FINAL REPORT
STRUCTURE FOUNDATION EXPLORATION
BRIDGE OVER GILROY DITCH
CLA-42-08.20
CLARK COUNTY, OHIO
PID#: 102707

Prepared For:

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NEAS PROJECT 21-0002

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National Engineering & Architectural Services Inc.

EXECUTIVE SUMMARY

The proposed project includes the design and replacement of the exiting the bridge over Gilroy Ditch on US 42 as the proposed project CLA-42-08.20 (PID 102707). The referenced bridge is located on US 42 approximately 2.2 miles northeast of the village of South Charleston, Clark County, Ohio. National Engineering and Architectural Services Inc. (NEAS) has been contracted to perform geotechnical engineering services to supplement the design of the proposed bridge. The purpose of the geotechnical engineering services was to perform geotechnical explorations within the project limits to obtain information concerning the subsurface soil and groundwater conditions relevant to the design and construction of the project.

The subsequent document presents the results of a structure foundation exploration with respect to the proposed construction of the bridge over Gilroy Ditch on US 42. As part of the exploration NEAS: 1) two structure borings, designated B-001-0-20 and B-004-0-20, were drilled to depths of approximately 70.0 to 75.0 feet below the existing ground surface at the rear and forward abutments of the referenced bridge; 2) two sounding borings, designated B-002-0-20 and B-003-0-20, were drilled to depths of approximately 11.0 to 15.0 feet below the existing ground surface at the original bridge; 3) one hand auger boring, designated H-005-0-20, was drilled to a depth of 2.0 ft below the ditch bed; and, 4) conducted laboratory testing of collected samples to characterize the soils for engineering purposes. The proposed bridge is a single span prestressed concrete box beam bridge with new composite reinforced concrete deck on new integral reinforced concrete abutments with HP pile foundations. The new bridge will be approximately 44 feet wide and 48.63 feet long.

The subsurface profile at the bridge site consists of surficial materials comprised of thirteen-inch-thick existing pavement section (asphalt and granular base) which is generally underlain by approximately 3.0 ft to 4.5 ft thick fills following by both cohesive and non-cohesive natural overburden soils (A-4a, A-4b, A-7-6, A-1-b, A-2-4 and A-3a). Bedrock was not encountered within depths of all the borings performed. It should be noted that **boulder or cobble** was possibly encountered in three out of four borings at various depths, including B-001-0-20, B-002-0-20, and B-003-0-20.

Bridge analyses of deep foundation systems were performed for the two substructure locations for the bridge based on the developed soil profiles at the referenced boring locations. For the analyses, HP 10x42 piles were analyzed at both substructure locations. According to our deep foundation analysis, and the estimated pile tip elevations for HP 10x42 piles are at 1067.3 ft and 1069.4 ft for rear abutment and forward abutment, respectively. Steel points are recommended to be utilized to protect the tips of HP piles during pile driving. In the area where there is the possibility of the first generation wingwall, the proposed piles shall be spaced at least 10 feet locally to avoid conflicts. New piles in this local area shall be sized appropriately, and all remaining new piles shall comply with current ODOT BDM requirements.

Based on the proposed bridge site plan provided by Fishbeck through email on May 20, 2021, most of the existing abutments will be left in front of the proposed abutments, except a small top portion of the existing abutments will be cut off. Therefore, it is NEAS's opinion that global stability at the proposed bridge site should not be a concern.

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1. INTRODUCTION

1.1. General

NEAS presents our Structure Foundation Exploration Report to supplement the design and replacement of the existing bridge carrying US 42 over Gilroy Ditch as the proposed project CLA-42-08.20 (PID 102707). The referenced bridge is located on US 42 approximately 2.2 miles northeast of the village of South Charleston, Clark County, Ohio. This report presents a summary of the encountered surficial and subsurface conditions and our recommendations for bridge foundation design and construction in accordance with Load and Resistance Factor Design (LRFD) method as set forth in AASHTO's Publication *LRFD Bridge Design Specifications, 9th Edition* with 2020 interim revisions (BDS) (AASHTO, 2020) and *ODOT's 2021 LRFD Bridge Design Manual* (BDM) (ODOT, 2021).

The exploration was conducted in general accordance with Barr Engineering, Inc.'s DBA NEAS, Inc. proposal to Fishbeck Inc. (Fishbeck), dated November 25, 2020 and with the provisions of ODOT's *Specifications for Geotechnical Explorations* (SGE) (ODOT, 2020). With respect to the proposed bridge replacement project, two structure borings, designated B-001-0-20 and B-004-0-20, were drilled to depths of approximately 70.0 to 75.0 feet below the existing ground surface at the rear and forward abutments of the referenced bridge; one hand auger boring, designated H-005-0-20, was drilled to a depth of 2.0 ft below the ditch bed; two sounding borings, designated B-002-0-20 and B-003-0-20, were drilled to depths of approximately 11.0 to 15.0 feet below the existing ground surface at the original bridge.

The scope of work performed by NEAS as the referenced project included: a review of published geotechnical information; performing 3 total test borings and 2 soundings; laboratory testing of soil samples in accordance with the SGE; performing geotechnical engineering analysis to assess foundation design and construction considerations; and development of this summary report.

1.2. Proposed Construction

The proposed project consists of the replacement of the bridge over a Gilroy Ditch on US 42. The existing bridge is a single-span reinforced concrete slab bridge with full height reinforced concrete abutments atop CIP piles. The proposed bridge is a single span prestressed concrete box beam bridge with new composite reinforced concrete deck on new integral reinforced concrete abutments with HP pile foundations. The new bridge will be approximately 44 feet wide and 48.63 feet long.

2. GEOLOGY AND OBSERVATIONS OF THE PROJECT

2.1. Geology and Physiography

The bridge site is located within the Darby Till Plain, a subdivision of the Southern Ohio Loamy Till Plain (ODGS, 1998). This is a moderately low relief, broadly hummocky ground moraine with several broad, indistinct recessional moraines. Between hummocks are poorly drained swales which held wet prairies or meadows during pioneer days. The till is high lime Wisconsinan-age material and frequently overlies sparse outwash deposits underlain by Silurian-age carbonate rocks.

The geology directly underneath the bridge in the project site is mapped as an average of 30 ft of Wisconsinan-age loam till followed by an average of 310 ft of Wisconsinan-age till, underlain by an

average of 60 ft of Pleistocene-age clay all overlying Devonian/Silurian-age dolomite bedrock (ODGS, 2005). The loam till is described as high carbonate content till containing silt, sand, and gravel lenses. Joints/fractures are common. At depth, this unit includes unspecified till units of various lithologies. The till is described undifferentiated subsurface till of an unspecified age. This unit is designated where insufficient data prohibits designating other till units. It is separated from overlying till units by its greater density (hardpan). The clay in Teays-age valleys is described as containing interbedded silt and find sand deltaic deposits where main trunk valleys join tributary valleys. Unit is lacustrine deposits found only in the subsurface in the largest, deeply buried valleys of the classical Teays Valley System.

Based on the Bedrock Geologic Units Map of Ohio (USGS & ODGS, 2006), bedrock within the project area consists of shale, limestone and dolomite of the Massie and Osgood Shales; Dayton and Brasfield Limestones; Laurel Dolomite formations, Undivided. The aforementioned undivided formations are comprised of Silurian-age limestone, shale, and dolomite. The shale in this formation is described as gray to bluish gray, weathers brown in color, thin to massive bedded, calcareous, with minor limestone and dolomite beds. The Dayton limestone in this formation is described as gray to bluish-gray, weathers grayish white in color, medium to thick bedded, and fine-grained. The Brassfield limestone in this formation is described as white to pink; locally gray to reddish brown in color, thin to medium bedded, coarsely crystalline, with abundant pelmatozoan fossils. The dolomite in this formation is described as gray to tan, weathers brown in color, argillaceous to non-argillaceous, wavy, and thin to medium bedded. Bedrock is anticipated not to generally follow the natural topography of the site which is relatively flat. Bedrock is anticipated to slope downwards from east to west (ODGS, 2003). Based on the ODNR bedrock topography map of Ohio, bedrock elevations at the project site can be expected to be around the elevations of 800 to 850 ft amsl, putting bedrock at depths ranging from about 276 to 326 ft below ground surface (bgs).

The soils at the project site have been mapped (Web Soil Survey) by the Natural Resources Conservation Service (USDA, 2015) Kokomo silty clay loam. Soils in the Kokomo series are characterized as very deep, very poorly drained soils formed in loamy materials overlying till. Kokomo soils are in depressions on till plains. The Kokomo series is comprised of primarily fine-grained soils and classifies as A-4, A-6, and A-7 type soils according to the AASHTO method of soil classification.

2.2. Hydrology/Hydrogeology

Groundwater at the project site can be expected at an elevation consistent with that of Gilroy Ditch as it is the most dominant hydraulic influence in the vicinity of the project's boundaries. The water level of the Gilroy Ditch may be generally representative of the local groundwater table. However, it should be noted that perched groundwater systems may be existent in areas due to the presence of fine-grained soils making it difficult for groundwater to permeate to the phreatic surface.

The project site is located within a special flood hazard zone based on available mapping by the Federal Emergency Management Agency's (FEMA) National Flood Hazard mapping program (FEMA, 2016).

2.3. Mining and Oil/Gas Production

No abandoned mines are noted on ODNR's Abandoned Underground Mine Locator in the vicinity of the project site (ODNR [1], 2016).

No abandoned oil or gas wells are noted on ODNR's Oil and Gas Well Locator in the vicinity of the project site (ODNR [1], 2020).

2.4. Historical Records and Previous Phases of Project Exploration

The following report/plans were available for review and evaluation for this report:

- Bridge Structure Sheets as part of ODOT project CLA-42-4.43-6.28, prepared by State of Ohio Department of Highways Bureau of Bridges., dated August 16, 1956.

However, no historic boring information was pertinent for review within the limits of project CLA-42-08.20 Therefore; historic borings are not referenced within this report nor within the bridge specific project developed Structure Foundation Exploration Sheets.

2.5. Site Reconnaissance

A field reconnaissance visit for the project site was conducted on March 16, 2021, during which site conditions were noted and photographed. During our field reconnaissance, no geohazards were observed within the immediate vicinity of the proposed bridge site.

Land use of the area surrounding the proposed project site can be described as agricultural properties.

The existing bridge carrying CLA-42-0820 over the Gilroy Ditch consists of a single-span, reinforced concrete slab bridge with full height reinforced concrete abutments atop CIP piles (Photograph 1). In the area of the referenced bridge, US 42 is roughly level with the surrounding area which rises very gently from southwest to northeast. Signs of instability were not observed during our site visit. The overall bridge structure appeared to be in fair condition with signs of distress observed. The underside of the bridge deck was observed to have some small sections broken off with reinforcing steel visible (Photograph 2). The concrete wingwalls appeared to be in poor condition with signs of deterioration such as longitudinal cracking, efflorescence, pop-outs as well as disintegration near the top of the wingwalls possibly due to chloride damage (Photographs 3). The abutments appeared to be in fair condition with wear similar to the underside of the bridge deck. The scour at the foundations of the bridge appeared to be minimal (Photograph 3). No apparent signs of distress due to geotechnical concerns were noted during our field reconnaissance visit.

The bridge deck and asphalt wearing course was observed to be in poor condition with frequent moderate severity transverse and longitudinal cracking as well as wheel track cracking, edge cracking, map cracking and patching (Photograph 4). With respect to drainage, the bridge deck and adjacent pavement appeared to be well drained, with no signs of ponding or drainage issues observed during our field visit. The adjacent US 42 roadway appeared to drain to drainage ditches that run parallel to the roadway. The bridge deck drained directly off either side of the bridge.

Photograph 1: Reinforced Concrete Bridge Deck and Full Height Abutments

Photograph 2: Spalling of Bridge Deck with Reinforcing Steel Exposed

Photograph 3: Signs of Deterioration at Wingwalls and Scour

Photograph 4: Pavement Condition

3. EXPLORATION

3.1. Field Exploration Program

The exploration for proposed bridge was conducted by NEAS between April 1, 2021 and April 2, 2021 and included 2 structure borings drilled to depths between 70.0 and 75.0 ft bgs, 1 hang auger boring drilled to a depth of 2 ft bgs, and 2 sounding borings drilled to depths between 11.0 ft and 15.0 ft bgs. The boring locations were selected by NEAS in general accordance with the guidelines contained in the SGE with the intent to evaluate subsurface soil and groundwater conditions. Borings were typically located near the substructure of the proposed bridge in locations that were not restricted by maintenance of traffic, underground utilities or dictated by terrain (i.e. steep embankment slopes). Each as-drilled project boring location and corresponding ground surface elevation was surveyed in the field by NEAS (project surveyor) following completion. Each individual project boring log (included within Appendix B) includes the recorded boring latitude and longitude location (based on the surveyed Ohio State Plane North, NAD83, location) and the corresponding ground surface elevation. Elevations of the borings are shown on Table 1 below.

Table 1: Project Boring Summary

Boring Number	Latitude	Longitude	Elevation (NAVD 88) (ft)	Depth (ft)	Substructure
B-001-0-20	39.838879	-83.596645	1126.6	70.0	Rear Abutment
B-002-0-20	39.838969	-83.596592	1126.2	15.0	NA
B-003-0-20	39.838976	-83.596566	1126.2	11.0	NA
B-004-0-20	39.839028	-83.596361	1126.5	75.0	Forward Abutment
H-005-0-20	39.838892	-83.596508	1121.0	2.0	NA

Notes:
1. As-drilled boring locatio and corresponding ground suface elevation were surveyed in the field by NEAS.

Structure borings were drilled using a CME 75T truck mounted drilling rig utilizing 3.25-inch diameter hollow stem augers. In general, soil samples were recovered at intervals of 2.5-ft to a depth of 30 ft bgs and at 5.0-ft intervals thereafter using a split spoon sampler (AASHTO T-206 “Standard Method for Penetration Test and Split Barrel Sampling of Soils.”). Boring drilled as scour analysis purpose obtained samples continuously within depths of the borings corresponding to the river surface elevation, respectively. The soil samples obtained from the exploration program were visually observed in the field by the NEAS field representative and preserved for review by a Geologist and possible laboratory testing. Standard penetration tests (SPT) were conducted using a CME auto hammer that has been calibrated to be 70.9% efficient (indicated on the boring logs) on March 28, 2019.

Field /boring logs were prepared by drilling personnel, and included lithological description, SPT results recorded as blows per 6-inch increment of penetration and estimated unconfined shear strength values on specimens exhibiting cohesion (using a hand-penetrometer). Groundwater level observations were recorded both during and after the completion of drilling. These groundwater level observations are included on the individual boring logs. After completing the borings, the boreholes were backfilled with either auger cuttings, bentonite chips, or a combination of these materials.

3.2. Laboratory Testing Program

The laboratory testing program consisted of classification testing and moisture content determinations. Data from the laboratory-testing program were incorporated onto the boring logs (Appendix B). Soil

samples are retained at the laboratory until ODOT Stage 2 approval, after which time they will be discarded.

3.2.1. Classification Testing

Representative soil samples were selected for index properties (Atterberg Limits) and gradation testing for classification purposes on approximately 36% of the samples. At each boring location, samples were selected for testing with the intent of identification and classification of all significant soil units. Soils not selected for testing were compared to laboratory tested samples/strata and classified visually. Moisture content testing was conducted on all samples. The laboratory testing was performed in general accordance with applicable AASHTO specifications.

A final classification of the soil strata was made in accordance with AASHTO M-145 "Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes," as modified by ODOT "Classification of Soils" once laboratory test results became available. The results of the soil classification are presented on the boring logs provided in Appendix B.

3.2.2. Standard Penetration Test Results

Standard Penetration Tests (SPT) and split-barrel (commonly known as split-spoon) sampling of soils were performed at varying intervals (i.e., 2.5-ft or 5.0-ft intervals) in the project borings performed. To account for the high efficiency (automatic) hammers used during SPT sampling, field SPT N-values were converted based on the calibrated efficiency (energy ratio) of the specific drill rig's hammer. Field N-values were converted to an equivalent rod energy of 60% (N_{60}) for use in analysis or for correlation purposes. The resulting N_{60} values are presented on the boring logs provided in Appendix B.

3.2.3. D_{50} values for Scour Evaluation

The D_{50} values from particle size analyses are shown in Table 2 and provided in Appendix B.

Table 2: D_{50} Values

Boring Number	Specimen Depth (ft)	ODOT (Modified AASHTO) ~ USCS Classification	D50 (mm)	Average D50 (mm)
HA-005-0-20	0.0	A-6b ~ LEAN CLAY with SAND(CL)	0.027	0.038
	0.5	A-7-6 ~ LEAN CLAY with SAND(CL)	0.013	
	1.0	A-6b ~ SANDY LEAN CLAY(CL)	0.028	
	1.5	A-6a ~ CLAYEY SAND with GRAVEL(SC)	0.085	

3.2.4. Sounding Boring

Two sounding borings B-002-0-20 and B-003-0-20 were performed for this project. The purpose of the soundings is to identify whether the original substructure is buried behind the existing abutment. B-002 was terminated at the depth of 15 ft below ground surface (elevation 1111.2 ft amsl). No refusal was encountered in B-002. B-003 was terminated at the depth of 11 ft below ground surface (elevation 1115.2 ft amsl). Refusal was encountered in B-003 at the depth of 11 ft below ground surface (elevation 1115.2 ft amsl).

4. FINDINGS

The subsurface conditions encountered during NEAS's explorations are described in the following subsections and on each boring log presented in Appendix B. The boring logs represent NEAS's interpretation of the subsurface conditions encountered at each boring location based on our site observations, field logs, visual review of the soil samples by NEAS's geologist, and laboratory test results. The lines designating the interfaces between various soil strata on the boring logs represent the approximate interface location; the actual transition between strata may be gradual and indistinct. The subsurface soil and groundwater characterizations included herein, including summary test data, are based on the subsurface findings from the geotechnical explorations performed by NEAS as part of the referenced project, and consideration of the geological history of the site.

4.1. Subsurface Conditions

The subsurface profile at the bridge site consists of surficial materials comprised of thirteen-inch-thick existing pavement section (asphalt and granular base) which is generally underlain by approximately 3.0ft to 4.5 ft thick fills following by both cohesive and non-cohesive natural overburden soils (A-4a, A-4b, A-7-6, A-1-b, A-2-4 and A-3a). Bedrock was not encountered within depths of all the borings performed. It should be noted that **boulder or cobble** was possibly encountered in three out of four borings at various depths, including B-001-0-20, B-002-0-20, and B-003-0-20.

4.1.1. Overburden Soil

At the proposed bridge site, the fills were encountered immediately below the surficial materials at both abutments. The natural glacial till soils were encountered below the fills. These materials and the general profile are further described below.

The fills at the rear abutment are about 4.5 ft medium dense Gravel and Stone Fragments with Sand and Silt (A-2-4) with N_{60} values between 17 and 28. The natural moisture content of the granular fills is 6 percent in moisture. The fills at the forward abutment are about 3.0 ft very stiff Silty Clay (A-6b) with a N_{60} value of 18. The unconfined compressive strength (estimated by means of hand penetrometer) is approximately 3.25 ton per square foot (tsf) and the natural moisture content of the cohesive fills is 16 percent in moisture.

The cohesive natural overburden soils encountered are classified on the borings logs as Sandy Silt (A-4a), Silt (A-4b) and Clay (A-7-6). The soils of this stratum can be described as having a soft to hard consistency based on N_{60} values between 2 and 100 and unconfined compressive strengths (estimated by means of hand penetrometer) between approximately 0.5 and 4.50 ton per square foot (tsf). Natural moisture contents of the fine-grained till soils ranged from 10 to 30 percent in moisture. Based on Atterberg Limits test performed on representative samples of the natural till soils, the liquid and plastic limits ranged from 20 to 59 percent and 13 to 27 percent, respectively.

The non-cohesive soils in this stratum are classified on the boring logs as Sandy Silt (A-4a) with PI less than 7, Silt (A-4b) with PI less than 7, Coarse and Fine sand (A-3a), as well as Gravel with Sand (A-1-b). These non-cohesive soils are described as medium dense to very dense in compactness correlating to N_{60} values between 18 and 73. The majority natural moisture content of the outwash stratum ranged from 9 to 22 percent.

It should be noted that **boulder or cobble** was possibly encountered in three out of four borings at various depths, including B-001-0-20, B-002-0-20, and B-003-0-20.

4.1.2. Groundwater

Groundwater measurements were taken during the boring drilling procedures and immediately following the completion of each borehole. Groundwater was encountered during drilling and after drilling in both bridge borings (see Table 3). Based on these borings, groundwater was encountered between depths of 12.5 and 14.9 ft bgs (between elevations 1112.1 ft and 1114.4 ft amsl).

It should be noted that groundwater is affected by many hydrologic characteristics in the area and may vary from those measured at the time of the exploration.

Table 3: Groundwater Summary

Boring ID	Free Water Depth (ft)	Free Water Elevation (ft)	Static Water Depth (ft)	Static Water Elevation (ft)
B-001-0-20	13.5	1113.4	12.5	1114.4
B-004-0-20	13.5	1113.5	14.9	1112.1

5. ANALYSES AND RECOMMENDATIONS

The proposed project consists of the replacement of the bridge over Gilroy Ditch on US 42 Road in Clark County, Ohio. It is our understanding that the proposed bridge is a single span prestressed concrete box beam bridge with new composite reinforced concrete deck on new integral reinforced concrete abutments with HP pile foundations.

Based on the above information in addition to: 1) the soil characteristics gathered during the subsurface exploration (i.e., SPT results, laboratory test results, etc.); 2) the developed generalized soil profile and estimated engineering properties and other design assumptions presented in subsequent sections of this report; and, 3) the proposed bridge site plan (Appendix A) provided by Fishbeck via email on May 20, 2021, Geotechnical design elements for the proposed project will include:

- Deep Foundation Analysis
- Global Stability Analysis

The geotechnical engineering analyses were performed in accordance with ODOT's BDM (ODOT, 2021) and AASHTO's LRFD BDS (AASHTO, 2020). Design recommendations are provided in the following sections.

5.1. Soil Profile for Analysis

For analysis purposes, each substructure location (boring log) was reviewed and a generalized material profile was developed for analysis. Utilizing the generalized soil profile, engineering properties for each soil strata were estimated based on the field (i.e., SPT N_{60} Values, hand penetrometer values, etc.) and laboratory (i.e., Atterberg Limits, grain size, etc.) test results using correlations provided in published engineering manuals, research reports and guidance documents. The developed soil profile and estimated engineering soil properties for use in analysis (with sited correlation/reference material) is summarized within Tables 4 through 5 below.

Table 4: Soil Profile and Estimated Engineering Properties - At Boring B-001-0-20

Bridge CLA-42-0820 over Gilroy Ditch: Rear Abutment, B-001-0-20						
Soil Description	**Unit Weight[1] (pcf)**	**Moist Unit Weight[1] (pcf)**	**Saturated Unit Weight[1] (pcf)**	**Undrained Shear Strength[2] (psf)**	**Effective Cohesion[3] (psf)**	**Effective Friction Angle[3] (degrees)**
Gravel with Sand and Silt Elevation (1126.6 ft - 1121.1 ft)	115	115	125	-	-	35
Clay Elevation (1121.1 ft - 1116.1 ft)	105	105	115	600	75	21
Clay Elevation (1116.1 ft - 1114.1 ft)	112	112	122	2,500	150	25
Gravel with Sand Elevation (1114.1 ft - 1112.6 ft)	125	115	125	-	-	32
Sandy Silt Elevation (1112.6 ft - 1111.1 ft)	122	112	122	8,000	250	28
Sandy Silt Elevation (1111.1 ft - 1108.6 ft)	135	125	135	5,850	250	27
Gravel with Sand Elevation (1108.6 ft - 1106.1 ft)	125	115	125	-	-	32
Gravel with Sand Elevation (1106.1 ft - 1101.1 ft)	130	120	130	-	-	35
Gravel with Sand Elevation (1101.1 ft - 1098.6 ft)	125	115	125	-	-	32
Gravel with Sand Elevation (1098.6 ft - 1094.8 ft)	130	120	130	-	-	34
Sandy Silt Elevation (1094.8 ft - 1089.8 ft)	128	118	128	-	-	33
Gravel with Sand Elevation (1089.8 ft - 1084.8 ft)	128	118	128	-	-	33
Sandy Silt Elevation (1084.8 ft - 1079.6 ft)	135	125	135	5,850	250	27
Sandy Silt Elevation (1079.6 ft - 1069.6 ft)	140	130	140	7,100	250	28
Sandy Silt Elevation (1069.6 ft - 1064.6 ft)	140	130	140	8,000	250	28
Sandy Silt Elevation (1064.6 ft - 1059.6 ft)	140	130	140	7,100	250	28
Sandy Silt Elevation (1059.6 ft - 1056.6 ft)	140	130	140	8,000	250	28

Notes:

1. *Values interpreted from Geotechnical Bulletin 7 Table 1.*
2. *Values calculated from Terzaghi and Peck (1967) if $N1_{60}$<52, else Stroud and Butler (1975) was used.*
3. *Values interpreted from Geotechnical Bulletin 7 Table 2.*

Table 5: Soil Profile and Estimated Engineering Properties - At Boring B-004-0-20

Bridge CLA-42-0820 over Gilroy Ditch: Forward Abutment, B-004-0-20						
Soil Description	**Unit Weight[1] (pcf)**	**Moist Unit Weight[1] (pcf)**	**Saturated Unit Weight[1] (pcf)**	**Undrained Shear Strength[2] (psf)**	**Effective Cohesion[3] (psf)**	**Effective Friction Angle[3] (degrees)**
Silty Clay Elevation (1126.5 ft - 1123.5 ft)	110	110	120	2,250	115	24
Clay Elevation (1123.5 ft - 1118.5 ft)	108	108	118	1,350	100	23
Silt Elevation (1118.5 ft - 1116 ft)	98	98	108	250	25	18
Silt Elevation (1116 ft - 1113.5 ft)	115	115	125	-	-	29
Sandy Silt Elevation (1113.5 ft - 1110 ft)	112	112	122	8,000	250	28
Gravel with Sand Elevation (1110 ft - 1106 ft)	132	122	132	-	-	35
Gravel with Sand Elevation (1106 ft - 1102.5 ft)	140	130	140	-	-	37
Coarse and Fine Sand Elevation (1102.5 ft - 1101 ft)	128	118	128	-	-	34
Coarse and Fine Sand Elevation (1101 ft - 1098.5 ft)	132	122	132	-	-	35
Gravel with Sand Elevation (1098.5 ft - 1094.7 ft)	140	130	140	-	-	37
Sandy Silt Elevation (1094.7 ft - 1084.5 ft)	125	115	125	3,500	180	25
Sandy Silt Elevation (1084.5 ft - 1079.5 ft)	135	125	135	6,000	250	28
Sandy Silt Elevation (1079.5 ft - 1064.5 ft)	140	130	140	8,000	250	28
Sandy Silt Elevation (1064.5 ft - 1059.5 ft)	140	130	140	8,000	250	28
Sandy Silt Elevation (1059.5 ft - 1051.5 ft)	135	125	135	6,150	250	28

Notes:
1. *Values interpreted from Geotechnical Bulletin 7 Table 1.*
2. *Values calculated from Terzaghi and Peck (1967) if $N1_{60}$<52, else Stroud and Butler (1975) was used.*
3. *Values interpreted from Geotechnical Bulletin 7 Table 2.*

5.2. Structure Foundation Exploration

5.2.1. Pile Foundation Recommendations

Deep foundations will be used to support the abutments of the referenced bridge. According to the proposed bridge site plan provided by Fishbeck through email on May 20, 2021, abutments are proposed to be supported on HP 10x42 piles instead of pipe piles since possible **boulder or cobble** was encountered in three out of four borings at various depths. The elevations of the bottom of pile cap will be at 1119.34 ft and 1119.40 ft for the rear abutment and the forward abutment, respectively. The factored load per pile for both rear and forward abutments is 130 kips. **Steel points** are recommended to be utilized to protect the tips of HP piles during pile driving in accordance with the ODOT BDM Section 305.3.5.6.

Based on our estimated engineering soil properties, a pile analysis was performed using the computer program *Driven* to determine the estimated geotechnical pile length at each substructure. We have evaluated the vertical load bearing capacities for HP 10x42 piles for both abutments. For the purposes of this report and our analysis the term 'geotechnical pile length' has been assumed to represent the length of pile from bottom of pile cap (pile cap bearing elevation) to the depth at which the required Ultimate Bearing Value (UBV) is obtained, and rounding up to the nearest 1 ft. The UBV is determined in accordance with Section 305.3.2 of the ODOT BDM in which the given total factored load for the pile at each substructure is divided by the appropriate driven pile resistance factor (ϕ_c = 0.7). The piles for the

referenced project are to be installed according the ODOT Construction and Materials Specifications (CMS) 507 and CMS 523 and as such, a driven pile resistance factor of 0.7 was used in our analysis.

Pile lengths based on: 1) the "Estimated Length" and "Order Length" definitions and formulas presented in Section 305.3.5.2 of the ODOT BDM, are shown in Table 6. It is assumed that the abutment piles will be supported from the elevations at the bottom of footing as shown in the site plan provided by Fishbeck through email on May 20, 2021. The calculated 'estimated' length assumes penetration through 2ft (according to Section 305.3.5.1 of the ODOT BDM) embedment in the pile cap and rounding up to the nearest 5 ft. *Driven* results for each substructure location can be found in Appendix C.

The existing bridge was constructed to the east of the first generation bridge and Gilroy Ditch was realigned. Two borings, B-002 and B-003, were performed to determine if the first generation wingwall was left in place when the existing bridge was constructed in a new location. However, due to the presence of the boulders in the area found with the boring B-001, it is unclear whether the first generation wingwall exists or not. Therefore, it is recommended that the proposed piles to be spaced at least 10 feet locally to avoid conflicts in the area where there is the possibility of the first general wingwall. New piles in this local area shall be sized appropriately, and all remaining new piles shall comply with current ODOT BDM requirements.

Table 6: Estimated HP Pile Lengths and Maximum Factored Axial Resistance

Pile Type	Factored Load Per Pile (kips)	Utimate Bearing Value [1] (kips)	Bottom of Pile Cap Elevation (ft amsl)	Assemed Pile Cutoff Elevation (ft amsl)	Geotechnical Pile Length (ft)	Geotechnical Pile Tip Elevation (ft amsl)	Estimated Pile Length[2] (ft)	Order Length[2] (ft)
CLA-42-0820 Bridge: Rear abutment, B-001-0-20								
HP10X42	130.0	185.7	1119.39	1121.39	52	1067.4	55	60
CLA-42-0820 Bridge: Forward abutment, B-004-0-20								
HP10X42	130.0	185.7	1119.44	1121.44	50	1069.4	55	60

Notes:
1. *A driven pile resistance factor of 0.7 was used to calculate Utimate Bearing Value.*
2. *Based on definitions and formulas presented in Section 305.3.5.2 of the 2021 BDM.*

5.2.2. Pile Drivability

Pile driveability is highly reliant upon the specific equipment used in construction. Therefore, it is recommended that the contractor provide an analysis to demonstrate that the equipment and piles planned for use are capable to driven to refusal on bedrock without overstressing the piles.

The minimum rated energy of the hammer used to install the piles shall be (43,000) foot-pounds. Ensure that stresses in the piles during driving do not exceed (45,000) pounds per square inch.

5.2.3. Global Stability

Based on the proposed bridge site plan provided by Fishbeck through email on May 20, 2021, most of the existing abutments will be left in front of the proposed abutments, except a small top portion of the existing abutments will be cut off. Therefore, it is NEAS's opinion that global stability at the proposed bridge site should not be a concern.

5.3. Seismic Design Parameters

Based on the results of the subsurface exploration, laboratory test data, and the AASHTO Site Class Definitions indicated in Table 3.10.3.1-1 of the *LRFD Bridge Design Specifications,9th Edition* (AASHTO LRFD, 2020), we recommend a project site classification of D – Stiff Soil. Following seismic site classification, seismic design parameters for the site were developed using the web-based ATC

Hazards by Location (ATC, 2019), which references the 2016 AASHTO Guide Specifications for LRFD Seismic Bridge Design. The ATC Hazards by Location Maps generated LRFD Seismic Design parameters as presented in Table 7. The ATC Hazards by Location Maps detailed report can be found in Appendix D.

Table 7: Seismic Design Parameters

Variable	Symbol (AASHTO 3.10)	Value
Latitude		39.838869
Longitude		-83.596638
Site Class		D
Peak Ground Acceleration	PGA	0.068g
Short Period Acceleration	S_s	0.132g
Long Period Acceleration	S_1	0.065g
Site Factor (zero period)	F_{PGA}	1.6
Site Factor (short period)	F_a	1.6
Site Factor (long period)	F_v	2.4
Zero period response seismic coefficient	$A_s = F_{PGA} * PGA$	0.1088g
Short period response seismic coefficient (0.2 seconds)	$S_{DS} = F_a * S_s$	0.141g
Long period response seismic coefficient (1.0 second)	$S_{D1} = F_v * S_1$	0.104g

6. QUALIFICATIONS

This investigation was performed in accordance with accepted geotechnical engineering practice for the purpose of characterizing the subsurface conditions at the site of CLA-42-08.20 bridge over Gilroy Ditch. This report has been prepared for Fishbeck, ODOT and their design consultants to be used solely in evaluating the soils underlying the bridge site and presenting geotechnical engineering recommendations specific to this project. The assessment of general site environmental conditions or the presence of pollutants in the soil, rock and groundwater of the site was beyond the scope of this geotechnical exploration. Our recommendations are based on the results of our field explorations, laboratory tests result from representative soil samples, and geotechnical engineering analyses. The results of the field explorations and laboratory tests, which form the basis of our recommendations, are presented in the appendices as noted. This report does not reflect any variations that may occur between the borings or elsewhere on the site, or variations whose nature and extent may not become evident until a later stage of construction. In the event that any changes in the nature, design or location of the proposed bridge is made, the conclusions and recommendations contained in this report should not be considered valid until they are reviewed, and have been modified or verified in writing by a geotechnical engineer.

It has been a pleasure to be of service to Fishbeck in performing this geotechnical exploration for CLA-42-08.20 Bridge project. Please call if there are any questions, or if we can be of further service.

Respectfully Submitted,

National Engineering and Architectural Services Inc.

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Geotechnical Engineer

Chunmei He, Ph.D., P.E.
Project Manager/Geotechnical Engineer

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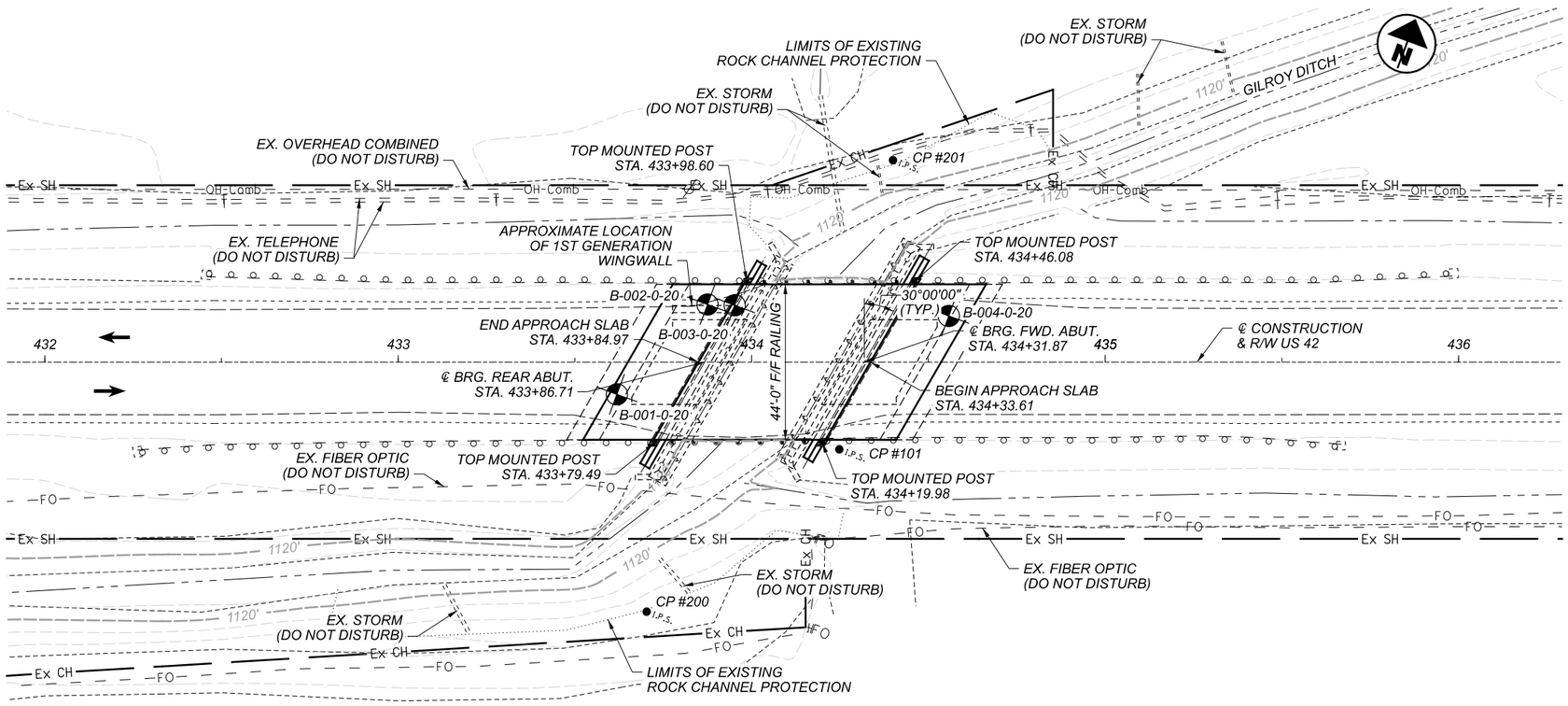
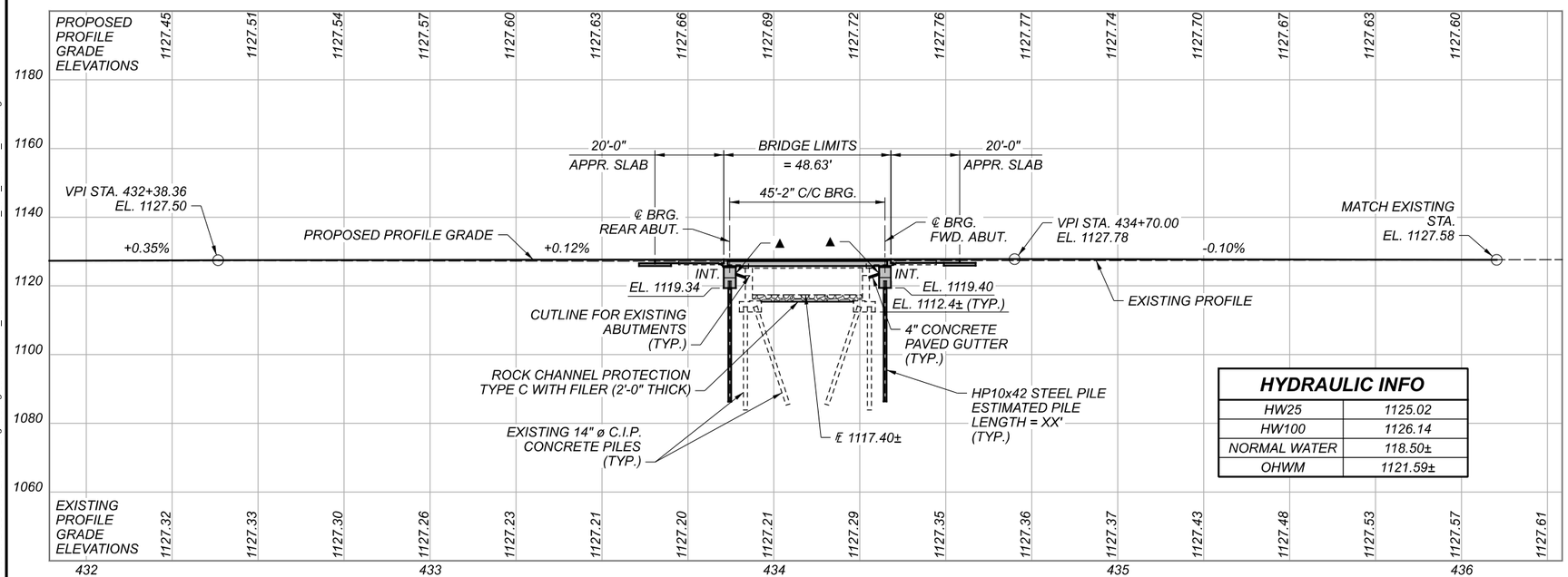
APPENDIX A

SITE PLAN



PLAN



PROFILE ALONG ℄ CONSTRUCTION US 42

HYDRAULIC INFO	
HW25	1125.02
HW100	1126.14
NORMAL WATER	118.50±
OHWM	1121.59±

BENCHMARK DATA

CP #101 STA. 434+24.81, ELEV. 1125.88, OFFSET 24.69' RT., IRON PIN SET
CP #200 STA. 433+70.30, ELEV. 1125.49, OFFSET 70.58' RT., IRON PIN SET
CP #201 STA. 434+39.99, ELEV. 1124.30, OFFSET 57.07' LT., IRON PIN SET

FOR ADDITIONAL BENCHMARK INFORMATION. SEE ROADWAY PLAN SHEET

NOTES

1. EARTHWORK LIMITS SHOWN ARE APPROXIMATE. ACTUAL SLOPES SHALL CONFORM TO PLAN CROSS SECTIONS.
2. A DATUM CORRECTION OF 1.28 FEET WAS USED FOR EXISTING ELEVATIONS.

DESIGN TRAFFIC:

2025 ADT = 2,300 2025 ADTT = 46
2045 ADT = 2,800 2045 ADTT = 56
DIRECTIONAL DISTRIBUTION = 0.60

LEGEND

⊕ BORING LOCATION
▲ T.O.S EL. 1123.56 REAR ABUT., T.O.S EL. 1123.62 FWD. ABUT.

HYDRAULIC DATA

DRAINAGE AREA = 4.16 SQ. MILES
Q (25) = 812 CFS V (25) = 6.75 FT/S
Q (100) = 1170 CFS V (100) = 7.03 FT/S
STRUCTURE CLEARS THE 25 YEAR
DESIGN HW BY 0.21 FEET.

BORING LOCATIONS

BORING	STATION	OFFSET
B-001-0-20	433+61.88	9.14' RT.
B-002-0-20	433+87.50	16.27' LT.
B-003-0-20	433+95.19	16.06' LT.
B-004-0-20	434+55.78	13.03' LT.

EXISTING STRUCTURE

TYPE: SINGLE SPAN REINFORCED CONCRETE SLAB WITH REINFORCED CONCRETE WALL TYPE ABUTMENTS ON CAST-IN-PLACE PILES
SPANS: 32'-0"± F/F OF ABUTMENTS
ROADWAY: 44'-0"± F/F GUARDRAIL
LOADING: CF=400(51)
SKEW: 30°00'00"± LF
WEARING SURFACE: 4"± BITUMINOUS ASPHALT OVERLAY
APPROACH SLABS: AS-1-54 (20'-0"± LONG)
ALIGNMENT: TANGENT
CROWN: 0.0156± FT/FT
STRUCTURE FILE NUMBER: 1202138
DATE BUILT: 7/1/1957
DISPOSITION: TO BE REPLACED

PROPOSED STRUCTURE

TYPE: SINGLE SPAN ADJACENT PRESTRESSED CONCRETE BOX BEAM SUPERSTRUCTURE WITH COMPOSITE REINFORCED CONCRETE DECK ON INTEGRAL ABUTMENTS
SPANS: 45'-2" C/C BEARINGS
ROADWAY: 44'-0" F/F RAILING
LOADING: HL93 AND 60 PSF FUTURE WEARING SURFACE
SKEW: 30°00'00" LF
WEARING SURFACE: 1" MONOLITHIC CONCRETE
APPROACH SLABS: 20'-0" LONG (AS-1-15, AS-2-15)
ALIGNMENT: TANGENT
CROWN: 0.016 FT/FT
DECK AREA: 2,140 SF

COORDINATES: LATITUDE N39°50'20.13"
LONGITUDE W83°35'47.69"

HORIZONTAL SCALE IN FEET
0 10 20 40

ALTERNATIVE 4 - SITE PLAN
BRIDGE NO. CLA-00042-08.200
OVER GILROY DITCH

SFN TBD
DESIGN AGENCY fishbeck
DESIGNER BMG CHECKER XXX
REVIEWER XXX MM-DD-YY
PROJECT ID 0
SUBSET 0 TOTAL 0
SHEET P.0 TOTAL 0

CLA-42-08.200

MODEL: 102707_SFN_1234567_SP004 [Sheet] PAPERSIZE: 17x11 (in.) DATE: 5/20/2021 TIME: 4:07:22 PM USER: bgarrison
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APPENDIX B

SOIL BORING LOGS AND LAB TEST REPORTS

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 7/5/22 08:18 - X:\ACTIVE PROJECTS\ACTIVE SOIL PROJECTS\1ARCHIVE BY YEAR\2021 ARCHIVE\CLA-42-08.20\GINT FILES\CLA-42-

PROJECT: CLA-42-08.20	DRILLING FIRM / OPERATOR: W / BW	DRILL RIG: CME 75T W	STATION / OFFSET: 433+62, 9' RT.	EXPLORATION ID B-001-0-20
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: NEAS / E. BEYER	HAMMER: CME AUTOMATIC	ALIGNMENT: US 42	
PID: 102707 SFN: 1202139	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 3/28/19	ELEVATION: 1126.6 (MSL) EOB: 70.0 ft.	PAGE 1 OF 3
START: 4/1/21 END: 4/1/21	SAMPLING METHOD: SPT	ENERGY RATIO (%): 70.9	LAT / LONG: 39.838879, -83.596645	

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
7.0" ASPHALT AND 6.0" BASE (DRILLERS DESCRIPTION)	1126.6																	
	1125.5																	
MEDIUM DENSE, BROWN AND DARK BROWN, **GRAVEL AND STONE FRAGMENTS WITH SAND AND SILT**, TRACE CLAY, DAMP **(FILL)** @3.5'; SS-2 CONTAINS NO RECOVERY		1 2 3 4 5	21 15 9	28	56	SS-1	-	37	23	13	18	9	NP	NP	NP	6	A-2-4 (0)	
			5 6 8	17	0	SS-2	-	-	-	-	-	-	-	-	-	-		
	1121.1	6 7 8 9 10																
STIFF TO VERY STIFF, GRAY MOTTLED WITH BROWN AND DARK GRAY, **CLAY**, "AND" SILT, TRACE TO LITTLE SAND, TRACE GRAVEL, SS-4 CONTAINS TRACE IRON STAINING, MOIST TO DAMP			3 2 3	6	61	SS-3	1.50	2	2	6	44	46	56	21	35	29	A-7-6 (19)	
			2 1 2	4	89	SS-4	1.00	-	-	-	-	-	-	-	-	24	A-7-6 (V)	
	1114.1	▽ 1114.1	3 7 10	20	22	SS-5	2.50	-	-	-	-	-	-	-	-	17	A-7-6 (V)	
MEDIUM DENSE, GRAY, **GRAVEL WITH SAND**, LITTLE SILT, LITTLE CLAY, MOIST	1112.6	W 1113.1																
STIFF TO VERY STIFF, GRAY, **SANDY SILT**, LITTLE CLAY, TRACE GRAVEL, DAMP		13 14 15	7 6 10	19	56	SS-6A	-	-	-	-	-	-	-	-	-	11	A-1-b (V)	
						SS-6B	2.00	9	13	18	41	19	20	14	6	13	A-4a (5)	
@16.0'; SS-7 CONTAINS A 2.5" GRANITE COBBLE		16 17 18	4 15 25	47	50	SS-7	2.00	-	-	-	-	-	-	-	-	12	A-4a (V)	
	1108.6																	
MEDIUM DENSE TO DENSE, BROWN AND GRAY, **GRAVEL WITH SAND**, TRACE SILT, TRACE CLAY, MOIST TO WET @18.5'; SS-8 CONTAINS NO RECOVERY, POSSIBLE ENCOUNTER WITH BOULDER OR COBBLE		19 20 21 22 23 24 25 26 27 28 29	6 7 12	22	0	SS-8	-	-	-	-	-	-	-	-	-	-		
			8 14 21	41	100	SS-9	-	-	-	-	-	-	-	-	-	10	A-1-b (V)	
			12 14 19	39	100	SS-10	-	-	-	-	-	-	-	-	-	15	A-1-b (V)	
			12 7 10	20	100	SS-11	-	-	-	-	-	-	-	-	-	18	A-1-b (V)	
			17 15 16	37	100	SS-12	-	-	-	-	-	-	-	-	-	15	A-1-b (V)	

PID: 102707	SFN: 1202139	PROJECT: CLA-42-08.20	STATION / OFFSET: 433+62, 9' RT.	START: 4/1/21	END: 4/1/21	PG 2 OF 3	B-001-0-20

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
MEDIUM DENSE TO DENSE, BROWN AND GRAY, **GRAVEL WITH SAND**, TRACE SILT, TRACE CLAY, MOIST TO WET *(continued)*	1096.6	31																
	1094.8	32																
MEDIUM DENSE, GRAY, **SANDY SILT**, LITTLE CLAY, TRACE GRAVEL, MOIST		33																
		34	18 10 15	30	100	SS-13	-	7	12	21	47	13	NP	NP	NP	17	A-4a (5)	
		35																
	1089.8	36																
DENSE, BROWN AND GRAY, **GRAVEL WITH SAND**, LITTLE SILT, TRACE CLAY, MOIST		37																
		38																
		39	10 12 16	33	100	SS-14	-	-	-	-	-	-	-	-	-	13	A-1-b (V)	
		40																
	1084.8	41																
VERY STIFF TO HARD, GRAY, **SANDY SILT**, SOME CLAY, TRACE TO LITTLE GRAVEL, DAMP		42																
		43																
		44	9 16 24	47	100	SS-15	3.75	8	10	21	39	22	20	13	7	11	A-4a (5)	
		45																
		46																
		47																
		48																
		49	11 20 30	59	72	SS-16	4.50	-	-	-	-	-	-	-	-	10	A-4a (V)	
		50																
		51																
		52																
		53																
		54	15 24 28	61	100	SS-17	4.50	-	-	-	-	-	-	-	-	10	A-4a (V)	
		55																
		56																
		57																
		58																
		59	18 27 33	71	100	SS-18	4.00	-	-	-	-	-	-	-	-	10	A-4a (V)	
		60																
		61																

PID: 102707	SFN: 1202139	PROJECT: CLA-42-08.20	STATION / OFFSET: 433+62, 9' RT.	START: 4/1/21	END: 4/1/21	PG 3 OF 3	B-001-0-20

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
VERY STIFF TO HARD, GRAY, **SANDY SILT**, SOME CLAY, TRACE TO LITTLE GRAVEL, DAMP *(continued)*	1064.5	63																
		64	15 23 28	60	100	SS-19	4.50	-	-	-	-	-	-	-	-	11	A-4a (V)	
		65																
		66																
		67																
		68																
		69	12 25 34	70	100	SS-20	4.50	-	-	-	-	-	-	-	-	10	A-4a (V)	
	1056.6	EOB 70																

NOTES: GROUNDWATER ENCOUNTERED AT 13.5' DURING DRILLING, 12.5' AT COMPLETION. HOLE CAVE-IN AT 24.2'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.5 BAG ASPHALT PATCH; SHOVELED SOIL CUTTINGS

PROJECT: CLA-42-08.20	DRILLING FIRM / OPERATOR: W / BW	DRILL RIG: CME 75T W	STATION / OFFSET: 433+88, 16' LT.	EXPLORATION ID B-002-0-20
TYPE: SOUNDING	SAMPLING FIRM / LOGGER: NEAS / E. BEYER	HAMMER: CME AUTOMATIC	ALIGNMENT: US 42	
PID: 102707 SFN: 1202139	DRILLING METHOD: 4.0" SSA	CALIBRATION DATE: 3/28/19	ELEVATION: 1126.2 (MSL) EOB: 15.0 ft.	PAGE 1 OF 1
START: 4/2/21 END: 4/2/21	SAMPLING METHOD:	ENERGY RATIO (%): 70.9	LAT / LONG: 39.838969, -83.596592	

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
7.0" ASPHALT AND 6.0" BASE (DRILLERS DESCRIPTION)	1126.2																	
	1125.1	1																
@5.0' TO 6.5'; DIFFICULT DRILLING/ENCOUNTERED POSSIBLE BOULDER OR COBBLE(S)		2 3 4 5 6 7 8 9 10 11 12 13 14																
	1111.2	EOB 15																

NOTES: NO SAMPLING WAS PERFORMED.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.5 BAG ASPHALT PATCH; SHOVELED SOIL CUTTINGS

PROJECT: CLA-42-08.20	DRILLING FIRM / OPERATOR: W / BW	DRILL RIG: CME 75T W	STATION / OFFSET: 433+95, 16' LT.
TYPE: SOUNDING	SAMPLING FIRM / LOGGER: NEAS / E. BEYER	HAMMER: CME AUTOMATIC	ALIGNMENT: US 42
PID: 102707 SFN: 1202139	DRILLING METHOD: 4.0" SSA	CALIBRATION DATE: 3/28/19	ELEVATION: 1126.2 (MSL) EOB: 11.0 ft.
START: 4/2/21 END: 4/2/21	SAMPLING METHOD:	ENERGY RATIO (%): 70.9	LAT / LONG: 39.838976, -83.596566

EXPLORATION ID B-003-0-20

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
7.0" ASPHALT AND 6.0" BASE (DRILLERS DESCRIPTION)	1126.2																	
	1125.1	1																
		2																
		3																
		4																
		5																
		6																
		7																
@7.0' TO 8.5'; DIFFICULT DRILLING/ENCOUNTERED POSSIBLE BOULDER OR COBBLE(S)		8																
		9																
		10																
	1115.2	EOB 11																
@11.0'; AUGER REFUSAL																		

NOTES: NO SAMPLING WAS PERFORMED.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.5 BAG ASPHALT PATCH; SHOVELED SOIL CUTTINGS

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 7/5/22 08:18 - X:\ACTIVE PROJECTS\ACTIVE SOIL PROJECTS\1ARCHIVE BY YEAR\2021 ARCHIVE\CLA-42-08.20\GINT FILES\CLA-42-

PROJECT: CLA-42-08.20	DRILLING FIRM / OPERATOR: W / BW	DRILL RIG: CME 75T W	STATION / OFFSET: 434+56, 13' LT.	EXPLORATION ID B-004-0-20
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: NEAS / E. BEYER	HAMMER: CME AUTOMATIC	ALIGNMENT: US 42	
PID: 102707 SFN: 1202139	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 3/28/19	ELEVATION: 1126.5 (MSL) EOB: 75.0 ft.	PAGE 1 OF 3
START: 4/1/21 END: 4/1/21	SAMPLING METHOD: SPT	ENERGY RATIO (%): 70.9	LAT / LONG: 39.839028, -83.596361	

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
7.0" ASPHALT AND 6.0" BASE (DRILLERS DESCRIPTION)	1126.5																	
	1125.4																	
VERY STIFF, BROWN AND GRAY, **SILTY CLAY**, SOME SAND, LITTLE GRAVEL, DAMP **(FILL)**	1123.5	1	4 7 8	18	61	SS-1	3.25	19	13	12	33	23	35	19	16	16	A-6b (7)	
STIFF TO VERY STIFF, DARK BROWN BECOMING GRAY MOTTLED WITH BROWN AND ORANGISH BROWN, **CLAY**, "AND" SILT, LITTLE SAND, TRACE GRAVEL, SS-2 IS SLIGHTLY ORGANIC, CONTAINS IRON STAINING, DAMP TO MOIST	1118.5	4	2 5 7	14	72	SS-2	2.75	4	8	9	40	39	59	27	32	27	A-7-6 (20)	
		7	1 3 4	8	100	SS-3	1.75	0	3	8	41	48	57	22	35	30	A-7-6 (19)	
SOFT TO MEDIUM STIFF, BROWN AND ORANGISH BROWN, **SILT**, LITTLE TO SOME SAND, LITTLE CLAY, TRACE GRAVEL, CONTAINS IRON STAINING, MOIST TO WET		9	1 0 2	2	28	SS-4	0.50	1	4	16	61	18	29	19	10	26	A-4b (8)	
@11.0'; SS-5 BECOMES MEDIUM DENSE	1113.5	12	4 8 7	18	22	SS-5	-	2	4	22	56	16	NP	NP	NP	22	A-4b (7)	
VERY STIFF TO HARD, GRAY, **SANDY SILT**, LITTLE CLAY, LITTLE GRAVEL, DAMP		▼ 0.5 hrs																
		▽ 1111.6																
	1110.0	14	3 8 10	21	100	SS-6	4.25	16	11	16	38	19	21	14	7	12	A-4a (4)	
DENSE TO VERY DENSE, GRAY, **GRAVEL AND STONE FRAGMENTS WITH SAND**, LITTLE SILT, TRACE CLAY, DAMP TO MOIST		16	4 17 19	43	78	SS-7A	3.00	-	-	-	-	-	-	-	-	12	A-4a (V)	
						SS-7B	-	-	-	-	-	-	-	-	-	9	A-1-b (V)	
		19	13 21 23	52	33	SS-8	-	-	-	-	-	-	-	-	-	10	A-1-b (V)	
		22	30 30 29	70	72	SS-9	-	-	-	-	-	-	-	-	-	14	A-1-b (V)	
	1102.5	24	12 11 17	33	56	SS-10A	-	-	-	-	-	-	-	-	-	10	A-1-b (V)	
DENSE TO VERY DENSE, GRAY, **COARSE AND FINE SAND**, LITTLE GRAVEL, TRACE SILT, TRACE CLAY, MOIST TO WET						SS-10B	-	-	-	-	-	-	-	-	-	17	A-3a (V)	
	1098.5	27	6 20 23	51	100	SS-11	-	-	-	-	-	-	-	-	-	20	A-3a (V)	
VERY DENSE, GRAY, **GRAVEL AND STONE FRAGMENTS WITH SAND**, LITTLE SILT, TRACE CLAY, DAMP		29	16 21 41	73	100	SS-12	-	-	-	-	-	-	-	-	-	9	A-1-b (V)	

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
VERY DENSE, GRAY, **GRAVEL AND STONE FRAGMENTS WITH SAND**, LITTLE SILT, TRACE CLAY, DAMP *(continued)*	1096.5	31																
		32																
		33																
		34	6 10 11	25	100	SS-13	4.00	10	9	20	38	23	21	13	8	12	A-4a (5)	
		35																
		36																
		37																
		38																
		39	6 10 16	31	100	SS-14	3.50	-	-	-	-	-	-	-	-	13	A-4a (V)	
		40																
		41																
		42																
		43																
		44	8 20 21	48	100	SS-15	4.25	-	-	-	-	-	-	-	-	11	A-4a (V)	
		45																
		46																
		47																
		48																
		49	18 35 28	74	100	SS-16	4.25	-	-	-	-	-	-	-	-	11	A-4a (V)	
		50																
		51																
		52																
		53																
		54	15 25 37	73	100	SS-17	4.50	-	-	-	-	-	-	-	-	10	A-4a (V)	
		55																
		56																
		57																
		58																
		59	14 27 35	73	100	SS-18	4.50	-	-	-	-	-	-	-	-	10	A-4a (V)	
		60																
		61																
VERY STIFF TO HARD, GRAY, **SANDY SILT**, SOME CLAY, TRACE TO LITTLE GRAVEL, DAMP	1094.7																	

PID: 102707	SFN: 1202139	PROJECT: CLA-42-08.20	STATION / OFFSET: 434+56, 13' LT.	START: 4/1/21	END: 4/1/21	PG 3 OF 3	B-004-0-20

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
VERY STIFF TO HARD, GRAY, **SANDY SILT**, SOME CLAY, TRACE TO LITTLE GRAVEL, DAMP *(continued)*	1064.4	63																
		64	31 41 44	100	83	SS-19	3.50	-	-	-	-	-	-	-	-	12	A-4a (V)	
		65																
		66																
		67																
		68																
		69	13 22 23	53	100	SS-20	4.50	-	-	-	-	-	-	-	-	10	A-4a (V)	
		70																
		71																
		72																
		73																
		74	14 15 24	46	100	SS-21	4.50	-	-	-	-	-	-	-	-	11	A-4a (V)	
	1051.5	EOB 75																

NOTES: GROUNDWATER ENCOUNTERED AT 13.5' DURING DRILLING, 14.9' AT COMPLETION, 13.5' AFTER PULLING AUGERS. HOLE CAVE-IN AT 53.9'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.5 BAG ASPHALT PATCH; SHOVELED SOIL CUTTINGS

PROJECT: CLA-42-08.20	DRILLING FIRM / OPERATOR: NEAS / E. BEYER	DRILL RIG:	STATION / OFFSET: 433+99, 18' RT.	EXPLORATION ID HA-005-0-20
TYPE: SCOUR	SAMPLING FIRM / LOGGER: NEAS / E. BEYER	HAMMER:	ALIGNMENT: US 42	
PID: 102707 SFN: 1202139	DRILLING METHOD: HAND AUGER	CALIBRATION DATE: N/A	ELEVATION: 1121.0 (MSL) EOB: 2.0 ft.	PAGE 1 OF 1
START: 4/2/21 END: 4/2/21	SAMPLING METHOD: HAND AUGER	ENERGY RATIO (%):	LAT / LONG: 39.838892, -83.596508	

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
SOFT, GRAY, **SILTY CLAY**, SOME SAND, TRACE GRAVEL, WET	1121.0																	
	1120.5				100	HA-1	0.25	4	6	20	45	25	39	23	16	45	A-6b (9)	
SOFT TO MEDIUM STIFF, GRAY AND BROWN, **CLAY**, "AND" SILT, LITTLE SAND, LITTLE GRAVEL, MOIST	1120.0	1			100	HA-2	0.50	12	5	10	38	35	48	21	27	34	A-7-6 (16)	
	1119.5				100	HA-3	0.25	15	9	14	37	25	37	19	18	25	A-6b (9)	
SOFT, GRAY AND BROWN, **SILTY CLAY**, SOME SAND, LITTLE GRAVEL, MOIST	1119.0	EOB 2			100	HA-4	0.25	21	15	15	30	19	29	18	11	18	A-6a (3)	
SOFT, GRAY AND BROWN, **SILT AND CLAY**, SOME SAND, SOME GRAVEL, DAMP																		

NOTES: NONE

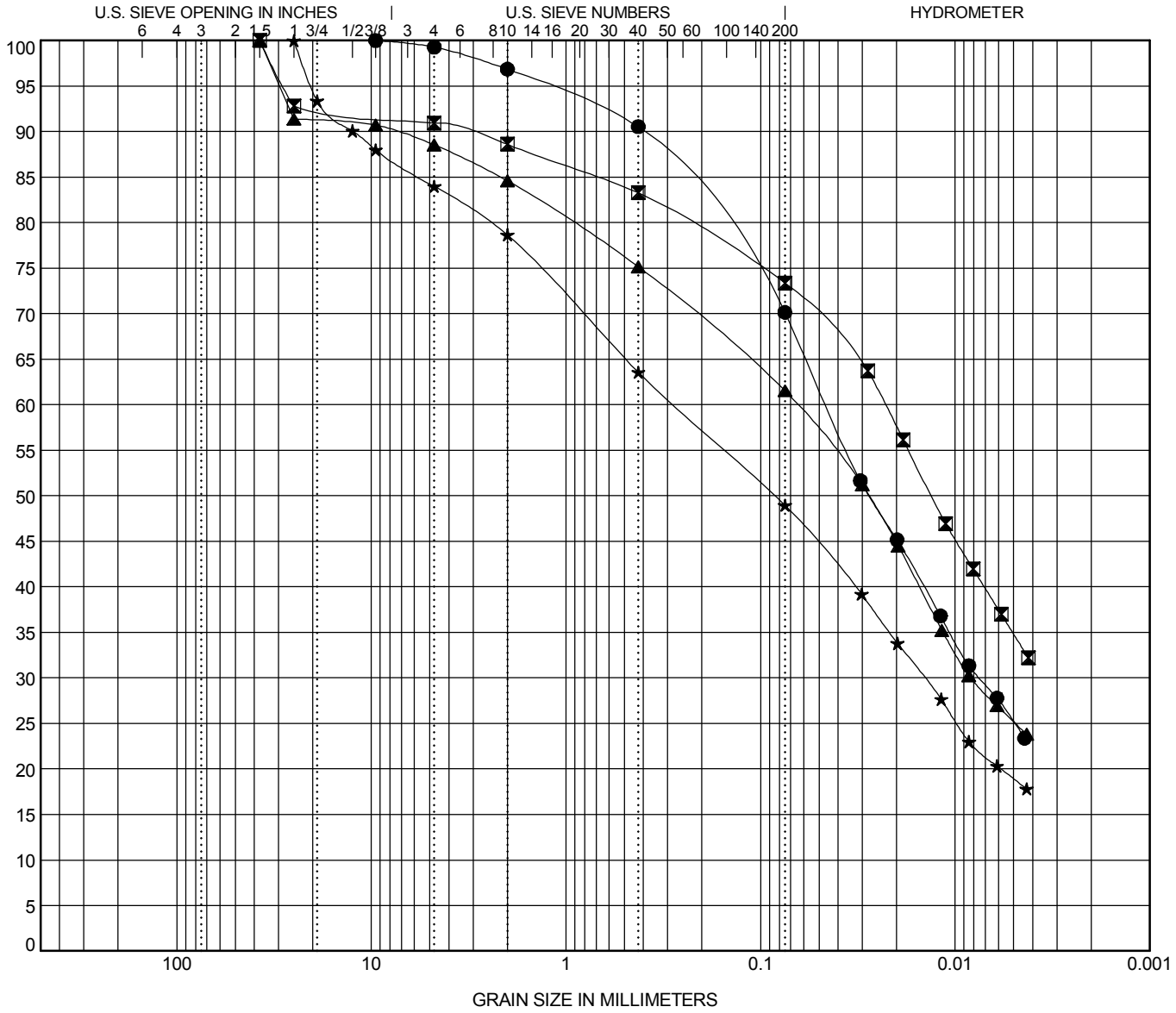
ABANDONMENT METHODS, MATERIALS, QUANTITIES: SHOVELED SOIL CUTTINGS

GRAIN SIZE DISTRIBUTION

OHIO DEPARTMENT OF TRANSPORTION
OFFICE OF GEOTECHNICAL ENGINEERING

PROJECT CLA-42-08.20 **PID** 102707

OGE NUMBER 0 **PROJECT TYPE**



COBBLES	GRAVEL	SAND		SILT	CLAY
		coarse	fine		

	Specimen Identification		ODOT (Modified AASHTO) ~ USCS Classification	LL	PL	PI
●	**HA-005-0-20**	**0.0**	**A-6b ~ LEAN CLAY with SAND(CL)**	**39**	**23**	**16**
⊠	**HA-005-0-20**	**0.5**	**A-7-6 ~ LEAN CLAY with SAND(CL)**	**48**	**21**	**27**
▲	**HA-005-0-20**	**1.0**	**A-6b ~ SANDY LEAN CLAY(CL)**	**37**	**19**	**18**
★	**HA-005-0-20**	**1.5**	**A-6a ~ CLAYEY SAND with GRAVEL(SC)**	**29**	**18**	**11**

	Specimen Identification		D90	D50	D30	D10	%G	%CS	%FS	%M	%C	Cc	Cu
●	**HA-005-0-20**	**0.0**	**0.406**	**0.027**	**0.007**		**4**	**6**	**20**	**45**	**25**		
⊠	**HA-005-0-20**	**0.5**	**3.34**	**0.013**			**12**	**5**	**10**	**38**	**35**		
▲	**HA-005-0-20**	**1.0**	**7.513**	**0.028**	**0.008**		**15**	**9**	**14**	**37**	**25**		
★	**HA-005-0-20**	**1.5**	**12.371**	**0.085**	**0.014**		**21**	**15**	**15**	**30**	**19**		

APPENDIX C

DEEP FOUNDATION ANALYSIS

DRIVEN ANALYSIS

REAR ABUTMENT

B-001-0-20

DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: C:\PROGRA~1\DRIVEN\CLA-42\REAR.DVN
Project Name: CLA-42-08.20 Project Date: 05/20/2021
Project Client: Fishbeck
Computed By: ZM
Project Manager: C. He

PILE INFORMATION

Pile Type: H Pile - HP10X42
Top of Pile: 0.00 ft
Perimeter Analysis: Box
Tip Analysis: Pile Area

ULTIMATE CONSIDERATIONS

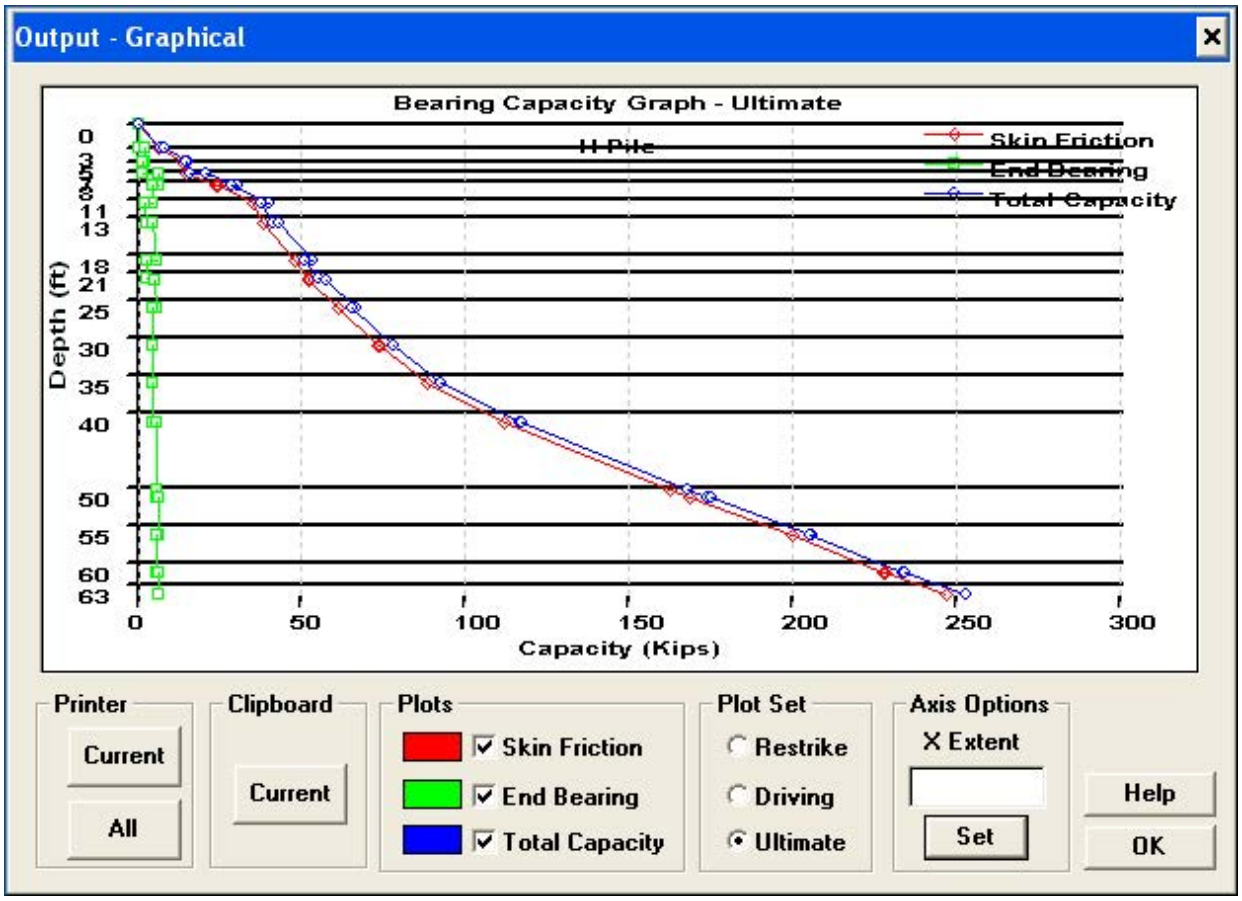
Water Table Depth At Time Of:	- Drilling:	6.24 ft
	- Driving/Restrike	5.24 ft
	- Ultimate:	5.24 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesive	3.24 ft	43.00%	115.00 pcf	600.00 psf	T-80 Same
2	Cohesive	2.00 ft	43.00%	122.00 pcf	2500.00 psf	T-80 Same
3	Cohesionless	1.50 ft	0.00%	125.00 pcf	32.0/32.0	Nordlund
4	Cohesive	1.50 ft	33.00%	122.00 pcf	8000.00 psf	T-80 Same
5	Cohesive	2.50 ft	33.00%	135.00 pcf	5850.00 psf	T-80 Same
6	Cohesionless	2.50 ft	0.00%	125.00 pcf	32.0/32.0	Nordlund
7	Cohesionless	5.00 ft	0.00%	130.00 pcf	35.0/35.0	Nordlund
8	Cohesionless	2.50 ft	0.00%	125.00 pcf	32.0/32.0	Nordlund
9	Cohesionless	3.80 ft	0.00%	130.00 pcf	34.0/34.0	Nordlund
10	Cohesionless	5.00 ft	17.00%	128.00 pcf	33.0/33.0	Nordlund
11	Cohesionless	5.00 ft	0.00%	128.00 pcf	33.0/33.0	Nordlund
12	Cohesive	5.20 ft	33.00%	135.00 pcf	5850.00 psf	T-80 Same
13	Cohesive	10.00 ft	33.00%	140.00 pcf	7100.00 psf	T-80 Same
14	Cohesive	5.00 ft	33.00%	140.00 pcf	8000.00 psf	T-80 Same
15	Cohesive	5.00 ft	33.00%	140.00 pcf	7100.00 psf	T-80 Same
16	Cohesive	3.00 ft	33.00%	140.00 pcf	8000.00 psf	T-80 Same

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.02 Kips	0.46 Kips	0.48 Kips
3.23 ft	6.20 Kips	0.46 Kips	6.66 Kips
3.25 ft	6.25 Kips	1.94 Kips	8.19 Kips
5.23 ft	13.49 Kips	1.94 Kips	15.42 Kips
5.25 ft	13.53 Kips	1.34 Kips	14.87 Kips
6.73 ft	14.64 Kips	1.54 Kips	16.18 Kips
6.75 ft	14.71 Kips	6.20 Kips	20.91 Kips
8.23 ft	23.99 Kips	6.20 Kips	30.19 Kips
8.25 ft	24.10 Kips	4.53 Kips	28.64 Kips
10.73 ft	35.48 Kips	4.53 Kips	40.02 Kips
10.75 ft	35.54 Kips	2.14 Kips	37.68 Kips
13.23 ft	38.50 Kips	2.48 Kips	40.98 Kips
13.25 ft	38.53 Kips	4.27 Kips	42.80 Kips
18.23 ft	47.74 Kips	5.51 Kips	53.25 Kips
18.25 ft	47.78 Kips	2.84 Kips	50.62 Kips
20.73 ft	52.12 Kips	2.84 Kips	54.96 Kips
20.75 ft	52.16 Kips	5.11 Kips	57.27 Kips
24.53 ft	60.92 Kips	5.84 Kips	66.76 Kips
24.55 ft	60.97 Kips	4.31 Kips	65.28 Kips
29.53 ft	73.45 Kips	4.31 Kips	77.76 Kips
29.55 ft	73.51 Kips	4.31 Kips	77.81 Kips
34.53 ft	87.98 Kips	4.31 Kips	92.29 Kips
34.55 ft	88.06 Kips	4.53 Kips	92.59 Kips
39.73 ft	111.83 Kips	4.53 Kips	116.36 Kips
39.75 ft	111.93 Kips	5.50 Kips	117.43 Kips
48.75 ft	162.37 Kips	5.50 Kips	167.87 Kips
49.73 ft	168.41 Kips	5.50 Kips	173.92 Kips
49.75 ft	168.54 Kips	6.20 Kips	174.74 Kips
54.73 ft	199.79 Kips	6.20 Kips	205.99 Kips
54.75 ft	199.91 Kips	5.50 Kips	205.41 Kips
59.73 ft	227.64 Kips	5.50 Kips	233.14 Kips
59.75 ft	227.76 Kips	6.20 Kips	233.96 Kips
62.73 ft	246.46 Kips	6.20 Kips	252.66 Kips



FORWARD ABUTMENT

B-004-0-20

DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: C:\PROGRA~1\DRIVEN\CLA-42\FORWARD.DVN
Project Name: CLA-42-08.20 Project Date: 05/20/2021
Project Client: Fishbeck
Computed By: ZM
Project Manager: C. He

PILE INFORMATION

Pile Type: H Pile - HP10X42
Top of Pile: 0.00 ft
Perimeter Analysis: Box
Tip Analysis: Pile Area

ULTIMATE CONSIDERATIONS

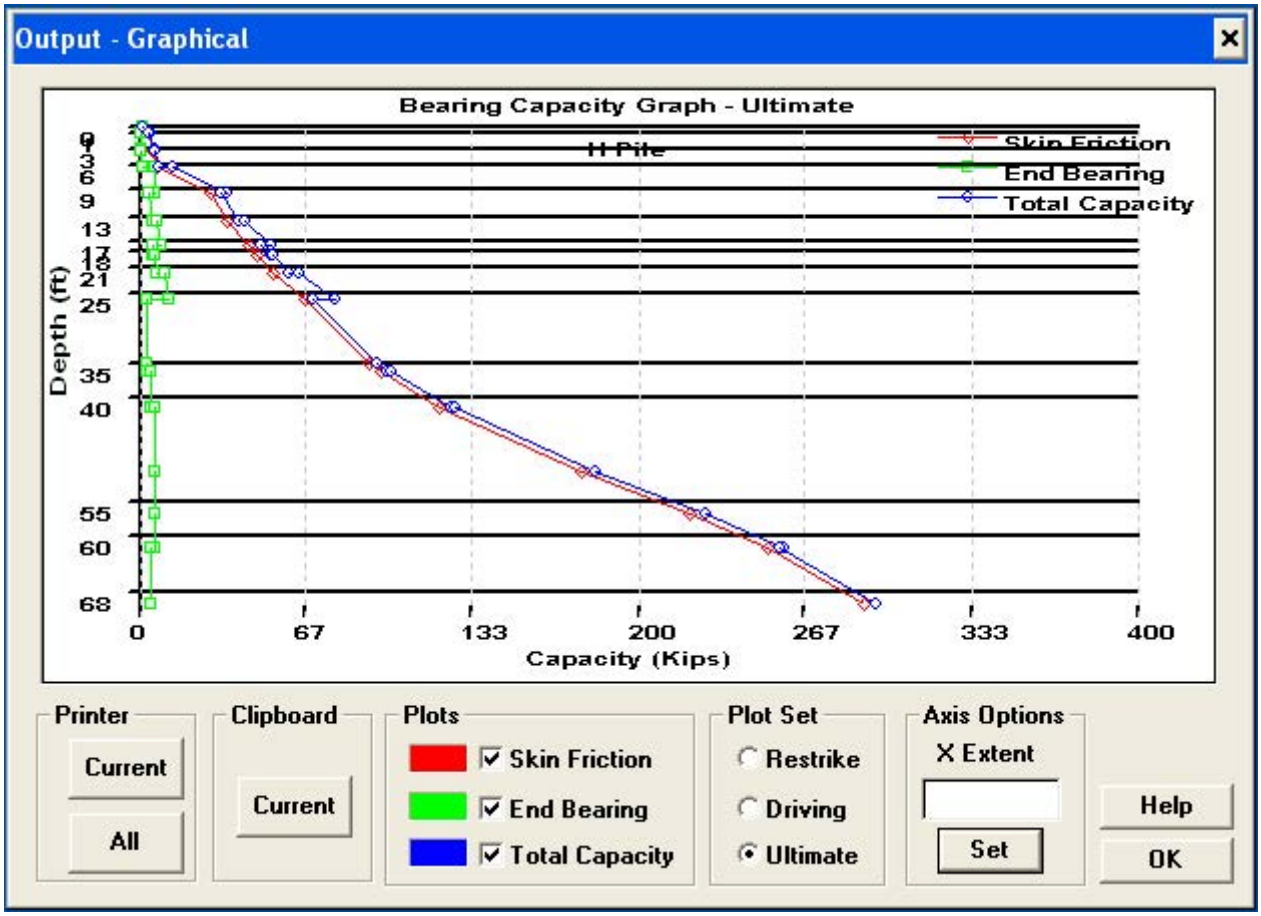
Water Table Depth At Time Of:	- Drilling:	6.40 ft
	- Driving/Restrike	7.80 ft
	- Ultimate:	7.80 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesive	0.90 ft	43.00%	118.00 pcf	1350.00 psf	T-80 Same
2	Cohesive	2.50 ft	33.00%	108.00 pcf	250.00 psf	T-80 Same
3	Cohesionless	2.50 ft	33.00%	125.00 pcf	29.0/29.0	Nordlund
4	Cohesive	3.50 ft	33.00%	122.00 pcf	8000.00 psf	T-80 Same
5	Cohesionless	4.00 ft	0.00%	132.00 pcf	35.0/35.0	Nordlund
6	Cohesionless	3.50 ft	0.00%	140.00 pcf	37.0/37.0	Nordlund
7	Cohesionless	1.50 ft	0.00%	128.00 pcf	34.0/34.0	Nordlund
8	Cohesionless	2.50 ft	0.00%	132.00 pcf	35.0/35.0	Nordlund
9	Cohesionless	3.80 ft	0.00%	140.00 pcf	37.0/37.0	Nordlund
10	Cohesive	10.20 ft	33.00%	125.00 pcf	3500.00 psf	T-80 Same
11	Cohesive	5.00 ft	33.00%	135.00 pcf	6000.00 psf	T-80 Same
12	Cohesive	15.00 ft	33.00%	140.00 pcf	8000.00 psf	T-80 Same
13	Cohesive	5.00 ft	33.00%	140.00 pcf	8000.00 psf	T-80 Same
14	Cohesive	8.00 ft	33.00%	135.00 pcf	6150.00 psf	T-80 Same

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.04 Kips	1.05 Kips	1.08 Kips
0.89 ft	3.42 Kips	1.05 Kips	4.47 Kips
0.91 ft	3.47 Kips	0.19 Kips	3.66 Kips
3.39 ft	5.48 Kips	0.19 Kips	5.67 Kips
3.41 ft	5.49 Kips	0.48 Kips	5.97 Kips
5.89 ft	6.66 Kips	0.87 Kips	7.53 Kips
5.91 ft	6.73 Kips	6.20 Kips	12.93 Kips
9.39 ft	28.57 Kips	6.20 Kips	34.77 Kips
9.41 ft	28.64 Kips	3.81 Kips	32.45 Kips
13.39 ft	35.15 Kips	4.85 Kips	40.00 Kips
13.41 ft	35.19 Kips	7.20 Kips	42.39 Kips
16.89 ft	43.87 Kips	8.70 Kips	52.57 Kips
16.91 ft	43.92 Kips	4.97 Kips	48.89 Kips
18.39 ft	47.07 Kips	5.25 Kips	52.32 Kips
18.41 ft	47.11 Kips	6.22 Kips	53.33 Kips
20.89 ft	53.26 Kips	6.84 Kips	60.10 Kips
20.91 ft	53.32 Kips	10.22 Kips	63.54 Kips
24.69 ft	66.41 Kips	11.85 Kips	78.26 Kips
24.71 ft	66.48 Kips	2.71 Kips	69.19 Kips
33.71 ft	92.24 Kips	2.71 Kips	94.96 Kips
34.89 ft	96.41 Kips	2.71 Kips	99.12 Kips
34.91 ft	96.50 Kips	4.65 Kips	101.15 Kips
39.89 ft	119.93 Kips	4.65 Kips	124.58 Kips
39.91 ft	120.04 Kips	6.20 Kips	126.24 Kips
48.91 ft	176.87 Kips	6.20 Kips	183.07 Kips
54.89 ft	220.36 Kips	6.20 Kips	226.56 Kips
54.91 ft	220.50 Kips	6.20 Kips	226.70 Kips
59.89 ft	251.75 Kips	6.20 Kips	257.95 Kips
59.91 ft	251.86 Kips	4.77 Kips	256.63 Kips
67.89 ft	290.36 Kips	4.77 Kips	295.12 Kips



APPENDIX D

SEISMIC PARAMETERS

Hazards by Location

Search Information

Coordinates: 39.838879, -83.596645

Elevation: 1127 ft

Timestamp: 2021-05-22T03:36:02.778Z

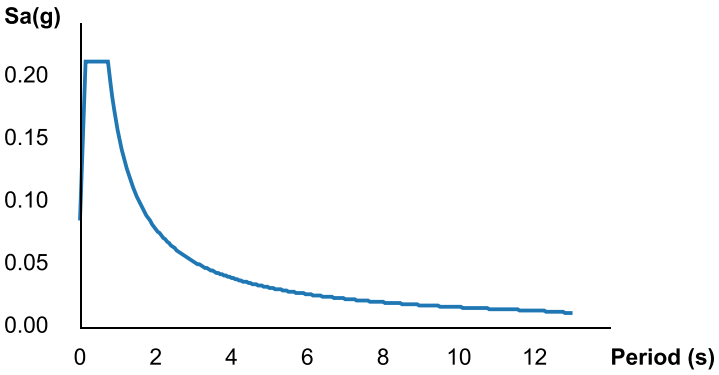
Hazard Type: Seismic

Reference Document: ASCE7-16

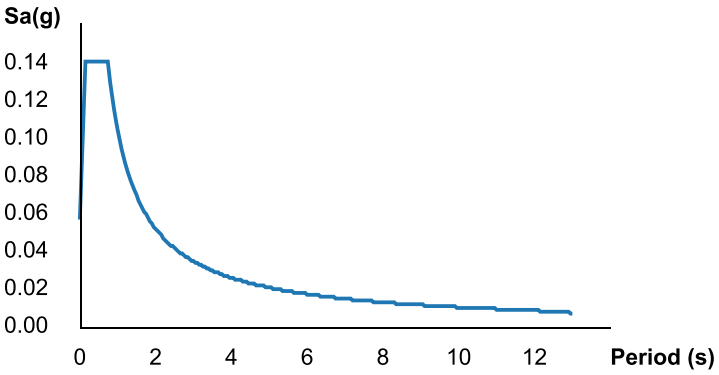
Risk Category: II

Site Class: D-default

MCER Horizontal Response Spectrum



Design Horizontal Response Spectrum



Basic Parameters

Name	Value	Description
S_S	0.132	MCE_R ground motion (period=0.2s)
S_1	0.065	MCE_R ground motion (period=1.0s)
S_{MS}	0.212	Site-modified spectral acceleration value
S_{M1}	0.156	Site-modified spectral acceleration value
S_{DS}	0.141	Numeric seismic design value at 0.2s SA
S_{D1}	0.104	Numeric seismic design value at 1.0s SA

Additional Information

Name	Value	Description
SDC	B	Seismic design category
F_a	1.6	Site amplification factor at 0.2s
F_v	2.4	Site amplification factor at 1.0s
CR_S	0.936	Coefficient of risk (0.2s)

CR_1	0.9	Coefficient of risk (1.0s)
PGA	0.068	MCE_G peak ground acceleration
F_{PGA}	1.6	Site amplification factor at PGA
PGA_M	0.109	Site modified peak ground acceleration
T_L	12	Long-period transition period (s)
SsRT	0.132	Probabilistic risk-targeted ground motion (0.2s)
SsUH	0.142	Factored uniform-hazard spectral acceleration (2% probability of exceedance in 50 years)
SsD	1.5	Factored deterministic acceleration value (0.2s)
S1RT	0.065	Probabilistic risk-targeted ground motion (1.0s)
S1UH	0.072	Factored uniform-hazard spectral acceleration (2% probability of exceedance in 50 years)
S1D	0.6	Factored deterministic acceleration value (1.0s)
PGAd	0.5	Factored deterministic acceleration value (PGA)

The results indicated here DO NOT reflect any state or local amendments to the values or any delineation lines made during the building code adoption process. Users should confirm any output obtained from this tool with the local Authority Having Jurisdiction before proceeding with design.

Disclaimer

Hazard loads are provided by the U.S. Geological Survey Seismic Design Web Services.

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