	749.5	23–25	7 5 8	20	100	SS-10	-	-	-	-	-	-	-	-	-	19	A-3 (V)	
VERY DENSE, GRAY, **COARSE AND FINE SAND**, LITTLE SILT, TRACE CLAY, MOIST TO WET		26–27	3 14 34	72	100	SS-11	-	-	-	-	-	-	-	-	-	17	A-3a (V)	
		28–29	7 17 49	99	83	SS-12	-	-	-	-	-	-	-	-	-	13	A-3a (V)	
@31': (FREE WATER NOTED)		30–32	20 34 40	111	83	SS-13	-	-	-	-	-	-	-	-	-	17	A-3a (V)	
@33.5': (FREE WATER NOTED)		33–34	24 36 50/5"	-	94	SS-14	-	-	-	-	-	-	-	-	-	17	A-3a (V)	
		35–37	8 42 50/4"	-	94	SS-15	-	-	-	-	-	-	-	-	-	15	A-3a (V)	
@38.5': (FREE WATER NOTED)	735.5	38–39; EOB 40	12 25 43	102	100	SS-16	-	-	-	-	-	-	-	-	-	17	A-3a (V)	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.5 BAG ASPHALT PATCH; AUGER CUTTINGS MIXED WITH 2 BAGS BENTONITE CHIPS

LEGEND KEY

LITHOLOGIC SYMBOLS
(Unified Soil Classification System)

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

A-2-4: Ohio DOT: A-2-4, gravel and/or stone fragments with sand and silt

A-3: Ohio DOT: A-3, fine sand

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

A-4B: Ohio DOT: A-4b, silt

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

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

PAVEMENT OR BASE: Ohio DOT: Pavement or Aggregate base

SAMPLER SYMBOLS

Thin Walled Undisturbed Sample

WELL CONSTRUCTION SYMBOLS

Soil Cuttings Backfill mixed with Bentonite Pellets or Chips

Asphalt or Concrete Pavement Patch

Notes:

1. Exploratory borings were drilled on November 20 and 21, 2023, using 3¼-inch inside diameter hollow-stem augers.

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 test borings were located in the field by CT Consultants, Inc. based on plan provided in the geotechnical proposal dated September 27, 2023.

SUMMARY OF SOIL TEST DATA
WIL-6-11.07, PID 107612

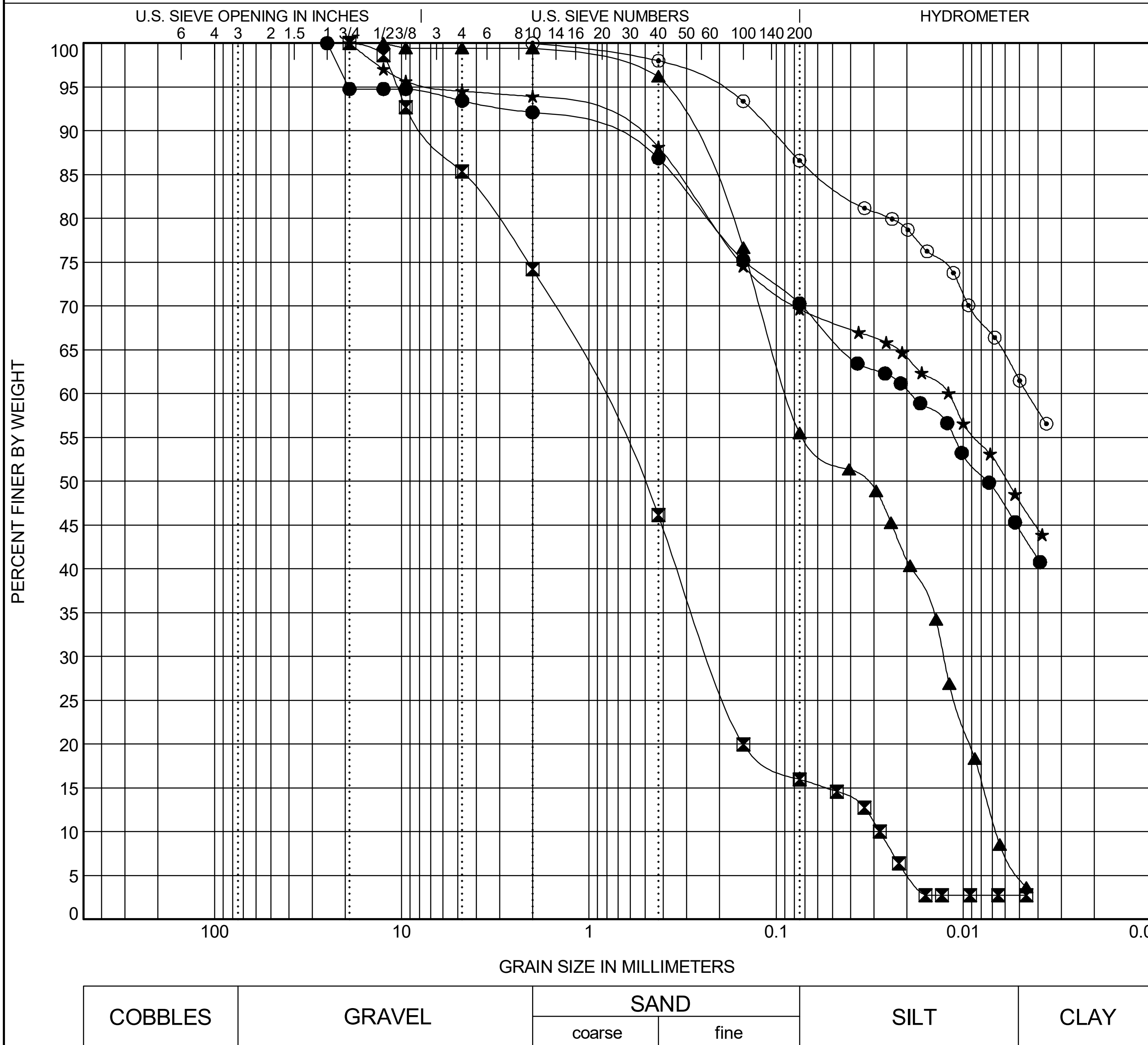
EXPLORATION ID., STATION & OFFSET	FROM - TO	SAMPLE ID	N60	% REC	tsf HP	% GR	% CS	% FS	% SILT	% CLAY	LL	PL	PI	% WC	ODOT CLASS (GI)
B-001-1-23	1.0 - 2.3	SS-1A	81	94	-	-	-	-	-	-	-	-	-	-	A-2-4 (VISUAL)
STA. 584+24, 22' RT.	2.3 - 2.5	SS-1B	-	-	>4.5	-	-	-	-	-	-	-	-	16	A-6b (VISUAL)
LATITUDE = 41.441361	3.5 - 5.0	SS-2	15	100	>4.5	-	-	-	-	-	-	-	-	18	A-6b (VISUAL)
LONGITUDE = -84.595770	6.0 - 7.5	SS-3	14	89	3.00	-	-	-	-	-	-	-	-	20	A-6b (VISUAL)
	8.0 - 8.5	ST-4A	ST	100	>4.5	-	-	-	-	-	-	-	-	-	A-6b (VISUAL)
	8.5 - 9.0	ST-4B	-	-	>4.5	8	5	17	26	44	36	17	19	16	A-6b (11)
	9.0 - 9.5	ST-4C	-	-	-	26	28	30	13	3	NP	NP	NP	7	A-1-b (0)
	9.5 - 10.0	ST-4D	-	-	-	-	-	-	-	-	-	-	-	-	A-1-b (VISUAL)
	11.0 - 12.5	SS-5	6	22	-	-	-	-	-	-	-	-	-	13	A-3a (VISUAL)
	13.5 - 15.0	SS-6	6	89	-	-	-	-	-	-	-	-	-	20	A-3a (VISUAL)
	16.0 - 17.5	SS-7	29	100	4.00	-	-	-	-	-	-	-	-	14	A-6a (VISUAL)
	18.5 - 20.0	SS-8	23	83	-	0	3	41	51	5	NP	NP	NP	19	A-4b (4)
	21.0 - 22.5	SS-9	48	72	-	-	-	-	-	-	-	-	-	7	A-1-b (VISUAL)
	23.5 - 25.0	SS-10	47	89	-	-	-	-	-	-	-	-	-	8	A-3a (VISUAL)
	26.0 - 27.5	SS-11	57	100	-	-	-	-	-	-	-	-	-	9	A-3a (VISUAL)
	28.5 - 30.0	SS-12	57	72	-	-	-	-	-	-	-	-	-	7	A-3a (VISUAL)
	31.0 - 32.5	SS-13	57	28	-	-	-	-	-	-	-	-	-	11	A-3a (VISUAL)
	33.5 - 35.0	SS-14	51	28	-	-	-	-	-	-	-	-	-	11	A-3a (VISUAL)
	36.0 - 37.5	SS-15	59	44	-	-	-	-	-	-	-	-	-	10	A-3a (VISUAL)
	38.5 - 40.0	SS-16	54	83	-	-	-	-	-	-	-	-	-	9	A-3a (VISUAL)
B-002-0-23	1.0 - 2.5	SS-1	17	78	-	-	-	-	-	-	-	-	-	6	A-2-4 (VISUAL)
STA. 584+68, 27' LT.	3.5 - 5.0	SS-2	11	100	3.25	6	6	18	22	48	36	16	20	19	A-6b (11)
LATITUDE = 41.441493	6.0 - 7.5	SS-3	12	100	3.00	-	-	-	-	-	-	-	-	20	A-6b (VISUAL)
LONGITUDE = -84.595608	8.5 - 10.0	SS-4	8	100	3.50	-	-	-	-	-	-	-	-	18	A-6b (VISUAL)
	11.0 - 13.0	ST-5	ST	75	-	-	-	-	-	-	-	-	-	-	A-6b (VISUAL)
	13.5 - 15.0	SS-6	11	89	2.00	-	-	-	-	-	-	-	-	17	A-6a (VISUAL)
	16.0 - 17.5	SS-7	32	100	>4.5	-	-	-	-	-	-	-	-	14	A-6a (VISUAL)
	18.0 - 20.0	ST-8	ST	75	>4.5	0	2	11	26	61	30	15	15	15	A-6a (10)
	21.0 - 22.5	SS-9	48	100	>4.5	-	-	-	-	-	-	-	-	11	A-6a (VISUAL)
	23.5 - 25.0	SS-10	20	100	-	-	-	-	-	-	-	-	-	19	A-3 (VISUAL)
	26.0 - 27.5	SS-11	72	100	-	-	-	-	-	-	-	-	-	17	A-3a (VISUAL)
	28.5 - 30.0	SS-12	99	83	-	-	-	-	-	-	-	-	-	13	A-3a (VISUAL)
	31.0 - 32.5	SS-13	111	83	-	-	-	-	-	-	-	-	-	17	A-3a (VISUAL)
	33.5 - 34.9	SS-14	24/36/50/5"	94	-	-	-	-	-	-	-	-	-	17	A-3a (VISUAL)
	36.0 - 37.3	SS-15	8/42/50/4"	94	-	-	-	-	-	-	-	-	-	15	A-3a (VISUAL)
	38.5 - 40.0	SS-16	102	100	-	-	-	-	-	-	-	-	-	17	A-3a (VISUAL)

GRAIN SIZE DISTRIBUTION

OHIO DEPARTMENT OF TRANSPORTION
OFFICE OF GEOTECHNICAL ENGINEERING

PROJECT WIL-6-11.07 **PID** 107612

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



Specimen Identification		ODOT (Modified AASHTO) ~ USCS Classification	LL	PL	PI
● B-001-1-23	8.5	**A-6b ~ LEAN CLAY with SAND(CL)**	36	17	19
⊠ B-001-1-23	9.0	**A-1-b ~ SILTY SAND(SM)**	NP	NP	NP
▲ B-001-1-23	18.5	**A-4b ~ SANDY SILT(ML)**	NP	NP	NP
★ B-002-0-23	3.5	**A-6b ~ SANDY LEAN CLAY(CL)**	36	16	20
⊙ B-002-0-23	18.0	**A-6a ~ LEAN CLAY(CL)**	30	15	15

Specimen Identification		D90	D50	D30	D10	%G	%CS	%FS	%M	%C	Cc	Cu
● B-001-1-23	8.5	1.069	0.007			8	5	17	26	44		
⊠ B-001-1-23	9.0	7.36	0.526	0.224	0.028	26	28	30	13	3	1.96	32.71
▲ B-001-1-23	18.5	0.305	0.034	0.013	0.007	0	3	41	51	5	0.28	12.97
★ B-002-0-23	3.5	0.697	0.006			6	6	18	22	48		
⊙ B-002-0-23	18.0	0.106				0	2	11	26	61		

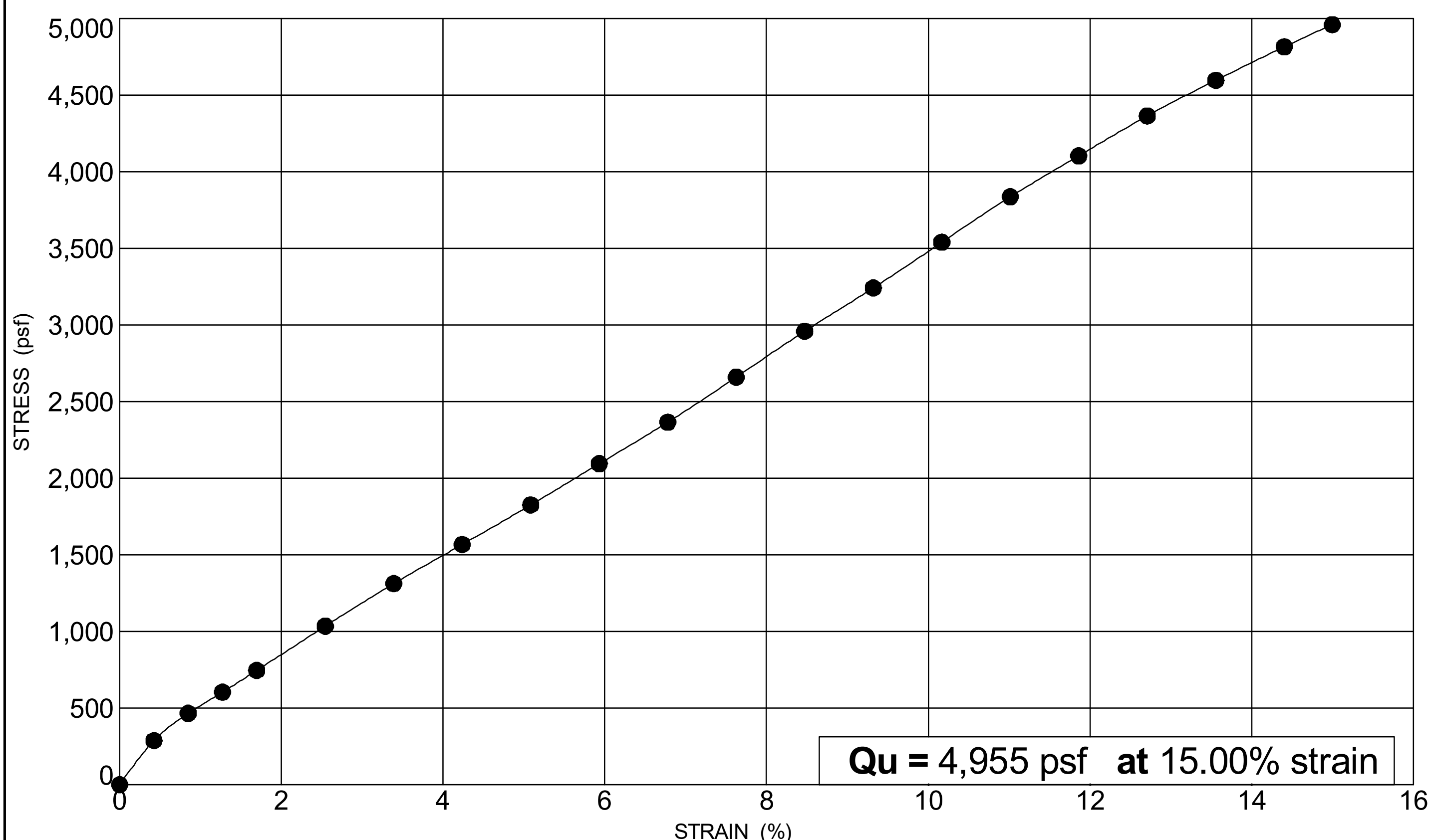
OHIO DEPARTMENT OF TRANSPORTION
OFFICE OF GEOTECHNICAL ENGINEERING

UNCONFINED COMPRESSION TEST
AASHTO T - 208

PROJECT WIL-6-11.07
PID 107612
OGE NUMBER N/A
PROJECT TYPE STRUCTURE FOUNDATION

SAMPLE IDENTIFICATION

BORING ID: B-001-1-23
SAMPLE ID: ST-4b
STATION: 584+24, 22' RT.
DEPTH: 8.5 - 9.0 feet



SPECIMEN FAILURE SKETCHES OR PHOTOGRAPHS

FRONT VIEW

SIDE VIEW

SPECIMEN DETAILS

HEIGHT: 149.900 mm
DIAMETER: 70.100 mm
WET UNIT WT: 131.76 pcf
DRY UNIT WT: 113.39 pcf

TESTED BY: KKC 12/14/2023

CLASSIFICATION RESULTS

GRADATION (%)

GR	CS	FS	SI	CL
8	5	17	26	44

ATTERBERG LIMITS / MOISTURE

LL	PL	PI	WC
36	17	19	16

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

DESCRIPTION: STIFF TO VERY STIFF, BROWN, SILTY CLAY, SOME SAND, TRACE GRAVEL, DAMP

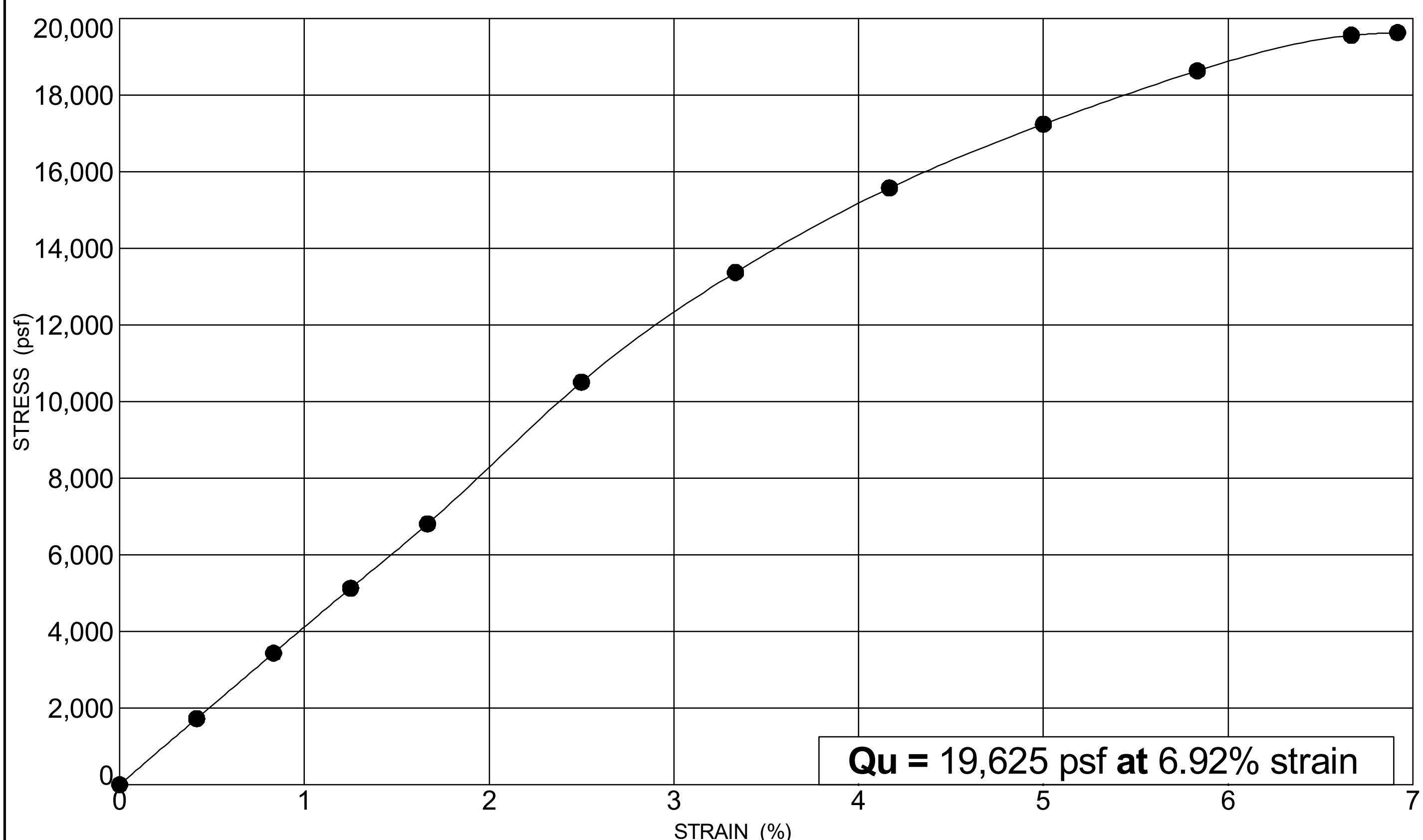
UNCONFINED COMPRESSION TEST
AASHTO T - 208

OHIO DEPARTMENT OF TRANSPORTION
OFFICE OF GEOTECHNICAL ENGINEERING

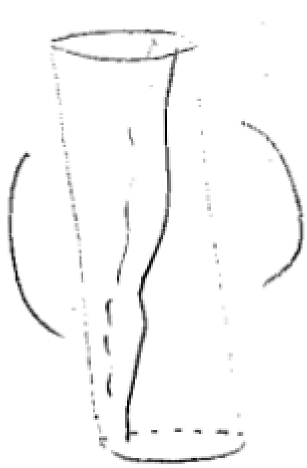
PROJECT WIL-6-11.07 **PID** 107612
OGE NUMBER N/A **PROJECT TYPE** STRUCTURE FOUNDATION

SAMPLE IDENTIFICATION

BORING ID: B-002-0-23 SAMPLE ID: ST-8
STATION: 584+68, 27' LT. DEPTH: 18.0 - 20.0 feet



SPECIMEN FAILURE SKETCHES OR PHOTOGRAPHS



FRONT VIEW SIDE VIEW

SPECIMEN DETAILS

HEIGHT: 152.400 mm
DIAMETER: 73.200 mm
WET UNIT WT: 134.76 pcf
DRY UNIT WT: 117.49 pcf

TESTED BY: KKC 12/14/2023

CLASSIFICATION RESULTS

GRADATION (%)

GR	CS	FS	SI	CL
0	2	11	26	61

ATTERBERG LIMITS / MOISTURE

LL	PL	PI	WC
30	15	15	15

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

DESCRIPTION: HARD, GRAY, SILT AND CLAY, LITTLE SAND, DAMP TO MOIST

Appendix A:
Engineering Calculations
(Including Subgrade Analysis Spreadsheet Spreadsheet)

100 YEARS
LEADING THROUGH
the next 100 years
www.ctconsultants.com

CT Project No. 232133

WIL-6-11.07, PID 107612

Calculation By: LGH 12-29-2023

Cohesive Soil Strength Evaluations

Stratum I Stiff to Very Stiff Cohesive Bearing Soils

Form surface to 18 feet and 16.8 feet (Elev. 756± and 757±)

	N60	**HP (tsf)**	**Qu (psf)**
B-001	15	4.50	-
	14	3.00	-
	-	4.50	4,955
	29	4.00	-
B-002	11	3.25	3,440
	12	3.00	-
	8	3.50	-
	-	-	-
	11	2.00	-
Minimum:	**8**	**2**	**3,440**
c (psf): N60x250/2=	1,000		
c (psf)=		2,000	1,720
Average:	**14.3**	**3.5**	**4,198**
c (psf): N60x250/2=	1,786		
c (psf)=		3,469	2,099
Average of Min., c =	1,573	psf	
Average of Avg., c =	2,451	psf	
	say su = c =	**1,750**	**psf**

CT Project No. 232133

WIL-6-11.07, PID 107612

Calculation By: LGH 12-29-2023

Cohesive Soil Strength Evaluations

Stratum II Hard Cohesive Bearing Soils

16.6 feet to 23 feet (Elev. 757± to 751±)

	N60	**HP (tsf)**	**Qu (psf)**
B-002	32	4.50	-
	-	4.50	19,625
	48	4.50	-
Minimum:	**32**	**4.5**	**19,625**
c (psf): N60x250/2=	4,000		
c (psf)=		4,500	9,813
Average:	**40.0**	**4.5**	**19,625**
c (psf): N60x250/2=	5,000		
c (psf)=		4,500	9,813
Average of Min., c =	6,104	psf	
Average of Avg., c =	6,438	psf	
	conservitavly say su = c =	**6,000**	**psf**

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CT Project No. 232133

WIL-6-11.07, PID 107612

Calculation By: LGH 12-29-2023

Granular Phi Angle Evaluations

Startum III Medium Dense Granular Soils From 18 to 21 feet in B-001 (Elev. 756 to 753)

Granular Startum III consited of ODOT A-4b (NP) and A-3 soils

Ground water generally encountered at 14'

Geotechnical Design Manual

404.2 Granular Soils

For granular soils, use SPT $N1_{60}$ and the relative percentage of fine or coarse materials in the soil/soil classification, in accordance with the AASHTO LRFD Article 10.4.6.2.4 to estimate the drained friction angle of the soil. Use the middle of the range of friction angles presented on each line in AASHTO LRFD Table 10.4.6.2.4-1, and apply the adjustment according to Table 400-3:

Table 400-3: ϕ' Adjustment

Soil Class	Adjustment
A-1-a	+2.5°
A-1-b	+1.5°
A-2-4	+0.5°
A-2-5	-0.5°
A-2-6	-0.5°
A-2-7	-0.5°
A-3	-1.5°
A-3a	-0.5°
A-4a	-2.5°
A-4b	-2.5°

The values of SPT $N1_{60}$ on each line of AASHTO LRFD Table 10.4.6.2.4-1 may be linearly interpolated for intermediate values. For example, SPT $N1_{60} = 4$ corresponds to a middle-range value of 29.5°, and SPT $N1_{60} = 10$ corresponds to a middle-range value of 32.5°; therefore, SPT $N1_{60} = 8$ corresponds to a middle-range value of approximately 31.5° by linear interpolation. If the soil was a Sandy Silt (A-4a) Soil class, the drained friction angle can be approximated as 31.5° - 2.5° = 29°.

For very dense granular soils, do not use a drained friction angle of $\phi' > 45°$. Considering the correlations published by Meyerhof (1956) and Bowles (1977), and the limits of the tabulated data in AASHTO LRFD Table 10.4.6.2.4-1 and publication FHWA-NHI-16-072 (GEC 5), we consider this to be a reasonably conservative limit for very dense granular soil.

AASHTO LRFD

$C_N = [0.77 \log_{10}(40/\sigma'_v)]$, and $C_N < 2.0$

σ'_v = vertical effective stress (ksf)

$$N1_{60} = C_N N_{60} \quad (10.4.6.2.4\text{-}3)$$

The drained friction angle of granular deposits should be determined based on the following correlation.

Table 10.4.6.2.4-1—Correlation of *SPT* $N1_{60}$ Values to Drained Friction Angle of Granular Soils (modified after Bowles, 1977)

$N1_{60}$	ϕ_f
<4	25–30
4	27–32
10	30–35
30	35–40
50	38–43

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Startum III Medium Dense Granular Soils From 18 to 21 feet in B-001 (Elev. 756 to 753)

Effective Overburden Pressure				
Layer	Depth (ft)	Thichness	γ_{TOTAL} (pcf)	Pressure* (psf)
1	2	2	120	240
2	9	7	130	910
3	14	5	120	600
4	16	2	56	112
5	18	2	66	132
6	19.5	1.5	56	42
Leave Blank				
*Last layer pressure contribution taken in middle of layer			Sum	2.04 ksf

C_N = 0.77*LOG10(40/ksf	1.00	
N_{60} =	21.5	*AVERAGE(20,23)*
$N1_{60} = C_N * N_{60}$ =	21	

from Table 10.4.6.2.4-1	min	max	Average
$N1_{60}$ = 10	30	35	32.5
$N1_{60}$ = 30	35	40	37.5

	$N1_{60}$	Average Phi	Interpolate (linear)	
	10	32.5		
	30	37.5	Average	35
Find	21		min	30
			max	40

	Phi ajustment	Ajusted average Phi
A-1-b	1.5	36.5
A-3	-1.5	33.5
A-3a	-0.5	34.5
A-4b	-2.5	32.5

use Phi = 32 degrees

Stratum III

CT Project No. 232133

WIL-6-11.07, PID 107612

Calculation By: LGH 12-29-2023

Granular Phi Angle Evaluations

Startum IV Dense to Very Granular Soils From 21 to 40 feet in B-001 (Elev. 753 to 734)

Granular Startum IV consited of ODOT A-1-b and A-3a soils

Ground water generally encountered at 14'

Geotechnical Design Manual

404.2 Granular Soils

For granular soils, use SPT $N1_{60}$ and the relative percentage of fine or coarse materials in the soil/soil classification, in accordance with the AASHTO LRFD Article 10.4.6.2.4 to estimate the drained friction angle of the soil. Use the middle of the range of friction angles presented on each line in AASHTO LRFD Table 10.4.6.2.4-1, and apply the adjustment according to Table 400-3:

Table 400-3: ϕ' Adjustment

Soil Class	Adjustment
A-1-a	+2.5°
A-1-b	+1.5°
A-2-4	+0.5°
A-2-5	-0.5°
A-2-6	-0.5°
A-2-7	-0.5°
A-3	-1.5°
A-3a	-0.5°
A-4a	-2.5°
A-4b	-2.5°

The values of SPT $N1_{60}$ on each line of AASHTO LRFD Table 10.4.6.2.4-1 may be linearly interpolated for intermediate values. For example, SPT $N1_{60}$ = 4 corresponds to a middle-range value of 29.5°, and SPT $N1_{60}$ = 10 corresponds to a middle-range value of 32.5°; therefore, SPT $N1_{60}$ = 8 corresponds to a middle-range value of approximately 31.5° by linear interpolation. If the soil was a Sandy Silt (A-4a) Soil class, the drained friction angle can be approximated as 31.5° - 2.5° = 29°.

For very dense granular soils, do not use a drained friction angle of $\phi' > 45°$. Considering the correlations published by Meyerhof (1956) and Bowles (1977), and the limits of the tabulated data in AASHTO LRFD Table 10.4.6.2.4-1 and publication FHWA-NHI-16-072 (GEC 5), we consider this to be a reasonably conservative limit for very dense granular soil.

AASHTO LRFD

C_N = $[0.77 \log_{10}(40/\sigma'_v)]$, and $C_N < 2.0$

σ'_v = vertical effective stress (ksf)

$$N1_{60} = C_N N_{60} \quad (10.4.6.2.4\text{-}3)$$

The drained friction angle of granular deposits should be determined based on the following correlation.

Table 10.4.6.2.4-1—Correlation of *SPT* $N1_{60}$ Values to Drained Friction Angle of Granular Soils (modified after Bowles, 1977)

$N1_{60}$	ϕ_f
<4	25–30
4	27–32
10	30–35
30	35–40
50	38–43

Startum IV Dense to Very Granular Soils From 21 to 40 feet in B-001 (Elev. 753 to 734)

Effective Overburden Pressure				
Layer	Depth (ft)	Thichness	γ_{TOTAL} (pcf)	Pressure* (psf)
1	2	2	120	240
2	9	7	130	910
3	14	5	120	600
4	16	2	56	112
5	18	2	66	132
6	21	3	56	168
7	26	5	61	152.5
Leave Blank				
			Sum	2.31 ksf

C_N = 0.77*LOG10(40/ksf	0.95	
N_{60} =	47.5	*AVERAGE(48,47)*

(N_{60} values in the granular soil ranged from 47 to SSR. The higher N_{60} values where lower than the antisipated bearing elevation. Bearing elevations are anticipated to be near the top of the granular layer in B-001. To be conservative, the lower N_{60} values from the top of this stratum were selected.)

$N1_{60} = C_N * N_{60}$ =	45		
from Table 10.4.6.2.4-1	min	max	Average
$N1_{60}$ = 30	35	40	37.5
$N1_{60}$ = 50	38	43	40.5

	$N1_{60}$	Average Phi	Interpolate (linear)	
	30	37.5		
	50	40.5	Average	39
Find	45		min	35
			max	43

	Phi ajustment	Ajusted average Phi					
A-1-b	1.5	40.5					
A-3	-1.5	37.5			**use Phi =**	**39**	**degrees**
A-3a	-0.5	38.5				Stratum IV	

CT Project No. 232133
WIL-6-11.07, PID 107612

Calculation By: LGH 12-29-2023

Granular Phi Angle Evaluations

Zone within Startum I Loose Granular Soils From 9 to 16 feet in B-001 (Elev. 764.7 to 757.7)
Granular Startum IV consited of ODOT A-1-b and A-3a soils
Ground water generally encountered at 14'

Geotechnical Design Manual

404.2 Granular Soils

For granular soils, use SPT N1₆₀ and the relative percentage of fine or coarse materials in the soil/soil classification, in accordance with the AASHTO LRFD Article 10.4.6.2.4 to estimate the drained friction angle of the soil. Use the middle of the range of friction angles presented on each line in AASHTO LRFD Table 10.4.6.2.4-1, and apply the adjustment according to Table 400-3:

Table 400-3: ϕ' Adjustment

Soil Class	Adjustment
A-1-a	+2.5°
A-1-b	+1.5°
A-2-4	+0.5°
A-2-5	-0.5°
A-2-6	-0.5°
A-2-7	-0.5°
A-3	-1.5°
A-3a	-0.5°
A-4a	-2.5°
A-4b	-2.5°

The values of SPT $N1_{60}$ on each line of AASHTO LRFD Table 10.4.6.2.4-1 may be linearly interpolated for intermediate values. For example, SPT $N1_{60}$ = 4 corresponds to a middle-range value of 29.5°, and SPT $N1_{60}$ = 10 corresponds to a middle-range value of 32.5°; therefore, SPT $N1_{60}$ = 8 corresponds to a middle-range value of approximately 31.5° by linear interpolation. If the soil was a Sandy Silt (A-4a) Soil class, the drained friction angle can be approximated as 31.5° - 2.5° = 29°.

For very dense granular soils, do not use a drained friction angle of $\phi' > 45°$. Considering the correlations published by Meyerhof (1956) and Bowles (1977), and the limits of the tabulated data in AASHTO LRFD Table 10.4.6.2.4-1 and publication FHWA-NHI-16-072 (GEC 5), we consider this to be a reasonably conservative limit for very dense granular soil.

AASHTO LRFD

C_N = $[0.77 \log_{10}(40/\sigma'_v)]$, and $C_N < 2.0$

σ'_v = vertical effective stress (ksf)

$$N1_{60} = C_N N_{60} \quad (10.4.6.2.4\text{-}3)$$

The drained friction angle of granular deposits should be determined based on the following correlation.

Table 10.4.6.2.4-1—Correlation of *SPT* $N1_{60}$ Values to Drained Friction Angle of Granular Soils (modified after Bowles, 1977)

$N1_{60}$	ϕ_f
<4	25–30
4	27–32
10	30–35
30	35–40
50	38–43

Zone within Startum I Loose Granular Soils From 9 to 16 feet in B-001 (Elev. 764.7 to 757.7)

Effective Overburden Pressure

Layer	Depth (ft)	Thichness	γ_{TOTAL} (pcf)	Pressure* (psf)
1	2	2	120	240
2	9	7	130	910
3	12.5	3.5	120	210
4				
5				
6				
7				
Leave Blank				

*Last layer pressure contribution taken in middle of layer

Sum 1.36 ksf

C_N = 0.77*LOG10(40/ksf	1.13
N_{60} =	6
$N1_{60} = C_N * N_{60}$ =	7

from Table 10.4.6.2.4-1	min	max	Average
$N1_{60}$ = 4	27	32	29.5
$N1_{60}$ = 10	30	35	32.5

	$N1_{60}$	Average Phi	Interpolate (linear)	
	4	29.5		
	10	32.5	Average	30
Find	7		min	27
			max	35

	Phi ajustment	Ajusted average Phi				
A-1-b	1.5	31.5				
A-3	-1.5	28.5		**use Phi =**	**29**	**degrees**
A-3a	-0.5	29.5			Stratum IV	

CT Project No. 232133

WIL-6-11.07, PID 107612

Calculation By: LGH 1-02-2024

Cohesive Phi' Angle Evaluations (ESSP)

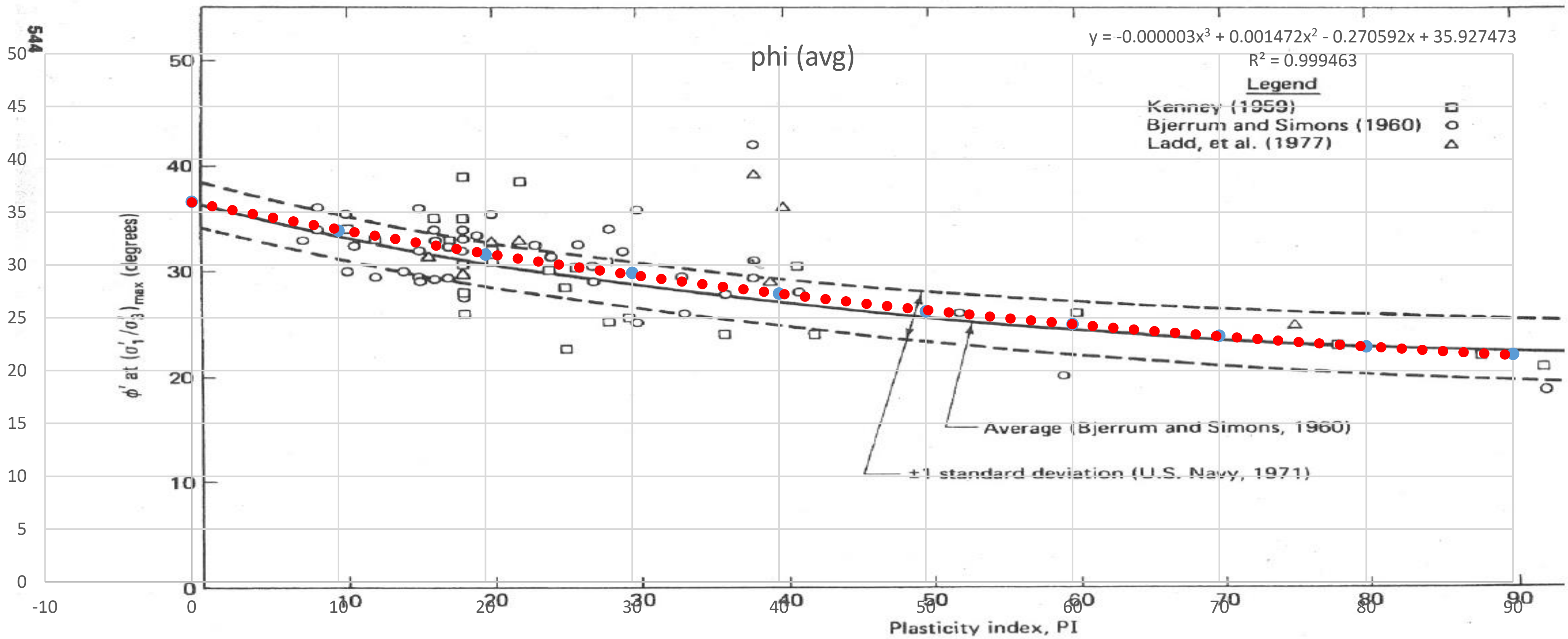


Fig. 11.27 Empirical correlation between φ' and PI from triaxial compression tests on normally consolidated undisturbed clays (after U.S. Navy, 1971 and Ladd, et al., 1977).

Boring ID	Stratum	FROM	-	TO	SAMPLE ID	LL	PL	PI	ODOT CLASS (GI)	average Phi' based on PI
B-001	I	8.5	-	9.0	ST-4B	36	17	19	A-6b (11)	31.30
B-002	I	3.5	-	5.0	SS-2	36	16	20	A-6b (11)	31.08
B-002	II	18.0	-	20.0	ST-8	30	15	15	A-6a (10)	32.19

Startum	**Phi' to Use**
I	**31**
II	**32**

Proj No. 232133 Calc LGH 2/13/2023
Checked CPI 2/13/2023

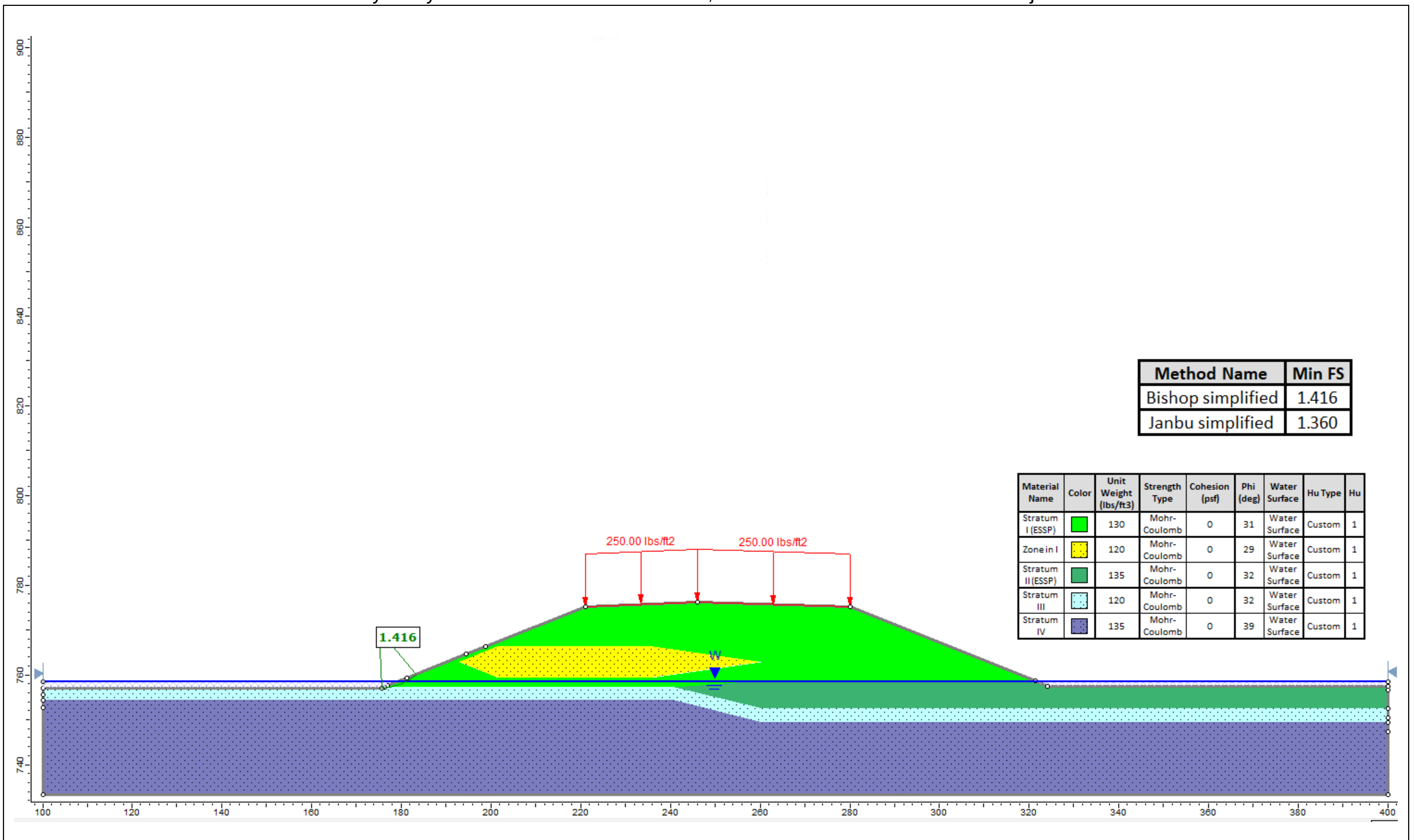
SOIL UNIT WEIGHT DETERMINATION

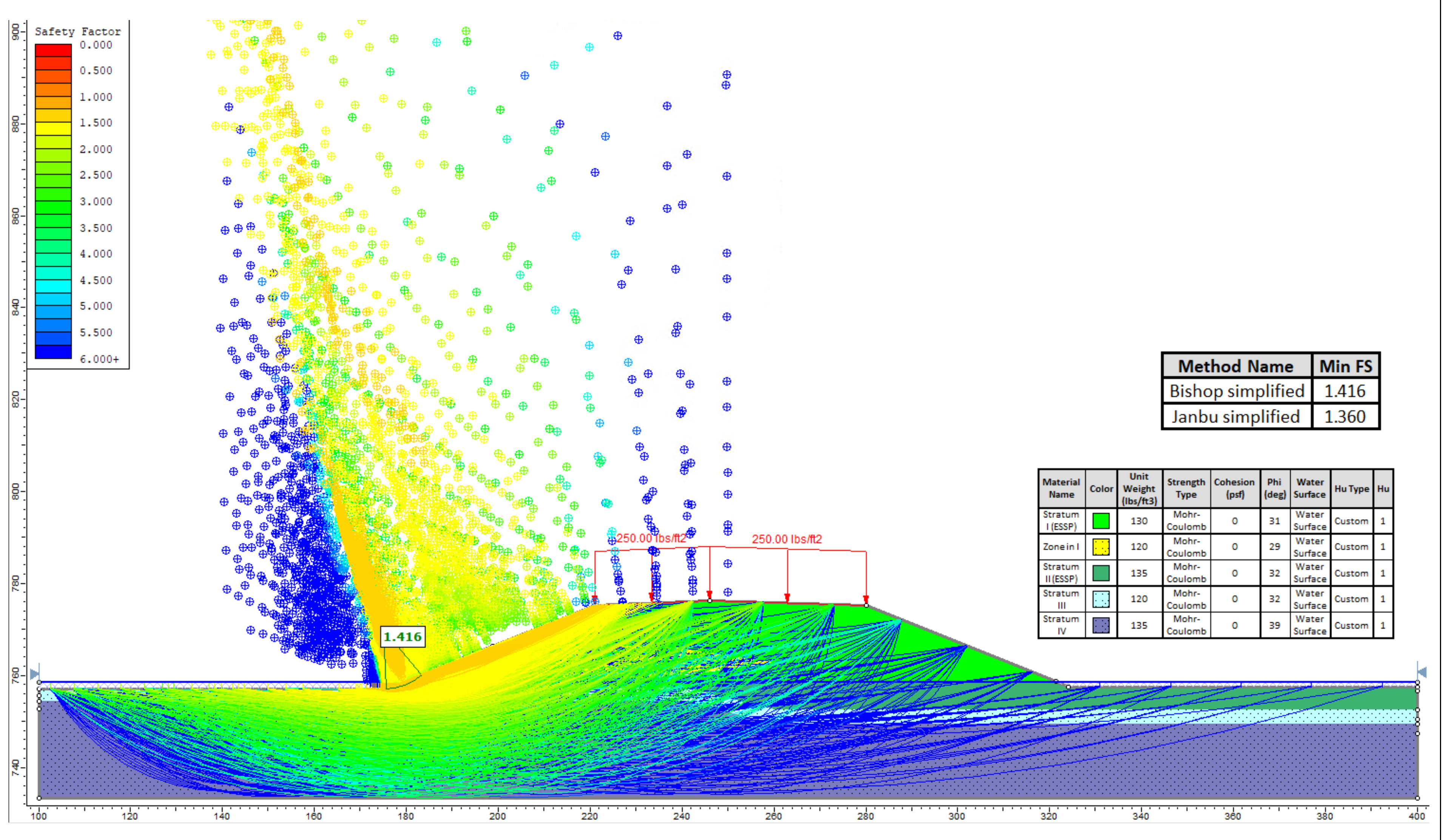
Stratum	Density Determined by Testing (Density of ST and SS Samples)	Wet Density Determined by Correlation (GDM Table 400-4)	Use
I	Generally ranging from 130 to 135 psf	Generally ranging from 120 to 125 psf	130 psf for Statum I
Granular Zone	N/a	On the order of 120	120 psf for Granular Zone
II	On the order of 135	Generally ranging from 130 to 135 psf	135 psf for Statum II
III	N/a	On the order of 120	120 psf for Statum III
IV	N/a	On the order of 130 to 140	130 psf for Statum IV

EXPLOR. ID	FROM	-	TO	SAMPLE ID	N60	% REC	tsf HP	% GR	% CS	% FS	% SILT	% CLAY	LL	PL	PI	% WC	ODOT CLASS (GI)	ppm SO4	Tested Wet_Density	Correlation Wet_Density by N60
B-001-1-23	1	-	2.3	SS-1A	81	94	-	-	-	-	-	-	-	-	-	-	A-2-4 (VISUAL)	-		140
B-001-1-23	2.3	-	2.5	SS-1B	-	-	>4.5	-	-	-	-	-	-	-	-	16	A-6b (VISUAL)	-		
B-001-1-23	3.5	-	5	SS-2	15	100	>4.5									18	A-6b (VISUAL)	-		122
B-001-1-23	6	-	7.5	SS-3	14	89	3									20	A-6b (VISUAL)	-		122
B-001-1-23	8	-	8.5	ST-4A	ST	100	>4.5									-	A-6b (VISUAL)	-		
B-001-1-23	8.5	-	9	ST-4B	-	-	>4.5									16	A-6b (11)	-	131.8	
B-001-1-23	9	-	9.5	ST-4C	-	-	-									7	A-1-b (0)	-		
B-001-1-23	9.5	-	10	ST-4D	-	-	-									-	A-1-b (VISUAL)	-		
B-001-1-23	11	-	12.5	SS-5	6	22	NP									13	A-3a (VISUAL)	-		118
B-001-1-23	13.5	-	15	SS-6	6	89	NP									20	A-3a (VISUAL)	-		118
B-001-1-23	16	-	17.5	SS-7	29	100	4									14	A-6a (VISUAL)	-	137.2	128
B-001-1-23	18.5	-	20	SS-8	23	83	NP									19	A-4b (4)	-	121.6	122
B-001-1-23	21	-	22.5	SS-9	48	72	NP									7	A-1-b (VISUAL)	-		130
B-001-1-23	23.5	-	25	SS-10	47	89	NP									8	A-3a (VISUAL)	-		130
B-001-1-23	26	-	27.5	SS-11	57	100	NP									9	A-3a (VISUAL)	-		135
B-001-1-23	28.5	-	30	SS-12	57	72	NP									7	A-3a (VISUAL)	-		135
B-001-1-23	31	-	32.5	SS-13	57	28	NP									11	A-3a (VISUAL)	-		135
B-001-1-23	33.5	-	35	SS-14	51	28	NP									11	A-3a (VISUAL)	-		130
B-001-1-23	36	-	37.5	SS-15	59	44	NP									10	A-3a (VISUAL)	-		135
B-001-1-23	38.5	-	40	SS-16	54	83	NP									9	A-3a (VISUAL)	-		130
B-002-0-23	1	-	2.5	SS-1	17	78	-	-	-	-	-	-	-	-	-	6	A-2-4 (VISUAL)	-		122
B-002-0-23	3.5	-	5	SS-2	11	100	3.25	6	6	18	22	48	36	16	20	19	A-6b (11)	-	127.3	120
B-002-0-23	6	-	7.5	SS-3	12	100	3	-	-	-	-	-	-	-	-	20	A-6b (VISUAL)	-		120
B-002-0-23	8.5	-	10	SS-4	8	100	3.5	-	-	-	-	-	-	-	-	18	A-6b (VISUAL)	-		118
B-002-0-23	11	-	13	ST-5	ST	75	-	-	-	-	-	-	-	-	-	-	A-6b (VISUAL)	-		
B-002-0-23	13.5	-	15	SS-6	11	89	2	-	-	-	-	-	-	-	-	17	A-6a (VISUAL)	-		120
B-002-0-23	16	-	17.5	SS-7	32	100	>4.5	-	-	-	-	-	-	-	-	14	A-6a (VISUAL)	-		128
B-002-0-23	18	-	20	ST-8	ST	75	>4.5	0	2	11	26	61	30	15	15	15	A-6a (10)	-	134.8	
B-002-0-23	21	-	22.5	SS-9	48	100	>4.5	-	-	-	-	-	-	-	-	11	A-6a (VISUAL)	-		135
B-002-0-23	23.5	-	25	SS-10	20	100	NP	-	-	-	-	-	-	-	-	19	A-3 (VISUAL)	-		122
B-002-0-23	26	-	27.5	SS-11	72	100	NP	-	-	-	-	-	-	-	-	17	A-3a (VISUAL)	-		140
B-002-0-23	28.5	-	30	SS-12	99	83	NP	-	-	-	-	-	-	-	-	13	A-3a (VISUAL)	-		140
B-002-0-23	31	-	32.5	SS-13	100	83	NP	-	-	-	-	-	-	-	-	17	A-3a (VISUAL)	-		140
B-002-0-23	33.5	-	34.9	SS-14	100	94	NP	-	-	-	-	-	-	-	-	17	A-3a (VISUAL)	-		140
B-002-0-23	36	-	37.3	SS-15	100	94	NP	-	-	-	-	-	-	-	-	15	A-3a (VISUAL)	-		140
B-002-0-23	38.5	-	40	SS-16	100	100	NP	-	-	-	-	-	-	-	-	17	A-3a (VISUAL)	-		140

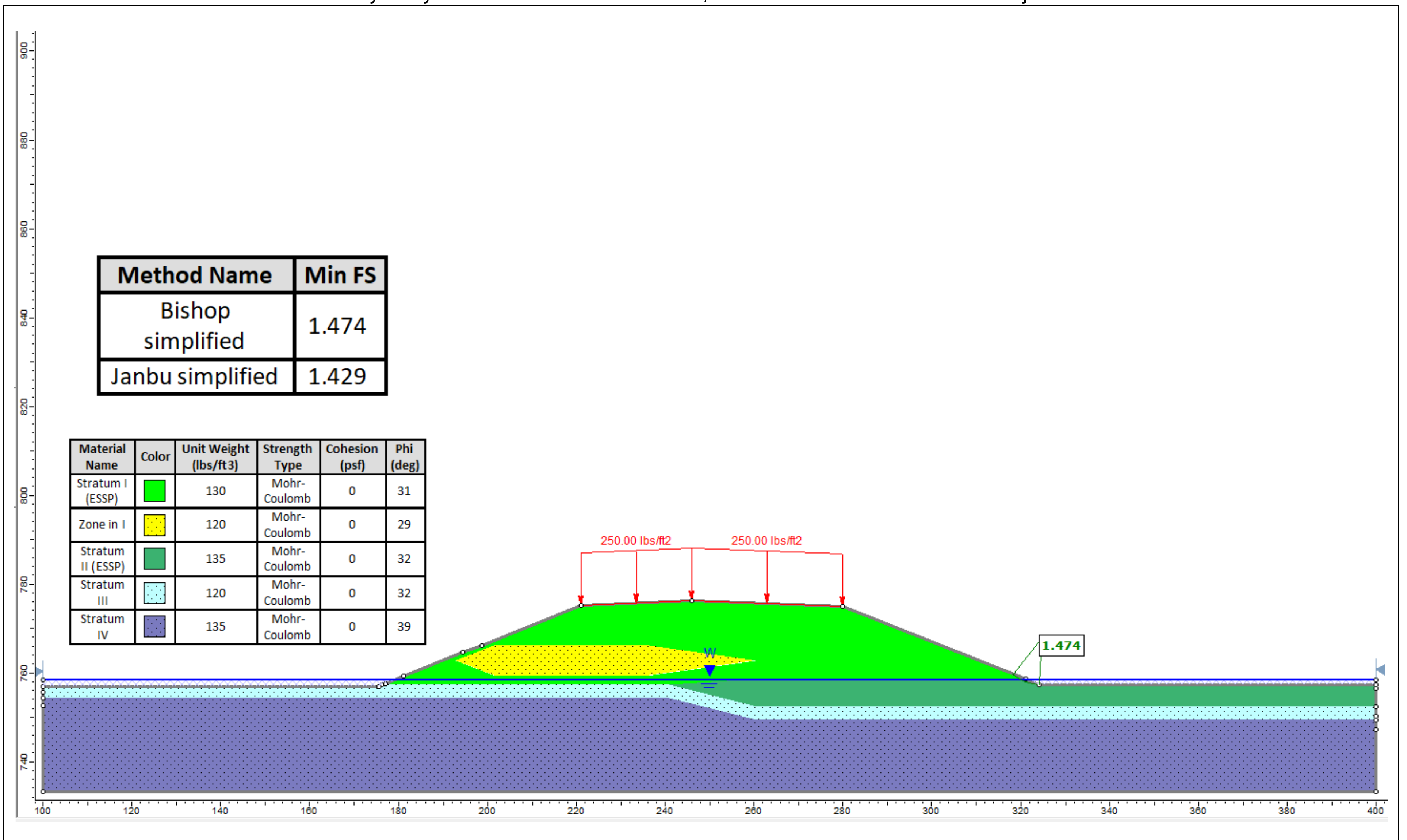
Table 400-4: Soil Unit Weight Estimated from N_{60}

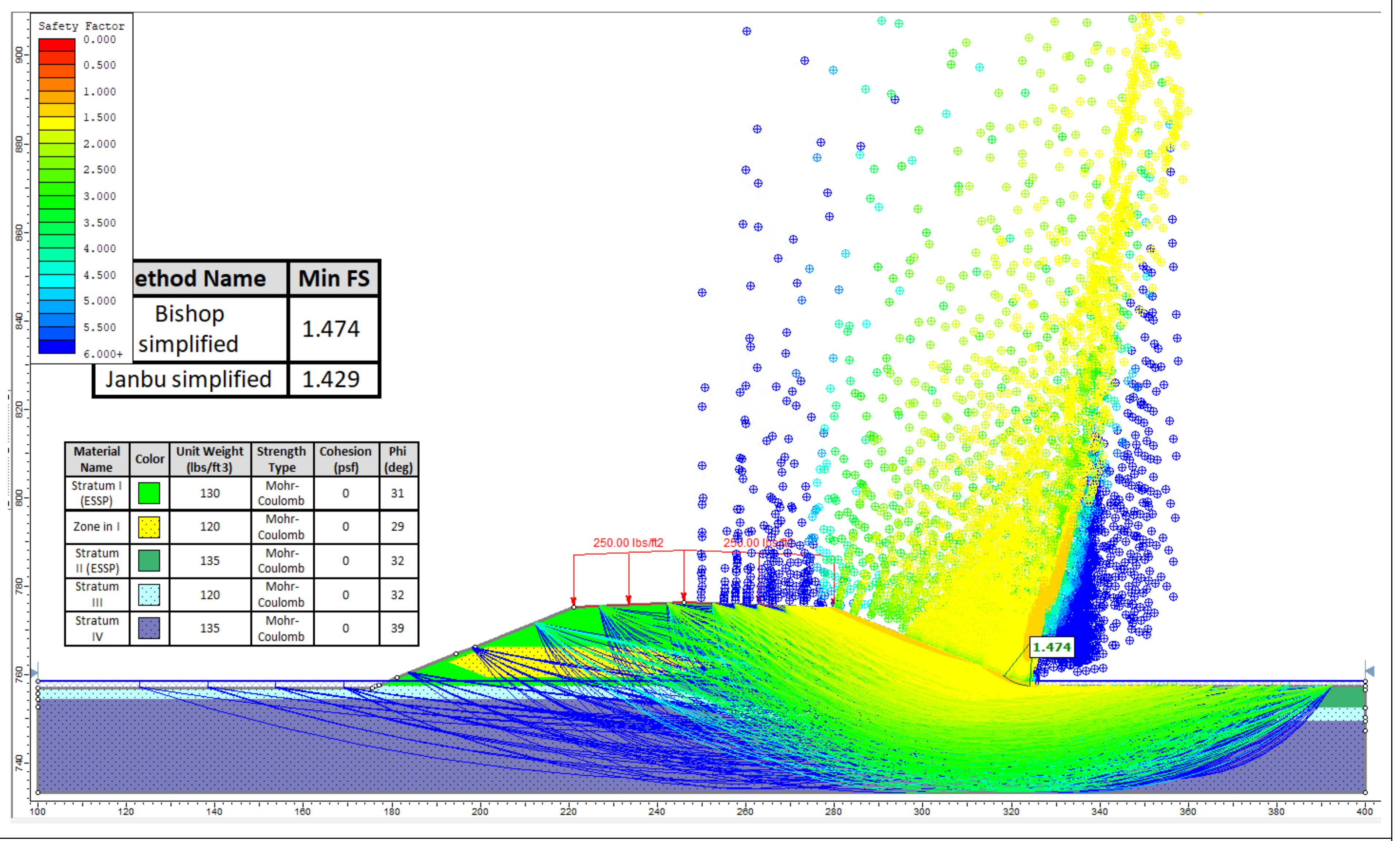
Cohesive N_{60}	Granular N_{60}	γ_{tot} (pcf)
0	-	100
1	-	105
2	-	108
3	0	110
4	-	112
5-6	1-2	115
7-9	3-5	118
10-13	6-8	120
14-19	9-14	122
20-27	15-24	125
28-35	25-34	128
36-39	35-44	130
40-43	45-54	132
44-51	55-64	135
52+	65+	140



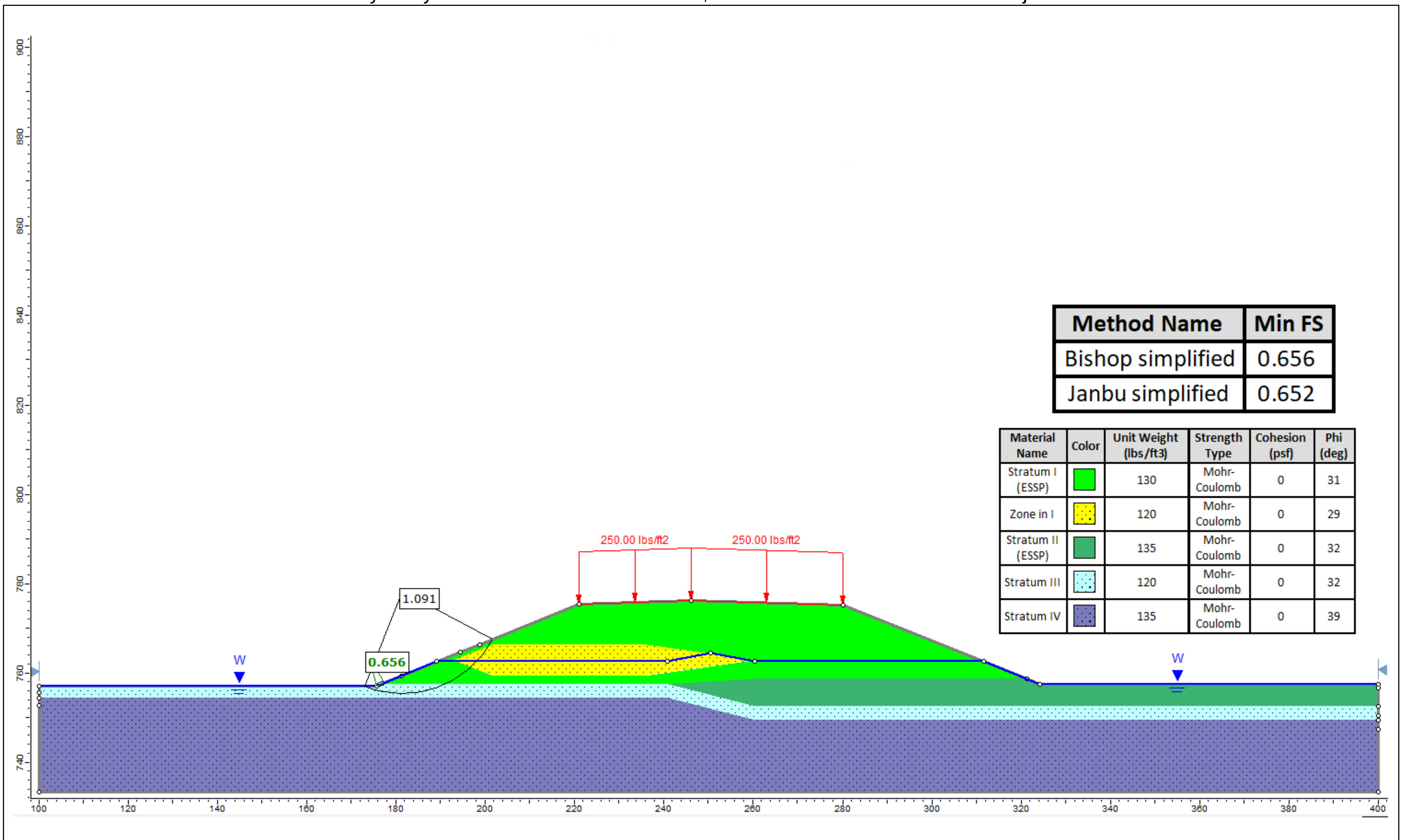


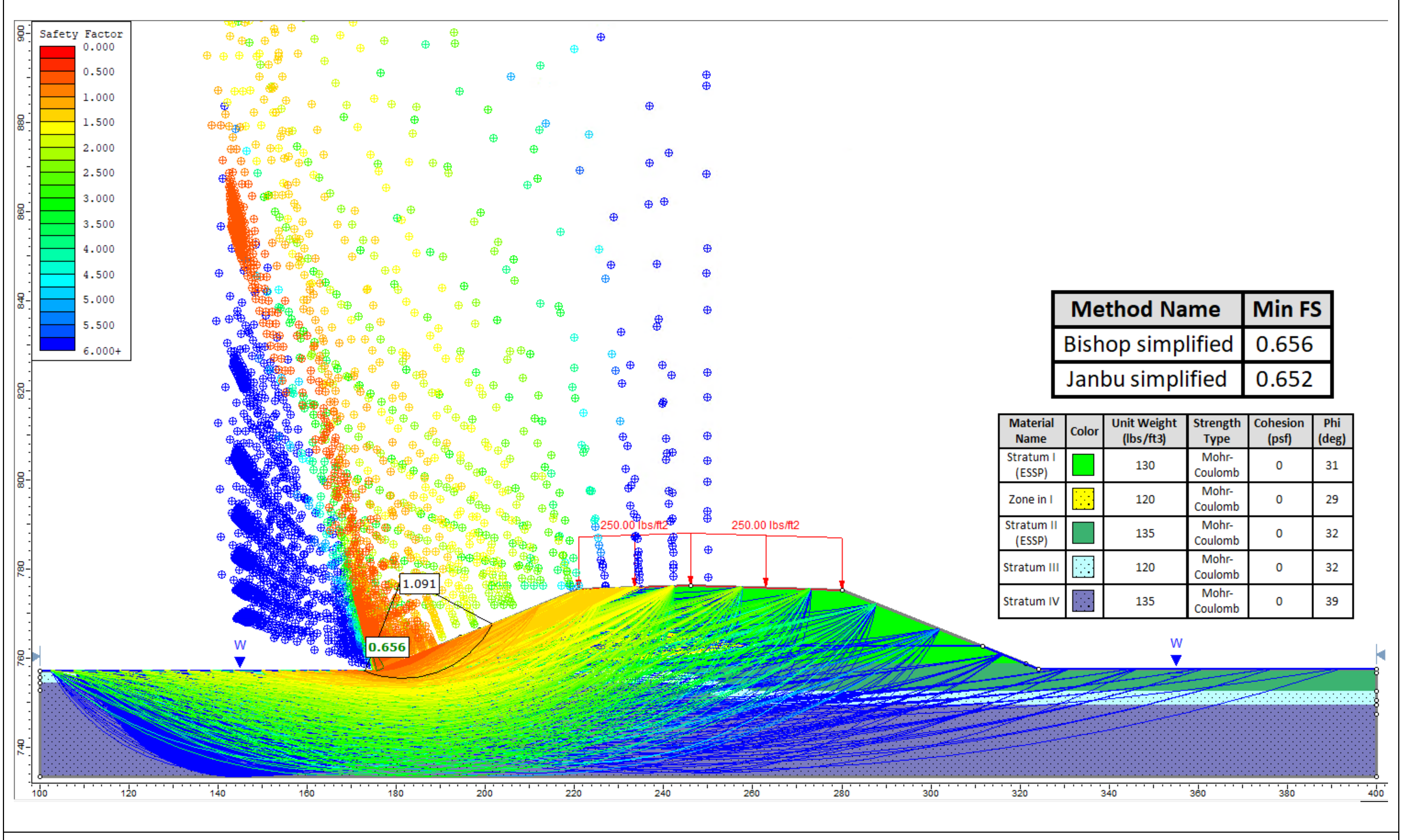
Long Term, Effective Stress Soil Parameters (ESSP)
Existing Soils at 2½H:1V | Ordinary High Water Mark: 758.56 Feet
Failure Direction: Right to Left (<--)





Long Term, Effective Stress Soil Parameters (ESSP)
Existing Soils at 2½H:1V | Ordinary High Water Mark: 758.56 Feet
Failure Direction: Left to Right (-->)

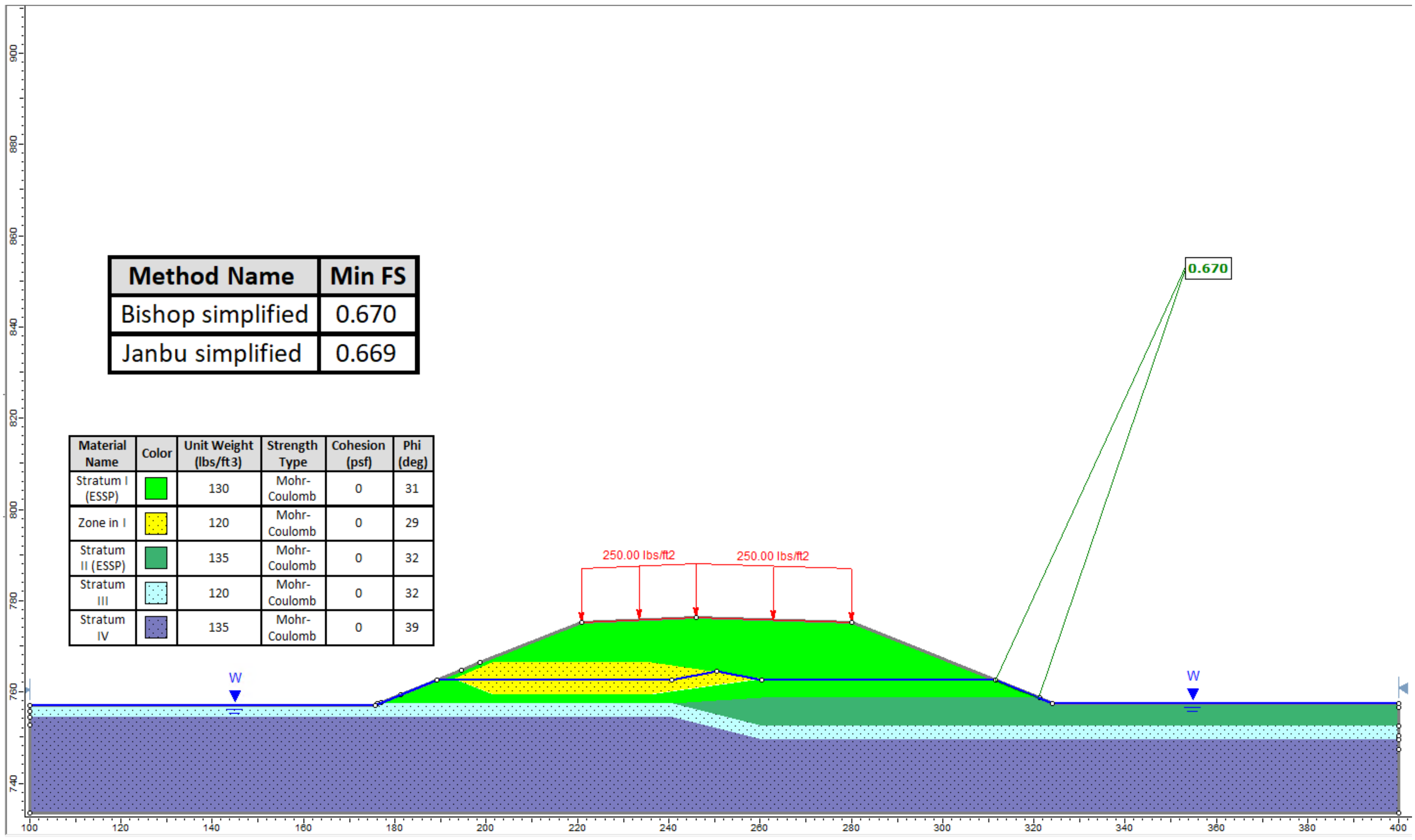


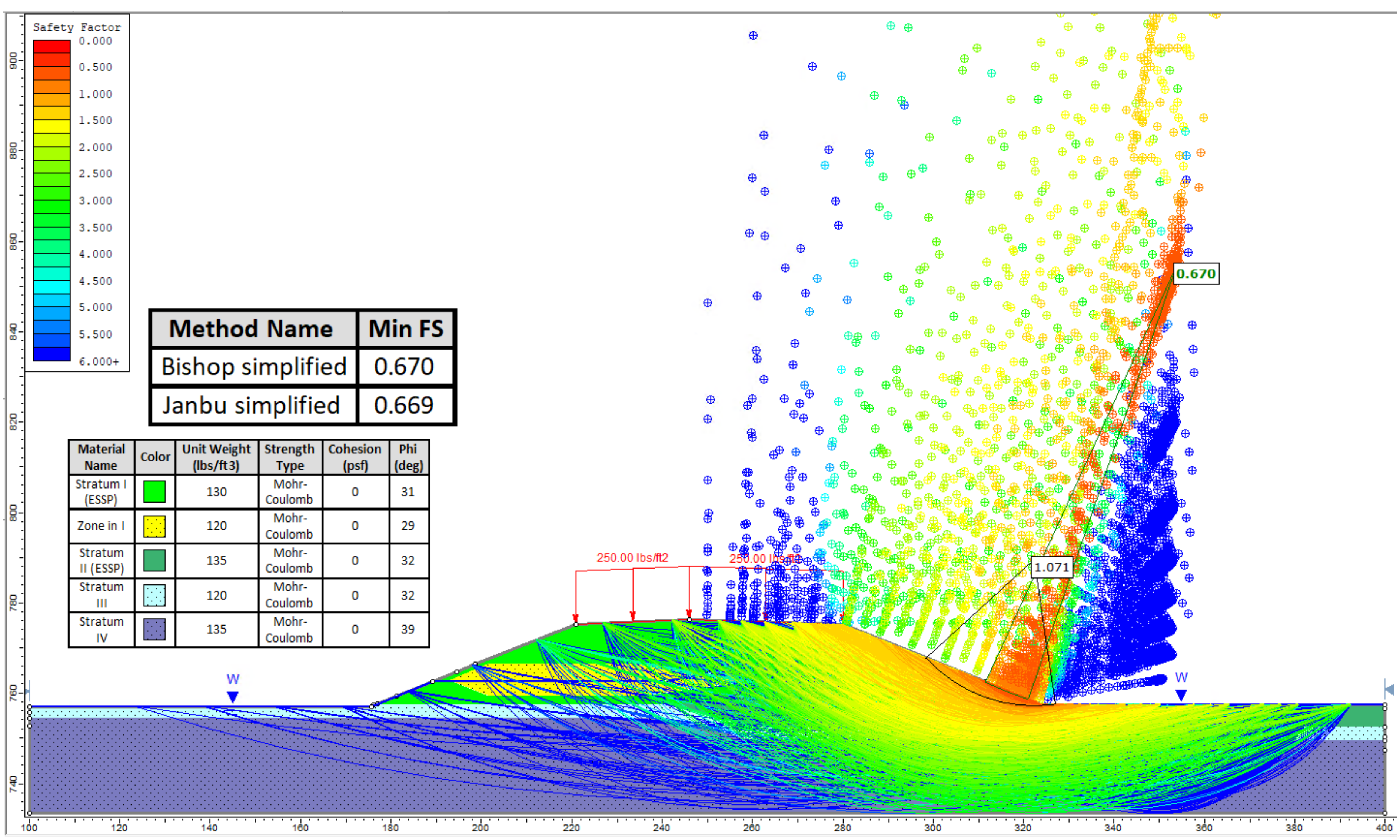


Long Term, Effective Stress Soil Parameters (ESSP)

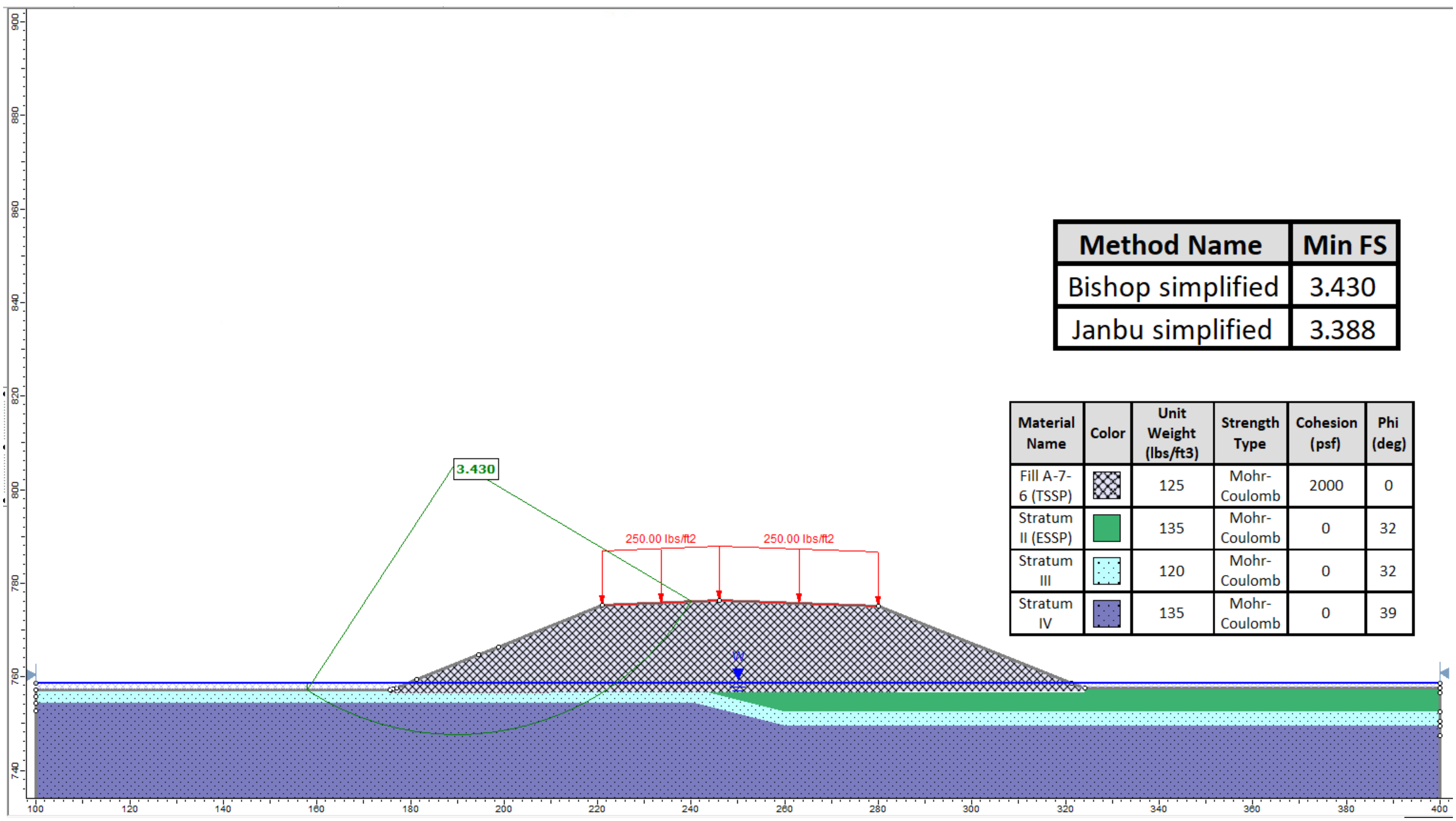
Existing Soils at 2½H:1V | Rapid Drawdown from 100 Year High Water Mark: 762.56 Feet

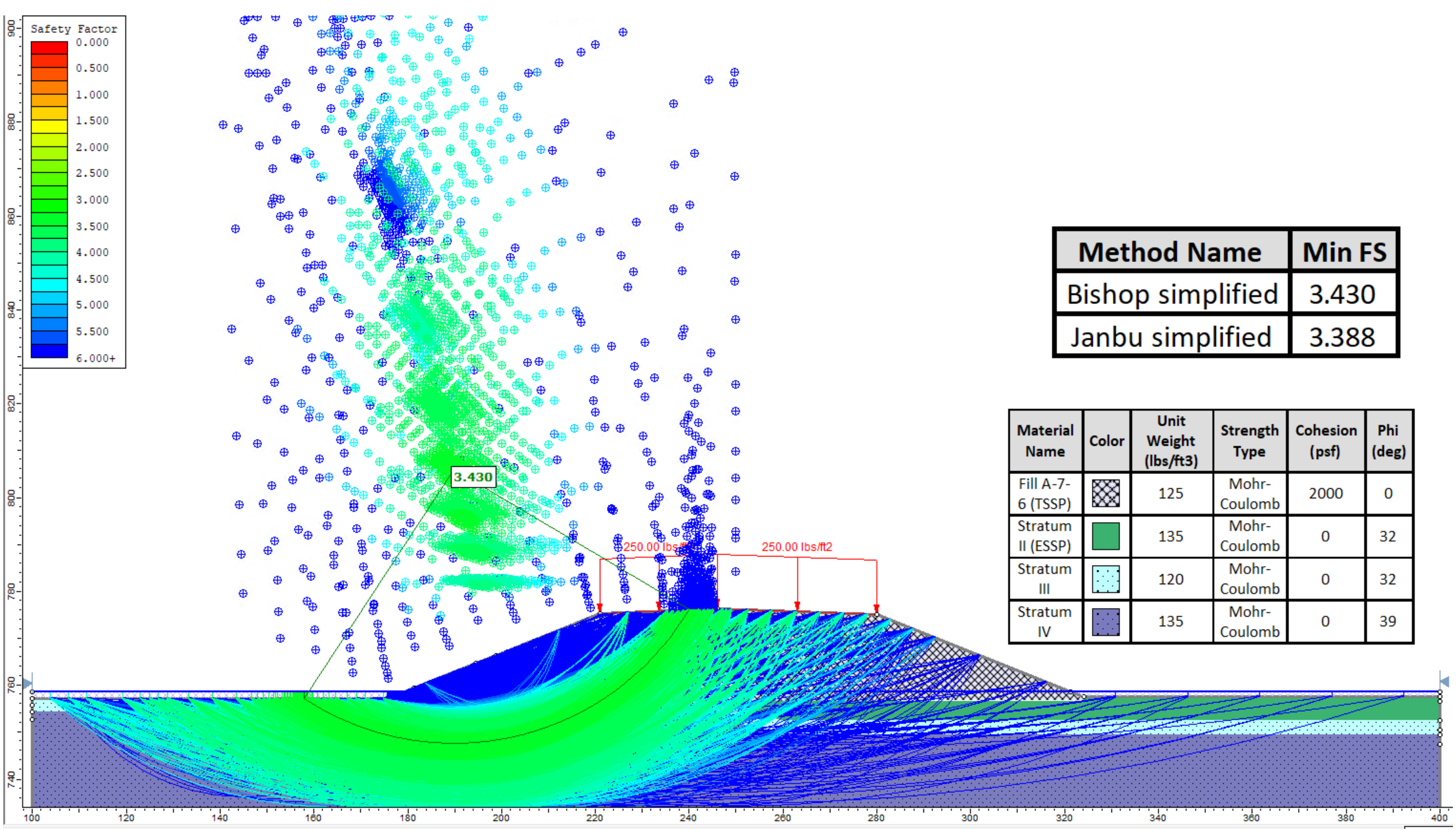
Failure Direction: Right to Left (<--)



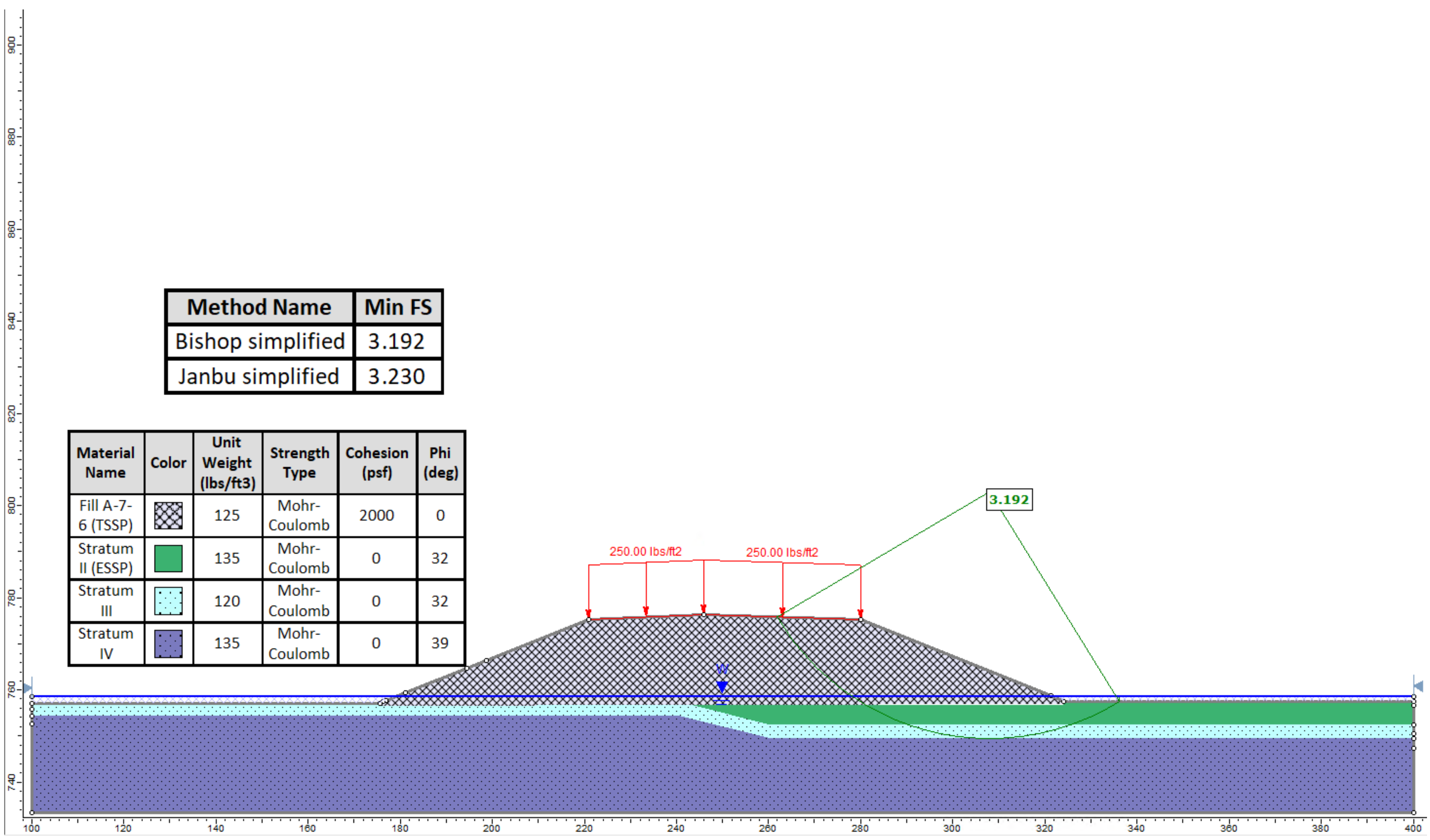


Long Term, Effective Stress Soil Parameters (ESSP)
Existing Soils at 2½H:1V | Rapid Drawdown from 100 Year High Water Mark: 762.56 Feet
Failure Direction: Left to Right (-->)



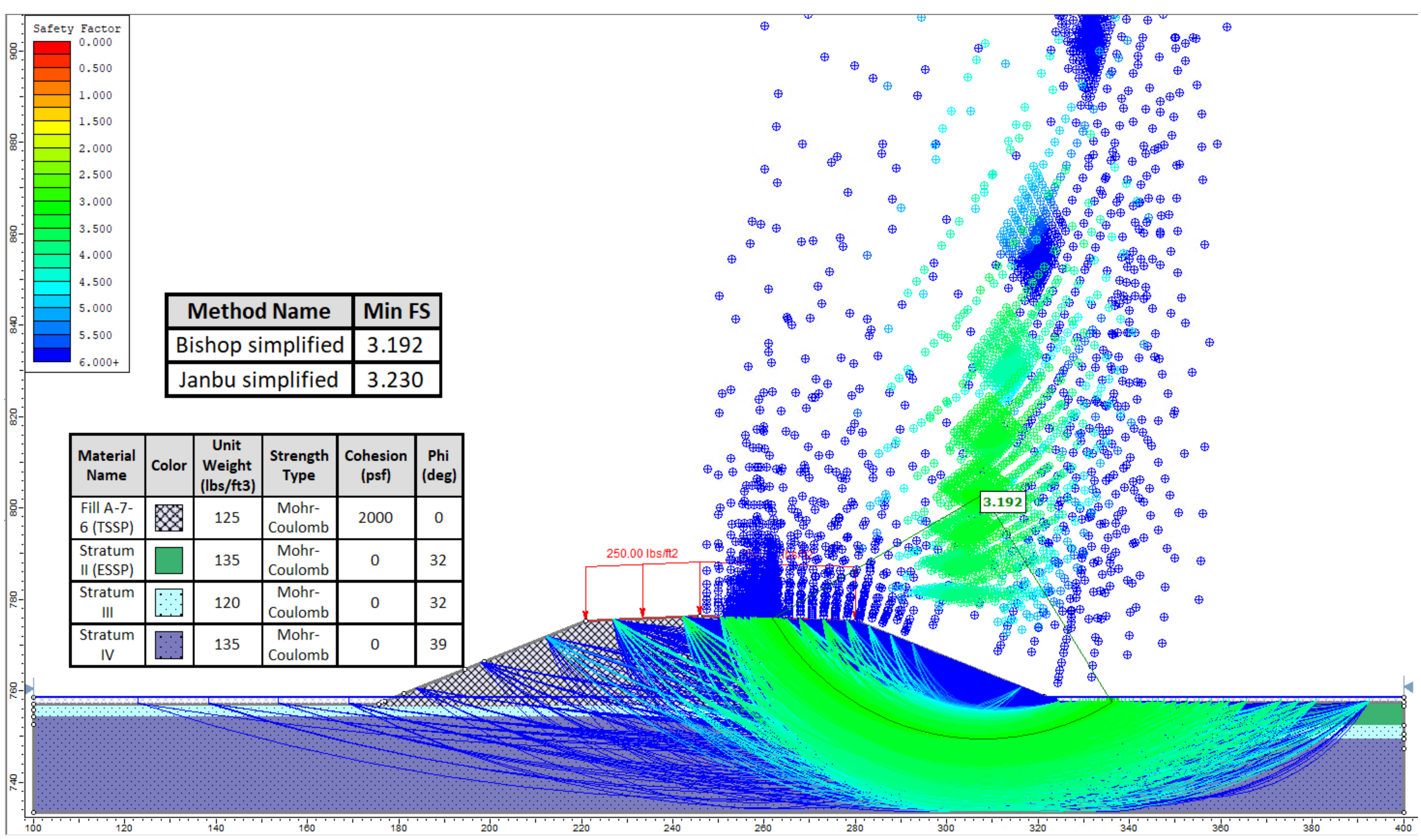


Short Term, Total Stress Soil Parameters (TSSP)
New Clay (A-7-6) Embankment Fill at 2½H:1V | Ordinary High Water Mark: 758.56 Feet
Failure Direction: Right to Left (<--)



Method Name	Min FS
Bishop simplified	3.192
Janbu simplified	3.230

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Fill A-7-6 (TSSP)		125	Mohr-Coulomb	2000	0
Stratum II (ESSP)		135	Mohr-Coulomb	0	32
Stratum III		120	Mohr-Coulomb	0	32
Stratum IV		135	Mohr-Coulomb	0	39

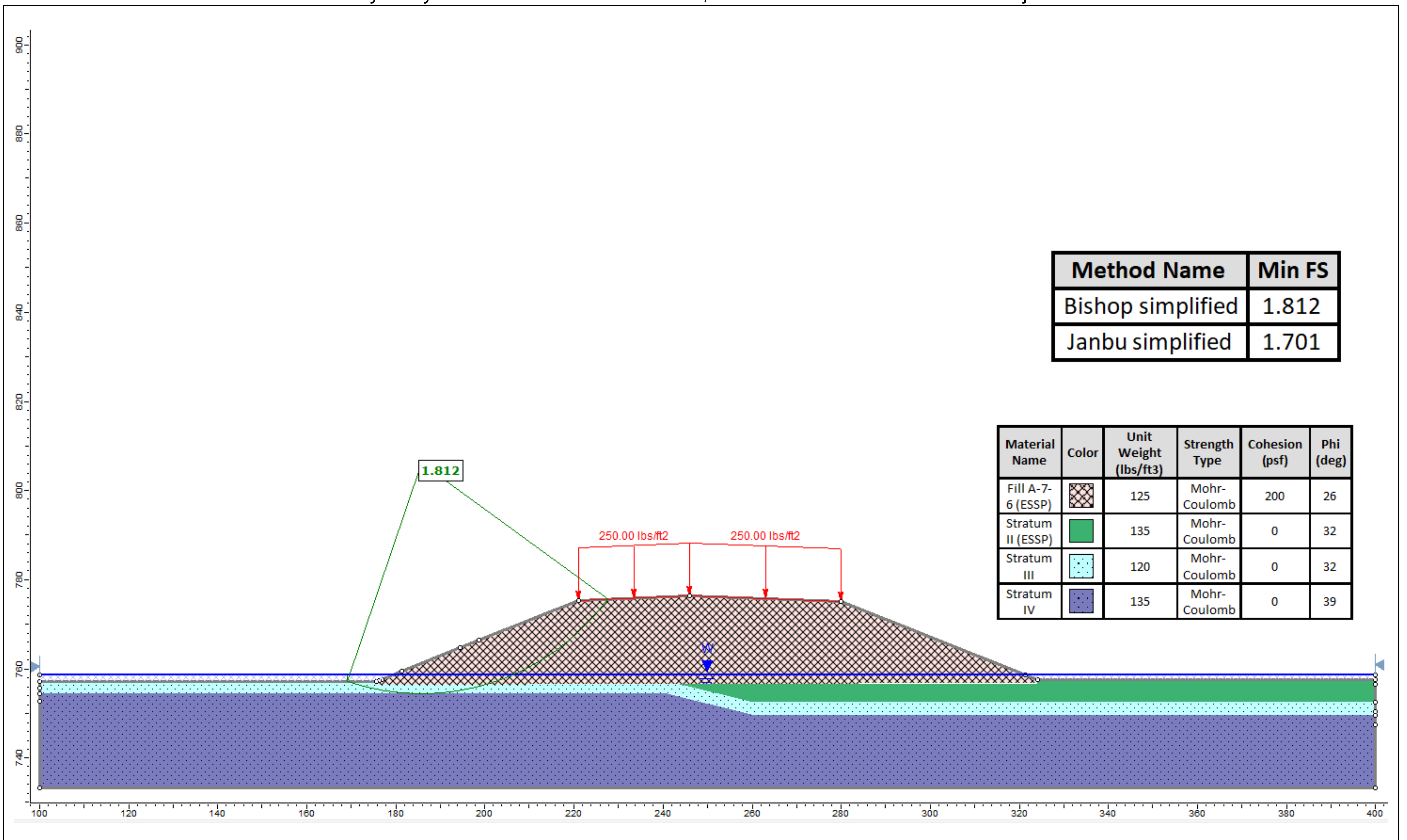


Method Name	Min FS
Bishop simplified	3.192
Janbu simplified	3.230

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Fill A-7-6 (TSSP)		125	Mohr-Coulomb	2000	0
Stratum II (ESSP)		135	Mohr-Coulomb	0	32
Stratum III		120	Mohr-Coulomb	0	32
Stratum IV		135	Mohr-Coulomb	0	39

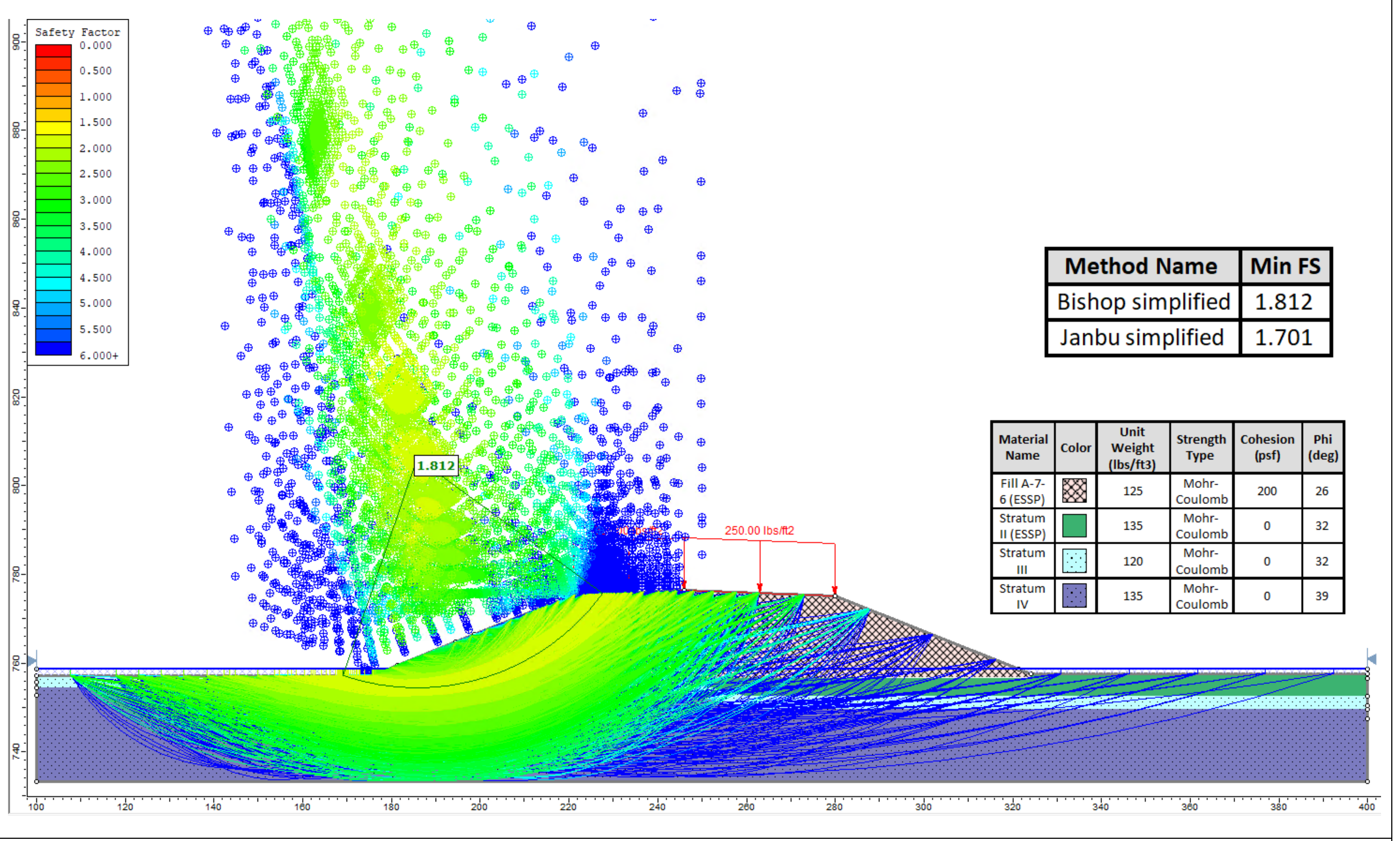
Short Term, Total Stress Soil Parameters (TSSP)
New Clay (A-7-6) Embankment Fill at 2½H:1V | Ordinary High Water Mark: 758.56 Feet
Failure Direction: Left to Right (-->)

Global Stability Analysis WIL-6-11.07, PID 107612 CT Project No. 232133



Method Name	Min FS
Bishop simplified	1.812
Janbu simplified	1.701

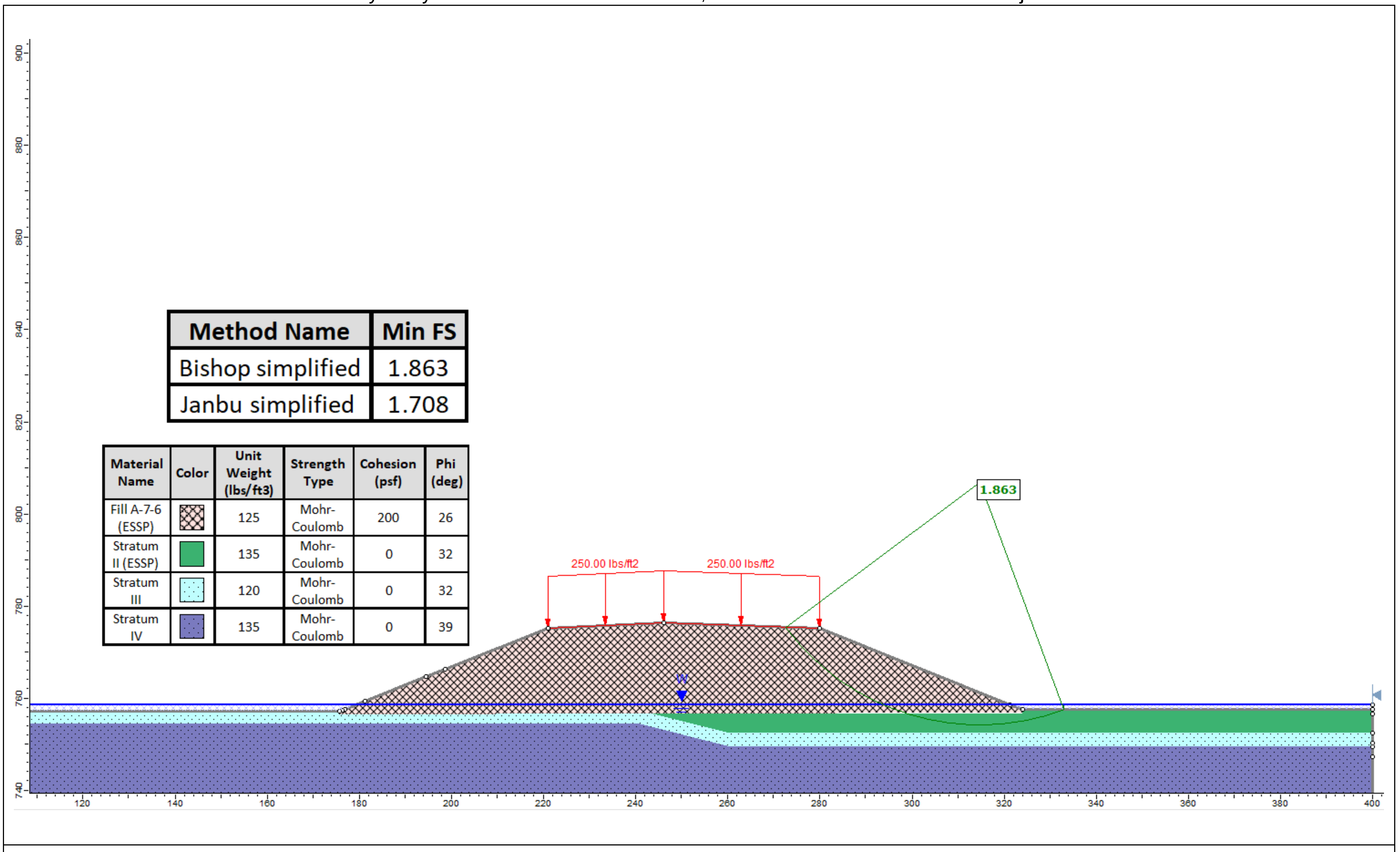
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Fill A-7-6 (ESSP)		125	Mohr-Coulomb	200	26
Stratum II (ESSP)		135	Mohr-Coulomb	0	32
Stratum III		120	Mohr-Coulomb	0	32
Stratum IV		135	Mohr-Coulomb	0	39

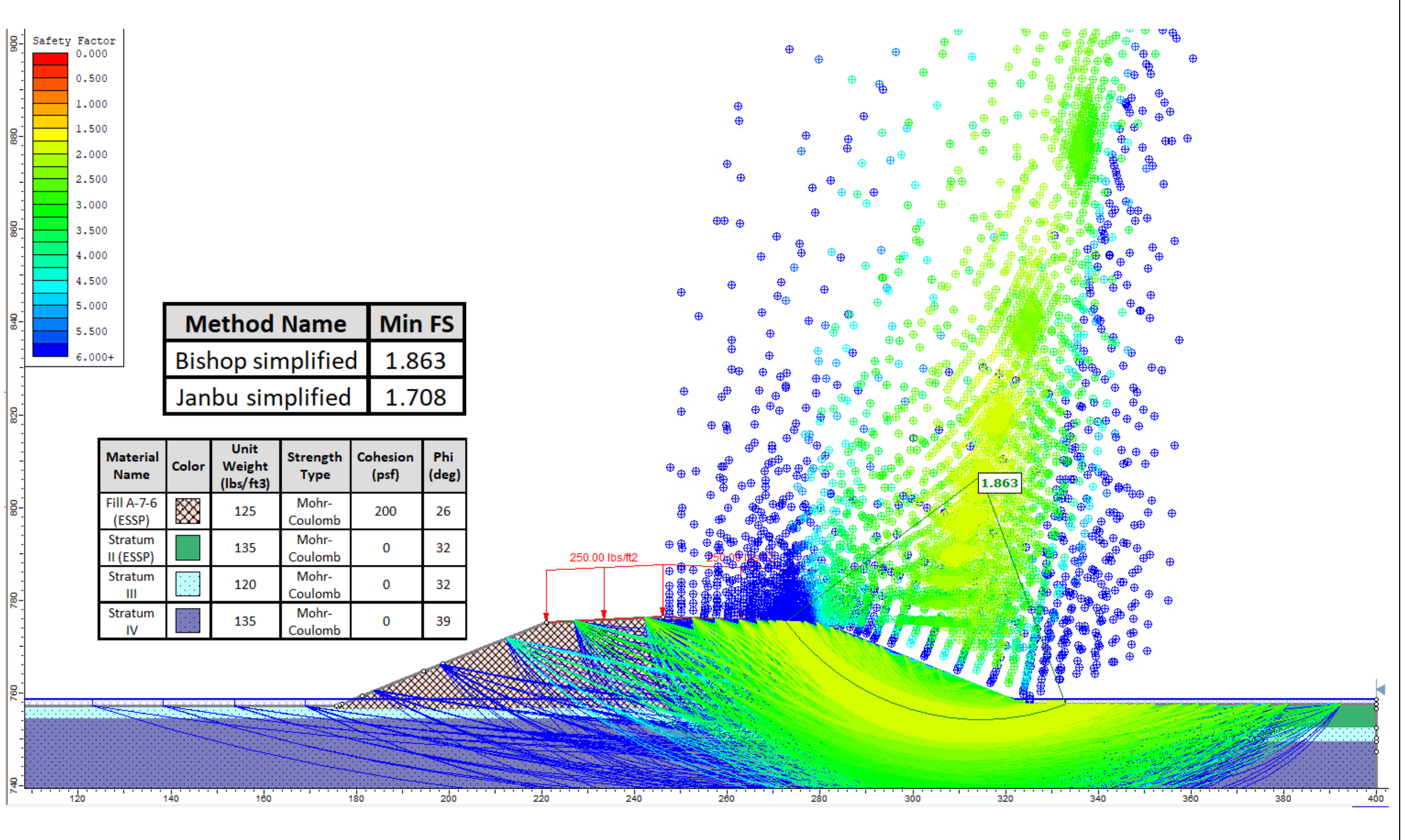


Method Name	Min FS
Bishop simplified	1.812
Janbu simplified	1.701

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Fill A-7-6 (ESSP)		125	Mohr-Coulomb	200	26
Stratum II (ESSP)		135	Mohr-Coulomb	0	32
Stratum III		120	Mohr-Coulomb	0	32
Stratum IV		135	Mohr-Coulomb	0	39

Long Term, Effective Stress Soil Parameters (ESSP)
New Clay (A-7-6) Embankment Fill at 2½H:1V | Ordinary High Water Mark: 758.56 Feet
Failure Direction: Right to Left (<--)





Long Term, Effective Stress Soil Parameters (ESSP)
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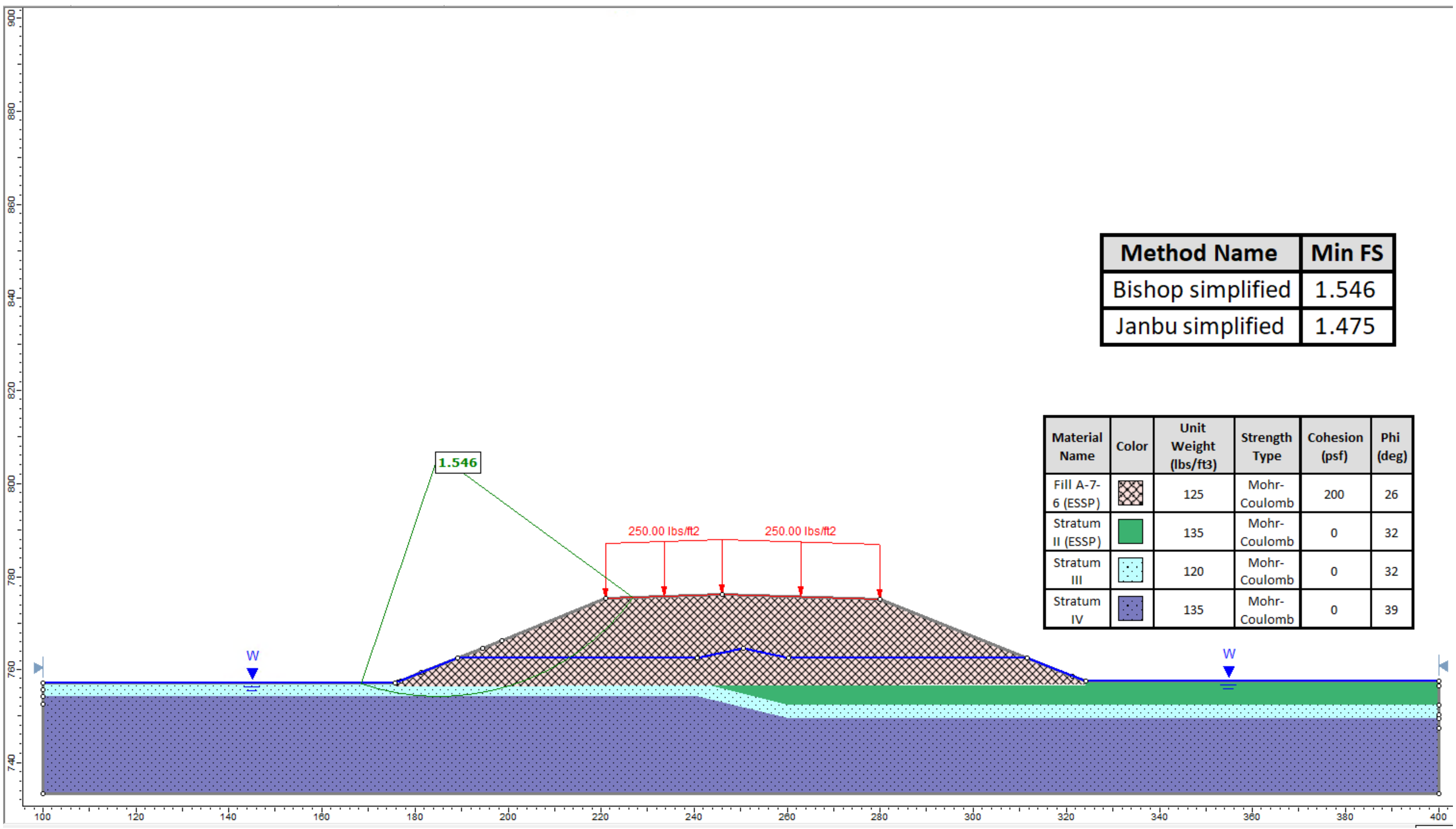

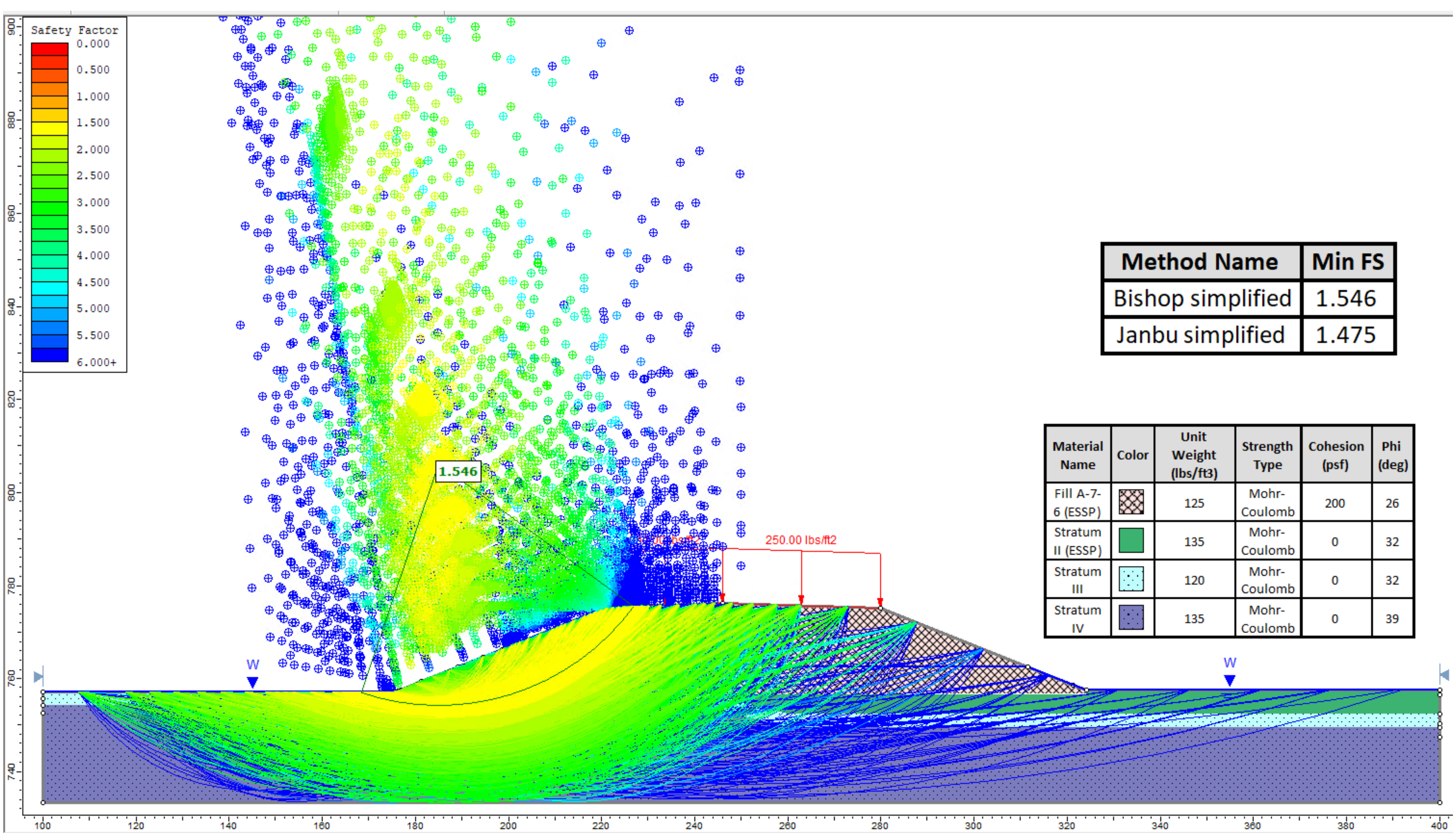

Long Term, Effective Stress Soil Parameters (ESSP)
New Clay (A-7-6) Embankment Fill at 2½H:1V | Rapid Drawdown from 100 Year High Water Mark: 762.56 Feet
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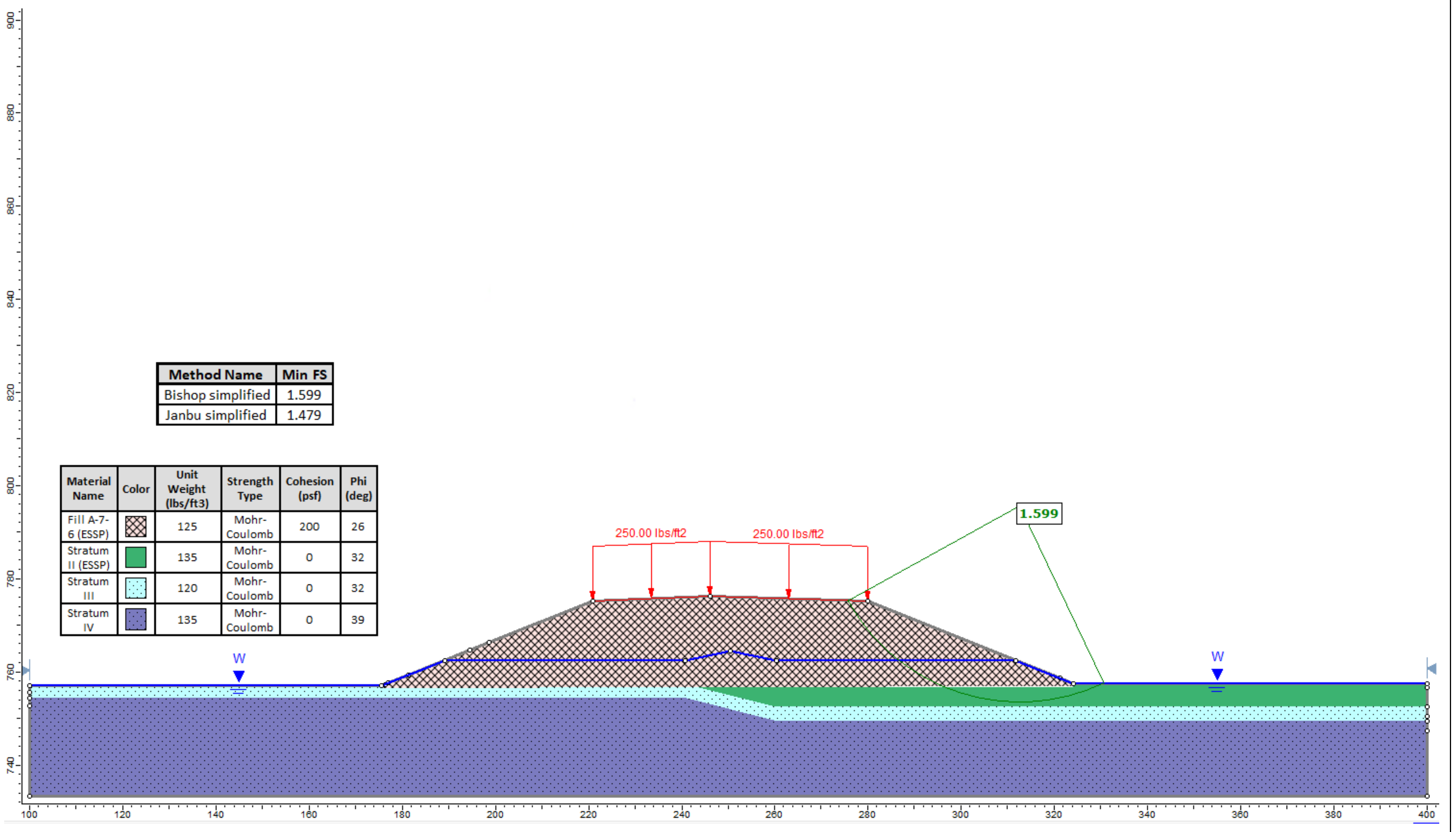

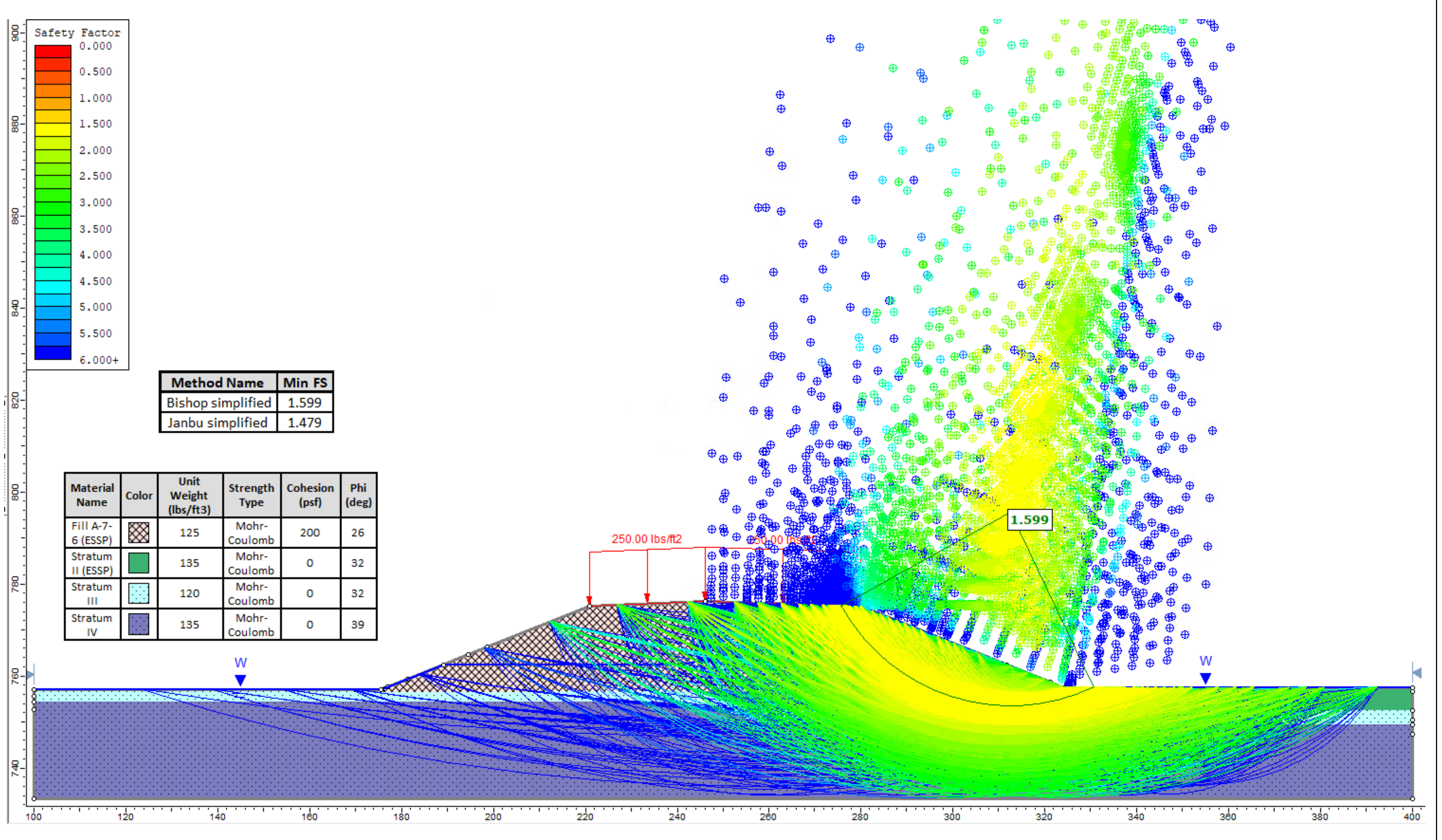

Long Term, Effective Stress Soil Parameters (ESSP)
New Clay (A-7-6) Embankment Fill at 2½H:1V | Rapid Drawdown from 100 Year High Water Mark: 762.56 Feet
Failure Direction: Left to Right (-->)

Appendix B:
Geotechnical Engineering
Design Checklists

LEADING THROUGH
the next 100 years
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Ohio Department of Transportation
Geotechnical Engineering
Design Checklists

Version 6.0
January 20, 2023

Preface

Geotechnical design features that arise in the development of roadway projects vary both in type and complexity. Cuts, embankments, wetlands, mine issues, and rock slopes are just some geotechnical issues encountered on transportation projects. Consistent and comprehensive reconnaissance, analysis, and plan preparation are necessary to ensure that all possible geotechnical issues that may occur on a project will be adequately identified and accounted for on the final plans.

A set of topical review checklists, a reference list, and a technical publications list have been developed to aid the project development personnel in their production of geotechnically sound project plans. All projects that contain geotechnical related issues will benefit from the use of this document. Although it is expected that the District Geotechnical Engineer will be one of the main users of these checklists, any personnel responsible for a geotechnical aspect of the project plan development will use this document. Possible users of this checklist include, but are not limited to, design and geotechnical Consultants and District and Central Office reviewers and project engineers.

The design checklists are provided to assist the project development personnel in:

- Developing a comprehensive geotechnical scope of services
- Developing and reviewing geotechnical reports and assimilating information
- Analyzing, designing, and reviewing geotechnical related aspects of a transportation project, including needs assessment, plans, and specifications
- Recognizing cost-saving opportunities
- Identifying deficiencies due to inadequate geotechnical exploration, analysis, or design
- Recognizing when to request additional technical assistance from a geotechnical specialist
- Defining areas of needed training

At first glance, the design checklist will seem to be inordinately lengthy. One, however, should not avoid using the checklist because of this. Only on major and complex projects will it be necessary to complete most of the checklist. Just those checklists that pertain to a specific geotechnical feature encountered on the project should be completed. Therefore, for most projects, only a small portion of the checklist will need to be completed.

Since several entities may be involved in the geotechnical development of a transportation project, it is possible that there may be more than one set of checklists completed for a specific project, or different entities may fill out different sections of the checklist. It is anticipated that all completed checklists will be included with the project file in District or Central Office.

<u>To utilize the checklists,</u>

- First fill out the project information on the Checklist Cover tab. The project information in the headings of the rest of the checklists will autopopulate. Also indicate which checklists will be utilized.
- Complete only the checklists that apply to the project by using the dropdown boxes.
- Submit the checklist cover along with all completed checklists with the report and plan submission

Additional topics and questions may be added as the development of these checklists continues and input is received from the users. All additional updates and design guidance will be issued from the Office of Geotechnical Engineering (OGE) and available on the internet at the Design Reference Resource Center and the OGE website. The OGE Administrator will be the point of contact regarding the checklist, and any questions, recommendations, and training requests should be directed to the Office Administrator.

Table of Contents

Symbols and Abbreviations

Y	Yes
N	No
X	Not Applicable (Reason should be explained in the “Notes” area of the checklist)
✓	Selected item utilized

AASHTO	American Association of State Highway and Transportation Officials
AML	Abandoned Mine Land Reclamation Program, DMRM, ODNR
AUMIRA	Manual for Abandoned Underground Mine Inventory and Risk Assessment, ODOT
BDM	Bridge Design Manual, ODOT
CBR	California Bearing Ratio
C&MS	Construction and Material Specifications, ODOT
DGE	District Geotechnical Engineer, ODOT District
DGS	Division of Geological Survey, ODNR
DMRM	Division of Mineral Resources Management, ODNR
DSWC	Division of Soil and Water Conservation, ODA
EPA	Ohio Environmental Protection Agency
FHWA	Federal Highway Administration
F.S.	Factor of Safety
GDM	Geotechnical Design Manual, ODOT
L&D1	Location & Design Manual, Volume 1, ODOT
L&D3	Location & Design Manual, Volume 3, ODOT
LRFD	Load and Resistance Factor Design
N_{60}	Standard Penetration Value, normalized to 60 percent of drill rod energy ratio
ODNR	Ohio Department of Natural Resources
ODOT	Ohio Department of Transportation
OGE	Office of Geotechnical Engineering, ODOT
OSMRE	Office of Surface Mining Reclaimation and Enforcement, U.S. Dept. of the Interior
ROW	Right of Way
RQD	Rock Quality Designation
SDI	Slake Durability Index
SGE	Specifications for Geotechnical Explorations, ODOT
SPT	Standard Penetration Test
TIMS	Transportation Information Mapping System
UBV	Ultimate Bearing Value
	Standard Penetration Test
USGS	U.S. Geological Survey
WEAP	Wave Equation Analysis of Pile Driving (Software)

I. Geotechnical Design Checklists

Project: WIL-6-11.07	PDP Path:
PID: 107612	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: WIL-6-11.07	PID: 107612	Reviewer: LGH	Date: 2/29/2024

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:	X	Plans prepared by others.
	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?	N	Boring location plan is included in this report submittal.
	The schedule of borings should present the following information for each boring:		
a.	exploration identification number	Y	
b.	location by station and offset	Y	
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	Type E2b
	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: WIL-6-11.07	PID: 107612	Reviewer: LGH	Date: 2/29/2024

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	X	
2	Have consolidation properties of the foundation soils been determined?		
	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.		
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?		
5	Have the total settlement and the time of consolidation analyses indicated acceptable values at all locations for the scope of the embankment work?		
6	If total settlement or time of consolidation is unacceptable, have the stations and lateral extent of the problem areas been defined?		
7	Has a method been chosen as a solution to the settlement issues?		
	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)?		
9	Has an economic analysis been performed to evaluate the cost benefits of the recommended solution compared to others?		
10	Have all necessary notes, specifications, and details for the chosen solution been determined?		
11	Have the need, locations, type, plan notes, and reading schedule for settlement platforms or cells been determined?		
12	Have the effects of the predicted settlement and the chosen solution been determined and accounted for on the construction schedule?		
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?		

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	Y	
15	Has the total (short term) and effective (long term) shear strength of the foundation soils been determined?	Y	Estimation from SPT or field tests and UCS testing.
	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?	Y	Assumed A-7-6 to be conservative

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.	Y	
18	Have the following F.S. been met or exceeded, as determined by the calculations, for the given stability conditions:	N	
a.	1.30 for short term (undrained) condition	Y	
b.	1.30 for long term (drained) condition	Y	
c.	1.10 for rapid drawdown, flood condition	N	Y, New A-7-6 Fill. N, Exisiting embankment
d.	1.50 for embankment containing or supporting a structural element	X	
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?	Y	
20	If the F.S. was not met or exceeded, have the stations and lateral extent of the problem areas been defined?	X	
21	Has a method been chosen as a solution to the stability issues?	N	Not part of the Scope of Work
	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)?	N	Not part of the Scope of Work
23	Has an economic analysis been performed to evaluate the cost benefits of the recommended solution compared to others?	N	Not part of the Scope of Work

III.B. Embankments Checklist

Stability		(Y/N/X)	Notes:
24	Have all necessary notes, specifications, and details for the chosen solution been determined?	X	
25	Have the need, location, type, plan notes, and reading schedule for piezometers and inclinometers been determined?	X	
26	If piezometers will be used, has the critical pressure value been determined and the appropriate information included in the plans?	X	
27	Have the effects of the stability solution been determined and accounted for on the construction schedule?	X	
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?	X	

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	X	
30	In accordance with GDM Section 800, have sidehill fills been evaluated to determine if special benching or shear keys are needed?		
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?		
b.	have quantities for both excavation and embankment been calculated for the benched areas and added to the plan General Quantities?		
c.	have the special benching or shear keys been indicated on the appropriate cross sections?		
32	Have water bearing zones been identified and their impact addressed?		
33	Have subsurface drainage controls been adequately addressed?		

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?	N	
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.A Foundations of Structures Checklist

C-R-S: WIL-6-11.07	PID: 107612	Reviewer: LGH	Date: 2/29/2024

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	Estimation from SPT or field tests and UCS testing.
	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	Y	
5	Have the recommended bottom of footing elevation and reason for this recommendation been provided?	N	N, Elevation provided by Client
a.	Has the recommended bottom of footing elevation taken scour from streams or other water flow into account?	X	
6	Were representative sections analyzed for the entire length of the structure for the following:	X	
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?	N	Not part of the Scope of Work
a.	If needed, have the details been included in the plans?	X	
8	If special conditions exist (e.g. geometry, sloping rock, varying soil conditions), was the bottom of footing “stepped” to accommodate them?	X	
9	Have the Service I and Maximum Strength Limit States for bearing pressure on soil or rock been provided?	X	

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?	X	
a.	Have the procedure and quantities related to this removal / treatment been included in the plans?	X	
Pile Structures		**(Y/N/X)**	**Notes:**
11	Are there piles on the project? If no, go to Question 17	N	
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.		
14	If scour is predicted, has pile resistance in the scour zone been neglected?		
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?		
16	If required for design, have sufficient soil parameters been provided and calculations performed to evaluate the:		
a.	Nominal unit tip resistance and maximum settlement of the piles?		
b.	Nominal unit side resistance for each contributing soil layer and maximum deflection of the piles?		
c.	Downdrag load on piles driven through new embankment or compressible soil layers, as per BDM 305.3.2.2?		
d.	Potential for and impact of lateral squeeze from soft foundation soils?		

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?	X	
a.	If needed, have details and plan notes for load testing been included in the plans?	X	

VI.A. Geotechnical Profile Checklist

C-R-S: WIL-6-11.07	PID: 107612	Reviewer: LGH	Date: 2/29/2024

General Presentation		(Y/N/X)	Notes:
1	Has an electronic copy of all geotechnical submissions been provided to the District Geotechnical Engineer (DGE)?	X	This submittal is being provided to Prime Consultant, whom will forward to DGE.
2	Have the cadd files been prepared using the appropriate version of the ODOT CADD standards?	Y	
3	Has the geotechnical specification (title and date) under which the work was performed been clearly identified on every submission (reports, plans, etc.)?	Y	
4	Has the first complete version of all documents being submitted been labeled as 'Draft'?	Y	File name for draft submittal was marked as draft. This is the draft submittal.
5	Subsequent to ODOT's review and approval, has the complete version of the revised documents being submitted been labeled as 'Final'?	Y	This is the draft submittal.
	a. Have the C-R-S, PID number, and product title been included in the folder name?	Y	
6	If the project includes structures, have all structure explorations been presented together under the same cover sheet? (Do not create separate Geotechnical Profile - Bridge Sheets)	X	
7	Has a scale of 1"=1' been used for cover sheets, laboratory test data sheets, and boring log sheets, if applicable?	X	Scale not shown on plans.
8	Based on the project length, has the correct horizontal scale been used to plot the project data?	Y	1" = 10'
	Check scale used:		
	1" = 5', 10', 20', 25', 40', or 50' for projects 1500' or less (use largest scale appropriate to present entire plan on one sheet)	✓	
	1" = 50' projects greater than 1500'		
9	Has a scale of 1" = 10' been utilized for the vertical scale of the project data?	Y	
10	If the project includes structures, has the plan and profile view been shown at the same scale as the Site Plan for the proposed structure(s), when possible?	X	

VI.A. Geotechnical Profile Checklist

General Presentation		(Y/N/X)	Notes:
11	If the project includes culverts, have the plan and profile been presented along the flowline of the culvert?	X	
12	Have the cross-sections been plotted at a scale of 1" = 10' (preferred) or 1" = 20' (for higher or wider slopes)?	X	
Cover Sheet		**(Y/N/X)**	**Notes:**
13	Has the following general information been provided on the cover sheet:		
a.	Brief description of the project, including the bridge number of each bridge involved in the plan set, if any?	Y	
b.	Brief description of historic geotechnical explorations referenced in this exploration? State if no historic records are available.	Y	
c.	Generalized information about the geology of the project area, including terrain, soil origin, bedrock types, and age?	Y	
d.	Brief presentation of geological and topographical information derived from the field reconnaissance? Include comments on structure and pavement conditions.	Y	
e.	Brief presentation of test boring and sampling methods? Include date of last calibration and drill rod energy ratio as a percent for the hammer systems used.	Y	
f.	Summary of general soil, bedrock, and groundwater conditions, including a generalized interpretation of findings?	Y	
g.	A statement of which version (date) of the SGE specification the exploration was performed in accordance with?	Y	
h.	Statement of where geotechnical reports are available for review?	Y	
i.	Initials of personnel and dates they performed field reconnaissance, subsurface exploration and preparation of the geotechnical profile?	Y	

VI.A. Geotechnical Profile Checklist

Cover Sheet		(Y/N/X)	Notes:
14	Has a Legend been provided?	Y	
15	Have the following items been included in the Legend:		
a.	Symbols and usual descriptions for only the soil and bedrock types presented in the Geotechnical Profile, as per the Soil and Rock Symbology Chart in Appendix D of the SGE?	Y	
b.	All miscellaneous symbols and acronyms, used on any of the sheets, defined?	Y	
c.	The number of soil samples for each classification that were mechanically classified and visually described in the current exploration?	Y	
16	Has a Location Map, showing the beginning and end stations for the project, been shown on the cover sheet, sized per the L&D3 Manual?	Y	
17	Have the station limits for each plan and profile sheet for projects with multiple alignments, or greater than 1500', been identified in a table?	Y	
18	Have the station limits for any cross section sheets been identified in the same table?	X	
19	Has a list of any structures for which structure foundation explorations been performed been identified in the same table?	X	
20	If sampling and testing for a scour analysis was performed, has this data been shown in tabular form?	X	
21	Has a summary table of test data for all roadway and subgrade boring samples been shown?	Y	
22	If borings from previous subsurface explorations are being used, has that data been shown in a separate table?	X	No relevent historic borings data.
23	In the summary table, has the data been displayed by roadway and subgrade boring in ascending stationing order for each roadway?	Y	
24	Have the centerline or baseline station, offset, and exploration identification number been provided for each boring presented in the table?	Y	

VI.A. Geotechnical Profile Checklist

Cover Sheet		(Y/N/X)	Notes:
25	For each sample, has the following information been provided in the summary table:		
a.	Sample depth interval?	Y	
b.	Sample number and type?	Y	
c.	N_{60}?	Y	
d.	Percent recovery?	Y	
e.	Hand Penetrometer?	Y	
f.	Percentage of aggregate, coarse sand, fine sand, silt, and clay size particles?	Y	
g.	Liquid limit, plastic limit, plasticity index, and water content, all rounded to the nearest percent or whole number?	Y	
h.	ODOT classification and Group Index?	Y	
i.	Visual description of samples not mechanically classified, including water content, and estimated ODOT classification with 'Visual' in parentheses?	Y	
j.	Sulfate Content test results?	Y	
26	Have all undisturbed test results been displayed in graphical format on the sheet prior to the plan and profile sheets?	Y	
Surface Data		(Y/N/X)	Notes:
27	Has the following information been shown on each roadway plan drawing:		
a.	Existing surface features described in Section 702.5.1?	Y	
b.	Proposed construction items, as described in Section 702.5.2?	Y	
c.	Project and historic boring locations, with appropriate exploration targets and exploration identification numbers?	Y	
d.	Notes regarding observations not readily shown by drawings?	Y	
28	Have the existing ground surface contours been presented?	Y	
29	If cross sections are to be developed for stationing covered on a plan sheet, has an index for the appropriate cross section sheets been included on the plan sheet?	X	

VI.A. Geotechnical Profile Checklist

Subsurface Data		(Y/N/X)	Notes:
30	Has all the subsurface data been presented in the form of a profile along the centerline or baseline, and on cross sections where applicable?		
31	Have the graphical boring logs been correctly shown, as follows:		
a.	Location and depth of boring indicated by a heavy dashed vertical line?	Y	
b.	Exploration identification number above the boring?	Y	
c.	Logs indicate soil and bedrock layers with symbols 0.4” wide and centered on the heavy dashed vertical line where possible?	Y	
d.	Bedrock exposures with 0.4” wide symbols, but without a heavy dashed vertical line?	Y	
e.	Soil and bedrock symbols as per ODOT Soil and Rock Symbology chart (SGE - Appendix D)?	Y	
f.	Historical borings shown in same manner with the exploration identification number above the boring?	Y	
32	Have the proposed groundline and existing groundline been shown on the profile view, according to ODOT CADD standards?	Y	
33	Have the locations of the proposed structure foundation elements been shown on the profile view?	Y	
34	Have the offsets from centerline or baseline been indicated above the borings in the profile view?	Y	
35	Have borings located immediately adjacent to the centerline or baseline and considered representative of centerline or baseline subsurface conditions been referenced directly to the centerline or baseline?	Y	
36	Have offset borings in or near the same elevation interval of a centerline or baseline boring been plotted either on a cross section or immediately above or below the centerline boring in a box containing an elevation scale?	X	
37	Have cross-sections been developed to show subsurface conditions disclosed by a series of borings drilled transverse to centerline or baseline?	X	

VI.A. Geotechnical Profile Checklist

Subsurface Data		(Y/N/X)	Notes:
38	Have the existing and proposed groundlines been displayed on cross section sheets according to ODOT CADD standards?	Y	
39	Have bedrock exposures shown on the cross sections been plotted along the contour of the cross section?	X	
40	Has the following information been provided adjacent to the graphical logs or bedrock exposure:		
a.	Thickness, to the nearest inch, of sod/topsoil or other shallow surface material written above the boring (with corresponding symbology at top of log)?	Y	
b.	Moisture content, to nearest whole percent, with the bottom of the text aligned with the bottom of the sample? Label this column as 'WC' at bottom of the boring.	Y	
c.	N_{60}, aligned with the bottom of sample? Label column as 'N_{60}' at bottom of boring.	Y	
d.	Free water indicated by a horizontal line with a 'w' attached, and water level at the end of drilling indicated by an open equilateral triangle, point down?	Y	
e.	Complete geologic description of each bedrock unit, including unit core loss, unit RQD, SDI, and compressive strength test results? (Do not present geologic descriptions for structure borings for which this information is presented on the boring logs as described in 703.3)	Y	
f.	Visual description of any uncontrolled fill or interval not adequately defined by a graphical symbol?	X	
g.	Organic content with modifiers, per 603.5?	X	No organic content testing was deemed necessary.
h.	Designate a plastic soil with moisture content equal to or greater than the liquid limit minus three with a 1/8" solid black circle adjacent to the moisture content?	Y	
i.	Designate a non-plastic soil with moisture content exceeding 25% or exceeding 19% but appearing wet initially, with a 1/8" open circle with a horizontal line through it adjacent to the moisture content?	Y	
j.	The reason for discontinuing a boring prior to reaching the planned depth indicated immediately below the boring?	X	

VI.A. Geotechnical Profile Checklist

Boring Logs		(Y/N/X)	Notes:
41	Have the boring logs of all structure borings, all geohazard borings, and any roadway borings drilled in the vicinity of the structures or geohazard been shown on the boring log sheets following the plan and profile sheets? (Create the logs in accordance with 703.3)	Y	
42	Have the boring logs been developed by integrating the driller's field logs, laboratory test data, and visual descriptions?	Y	
43	Has the following boring information been included in the heading of each boring log:	Y	
a.	Exploration identification number?	Y	
b.	Project designation (C-R-S) and PID?	Y	
c.	Structure File Number (if applicable) and project type?	Y	
d.	Centerline or baseline name, station, offset, and surface elevation?	Y	
e.	Coordinates?	Y	
f.	Method of drilling?	Y	
g.	Date started and date completed?	Y	
h.	Method and material (including quantity) used for backfilling or sealing, including type of instrumentation, if any (reported in the footer)?	Y	
i.	Date of last calibration and drill rod energy ratio (ER) in percent for the hammer system(s) used, not to exceed 90%?	Y	
44	Has the following boring information been included in each boring log:		
a.	A depth and elevation scale?	Y	
b.	Indication of stratum change?	Y	
c.	Description of material in each stratum?	Y	
d.	Depth of bottom of boring?	Y	
e.	Depth of boulders or cobbles, if encountered?	Y	
f.	Caving depth?	X	
g.	Water level observations?	Y	
h.	Artesian water level and height of rise?	X	
i.	Heaving sand?	X	
j.	Cavities or other unusual conditions?	X	
k.	Depth interval represented by sample?	Y	
l.	Sample number and type?	Y	
m.	Percent recovery for each sample?	Y	
n.	Measured blow counts for each 6 inches of drive for split spoon samples, not to exceed 18 inches total?	Y	
o.	N_{60} to the nearest whole number?	Y	

p. Hand penetrometer?	Y	

VI.A. Geotechnical Profile Checklist

Boring Logs		(Y/N/X)	Notes:
q.	Particle-size analysis?	Y	
r.	Liquid limit, plastic limit, plasticity index?	Y	
s.	Water content?	Y	
t.	ODOT soil classifications, with "V" in parentheses for those samples that are not mechanically classified?	Y	
u.	Top of bedrock and bedrock descriptions?	X	
v.	Rock core run percent recovery?	X	
w.	Run RQD?	X	
x.	Unit rock core percent recovery?	X	
y.	Unit RQD?	X	
z.	SDI, if applicable?	X	
aa.	Rock compressive strength test results, if applicable?	X	

VI.B. Geotechnical Reports

C-R-S: WIL-6-11.07	PID: 107612	Reviewer: LGH	Date: 2/29/2024

General		(Y/N/X)	Notes:
1	Has an electronic copy of all geotechnical submissions been provided to the District Geotechnical Engineer (DGE)?	X	This submittal will forward to DGE by our ODOT contact.
2	Has the first complete version of a geotechnical report being submitted been labeled as 'Draft'?	Y	Yes. This is the final submittal.
3	Subsequent to ODOT's review and approval, has the complete version of the revised geotechnical report being submitted been labeled 'Final'?	Y	Yes. This is the final submittal.
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	For this final report submittal, gINT files have been provided.
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	Note, that link returns: "The page you're looking for doesn't exist or has moved. ODOT has migrated material to a new site, please try using the search"
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	Rock not applicable
11	Do the Appendices include reports of undisturbed test data as described in Section 706.8.3 of the SGE?	Y	However, only incude one sketch.
12	Do the Appendices include calculations in a logical format to support recommendations as described in Section 706.8.4 of the SGE?	Y	

VII. References

Publications - FHWA

Advanced Course on Slope Stability, Volume 1 and 2, Abramson, Lee, Boyce, Glenn, et al., Publication No. FHWA-SA-94-005 and 006

Corrosion/Degradation of Soil Reinforcement for Mechanically Stabilized Earth Walls and Reinforced Soil Slopes, Elias, Publication No. FHWA-NHI-09-087

Geotechnical Engineering Circular No. 2 - Earth Retaining Systems, Sabitini, Elias, et al., Publication No. FHWA-SA-96-038

Geotechnical Engineering Circular No. 3 - LRFD Seismic Analysis and Design of Transportation Geotechnical Features and Structural Foundations, Kavazanjian, Publication No. FHWA-NHI-11-032

Geotechnical Engineering Circular No. 4 - Ground Anchors and Anchor Systems, Sabitini, Pass and Bachus, Publication No. FHWA-IF-99-015

Geotechnical Engineering Circular No. 5 – Geotechnical Site Characterization, Loehr, et. al., Publication No. FHWA-NHI-16-072

Geotechnical Engineering Circular No. 6 – Shallow Foundations, Kimmerling, Publication No. FHWA-IF-02-054

Geotechnical Engineering Circular No. 7 – Soil Nail Walls Reference Manual, Lazarte, et. al., Publication No. FHWA-NHI-14-007

Geotechnical Engineering Circular No. 8 – Design and Construction of Continuous Flight Auger Piles, Brown, et. al., Publication No. FHWA-HIF-07-039

Geotechnical Engineering Circular No. 9 – Design and Analysis of Laterally Loaded Deep Foundations, Parkes, et. al., Publication No. FHWA-HIF-18-031

Geotechnical Engineering Circular No. 10 - Drilled Shafts: Construction Procedures and Design Methods, Brown, et. al., Publication No. FHWA-NHI-18-024

Geotechnical Engineering Circular No. 11 - Design and Construction of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes, Volume I and II, Berg, Christopher, and Samtani, Publication No. FHWA-NHI-10-024 and 025

Geotechnical Engineering Circular No. 12 - Design and Construction of Driven Pile Foundations, Volume I and II, Hannigan, Rausche, Likins, Robinson, and Becker, Publication No. FHWA-NHI-16-009 and 010

Geotechnical Engineering Circular No. 13 – Ground Modification Methods Reference Manual, Volume I and II, Schaefer, et. al., Publication No. FHWA-NHI-16-027 and 028

Geotechnical Engineering Circular No. 15 – Acceptance Procedures for Structural Foundations, Loehr, et. al., Publication No. FHWA-HIF-22-024

Geotechnical Instrumentation Reference Manual, Dunnicliff, NHI Course No. 13241 - Module 11

Prefabricated Vertical Drains: Volume 1: Engineering Guidelines, Rixner, Kraemer, and Smith, Publication No. FHWA-RD-86-168

Soils and Foundations Workshop, Reference Manual and Participant Workbook, Cheney and Chassie, Publication No. NHI-00-045

Soils and Foundations Reference Manual, Volume I and II, Samtani and Nowatzki, Publication No. NHI-06-088 and 089

Highway Subdrainage Design, Moulton, Publication No. FHWA-TS-80-224

Tiebacks, Weatherby, Publication No. FHWA/RD-82/047

VII. References

Publications - ODOT (www.dot.state.oh.us/drrc/)

Bridge Design Manual, Office of Structural Engineering
CADD Engineering Standards Manual, Office of CADD and Mapping
Construction and Material Specifications, Office of Construction Administration
Geotechnical Design Manual, Office of Geotechnical Engineering
Location and Design Manual: Volume 1 - Roadway Design, Office of Roadway Engineering
Location and Design Manual: Volume 3 - Highway Plans, Office of CADD and Mapping
Manual for Abandoned Underground Mine Inventory and Risk Assessment (AUMIRA), Office of Geotechnical Engineering
Pavement Design Manual, Office of Pavement Engineering
Specifications for Geotechnical Explorations, Office of Geotechnical Engineering

Publications - ODNR (www.dnr.state.oh.us/)

Bedrock Geology Map, DGS
Bedrock Structure Map, DGS
Bedrock Topography Map, DGS
Known and Probable Karst in Ohio, DGS
Geologic Map of Ohio, DGS
Quaternary Geology of Ohio, DGS
USGS Open File Map Series #78-1057 Landslides and Related Features, DGS

Other publications or information available from ODNR:

Bulletins	Boring logs	Measured geologic section(s)
Information Circulars	Water well logs	Report of Investigations

Publications – Other Organizations

AASHTO LRFD Bridge Design Specifications, Highway Subcommittee on Bridges and Structures, latest edition
Soil Survey, Natural Resources Conservation Service (https://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/survey/)
Wetlands Mapper, National Wetlands Inventory (https://www.fws.gov/wetlands/data/Mapper.html)

Appendix C:
Historic Test Hole Data

LEADING THROUGH
the next 100 years
www.ctconsultants.com

1944 Year 015725

STORAGE DATA	
Folder	
Section File No.	FEP-41
Record Center No.	5A-037/4D-05
Tracings	
Section File No.	FET-44
Record Center No.	4-M-44

Job No.

Changes

County WILLIAMS

Project Ident. WIL-6-3.63 WIL-SH 717-A

Project Code				

Proj. No.

Topo Sheet	

Begin Sta.

End Sta.

		Rev.
Drafting By		
Comp. Date		
Drafting Hrs.		

Design By

Length Miles

	RECON	AUGER	CORE	DRIVE ROD	RESISTIVITY
By					
Dates		11/29/44			
No. of Holes or Soundings					
Footage					
Samples Tested					

No. of Tracings	4

Remarks

☐ Samples Accounted

Transmittal Date Revisions Refer to

Length	Auger Data			Core Data			Drive Rod Data		Resistivity
	No. of Holes	Footage	Samples	No. of Holes	Footage	Samples	No. of Soundings	Footage	No. of Locations

Form TE-155

* See Reverse Side

SUMMARY OF TESTS ON SOIL PROFILE SUBGRADE SAMPLES

Williams County — Note Book No. 119&117 — (2)

S.H. 717 Sec. A

Lab. No. So.	Field No.	Station	No.	Represents Feet	Mechanical Analysis: Agg. %	C Sand %	F Sand %	Silt %	Clay %	Physical Charact.: L.L.	P.I.	Water Content	Density Data: Comp.	Opt.	Max. Dry Wt.	Class. No.: SHTL	FPA
									8								
46963	98	263+00	16R	½-1	1.6	5.0	11.5	53.4	28.5	36.1	10.1	27.9					
161	877	89+25	20L	11½-15	1.0	2.8	12.9	55.6	27.7	19.1	4.2	18.3					
					2												
				S	2.6	7.8	24.4	109.0	56.2	55.2	14.3	46.2		8			
				A	1.3	3.9	12.2	54.5	28.1	27.6	7.1	23.1					
46783	4	86+	15R	½-1½	18.6	14.3	14.7	30.6	21.8	27.7	8.7	19.1					
845	22	91		4½-5½	10.1	5.5	11.3	35.6	37.5	28.0	7.9	15.5		9			
847	24	93	12	½-2	11.6	34.5	16.4	19.2	18.3	23.0	9.1	16.5					
855	32	111		½-2	1.5	22.8	18.7	35.7	21.3	29.0	9.6	25.3					
875	52	181		1½-3	2.6	29.0	9.7	38.9	19.8	22.8	6.4	21.4					
933	73	230	7L	½-2	13.8	23.1	15.3	44.2	23.6	26.3	9.0	23.8					
938	78	236	19R	3½-5	2.8	21.5	19.1	31.9	24.7	21.5	7.6	24.6					
962	87	261		2½-5	1.1	29.7	28.9	15.1	25.2	24.5	10.8	21.8					
970	95	271	15R	½-2½	0.4	32.8	28.8	20.0	18.0	18.2	8.1	20.0					
974	99	277	12L	4½-6½	8.9	27.6	13.2	22.8	27.5	25.7	11.3	21.6					
977	102	289	10L	½-5	1.8	24.2	27.2	21.4	25.4	24.5	11.8	17.4					
980	105	295	14R	3-5	1.3	10.3	41.4	25.4	21.6	22.1	8.9	18.7					
47012	118	335	14R	2-4	7.2	11.1	23.6	23.5	24.6	20.5	7.8	14.6					
26	132	371	11	1½-4	0.3	[illegible]	27.8	24.9	25.8	28.4	10.9	26.6					
32	136	391	14L	4½-2½	16.5	19.7	13.9	22.2	27.7	24.6	10.7	13.3					
35	141	395	17	3-6	[illegible]	9.6	50.0	[illegible]	[illegible]	31.7	9.5	22.4					
37	143	404+68	14R	2-3½	[illegible].4	2.9	39.3	22.2	35.2	23.4	10.2	17.9					
158	174	88+00	35L	20½-21	5.3	21.5	24.7	[illegible]	25.9	18.6	7.4	21.9					
169	185	"	15R	5½-7½	4.8	16.5	21.0	26.9	30.8	30.8	9.9	21.4					
					19												
				S	109.0	377.8	445.0	501.7	476.5	461.5	172.6	383.8					
				A	5.7	19.9	23.4	26.4	24.6	24.3	9.1	20.2					

SUMMARY OF TESTS ON SOIL PROFILE SUBGRADE SAMPLES

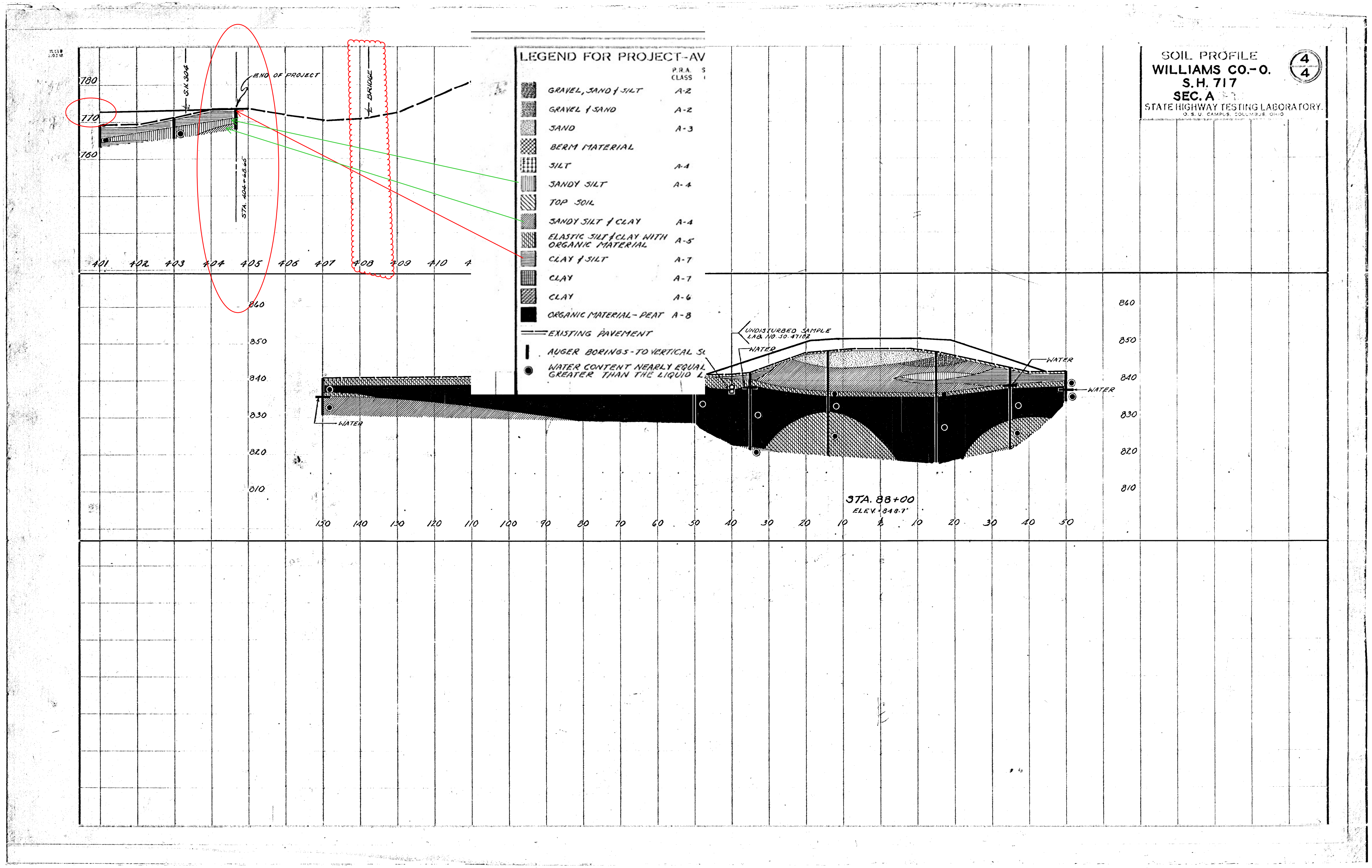
Williams County

Note Book No. ______

(4)

S.H. 717 Sec. A

Lab. No. So.	Field No.	Station No.		Represents Feet	Mechanical Analysis: Agg. %	C Sand %	F Sand %	Silt %	Clay %	Physical Charact.: L.L.	P.I.	Water Content	Density Data: Comp.	Opt.	Max. Dry Wt.	Class. No.: SHTL	PRA
47010	116	327	15	2½-4½	0.6	24.2	32.8	17.8	24.6	25.0	13.6	18.7					
11	117	329	13	½-1½	0.8	11.0	17.4	35.8	35.0	32.0	13.0	25.8					
13	119	335	14	5-6	1.1	3.0	7.8	49.8	38.3	23.2	7.1	19.7					
14	120	339	15	1½-2½	0.6	13.0	18.7	33.9	33.8	29.5	13.9	22.0					
23	129	361	14	5-7	4.8	5.6	8.5	26.3	54.8	30.7	13.7	15.6					
24	130	367	13	½-2½	1.1	10.9	15.7	39.1	33.2	33.5	13.7	27.4					
25	131	"		2½-3½	0	11.8	17.1	35.8	35.3	34.6	13.5	26.4					
27	133	377	14	4-5½	0.8	5.3	9.3	44.7	39.9	32.0	14.9	17.0					
28	134	381	13	½-2	1.5	12.1	15.4	37.9	33.1	28.9	11.9	21.8					
33	139	393	16½	1½-5	0	13.5	20.2	28.6	37.7	29.9	14.1	20.3					
38	144	440+68		3½-5	0	0.2	17.0	45.0	37.8	19.3	8.0	14.4					
45	146	143		2½-5	0.4	6.7	10.5	31.8	50.6	31.7	15.3	17.7					
57	138	211		½-5	10.6	11.9	17.0	21.0	29.1	30.1	11.5	21.2					
61	162	88	14	4½-6	4.8	23.4	13.5	21.8	36.5	30.0	15.1	20.0					
62	163	"		6-11	2.9	16.4	14.6	28.9	37.2	32.0	13.9	21.1					
156	172	"	35	2½-22	2.2	6.9	8.2	30.2	52.5	28.6	11.5	21.4					
163	179	86	262	8-10½	3.6	8.2	8.7	30.2	49.3	30.6	13.1	23.2					
164	180	"	"	10½-15	2.0	7.4	7.4	29.0	54.2	31.6	14.0	20.6					
170	186	88	15R	8½-11	0.2	10.3	21.8	34.8	32.9	32.4	12.9	25.1					
					51							50	1	2	2		
				S	[illegible].6	556.8	682.5	1666.7	2004.9	1550.4	660.4	1034.1	87.7	38.6	212.5		
				A	3.6	10.9	13.4	32.7	39.4	30.4	12.9	20.7	8.77	19.3	106.7		



SOIL PROFILE
WILLIAMS CO.-O.
S.H. 717
SEC. A
STATE HIGHWAY TESTING LABORATORY
O. S. U. CAMPUS, COLUMBUS, OHIO
4
4
LEGEND FOR PROJECT-AV
P.R.A. CLASS
GRAVEL, SAND & SILT A-2
GRAVEL & SAND A-2
SAND A-3
BERM MATERIAL
SILT A-4
SANDY SILT A-4
TOP SOIL
SANDY SILT & CLAY A-4
ELASTIC SILT & CLAY WITH ORGANIC MATERIAL A-5
CLAY & SILT A-7
CLAY A-7
CLAY A-6
ORGANIC MATERIAL - PEAT A-8
EXISTING PAVEMENT
AUGER BORINGS - TO VERTICAL SC
WATER CONTENT NEARLY EQUAL GREATER THAN THE LIQUID L
END OF PROJECT
S.H. 304
BRIDGE
STA. 404+28.65
780
770
760
401
402
403
404
405
406
407
408
409
410
860
850
840
830
820
810
UNDISTURBED SAMPLE LAB. NO. 50-47182
WATER
WATER
WATER
WATER
STA. 88+00
ELEV. 848.7'
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
10
20
30
40
50

1950 Year 015758

STORAGE DATA	
Folder	
Section File No.	FEP 41
Record Center No.	5A-037/4D-05
Tracings	
Section File No.	FET-44
Record Center No.	4-M-44

Job No.

Changes

County WILLIAMS

Project Ident. WIL-384-(0,10-2,44)

Project Code				

Proj. No.

Topo Sheet	

Begin Sta. 0+00

End Sta. 168+50

Design By

Length 3.19 Miles

		Rev.
Drafting By	J.K.D.	
Comp. Date	9/-/50	
Drafting Hrs.		

	RECON	AUGER	CORE	DRIVE ROD	RESISTIVITY
By		DGR			
Dates		9/-/50			
No. of Holes or Soundings					
Footage		323.5			
Samples Tested		36			

☐ Samples Accounted

No. of Tracings	2

Remarks

Transmittal Date 9-13-50 Revisions Refer to

Length	Auger Data			Core Data			Drive Rod Data		Resistivity
	No. of Holes	Footage	Samples	No. of Holes	Footage	Samples	No. of Soundings	Footage	No. of Locations
3.19		323.5	36	—	—	—	—	—	—

Form TE-155

* See Reverse Side

SUMMARY OF TESTS ON SOIL PROFILE SUBGRADE SAMPLES

WILLIAMS County — Note Book No. 186 — (1/2)

S.H. ________ Sec. WIL-384-(0.10-2.44)

Lab. No. So.	Field No.	Station No.	Represents Feet	Mechanical Analysis: Agg. %	C Sand %	F Sand %	Silt %	Clay %	Physical Charact.: L.L.	P.I.	Water Content	Density Data: Comp.	Opt.	Max. Dry Ft.	Class. No.: SHTL	FPA
77655	4	3+00	4-5	54	12	16	10	8	18	6	11				(2)	A-1-b(0)
77657	6	9+00	.05-3	21	34	15	21	9	16	3	8					
77658	7	9+00	3-6	9	37	30	19	5	23	N-P	20					
77665	14	63+00	2.5-3.5	5	43	30	15	7	17	3	19				(4)	
77681	30	147+00	1.5-3.5	3	28	49	11	9	N.P.	N.P.	8					
77685	1-Comp.	9+00	0.5-5	10	42	24	16	8	22	N.P.	—		9.0	130.2		
		(5) SUM		48	184	148	82	38	78	6	55					A-2-4(0)
		AVG.		10	36	30	16	8	20	1	14					
77672	21	96+00	5-10	2	3	3	63	29	19	5	17					
77673	22	99+00	2.5-6	0	5	33	55	7	N.P.	N.P.	20				(8)	
		(2) SUM		2	8	36	118	36	19	5	37					A-4(8)
		AVG.		1	4	18	59	18	19	3	18					
77653	2	0+00	3-4	6	33	13	26	22	25	10	20					
77654	3	0+00	4-5	2	10	17	42	29	30	6	19					
77656	5	6+00	3-4	4	30	29	26	11	20	4	23					
77661	10	33+00	0.5-1.5	26	17	17	27	13	27	10	14					
77668	17	81+00	3-5	4	23	13	41	19	24	10	17					
77676	25	123+00	2.5-5	6	36	19	26	13	13	N.-P.	17				(9)	
77678	27	129+00	0.5-2.5	7	26	25	31	11	22	7	11					
77679	28	129+00	2.5-5	5	36	23	23	13	22	8	15					
77682	31	168+00	1-3	6	23	27	33	11	23	9	7					
77683	32	170+00	0.5-2	19	17	17	33	14	24	9	11					
77687	3-Comp.	96+00	0.5-5	3	15	11	46	25	27	10	—		13.6	118.1		
		(11) SUM		88	266	211	354	181	257	83	145					A-4(3)
		AVG.		8	24	19	[illegible]	17	23	7	13					

SUMMARY OF TESTS ON SOIL PROFILE SUBGRADE SAMPLES

WILLIAMS County Note Book No. 186 (2/2)

S.H. ______ Sec. WIL-384-(0.10-2.44)

Lab. No. So.	Field No.	Station No.	Represents Feet	Mechanical Analysis Agg. %	C Sand %	F Sand %	Silt %	Clay %	Physical Charact. L.L.	P.I.	Water Content	Density Data Comp.	Opt.	Max. Dry Wt.	Class. No. SHTL	FPA
77652	1	0+00	0.5-3	9	23	13	29	26	28	13	17					
77659	8	9+00	6-10	4	12	9	41	34	29	15	15					
77663	12	54+00	2-3.5	4	23	29	27	17	24	11	19					
77664	13	57+00	2-3.5	2	13	31	41	13	26	11	20					
77666	15	63+00	3.5-5	2	19	12	40	27	31	14	24					
77669	18	87+00	0.5-5	4	14	15	39	28	30	14	13				(11)	
77670	19	90+00	0.5-4	5	21	10	46	18	32	15	18					
77671	20	90+00	4-10	5	9	10	44	32	32	13	23					
77674	23	102+00	2.5-5	2	7	12	46	33	32	15	21					
77675	24	114+00	2.5-5	7	27	19	27	20	27	12	19					
77686	2-comp.	78+00	0.5-4	4	11	9	46	30	34	16	—		14.9	112.4		
		(11) SUM		48	177	169	426	278	325	149	189					
		AVG		4	16	15	40	25	30	13	17					A-6(7)
77660	9	15+00	4-5	4	4	12	38	42	34	18	21					
77662	11	48+00	2-3	2	16	20	37	25	35	19	18					
77677	26	126+00	3-5	6	7	7	34	46	39	20	19				(15)	
77680	29	138+00	4-5	0	2	2	47	49	35	17	20					
		(4) SUM		12	29	41	156	162	153	74	78					A-6(11)
		AVG.		3	7	10	39	41	~~34~~ 38	18	19					
77684	33	170+00	2-5	2	3	5	47	43	47	26	23				(16)	(A-7-6(16
77667	16	69+00	4-5	4	4	8	2	82	38	29	16				(17)	A-6(16)

LEGEND FOR PROJECT-AVERAGE RESULTS OF TESTS- 36 SAMPLES TESTED

DESCRIPTION	H.R.B. CLASS	S.H.T.L. CLASS	% AGG.	% C. SAND	% F. SAND	% SILT	% CLAY	LIQUID LIMIT	PLASTICITY INDEX	WATER CONTENT	SAMPLES TESTED
GRAVEL, SAND & SILT	A-1-b(0)	2	54	12	16	10	8	18	6	11	1
SAND	A-2-4(0)	4	10	36	30	16	8	20	1	14	5
SILT	A-4(8)	8	1	4	18	59	18	19	3	18	2
SANDY SILT	A-4(3)	9	8	24	19	32	17	23	7	13	11
SANDY SILT & CLAY	A-6(7)	11	4	16	15	40	25	30	13	17	11
CLAY & SILT	A-6(11)	15	3	7	10	39	41	38	18	19	4
CLAY	A-7-6(16)	16	2	3	5	47	43	47	26	23	1
CLAY	A-6(16)	17	4	4	8	2	82	38	29	16	1

EXISTING PAVEMENT

AUGER BORINGS - TO VERTICAL SCALE ONLY.

WATER CONTENT NEARLY EQUAL TO OR GREATER THAN THE LIQUID LIMIT.

~ SAMPLES TESTED ~
LAB. NO'S. SO. 77652 - 77687 INCL.

~ MOISTURE-DENSITY SAMPLES ~
LAB. NO'S. SO. 77685 - 77687 INCL.

NOTE:- FIGURES NEAR BORINGS REPRESENT WATER CONTENT IN PER CENT.

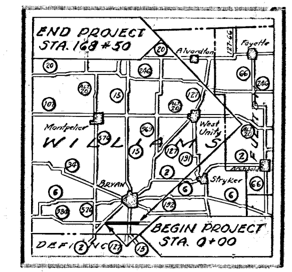
SOIL PROFILE

WILLIAMS COUNTY
WIL-384-(0.10-244)

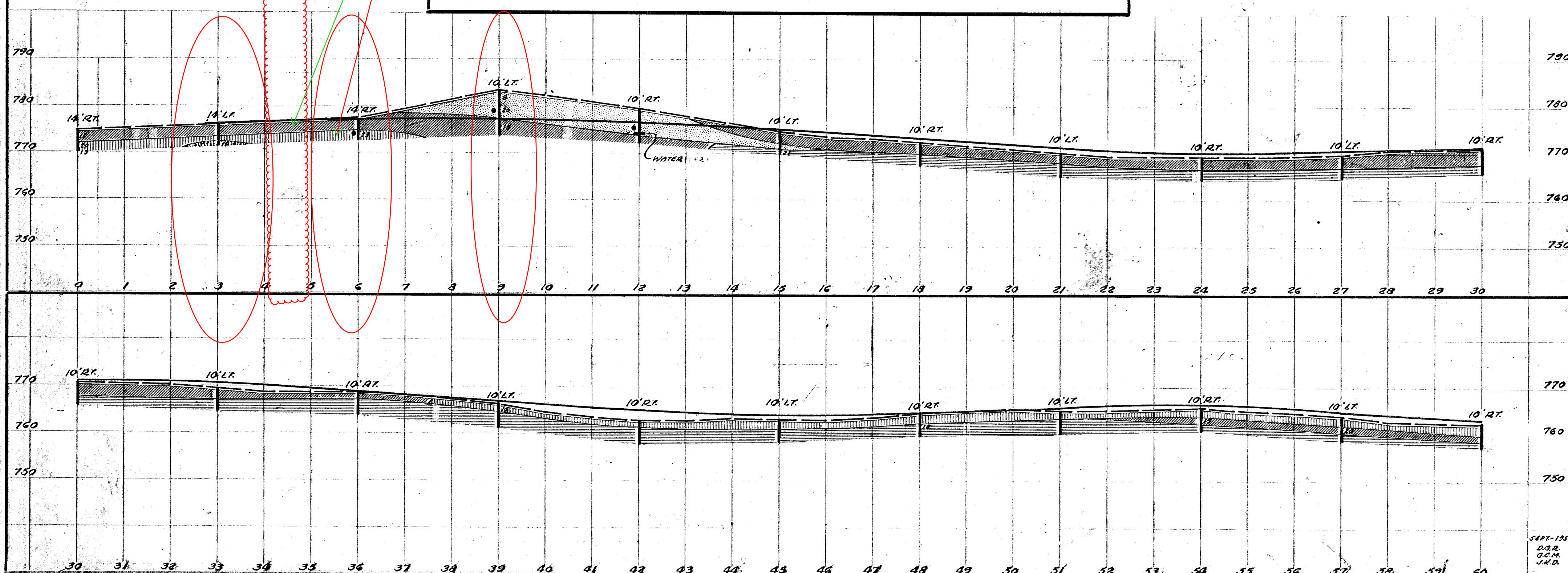
1 / 2

STATE HIGHWAY TESTING AND RESEARCH LABORATORY
O. S. U. CAMPUS, COLUMBUS, OHIO

NOTE: THE INFORMATION SHOWN BY THIS SUBGRADE PROFILE WAS SECURED FOR THE INFORMATION OF THE STATE OF OHIO. THE STATE DOES NOT GUARANTEE THE CORRECTNESS THEREOF AND DOES NOT INCLUDE IT AS A PART OF THE PLANS GOVERNING THE CONSTRUCTION OF THE PROJECT.



LOCATION MAP



SEPT.-1950
D.S.R.
O.C.M.
J.K.D.