STRUCTURE FOUNDATION EXPLORATION

LUC-25-5.04, PID 79901

Proposed Culvert Replacement

Anthony Wayne Trail over Delaware Creek
Toledo, Lucas County, Ohio

Submitted to *ODOT District 2*
Date *April 2023*

Prepared by TTL associates inc Environmental, Geotechnical Engineering & Testing

Ohio Department of Transportation

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April 4, 2023

TTL Project No. 2292401

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

FINAL Report
Structure Foundation Exploration
Proposed Culvert Replacement
LUC-25-5.04, PID 79901
Anthony Wayne Trail over Delaware Creek
Toledo, Lucas County, Ohio

Dear Ms. Summersett:

Following is the report of our structure foundation exploration performed by TTL Associates, Inc. (TTL) for the referenced site. This study was performed in accordance with TTL Proposal No. 2292401, dated August 16, 2022, and was authorized by ODOT Agreement No. 37607, dated August 31, 2022.

This report contains the results of our study, our engineering interpretation of the results with respect to the project characteristics, as well as our design and construction recommendations for the replacement culvert. It is our understanding that the draft version of this report was reviewed by ODOT District 2. At the request of Mr. David Geckle with ODOT District 2, we are now submitting the report as "FINAL" in accordance with ODOT protocol.

The soil and rock samples collected during this exploration will be stored at our laboratory for 90 days from the date of this report. The samples will be discarded after this time unless you request that they be saved or delivered to you.

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

Sincerely,

TTL Associates, Inc.

STATE OF OHIO
KATHERINE HENNICKEN
E-83245
REGISTERED
PROFESSIONAL ENGINEER

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FINAL REPORT
STRUCTURE FOUNDATION EXPLORATION
PROPOSED CULVERT REPLACEMENT
LUC-25-5.04, PID 79901
ANTHONY WAYNE TRAIL OVER DELAWARE CREEK
TOLEDO, LUCAS COUNTY, OHIO

FOR

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

SUBMITTED

APRIL 4, 2023
TTL PROJECT NO. 2292401

TTL ASSOCIATES, INC.
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EXECUTIVE SUMMARY

This structure foundation exploration report has been prepared for the proposed replacement of the culvert along State Route 25 (SR 25), in Toledo, Lucas County, Ohio, designated as LUC-25-5.04, PID 79901. This exploration included five test borings laboratory testing, and engineering evaluations for support for the proposed culverts and headwall foundations. A summary of the conclusions and recommendations of this study are as follows:

1. The surface materials encountered in Borings B-001, B-002, and B-004 consisted of asphalt ranging in thickness from 5 to 8 inches. Aggregate base was encountered under the asphalt in Borings B-001 and B-002, with thicknesses of approximately 5 inches and 28 inches, respectively. Approximately 7½ inches of concrete was encountered under the asphalt in Boring B-004. The surface materials encountered in Borings B-003 and B-005 consisted of topsoil approximately 4 inches and 3 inches in thickness, respectively.

2. Underlying the surface materials, existing fill materials were encountered. Within the borings, the existing fill materials were encountered to approximate Elevs. 583 to 577. The existing fill materials consisted of predominantly cohesive materials, with zones of granular materials. The granular fill materials consisted of gravel and stone fragments with sand, fine sand, as well as coarse and fine sand. The encountered cohesive existing fill materials included sandy silt, silt and clay, as well as silty clay.

3. Based on the results of our field and laboratory tests, the subsoils encountered underlying the existing fill materials can be generally be described as a stratum of granular alluvium underlain by a stratum of cohesive glacial till. The soils at the site were underlain by weathered dolomite bedrock. **Stratum I** consisted of medium dense native granular soils interpreted as alluvium encountered underlying the existing cohesive fill materials in Boring B-003 to approximate Elev. 574. The granular soils consisted of coarse and fine sand (ODOT A-3a), as well as gravel and stone fragments with sand (ODOT A-1-b). **Stratum II** consisted of predominantly very stiff to hard cohesive soils encountered underlying Stratum I to approximate Elevs. 564 to 558. Borings B-002 and B-004 were terminated within Stratum II at approximate Elev. 556. The Stratum II cohesive soils consisted of sandy silt (ODOT A-4a), silty clay (ODOT A-6a), silt and clay (ODOT A-6b), as well as clay (ODOT A-7-6). A zone of granular soils was encountered within Boring B-003 to Elev. 553. The granular soils consisted of gravel and stone fragments with sand, silt, and clay (ODOT A-2-6). Weathered dolomite that was penetrable with augers was encountered underlying the soils at this site. Boring B-001 was terminated within the weathered dolomite at Elev. 557. Borings B-003 and B-005 encountered auger refusal at approximate Elevs. 553 and 564, respectively.

4. During this exploration, groundwater was initially encountered during drilling at approximate Elevs. 602 to 558. Groundwater was observed upon completion of drilling at approximate Elevs. 569 to 557. Apart from streamflow influences in the creek, it is our opinion that the "normal" groundwater level can generally be expected at elevations on the order of Elevs. 580 to 570 feet.

5. Based on the conditions encountered in the borings, the soils encountered within the alignment of the culvert are anticipated to consist of cohesive existing fill materials, Stratum I medium dense granular soils, as well as Stratum II predominantly very stiff to hard cohesive soils. Special care should be exercised where drilling operations transition from one soil type to another, especially at this site where the transition occurs along the culvert alignment.

6. Based on the test borings, the soils at the headwall bearing elevations are expected to consist of Stratum II predominantly very stiff to hard cohesive glacial till deposits, which are considered generally suitable for the support of the proposed headwalls.

7. We understand that the culvert headwall will be designed using LRFD specifications. At the **service** limit state, the factored bearing resistance was determined to be 6 ksf. Settlement associated with this bearing resistance was calculated to be on the order of 1 inch or less. At the **strength** limit state, the factored bearing resistance was calculated to be 7.3 ksf. The bearing soils should be confirmed as being native cohesive soils with an unconfined compressive strength of at least 5,500 pounds per square foot (hand penetrometer reading of 2.75 tsf or greater).

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

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1.0 INTRODUCTION

This structure foundation exploration report has been prepared for the proposed replacement of the culvert along State Route 25 (SR 25) in Toledo, Lucas County, Ohio, designated as LUC-25-5.04, PID 79901. The culvert is located approximately 1,100 feet south of the south intersection of Anthony Wayne Trail (SR 25) and Glendale Avenue, as shown on the attached Site Location Map (Plate 1.0).

This study was performed in accordance with TTL Proposal No. 2292401, dated August 16, 2022, and was authorized by Ohio Department of Transportation Agreement No. 37607, dated August 31, 2022.

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, five test borings, field and laboratory soil testing, a geotechnical engineering evaluation of the test results, 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 also presents provides our design and construction recommendations for culvert support.

This report includes:

- A description of the existing surface cover, subsurface soils, rock, and groundwater conditions encountered in the borings.
- Design recommendations for culvert support.
- Recommendations concerning soil-, rock-, and groundwater-related construction procedures such as site preparation, earthwork, culvert installation, as well as related field testing.

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 existing culvert along Delaware Creek will be replaced with a new reinforced concrete pipe culvert below SR 25, Fanning Drive, and Rohr Boulevard. We understand that the existing pavement along SR 25 has recently undergone reconstruction, and that the new culvert is planned to be installed via tunneling methods. The culvert inverts are indicated to be Elevs. 572.71 and 571.91 at the inlet and outlet, respectively.

Based on the provided drawing, the culvert is planned to be 90 inches in diameter, and it is assumed the headwalls will be designed as half-height headwalls. As such, the ODOT standard drawing HW 2.2 half-height headwalls for concrete pipe will be utilized.

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 Physiographic Region of the Huron-Erie Lake Plains Section of Ohio. Within this region, the predominant geologic deposits consist of Pleistocene-age silt, clay, and wave-planed clayey till over Silurian-age and Devonian-age carbonate bedrock and shale. 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.

Bedrock in the project area is broadly mapped on the "Geologic Map of Ohio" as Silurian-age Monroe limestone. Specific to the project site, the uppermost carbonate rock formation is mapped as Tymochtee dolomite. Bedrock was encountered within the borings performed for this investigation at approximate Elevs. 564 to 553.

2.1.1 Generalized Near-Surface Soils

The USDA Natural Resource Conservation Service (NRCS) Web Soil Survey indicates that soils in the project area are mapped as Sloan loam. These soils consist of alluvium formed on flood plains, and are considered very poorly drained, with moderately high to high permeability.

2.2 Site Reconnaissance

TTL performed site reconnaissance on September 9, 2022. The site is located in a predominantly wooded area with residential developments north and south of the creek valley.

In the area of the existing culvert, surface depressions were observed within the median along SR 25, indicative of some subsurface soil subsidence. The unpaved shoulder along the west side of SR 25 was soft from recent pavement reconstruction activities, and boot print indentations of up to 2 inches in depth were observed.

Slopes extending downward from SR 25 appeared to be in fair condition, although we understand that a broken watermain along the east edge of SR 25 was indicated to have caused a slope failure approximately 175 feet north of the creek. At the time of our reconnaissance, tree clearing was being performed in that failure area, and the surface was observed to be hummocky with substantial areas of washout.

The existing asphalt pavement along Rohr Boulevard appeared in good condition with minimal longitudinal cracking along the shoulder. The existing slopes were covered in vegetation. The existing guardrail along the east side of Rohr Boulevard near the outlet appeared in good condition. The outlet headwall was not visible from the roadway elevation, and site grades were not conducive to exploration.

The existing pavement along Fanning Drive consisted of asphalt pavement in poor condition, with several potholes, extensive patching, crumbling asphalt along the edges of the roadway, and areas of apparent raveling. The slope appeared hummocky with several areas of subsidence noted, and little to no ground cover beneath a dense tree canopy. The slope appears to have eroded away from the inlet headwall.

3.0 EXPLORATION

3.1 Historic Borings

Historic borings were not available within the project vicinity. However, photographs of the slopes immediately east and west of SR 25 were available. These photographs showed generally hummocky slopes in the vicinity of the project.

3.2 Project Exploration Program

Five test borings, designated as Borings B-001-0-22 through B-005-0-22 were drilled by TTL on September 12 and 13, 2022, as well as January 19, 2023. These borings are fully designated in accordance with ODOT protocol, but the -0-22 portion of the nomenclature is generally omitted in the discussions within this report. Boring B-001 was located within the Fanning Drive roadway, drilled near the inlet side of the culvert. Borings B-002, B-003, and B-004 were located within the Anthony Wayne Trail roadway and right of way. Boring B-005 was located within the Rohr Boulevard right of way, drilled near the outlet side of the culvert. The existing site features and approximate locations of the borings are presented on the Test Boring Location Plan (Plate 2.0).

Latitude, Longitude, and ground surface elevations at the boring locations were surveyed by TTL via a hand-held GPS. These data are presented on the logs of test borings, and are summarized in the following table. Stationing and offsets at the boring locations were not provided.

Table 3.2 General Boring Location Information

Boring Number	Ground Surface Elevation (feet)	Latitude (Degrees)	Longitude (Degrees)
B-001-0-22	610.4	41.608419	-83.597138
B-002-0-22	620.9	41.608422	-83.596853
B-003-0-22	621.5	41.608424	-83.596694
B-004-0-22	621.2	41.608424	-83.596537
B-005-0-22	600.8	41.608424	-83.596165

Borings B-001 and B-005 were planned as Type E2b structure borings per geotechnical investigative procedures outlined in Ohio Department of Transportation (ODOT) "Specifications for Geotechnical Explorations" (SGE). Borings B-002, B-003, and B-004 were be performed as ODOT Type E2c borings. Each of the borings were terminated at a depth of approximately 20 feet below the invert elevation.

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 during this exploration were drilled with a CME 75 truck-mounted drilling rig, as well as a Diedrich D70 track-mounted drilling rig, each utilizing 3¼-inch inside diameter hollow-stem augers. During auger advancement, split-spoon drive samples were 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 CME 75 truck-mounted drill rig utilized in this project was 66.0 percent, based on calibration on March 15, 2021. The calibrated hammer/rod energy ratio for the Diedrich D70 track-mounted drill rig utilized in this project was 90.0 percent, based on calibration on March 15, 2021. The N_{60}-values are presented on the attached Logs of Test Borings.

Shelby tube samples, designated ST on the Logs of Test Borings, were obtained from Borings B-001 (16 to 18 feet) and B-005 (21 to 23 feet). Each Shelby tube sample was 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 and rock 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 and rock.

3.4 <u>Laboratory Testing Program</u>

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 selected 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 6913 and D 7928) were performed on selected samples to determine soil classification and index properties. These test results are presented on the Logs of Test Borings and Unconfined Compression Test sheet.

4.0 FINDINGS

4.1 General Site Conditions

The site is located along Anthony Wayne Trail (SR 25), approximately 1,100 feet south of the south intersection with Glendale Avenue. In the project area, grades along SR 25 were on the order of Elevs. 622 to 621. Grades along Fanning Drive at the culvert crossing were on the order of Elev. 610. Grades along Rohr boulevard were on the order of Elev. 601.

The surface materials encountered in Borings B-001, B-002, and B-004 consisted of asphalt ranging in thickness from 5 to 8 inches. Aggregate base was encountered under the asphalt in Borings B-001 and B-002, with thicknesses of approximately 5 inches and 28 inches, respectively. Approximately 7½ inches of concrete was encountered under the asphalt in Boring B-004. The surface materials encountered in Borings B-003 and B-005 consisted of topsoil approximately 4 inches and 3 inches in thickness, respectively.

Underlying the surface materials, existing **fill** materials were encountered. Historically, the Erie-Miami Canal followed the alignment of the present Anthony Wayne Trail. Fill materials were placed during the demolition and filling of the canal. Based on available topographic mapping, native ground surface elevations along Delaware Creek in the vicinity of the boring locations are on the order of Elevs. 580 to 575. Within the borings, the existing fill materials were encountered to approximate Elevs. 583 to 577. The existing fill materials consisted of predominantly cohesive materials, with zones of granular materials.

The granular fill materials consisted of:

- gravel and stone fragments with sand,
- fine sand, as well as
- coarse and fine sand.

Within the granular existing fill materials, SPT N_{60}-values typically ranged from 3 to 20 blows per foot (bpf), indicating predominantly **very loose** to medium dense compactness. Moisture contents ranged from 3 to 21 percent.

The encountered cohesive existing fill materials included:

- sandy silt,
- silt and clay, as well as
- silty clay.

SPT N_{60}-values typically ranged from 5 to 15 bpf, indicating predominantly medium stiff to stiff consistency. Moisture contents ranged from 13 to 29 percent.

4.2 General Soil Conditions

Based on the results of our field and laboratory tests, the subsoils encountered underlying the existing fill materials can be generally be described as a stratum of granular alluvium underlain by a stratum of cohesive glacial till. The soils at the site were underlain by weathered dolomite bedrock.

Stratum I consisted of medium dense native granular soils interpreted as alluvium encountered underlying the existing cohesive fill materials in Boring B-003 to approximate Elev. 574. The granular soils consisted of coarse and fine sand (ODOT A-3a), as well as gravel and stone fragments with sand (ODOT A-1-b). SPT N_{60}-values of 26 blows per foot (bpf) and 17 bpf and a moisture content of 29 percent were determined for the samples obtained in this stratum.

Stratum II consisted of predominantly very stiff to hard cohesive soils encountered underlying Stratum I to approximate Elevs. 564 to 558. Borings B-002 and B-004 were terminated within Stratum II at approximate Elev. 556. The Stratum II cohesive soils consisted of sandy silt (ODOT A-4a), silty clay (ODOT A-6a), silt and clay (ODOT A-6b), as well as clay (ODOT A-7-6). SPT N_{60}-values typically ranged from 17 to 47 bpf. Unconfined compressive strengths generally ranged from 4,000 to 9,000 psf. Moisture contents varied from 9 to 29 percent.

A zone of granular soils was encountered within Boring B-003 to Elev. 553. The granular soils consisted of gravel and stone fragments with sand, silt, and clay (ODOT A-2-6). SPT N_{60}-values of 54 bpf and 93 bpf and moisture contents of 8 percent and 7 percent were determined for these soils.

Weathered dolomite that was penetrable with augers was encountered underlying the soils at this site. Boring B-001 was terminated within the weathered dolomite at Elev. 557. Borings B-003 and B-005 encountered auger refusal at approximate Elevs. 553 and 564, respectively.

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

4.3 Groundwater Conditions

During this exploration, groundwater was initially encountered during drilling at approximate Elevs. 602 to 558. Groundwater was observed upon completion of drilling at approximate Elevs. 569 to 557. It should be noted that the boreholes were drilled and sealed within the same day, and stabilized water levels may not have occurred over this limited time period.

Apart from streamflow influences in the creek, it is our opinion that the “normal” groundwater level can generally be expected at elevations on the order of Elevs. 580 to 570 feet. However, groundwater elevations can fluctuate with seasonal and climatic influences, and will also be particularly affected locally by water levels in the creek. Therefore, groundwater conditions may vary at different times of the year from those encountered during this exploration.

4.4 Remedial Measures

Based on the conditions encountered in the borings, the soils encountered within the alignment of the culvert are anticipated to consist of cohesive existing fill materials, Stratum I medium dense granular soils, as well as Stratum II predominantly very stiff to hard cohesive soils. Special care should be exercised where drilling operations transition from one soil type to another, especially at this site where the transition occurs along the culvert alignment.

Based on the test borings, the soils at the headwall bearing elevations are expected to consist of Stratum II predominantly very stiff to hard cohesive glacial till deposits, which are considered generally suitable for the support of the proposed headwalls.

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 TTL.

5.1 Culvert and Headwall Support

5.1.1 Tunnelling Considerations

We anticipate that tunneling installation methods are planned for the proposed culvert. For the culvert replacement, the reinforced concrete pipe culvert is planned to be 90 inches in diameter. The culvert inverts are indicated to be Elevs. 572.71 and 571.91 at the inlet and outlet, respectively. Based on the conditions encountered in the borings, the soils encountered within the alignment of the culvert are anticipated to consist of:

- cohesive existing **fill** materials with a design undrained shear strength of 2,000 pounds per square foot (psf),
- Stratum I medium dense granular soils with a design internal angle of friction (ϕ) of 34.9 degrees, as well as
- Stratum II predominantly very stiff to hard cohesive soils with a design undrained shear strength of 2,750 psf.

It is presumed that directional drilling will be initiated from the ground surface. However, if access excavations for the directional drilling equipment are utilized, or in the case of using pits for bore-and-jack installation, they may be constructed with appropriate slope layback as presented in 5.2.3, or using bracing such as soldier piles with lagging or sheet piling as presented in Section 5.2.5.

Special care should be exercised during any boring or directional drilling operations to prevent "loss of ground" caused by the movement of excessive amount of soils out of the horizontal borehole. The movement of excessive amounts of soil during the boring operation could result in surface settlements along the boring alignment. Care should also be exercised where drilling operations transition from one soil type to another, especially at this site where the transition occurs along the culvert alignment.

It should be noted that cobbles and boulders are not uncommon in glacial till soils, such as those encountered in Stratum II. Should obstructions or tunneling penetration refusal/blockages occur during installation, cobbles or boulders may be indicated. Provisions must be made to remove any cobbles, boulders, or large obstructions encountered during the tunneling or directional drilling operations.

5.1.2 Headwall Foundations

For the culvert replacement, the reinforced concrete pipe culvert is planned to be 90 inches in diameter. The culvert inverts are indicated to be Elevs. 572.71 and 571.91 at the inlet and outlet, respectively. It is assumed the headwalls will be designed as half-height headwalls. As such, the ODOT standard drawing HW 2.2 half-height headwalls for concrete pipe plans indicate that a design culvert diameter of 90 inches requires a headwall footing width of 22 inches, and a total length of 16.7 feet.

Based on the conditions encountered in the borings, the soils at the anticipated culvert headwall bearing elevation are expected to consist of Stratum II predominantly stiff to very stiff native cohesive soils, which are considered generally suitable for support of the proposed culvert. The bearing soils should be confirmed as being native cohesive soils with an unconfined compressive strength of at least 5,500 pounds per square foot (hand penetrometer reading of 2.75 tsf or greater).

We understand that the culvert bearing slab will be designed using LRFD specifications. At the **service** limit state, a nominal (unfactored) bearing resistance (q_n) of 6 kips per square foot (ksf) was determined for the culvert base bearing in Stratum II predominantly stiff to very stiff native cohesive soils. At the service limit state, the resistance factor (ϕ_b) is 1.0. Therefore, the factored bearing resistance (q_r) is 6 ksf. From a conventional allowable stress design comparison, this is roughly akin to using an allowable bearing pressure.

At the **strength** limit state, we recommend a nominal bearing resistance (q_n) of 14.6 ksf for the culvert base bearing in Stratum II predominantly stiff to very stiff native cohesive soils. At the strength limit state, the resistance factor (ϕ_b) is 0.5. Therefore, the factored bearing resistance (q_r) is 7.3 ksf. From a conventional allowable stress design comparison, this is roughly akin to calculating an ultimate bearing capacity and applying a factor of safety.

Settlement of the culvert was calculated by conventional consolidation theory utilizing recompression indices for the over-consolidated cohesive soils based on empirical relations using moisture content. Based on a bearing pressure of 6 ksf, using the service limit state bearing resistance indicated above, total settlement was calculated to be on the order of 1 inch or less.

Although not anticipated to be prevalent, if unsuitable bearing soils are encountered during culvert installation, over-excavation should extend through these materials to suitable bearing soils. The base of the over-excavation should be widened 6 inches for every foot of depth extending beyond the edge of the culvert. The over-excavated areas should be backfilled with dense-graded aggregate. The aggregate should be placed and compacted as described in Section 5.2.5. Alternatively, the over-excavated areas could be backfilled with lean concrete having a minimum compressive strength of 1,500 pounds per square inch (psi) or other flowable controlled-density fill having a minimum compressive strength of 300 psi. If foundations will be placed at the base of the over-excavation or the lean concrete fill option will be utilized, widening the footing over-excavation will not be required. If the controlled-density fill option is utilized, the footing over-excavation shall be widened as discussed above.

For culvert walls that are restrained at the top of the wall, lateral earth pressures should be assumed for “at-rest” conditions. It is anticipated that excavated on-site cohesive soils will comprise the majority of the backfill behind the new culvert walls. For the cohesive soils, an active earth pressure coefficient (k_a) of 0.5 should be used in determining the lateral pressure acting on the walls, along with a total (moist) soil unit weight of 130 pounds per cubic foot (pcf). Alternatively, an equivalent fluid weight of 65 pcf may be used for the “at-rest” case design.

If lower at-rest earth pressures are preferred for structural reasons, we recommend that a select, free-draining granular fill (such as No. 57 or 67 stone) be utilized for the entire culvert backfill zone extending to the surface from the base of the wall at 45 degrees. For these granular fill types, k_o may be taken as 0.4, and the soil unit weight may be assumed as 120 pcf. Alternatively, an equivalent fluid weight of 50 pcf may be used for these granular fills.

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

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

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

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

- The cohesion (c) of the clay, for which we recommend c be taken as 2,750 psf, or
- Although not anticipated to be the case, where footings are supported on at least 6 inches of compacted granular material, one-half the normal stress on the interface between the footing and soil.

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

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

5.2 Construction

5.2.1 Sedimentation and Erosion Control

In planning the implementation of earthwork operations, special consideration should be given to provide measures to prevent or reduce soil erosion and the subsequent sedimentation into nearby waterways. These measures may include some or all of the following:

1. Scheduling of earthwork operations such that erodible areas are kept as small as possible and are exposed for the shortest possible time.
2. Using special grading practices, along with diversion or interceptor structures, to reduce the amount of run-off water from an erodible area.
3. Providing vegetative buffer zones, filter berms, or sedimentation basins to trap sediment from surface run-off water.

A specific and detailed soil erosion and sedimentation control program and permits may be required by local, state, or federal regulatory agencies.

5.2.2 Site Preparation

Prior to proceeding with construction operations, all structures, pavements, topsoil, root systems, vegetation, and other deleterious non-soil materials should be removed from the proposed construction areas.

5.2.3 Temporary Excavations and Permanent Slopes

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

Although the encountered cohesive soils should be generally conducive to stable excavation slopes, the anticipated "normal" groundwater level is anticipated to roughly coincide with the creek bottom elevation. As such, seepage may occur in open excavations for culvert installation which could affect the stability of the excavation slopes. Provisions should be made for the culvert installation to proceed as a sloped-bank excavation, or as a steeper trench-type cut with properly designed and installed lateral bracing. The latter system may include the use of a portable trench box or a sliding trench shield.

If the excavation is to be performed with sloped banks, adequate stable slopes must be provided in accordance with OSHA criteria. The soils encountered in the test borings within the anticipated depth of excavations may include:

- OSHA Type A soils (native cohesive soils with unconfined compressive strengths of 3,000 pounds per square foot (psf) or greater),
- OSHA Type B soils (native cohesive soils with unconfined compressive strengths greater than 1,000 psf but less than 3,000 psf), and
- OSHA Type C soils (granular soils and fill materials).

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

For permanent excavations and slopes, we recommend that grades generally be no steeper than 3H:1V. It should be noted that ODOT routinely uses 2H:1V slopes for roadway embankments. These steeper slopes could be used, with recognition that the embankment faces are more prone to erosion and sloughing.

5.2.4 Support of Excavations

Where existing structures, underground utilities, and embankments are located within a distance from the excavation equal to approximately twice the depth of the excavation, an adequate system of sheet piling, lateral bracing, trench boxes, or an alternate construction procedure may be required to prevent lateral movements that may cause settlement of these entities. Sheet piling may also be used in combination with laid-back slopes limited to the upper portion of the profile to avoid an excessively large, open excavation.

Design of sheet-pile cutoff walls or H-pile and lagging systems should be the responsibility of the contractor, since their installation and performance is integrally tied to the contractor's means and methods of construction. In any case, applicable OSHA standards must be followed. It is the responsibility of the installation contractor to develop appropriate installation methods and equipment specifications prior to commencement of work, and to obtain the services of a qualified engineer to design or approve sloped or benched excavations and/or lateral bracing systems as required by OSHA criteria. In addition, OSHA requires that excavations with open-cut slopes higher than 20 feet, or braced excavation support systems such as sheetpiling or cofferdams be reviewed and designed by a registered professional engineer.

Retaining structures or walls that are not restrained at the top of the wall should be designed for active lateral earth pressure condition. An active earth pressure coefficient (k_a) of 0.33 may be used for design. A passive earth pressure coefficient (k_p) of 3.0 may be utilized for the portion of the wall that is below the excavation bottom. It should be noted that some wall movement or horizontal displacement is typically associated with active and passive earth pressure conditions. In particular, appreciable movements are needed to mobilize the **full** (theoretical) passive pressure of the soil. Specific bracing systems selected by the contractor may have variations of lateral earth pressure (and associated coefficients) that range between the active and passive cases.

In determining lateral earth pressures, total unit weights of 130 pounds per cubic foot (pcf) and 125 pcf may be utilized for the cohesive soils and granular soils, respectively. Below the groundwater table, effective ("submerged") unit weights should be utilized by reducing the total unit weights by the unit weight of water (62.4 pcf). Additionally, hydrostatic pressures should be considered below the groundwater or streamflow level(s).

It should also be noted that the above earth pressures are based on a level backfill condition behind the retaining wall. In areas where appreciable sloping materials will be present behind the top of the wall, surcharge loading or equivalent higher earth pressure coefficients should be evaluated, based on the sloping material, backfill slope, and proximity to the wall. In general, 50 percent of the vertical surcharge load should be used for lateral loading in the design of the wall.

5.2.5 Construction Dewatering and Groundwater Control

Groundwater conditions encountered during our exploration are summarized in Section 4.3. Based on the soil characteristics and groundwater conditions encountered in the borings, it is our opinion that the "normal" groundwater level (apart from creek streamflow levels) can generally be expected at elevations on the order of Elevs. 580 to 570 feet.

If construction does not occur during a particularly wet period, adequate control of groundwater seepage into excavations should be achievable by minor dewatering systems, such as pumping from prepared sumps. Even at depths a few feet below the "normal" groundwater level, control of groundwater using sumps should be feasible due to the predominantly cohesive nature of the encountered soils and their associated low permeability, but will require due diligence by the contractor to maintain a stable subgrade condition at the bottom of the excavation.

Based on the location of the proposed excavation relative to the creek, it is likely that the culvert and headwall installation excavations will encounter saturated subgrade conditions including groundwater seepage. In addition to dewatering measures, the contractor may need to incorporate a thin mat of lean concrete over the bottom of the excavation to avoid loss of subgrade strength and excessive undercutting of the bearing soils from groundwater seepage or surface run off.

5.2.6 Fill

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

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

6.0 QUALIFICATION OF RECOMMENDATIONS

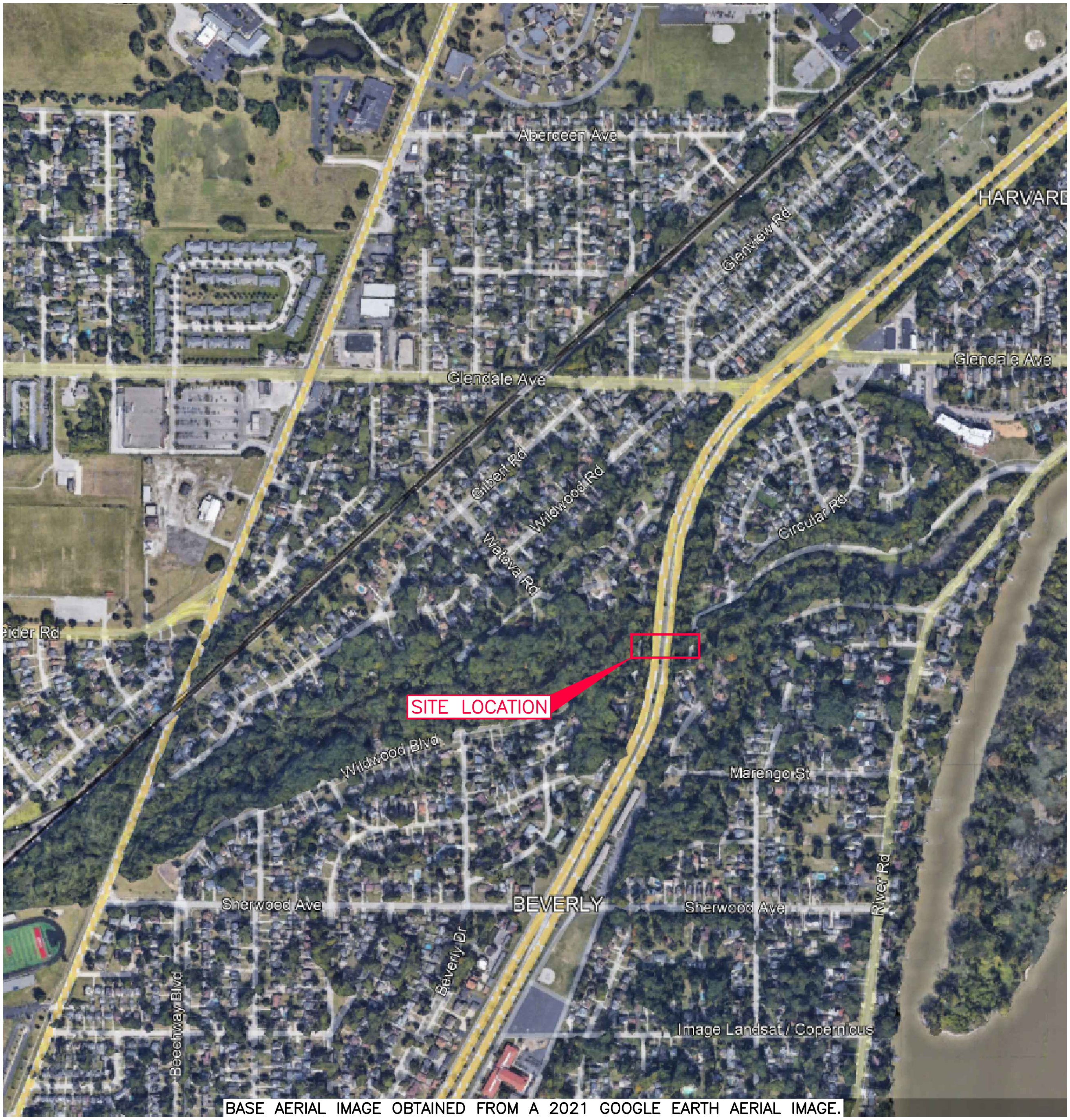
Our evaluation of design and construction conditions for the proposed culvert replacement has been based on our understanding of the site and project information and the data obtained during our field exploration. The general subsurface conditions were based on interpretation of the data obtained at 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 potential is increased at previously developed sites. Therefore, experienced geotechnical engineers should observe earthwork and foundation construction to confirm that the conditions anticipated in design are noted. Otherwise, TTL assumes no responsibility for construction compliance with the design concepts, specifications, or recommendations.

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

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

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

PLATES



BASE AERIAL IMAGE OBTAINED FROM A 2021 GOOGLE EARTH AERIAL IMAGE.

LEGEND

APPROXIMATE SITE LOCATION

N

APPROXIMATE SCALE – FEET

0 800 1,600

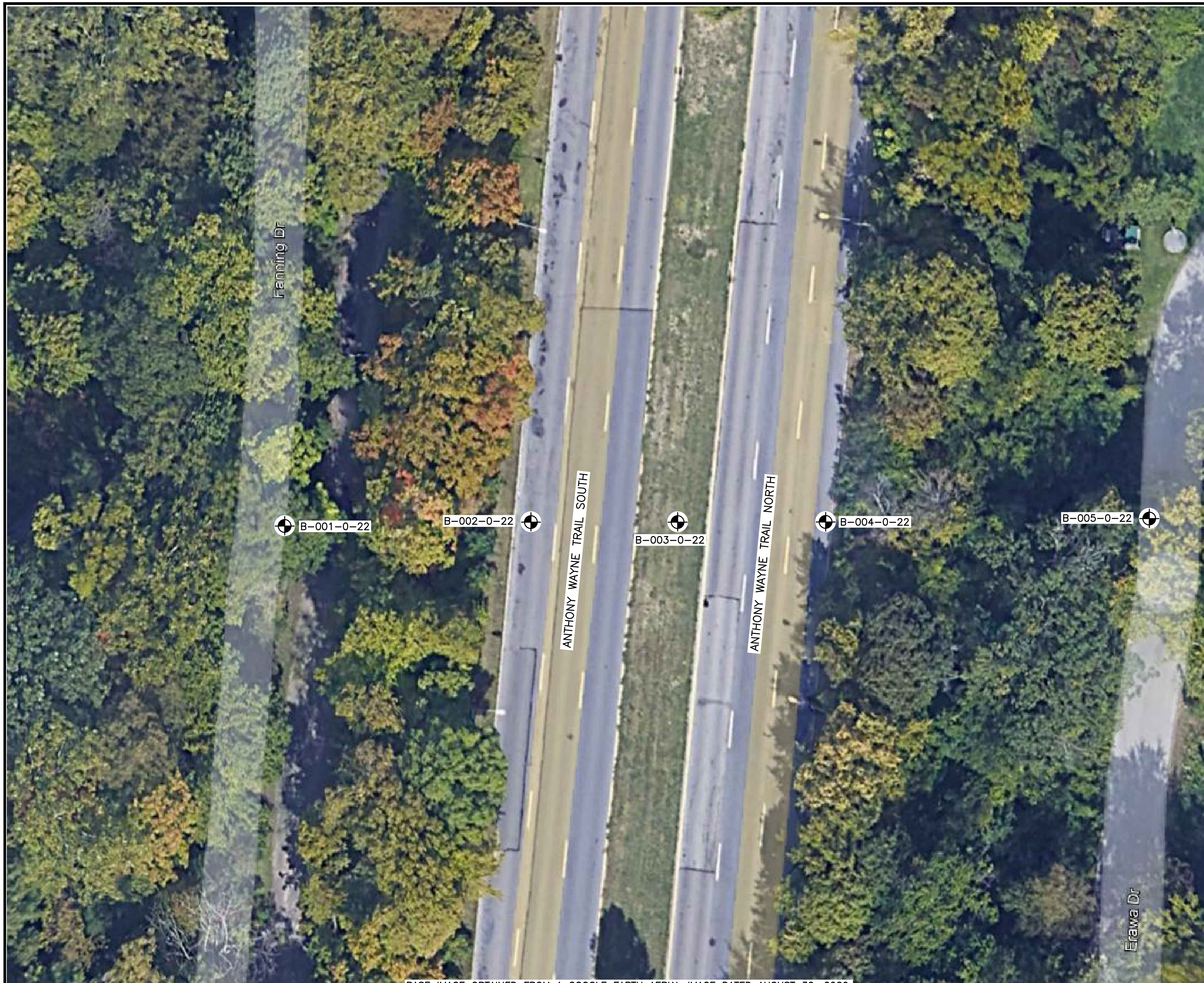
PLATE 1.0
SITE LOCATION MAP

LUC–25–5.04, PID 79901
ANTHONY WAYNE TRAIL OVER DELAWARE CREEK
TOLEDO, OHIO

PREPARED FOR
ODOT DISTRICT 2
BOWLING GREEN, OHIO

DRAWN	TRR/11–11–22	CHECKED	KCH/11–14–22
REVISED		APPROVED	
JOB NO.	2292401		
DRAWING NUMBER	**2292401–01G**		

TTL associates inc
Environmental, Geotechnical Engineering & Testing



BASE IMAGE OBTAINED FROM A GOOGLE EARTH AERIAL IMAGE DATED AUGUST 30, 2020.

PLATE 2.0
TEST BORING LOCATION PLAN
LUC–25–5.04, PID 79901
ANTHONY WAYNE TRAIL OVER DELAWARE CREEK
TOLEDO, OHIO

PREPARED FOR
ODOT DISTRICT 2
BOWLING GREEN, OHIO

DRAWN TRR/11–11–22	CHECKED KCH/11–14–22
REVISED	APPROVED
JOB NO. 2292401	TTL associates inc
DRAWING NUMBER **2292401–02G**	Environmental, Geotechnical Engineering & Testing

FIGURES

PROJECT: LUC-25-05.04	DRILLING FIRM / OPERATOR: TTL / TB	DRILL RIG: CME 75 TRUCK 844	STATION / OFFSET:
TYPE: CULVERT	SAMPLING FIRM / LOGGER: TTL / KKC	HAMMER: CME AUTOMATIC	ALIGNMENT:
PID: 79901 SFN: 4801490	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 3/15/21	ELEVATION: 610.4 (NAVD88) EOB: 53.9 ft.
START: 9/13/22 END: 9/13/22	SAMPLING METHOD: SPT / ST	ENERGY RATIO (%): 66	LAT / LONG: 41.608419, -83.597138

EXPLORATION ID B-001-0-22

MATERIAL DESCRIPTION AND NOTES	ELEV. 610.4
ASPHALT - 5 INCHES	610.0
AGGREGATE BASE - 5 INCHES	609.6
MEDIUM DENSE, GRAY, **COARSE AND FINE SAND**, LITTLE SILT, TRACE GRAVEL, TRACE CLAY, MOIST FILL	608.9
MEDIUM DENSE, BROWN, **GRAVEL AND STONE FRAGMENTS WITH SAND**, TRACE SILT, TRACE CLAY, MOIST FILL	608.1
STIFF TO VERY STIFF, BROWN/BLACK, **SILTY CLAY**, LITTLE ASPHALT FRAGMENTS, TRACE SAND, TRACE GRAVEL, MOIST FILL	607.4
SOFT, BROWN, **SILTY CLAY**, TRACE SAND, MOIST FILL	605.4
MEDIUM STIFF TO STIFF, BROWN, **SILTY CLAY**, TRACE SAND, MOIST FILL	602.4
MEDIUM STIFF, BROWN, **SANDY SILT**, LITTLE CLAY, DAMP FILL	599.4
MEDIUM STIFF, BROWN, **SILTY CLAY**, SOME SAND, DAMP FILL @13': TRACE SAND, MOIST	594.4
VERY STIFF, BROWN, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, MOIST FILL	591.9
MEDIUM STIFF, BROWN, **SILTY CLAY**, TRACE SAND, MOIST FILL	589.4
STIFF TO VERY STIFF, BROWN, **SILTY CLAY**, SOME SAND, MOIST FILL	587.4
MEDIUM STIFF, BROWN/GRAY, **SILTY CLAY**, TRACE SAND, DAMP FILL	583.9
STIFF TO VERY STIFF, BROWN, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP FILL	581.9
MEDIUM STIFF TO STIFF, GRAY, **SILTY CLAY**, TRACE SAND, DAMP FILL	

SPT/RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)
5 8 4	13	89	SS-1A	-	-	-	-	-	-	-	-	-	-	A-3a (V)
			SS-1B	-	-	-	-	-	-	-	-	-	-	A-1-b (V)
			SS-1C	3.50	-	-	-	-	-	-	-	-	19	A-6b (V)
1 1 3	4	67	SS-2	2.50	-	-	-	-	-	-	-	-	23	A-6b (V)
3 3 4	8	78	SS-3	3.50	-	-	-	-	-	-	-	-	21	A-6b (V)
1 2 3	6	100	SS-4	1.50	-	-	-	-	-	-	-	-	15	A-4a (V)
2 3 4	8	100	SS-5	2.75	-	-	-	-	-	-	-	-	17	A-6b (V)
2 3 4	8	100	SS-6	3.25	-	-	-	-	-	-	-	-	23	A-6b (V)
		100	ST-7	2.50	2	3	18	24	53	29	18	11	20	A-6a (8)
2 3 3	7	100	SS-8	2.50	-	-	-	-	-	-	-	-	26	A-6b (V)
3 4 4	9	100	SS-9	2.00	-	-	-	-	-	-	-	-	26	A-6b (V)
2 2 4	7	78	SS-10	3.25	-	-	-	-	-	-	-	-	16	A-6b (V)
3 4 5	10	100	SS-11	4.00	-	-	-	-	-	-	-	-	18	A-6b (V)
2 2 4	7	100	SS-12	1.75	-	-	-	-	-	-	-	-	21	A-6b (V)

PID: 79901	SFN: 4801490	PROJECT: LUC-25-05.04	STATION / OFFSET:	START: 9/13/22	END: 9/13/22	PG 2 OF 2	B-001-0-22

MATERIAL DESCRIPTION AND NOTES	ELEV. 580.4	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
MEDIUM STIFF TO STIFF, GRAY, **SILTY CLAY**, TRACE SAND, DAMP FILL *(continued)* @31.0' TO 32.5': 3,445 PSF	577.4	31–32	3 3 4	8	100	SS-13	2.25	-	-	-	-	-	-	-	-	17	A-6b (V)	
VERY STIFF TO HARD, GRAY, **SILTY CLAY**, SOME GRAVEL, TRACE SAND, DAMP	574.4	34–35	7 7 11	20	89	SS-14	4.50	20	2	6	17	55	38	22	16	21	A-6b (10)	
VERY STIFF, GRAY, **CLAY**, SOME SILT, TRACE SAND, TRACE GRAVEL, DAMP		36–37	8 9 12	23	100	SS-15	3.75	2	2	5	24	67	41	23	18	20	A-7-6 (11)	
@38.5': VERY STIFF TO HARD		39–40	6 6 9	17	100	SS-16	4.50	-	-	-	-	-	-	-	-	18	A-7-6 (V)	
		41–42	6 8 11	21	100	SS-17	4.50	-	-	-	-	-	-	-	-	17	A-7-6 (V)	
	565.9	44–45	4 6 6	13	100	SS-18	2.25	-	-	-	-	-	-	-	-	21	A-7-6 (V)	
STIFF TO VERY STIFF, GRAY, **CLAY**, SOME SILT, TRACE SAND, TRACE GRAVEL, DAMP	564.4	▼ 45																
VERY STIFF TO HARD, GRAY, **CLAY**, SOME SILT, TRACE SAND, LITTLE GRAVEL, DAMP	562.4	46–47	4 7 9	18	100	SS-19	4.50	-	-	-	-	-	-	-	-	13	A-6b (V)	
HARD, GRAY, **SILTY CLAY**, LITTLE SAND, LITTLE COBBLES, DAMP		49–50	38 18 16	37	89	SS-20	4.50	-	-	-	-	-	-	-	-	10	A-6b (V)	
@52.0': VERY STIFF TO HARD	557.6	51–52; W 557.6 TR	16 15 22	41	100	SS-21	2.00	-	-	-	-	-	-	-	-	11	A-6b (V)	
GRAY, **WEATHERED DOLOMITE**	556.5	53; EOB	50/5"	-	80	SS-22	-	-	-	-	-	-	-	-	-	9	Rock (V)	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.25 BAG ASPHALT PATCH; PUMPED 16 CF CEMENT-BENTONITE GROUT

PROJECT: LUC-25-05.04	DRILLING FIRM / OPERATOR: TTL / TB	DRILL RIG: DIEDRICH D70 TRACK	STATION / OFFSET:	EXPLORATION ID B-002-0-22
TYPE: CULVERT	SAMPLING FIRM / LOGGER: TTL / KKC	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT:	
PID: 79901 SFN: 4801490	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 4/13/22	ELEVATION: 620.9 (NAVD88) EOB: 65.0 ft.	PAGE 1 OF 3
START: 1/19/23 END: 1/19/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 90	LAT / LONG: 41.608422, -83.596853	

MATERIAL DESCRIPTION AND NOTES	ELEV. 620.9	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
ASPHALT - 8 INCHES	620.2																	
AGGREGATE BASE - 28 INCHES	617.9	1, 2, 3	12 12 9	32	89	SS-1	-	-	-	-	-	-	-	-	-	5	A-1-b (V)	
STIFF, BROWN, **SILTY CLAY**, LITTLE SAND, MOIST FILL	614.6	4, 5, 6	2 4 4	12	78	SS-2	1.75	-	-	-	-	-	-	-	-	20	A-6b (V)	
			6 6 7	20	100	SS-3A	-	-	-	-	-	-	-	-	-	-	A-6b (V)	
MEDIUM DENSE, BROWN, **COARSE AND FINE SAND**, LITTLE SILT, TRACE CLAY, MOIST FILL	612.9	7, 8				SS-3B	-	-	-	-	-	-	-	-	-	16	A-3a (V)	
STIFF, BROWN, **SILTY CLAY**, LITTLE SAND, DAMP FILL	609.9	9, 10	3 3 5	12	89	SS-4	-	-	-	-	-	-	-	-	-	16	A-6b (V)	
MEDIUM DENSE, BROWN, **COARSE AND FINE SAND**, LITLTE SILT, TRACE CLAY, MOIST FILL	607.4	11, 12, 13	4 6 6	18	100	SS-5	-	-	-	-	-	-	-	-	-	14	A-3a (V)	
STIFF, BROWN, **SILTY CLAY**, TRACE SAND, MOIST FILL	604.9	14, 15	3 4 4	12	100	SS-6	1.50	-	-	-	-	-	-	-	-	23	A-6b (V)	
MEDIUM DENSE, BROWN, **COARSE AND FINE SAND**, LITTLE CLAY, TRACE SILT, MOIST FILL		16, 17, 18	4 5 5	15	100	SS-7	-	-	-	-	-	-	-	-	-	19	A-3a (V)	
@18.5': LOOSE	599.4	19, 20	2 2 3	8	100	SS-8	-	-	-	-	-	-	-	-	-	19	A-3a (V)	
		21	3 4 6	15	100	SS-9A	-	-	-	-	-	-	-	-	-	-	A-3a (V)	
STIFF, BROWN, **SILTY CLAY**, TRACE SAND, MOIST FILL	598.7	22				SS-9B	1.50	-	-	-	-	-	-	-	-	25	A-6b (V)	
STIFF, BROWN, **SILT**, SOME CLAY, TRACE SAND, MOIST FILL	597.9	23				SS-9C	-	-	-	-	-	-	-	-	-	-	A-4b (V)	
LOOSE, GRAY, **COARSE AND FINE SAND**, SOME SILT, TRACE CLAY, MOIST FILL		24, 25	2 2 3	8	100	SS-10	-	0	1	64	33	2	NP	NP	NP	16	A-3a (0)	
	594.1	26	3 4 6	15	100	SS-11A	-	-	-	-	-	-	-	-	-	-	A-3a (V)	
STIFF, GRAY, **SILTY CLAY**, SOME SAND, DAMP FILL		27, 28				SS-11B	-	-	-	-	-	-	-	-	-	18	A-6b (V)	
		29	2 3 3	9	100	SS-12	1.75	-	-	-	-	-	-	-	-	23	A-6b (V)	

PID: 79901	SFN: 4801490	PROJECT: LUC-25-05.04	STATION / OFFSET:	START: 1/19/23	END: 1/19/23	PG 2 OF 3	B-002-0-22

MATERIAL DESCRIPTION AND NOTES	ELEV. 590.9	DEPTHS
@29.6': LITTLE SAND, MOIST STIFF, GRAY, **SILTY CLAY**, SOME SAND, DAMP FILL *(continued)* @31': VERY STIFF	584.5	W 584.5
MEDIUM DENSE, GRAY, **COARSE AND FINE SAND**, LITTLE CLAY, TRACE SILT, WET FILL	583.9	
MEDIUM STIFF, GRAY, **SILTY CLAY**, LITTLE SAND, WET FILL, (FREE WATER NOTED)	582.9	
MEDIUM STIFF TO STIFF, GRAY, **SILT AND CLAY**, "AND" SAND, TRACE GRAVEL, MOIST @41': STIFF @43': MEDIUM STIFF, SOME SAND	574.4	
STIFF TO VERY STIFF, GRAY, **SILTY CLAY**, SOME SAND, TRACE GRAVEL, DAMP @48': VERY STIFF, LITTLE GRAVEL, TRACE SAND	569.9	
HARD, GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, MOIST	567.9	
VERY STIFF TO HARD, GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, MOIST	564.9	
VERY STIFF TO HARD, GRAY, **SILT AND CLAY**, TRACE SAND, MOIST	562.9	
STIFF TO VERY STIFF, GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP	559.9	
VERY STIFF TO HARD, GRAY, **SILTY CLAY**, LITTLE SAND, TRACE ROCK FRAGMENTS, DAMP		

SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
3-4-7	17	100	SS-13	2.50	-	-	-	-	-	-	-	-	23	A-6b (V)	
2-2-4	9	100	SS-14	1.75	-	-	-	-	-	-	-	-	29	A-6b (V)	
2-3-4	11	100	SS-15A	-	-	-	-	-	-	-	-	-	-	A-6b (V)	
			SS-15B	-	-	-	-	-	-	-	-	-	-	A-3a (V)	
			SS-15C	-	-	-	-	-	-	-	-	-	28	A-6b (V)	
2-2-3	8	100	SS-16	2.00	-	-	-	-	-	-	-	-	20	A-6a (V)	
3-3-4	11	100	SS-17	2.00	5	8	30	26	31	28	17	11	20	A-6a (5)	
2-2-3	8	100	SS-18	0.75	-	-	-	-	-	-	-	-	20	A-6a (V)	
2-3-6	14	100	SS-19	4.00	-	-	-	-	-	-	-	-	18	A-6b (V)	
5-8-11	29	100	SS-20	3.25	10	2	4	24	60	38	21	17	19	A-6b (11)	
8-13-18	47	44	SS-21	-	-	-	-	-	-	-	-	-	29	A-6b (V)	
5-7-9	24	100	SS-22	4.25	-	-	-	-	-	-	-	-	23	A-6b (V)	
9-11-17	42	100	SS-23	3.00	-	-	-	-	-	-	-	-	20	A-6a (V)	
3-6-12	27	100	SS-24	1.50	-	-	-	-	-	-	-	-	17	A-6b (V)	
11-13	44	78	SS-25	3.75	-	-	-	-	-	-	-	-	12	A-6b (V)	

PID: 79901	SFN: 4801490	PROJECT: LUC-25-05.04	STATION / OFFSET:	START: 1/19/23	END: 1/19/23	PG 3 OF 3	B-002-0-22

MATERIAL DESCRIPTION AND NOTES	ELEV. 558.8	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
VERY STIFF TO HARD, GRAY, **SILTY CLAY**, LITTLE SAND, TRACE ROCK FRAGMENTS, DAMP *(continued)*		63	16															
@63': HARD, SOME SAND, LITTLE ROCK FRAGMENTS	555.9	64 EOB 65	5 10 15	38	100	SS-26	-	-	-	-	-	-	-	-	-	9	A-6a (V)	

NOTES: NONE

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

PROJECT: LUC-25-05.04 TYPE: CULVERT PID: 79901 SFN: 4801490 START: 9/12/22 END: 9/12/22	DRILLING FIRM / OPERATOR: TTL / TB SAMPLING FIRM / LOGGER: TTL / KKC DRILLING METHOD: 3.25" HSA SAMPLING METHOD: SPT	DRILL RIG: DIEDRICH D70 TRACK HAMMER: DIEDRICH AUTOMATIC CALIBRATION DATE: 4/13/22 ENERGY RATIO (%): 90	STATION / OFFSET: ALIGNMENT: ELEVATION: 621.5 (NAVD88) EOB: 68.6 ft. LAT / LONG: 41.608424, -83.596694	EXPLORATION ID B-003-0-22

MATERIAL DESCRIPTION AND NOTES	ELEV. 621.5
TOPSOIL - 4 INCHES	621.2
MEDIUM STIFF, BROWN, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, TRACE ORGANICS, DAMP FILL	619.0
SOFT TO MEDIUM STIFF, BROWN, **SILTY CLAY**, SOME SAND, TRACE GRAVEL, DAMP FILL @4': BROWN	615.0
LOOSE, BROWN, **COARSE AND FINE SAND**, TRACE SILT, TRACE CLAY, MOIST TO WET FILL	613.5
SOFT TO MEDIUM STIFF, BROWN/GRAY, **SILTY CLAY**, TRACE SAND, MOIST FILL	610.5
SOFT TO MEDIUM STIFF, BROWN/GRAY, **SILTY CLAY**, TRACE SAND, MOIST TO DAMP FILL @13.5': SOME SAND, DAMP @16': MEDIUM STIFF, GRAY, LITTLE SAND	600.5
MEDIUM DENSE, GRAY, **FINE SAND**, TRACE SILT, MOIST FILL	598.5
MEDIUM STIFF TO STIFF, BROWN/GRAY, **SILTY CLAY**, SOME SAND, DAMP FILL	595.5
MEDIUM STIFF, GRAY, **SILTY CLAY**, LITTLE SAND, MOIST FILL	593.5
SOFT TO MEDIUM STIFF, GRAY, **SILTY CLAY**, SOME SAND, DAMP FILL	

SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
4 3 2	8	78	SS-1	-	-	-	-	-	-	-	-	-	13	A-6a (V)	
2 1 2	5	78	SS-2	0.50	-	-	-	-	-	-	-	-	22	A-6b (V)	
2 2 2	6	89	SS-3A	-	-	-	-	-	-	-	-	-	-	A-6b (V)	
			SS-3B	-	-	-	-	-	-	-	-	-	21	A-3a (V)	
1 1 1	3	100	SS-4	0.50	0	0	9	23	68	40	18	22	26	A-6b (13)	
1 2 2	6	89	SS-5	1.00	-	-	-	-	-	-	-	-	22	A-6b (V)	
2 3 2	8	83	SS-6	1.00	-	-	-	-	-	-	-	-	21	A-6b (V)	
2 2 3	8	89	SS-7	0.75	-	-	-	-	-	-	-	-	21	A-6b (V)	
2 2 3	8	100	SS-8	-	-	-	-	-	-	-	-	-	18	A-6b (V)	
2 4 5	14	100	SS-9	-	-	-	-	-	-	-	-	-	16	A-3 (V)	
1 1 2	5	78	SS-10	1.50	-	-	-	-	-	-	-	-	19	A-6b (V)	
4 4 3	11	100	SS-11	-	-	-	-	-	-	-	-	-	26	A-6b (V)	
2 3 2	8	89	SS-12	0.25	-	-	-	-	-	-	-	-	15	A-6b (V)	

PID: 79901	SFN: 4801490	PROJECT: LUC-25-05.04	STATION / OFFSET:	START: 9/12/22	END: 9/12/22	PG 2 OF 3	B-003-0-22

MATERIAL DESCRIPTION AND NOTES	ELEV. 591.5	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
	590.5																	
VERY STIFF, BROWN/GRAY, **SILT AND CLAY**, SOME SAND, DAMP FILL	588.0	31–33	4 5 7	18	100	SS-13	-	-	-	-	-	-	-	-	-	15	A-6a (V)	
STIFF, GRAY/BROWN, **SILTY CLAY**, LITTLE SAND, MOIST FILL		34–35	3 3 3	9	100	SS-14	-	-	-	-	-	-	-	-	-	25	A-6b (V)	
@36': BROWN/GRAY	583.5	36–38	2 3 6	14	89	SS-15	-	-	-	-	-	-	-	-	-	23	A-6b (V)	
MEDIUM STIFF TO STIFF, GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, MOIST FILL		39–40	3 4 4	12	56	SS-16	1.00	-	-	-	-	-	-	-	-	21	A-6b (V)	
	578.5	41–43	3 4 5	14	100	SS-17	1.00	-	-	-	-	-	-	-	-	20	A-6b (V)	
MEDIUM DENSE, GRAY, **COARSE AND FINE SAND**, SOME CLAY, LITTLE WOOD, TRACE GRAVEL, TRACE SILT, WET	577.0	W 577.0 / 44	4 8 9	26	100	SS-18A	-	-	-	-	-	-	-	-	-	-	A-3a (V)	
MEDIUM DENSE, BLACK, **GRAVEL AND STONE FRAGMENTS WITH SAND**, LITTLE WOOD, LITTLE SILT, TRACE CLAY, WET		45				SS-18B	-	52	14	19	13	2	NP	NP	NP	29	A-1-b (0)	
	574.3	46–47	5 5 6	17	100	SS-19A	-	-	-	-	-	-	-	-	-	-	A-1-b (V)	
STIFF TO VERY STIFF, GRAY, **SILTY CLAY**, LITTLE SAND, LITTLE GRAVEL, MOIST @47.2' TO 47.5': Qu = 2,390 PSF		47–48				SS-19B	3.00	-	-	-	-	-	-	-	-	23	A-6b (V)	
@48': VERY STIFF, TRACE GRAVEL, DAMP		49–50	3 8 12	30	100	SS-20	3.00	-	-	-	-	-	-	-	-	17	A-6b (V)	
@51': VERY STIFF TO HARD, DAMP TO MOIST		51–53	6 12 15	41	100	SS-21	3.25	-	-	-	-	-	-	-	-	20	A-6b (V)	
@53.5': VERY STIFF, DAMP		54–55	4 6 8	21	100	SS-22	2.75	-	-	-	-	-	-	-	-	16	A-6b (V)	
@56': MOIST	563.0	56–58 ▼	5 7 10	26	100	SS-23	2.25	-	-	-	-	-	-	-	-	23	A-6b (V)	
STIFF, GRAY, **SANDY SILT**, "AND" CLAY, TRACE GRAVEL, DAMP	560.0	59–60	3 3 7	15	100	SS-24	1.75	8	9	11	36	36	25	18	7	15	A-4a (7)	
		61	7 8	35	100	SS-25	3.00	-	-	-	-	-	-	-	-	16	A-4a (V)	

PID: 79901	SFN: 4801490	PROJECT: LUC-25-05.04	STATION / OFFSET:	START: 9/12/22	END: 9/12/22	PG 3 OF 3	B-003-0-22

MATERIAL DESCRIPTION AND NOTES	ELEV. 559.4	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
VERY STIFF TO HARD, GRAY, **SANDY SILT**, "AND" CLAY, TRACE GRAVEL, DAMP *(continued)*	558.5	63	15															
VERY DENSE, GRAY, **GRAVEL AND STONE FRAGMENTS WITH SAND, SILT, AND CLAY**, TRACE ROCK FRAGMENTS, DAMP		64 – 65	25 16 20	54	89	SS-26	-	-	-	-	-	-	-	-	-	8	A-2-6 (V)	
		66 – 67	25 30 32	93	83	SS-27	-	-	-	-	-	-	-	-	-	7	A-2-6 (V)	
	553.0	68																
GRAY, **WEATHERED DOLOMITE**, TRACE SILT, TRACE CLAY	552.9	TR	50/1"	-	100	SS-28	-	-	-	-	-	-	-	-	-	11	Rock (V)	

NOTES: AUGER REFUSAL ENCOUNTERED AT 68.6 FEET

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

PROJECT: LUC-25-05.04	DRILLING FIRM / OPERATOR: TTL / TB	DRILL RIG: DIEDRICH D70 TRACK	STATION / OFFSET:	EXPLORATION ID B-004-0-22
TYPE: CULVERT	SAMPLING FIRM / LOGGER: TTL / KKC	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT:	
PID: 79901 SFN: 4801490	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 4/13/22	ELEVATION: 621.2 (NAVD88) EOB: 65.0 ft.	PAGE 1 OF 3
START: 9/12/22 END: 9/12/22	SAMPLING METHOD: SPT	ENERGY RATIO (%): 90	LAT / LONG: 41.608424, -83.596537	

MATERIAL DESCRIPTION AND NOTES	ELEV. 621.2	DEPTHS	SPT/RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
ASPHALT - 6.5 INCHES	620.7																	
CONCRETE - 7.5 INCHES	620.0	1																
MEDIUM DENSE, GRAY/BROWN, **COARSE AND FINE SAND**, LITTLE SILT, TRACE GRAVEL, TRACE CLAY, MOIST FILL @2': BROWN	618.2	2 – 3	6 9 7	24	94	SS-1	-	-	-	-	-	-	-	-	-	13	A-3a (V)	
MEDIUM STIFF, BROWN, **SILT AND CLAY**, SOME SAND, MOIST FILL	614.7	4 – 5	2 2 3	8	100	SS-2	-	0	2	26	24	48	26	14	12	21	A-6a (8)	
STIFF TO VERY STIFF, BROWN, **SILTY CLAY**, SOME SAND, MOIST FILL		6 – 7	3 3 3	9	100	SS-3	2.25	-	-	-	-	-	-	-	-	22	A-6b (V)	
@8': DAMP	610.2	8 – 10	2 2 3	8	100	SS-4	1.75	-	-	-	-	-	-	-	-	19	A-6b (V)	
MEDIUM DENSE, BROWN, **COARSE AND FINE SAND**, LITTLE CLAY, TRACE SILT, MOIST FILL		11 – 12	3 3 4	11	100	SS-5	-	-	-	-	-	-	-	-	-	13	A-3a (V)	
	605.2	13 – 15	3 3 5	12	100	SS-6	-	-	-	-	-	-	-	-	-	16	A-3a (V)	
STIFF, BROWN, **SILTY CLAY**, LITTLE SAND, MOIST FILL		16 – 17	3 3 5	12	83	SS-7	1.75	-	-	-	-	-	-	-	-	21	A-6b (V)	
		W 602.3 18 – 20	1 4 5	14	100	SS-8	1.50	-	-	-	-	-	-	-	-	20	A-6b (V)	
@21': STIFF TO VERY STIFF, MOIST TO WET		21 – 22	4 4 6	15	100	SS-9	2.00	-	-	-	-	-	-	-	-	27	A-6b (V)	
@23': MOIST	595.2	23 – 25	2 3 5	12	89	SS-10	2.75	-	-	-	-	-	-	-	-	20	A-6b (V)	
VERY STIFF, BROWN, **SANDY SILT**, LITTLE CLAY, TRACE GRAVEL, MOIST FILL	592.2	26 – 28	4 6 6	18	100	SS-11	-	1	2	39	42	16	21	14	7	17	A-4a (5)	
		29	3 3 5	12	100	SS-12A	-	-	-	-	-	-	-	-	-	-	A-4a (V)	
						SS-12B	1.25	-	-	-	-	-	-	-	-	18	A-6b (V)	

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 3/3/23 09:16 - S:\PROJECTS\2292401.GPJ

PID: 79901	SFN: 4801490	PROJECT: LUC-25-05.04	STATION / OFFSET:	START: 9/12/22	END: 9/12/22	PG 2 OF 3	B-004-0-22

MATERIAL DESCRIPTION AND NOTES	ELEV. 591.2
STIFF, BROWN/GRAY, **SILTY CLAY**, LITTLE SAND, DAMP FILL *(continued)*	590.2
MEDIUM DENSE, BROWN, **COARSE AND FINE SAND**, LITTLE SILT, TRACE CLAY, MOIST FILL	588.2
STIFF TO VERY STIFF, GRAY, **SILTY CLAY**, LITTLE SAND, MOIST FILL	584.7
MEDIUM STIFF TO STIFF, GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, MOIST FILL @38': TRACE ORGANICS, DAMP	578.2
VERY STIFF TO HARD, GRAY, **SILT AND CLAY**, LITTLE SAND, LITTLE GRAVEL, DAMP @43.5' TO 45': Qu = 5,920 PSF @46': STIFF, TRACE GRAVEL @48.5': VERY STIFF, DAMP @51': LITTLE GRAVEL @53': VERY STIFF, TRACE SAND	564.7
VERY STIFF, GRAY, **SILTY CLAY**, TRACE SAND, MOIST	563.2
STIFF TO VERY STIFF, GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP	560.2
VERY STIFF TO HARD, GRAY, **SILT AND CLAY**, SOME SAND, LITTLE DOLOMITE FRAGMENTS, DAMP	

DEPTHS: 31 – 61

SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
4 5 6	17	100	SS-13	-	-	-	-	-	-	-	-	-	16	A-3a (V)	
2 3 3	9	100	SS-14	2.00	-	-	-	-	-	-	-	-	22	A-6b (V)	
3 3 4	11	100	SS-15	0.50	-	-	-	-	-	-	-	-	23	A-6b (V)	
3 4 4	12	100	SS-16	0.75	-	-	-	-	-	-	-	-	17	A-6b (V)	
3 4 5	14	100	SS-17	-	-	-	-	-	-	-	-	-	-	A-6b (V)	
3 6 7	20	100	SS-18	4.50	-	-	-	-	-	-	-	-	15	A-6a (V)	
4 5 8	20	100	SS-19	3.00	4	4	6	21	65	35	20	15	20	A-6a (10)	
4 6 10	24	100	SS-20	4.00	-	-	-	-	-	-	-	-	19	A-6a (V)	
5 8 13	32	100	SS-21	3.25	-	-	-	-	-	-	-	-	18	A-6a (V)	
6 7 10	26	100	SS-22	2.50	-	-	-	-	-	-	-	-	19	A-6a (V)	
6 8 11	29	100	SS-23A	-	-	-	-	-	-	-	-	-	-	A-6a (V)	
			SS-23B	2.50	-	-	-	-	-	-	-	-	22	A-6b (V)	
2 3 5	12	100	SS-24	2.50	-	-	-	-	-	-	-	-	14	A-6b (V)	
5 7	35	89	SS-25	2.25	-	-	-	-	-	-	-	-	12	A-6a (V)	

MATERIAL DESCRIPTION AND NOTES	ELEV. 559.0	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
VERY STIFF TO HARD, GRAY, **SILT AND CLAY**, SOME SAND, LITTLE DOLOMITE FRAGMENTS, DAMP *(continued)*		63	16															
@63': HARD	556.2	64 – EOB 65	8 9 19	42	83	SS-26	-	-	-	-	-	-	-	-	-	9	A-6a (V)	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.25 BAG ASPHALT PATCH; PUMPED 19 CF CEMENT-BENTONITE GROUT

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 3/3/23 09:16 - S:\PROJECTS\2292401.GPJ

PROJECT: LUC-25-05.04	DRILLING FIRM / OPERATOR: TTL / TB	DRILL RIG: CME 75 TRUCK 844	STATION / OFFSET:	EXPLORATION ID B-005-0-22
TYPE: CULVERT	SAMPLING FIRM / LOGGER: TTL / KKC	HAMMER: CME AUTOMATIC	ALIGNMENT:	
PID: 79901 SFN: 4801490	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 3/15/21	ELEVATION: 600.8 (NAVD88) EOB: 37.2 ft.	PAGE 1 OF 2
START: 9/13/22 END: 9/13/22	SAMPLING METHOD: SPT / ST	ENERGY RATIO (%): 66	LAT / LONG: 41.608424, -83.596165	

MATERIAL DESCRIPTION AND NOTES	ELEV. 600.8
TOPSOIL - 3 INCHES	600.5
AGGREGATE BASE - 8 INCHES	599.9
MEDIUM STIFF TO STIFF, GRAY/BROWN, **SILTY CLAY**, LITTLE SAND, LITTLE GRAVEL, DAMP FILL	596.8
VERY LOOSE, GRAY, **COARSE AND FINE SAND**, LITTLE GRAVEL, LITTLE CLAY, LITTLE SILT, MOIST FILL @6': SOME CLAY @8.8': LITTLE CLAY, MOIST TO WET	588.5
SOFT, GRAY, **SILTY CLAY**, SOME SAND, TRACE WOOD, MOIST FILL	587.8
VERY SOFT, GRAY, **SANDY SILT**, TRACE CLAY, TRACE GRAVEL, TRACE ORGANICS, WET FILL @14.6': SOFT, SOME CLAY	582.8
STIFF, GRAY, **SILT AND CLAY**, TRACE SAND, TRACE GRAVEL, MOIST FILL	579.8
VERY STIFF, GRAY, **SILT AND CLAY**, TRACE SAND, TRACE GRAVEL, DAMP @21.0' TO 23.0': Qu = 5,213 PSF @23.5': VERY STIFF TO HARD @26': DAMP TO MOIST	572.8
STIFF, GRAY, **SILT AND CLAY**, TRACE SAND, TRACE GRAVEL, MOIST	

DEPTHS: W 589.3

SPT/RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
1 2 3	6	67	SS-1	1.00	-	-	-	-	-	-	-	-	18	A-6b (V)	
2 2 2	4	72	SS-2	-	-	-	-	-	-	-	-	-	16	A-3a (V)	
1 2 2	4	100	SS-3	-	-	-	-	-	-	-	-	-	17	A-3a (V)	
1 2 1	3	100	SS-4	-	-	-	-	-	-	-	-	-	20	A-3a (V)	
0 1 2	3	78	SS-5A	-	-	-	-	-	-	-	-	-	-	A-3a (V)	
			SS-5B	0.25	-	-	-	-	-	-	-	-	25	A-6b (V)	
1 0 1	1	78	SS-6	-	3	5	40	47	5	18	14	4	22	A-4a (3)	
0 2 2	4	100	SS-7	-	-	-	-	-	-	-	-	-	24	A-4a (V)	
2 4 6	11	100	SS-8	-	-	-	-	-	-	-	-	-	23	A-6a (V)	
		88	ST-9	3.50	4	3	6	22	65	36	21	15	19	A-6a (10)	
4 6 10	18	100	SS-10	4.25	-	-	-	-	-	-	-	-	19	A-6a (V)	
8 12 16	31	100	SS-11	2.25	0	2	6	24	68	34	20	14	20	A-6a (10)	
4 5 9	15	100	SS-12	-	-	-	-	-	-	-	-	-	-	A-6a (V)	

PID: 79901	SFN: 4801490	PROJECT: LUC-25-05.04	STATION / OFFSET:	START: 9/13/22	END: 9/13/22	PG 2 OF 2	B-005-0-22

MATERIAL DESCRIPTION AND NOTES	ELEV. 570.8	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
	569.8																	
STIFF TO VERY STIFF, GRAY, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, MOIST		31 – 32	5 8 10	20	100	SS-13	2.00	-	-	-	-	-	-	-	-	23	A-6a (V)	
@33': LITTLE SAND, LITTLE GRAVEL, DAMP		33																
		34 – 35	8 9 12	23	100	SS-14	2.00	-	-	-	-	-	-	-	-	15	A-6a (V)	
@34.8': TRACE ROCK FRAGMENTS		35 – 36																
	564.0	36 – 37	29 47 5/2"	-	93	SS-15A	-	-	-	-	-	-	-	-	-	-	A-6a (V)	
GRAY, **WEATHERED DOLOMITE**, LITTLE SILT, LITTLE CLAY	563.6	TR EOB 37				SS-15B	-	-	-	-	-	-	-	-	-	10	Rock (V)	

NOTES: AUGER REFUSAL ENCOUNTERED AT 37.2 FEET.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PUMPED 11 CF CEMENT-BENTONITE GROUT

LEGEND KEY

LITHOLOGIC SYMBOLS
(Unified Soil Classification System)

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

A-2-6: Ohio DOT: A-2-6, gravel and/or stone fragments with sand, silt and clay

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

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

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

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

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

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

DOLOMITE: Ohio DOT: Dolomite

PAVEMENT OR BASE: Ohio DOT: Pavement or Aggregate base

TOPSOIL: Ohio DOT: Sod and Topsoil

SAMPLER SYMBOLS

Thin Walled Undisturbed Sample

WELL CONSTRUCTION SYMBOLS

Bentonite: Bottom of hole

Asphalt or Concrete Pavement Patch

Notes:

1. Exploratory borings were performed on September 12 and 13, 2022, as well as January 19, 2023, utilizing 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. Latitude, Longitude, and ground surface elevations at the as-drilled boring locations were surveyed by TTL.

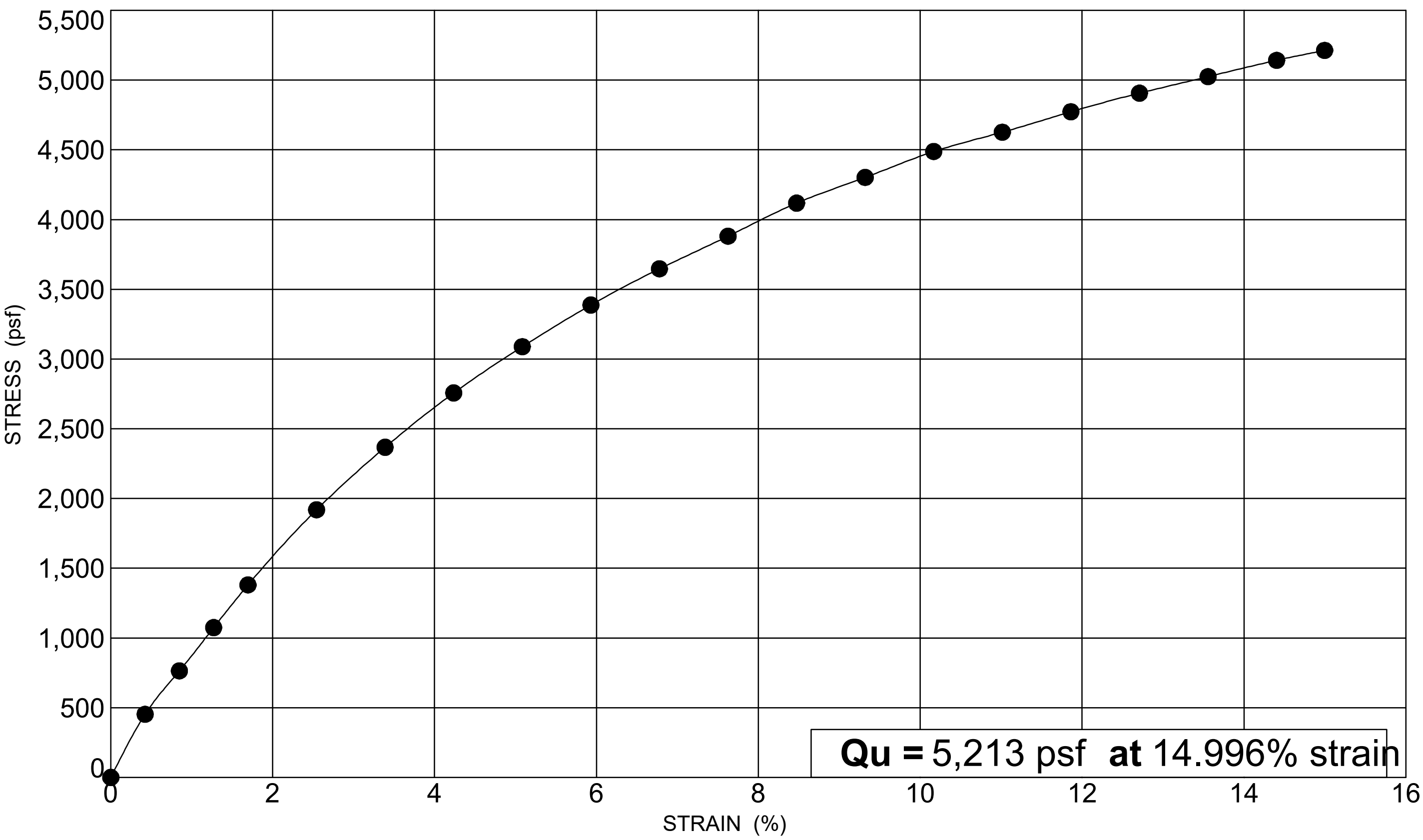
UNCONFINED COMPRESSION TEST
AASHTO T - 208

OHIO DEPARTMENT OF TRANSPORTION
OFFICE OF GEOTECHNICAL ENGINEERING

PROJECT LUC-25-05.04 **PID** 79901
OGE NUMBER N/A **PROJECT TYPE** STRUCTURE FOUNDATION

SAMPLE IDENTIFICATION

BORING ID: B-005-0-22 SAMPLE ID: ST-9
STATION: NOT RECORDED DEPTH: 21.0 - 23.0 feet



SPECIMEN FAILURE SKETCHES OR PHOTOGRAPHS

FRONT VIEW SIDE VIEW

SPECIMEN DETAILS

HEIGHT: 149.900 mm
DIAMETER: 73.200 mm
WET UNIT WT: 129.26 pcf
DRY UNIT WT: 108.44 pcf

TESTED BY: KKC 9/25/2022

CLASSIFICATION RESULTS

GRADATION (%)

GR	CS	FS	SI	CL
4	3	6	22	65

ATTERBERG LIMITS / MOISTURE

LL	PL	PI	WC
36	21	15	19

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

OHDOT UNCONFINED COMPRESSION - OH DOT.GDT - 11/14/22 14:16 - S:\PROJECTS\2292401.GPJ

Appendix A:
Engineering Calculations

Data Summary by Stratum:

Granular Fill

GF	Average	Median	High	Low	Std Dev	Quantity
SPT N_{60}	13	14	32	3	8	16
DD	-	-	-	-	-	0
Tot D	-	-	-	-	-	0
w	17	16	28	5	5	15
LL	-	-	-	-	-	0
PI	-	-	-	-	-	0

Cohesive Fill

CF	Average	Median	High	Low	Std Dev	Quantity
SPT N_{60}	10	9	18	1	4	55
UCS	3,445	3,445	3,445	3,445	-	1
HP	3,573	3,500	8,000	500	1,853	41
DD	107	107	110	104	2	3
Tot D	129	126	135	125	4	3
w	21	21	29	13	3	55
LL	27	26	40	18	8	5
PI	11	11	22	4	6	5

Stratum I

1	Average	Median	High	Low	Std Dev	Quantity
SPT N_{60}	22	22	26	17	5	2
DD	-	-	-	-	-	0
Tot D	-	-	-	-	-	0
w	26	26	29	23	3	2
LL	-	-	-	-	-	0
PI	-	-	-	-	-	0

Stratum II

2	Average	Median	High	Low	Std Dev	Quantity
SPT N_{60}	26	24	47	8	10	39
N_{60}*250	6,449	6,000	11,750	2,000	2,550	39
UCS	4,301	4,447	5,920	2,390	1,368	4
HP	6,139	6,000	9,000	1,500	1,999	36
DD	109	111	114	100	6	4
Tot D	129	130	135	122	5	4
w	18	18	29	9	4	38
LL	34	36	41	25	5	8
PI	14	15	18	7	3	8

Recommended Soil Properties for Design:

Granular Fill Use for design:

γ_{tot} = 125 pcf (GDM Table 500-2)

phi = 32 deg (GDM Table 500-2)

Cohesive Fill Use for design:

γ_{tot} = 125 pcf (GDM Table 500-2)

c = 2000 psf (GDM Table 500-2) based on A-4a soils

Native Granular Soils Use for design:

γ_{tot} = 125 pcf (GDM 405, Table 400-4)

phi = 34.9 deg (AASHTO LRFD Table 10.4.6.2.4-1, GDM Table 400-3)
Linear Inerpolate between avg phi values for N60 of 10 and 30, minus 0.5 degrees for A-3a soils

A-1-b and A-3a

Native Cohesive Soils Use for design:

γ_{tot} = 130 pcf (rounded average of tested values)

c = 2750 psf (based on GDM 404.1, min HP = 2.75 tsf for inspection)

ODOT Class A-4a, A-6a, A-6b, & A-7-6

f_1 Value 5.3 (GDM 404.1, Table 400-1)

c = 2895 psf (GDM 404.1)

GENERAL FOUNDATION INFORMATION:

The culvert inverts are indicated to be Elevs. 572.71 and 571.91 at the inlet and outlet, respectively.

From the Standard Bridge Drawing for Half-Height Headwalls for Concrete Pipe:

Width of headwall = t = 22"
Length of headwall = w = 16'-8"

GENERAL SOIL INFORMATION:

Borings B-001-0-22 and B-005-0-22 were used for our evaluation

At Elevs. 572.71 and 571.91, the foundations are expected to bear in:
Stratum II predominantly very stiff to hard cohesive soils.

USE c =	2.8	ksf for this analysis

Groundwater

Model groundwater in creek above foundatation bearing elevation
(shown as Elev. 580 in provided drawing)

STRENTH LIMIT STATE:

$q_R = \varphi_b * q_n$ (AASTHO LRFD 10.6.3.1.1-1)

q_R = factored resistance at strength limit state (ksf)

φ_b = resistance factor (Article 10.5.5.2.2)

q_n = nominal bearing resistance (ksf)

$q_n = cN_{cm} + gD_fN_{qm}C_{wq} + 0.5gBN_{\gamma m}C_{w\gamma}$ (AASTHO LRFD 10.6.3.1.2a-1)

$N_{cm} = N_cs_ci_c$ (AASTHO LRFD 10.6.3.1.2a-2)

$N_{qm} = N_qs_qd_qi_q$ (AASTHO LRFD 10.6.3.1.2a-3)

$N_{\gamma m} = N_\gamma s_\gamma i_\gamma$ (AASTHO LRFD 10.6.3.1.2a-4)

c = cohesion, undrained shear strength (ksf)

N_c = cohesion term (Table 10.6.3.1.2a-1)

N_q = surcharge term (Table 10.6.3.1.2a-1)

N_g = unit weight term (Table 10.6.3.1.2a-1)

γ = total (moist) unit weight (kcf)

D_f = footing embedment depth (ft)

B = footing width (ft)

C_{wq} , $C_{w\gamma}$= groundwater correction factors (Table 10.6.3.1.2a-2)

s_c , s_γ , s_q = shape correction factors (Table 10.6.3.1.2a-3)

d_q = shear resistance thought cohesionless material correction factor (Table 10.6.3.1.2a-4)

i_c , i_γ , i_q = inclination correction factors

<u>Bearing in Very Stiff to Hard cohesive soils</u>

Setup	$c =$	2.8	ksf		
	$\phi_f =$	0	degrees	assumed zero in cohesive soil	
	$N_c =$	5.14	*units*		
	$N_q =$	1.0	*units*	for soil with a $\phi_f =$ 0 Degrees	
	$N_\gamma =$	0.0	*units*		
	$\gamma =$	0.073	kcf	(0.135 soil - 0.062 water)	
	$D_f =$	3	ft	(H (6.75 feet) - D/2 (7.5/2 feet))	
	$B =$	1.83	ft	Width	
	$L =$	16.7	ft	Length	
	$D_w =$	0	ft	highest anticipated groundwater depth	
	$C_{wq} =$	0.5	*units*	where $D_w = 0.0$	$1.5B + D_f =$ 5.75
	$C_{w\gamma} =$	0.5	*units*	(above D_f)	
	$s_c =$	1.02	*units*	$s_c = 1 + (B/(5L))$	$s_c = 1 + (B/(5L))(Nq/Nc)$
	$s_g =$	1.00	*units*	for $\phi_f = 0$ $s_\gamma = 1$	for $\phi_f > 0$ $s_g = 1 - 0.4(B/L)$
	$s_q =$	1.00	*units*	$s_q = 1$	$s_q = 1 + ((B/L)\tan(\phi_f))$
	$d_q =$	1.0	*units*	taken as 1 since cohesive soil	$D_f / B =$ 1.636364
	$i_c, i_\gamma, i_q =$	1.0	*units*	Assumed loaded without inclination	

calculation	$N_{cm} = N_c s_c i_c$	= 5.14 * 1.022 * 1 =	5.253
	$N_{qm} = N_q s_q d_q i_q$	= 1 * 1 * 1 * 1 =	1
	$N_{\gamma m} = N_\gamma s_\gamma i_\gamma$	= 0 * 1 * 1 =	0

$q_n = cN_{cm} + gD_fN_{qm}C_{wq} + 0.5gBN_{\gamma m}C_{w\gamma}$ — $cN_{cm} =$ 14.446

= (2.75*5.253) + (0.0726*3*1*0.5) + (0.5*1.83*0*0.5) = — $\gamma D_f N_{qm} C_{wq} =$ 0.109

= (14.446) + (0.109) + (0) = — $0.5\gamma B N_{\gamma m} C_{w\gamma} =$ 0

$q_n =$ 14.555 ksf

$\varphi_b =$ 0.5 based on theoretical method (Munfakh et al., 2001), in clay

$q_R = \varphi_b * q_n$ = 0.5 * 14.555 = 7.2775 ksf

Factored resistance at the strength limit state for the proposed half height headwall at the inlet is equal to 7.3 ksf

SERVICE LIMIT STATE:

Based on : (Table C10.6.2.6.1-1)

"Presumptive Bearing Resistance for Spread Footing Foundations at the Service Limit State" Table

Stratum II predominantly very stiff to hard cohesive soils.

within applicable borings and depths:

Consistency	Soil Type	Bearing Resistance (ksf)	
		Ordinary Range	Recommended Value of Use*
"Very Dense"	Lean Clay (CL)	6-12	8

* recomented value based on Table C10.6.2.6.1-1

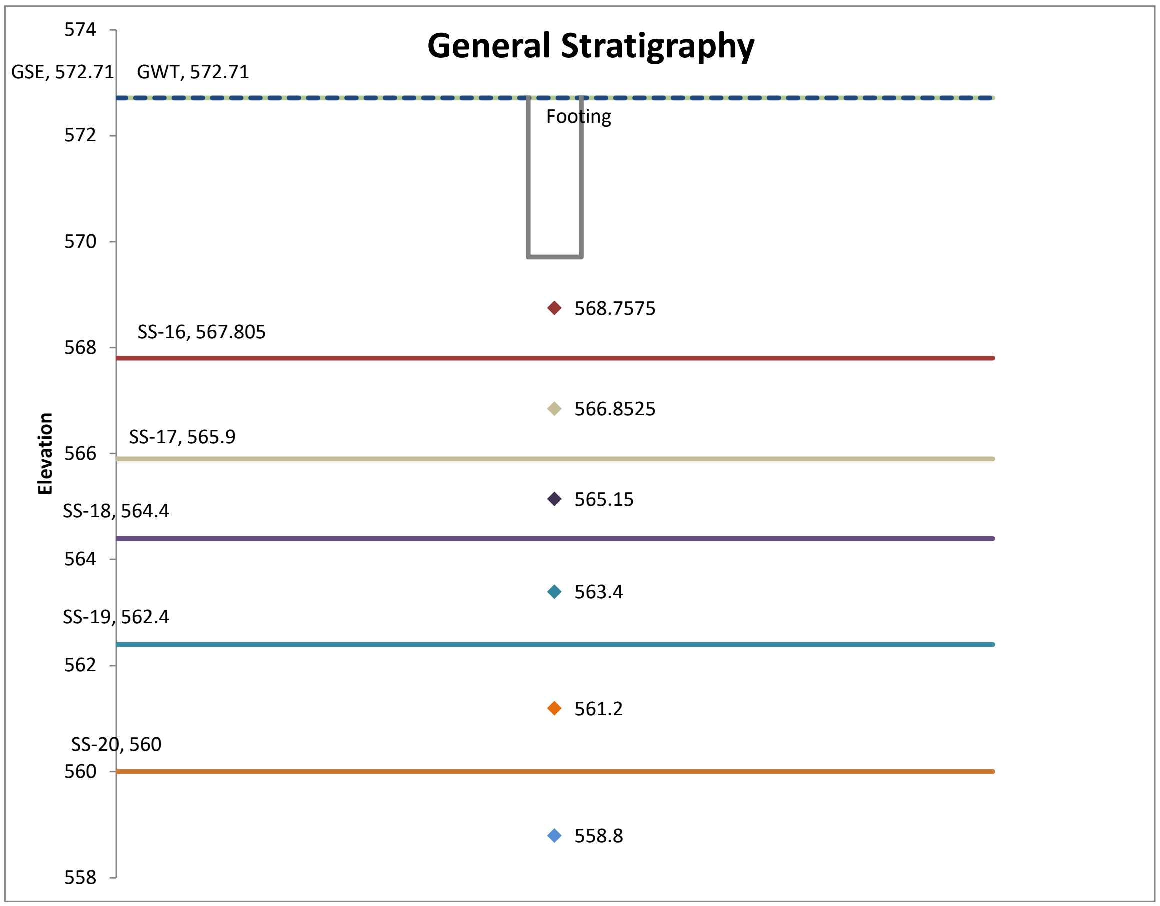
φ_b = 1

Factored bearing resistance = 8 ksf

Recommend 6 ksf based on settlement ≤1" (see attached *Settlement Calculation*)

Project Name:	LUC-25-5.04, PID 79901	Boring Number	B-001
Project Number:	2292401	Analysis Type	Rectangular
Calculated by:	KCH 11/14/2022		

Layer	H (feet)	C_r	e_o	σ_v' (psf)	z (feet)	b (feet)	(z-Df) / b	I_z	delta p@	6000 psf	(check) sigma v+ΔP	delta H (inches)			
SS-16	1.9	0.018	0.53	267	1.0	1.8	0.5	0.201	4835		5102	0.34			
SS-17	1.9	0.017	0.52	396	2.9	1.8	1.6	0.095	2286		2682	0.21			
SS-18	1.5	0.021	0.57	511	4.6	1.8	2.5	0.061	1463		1974	0.14			
SS-19	2.0	0.013	0.47	629	6.3	1.8	3.4	0.043	1031		1660	0.09			
SS-20	2.4	0.010	0.43	778	8.5	1.8	4.6	0.030	717		1495	0.06			
SS-21	2.4	0.011	0.70	940	10.9	1.8	6.0	0.021	510		1450	0.04			
											Total delta H (in.)	0.88			
											+15%	1.01			
											-15%	0.75			



Nominal 1" or less settlement
give q = 6000 psf

Appendix B:
Geotechnical Engineering Design Checklists

I. Geotechnical Design Checklists

Project:	LUC-25-5.04	PDP Path:	
PID:	79901	Review Stage:	1

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. Soil Profile VI. D. Geotechnical Reports	✓

II. Reconnaissance and Planning Checklist

C-R-S: LUC-25-5.04	PID: 79901	Reviewer: KCH	Date: 4/4/2023

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 to be 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?	Y	Included with proposal.
	The schedule of borings should present the following information for each boring:		
a.	exploration identification number	Y	
b.	location by station and offset	X	Station and offset were not available during planning.
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, probes, 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?	X	

II. Reconnaissance and Planning Checklist

Planning – Boring Types		(Y/N/X)	Notes:
14	Based on Sections 303.3 to 303.7.6 of the SGE, have the location, depth, and sampling requirements for the following boring types been determined for the project?	Y	
	Check all boring types utilized for this project:		
	Existing Subgrades (Type A)		
	Roadway Borings (Type B)		
	Embankment Foundations (Type B1)		
	Cut Sections (Type B2)		
	Sidehill Cut Sections (Type B3)		
	Sidehill Cut-Fill Sections (Type B4)		
	Sidehill Fill Sections on Unstable Slopes (Type B5)		
	Geohazard Borings (Type C)		
	Lakes, Ponds, and Low-Lying Areas (Type C1)		
	Peat Deposits, Compressible Soils, and Low Strength Soils (Type C2)		
	Uncontrolled Fills, Waste Pits, and Reclaimed Surface Mines (Type C3)		
	Underground Mines (C4)		
	Landslides (Type C5)		
	Rockfall (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,b,c)		
	Noise Barrier (Type E4)		
	CCTV & High Mast Lighting Towers (Type E5)		
	Buildings and Salt Domes (Type E6)		

IV.A Foundations of Structures Checklist

C-R-S: LUC-25-5.04	PID: 79901	Reviewer: KCH	Date: 4/4/2023

If you do not have such a foundation or structure on the project, you do not have to fill out this checklist.

Soil and Bedrock Strength Data		(Y/N/X)	Notes:
1	Has the shear strength of the foundation soils been determined?	Y	
	Check method used:		
	laboratory shear tests	✓	
	estimation from SPT or field tests	✓	
2	Have sufficient soil shear strength, consolidation, and other parameters been determined so that the required allowable loads for the foundation/structure can be designed?	Y	
3	Has the shear strength of the foundation bedrock been determined?	X	
	Check method used:		
	laboratory shear tests		
	other (describe other methods)		

Spread Footings		(Y/N/X)	Notes:
4	Are there spread footings on the project? If no, go to Question 11	Y	
5	Have the recommended bottom of footing elevation and reason for this recommendation been provided?	Y	
a.	Has the recommended bottom of footing elevation taken scour from streams or other water flow into account?	N	
6	Were representative sections analyzed for the entire length of the structure for the following:	Y	
a.	factored bearing resistance?	Y	
b.	factored sliding resistance?	Y	Recommended soil parameters provided
c.	eccentric load limitations (overturning)?	N	
d.	predicted settlement?	Y	
e.	overall (global) stability?	N	
7	Has the need for a shear key been evaluated?	N	
a.	If needed, have the details been included in the plans?	X	Plans to be prepared by others.
8	If special conditions exist (e.g. geometry, sloping rock, varying soil conditions), was the bottom of footing “stepped” to accommodate them?	X	Conditions not present.
9	Have the Service I and Maximum Strength Limit States for bearing pressure on soil or rock been provided?	Y	

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	Conditions not present.
a.	Have the procedure and quantities related to this removal / treatment been included in the plans?	X	See response for Item 10, above.
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 305.4.1.2 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 305.4.2.2?		
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 305.4.5.6?		
18	If subsurface obstacles exist, has preboring been recommended to avoid these obstructions?		
19	If piles will be driven through 15 feet or more of new embankment, has preboring been specified as per BDM 305.4.5.7?		

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 305.5.2?		
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?	N	
a.	If needed, have details and plan notes for load testing been included in the plans?		

VI.B. Geotechnical Reports

C-R-S: LUC-25-5.04	PID: 79901	Reviewer: KCH	Date: 4/4/2023

General		(Y/N/X)	Notes:
1	Has an electronic copy of all geotechnical submissions been provided to the District Geotechnical Engineer (DGE)?	Y	
2	Has the first complete version of a geotechnical report being submitted been labeled as 'Draft'?	Y	
3	Subsequent to ODOT's review and approval, has the complete version of the revised geotechnical report being submitted been labeled 'Final'?	Y	This report is being submitted as "Final."
4	Has the boring data been submitted in a native format that is DIGGS (Data Interchange for Geotechnical and Geoenvironmental) compatable? gINT files may be used for this.	Y	
5	Does the report cover format follow ODOT's Brand and Identity Guidelines Report Standards found at http://www.dot.state.oh.us/brand/Pages/default.aspx ?	Y	
6	Have all geotechnical reports being submitted been titled correctly as prescribed in Section 705.1 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 705.2 of the SGE?	Y	
b.	an Introduction as described in Section 705.3 of the SGE?	Y	
c.	a section titled "Geology and Observations of the Project," as described in Section 705.4 of the SGE?	Y	
d.	a section titled "Exploration," as described in Section 705.5 of the SGE?	Y	
e.	a section titled "Findings," as described in Section 705.6 of the SGE?	Y	
f.	a section titled "Analyses and Recommendations," as described in Section 705.7 of the SGE?	Y	
Appendices		**(Y/N/X)**	**Notes:**
8	Do all geotechnical reports being submitted contain all applicable Appendices as described in Section 705.8 of the SGE?	Y	
9	Do the Appendices present a site Boring Plan showing all boring locations as described in Section 705.8.1 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 705.8.2 of the SGE?	Y	
11	Do the Appendices include reports of undisturbed test data as described in Section 705.8.3 of the SGE?	Y	
12	Do the Appendices include calculations in a logical format to support recommendations as described in Section 705.8.4 of the SGE?	Y	