Stantec

Stantec Consulting Services Inc.
11687 Lebanon Road, Cincinnati OH 45241-2012

October 30, 2018
File: 175538045

Attention: Joseph A. Smithson, PE
Ohio Department of Transportation, District 8
505 South SR 741
Lebanon, Ohio 45036

Reference: BUT-73-13.05
Report of Structure Foundation Exploration (FINAL)
PID No. 102059

Dear Mr. Smithson,

Stantec Consulting Services Inc. (Stantec) has completed the Report of Structure Foundation Exploration for the culvert extension project near mileage 13.05 of State Route 73 in Butler County, Ohio. The enclosed report contains a brief description of the site, geologic conditions encountered, the scope of work performed, and geotechnical recommendations for the proposed culvert extension.

Regards,

Stantec Consulting Services Inc.

Robert Lopina

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Project Engineer

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Geotechnical Task Manager

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Attachment: Report of Structure Foundation Exploration (FINAL)

STATE OF OHIO
ERIC M.
KISTNER
E-65597
10-30-18
REGISTERED
PROFESSIONAL ENGINEER

BUT-73-13.05
Report of Structure Foundation Exploration (FINAL)

PID No. 102059

Butler County, Ohio

October 30, 2018

Prepared for:

Ohio Department of Transportation,
District 8

Prepared by:

Stantec Consulting Services Inc.
Cincinnati, Ohio

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Executive Summary

The Ohio Department of Transportation (ODOT) plans to construct a roundabout at the intersection of State Route (SR) 73 and Jacksonburg Road near straight line mileage 13.05 of SR 73 in Butler County, Ohio. The project site is approximately 3 miles west of Trenton, Ohio. As part of the project, the existing culvert just east of the intersection will be extended in both the upstream and downstream directions approximately 20 to 25 feet.

Two soil borings and a laboratory testing program were performed for this project to obtain geotechnical data for the proposed culvert extension. One boring was advanced at the property located at 3712 Jacksonburg Road, and one boring was advanced through the westbound shoulder of SR 73.

The surface materials encountered consisted of 0.2 feet of topsoil in B-001-0-18 and 0.8 feet of asphalt pavement underlain by 0.5 feet of granular base material in B-002-0-18. Below the topsoil in B-001-0-18, silt and clay (A-6a) material was encountered to a depth of 9.5 feet. Below the roadway materials in B-002-0-18, fill material classifying as silt and clay (A-6a) and silty clay (A-6b) was encountered to a depth of 10.5 feet. Glacial till material was encountered at depths of 9.5 feet in B-001-0-18 and 10.5 feet in B-002-0-18. The glacial till was typically classified as silt and clay (A-6a) or silty clay (A-6b) with little to some gravel and sand. A five-foot layer of gravel and stone fragments with sand (A-1-b) was encountered in B-001-0-18 from a depth of 17 feet to 22 feet. Gray weathered shale was encountered at a depth of 34.4 feet in B-001-0-18, while bedrock was not encountered in B-002-0-18. Groundwater was encountered during drilling at a depth of 9.5 feet in B-001-0-18 and 12.7 feet in B-002-0-18.

It is recommended that the culvert bear on gravel bedding underlain by glacial till soil at an elevation of 708 feet or lower southwest of SR 73 and 710 feet or lower northeast of SR 73. Bedding material should consist of at least 6 inches of ODOT Type 1 structural backfill meeting the gradations of Items 304, 411, or 617 (except 0 to 20 percent may pass the No. 200 sieve). Wingwalls should be supported by shallow spread footings bearing on the same soils at an elevation of 708 feet or lower (southwest of SR 73) or 710 feet and lower (northeast of SR 73).

The nominal bearing resistance for the box culvert and wingwall spread footings bearing on glacial till material at an elevation of 708 feet (southwest of SR 73) and 710 feet (northeast of SR 73) or lower at service limit state was estimated as 8 ksf. A nominal bearing resistance of 10 ksf (factored bearing resistance of 5 ksf) is recommended for design of the culvert and wingwall spread footings at strength limit state.

The wingwall backfill immediately behind the wall should consist of a 2-foot thick layer of porous material wrapped with geotextile fabric from 1-foot below subgrade to the top of the footing. Horizontal drains and weepholes should be designed to drain this layer behind the wall. Other backfill behind the wingwalls should consist of non-granular cohesive soil. Based on the probable available soils in the project vicinity, it can be assumed that this backfill will consist of lean clay with a wet unit weight of 125 pounds per cubic foot and an internal angle of friction of 28 degrees. The active earth pressure coefficient (K_a) for this soil can be taken as 0.36. The coefficient of friction (tan δ) between the mass concrete of spread footings against stiff clay can be taken as 0.33.

Backfill above the culvert and embankments should be constructed according to Item 203 in the current ODOT Construction and Materials Specifications (CMS). Lateral earth pressure parameters for the design of temporary sheeting for partial-width construction are provided herein. Embankment slopes should be designed no steeper than a grade of 2:1 (horizontal to vertical). A design CBR of 7 should be used for pavement design based on the anticipated backfill soils.

1.0 INTRODUCTION

The Ohio Department of Transportation (ODOT) plans to construct a roundabout at the intersection of State Route (SR) 73 and Jacksonburg Road near straight line mileage 13.05 of SR 73 in Butler County, Ohio. The project site is approximately 3 miles west of Trenton, Ohio. As part of the project, the existing culvert just east of the intersection will be extended in both the upstream and downstream directions approximately 20 to 25 feet. Stantec Consulting Services Inc. (Stantec) was contracted by ODOT to perform the geotechnical exploration and design for the culvert extension. Figure 1 shows the site vicinity.

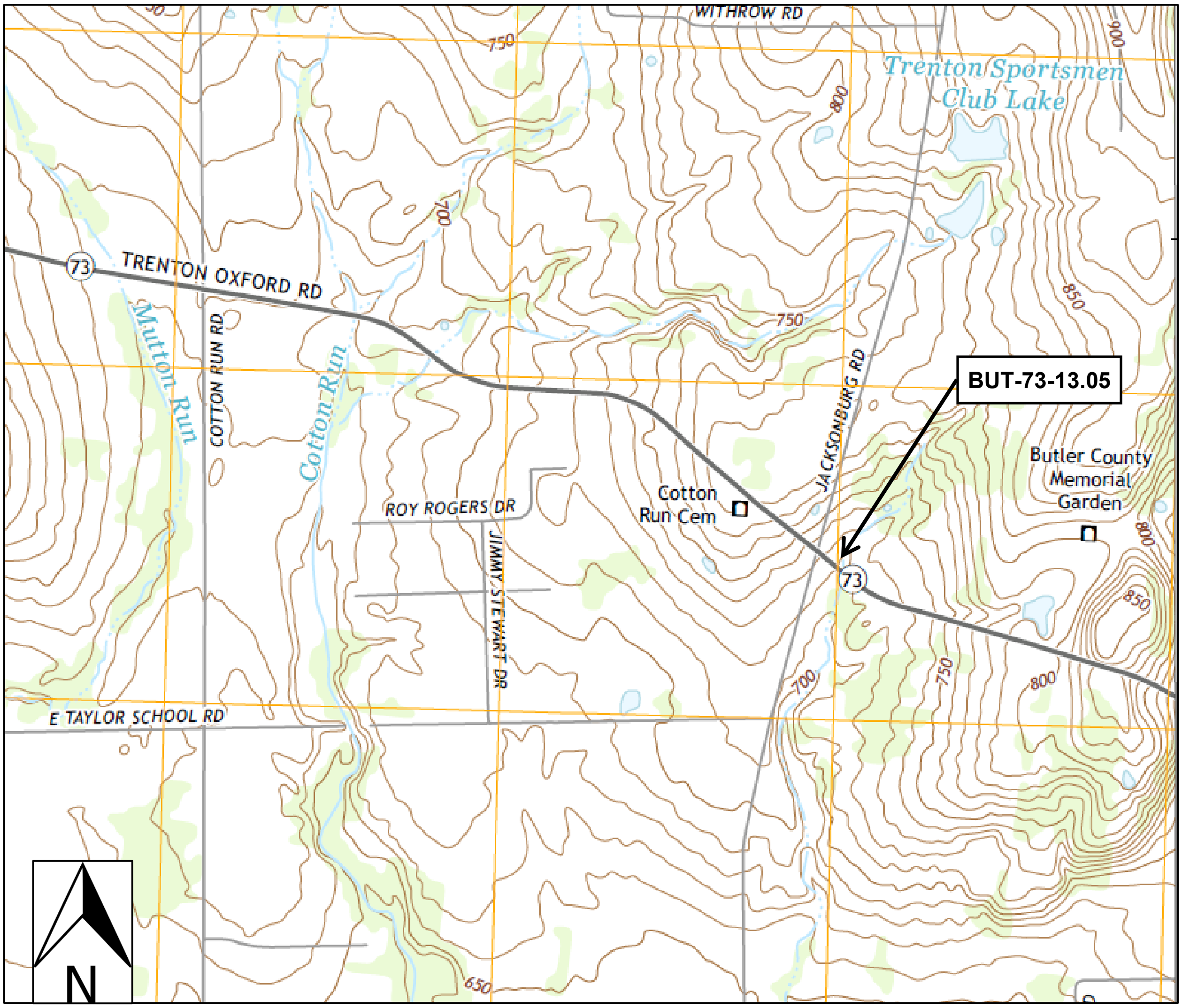


Figure 1. Site Vicinity
(Portion of USGS Topographic Map, Hamilton, OH Quadrangle 2016, Not to Scale)

2.0 GEOLOGY AND OBSERVATIONS OF THE PROJECT

2.1 GENERAL

The Physiographic Regions of Ohio Map (Ohio Department of Natural Resources (ODNR), 1998) indicates that the project is located in the Southern Ohio Loamy Till Plain of the Till Plains physiographic region. The Southern Ohio Loamy Till Plain region is described as containing surfaces of loamy till and end and recessional moraines which are commonly associated with boulder belts. Stream valleys are filled with outwash and alternate between broad floodplains and narrows, with buried valleys common. The region has moderate relief (generally 200 feet) with elevations of 530 to 1,150 feet.

2.2 SOIL GEOLOGY

According to the Quaternary Geology of Ohio map (ODNR, 1999), the project site is underlain by loam till with thin (less than 1 meter) loess cover and a flat to gently undulating ground moraine originating in the late Wisconsinan age.

The soil survey (Web Soil Survey of Butler County, Ohio, United States Department of Agriculture (USDA), 2018) indicates that the project site is underlain primarily by soils from the Genesee loam complex. These soils consist primarily of loam, silt loam, or sandy loam and are well drained with a moderately high to high capacity to transmit water.

The Drift Thickness Map of Ohio (ODNR, 2004) suggests a range of soil cover along the project site between 0 and 50 feet.

2.3 BEDROCK GEOLOGY

Bedrock mapping (Reconnaissance Bedrock Geology of the Hamilton, Ohio Quadrangle [ODNR, 1998]) and Descriptions of Geologic Map Units (ODNR, 2011) indicates that the overburden soils at the project site are underlain primarily by sedimentary bedrock from the Grant Lake Formation of the Ordovician System. The Grant Lake Formation consists of interbedded limestone and shale, averaging 50 percent limestone and 50 percent shale. The bedrock is described as gray to bluish gray and planar, wavy, irregular, and/or nodular bedded. The thickness ranges from 60 to 130 feet.

According to the Ohio Mine Locator (ODNR, 2015), there is an abandoned surface clay mine approximately 0.5 miles south of the project site. Additionally, an active surface sand and gravel mine is located 1.5 miles south of the project site.

The Ohio Karst Areas map (ODNR, 2009) indicates there are no probable karst areas in Butler County.

2.4 SEISMIC

A review of the seismic data available in the project vicinity included the OhioSeis database developed by the ODNR, Division of Geological Survey. The review was performed using the internet mapping service (rev. 2012) at the following website: https://gis.ohiodnr.gov/website/dgs/earthquakes/.

Overall, Ohio has a relatively limited amount of seismic activity. Within a 25-mile radius of the project, there have been three earthquake epicenters, with magnitudes ranging between 3.0 to 3.5. The available data reviewed included events that occurred from 1804 to present day.

2.5 HYDROLOGY

An unnamed creek flows beneath SR 73 through the culvert to be extended in this project. The creek flows north to south to a pond approximately 2,000 feet south of the SR 73.

2.6 HYDROGEOLOGY

Groundwater migrates through both primary and secondary porosity at the site, with some of that water migrating along the top of bedrock, saturating the interface between the top of bedrock and unconsolidated material, until the groundwater seeps into the bedrock or into a fracture or joint, until the groundwater intercepts the existing groundwater table in the area.

A search was performed using the ODNR Ohio Water Wells Map (2018). According to the map, 15 water wells have been drilled within 0.5 miles of the project footprint. Water well logs in the area show considerable variance due to a sloping bedrock surface. The well logs indicate that bedrock is 10 to 68 feet deep and water was encountered at depths of 15 to 75 feet. The groundwater is sometimes present above bedrock where the bedrock surface is deeper and sometimes present below the bedrock surface where the bedrock surface is shallower. A search of the ODNR Oil & Gas Well Locator (2018) indicates that no oil or gas wells are located within five miles of the project site.

2.7 RECONNAISSANCE

Stantec representatives visited the site on August 29, 2018. Residential properties are located in the vicinity of the culvert. A small amount of flow was observed in the culvert during the field reconnaissance. Boring B-001-0-18 was staked in the residential property at 3712 Jacksonburg Road. Boring B-002-0-18 was staked in westbound shoulder of SR 73.

3.0 EXPLORATION

3.1 HISTORIC EXPLORATION PROGRAMS

The ODOT Traffic Information Management System (TIMS) provides information for two projects performed within one mile of the project site. Two borings were advanced approximately 0.8 miles northwest of the project site along SR 73 for BUT-73-12.20, which was performed in 2009 for a bridge over a branch of Cotton Run. Another project, BUT-CR233-5.34, included seven borings advanced in 1992 for another bridge along Taylor School Road approximately 0.9 miles southwest of the project site. The encountered soils typically classified as gravel with sand, coarse and fine sand, sandy silt, silt and clay, and silty clay. The soils were typically described as stiff to hard or dense to very dense. Soil described as glacial till was encountered in the borings in BUT-233-5.34.

3.2 PROJECT EXPLORATION PROGRAM

Two borings were advanced for this project to obtain geotechnical data for the proposed culvert extension. One boring was advanced at the property located at 3712 Jacksonburg Road, and one boring was advanced through the westbound shoulder of SR 73. A summary of these borings is shown in Table 1. Boring locations are shown on the site plan in the geotechnical drawings provided in Appendix A. Boring logs are provided in Appendix A.

Table 1. Boring Summary

Boring No.	Station[1] (feet)	Offset[1] (feet)	Ground Surface Elevation (feet)	Top of Bedrock Elevation (feet)	Bottom of Boring Elevation (feet)
B-001-0-18	700+04	68’ RT.	717.7	683.3	683.3
B-002-0-18	700+33	16’ LT.	722.5	n/a	681.0

[1] Stations are measured along the centerline of SR 73.

The borings were advanced in accordance with the Ohio Department of Transportation (ODOT) Specifications for Geotechnical Explorations (SGE). The borings were performed with a CME 55 track-mounted drill rig using 3¼-inch inside diameter (ID) hollow stem augers to advance the borings through soil. Standard Penetration Test (SPT) sampling was performed at 2.5-foot intervals. The energy ratio (ER) of the automatic hammer and drill rod system was measured to be 89.8 percent on October 19, 2017.

The SPT is performed by advancing a split-spoon sampler, 18 inches in length, with a 140-pound automatic hammer dropping 30 inches at select depth intervals in the boring. The number of hammer blows needed to advance the sampler each 6-inch increment is recorded. The blow count from the first 6-inch increment is discarded due to ground disturbance at the bottom of the borehole. The sum of the blow counts from the last two 6-inch increments is called the field N-value (N_{field}). The field N-value is corrected to an equivalent rod energy ratio of 60 percent (N_{60}) according to the equation below.

$$N_{60} = N_{field}\left(\frac{ER}{60}\right)$$

The depths/elevations of the SPTs with the corresponding N_{60}-values are shown on the boring logs in Appendix A.

The materials encountered were logged by a geotechnical inspector, with particular attention given to soil type, consistency, and moisture content. The borings were checked for the presence of groundwater during drilling and at its conclusion with the depth of water recorded. The borings were backfilled/sealed according the ODOT SGE, and the boring advanced through the pavement was capped with asphalt cold patch.

The soil samples obtained from the borings were returned to a geotechnical laboratory for visual classification and tested for water content. Engineering classification testing was performed on samples reflecting each of the main soil horizons. The engineering classification tests conducted on the samples were sieve and hydrometer analysis (ASTM D 422) and Atterberg limits (ASTM D 4318). The samples were classified according to the ODOT classification method.

4.0 FINDINGS

The surface materials encountered consisted of 0.2 feet of topsoil in B-001-0-18 and 0.8 feet of asphalt pavement underlain by 0.5 granular base material in B-002-0-18. Below the topsoil in B-001-0-18, silt and clay (A-6a) material was encountered to a depth of 9.5 feet. This material was described as medium stiff to very stiff and damp. Below the roadway materials in B-002-0-18, fill material classifying as silt and clay (A-6a) and silty clay (A-6b) was encountered to a depth of 10.5 feet. This material was described as very stiff to hard, damp, and containing concrete fragments in the silt and clay (A-6a) material.

Glacial till material was encountered at a depth of 9.5 feet (Elevation 708.2 feet) B-001-0-18 and 10.5 feet (Elevation 712.0 feet) in B-002-0-18. The glacial till was typically described as gray, hard, and damp, typically classifying as silt and clay (A-6a) or silty clay (A-6b) with little to some gravel and sand. A five-foot layer of gravel and stone fragments with sand (A-1-b) was encountered in B-001-0-18 from a depth of 17 feet to 22 feet.

Gray weathered shale was encountered at a depth of 34.4 feet (Elevation 683.3 feet) in B-001-0-18 with auger refusal occurring at a depth of 35.8 feet (Elevation 681.9 feet). Bedrock was not encountered in B-002-0-18.

Groundwater was encountered during drilling at a depth of 9.5 feet (Elevation 708.2 feet) in B-001-0-18 and 12.7 feet (Elevation 709.8 feet) in B-002-0-18.

5.0 ANALYSIS AND RECOMMENDATIONS

5.1 GENERAL

The recommendations that follow are based on the information discussed in this report and the interpretation of the subsurface conditions encountered at the site during our fieldwork. If future design changes are made, Stantec should be notified so that such changes can be reviewed and the recommendations amended as necessary.

These conclusions and recommendations are based on data and subsurface conditions from the borings advanced during this exploration using the degree of care and skill ordinarily exercised under similar circumstances by competent members of the engineering profession. No warranties can be made regarding the continuity of conditions.

Excavations and shoring should be performed in accordance with Occupational Safety and Health Administration (OSHA) standards (OSHA Technical Manual Section V: Chapter 2 titled “Excavations: Hazard Recognition in Trenching and Shoring”). Type B soils can be assumed for design of the project.

Applicable ODOT Geotechnical Engineering Design Checklists have been completed and are included in Appendix C.

5.2 BEARING CAPACITY FOR CULVERT AND WINGWALLS

It is recommended that the box culvert bear on gravel bedding underlain by glacial till soil at an elevation of 708 feet or lower southwest of SR 73 or 710 feet and lower northeast of SR 73. Bedding material should consist of at least 6 inches of ODOT Type 1 structural backfill meeting the gradations of Items 304, 411, or 617 (except 0 to 20 percent may pass the No. 200 sieve). Wingwalls should be supported by shallow spread footings bearing on the same soils at an elevation of 708 feet or lower southwest of SR 73 and 710 feet or lower northeast of SR 73.

A nominal bearing resistance of 10 ksf (factored bearing resistance of 5 ksf) is recommended for design of the box culvert and wingwall spread footings at strength limit state. The nominal bearing resistance at strength limit state was calculated according to AASHTO guidelines and is shown in Appendix B.

The nominal bearing resistance for the box culvert and wingwall spread footings at service limit state was estimated as 8 ksf according to Table C10.6.2.6.1-1 in the AASHTO LRFD Bridge Design Specifications (2017) for “very dense sandy or silty clay”. Further discussion on the service limit state is provided in Appendix B.

5.3 LATERAL EARTH PRESSURE FOR WINGWALLS

According to the ODOT Bridge Design Manual (2007), wingwall backfill immediately behind the wall should consist of a 2-foot thick layer of porous material wrapped with geotextile fabric from 1-foot below subgrade to the top of the footing. Horizontal drains and weepholes should be designed to drain this layer behind the wall. Other backfill behind the wingwalls should consist of non-granular cohesive soil. Based on the probable available soils in the project vicinity, it can be assumed that this backfill will consist of lean clay with a wet unit weight of 125 pounds per cubic foot and an internal angle of friction of 28 degrees. The active earth pressure coefficient (K_a) for this soil can be taken as 0.36. The coefficient of friction (tan δ) between the mass concrete of spread footings against stiff clay can be taken as 0.33 according to Table C3.11.5.3-1 of the AASHTO LRFD Bridge Design Specifications (2017).

5.4 LATERAL EARTH PRESSURE FOR TEMPORARY SHORING

It is assumed that partial-width construction will be used to install the culvert, thus requiring temporary sheeting near existing centerline of SR 73. Based on the soils encountered in B-002-0-18, the soil above the culvert invert and bedding will consist of fill material that classified as silty clay (A-6b) and silt and clay (A-6a) with N_{60}-values ranging from 24 to over 50 blows per foot. The high N-values can likely be attributed to gravel and concrete fragments. The active earth pressure coefficient (K_a) for this soil can be taken as 0.36 for an assumed internal angle of friction of 28 degrees. The wet unit weight of the soil can be assumed as 125 pounds per cubic foot. The coefficient of friction (tan δ) between sheetpiling and the fill material can be taken as 0.19 according to Table C3.11.5.3-1 of the AASHTO LRFD Bridge Design Specifications (2017).

Embedment soil for the sheeting will consist of hard glacial till with N_{60}-values of over 30 blows per foot. Based on an assumed internal angle of friction of 30 degrees, an active earth pressure coefficient (K_a) of 0.33 and a passive earth pressure coefficient of 3.0 can be assumed for the glacial till. It should be assumed that the groundwater table is at or near the invert of the culvert. As such, the effective unit weight of the glacial till should be assumed as 67.6 pounds per cubic foot.

5.5 ROADWAY

Backfill above the culvert and embankments should be constructed according to Item 203 in the current ODOT Construction and Materials Specifications (CMS). Embankment slopes should be designed no steeper than a grade of 2:1 (horizontal to vertical). A design CBR of 7 should be used for pavement design based on the anticipated backfill soils.

APPENDIX A

Geotechnical Drawings

PROJECT DESCRIPTION

THIS PROJECT, BUT-73-13.05, IS THE EXPLORATION FOR THE EXTENSION OF THE EXISTING CULVERT EAST OF THE INTERSECTION OF SR 73 AND JACSONBURG ROAD IN BUTLER COUNTY, OHIO.

HISTORIC RECORDS

TWO GEOTECHNICAL EXPLORATIONS WERE PERFORMED WITHIN ONE MILE OF THE PROJECT SITE. THESE EXPLORATIONS WERE USED TO UNDERSTAND THE GENERAL GEOLOGY OFF THE PROJECT AREA. THE HISTORICAL BORINGS ARE NOT PRESENTED IN THIS STRUCTURE FOUNDATION EXPLORATION BECAUSE THE HISTORICAL BORINGS ARE NOT LOCATED AT THE EXACT PROJECT SITE.

GEOLOGY

THE PROJECT SITE IS LOCATED IN THE SOUTHERN OHIO LOAMY TILL PLAIN OF THE TILL PLAINS. THE SOUTHERN OHIO LOAMY TILL PLAIN REGION IS DESCRIBED AS CONTAINING SURFACES OF LOAMY TILL AND END AND RECESSIONAL MORAINES WHICH ARE COMMONLY ASSOCIATED WITH BOULDER BELTS. STREAM VALLEYS ARE FILLED WITH OUTWASH AND ALTERNATE BETWEEN BROAD FLOODPLAINS AND NARROWS, WITH BURIED VALLEYS COMMON. THE PROJECT SITE IS UNDERLAIN BY LOAM TILL WITH THIN (LESS THAN 1 METER) LOESS COVER AND FLAT TO GENTLY UNDULATING GROUND MORAINE ORIGINATING IN THE LATE WISCONSINAN AGE. OVERBURDEN SOILS AT THE PROJECT SITE ARE UNDERLAIN PRIMARILY BY SEDIMENTARY BEDROCK OF THE GRANT LAKE FORMATION OF THE ORDOVICIAN SYSTEM. THE GRANT LAKE FORMATION CONSISTS OF INTERBEDDED LIMESTONE AND SHALE, AVERAGING 50 PERCENT LIMESTONE AND 50 PERCENT SHALE.

RECONNAISSANCE

STANTEC REPRESENTATIVES VISITED THE SITE ON AUGUST 29, 2018. RESIDENTIAL PROPERTIES ARE LOCATED IN THE VICINITY OF THE CULVERT. A SMALL AMOUNT OF FLOW WAS OBSERVED IN THE CULVERT DURING THE FIELD RECONNAISSANCE. IN GENERAL, THE PAVEMENT WAS IN FAIR TO GOOD CONDITION. SOME CRACKING WAS OBSERVED DUE TO THE AGE OF THE PAVEMENT. THE EXISTING CULVERT APPEARED TO BE IN GOOD CONDITION.

SUBSURFACE EXPLORATION

TWO BORINGS WERE ADVANCED FOR THIS PROJECT. ONE BORING WAS ADVANCED AT THE PROPERTY LOCATED AT 3712 JACKSONBURG ROAD, AND ONE BORING WAS ADVANCED THROUGH THE WESTBOUND SHOULD OF SR 73. THESE BORINGS WERE DRILLED WITH A TRACK-MOUNTED DRILL RIG USING 3.25-INCH I.D. HOLLOW-STEM AUGERS. DISTURBED SOIL SAMPLES WERE OBTAINED IN ACCORDANCE WITH THE STANDARD PENETRATION TEST (AASHTO T206) AT 2.5-FOOT SAMPLING INTERVALS. THE AUTOMATIC SAMPLING HAMMER WAS CALIBRATED ON OCTOBER 19, 2017 AND HAS A DRILL ROD ENERGY RATIO (ER) OF 89.8 PERCENT.

EXPLORATION FINDINGS

THE SURFACE MATERIALS ENCOUNTERED CONSISTED OF 0.2 FEET OF TOPSOIL IN B-001-0-18 AND 0.8 FEET OF ASPHALT PAVEMENT UNDERLAIN BY 0.5 GRANULAR BASE MATERIAL IN B-002-0-18. BELOW THE TOPSOIL IN B-001-0-18, SILT AND CLAY (A-6A) MATERIAL WAS ENCOUNTERED TO A DEPTH OF 9.5 FEET. BELOW THE ROADWAY MATERIALS IN B-002-0-18, FILL MATERIAL CLASSIFYING AS SILT AND CLAY (A-6A) AND SILTY CLAY (A-6B) WAS ENCOUNTERED TO A DEPTH OF 10.5 FEET. GLACIAL TILL MATERIAL WAS ENCOUNTERED AT A DEPTH OF 9.5 FEET B-001-0-18 AND 10.5 FEET IN B-002-0-18. THE GLACIAL TILL WAS TYPICALLY CLASSIFIED AS SILT AND CLAY (A-6A) OR SILTY CLAY (A-6B) WITH LITTLE TO SOME GRAVEL AND SAND. A FIVE-FOOT LAYER OF GRAVEL AND STONE FRAGMENTS WITH SAND (A-1-B) WAS ENCOUNTERED IN B-001-0-18 FROM A DEPTH OF 17 FEET TO 22 FEET. GRAY WEATHERED SHALE WAS ENCOUNTERED AT A DEPTH OF 34.4 FEET IN B-001-0-18. BEDROCK WAS NOT ENCOUNTERED IN B-002-0-18.

GROUNDWATER WAS ENCOUNTERED DURING DRILLING AT A DEPTH OF 9.5 FEET IN B-001-0-18 AND 12.7 FEET IN B-002-0-18.

SPECIFICATIONS

THIS GEOTECHNICAL EXPLORATION WAS PERFORMED IN ACCORDANCE WITH THE STATE OF OHIO, DEPARTMENT OF TRANSPORTATION, OFFICE OF GEOTECHNICAL ENGINEERING, SPECIFICATIONS FOR GEOTECHNICAL EXPLORATIONS, DATED JULY 2018.

AVAILABLE INFORMATION

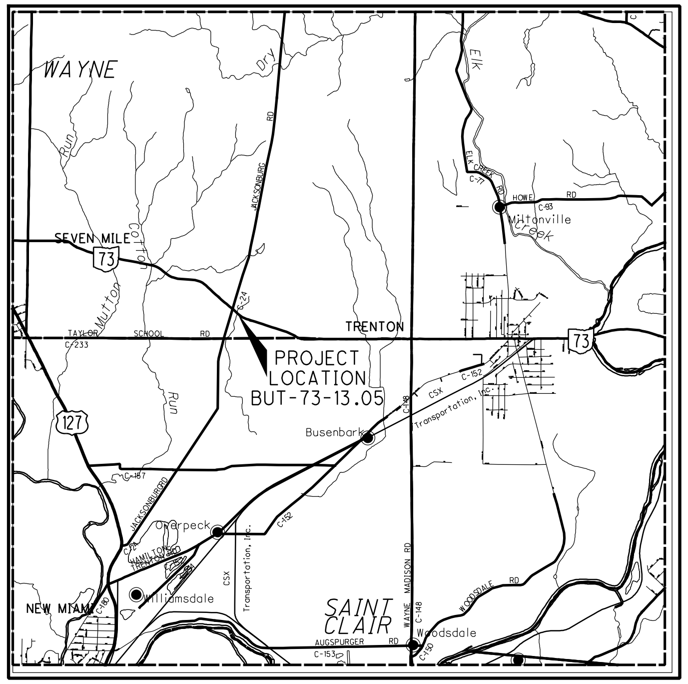
THE AVAILABLE SOIL AND BEDROCK INFORMATION THAT CAN BE CONVENIENTLY SHOWN ON THE GEOTECHNICAL EXPLORATION SHEETS HAS BEEN SO REPORTED. ADDITIONAL EXPLORATIONS MAY HAVE BEEN MADE TO STUDY SOME SPECIAL ASPECTS OF THE PROJECT. COPIES OF THIS DATA, IF ANY, MAY BE INSPECTED IN THE DISTRICT DEPUTY DIRECTOR'S OFFICE OF GEOTECHNICAL ENGINEERING AT 1980 WEST BROAD STREET.

LEGEND

	DESCRIPTION	ODOT CLASS	CLASSIFIED MECH.	CLASSIFIED VISUAL
▦	GRAVEL AND/OR STONE FRAGMENTS WITH SAND	A-1-b	1	1
▨	SILT AND CLAY	A-6a	6	10
▤	SILTY CLAY	A-6b	4	7
		TOTAL	11	18
▩	SHALE	VISUAL		
⊠	PAVEMENT OR BASE = X = APPROXIMATE THICKNESS	VISUAL		
▧	SOD OR TOPSOIL = X = APPROXIMATE THICKNESS	VISUAL		

⊕	BORING LOCATION - PLAN VIEW
⊞	DRIVE SAMPLE AND/OR ROCK CORE BORING PLOTTED TO VERTICAL SCALE ONLY. HORIZONTAL BAR INDICATES A CHANGE IN STRATIGRAPHY.
N_{60}	INDICATES STANDARD PENETRATION RESISTANCE NORMALIZED TO 60% DRILL ROD ENERGY RATIO.
X/Y/D"	NUMBER OF BLOWS FOR STANDARD PENETRATION TEST (SPT): X= NUMBER OF BLOWS FOR 6 INCHES (UNCORRECTED). Y/D"= NUMBER OF BLOWS (UNCORRECTED) FOR D" OF PENETRATION AT REFUSAL.
W	INDICATES FREE WATER ELEVATION .
WC	INDICATES WATER CONTENT IN PERCENT.
NP	INDICATES A NON-PLASTIC SAMPLE.
SS	INDICATES A SPLIT SPOON SAMPLE, STANDARD PENETRATION TEST.
TR	INDICATES TOP OF ROCK.

RECON. - EK 08/29/18
DRILLING - EC & TC 09/04/18 TO 09/05/18
DRAWN - MJ 10/18
REVIEWED - EK 10/18



LOCATION MAP

SCALE IN MILES

0 1 2 3 4

N

PARTICLE SIZE DEFINITIONS

BOULDERS		COBBLES		GRAVEL		COARSE SAND		FINE SAND		SILT		CLAY
	12"		3"		2.0 mm		0.42 mm		0.074 mm		0.005 mm	
					No. 10 SIEVE		No. 40 SIEVE		No. 200 SIEVE			

DESIGN AGENCY
Stantec
11687 Lebanon Road
Cincinnati, Ohio 45241
(513) 842-8200

PID NO.
102059

STRUCTURE FOUNDATION EXPLORATION
S.R. 73 OVER TRIBUTARY OF FOUR MILE CREEK

BUT-73-13.05

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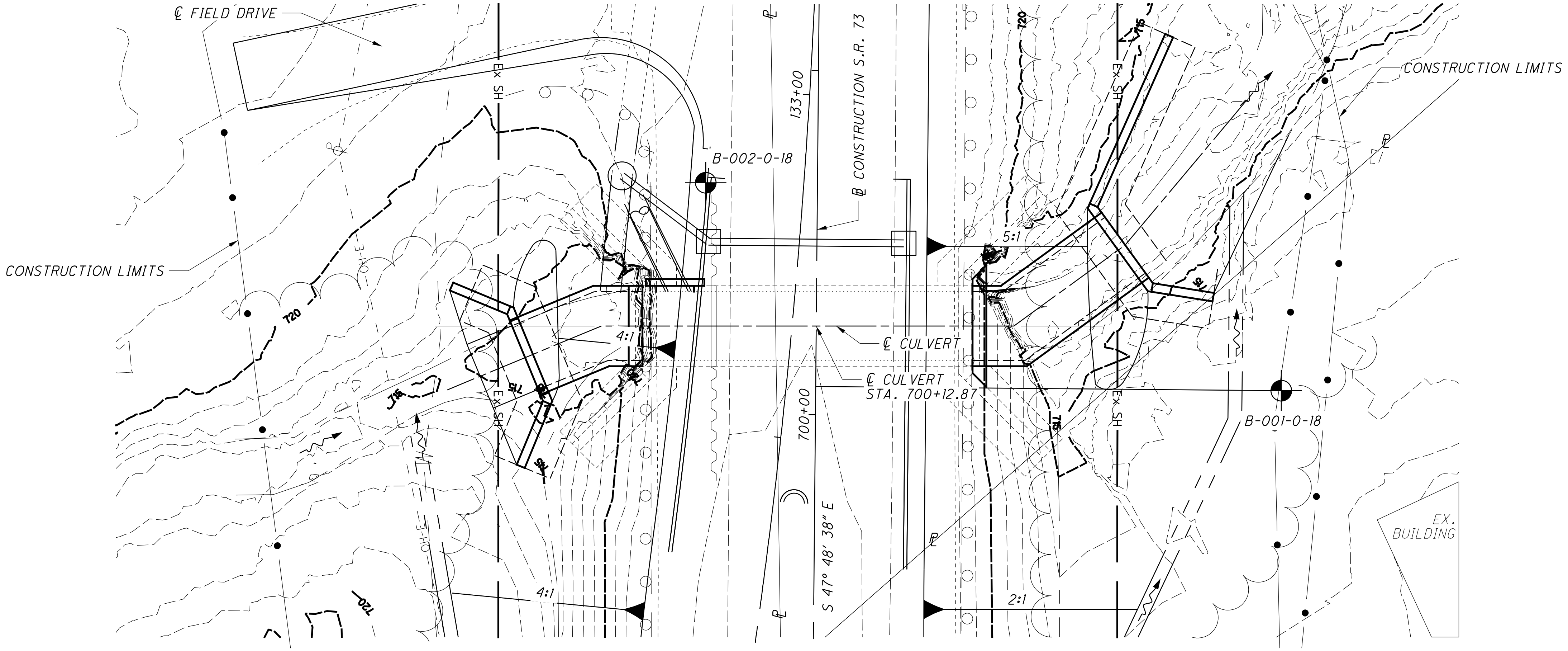
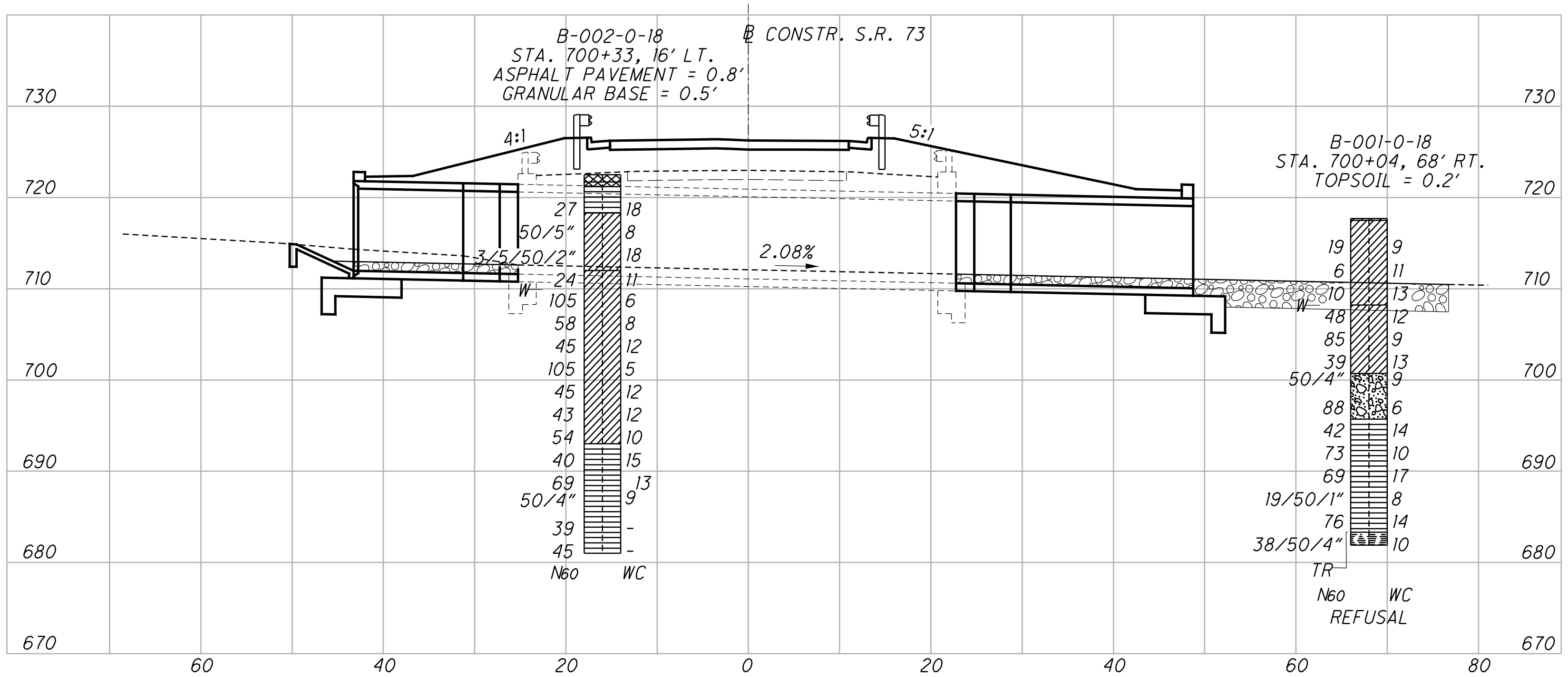




STRUCTURE FOUNDATION EXPLORATION
S.R. 73 OVER TRIBUTARY OF FOUR MILE CREEK

BUT-73-13.05

0 5 10 20
HORIZONTAL SCALE IN FEET

DRAWN MSJ
CHECKED EMK

OHIO DEPARTMENT OF TRANSPORTATION
OFFICE OF GEOTECHNICAL ENGINEERING

LOG OF BORING

PROJECT: BUT-73-13.05
TYPE: STRUCTURE FOUNDATION
PID: 102059 SFN: 0901253
START: 9/4/18 END: 9/4/18

DRILLING FIRM / OPERATOR: STANTEC / EC
SAMPLING FIRM / LOGGER: STANTEC / TC
DRILLING METHOD: 3.25" HSA
SAMPLING METHOD: SPT

DRILL RIG: CME 55T#2 (711)
HAMMER: CME AUTOMATIC
CALIBRATION DATE: 10/19/17
ENERGY RATIO (%): 89.8

STATION / OFFSET: 700+04, 68' RT.
ALIGNMENT: SR 73
ELEVATION: 717.7 (MSL) EOB: 35.8 ft.
LAT / LONG: 39.483846, -84.511748

EXPLORATION ID B-001-0-18
PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 717.7	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
TOPSOIL	717.5																	
MEDIUM STIFF TO STIFF, BROWN, **SILT AND CLAY**, LITTLE SAND, DAMP -SS-1 VERY STIFF		3	7 7 6	19	93	SS-1	4.50	0	1	15	59	25	31	19	12	9	A-6a (9)	
		6	5 2 2	6	60	SS-2	4.50	-	-	-	-	-	-	-	-	11	A-6a (V)	
	708.2	8 W	4 2 5	10	33	SS-3	1.25	-	-	-	-	-	-	-	-	13	A-6a (V)	
HARD, BROWN TO GRAY, **SILT AND CLAY**, LITTLE GRAVEL, SOME SAND, TILL, DAMP		11	10 13 19	48	100	SS-4	4.50	10	10	12	37	31	29	16	13	12	A-6a (8)	
		13	11 31 26	85	80	SS-5	4.50	-	-	-	-	-	-	-	-	9	A-6a (V)	
	700.7	16	12 13 13	39	87	SS-6	4.50	-	-	-	-	-	-	-	-	13	A-6a (V)	
VERY DENSE, GRAY, **GRAVEL AND STONE FRAGMENTS WITH SAND**, LITTLE SILT, TRACE CLAY, TILL, DAMP		18	50/4"	-	100	SS-7	-	-	-	-	-	-	-	-	-	9	A-1-b (V)	
	695.7	21	28 30 29	88	100	SS-8	-	38	25	17	14	6	NP	NP	NP	6	A-1-b (0)	
HARD, GRAY, **SILTY CLAY**, SOME GRAVEL, LITTLE SAND, TILL, DAMP		23	12 13 15	42	73	SS-9	4.50	-	-	-	-	-	-	-	-	14	A-6b (V)	
		26	19 24 25	73	93	SS-10	4.50	-	-	-	-	-	-	-	-	10	A-6b (V)	
		28	21 23 23	69	80	SS-11	-	-	-	-	-	-	-	-	-	17	A-6b (V)	
		30	19 50/1"	-	100	SS-12	-	27	10	10	25	28	32	16	16	8	A-6b (6)	
	683.3	33 TR	22 25 26	76	73	SS-13	-	27	10	10	25	28	32	16	16	14	A-6b (6)	
GRAY WEATHERED SHALE	681.9	35 EOB	38 50/4"	-	100	SS-14	-	-	-	-	-	-	-	-	-	10	Rock (V)	

NOTES: AUGER REFUSAL AT 35.8 FEET
ABANDONMENT METHODS, MATERIALS, QUANTITIES: BENTONITE PELLETS

STRUCTURE FOUNDATION EXPLORATION
BORING LOG B-001-0-18

DRAWN MSJ
CHECKED EMK

OHIO DEPARTMENT OF TRANSPORTATION
OFFICE OF GEOTECHNICAL ENGINEERING
LOG OF BORING

PROJECT: BUT-73-13.05	DRILLING FIRM / OPERATOR: STANTEC / EC	DRILL RIG: CME 55T#2 (711)	STATION / OFFSET: 700+33, 16' LT.	EXPLORATION ID B-002-0-18
TYPE: STRUCTURE FOUNDATION	SAMPLING FIRM / LOGGER: STANTEC / TC	HAMMER: CME AUTOMATIC	ALIGNMENT: SR 73	
PID: 102059 SFN: 0901253	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 10/19/17	ELEVATION: 722.5 (MSL) EOB: 41.5 ft.	PAGE 1 OF 1
START: 9/5/18 END: 9/5/18	SAMPLING METHOD: SPT	ENERGY RATIO (%): 89.8	LAT / LONG: 39.483967, -84.511475	

MATERIAL DESCRIPTION AND NOTES	ELEV. 722.5	DEPTHS	SPT/ RQD	N₆₀	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
ASPHALT PAVEMENT	721.7																	
GRANULAR BASE	721.2																	
VERY STIFF, BROWN, **SILTY CLAY**, SOME GRAVEL, SOME SAND, FILL, DAMP	718.3	3	8 9 9	27	100	SS-1	-	23	12	11	33	21	37	19	18	18	A-6b (7)	
HARD, BROWN, **SILT AND CLAY**, SOME GRAVEL, SOME SAND, CONTAINS CONCRETE FRAGMENTS, FILL, DAMP		5	50/5"	-	100	SS-2	-	-	-	-	-	-	-	-	-	8	A-6a (V)	
	712.0	8	3 5 50/2"	-	100	SS-3	-	24	10	13	35	18	31	18	13	18	A-6a (5)	
VERY STIFF TO HARD, GRAY, **SILT AND CLAY**, LITTLE TO SOME GRAVEL, LITTLE TO SOME SAND, TILL, DAMP		11	3 4 12	24	53	SS-4	4.50	-	-	-	-	-	-	-	-	11	A-6a (V)	
		W 13	13 26 44	105	100	SS-5	4.50	-	-	-	-	-	-	-	-	6	A-6a (V)	
		16	15 13 26	58	100	SS-6	-	19	9	11	32	29	25	13	12	8	A-6a (6)	
		18	7 10 20	45	100	SS-7	4.50	-	-	-	-	-	-	-	-	12	A-6a (V)	
		21	31 35 35	105	93	SS-8	-	-	-	-	-	-	-	-	-	5	A-6a (V)	
		23	13 13 17	45	73	SS-9	-	21	9	11	30	29	27	14	13	12	A-6a (6)	
		26	12 12 17	43	67	SS-10	-	21	9	11	30	29	27	14	13	12	A-6a (6)	
	693.0	28	22 19 17	54	73	SS-11	-	-	-	-	-	-	-	-	-	10	A-6a (V)	
HARD, GRAY, **SILTY CLAY**, LITTLE GRAVEL, LITTLE SAND, TILL, DAMP TO MOIST		31	12 12 15	40	87	SS-12	-	-	-	-	-	-	-	-	-	15	A-6b (V)	
		33	15 19 27	69	40	SS-13	-	12	9	11	31	37	31	14	17	13	A-6b (9)	
		35	50/4"	-	100	SS-14	-	-	-	-	-	-	-	-	-	9	A-6b (V)	
		38	11 11 15	39	93	SS-15	-	-	-	-	-	-	-	-	-	-	A-6b (V)	
	681.0	41 EOB	12 11 19	45	80	SS-16	-	-	-	-	-	-	-	-	-	-	A-6b (V)	

NOTES: NO REFUSAL
ABANDONMENT METHODS, MATERIALS, QUANTITIES: BENTONITE PELLETS

4/4 BUT-73-13.05

STRUCTURE FOUNDATION EXPLORATION
BORING LOG B-002-0-18

DRAWN MSJ
CHECKED EMK

APPENDIX B

Calculations

SUMMARY OF CALCULATIONS

Elevation	Limit State	Factored Bearing Resistance
708 feet and below (southwest) 710 feet and below (northeast)	Strength	5 ksf
	Service	8 ksf

Service Limit State (2017 AASHTO LRFD Bridge Design Specifications):

Elevation 708 feet and below (B-001-0-18) or 710 feet and below (B-002-0-18):

Typically ODOT A-6a or A-6b / USCS CL, with N_{60} values between 39 and >100.

Undrained ($\Phi_f = 0$)

Hand penetrometer values were recorded as greater than 9.0 ksf.
From ODOT SGE Table 600-2: For $N_{60} > 30 \rightarrow q_u > 8.0$ ksf
Use $q_u = 8.0$ ksf, conservatively

Nominal bearing resistance equation:

$$q_n = c\, N_{cm} + \gamma\, D_f\, N_{qm}\, C_{wq} + 0.5\, \gamma\, B\, N_{\gamma m}\, C_{w\gamma} \quad (10.6.3.1.2a\text{-}1)$$

Where:

c = cohesion, taken as undrained shear strength (s_u) $s_u = 0.5\, q_u$ for $\Phi_f = 0$
$c = 0.5\, q_u = 0.5\,(8.0 \text{ ksf}) = 4.0$ ksf
$N_{cm} = N_c\, s_c\, i_c = 5.14\,(1)\,(1) = 5.14$
$D_f = 0$ *feet*
$N_{\gamma m} = N_\gamma\, s_\gamma\, i_\gamma = 0$

$q_n = 4.0$ ksf $(5.14) + 0 + 0$
$q_n = 20.56$ ksf

Performed by:	Robert Lopina	**Date:**	10/26/2018
Checked by:	Eric Kistner	**Date:**	10/30/2018

Drained ($\Phi_f > 0$)

From ODOT GB 7: For N_{60} much greater than 30 → $\Phi_f = 28°$, c = 250 psf = 0.25 ksf

Nominal bearing resistance equation:

$$q_n = c\, N_{cm} + \gamma\, D_f\, N_{qm}\, C_{wq} + 0.5\, \gamma\, B\, N_{\gamma m}\, C_{w\gamma} \quad (10.6.3.1.2a\text{-}1)$$

$N_{cm} = N_c\, s_c\, i_c = 25.8\ (1)\ (1) = 25.8$
$N_{\gamma m} = N_\gamma\, s_\gamma\, i_\gamma = 16.7\ (1)\ (1) = 16.7$
C_{wq}, $C_{w\gamma}$ = correction factors to account for groundwater
    D_w = 0 feet (Elevation 708 or 710 feet), conservatively → C_{wq}, $C_{w\gamma}$ = 0.5
γ = Unit weight of soil = 120 pcf = 0.120 kcf
$D_f = 0$ *feet*
B = Width of footing, say 8.75 ft (from drawings)

q_n = 0.25 ksf (25.8) + 0 + 0.5 (0.120 kcf) (8.75 ft) (16.7) (0.5)
q_n = 6.45 ksf + 0 ksf + 4.38 ksf
q_n = 10.83 ksf

Drained controls, q_n = 10.83 ksf

Factored Resistance:

$$q_R = \varphi_b\, q_n \qquad (10.6.3.1.1\text{-}1)$$

Where:
    q_R = allowable bearing resistance (ksf)
    φ_b = resistance factor = 0.50 for shallow foundations in clay (Table 10.5.5.2.2-1)
    q_n = nominal bearing resistance (ksf)

q_R = 0.5 (10.83 ksf) = 5.42 ksf, say **5 ksf**

Service Limit State (2017 AASHTO LRFD Bridge Design Specifications):

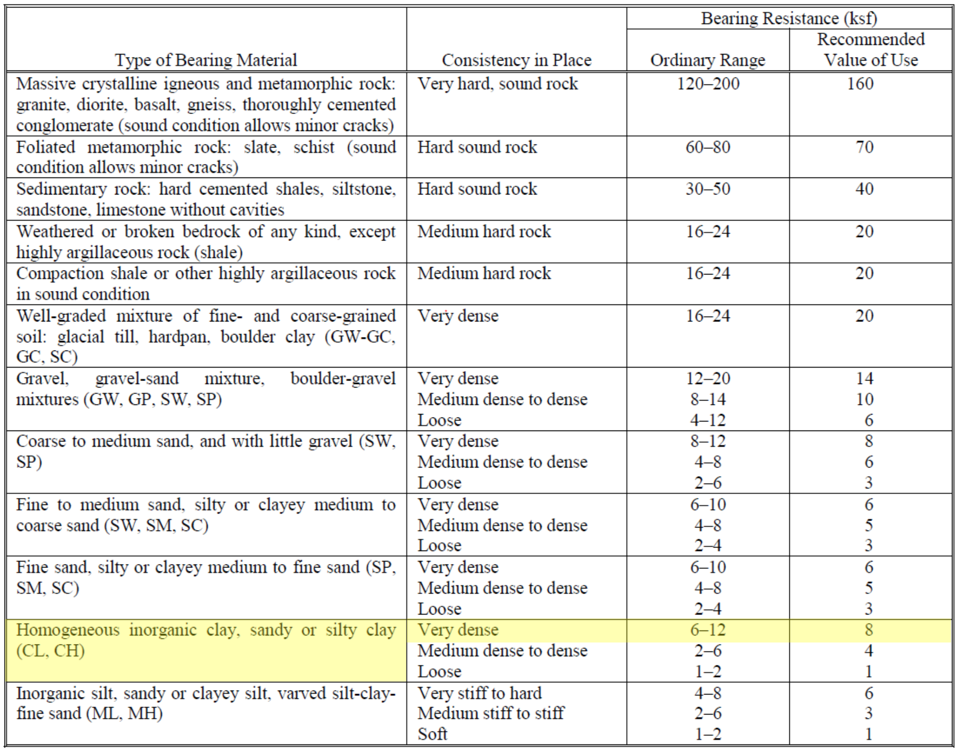
The Presumptive Bearing Resistance for Spread Footing Foundations at the Service Limit State (Table C10.6.2.6.1-1) is used. Soil is classified as CL using the USCS. From table, for “very dense sandy or silty clay (CL or CH)”:

Service Limit State = **8 ksf**

Performed by:	Robert Lopina	**Date:**	10/26/2018
Checked by:	Eric Kistner	**Date:**	10/30/2018

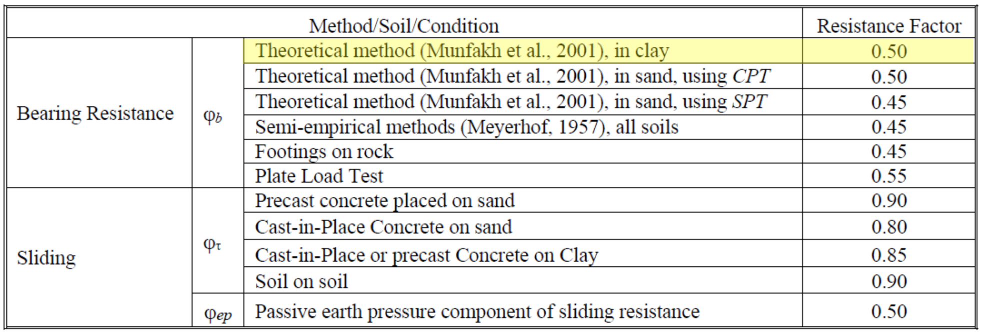
AASHTO LRFD Bridge Design Specifications (2017)

Table C10.6.2.6.1-1—Presumptive Bearing Resistance for Spread Footing Foundations at the Service Limit State Modified after U.S. Department of the Navy (1982)



Type of Bearing Material	Consistency in Place	Bearing Resistance (ksf) Ordinary Range	Bearing Resistance (ksf) Recommended Value of Use
Massive crystalline igneous and metamorphic rock: granite, diorite, basalt, gneiss, thoroughly cemented conglomerate (sound condition allows minor cracks)	Very hard, sound rock	120–200	160
Foliated metamorphic rock: slate, schist (sound condition allows minor cracks)	Hard sound rock	60–80	70
Sedimentary rock: hard cemented shales, siltstone, sandstone, limestone without cavities	Hard sound rock	30–50	40
Weathered or broken bedrock of any kind, except highly argillaceous rock (shale)	Medium hard rock	16–24	20
Compaction shale or other highly argillaceous rock in sound condition	Medium hard rock	16–24	20
Well-graded mixture of fine- and coarse-grained soil: glacial till, hardpan, boulder clay (GW-GC, GC, SC)	Very dense	16–24	20
Gravel, gravel-sand mixture, boulder-gravel mixtures (GW, GP, SW, SP)	Very dense Medium dense to dense Loose	12–20 8–14 4–12	14 10 6
Coarse to medium sand, and with little gravel (SW, SP)	Very dense Medium dense to dense Loose	8–12 4–8 2–6	8 6 3
Fine to medium sand, silty or clayey medium to coarse sand (SW, SM, SC)	Very dense Medium dense to dense Loose	6–10 4–8 2–4	6 5 3
Fine sand, silty or clayey medium to fine sand (SP, SM, SC)	Very dense Medium dense to dense Loose	6–10 4–8 2–4	6 5 3
Homogeneous inorganic clay, sandy or silty clay (CL, CH)	Very dense Medium dense to dense Loose	6–12 2–6 1–2	8 4 1
Inorganic silt, sandy or clayey silt, varved silt-clay-fine sand (ML, MH)	Very stiff to hard Medium stiff to stiff Soft	4–8 2–6 1–2	6 3 1

Table 10.5.5.2.2-1—Resistance Factors for Geotechnical Resistance of Shallow Foundations at the Strength Limit State



Method/Soil/Condition			Resistance Factor
Bearing Resistance	φ_b	Theoretical method (Munfakh et al., 2001), in clay	0.50
		Theoretical method (Munfakh et al., 2001), in sand, using *CPT*	0.50
		Theoretical method (Munfakh et al., 2001), in sand, using *SPT*	0.45
		Semi-empirical methods (Meyerhof, 1957), all soils	0.45
		Footings on rock	0.45
		Plate Load Test	0.55
Sliding	φ_τ	Precast concrete placed on sand	0.90
		Cast-in-Place Concrete on sand	0.80
		Cast-in-Place or precast Concrete on Clay	0.85
		Soil on soil	0.90
	φ_{ep}	Passive earth pressure component of sliding resistance	0.50

ODOT Specifications for Geotechnical Explorations (2017)

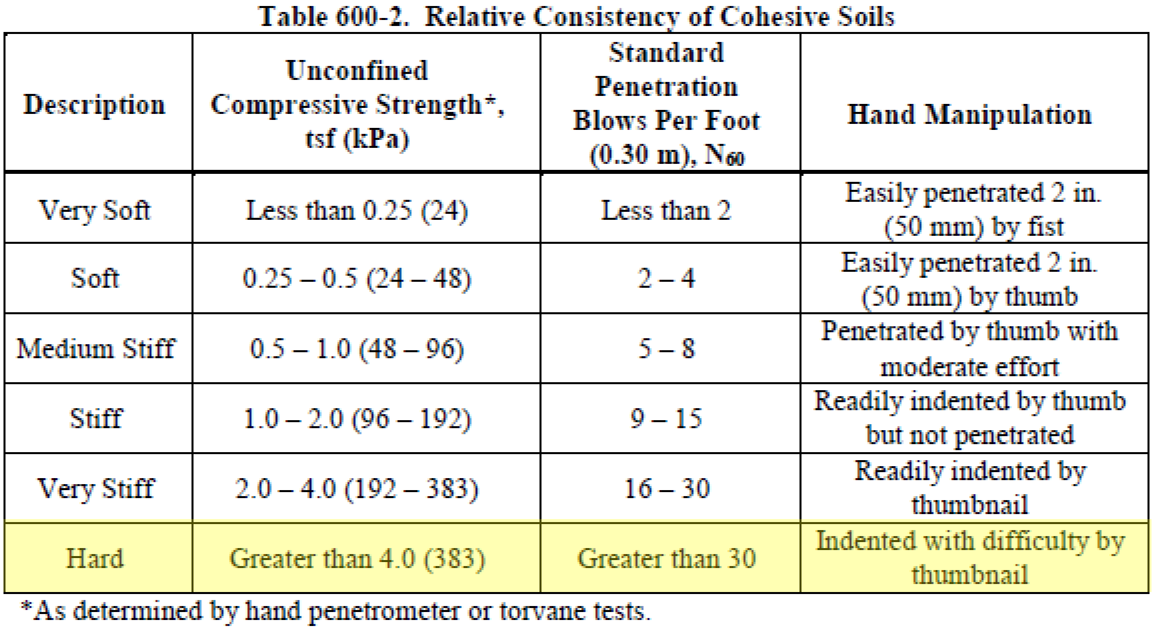


Table 600-2. Relative Consistency of Cohesive Soils

Description	Unconfined Compressive Strength*, tsf (kPa)	Standard Penetration Blows Per Foot (0.30 m), N_{60}	Hand Manipulation
Very Soft	Less than 0.25 (24)	Less than 2	Easily penetrated 2 in. (50 mm) by fist
Soft	0.25 – 0.5 (24 – 48)	2 – 4	Easily penetrated 2 in. (50 mm) by thumb
Medium Stiff	0.5 – 1.0 (48 – 96)	5 – 8	Penetrated by thumb with moderate effort
Stiff	1.0 – 2.0 (96 – 192)	9 – 15	Readily indented by thumb but not penetrated
Very Stiff	2.0 – 4.0 (192 – 383)	16 – 30	Readily indented by thumbnail
Hard	Greater than 4.0 (383)	Greater than 30	Indented with difficulty by thumbnail

*As determined by hand penetrometer or torvane tests.

ODOT Geotechnical Bulletin 7 (2014)

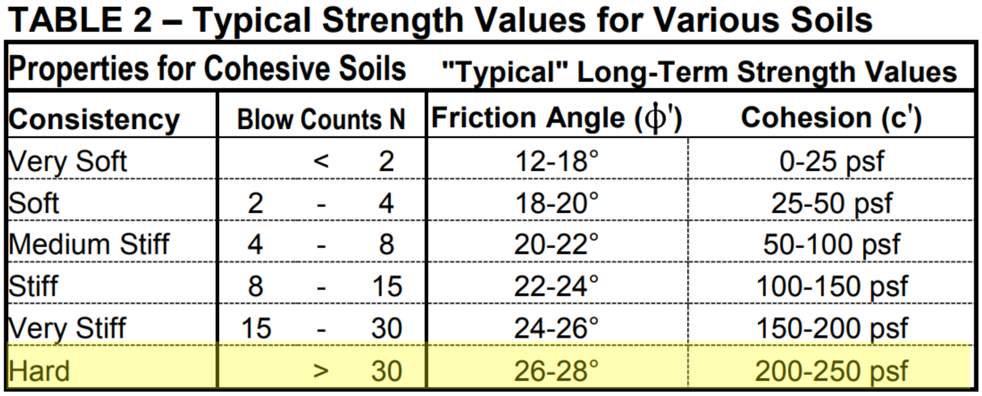


TABLE 2 – Typical Strength Values for Various Soils

Properties for Cohesive Soils		"Typical" Long-Term Strength Values	
Consistency	Blow Counts N	Friction Angle (ϕ')	Cohesion (c')
Very Soft	< 2	12-18°	0-25 psf
Soft	2 - 4	18-20°	25-50 psf
Medium Stiff	4 - 8	20-22°	50-100 psf
Stiff	8 - 15	22-24°	100-150 psf
Very Stiff	15 - 30	24-26°	150-200 psf
Hard	> 30	26-28°	200-250 psf

APPENDIX C

Engineering Design Checklists

IV.A Foundations/Structures - Non-bridge Applications

C-R-S: BUT-73-13.05	PID: 102059	Reviewer: R. Lopina	Date: 9/28/2018

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 ☒ 1 Has the shear strength of the foundation soils been determined?

Check method used:

☐ laboratory shear tests

☐ estimation from SPT or field tests

Y N ☒ 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 N ☒ 3 Has the shear strength of the foundation bedrock been determined?

Check method used:

☐ laboratory shear tests

☐ other List Other items:

Notes:

Stage 1:

IV.A Foundations/Structures - Non-bridge Applications

Spread Footings			
[✓ Y] N	4	Are there spread footings on the project? If no, go to Question **11**	
[✓ Y] N X	5	Has the recommended bottom of footing elevation and reason for this recommendation been provided?	
[✓ Y] N X		a Has the recommended bottom of footing elevation taken scour from streams or other water flow into account?	
	6	Were representative sections analyzed for the entire length of the structure for the following:	
[✓ Y] N X		a bearing capacity?	
Y N [✓ X]		b sliding?	
Y N [✓ X]		c overturning?	
Y N [✓ X]		d settlement?	
Y N [✓ X]	7	Has the need for a shear key been evaluated?	
Y N [✓ X]		a If needed, have the details been included in the plans?	
Y N [✓ X]	8	If special conditions exist (e.g. geometry, sloping rock, varying soil conditions), was the bottom of footing “stepped” to accommodate them?	
[✓ Y] N X	9	Has the recommended allowable soil or rock bearing pressure been provided?	
Y N [✓ X]	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?	
Y N [✓ X]		a Have the procedure and quantities related to this removal / treatment been included in the plans?	

Notes:

Stage 1:

IV.A Foundations/Structures - Non-bridge Applications

Pile Structures			
Y [✓ N]	11	Are there piles on the project? If no, go to Question **17**	
Y N	12	Has an appropriate pile type been selected? Check the type selected: ☐ H-pile (driven) ☐ H-pile (drilled) ☐ Cast In-place Concrete ☐ other List Other items:	
Y N X	13	Have the estimated pile length or tip elevation and section (diameter) been specified? Check method used: ☐ SPILE, DRIVEN, or equivalent software ☐ hand calculations	
	14	If required for design, have sufficient soil parameters been provided and calculations performed to evaluate the:	
Y N X		a Lateral load capacity and maximum deflection of the piles?	
Y N X		b Vertical load capacity and maximum settlement of the piles?	
Y N X		c Negative skin friction on piles driven through new embankment or soft foundation layers?	
Y N X		d Potential for and impact of lateral squeeze from soft foundation soils?	
Y N X	15	If piles are to be driven to bedrock, have “pile points” been recommended to assure secure contact with the rock surface, as per BDM 202.2.3.2.a?	
Y N X	16	If subsurface obstacles exist, has preboring been recommended to avoid these obstructions?	

Notes:

Stage 1:

IV.A Foundations/Structures - Non-bridge Applications

Drilled Shafts			
Y [✓ N]	17	Are there drilled shafts on the project? If no, go to the next checklist.	
Y N X	18	Have the drilled shaft diameter and embedment length been specified?	
Y N X	19	Have the recommended drilled shaft diameter and embedment been developed based on side friction and end bearing for vertical loading situations?	
	20	For shafts undergoing lateral loading, have the following been determined:	
Y N X		a. maximum lateral shear	
Y N X		b. maximum bending moment	
Y N X		c. maximum deflection	
Y N X		d. reinforcement design	
Y N X	21	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?	
Y N X	22	If a bedrock socket is required below soil embedment, have separate quantities been estimated based on shaft diameters and materials to be excavated?	
Y N X	23	Has the site been assessed for groundwater influence?	
Y N X		a If yes, if artesian flow is a potential concern, does the design address control of groundwater flow during construction?	
Y N X	24	If special construction features (e.g., slurry, casing, load tests) are required, have all the proper items been included in the plans?	

Notes:

Stage 1

VI.B. Structure Foundation Exploration Checklist

C-R-S: BUT-73-13.05	PID: 102059	Reviewer: R. Lopina	Date: 9/28/2018

General Presentation

[✓ Y] N X 1 Has the geotechnical information for explorations involving structures only (no roadway) been presented as plan drawings in the form of a Structure Foundation Exploration?

Y N [✓ X] 2 Have structures explored as part of the same construction project been presented together under the same cover sheet?

[✓ Y] N X 3 Has a paper copy and electronic copy of all geotechnical submissions been provided to the District Geotechnical Engineer (DGE)?

[✓ Y] N X 4 Has the geotechnical specification (title and date) under which the work was performed been clearly identified on every submission (reports, plans, etc.)?

[✓ Y] N X 5 Has the first complete version of all documents being submitted been labeled as ‘Draft’?

Y N [✓ X] 6 Subsequent to ODOT’s review and approval, has the complete version of the revised documents being submitted been labeled as ‘Final’?

Y N [✓ X] 7 Have the electronic copies of the final geotechnical plan sheets been submitted as TIFF images?

[✓ Y] N X 8 Have the plan sheets been prepared using the size, lettering, format, file management, and CADD standards as prescribed in the applicable sections of the ODOT CADD Engineering Standards Manual?

[✓ Y] N X 9 Has a scale of 1”=1’ been used for cover sheets and laboratory test data sheets?

VI.B. Structure Foundation Exploration Checklist

Cover Sheet

10 Has the following general information been provided on the cover sheet

[✓ Y] N X a. Brief description of the project?

[✓ Y] N X b. Brief presentation of geological and topographical information? Include comments on structure and pavement conditions.

[✓ Y] N X c. Brief presentation of boring and sampling methods? Include date of last calibration and drill rod energy ratio as a percent for the hammer systems used.

[✓ Y] N X d. Summary of general soil, bedrock, and groundwater conditions, including a generalized interpretation of findings?

[✓ Y] N X e. Statement of where original drawings and data may be inspected?

[✓ Y] N X f. Statement of where soil or rock samples may be inspected, if applicable?

[✓ Y] N X g. Initials of personnel and dates they performed field reconnaissance, subsurface exploration and preparation of the soil profile?

[✓ Y] N X 11 Has a Legend been provided on the cover sheet?

12 Have the following items been included in the Legend:

[✓ Y] N X a. Symbols and usual descriptions for only the soil and bedrock types encountered, as per the Soil and Rock Symbology Chart in Appendix D of the SGE?

[✓ Y] N X b. All miscellaneous symbols and acronyms, used on any of the sheets, defined?

[✓ Y] N X c. The number of soil samples for each classification that were mechanically classified and visually described?

[✓ Y] N X 13 Has a Location Map, showing the beginning and end stations for the project, been shown on the cover sheet, sized per the L&D Manual?

Y N [✓ X] 14 If sampling and testing for a scour analysis was performed, has this data been shown in tabular form?

VI.B. Structure Foundation Exploration Checklist

Plan and Profile				
[✓ Y] N X	15		Has the plan and profile view been shown at the same scale as the Site Plan for the proposed structure (when possible)?	
[✓ Y] N X	16		Has the plan and profile been presented along the flowline for culverts?	
	17		Has the following information been shown in a roadway plan drawing:	
[✓ Y] N X		a	Existing surface features described in Section 702.5.1?	
[✓ Y] N X		b	Proposed construction items, as described in Section 702.5.2?	
[✓ Y] N X		c	Project and historic boring locations, with appropriate exploration targets and exploration identification numbers?	
Y N [✓ X]		d	Notes regarding observations not readily shown by drawings?	
[✓ Y] N X	18		Have the existing ground surface contours been presented?	
[✓ Y] N X	19		Has all the subsurface data been presented in the form of a profile along the centerline or baseline?	
	20		Have the graphical boring logs been correctly shown, as follows:	
[✓ Y] N X		a.	Location and depth of boring indicated by a heavy dashed vertical line?	
[✓ Y] N X		b.	Exploration identification number above the boring	
[✓ Y] N X		c.	Logs indicate soil and bedrock layers with symbols 0.4” wide and centered on the heavy dashed vertical line where possible?	
Y N [✓ X]		d.	Bedrock exposures with 0.4” wide symbols, but without a heavy dashed vertical line.	
[✓ Y] N X		e.	Soil and bedrock symbols as per ODOT Soil and Rock Symbology chart (SGE - Appendix D)?	
Y N [✓ X]		f.	Historical borings shown in same manner with the exploration identification number above the boring?	
[✓ Y] N X	21		Have the proposed profile and existing groundline been shown on the profile view, according to ODOT CADD standards?	

VI.B. Structure Foundation Exploration Checklist

[✓ Y] N X 22 Have the locations of the proposed structure foundation elements been shown on the profile view?

[✓ Y] N X 23 Have the offsets from centerline or baseline been indicated above the borings in the profile view?

24 Has the following information been provided adjacent to the graphical logs or bedrock exposure:

[✓ Y] N X a. Thickness, to the nearest 0.1’, of sod/topsoil or other shallow surface material written above the boring (with corresponding symbology at top of log)?

[✓ Y] N X b. Moisture content, to nearest whole percent, with the text aligned with the bottom of the sample? Label this column as ‘WC’ at bottom of boring.

[✓ Y] N X c. N_{60}, aligned with bottom of sample? Label this column as ‘N_{60}’ at bottom of boring.

[✓ Y] N X d. Free water indicated by a horizontal line with a ‘w’ attached, and static water indicated by a shaded equilateral triangle, point down?

Y N [✓ X] e. Visual description of any uncontrolled fill or interval not adequately defined by a graphical symbol?

Y N [✓ X] f. Organic content with modifiers, per 603.5?

Y N [✓ X] g. 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 N [✓ X] h. 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] N X i. The reason for discontinuing a boring prior to reaching the planned depth indicated immediately below the boring?

VI.B. Structure Foundation Exploration Checklist

Boring Logs

[✓ Y] N X 25 Have the boring logs of all structure borings been shown on the sheet(s) following the plan and profile views?

[✓ Y] N X 26 Has a scale of 1”=1’ been used for the boring log sheets?

[✓ Y] N X 27 Have the boring logs been developed by integrating the driller’s field logs, laboratory test data, and visual descriptions?

28 Has the following boring information been included in the heading of each boring log:

[✓ Y] N X a. Exploration identification number?

[✓ Y] N X b. Project designation (C-R-S) and PID?

[✓ Y] N X c. Bridge identification (if applicable)?

[✓ Y] N X d. Centerline or baseline name, station, offset, and surface elevation?

[✓ Y] N X e. Coordinates?

[✓ Y] N X f. Method of drilling?

[✓ Y] N X g. Static and free water-level observations?

[✓ Y] N X h. Date started and date completed?

[✓ Y] N X i. Method and material (including quantity) used for backfilling or sealing, including type of instrumentation, if any?

[✓ Y] N X j. Date of last calibration and drill rod energy ratio (ER) in percent for the hammer system(s) used?

29 Has the following boring information been included in each boring log:

[✓ Y] N X a. A depth and elevation scale?

[✓ Y] N X b. Indication of stratum change?

[✓ Y] N X c. Description of material in each stratum?

[✓ Y] N X d. Depth of bottom of boring?

Y N [✓ X] e. Depth of boulders or cobbles, if encountered?

Y N [✓ X] f. Caving depth?

Y N [✓ X] g. Artesian water level and height of rise?

Y N [✓ X] h. Running sand?

Y N [✓ X] i. Cavities or other unusual conditions?

[✓ Y] N X j. Depth interval represented by sample?

[✓ Y] N X k. Sample number and type?

VI.B. Structure Foundation Exploration Checklist

[✓ Y] N X l. Percent recovery for each sample?

[✓ Y] N X m. Measured blow counts for each 6 inches of drive for split spoon samples?

[✓ Y] N X n. N_{60} to the nearest whole number?

[✓ Y] N X o. Particle-size analysis?

[✓ Y] N X p. Liquid limit, plastic limit, plasticity index?

[✓ Y] N X q. Water content?

[✓ Y] N X r. ODOT soil classifications, with ‘Visual’ in parentheses for those samples visually classified?

[✓ Y] N X s. Bedrock descriptions?

Y N [✓ X] t. Run rock core percent recovery?

Y N [✓ X] u. Run RQD?

Y N [✓ X] v. Unit rock core percent recovery?

Y N [✓ X] w. Unit RQD?

Y N [✓ X] x. SDI, if applicable?

Y N [✓ X] y. Rock compressive strength test results, if applicable?

Y N [✓ X] 30 Have all undisturbed test results been displayed in graphical format on the sheet(s) following the boring log sheet(s)?

Notes:

Stage 1:

VI.D. Geotechnical Reports

C-R-S: BUT-73-13.05	PID: 102059	Reviewer: R. Lopina	Date: 10/29/2018

General

[✓ Y] N X 1 Has the first complete version of a geotechnical report being submitted been labeled as ‘Draft’?

[✓ Y] N X 2 Subsequent to ODOT’s review and approval, has the complete version of the revised geotechnical report being submitted been labeled ‘Final’?

[✓ Y] N X 3 Have all geotechnical reports being submitted been titled correctly as prescribed in Section 705.1 of the SGE?

Report Body

[✓ Y] N X 4 Do all geotechnical reports being submitted contain an Executive Summary as described in Section 705.2 of the SGE?

[✓ Y] N X 5 Do all geotechnical reports being submitted contain an Introduction as described in Section 705.3 of the SGE?

[✓ Y] N X 6 Do all geotechnical reports being submitted contain a section titled "Geology and Observations of the Project," as described in Section 705.4 of the SGE?

[✓ Y] N X 7 Do all geotechnical reports being submitted contain a section titled "Exploration," as described in Section 705.5 of the SGE?

[✓ Y] N X 8 Do all geotechnical reports being submitted contain a section titled "Findings," as described in Section 705.6 of the SGE?

[✓ Y] N X 9 Do all geotechnical reports being submitted contain a section titled "Analyses and Recommendations," as described in Section 705.7 of the SGE?

VI.D. Geotechnical Reports

Appendices		
[✓ Y] N X 10	Do all geotechnical reports being submitted contain all applicable Appendices as described in Section 705.8 of the SGE?	
[✓ Y] N X 11	Do the Appendices present a site Boring Plan showing all boring locations as described in Section 705.8.1 of the SGE?	
[✓ Y] N X 12	Do the Appendices include boring logs as described in Section 705.8.2 of the SGE?	
[✓ Y] N X 13	Do the Appendices present reports of undisturbed test data as described in Section 705.8.3 of the SGE?	
[✓ Y] N X 14	Do the Appendices present calculations in a logical format to support recommendations as described in Section 705.8.4 of the SGE?	

Notes: