FINAL REPORT
STRUCTURE FOUNDATION EXPLORATION
RETAINING WALL AJ
CUY-90-16.28 (CCG3A)
CUYAHOGA COUNTY, OHIO
PID#: 82382

Prepared For:

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NEAS PROJECT 21-0011

May 15, 2024

National Engineering & Architectural Services Inc.

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1. INTRODUCTION

1.1. General

National Engineering & Architectural Services, Inc. (NEAS) presents our Structure Foundation Exploration Report for the proposed Retaining Wall AJ (RW-AJ) structure as part of the proposed Ohio Department of Transportation (ODOT) project CCG3A (CUY-90-16.28, PID 82380) in the City of Cleveland, Cuyahoga County, Ohio. The overall project objective is to reconstruct and improve the IR-77/IR-90 interchange, IR-90 and associated surface streets within the project limits. The referenced retaining wall is proposed along the south side of Ramp IJ3 located south of IR-90. As a part of the interchange improvement project, it is our understanding that ODOT is planning to construct Ramp IJ3 to realign access to IR-77 from East 14th Street (St). In order to allow for the construction of the proposed Ramp IJ3, RW-AJ is planned to provide the necessary grade separation between Ramp IJ3 and the IR-77 northbound (NB) exit ramp to East 14th St. This report presents a summary of the encountered surficial and subsurface conditions and our recommendations for retaining wall 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* (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. DBA National Engineering & Architectural Services, Inc.'s (formerly Barr & Prevost) proposal to Michael Baker International (Baker) dated June 11, 2014, subsequent Modification 7 (MOD 7) proposal to Baker dated October 12, 2020. The exploration was also conducted in general accordance with the provisions of the July 2014 (ODOT, 2014) and January 2021 (ODOT, 2021) revisions of ODOT's *Specifications for Geotechnical Explorations* (SGE).

The scope of work performed by NEAS as part of the CCG3A project included: 1) a review of published geotechnical information; 2) performing 182 total test soil borings (2 utilized within this report as a part of the indicated structure foundation exploration); 3) performing 30 total cone penetration test (CPT) soundings; 4) laboratory testing of soil samples in accordance with the SGE; 5) performing geotechnical engineering analysis to assess foundation design and construction considerations; and 6) development of this summary report.

1.2. Proposed Construction

The proposed construction of Ramp IJ3 as part of the overall CCG3A project (CUY-90-16.28, PID 82380) will require the construction of RW-AJ to provide grade separation between the referenced ramp and the existing IR-77 NB exit ramp to East 14th St. The existing topography at the wall location consists of embankment slopes for both the existing IR-77 NB exit ramp to East 14th St as well as another existing ramp that is to be removed as part of CCG3A. The existing embankment slopes at grades of about 2 Horizontal to 1 Vertical (2H:1V). RW-AJ is proposed along the south side of Ramp AJ from approximate STA 108+05 to approximate STA 105+30.

Based on design information provided within the Retaining Wall AJ design files developed by Michael Baker International (MB) and accessed on September 15, 2021, the proposed RW-AJ will be a solider pile lagging (SPL) wall. It is our understanding that the wall will be approximately 270 ft in length and will have a maximum total height of approximately 16 ft at about RW-AJ Station 200+75 and a maximum total exposed wall height of approximately 14.75 ft.

2. GEOLOGY AND OBSERVATIONS OF THE PROJECT

2.1. Geology and Physiography

The retaining wall site is located within the Erie Lake Plain, part of the Huron-Erie Lake Plains. This area is characterized as the edge of the very low-relief (10 ft), Ice-Age lake basin separated from the modern Lake Erie by shoreline cliffs with major streams in deep gorges being characteristic. The geology in this region is described as Pleistocene-age lacustrine sand, silt, clay and wave-planed glacial till over Devonian- and Mississippi-age shales and sandstones (ODGS, 1998).

The geology at the proposed retaining wall site is mapped as an average of 10 ft of Wisconsinan-age sand atop an average of 90 ft of Wisconsinan-age lacustrine silt and clay followed by an average of 80 ft of Wisconsinan-age till underlain by Wisconsinan-age sand all over Devonian-age Ohio Shale (ODGS, 2002). The Wisconsinan-age sand mapped at the site is characterized as well to moderately sorted, moderately to well rounded, finely stratified to massive and contains minor amounts of disseminated gravel or thin lenses of silt or clay. The lacustrine soils at the site is described as laminated silts and clays that may contain fine sand or gravel layers. The till is described as an unsorted mix of clay, silt, sand, gravel and boulders which may contain silt, sand and gravel lenses. Till in buried valleys and thicker areas are noted as potentially being older than Wisconsinan.

Bedrock beneath the proposed retaining wall has been mapped as sedimentary Devonian-age Ohio shale with carbonate and/or siderite concretions in the lowermost 50 ft. This brownish black to greenish gray shale is carbonaceous to clayey, laminated to thin bedded, and can have a petroliferous odor (USGS & ODGS, 2006). Based on the ODNR bedrock topography map of Ohio, bedrock elevations near the proposed retaining wall can be expected to be between elevations of 450 and 400 ft above mean sea level (amsl), putting bedrock at a depth ranging from about 240 to 300 ft below ground surface (bgs).

The soils at the retaining wall site have been mapped (Web Soil Survey) by the Natural Resources Conservation Service as Udorthents, loamy (Ua) and Urban Land (Ub). These are soils that have been disturbed by cutting or filling and are not rated for local roads (USDA, 2019).

2.2. Hydrology/Hydrogeology

The local hydro-geologic system is dominated by the valley of the Cuyahoga River, located approximately a quarter to a half mile to the southwest and flows northwest discharging into Lake Erie. The elevation of the Cuyahoga River and Lake Erie is about 570 to 575 ft amsl and is likely to be representative of the regional groundwater table. As mentioned previously, the surficial geology consists of primarily granular soils underlain by a relatively impermeable lacustrine or glacial silt and clay layer. It is possible for groundwater to become trapped in granular soils above the regional groundwater level by an underlying impermeable layer forming a perched water table. The project site follows a similar geological model and therefore, could result in a groundwater elevation within the project limits that is likely above the regional groundwater table elevation.

The proposed RW-AJ site is not located within a special flood hazard area based on available mapping by the Federal Emergency Management Agency's (FEMA) National Flood Hazard mapping program (FEMA, 2019).

2.3. Mining and Oil/Gas Production

No abandoned mines are noted on ODNR's Abandoned Underground Mine Locator within the immediate vicinity of the proposed RW-AJ location (ODNR [1], 2016).

No oil or gas wells are noted on ODNR's Ohio Oil & Gas Locator within the immediate vicinity of the proposed RW-AJ location (ODNR [2], 2016).

2.4. Historical Records and Previous Phases of Project Exploration

A historic record search was performed through ODOT's Transportation Information Mapping System (TIMS). However, no geotechnical data or information was available for review within the immediate vicinity of the proposed retaining wall site. Therefore, historic borings are not referenced within this report nor pictured within the associated developed Structure Foundation Exploration Sheets.

2.5. Site Reconnaissance

A field reconnaissance visit for the proposed RW-AJ site was conducted. During the site visit, site conditions were noted along proposed Ramp IJ3 and existing IR-77 NB exit ramp within the limits of the referenced wall site. No geohazards were observed within the immediate vicinity of the referenced wall site.

The existing topography at the wall location consists of embankment slopes for both the existing IR-77 NB exit ramp to East 14th St as well as another existing ramp that is to be removed as part of CCG3A. At beginning portions of the proposed wall, slopes appeared to have an estimated average slope of about 2 Horizontal to 1 Vertical (2H:1V) with grades ranging from 2H:1V to 3H:1V. The existing slope grades transition to being flatter at the middle portions of the proposed wall. The proposed wall will end on the embankment slopes of the existing IR-77 NB exit ramp to East 14th St, which appeared to have an estimated average slope of about 3H:1V. The embankment slopes at the site are grassy with some vegetation. No erosion or poor drainage was observed along the slope.

The pavement condition at the existing IR-77 NB exit ramp near the wall site appeared to be in fair condition with minor signs of distress. The roadways appeared to be well drained with no observable signs of standing water. Nearby signs, light poles and existing bridges appeared to be in fair to good condition without apparent signs of distress related to the underlying soil conditions.

3. GEOTECHNICAL EXPLORATION

3.1. Field Exploration Program

The exploration for this retaining wall was conducted by NEAS between May 19, 2021 and July 2, 2021 and included 2 borings drilled to depths between of 25.0 ft and 66.5 ft bgs. The boring locations were selected by NEAS in general accordance with the guidelines contained in the SGE at the time of the exploration with the intent to evaluate subsurface soil and groundwater conditions. Borings were typically located at/near proposed wall location that were not restricted by maintenance of traffic, underground utilities or dictated by terrain (i.e. steep embankment slopes). Project boring locations were located and surveyed in the field by NEAS after the completion of drilling. 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. A summary of the borings including stationing, offsets, location information and elevations of the RW-AJ structure borings are shown in Table 1 below, while the boring locations are depicted on the Soil Profile Sheets provided within Appendix A

Table 1: Project Boring Summary

Boring Number	Latitude	Longitude	Elevation (NAVD 88) (ft)	Depth (ft)	Structure
B-129-1-20	41.495084	-81.677667	676.2	25.0	RW-AJ
B-151-1-20	41.494812	-81.678570	686.6	66.5	RW-AJ

Notes:
1. As-drilled boring location and corresponding ground surface elevation was surveyed in the field by NEAS Inc.

The boring was drilled using a either a CME 55T or CME 75T truck mounted drilling rig utilizing 3.25-inch diameter hollow stem augers. Soil samples were generally recovered at 2.5-ft intervals 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"). 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 CME auto hammers that had been calibrated to be between 68.4% and 89% efficient as indicated on the boring log. 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 log. 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. The individual laboratory data sheets and results are included in Appendix B. Additionally, data from the laboratory testing program was incorporated onto the final borings logs. Soil samples are retained at the laboratory for 60 days following report submittal, 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 33% 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 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 and 5.0-ft) 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.

4. GEOTECHNICAL 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, results of historical explorations, and consideration of the geological history of the site.

4.1. Subsurface Conditions

The general subsurface profile is relatively uniform and consistent with the geological model for the project. The subsurface profile at the RW-AJ site generally consists of surficial materials (i.e., pavement section) underlain by existing embankment fill soils followed by natural sands and gravels. The embankment fills at the site can generally be described as medium dense to dense non-cohesive, granular soils while the natural sands and gravels encountered at the site were comprised of loose to dense, granular material. Bedrock was not encountered within the depths of the explorations performed.

4.1.1. Overburden Soil

At the site of proposed RW-AJ, two different materials were encountered below the surficial material. In general, the two different overburden materials consisted of embankment "man-made" fill soils and natural sands and gravels. These materials and the general profile underlying the site is further described below.

Fill soils were encountered in one boring B-151-1-20 performed for the proposed retaining wall. These fill soils were encountered immediately below the pavement section and extended to depth of 12.0 ft bgs (approximate elevation 674.6 ft amsl). Based on laboratory testing results and a visual review of the soil samples obtained in the referenced boring, the fills at the RW-AJ site consisted of predominantly non-cohesive, granular material which was comprised of Coarse and Fine Sand (A-3a) and Sandy Silt (A-4a). With respect to the soil strength, the granular fill soils can be described having a relative compactness of medium dense to dense correlating to converted SPT N values (N_{60}) between 25 and 44 blows per foot (bpf).

The stratum encountered immediately beneath the fills consisted of a natural gravel and sand layer extending to end of boring. The soils in this stratum are generally classified on the boring logs as Gravel with Sand (A-1-b) and Coarse and Fine Sand (A-3a). With respect to the relative compactness of the natural sand, the descriptions varied from loose to dense, correlating to N_{60} values between 10 and 33 bpf. Natural moisture contents of the granular material ranged from 4 to 25 percent.

4.1.2. Groundwater

Groundwater measurements were taken during the boring drilling procedures and immediately following the completion of the borings performed. Groundwater was observed during drilling in both of the borings performed at the retaining wall site at depths ranging from 23.5 to 33.0 ft bgs (elevations 652.7 to 653.6 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. The specific groundwater and pore pressure readings are included on the logs located within Appendix B.

5. ANALYSES AND RECOMMENDATIONS

A foundation review was completed for the foundations of the proposed SPL retaining wall based on: 1) information gathered during the subsurface exploration (i.e., SPT results, laboratory test results, etc.); 2) the soil profile, estimated engineering properties and other design assumptions presented in previous sections of this report; and, 3) Stage 1 Plan sheets of the proposed retaining wall provided by MBI and accessed on ProjectWise on September 15, 2021. Geotechnical analyses consisting of the development of soil parameters and global stability was performed. The geotechnical engineering analyses were performed in accordance with ODOT's BDM (ODOT, 2021) and AASHTO's LRFD BDS 9th Edition (AASHTO, 2020).

5.1.1. Soil Profile for Analysis

For analysis purposes, each boring log was reviewed and a generalized material profile was developed. Utilizing the generalized soil profile, engineering properties for each soil stratum were estimated based on their field (i.e., SPT N_{60} Values, hand penetrometer values, etc.) and laboratory test (i.e., Atterberg Limits, grain size, etc.) results using correlations provided in published engineering manuals, research reports and guidance documents. Engineering soil properties were estimated for each individual classified layer per boring location. The developed soil profiles and estimated engineering soil properties for use in analysis of RW-AJ (with cited correlation/reference material) are summarized within Tables 2 and 3 below.

Table 2: Soil Profile and Estimated Engineering Properties - At Boring B-129-1-20

Wall AJ: Stability Analysis, B-129-1-20					
Soil Description	Moist Unit Weight(1) (pcf)	Total Cohesion(2) (psf)	Total Friction Angle (degrees)	Effective Cohesion(3) (psf)	Effective Friction Angle(3) (degrees)
Gravel with Sand Depth (672.6 ft - 653.7 ft)	115	-	36	-	36
Coarse and Fine Sand Depth (653.7 ft - 651.2 ft)	128	-	35	-	35

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 for cohesive soils and Kulhawy & Mayne (1990) for granular soils.*

Table 3: Soil Profile and Estimated Engineering Properties - At Boring B-151-1-20

Wall AJ: Stability Analysis, B-151-1-20					
Soil Description	Moist Unit Weight[(1)] (pcf)	Total Cohesion[(2)] (psf)	Total Friction Angle (degrees)	Effective Cohesion[(3)] (psf)	Effective Friction Angle[(3)] (degrees)
Coarse and Fine Sand Depth (686.6 ft - 677.1 ft)	118	-	36	-	36
Sandy Silt Depth (677.1 ft - 674.6 ft)	120	-	36	-	36
Gravel with Sand Depth (674.6 ft - 659.6 ft)	112	-	32	-	32
Coarse and Fine Sand Depth (659.6 ft - 620.1 ft)	125	-	31	-	31

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 for cohesive soils and Kulhawy & Mayne (1990) for granular soils.*

5.1.2. Parameters for Lateral Load Analysis

Deep foundation elements subjected to horizontal loads and/or moments should be analyzed for maximum bending moments and lateral deflections. The required lateral load capacity can be obtained by increasing the diameter or the embedment depth of the foundation element. The generalized soil and rock parameters, including recommended lateral soil/rock modulus, and soil/rock strain to be used to analyze the laterally loaded shaft by the p-y curve method are presented in Table 4 below. Furthermore, a resistance factor of 1.0 should be used when estimating the lateral geotechnical resistance of a single shaft/pile or shaft/pile group in accordance with LRFD BDS Tables 10.5.5.2.3-1 and 10.5.5.2.4-1.

Table 4: Generalized Soil Parameters for Lateral Load Analysis

p-y Curve Model	Elevation (ft)	Undrained Shear Strength, S_u (psf)	Soil Modulus Parameter, k (lb/in^3)	Soil Strain Parameter, E_{50}
B-129-1-20				
Sand (Reese)	672.6 - 653.7	-	353	-
Sand (Reese)	653.7 - 651.2	-	125	-
B-151-1-20				
Sand (Reese)	686.6 - 677.1	-	437	-
Sand (Reese)	677.1 - 674.6	-	284	-
Sand (Reese)	674.6 - 659.6	-	140	-
Sand (Reese)	659.6 - 620.1	-	56	-

5.1.3. Drilled Shaft Lateral Load Analysis

The lateral load analysis of the project drilled shafts has been performed by MBI. These calculations will be provided to ODOT as part of a separate submission.

5.1.4. Global Stability

For purposes of evaluating the stability of the proposed RW-AJ site, NEAS reviewed one cross-section within the project limits that was interpreted to represent conditions that posed the greatest potential for slope instability. In general, cross-sections along the proposed wall alignment were reviewed to determine if the section would represent a combination of existing subsurface conditions and planned site grading that would be most critical to slope stability (i.e., maximum total wall height, maximum embankment height measured from toe of slope to top of wall coping, proposed cut into existing embankment slopes, weak or thick soil layer, etc.). Based on our review of the available information at the referenced locations and the associated soil properties, one (1) cross-section was estimated to be most "critical" and was analyzed for global stability. The one cross-section analyzed for global stability include STA 200+75 in reference to the RW-AJ alignment.

For the cross-section, NEAS developed a representative cross-sectional model to use as the basis for global stability analyses. The model was developed from NEAS's interpretation of the available information which included: 1) The proposed RW-AJ site plan developed by MBI on September 15, 2021; 2) a live load surcharge of 250 pounds per square foot (psf), accounting for traffic induced loads; and, 3) test borings and laboratory data developed as part of this report; 4) the steel reinforcing beam W21x166 has 50 ksi (ASTM grade 50) yield strength. With respect to the soil's engineering properties, the provided Soil Profile and Estimated Engineering Properties presented in Section 5.1.1. of this report were used in our analyses.

The above referenced slope stability model was analyzed for long-term (Effective Stress) and short-term (Total Stress) slope stability utilizing the software entitled *Slide 7.0* by Rocscience, Inc. Specifically, the Modified Bishop, Corrected Janbu, Spencer and GLE analysis methods were used to calculate a factor of safety (FOS) for circular and block type slope failures, respectively. The FOS is the ratio of the resisting forces and the driving forces, with the desired safety factor being more than about 1.33 which equates to an AASHTO resistance factor less than 0.75 (per AASHTO's LRFD BDS the specified resistance factors are essentially the inverse of the FOS that should be targeted in slope stability programs). For this analysis, a resistance factor of 0.75 or lower is targeted as the slope does not contain or support a structural element.

Based on our slope stability analyses for the referenced retaining wall section, the minimum slope stability safety factor is about 2.918 (0.34 resistance factor). The graphical output of the slope stability program (cross-sectional model, calculated safety factor, and critical failure plane) is presented in Appendix C.

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 Retaining Wall AJ for the CCG3A project (CUY-90-16.28, PID 82380). This report has been prepared for MBI, ODOT and their design consultants to be used solely in evaluating the soils underlying the retaining wall 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 results 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 retaining wall (RW-AJ) 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 Michael Baker International in performing this geotechnical exploration for the CCG3A project (CUY-90-16.28, PID 82380). Please call if there are any questions, or if we can be of further service.

Respectfully Submitted,

Zhao Mankoci, Ph.D., P.E.
Geotechnical Engineer

Brendan P. Andrews, P.E.
Geotechnical Engineer

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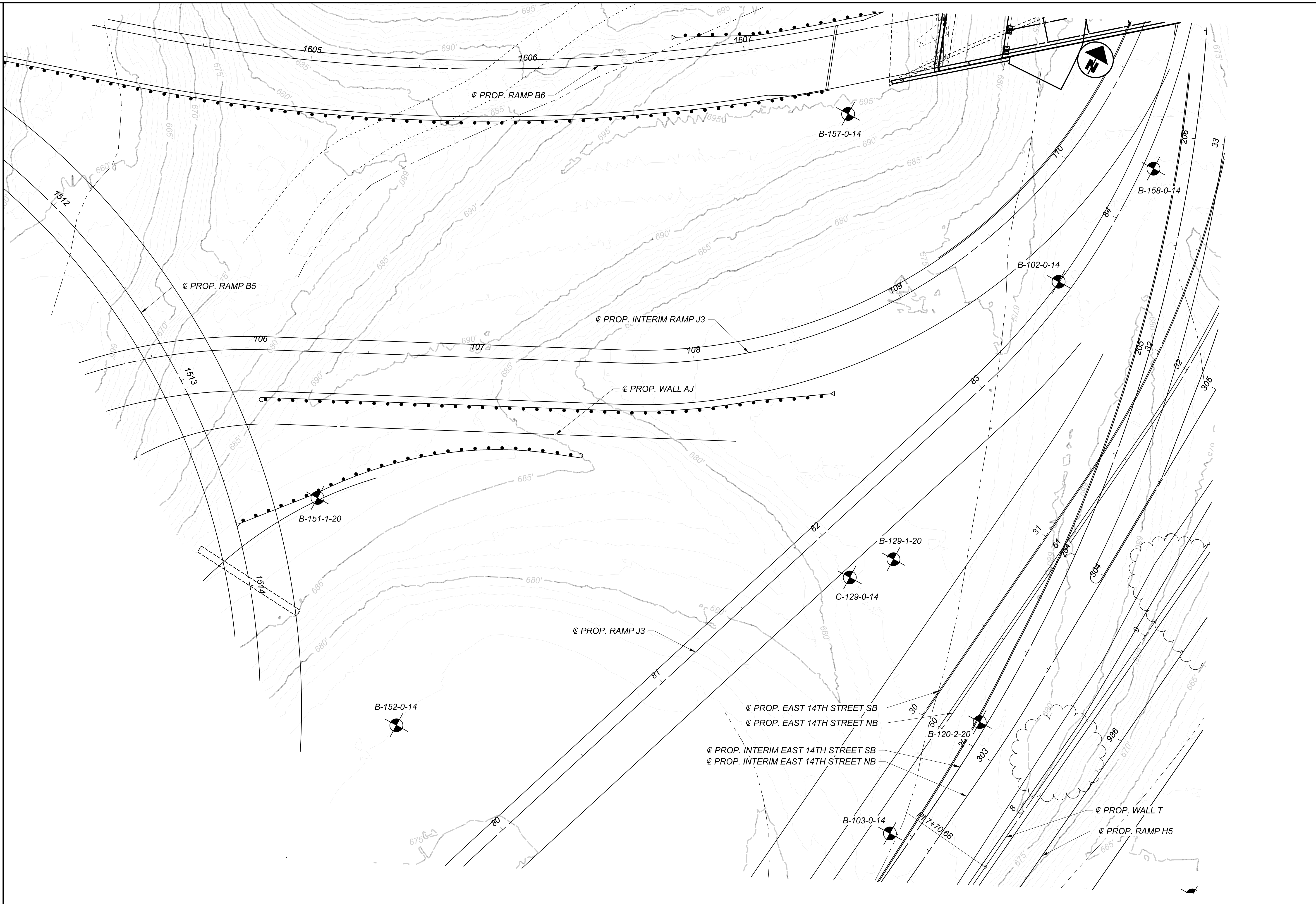
APPENDIX A

SOIL PROFILE SHEETS



HORIZONTAL SCALE IN FEET

0 10 20 40

SOIL PROFILE - ROADWAY
BEGIN TO END RETAINING WALL AJ

DESIGN AGENCY

NEAS

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DESIGNER: MWJ

REVIEWER: BPA 06/23/22

PROJECT ID: 82382

SUBSET 94 | TOTAL 302

SHEET P.0 | TOTAL 0

CUY-90-16.28 (CCG3A)

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APPENDIX B

SOIL BORING LOGS AND LABORATORY TESTING RESULTS

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 6/22/22 13:25 - X:\ACTIVE PROJECTS\ACTIVE SOIL PROJECTS\CUY-90-16.28 (CCG3A - MOD#7)\GINT FILES\CUY-90-16.28 (CCG3A

PROJECT: CUY-90-16.28 (CCG3A) TYPE: RETAINING WALL PID: 82382 SFN: START: 5/19/21 END: 5/19/21	DRILLING FIRM / OPERATOR: NEAS / J. HODGES SAMPLING FIRM / LOGGER: NEAS / J. HODGES DRILLING METHOD: 3.25" HSA SAMPLING METHOD: SPT	DRILL RIG: CME 75T HAMMER: CME AUTOMATIC CALIBRATION DATE: 5/1/19 ENERGY RATIO (%): 89	STATION / OFFSET: 30+52, 52' LT. ALIGNMENT: SB E 14TH ST ELEVATION: 676.2 (MSL) EOB: 25.0 ft. LAT / LONG: 41.495084, -81.677667

EXPLORATION ID B-129-1-20

MATERIAL DESCRIPTION AND NOTES	ELEV. 676.2	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
MEDIUM DENSE TO DENSE, BROWN, **GRAVEL WITH SAND**, TRACE TO LITTLE SILT, TRACE CLAY, DAMP TO MOIST		3 - 4	5 6 6	18	100	SS-1	-	5	47	27	14	7	NP	NP	NP	8	A-1-b (0)	
		5 - 6	5 7 8	22	39	SS-2	-	-	-	-	-	-	-	-	-	7	A-1-b (V)	
		7.5 - 9	7 9 13	33	44	SS-3	-	-	-	-	-	-	-	-	-	8	A-1-b (V)	
		10 - 11.5	8 10 11	31	28	SS-4	-	-	-	-	-	-	-	-	-	8	A-1-b (V)	
		12.5 - 14	7 6 7	19	78	SS-5	-	-	-	-	-	-	-	-	-	8	A-1-b (V)	
		15 - 16.5	6 3 5	12	56	SS-6	-	-	-	-	-	-	-	-	-	12	A-1-b (V)	
		17.5 - 19	5 6 8	21	89	SS-7	-	24	56	13	6	1	NP	NP	NP	5	A-1-b (0)	
		20 - 21.5	6 7 9	24	33	SS-8	-	-	-	-	-	-	-	-	-	4	A-1-b (V)	
	653.7	22.5																
MEDIUM DENSE, BROWNISH GRAY, **COARSE AND FINE SAND**, TRACE SILT, TRACE CLAY, TRACE GRAVEL, WET		W 652.7																
		23.5 - 25	8 9 10	28	100	SS-9	-	2	11	75	8	4	NP	NP	NP	22	A-3a (0)	
	651.2	EOB 25																

NOTES: GROUNDWATER ENCOUNTERED AT 23.5' DURING DRILLING. HOLE DID NOT CAVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: SHOVELED SOIL CUTTINGS

PROJECT: CUY-90-16.28 (CCG3A)	DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH	DRILL RIG: CME 55T	STATION / OFFSET: 1605+19, 200' RT.	EXPLORATION ID B-151-1-20
TYPE: RETAINING WALL	SAMPLING FIRM / LOGGER: NEAS / ASHBAUGH	HAMMER: CME AUTOMATIC	ALIGNMENT: RAMP B6	
PID: 82382 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 12/5/19	ELEVATION: 686.6 (MSL) EOB: 66.5 ft.	PAGE 1 OF 3
START: 7/2/21 END: 7/2/21	SAMPLING METHOD: SPT	ENERGY RATIO (%): 68.4	LAT / LONG: 41.494812, -81.678570	

MATERIAL DESCRIPTION AND NOTES	ELEV. 686.6	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
5.0" TOPSOIL (DRILLERS DESCRIPTION)	686.2																
MEDIUM DENSE TO DENSE, BROWN, **COARSE AND FINE SAND**, LITTLE SILT, TRACE TO LITTLE GRAVEL, TRACE CLAY, CONTAINS TRACE IRON STAINING, DAMP **(FILL)**		8-18-21	44	67	SS-1	-	-	-	-	-	-	-	-	-	9	A-3a (V)	
		7-10-12	25	56	SS-2	-	-	-	-	-	-	-	-	-	11	A-3a (V)	
	677.1	7-15-16	35	61	SS-3	-	-	-	-	-	-	-	-	-	11	A-3a (V)	
DENSE, BROWN, **SANDY SILT**, SOME GRAVEL, TRACE CLAY, CONTAINS CONCRETE AND BRICK FRAGMENTS, DAMP **(FILL)**	674.6	10-21-18	44	33	SS-4	-	25	11	27	27	10	NP	NP	NP	12	A-4a (0)	
MEDIUM DENSE, BROWN, **GRAVEL WITH SAND**, TRACE TO LITTLE SILT, TRACE CLAY, DAMP TO MOIST		11-8-4	14	56	SS-5	-	-	-	-	-	-	-	-	-	12	A-1-b (V)	
		7-6-4	11	78	SS-6	-	-	-	-	-	-	-	-	-	13	A-1-b (V)	
		4-5-5	11	56	SS-7	-	11	46	33	7	3	NP	NP	NP	7	A-1-b (0)	
		6-6-7	15	83	SS-8	-	-	-	-	-	-	-	-	-	10	A-1-b (V)	
		7-6-7	15	56	SS-9	-	-	-	-	-	-	-	-	-	7	A-1-b (V)	
	659.6	7-7-8	17	56	SS-10	-	22	34	26	13	5	NP	NP	NP	6	A-1-b (0)	
LOOSE TO MEDIUM DENSE, BROWN BECOMING GRAYISH BROWN, **COARSE AND FINE SAND**, TRACE TO LITTLE SILT, TRACE GRAVEL, TRACE CLAY, DAMP		6-8-12	23	56	SS-11	-	-	-	-	-	-	-	-	-	7	A-3a (V)	

DEPTHS: 1 – 29

PID: 82382	SFN:	PROJECT: CUY-90-16.28 (CCG3A)	STATION / OFFSET: 1605+19, 200' RT.	START: 7/2/21	END: 7/2/21	PG 2 OF 3	B-151-1-20

MATERIAL DESCRIPTION AND NOTES	ELEV. 656.6	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
LOOSE TO MEDIUM DENSE, BROWN BECOMING GRAYISH BROWN, **COARSE AND FINE SAND**, TRACE TO LITTLE SILT, TRACE GRAVEL, TRACE CLAY, DAMP *(continued)*		31	7-10-9	22	78	SS-12	-	-	-	-	-	-	-	-	-	4	A-3a (V)	
	W 653.6	33																
@35.0'; BECOMES WET		35–36	4-4-5	10	67	SS-13	-	-	-	-	-	-	-	-	-	21	A-3a (V)	
		40–41	5-4-6	11	67	SS-14	-	-	-	-	-	-	-	-	-	19	A-3a (V)	
		45–46	6-7-6	15	72	SS-15	-	-	-	-	-	-	-	-	-	16	A-3a (V)	
		50–51	7-8-8	18	67	SS-16	-	-	-	-	-	-	-	-	-	17	A-3a (V)	
		55–56	8-9-11	23	89	SS-17	-	-	-	-	-	-	-	-	-	19	A-3a (V)	
		60–61	8-10-9	22	78	SS-18	-	-	-	-	-	-	-	-	-	25	A-3a (V)	

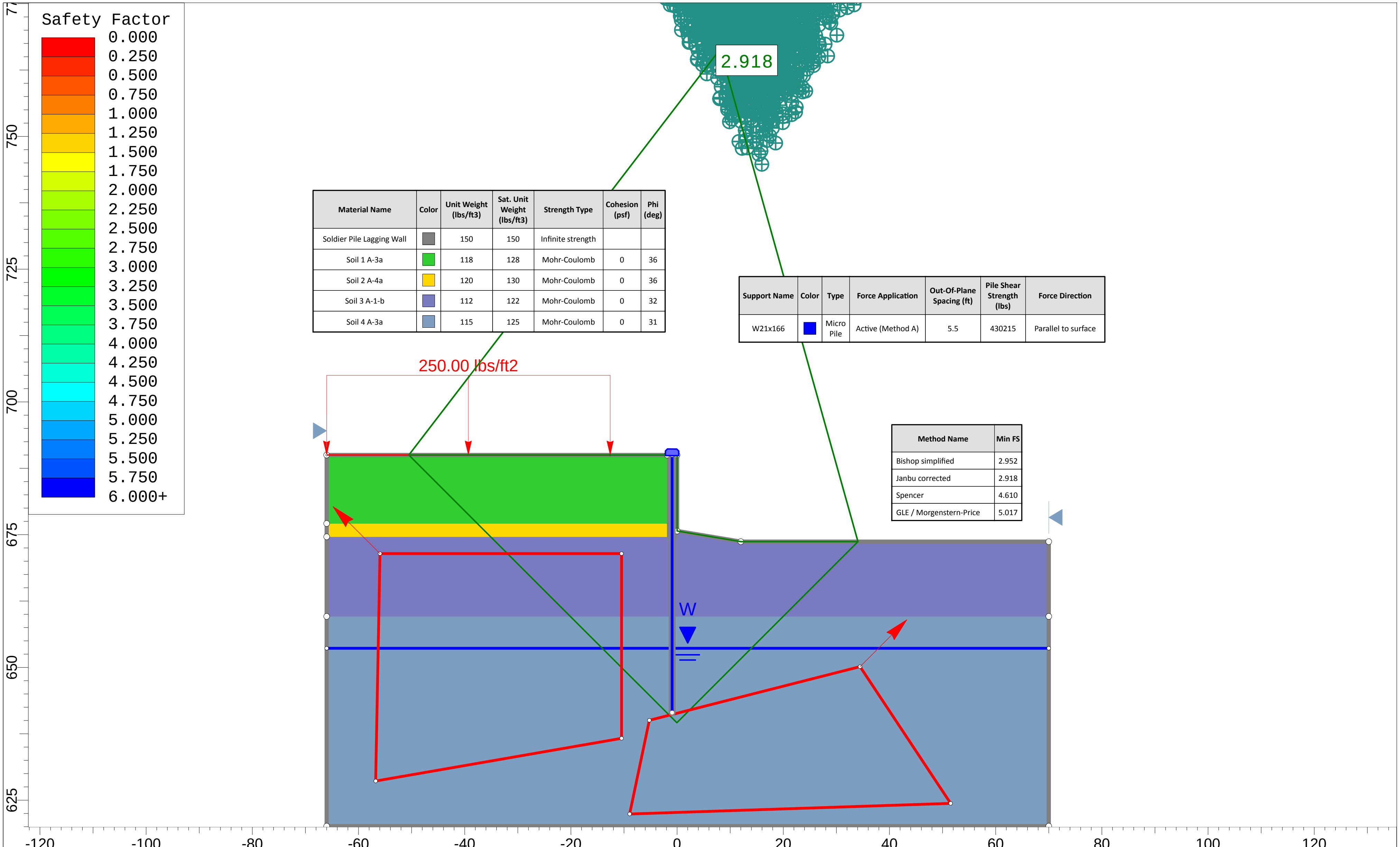
MATERIAL DESCRIPTION AND NOTES	ELEV. 624.5	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
LOOSE TO MEDIUM DENSE, BROWN BECOMING GRAYISH BROWN, **COARSE AND FINE SAND**, TRACE TO LITTLE SILT, TRACE GRAVEL, TRACE CLAY, DAMP *(continued)*		63 64 65																
	620.1	66 EOB	9 10 11	24	89	SS-19	-	-	-	-	-	-	-	-	-	25	A-3a (V)	

NOTES: GROUNDWATER ENCOUNTERED AT 33.0' DURING DRILLING. HOLE DID NOT CAVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PUMPED 140 GAL. BENTONITE GROUT; POURED 1 BAG HOLE PLUG

APPENDIX C

GLOBAL STABILITY ANALYSIS



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Soldier Pile Lagging Wall		150	150	Infinite strength		
Soil 1 A-3a		118	128	Mohr-Coulomb	0	36
Soil 2 A-4a		120	130	Mohr-Coulomb	0	36
Soil 3 A-1-b		112	122	Mohr-Coulomb	0	32
Soil 4 A-3a		115	125	Mohr-Coulomb	0	31

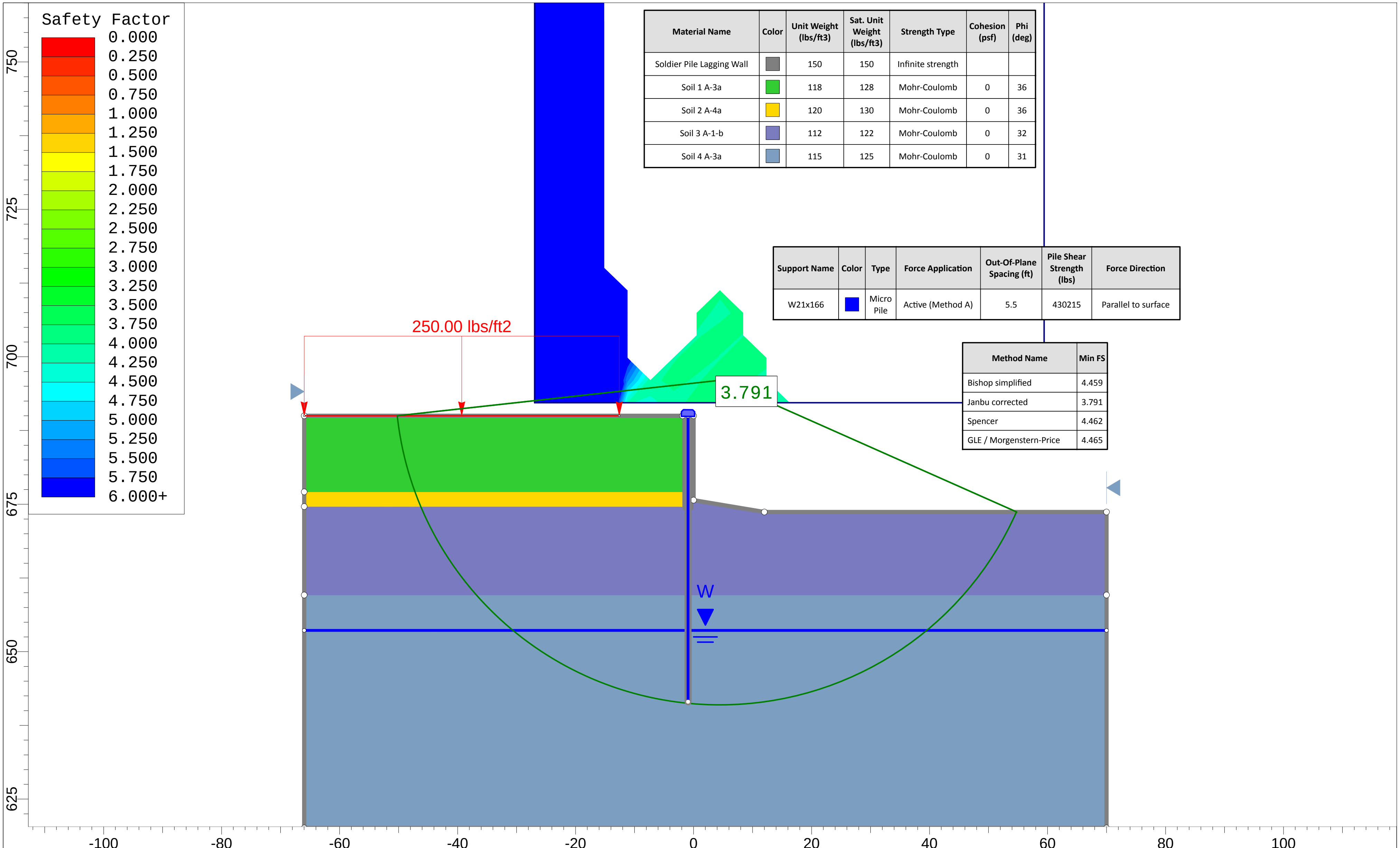
Support Name	Color	Type	Force Application	Out-Of-Plane Spacing (ft)	Pile Shear Strength (lbs)	Force Direction
W21x166		Micro Pile	Active (Method A)	5.5	430215	Parallel to surface

Method Name	Min FS
Bishop simplified	2.952
Janbu corrected	2.918
Spencer	4.610
GLE / Morgenstern-Price	5.017

rocscience

SLIDEINTERPRET 7.038

Project	CCGA Retaining Wall-AJ
Analysis Description	STA 200+75
Drawn By	ZM
Scale	1:300
Company	National Engineering & Architectural Services, Inc
Date	9/20/2021
File Name	WallAJ_STA200+75_Block_Effective_091921.slim



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Soldier Pile Lagging Wall		150	150	Infinite strength		
Soil 1 A-3a		118	128	Mohr-Coulomb	0	36
Soil 2 A-4a		120	130	Mohr-Coulomb	0	36
Soil 3 A-1-b		112	122	Mohr-Coulomb	0	32
Soil 4 A-3a		115	125	Mohr-Coulomb	0	31

Support Name	Color	Type	Force Application	Out-Of-Plane Spacing (ft)	Pile Shear Strength (lbs)	Force Direction
W21x166		Micro Pile	Active (Method A)	5.5	430215	Parallel to surface

Method Name	Min FS
Bishop simplified	4.459
Janbu corrected	3.791
Spencer	4.462
GLE / Morgenstern-Price	4.465

rocscience	*Project*	CCGA Retaining Wall-AJ	
	Analysis Description	STA 200+75	
	Drawn By ZM	*Scale* 1:270	*Company* National Engineering & Architectural Services, Inc
SLIDEINTERPRET 7.038	*Date* 9/20/2021	*File Name* WallAJ_STA200+75_Circular_Effective_091921.slim	