Structural Geotechnical Report

IDOT PTB 204-001
Michigan City Road over I-94
Existing Bridge SN: 016-1068
Proposed Bridge SN: 016-8320
Cook County, Illinois

Prepared for

Illinois Department of Transportation (IDOT)
Contract Number: P-91-158-22

Project Design Engineer Team
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Structural Geotechnical Report
Michigan City Road over I-94
Existing Bridge SN: 016-1068
Proposed Bride SN: 016-8320
IDOT PTB 204-001

Dear Mr. Arif:

Attached is a copy of the Structural Geotechnical Report for the above referenced project. This report provides a brief description of the site investigation, site conditions, and foundation and construction recommendations for the above referenced project. The site investigation included advancing seven (7) soil borings to depths ranging from 60 to 110 feet. The foundation recommendations for the bridge include supporting the proposed abutments on driven piles and the piers on drilled shafts. MSE walls will also be constructed below each of the abutments.

Should you have any questions or require additional information, please call us at 630-994-2600.

Sincerely,

A. Alyousef

Abdulaziz Alyousef, E.I.T.
Staff Engineer

Dawn Edgell.

Dawn Edgell, P.E.
Sr. Project Engineer

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1.0 INTRODUCTION

GSG Consultants, Inc. (GSG) completed a geotechnical investigation for the replacement of the Michigan City Road bridge over I-94 in Cook County, Illinois. The purpose of the investigation was to explore the subsurface conditions, to determine engineering properties of the subsurface soil, and to develop design and construction recommendations for the project. The general project limits are shown in **Exhibit 1**.

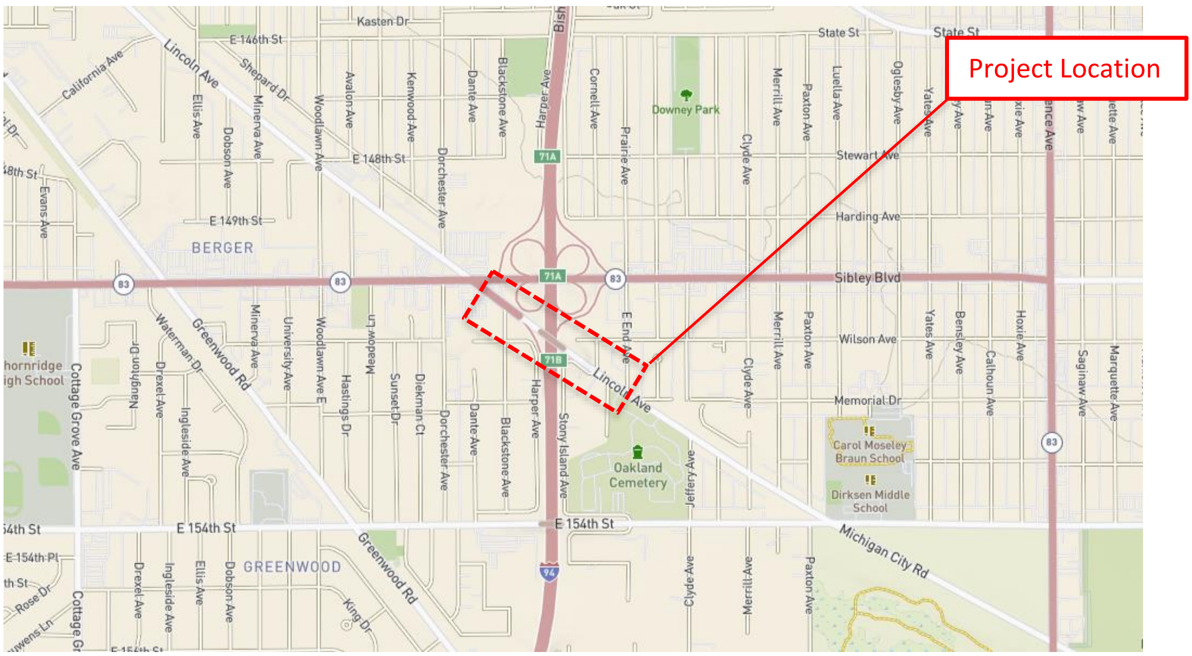


Exhibit 1 – Project Location Map
(Source: USGS Topographic Maps, usgs.gov)

1.1 Existing Bridge Information

The existing Michigan City Road bridge (SN: 016-1068) over I-94 is a 70-year-old, four-span steel beam bridge. The length of the bridge from back-to-back of the abutments is 277’-8 3/4”. The out-to-out deck width of the bridge is approximately 64 feet. The entire structure is proposed to be removed and replaced. **Exhibits 2a and 2b** show the existing Michigan City Road Bridge. There is an existing sewer in the median of I-94 of the southbound road.

Exhibit 2a – Existing Site Conditions at Proposed Bridge Location Looking North

Exhibit 2b – Existing Site Conditions at Proposed Bridge Location Looking South

1.2 Proposed Bridge Information

Based on the design information and drawings provided by Delta Engineering Group, LLC. (dated 4/19/2024, **Appendix A**), the existing Michigan City Road over I-94 bridge will be fully reconstructed with a new two-span continuous composite steel bridge (SN: 016-8320) with a center pier and integral abutments with wrap around MSE walls at each end. It is anticipated that the new abutments will be supported on new driven piles. The center pier will be supported on drilled shafts to avoid the existing sewer below I-94. The new bridge will have a total back-to-back abutment length of 220'-0'' and out-to-out width of 73'-0". New MSE walls will be constructed below each of the abutments.

2.0 SITE SUBSURFACE CONDITIONS

This section describes the subsurface exploration program and laboratory testing program completed as part of this project. The proposed locations and depths of the soil borings were selected in accordance with IDOT requirements. The borings were completed in the field based on field conditions and accessibility.

2.1 Subsurface Exploration Program

The subsurface exploration program for the borings was conducted between July 23 and October 26, 2023, and included advancing seven (7) standard penetration test (SPT) borings at the proposed bridge foundation locations. Five (5) borings were completed at the proposed abutments and two (2) borings at the proposed center pier. The borings were completed per IDOT requirements, to meet 500 kips capacity or the top of bedrock, which was encountered at depths of 85 to 106 feet (El. 506.0 to 510.0 feet).

The coordinates and existing ground surface elevations shown on the soil boring logs were obtained by GSG's field crew using GPS surveying equipment and available google earth information. The as-drilled locations of the soil borings are shown on the Soil Boring Location Map and Subsurface Profile (**Appendix B**). **Table 1** presents a list of the borings completed. Copies of the Soil Boring Logs are provided in **Appendix C**.

Table 1 – Summary of Subsurface Exploration Borings

Boring ID	Location	Station[1]	Offset (ft)/ Direction	Depth (ft)	Surface Elevation (ft)
BSB-01	West Abutment	397+96.00	8.9 RT	110.0	614.5
BSB-02	West Abutment	399+00.00	42.0 LT	93.5	595.0
BSB-03	Center Pier	400+48.00	51.0 RT	97.0	596.0
BSB-04	Center Pier	399+69.68	43.0 LT	80.0	596.0
BSB-05	East Abutment	400+90.70	40.0 RT	60.0	595.0
BSB-06	East Abutment	401+77.00	14.6 RT	108.5	614.0
BSB-06A	East Abutment	401+71.66	26.6 LT	80.0	614.0

1 Based on proposed Michigan City Road Stationing.

The soil borings were drilled using truck-mounted Diedrich D-50 (hammer efficiency 99.5%), B-57 Mobile (hammer efficiency 89.0%), and CME-75 (hammer efficiency 79.8%) drill rigs, each equipped with 3¼-inch I.D. hollow stem augers and an automatic hammer. Soil sampling was performed according to AASHTO T 206, "Penetration Test and Split Barrel Sampling of Soils." Soil samples were obtained at 2.5-foot intervals to a depth of 30 feet below existing grade, and at 5-foot intervals thereafter until reaching auger refusal. Water level measurements were made in each boring when evidence of free groundwater was detected on the drill rods or in the samples. The boreholes were also checked for free water immediately after auger removal, and before filling the open boreholes with soil cuttings and surface patching with asphalt.

GSG's field representative inspected, visually classified, and logged the soil samples during the subsurface exploration activities and performed unconfined compressive strength tests on cohesive soil samples using a calibrated Rimac compression tester and a calibrated hand penetrometer in accordance with IDOT procedures and requirements. Representative soil samples collected from each sample interval, were placed in jars, and returned to the laboratory for further testing and evaluation.

2.4 Laboratory Testing Program

All samples were inspected in the laboratory to verify the field classifications. A laboratory testing program was undertaken to characterize and determine engineering properties of the subsurface soils encountered. The following laboratory tests were performed on representative soil samples:

- Moisture content ASTM D2216 / AASHTO T-265
- Atterberg Limits ASTM D4318 / AASHTO T-89 / AASHTO T-90
- Particle-Size Analysis of Soils – ASTM D422/ AASHTO T-88

The laboratory tests were performed in accordance with test procedures outlined in the most current IDOT Geotechnical Manual, and per ASTM and AASHTO requirements. Based on the laboratory test results, the soils encountered were classified according to the AASHTO and the Illinois Division of Highways (IDH) classification systems. The results of the laboratory testing program are included in the Laboratory Test Results **(Appendix D)** and are also shown along with the field test results in the Soil Boring Logs **(Appendix C)**.

2.5 Subsurface Soil Conditions

This section provides a brief description of the soils encountered in the borings performed in the vicinity of the proposed bridge. Detailed descriptions of the subsurface soils are provided in the Soil Boring Logs (**Appendix C**). The soil boring logs provide specific conditions encountered at each boring location, including soil descriptions, stratifications, penetration resistance, elevations, location of the samples, water levels (when encountered), and laboratory test data. Variations in the general subsurface soil profile were noted during the drilling activities. The stratifications shown on the boring logs represent the conditions only at the actual boring locations and represent the approximate boundary between subsurface materials; however, the actual transition may be gradual.

Borings BSB-01, BSB-06, and BSB-06A were drilled through the existing pavement and embankment of Michigan City Road with a surface elevation of 614 feet; and noted 10 inches of concrete, followed by 2 to 8 inches of aggregate base. Borings B-02 through B-05 were drilled on the shoulders of I-94 and had surface elevations ranging between 595 to 596 feet; and noted 3 to 15 inches of asphalt. Borings BSB-03 and BSB-04 noted 9 to 10 inches of concrete below the asphalt.

Beneath the pavement section, the borings completed on Michigan City Road noted existing sand fill soils extending to depths between 11 to 16 feet (El. 598.0 to 603.0 feet). Borings completed on I-94 noted sand fill to a depth of 3.5 feet (El. 592.5 feet). Beneath the existing fill soils, the borings generally encountered loose to dense brown sand extending to depths ranging between 6.0 to 24.0 feet (El. 589.0 to 592.5 feet), followed by medium stiff to very hard gray silty clay to the boring termination depths; at which point highly weathered rock was encountered in borings BSB-02, BSB-03 and BSB-06 at depths ranging between 93.5 to 108.5 feet (elevations 499 to 505.5 feet). Layers of medium dense to very dense silty loam were encountered in multiple borings. Boring BSB-06A noted a gray sand layer at a depth of 21 to 23.5 feet. Borings BSB-03 and BSB-06A encountered cobbles and rock fragments at depths ranging between of 58.8 and 78.5 feet.

The native sand soil has an SPT blow count (N) values ranging from 6 to 36 blows per foot (bpf) with an average value of 19 bpf. The upper native gray, extending to depths of 43.5 to 48.5 feet, silty clay had unconfined compressive strengths ranging from 0.8 to 6.0 tsf with most values over 2.5 tsf and an average strength of 3.0 tsf. The lower gray silty clay had unconfined compressive strengths ranging from 1.3 to 10.8 tsf, with an average strength of 6.4 tsf. The native gray silty loam had an SPT blow count (N) values ranging from 16 to 89 bpf with an average of 49 bpf.

2.7 Groundwater Conditions

Water levels were checked in each boring to determine the general groundwater conditions present at the site and were measured while drilling and after each boring was completed. Mud rotary drilling techniques were utilized in the borings beginning at depths of 10 to 30 feet below grade. Groundwater was encountered in borings BSB-06 and BSB-6A at depths of 18.5 and 23.5 feet, respectively. Groundwater was not encountered prior to beginning mud rotary drilling and was obscured below these depths for the remaining borings. The borings were not left open for delayed readings and were backfilled upon completion.

Based on the color change from brown and gray to gray, it is anticipated that the long-term groundwater level could range between elevations 589.0 to 592.5 feet. Perched water may be present within the existing fill materials. Water level readings were made in the boreholes at times and under conditions shown on the boring logs and stated in the text of this report. However, it should be noted that fluctuations in groundwater level may occur due to variations in rainfall, other climatic conditions, or other factors not evident at the time measurements were made and reported herein.

3.0 GEOTECHNICAL ANALYSES

This section provides GSG's geotechnical analysis and recommendations for the design of the proposed bridge based on the results of the field exploration, laboratory testing, and geotechnical analysis. Subsurface conditions in unexplored locations may vary from those encountered at the boring locations. If structure locations, loadings, or elevations are changed, we request that GSG be contacted so that we may re-evaluate our recommendations.

3.1 Scour

The bridge structure carrying Michigan City Road over I-94 has no waterways in the vicinity; therefore, scour will not be a concern for this project.

3.2 Abutment Settlement

It is understood that the existing Michigan City Road Bridge over I-94 will be fully reconstructed and will require adding new engineered fill to raise the bridge elevation and construct the new east and west MSE walls, respectively. Based on the drawings provided (**Appendix A**), the average thickness of new fill behind the wall is approximately 10 feet.

An analysis was performed to evaluate the anticipated total settlement due to the new embankment construction for the alignment. Immediate settlement for cohesionless soils can typically occur during the filling operations, while the consolidation settlement for cohesive soils generally occurs over a longer period of time. The maximum estimated total settlements within the native soils were calculated as shown in **Table 2** where 90% of the total settlement is estimated to be completed within 12 to 18 months. The settlement values provided in **Table 2** do not include any potential settlement of the newly constructed embankment materials as it is assumed the new embankment will be compacted and constructed per IDOT specifications.

Table 2 – Anticipated Abutment Fill Settlement

Location	Nearest Boring	Embankment				Anticipated Total Settlement (inches)
		Width (feet)	Length (feet)	Total Height (feet)	Bottom of wall Elevation (ft)	
West Abutment	BSB-02	18.0	72	24.75	591.5	0.57
East Abutment	BSB-05	18.0	72	24.5	591.5	0.55

Based on the general nature of the cohesive soils encountered below the proposed abutments and MSE walls, the estimated settlement from the new fill could be approximately 0.57 inches for the west abutment and 0.55 inches for the east abutment.

3.3 Slope Stability

The bridge will be supported on a deep foundation system that will be designed to support the substructure against lateral and slope failure. Therefore, there are no slope stability concerns anticipated for the bridge structure.

3.4 Seismic Parameters

The seismic hazard for the site was analyzed per the IDOT Geotechnical Manual, IDOT Bridge Design Manual, and AASHTO LRFD Bridge Design Specifications. The Seismic Soil Site Class was determined per the requirements of "All Geotechnical Manual Users" (AGMU) Memo 9.1, Design Guide for Seismic Site Class Determination, and the "Seismic Site Class Determination" Excel spreadsheet provided by IDOT. A global Site Class Definition was determined for this project, and was found to be Soil Site Class D. The Seismic Performance Zone (SPZ) was determined using Figure 2.3.10-2 in the IDOT Bridge Manual and was found to be Seismic Performance Zone 1.

The AASHTO Seismic Design Parameters program was used to determine the peak ground acceleration coefficient (PGA), and the short (S_{DS}) and long (S_{D1}) period design spectral acceleration coefficients for each of the proposed structures. For this section of the project, the S_{DS} and the S_{D1} were determined using 2020 AASHTO Guide Specifications as shown in **Table 3**. Given the site location and materials encountered, the potential for liquefaction is minimal.

Table 3 – Seismic Parameters

Building Code Reference	PGA	S_{DS}	S_{D1}
2020 AASHTO Guide for LRFD Seismic Bridge Design	0.043g	0.151g	0.09g

4.0 GEOTECHNICAL BRIDGE DESIGN RECOMMENDATIONS

The foundations for the proposed bridge must provide sufficient support to resist dead and live loads, as well as seismic loading. The foundation design recommendations presented within this section were completed per the AASHTO LRFD 9th Edition (2020). The total loads for the center bridge pier and the bridge abutments were provided by Delta as shown in **Table 4**.

Table 4a – Bridge Abutment and Pier Loads

Load		East Abutment	Center Pier	West Abutment
Unfactored (kips)	Service Dead Load (DC1+DC2+DW)	703	2,188	566
	Live Load	556	608	520
	Abutment/Pier Weight	600	700	600
	Total	1,859	3,496	1,686
Factored (kips)	Service Dead Load (DC1+DC2+DW)	917	2,847	739
	Live Load	973	1,064	910
	Abutment/Pier Weight	750	875	750
	Total	2,640	4,786	2,399

4.1 Bridge Foundation Recommendations

GSG evaluated potential foundation systems for the proposed bridge. GSG's evaluation included shallow spread footings, drilled shafts, and driven piles. The results of the evaluation are presented below.

4.2 Shallow Foundations

Based on the soils encountered, the new span length and the anticipated loads, shallow foundations are not anticipated to be a feasible option for the proposed substructure of the bridge. We anticipate that shallow foundations will undergo excessive settlement, or the size of the footings will be very large, and therefore will not be a feasible option and are not discussed further in the report.

4.3 Drilled Shafts

Drilled shafts are generally not recommended for integral abutments because they do not have the lateral flexibility necessary to accommodate the thermal movements for integral abutments. However, drilled shafts could be considered to support the central pier. Boring BSB-03 and BSB-04 were completed for the center pier of the Michigan City Road Bridge at an elevation of 596 feet. Boring BSB-03 encountered hard to very hard gray silty clay at an elevation of 550.0 feet extending to a depth of 499.0 feet; at which point highly weathered rock was encountered. Boring BSB-04 encountered hard to very hard silty clay at an elevation of 557.0, dense to extremely dense gray silty loam at an elevation of 537.0 feet, and hard silty clay at 517.0 feet extending to the boring termination depth at 515.0 feet. Based on the anticipated bridge loading, drilled shafts could be extended to a minimum depth of 40 feet for the bridge pier. Design recommendations for drilled shafts are provided in *Section 4.5* of this report.

4.4 Drilled Shaft Design Recommendation

Drilled shafts are considered a feasible foundation option for the proposed center pier locations. The drilled shafts could be supported on the very hard silty clay soils encountered at a depth of 45 feet (el. 551.0 feet) below existing grade or upon weathered bedrock at an approximate depth of 90 feet (el. 506.0 feet) below existing grade. Drilled shafts should be designed in accordance with the design parameters provided in **Tables 5a and 5b**.

Table 5a – Drilled Shaft End Bearing Parameters

Bearing Elevation Depth (ft)	Soil Description	Nominal Tip Resistance (ksf)	Resistance Factor ϕ	Factored Tip Resistance (ksf)
551	Hard Gray Silty Clay	58.5	0.4	23.4
506	Weathered Bedrock	75.5	0.5	37.7

Table 5b – Drilled Shaft Side Resistance Parameters

Elevation Range (ft)	Soil Description	Nominal Side Resistance (ksf)	Side Resistance Factor ϕ	Factored Side Resistance (ksf)
593-590	Medium Dense Light Brown Sand	0.72	0.55	0.40
590-556	Very Stiff Gray Silty Clay	1.43	0.45	0.64
556-506	Hard Gray Silty Clay	2.56	0.45	1.15

We recommend designing the drilled shaft using a minimum diameter of at least 36", and that the drilled shafts be installed with a minimum center-to-center spacing of at least 3 shaft diameters, because drilling the shafts at close spacing can reduce the total resistance of the drilled shafts.

If the drilled shafts extend into the silty loam soils encountered in BSB-04 below depths of 55 feet, then the drilled shafts should be straight shaft, with no bell. Geotechnical losses due to downdrag were not included in the drilled shaft calculations. A protective casing may also be required for any shafts extending through the silty loam materials. Construction of drilled shafts should be following the recommendations in Section 6.4.

4.5 Driven Pile Foundations

Piles considered for this site include metal shell piles, concrete piles, and H-piles. Concrete piles are not recommended for this site because the pile lengths cannot be readily adjusted to accommodate variability in soil conditions. Metal shell piles and H-piles are a feasible option for the construction of the abutments and center piers for the proposed bridge structures. Design recommendations for driven piles are provided in *Section 4.6* of this report.

4.6 Driven Pile Foundation Design Recommendation

The Modified IDOT static method-excel spreadsheet was used to estimate the pile lengths at various axial geotechnical resistances for driven piles per IDOT AGMU Memo 10.2. The factored resistance includes a reduction of 0.55 for the geotechnical resistance for the pile installation. The geotechnical losses due to down drag or liquefaction were not included in the axial pile resistance calculations.

Due to the MSE wall construction below the abutments, the top of the pile foundations for the abutments will extend through new embankment materials which will require corrugated steel pipes/sleeves to be installed within the MSE wall. Per Section 3.8.3 of the IDOT Bridge Manual (2023) for integral abutments, , the void space between the sleeve and pile shall remain empty for the top 10 feet of the sleeves below the bottom of the abutment caps. The space below the top 10 feet should be filled with dry loose clean sand.

According to AASHTO Section 3.11.8-Downdrag, the pile should be designed to resist the downdrag if the ground settlement is 0.4 inches or greater. The nominal geotechnical resistance available to resist the structure load plus the downdrag load is estimated by considering only the positive side resistance and tip resistance below the lowest layer contributing to the downdrag. Based on the proposed fill heights at the bridge abutments, it is anticipated that settlement will be greater than 0.4 inches; therefore, downdrag will be discussed further in this report.

4.7 Pile Design with Downdrag

This section presents pile design recommendations including the effect of downdrag due to the downward movement of the soil relative to the piles if the new embankment in the area of the bridge and approach is constructed after pile installation. According to AASHTO Section 3.11.8-Downdrag, the pile should be designed to resist the downdrag if the ground settlement is 0.4 inches or greater. For the purpose of this report about 9.5 feet of downdrag was estimated. The nominal geotechnical resistance available to resist the structure load plus the downdrag load is estimated by considering only the positive side resistance and tip resistance below the lowest layer contributing to the downdrag.

Tables 6a and 6b summarize the estimated maximum pile lengths for representative pile sections along with the factored resistance available for the piles that are feasible for the proposed substructures. The complete IDOT Pile Design Tables, including factored resistance available (RF) and nominal required bearing (R_N), are included in **Appendix E**.

The estimated pile lengths shown in **Table 6a and 6b** and in **Appendix E** are based on the pile cut off elevations estimated from the preliminary plans and noted below each table. The actual pile length and resistance should be evaluated based on test piles installed in accordance with the specifications provided in Section 512.15 of IDOT Standard Specifications for Road and Bridge

Construction. Per section 3.10.1.11 of the IDOT Bridge Manual (2023), the minimum pile spacing should be 3 pile diameters, and the maximum pile spacing should not be more than 3.5 times the effective footing thickness plus one foot, not to exceed a total of 8 feet.

Table 6a – West Abutment Pile Design (BSB-02) – with Downdrag

Pile Section	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (FT)
Metal Shell 14'' Φ w/0.25'' walls (Max. R_N = 459 Kips)	338	99	49
	447	159	54
	459	166	55
Metal Shell 14'' Φ w/0.312'' walls (Max. R_N = 570 Kips)	338	99	49
	459	166	55
	570	227	60
Metal Shell 16'' Φ w/0.312'' walls (Max. R_N = 654 Kips)	397	119	49
	543	199	55
	654	260	56

NOTES:
Pile cut off elevation = 609.2 feet (preliminary TS&L)
Ground surface elevation against pile during driving = 591.5 feet (preliminary TS&L)
Downdrag influence to elevation 582 feet

Table 6b – East Abutment Pile Design (BSB-06) – with Downdrag

Pile Section	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (FT)
Metal Shell 14'' Φ w/0.25'' walls (Max. R_N = 459 Kips)	289	43	45
	358	81	50
	459	166	56
Metal Shell 14'' Φ w/0.312'' walls (Max. R_N = 570 Kips)	358	81	50
	416	113	55
	570	198	56
Metal Shell 16'' Φ w/0.312'' walls (Max. R_N = 654 Kips)	420	99	50
	487	136	55
	654	260	56

NOTES:
Pile cut off elevation = 609.0 feet (preliminary TS&L)
Ground surface elevation against pile during driving = 591.5 feet (preliminary TS&L)
Downdrag influence to elevation 582 feet

4.8 Pile Design with Downdrag Mitigation (Precore)

This section presents pile design recommendations including the effect of downdrag induced due to the downward movement of the soil relative to the piles if the embankment is constructed after pile installation. According to AASHTO Section 3.11.8-Downdrag, the pile should be designed to resist the downdrag if the ground settlement is 0.4 inches or greater. The nominal geotechnical resistance available to resist the structure load plus the downdrag load is estimated by considering only the positive side resistance and tip resistance below the lowest layer contributing to the downdrag. Based on the subsurface profile, the soil layer below the depth where the settlement is less than 0.4 inches can be considered relatively incompressible, where no downdrag will occur. This depth is anticipated at an elevation of 582 feet for both abutments. GSG utilized the Modified IDOT static method-excel spreadsheet to estimate the pile resistance with this downdrag load applied. It was found that only the H piles with largest sections can provide a certain amount of resistance when the pile bears on bedrock, below 200 kips. This will likely lead to an uneconomically long pile length, large pile numbers and pile sections. Therefore, it is recommended to mitigate the downdrag influence.

There are several mitigation measures to resist the downdrag forces for driven piles. This includes soil surcharging and preloading, ground improvement, increasing the pile section, using a larger pile diameter, increasing the number of piles, restrike piles after primary settlement completes and precoring. Soil preloading and surcharging or ground improvement are not viable options due to the existing site conditions. Although restriking the pile after primary settlement completes can regain the side resistance within the downdrag influence depth, it has similar scheduling concerns as the preloading option, and it is uncertain how much the resistance can be regained or included in the design. Therefore, the preferred alternative is to precore the pile location to the depth where settlement will be less than 0.4 inches to eliminate the downdrag effects. This is anticipated at a depth of 582 feet for both abutments. Considering the potential caving at depth when encountering sandy/silty soils, pile sleeves or temporary casing could be used to keep the precored hole open. The void between the plie sleeves/ casing and the piles should be filled with clean sand below the elevation at the bottom of the MSE wall. The advantage of this process includes the reduction or elimination of downdrag forces; disadvantages include increased costs, construction time and longer pile lengths.

GSG utilized the Modified IDOT static method-excel spreadsheet to estimate the pile lengths at various axial geotechnical resistances for driven piles with precoring per IDOT AGMU Memo 10.2. Precoring was simulated in the design by removing the soil within the precored depth in the spreadsheet. No additional geotechnical losses due to downdrag or liquefaction were included in the axial pile resistance calculations.

Tables 7a through 7b summarize the estimated maximum pile lengths for representative pile sections along with the factored resistance available for piles that are feasible for the proposed substructures.

Due to the MSE wall construction below the abutments, the top of the pile foundations for the abutments will extend through new embankment materials which will require corrugated steel pipes/sleeves to be installed within the MSE wall. Per Section 3.8.3 of the IDOT Bridge Manual (2023) for integral abutments, the void space between the sleeve and pile shall remain empty for the top 10 feet of the sleeves below the bottom of abutment caps. The space below the top 10 feet should be filled with dry loose clean sand. The estimated pile lengths for the proposed abutments shown in **Tables 7a and 7b** include the length of pile within this pipe, as necessary.

The estimated pile lengths shown in **Tables 7a** and **7b** and in **Appendix E** are based on the pile cut off elevations shown on the GPE and noted below each table. The actual pile length and resistance should be evaluated based on test piles installed in accordance with the specifications provided in Section 512.15 of IDOT Standard Specifications for Road and Bridge Construction. Per section 3.10.1.11 of the IDOT Bridge Manual (2023), the minimum pile spacing should be 3 pile diameters, and the maximum pile spacing should not be more than 3.5 times the effective footing thickness plus one foot, not to exceed a total of 8 feet.

Table 7a – West Abutment Pile Design (BSB-02) – with Precore to 582 feet

Pile Section	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (FT)
Metal Shell 14'' Φ w/0.25'' walls (Max. R_N = 459 Kips)	286	157	49
	394	217	54
	459	252	55
Metal Shell 14'' Φ w/0.312'' walls (Max. R_N = 570 Kips)	513	282	59
	547	301	64
	570	313	65
Metal Shell 16'' Φ w/0.312'' walls (Max. R_N = 654 Kips)	469	258	54
	614	338	59
	654	359	64

NOTES:
Pile cut off elevation = 609.2 feet (preliminary TS&L)
Ground surface elevation against pile during driving = 591.5 feet (preliminary TS&L)
Precore to 582.0 feet

Table 7b – East Abutment Pile Design (BSB-06) – with Precore to 582.0 feet

Pile Section	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (FT)
Metal Shell 14'' Φ w/0.25'' walls (Max. R_N = 459 Kips)	272	150	50
	331	182	55
	459	252	56
Metal Shell 14'' Φ w/0.312'' walls (Max. R_N = 570 Kips)	272	150	50
	478	263	55
	570	313	55.5
Metal Shell 16'' Φ w/0.312'' walls (Max. R_N = 654 Kips)	323	177	50
	635	349	60
	654	359	60.5

NOTES:
Pile cut off elevation = 609.0 feet (preliminary TS&L)
Ground surface elevation against pile during driving = 591.5 feet (preliminary TS&L)
Precore to 582.0 feet

4.9 Pile Driving Considerations

The subsurface conditions appear to be consistent throughout the soil boring locations. The soil borings were completed within the proposed substructure locations. Therefore, the subsurface soil conditions during the pile driving would be fairly predictable. Based on the general consistency of the soils for the abutments, test piles should be considered at alternating substructure locations.

Driving shoes for the piles, in accordance with Section 1006.05 (e) of the IDOT Standard Specifications for Road and Bridge Construction (SSRBC), should be considered if the piles are to be driven through cobbles or dense to very dense sand and gravel. For metal shell piles, a wall thickness of 0.25" or greater is recommended to minimize potential damage during driving with a conical tip welded to the pile to avoid abrupt overstress.

Pile setup is a consideration that can contribute to an increase to long-term pile resistance of displacement piles (i.e. driven pile). This increase in resistance is referred to as pile setup which is the gain in pile resistance over time that occurs mainly due to dissipation of pore water pressures and healing of the distorted and remolded soils immediately surrounding the pile. The magnitude of soil setup is function of pile type as well as soil type and consistency. A greater magnitude of soil setup is generally expected for soft clays, dense granular deposits, and displacement type piles than for stiff clays, loose granular deposits, and non-displacement type piles. However, pile setup consideration should not be included in the pile resistance during the design phase of the project, but this may be considered during the construction phase if a pile does not achieve the required bearing during installation. Based on the subsurface soil conditions, we do not anticipate any setup for the driven piles.

4.10 Lateral Load Resistance

Lateral loadings applied to pile foundations are typically resisted by battering selected piles, the soil/structure interaction, pile flexure, or a combination of these factors. Section 3.10.1.10 of the 2023 IDOT Bridge Manual requires performing detailed structure interaction analysis if the factored lateral loading per pile exceeds 3 kips. The analysis shall determine actual pile moment and deflection to determine the selected pile adequacy for the proposed loadings. **Table F-1** in **Appendix F** provides generalized soil parameters for the entire site and includes recommended lateral soil modulus and soil strain parameters that can be used for laterally loaded pile analysis via the p-y curve method based on the encountered subsurface conditions.

5.0 GEOTECHNICAL WALL DESIGN RECOMMENDATIONS

This section provides GSG's geotechnical recommendations for the design of the proposed abutment retaining walls based on the results of the field exploration, laboratory testing, and geotechnical analyses.

Based on the design drawings, MSE walls are proposed to retain the embankment fill below the bridge abutments. MSE walls are typically associated with fill wall construction and consist of facing such as segmental precast units, dry block concrete or CIP concrete facing units connected to horizontal steel strips, bars or geosynthetic to create a reinforced soil mass. The reinforcement is typically placed in horizontal layers between successive layers of granular backfill. A free draining backfill is required to provide adequate performance of the wall. MSE walls can be used in cut situations as well. The additional cost of the excavations for a MSE wall is usually offset by the savings in construction costs and schedule as compared to a CIP wall on spread footings.

The design of MSE walls for internal stability is the Contractor's responsibility and will need to be designed by a licensed Structural Engineer in the State of Illinois. The length of the reinforced soil mass from the outside face should be a minimum of 8 feet, but not less than 70% of the wall height. The length should be determined to satisfy the eccentricity and sliding criteria and provide adequate length to prevent structural failure with respect to pullout and rupture of reinforcement. The MSE wall could be designed using a unit weight of 125 pcf and a friction angle of 34 degrees for the reinforced backfill soils.

GSG evaluated the global and external stabilities (sliding and overturning) to determine the suitability of a MSE retaining wall system for this project.

5.1 MSE Wall Design Recommendations

The engineering analyses performed for evaluation of the retaining wall options followed the current AASHTO Load and Resistance Factor Design (LRFD) Methodology as required by IDOT. LRFD methodology incorporates the use of load factors and resistance factors to account for uncertainty in applied loads and load resistance of structure elements separately. The AASHTO LRFD Bridge Design Specifications outline load factors and combinations for various strength, extreme event, service, and fatigue limit states. Section 11, which outlines geotechnical criteria for retaining walls, of the AASHTO Specifications requires the evaluation of bearing resistance failure, lateral sliding, and overturning at the strength limit state and excessive vertical displacement, excessive lateral displacement, and overall stability at the service limit state. **Table 8** outlines the load factors used in evaluation of the retaining walls in accordance with Tables 3.4.1-1 and 3.4.1-2.

Table 8 – LRFD Load Factors for Retaining Wall Analyses

	Type of Load	Sliding and Eccentricity Strength Ia	Bearing Resistance Strength Ib	Sliding and Eccentricity Extreme IIa	Bearing Resistance Extreme IIb	Settlement Service I
Load Factors for Vertical Loads	Dead Load of Structural Components (DC)	0.90	1.25	0.90	1.25	1.00
	Vertical Earth Pressure Load (EV)	1.00	1.35	1.00	1.35	1.00
	Earth Surcharge Load (ES)		1.50			
	Live Load Surcharge (LS)		1.75			1.00
Load Factors for Horizontal Loads	Horizontal Earth Pressure Load (EH) Active At-Rest AEP for anchored walls	1.50	 1.50 1.35 1.35	1.00	1.00	1.00
	Earth Surcharge (ES)		1.50			
	Live Load Surcharge (LS)	1.75	1.75			1.00
Load Factor for Vehicular Collision				1.00	1.00	

5.2 Lateral Earth Pressures and Loading

The walls shall be designed to withstand earth and live lateral earth pressures. The lateral earth pressures on MSE walls should be determined in accordance with AASHTO 3.11.5.8. Earth loads of retained soils behind the MSE walls may be calculated using an active earth pressure coefficient, K_a, calculated using the Rankine Theory. **Table F-1** in **Appendix F** presents the soil design properties for the retaining wall for the anticipated soil types at the site and provide recommended lateral soil modulus and soil strain parameters that can be used for laterally loaded pile analysis via the p-y curve method based on the encountered subsurface conditions.

Traffic and other surcharge loads should be included in the design of the retaining walls. A live load surcharge shall be applied where vehicular load is expected to act on the surface of the backfill within a distance equal to one-half the wall height behind the back face of the wall in accordance with AASHTO 3.11.6.4. The live load surcharge may be estimated as a uniform horizontal earth pressure due to an equivalent height (H_{eq}) as shown in **Table 9** for vehicular loading perpendicular to traffic.

Table 9 - Equivalent Height of Soil for Vehicular Loading on Abutments Perpendicular to Traffic

Abutment Height (feet)	H_{eq} (feet)
5	4.0
10	3.0
⩾20	2.0

Reference: AASHTO LRFD Table 3.11.6.4-1

The retaining walls should be designed with free draining material as reinforced soil mass and the discharging water should be collected within the reinforced fill and drained away from the wall system. This will allow movement of any water behind the wall panel, and no hydrostatic (seepage) pressures will develop in the active soil wedge behind the wall panel. The backfill should be placed in accordance with the IDOT SSRBC. Heavy compaction equipment should not be allowed closer than five (5) feet to the retaining wall to prevent inducing high lateral earth pressures and causing wall yielding and/or other damage. The passive lateral earth pressure coefficient (K_p) from the upper 3.5 feet of level backfill at the toe of the wall should be neglected, unless the soil is confined or protected by a concrete slab or well drained pavement. The passive lateral earth pressure coefficient from the upper 3.5 feet of soil for a descending slope at the wall toe should also be neglected, regardless of any surface protection.

5.3 Bearing Resistance

Bearing resistance for the retaining walls founded on a granular fill leveling slab shall be evaluated at the strength limit state using load factors (see **Table 10**), and factored bearing resistances. The bearing resistance factor, ϕ_b, for a MSE wall is 0.65 per AASHTO Table 11.5.7-1. The bearing resistance shall be checked for the extreme event limit state with a resistance factor of 1.0. **Table 10** presents the proposed bearing elevations and recommended bearing resistances of suitable materials to support the wall systems.

Table 10 – Recommended Bearing Resistance

Location	Elevation* (feet)	Nominal Resistance (ksf)	Factored Bearing Resistance (ksf)	Bearing** Resistance for 1.0-inch Settlement Service Limit (ksf)	Bearing** Resistance for 2.0-inch Settlement Service Limit (ksf)	Anticipated Bearing Soil
West Abutment	591.5	8.8	6.0	4.2	5.8	New Engineering Granular Fill
East Abutment	591.5	8.8	6.0	4.5	6.0	New Engineering Granular Fill

*Elevations estimated from design cross section drawings provided by Delta

** Based on the existing soil profile with undercuts in **Table 11**.

The minimum depth of the wall foundations should be 3.5 feet below the final exterior grade to alleviate the effects of frost. The subgrade soils encountered at the bearing elevations should be cleared of any unsuitable material, such as topsoil. Based on the results of the subsurface exploration, we anticipate the walls would be supported upon the soil types noted in **Table 10.**

5.4 Subgrade Undercut Areas

Based on the soil conditions along the wall alignments, it is anticipated that high moisture content/loose sand materials may be encountered near the bearing elevations. These soils are not generally considered suitable for foundation bearing as they will not provide adequate bearing resistance. It is recommended to dry and scarify the top 12 inches of loose materials. After the material is scarified it should be compacted to a minimum of 95% of the maximum dry density, as determined by AASHTO T-180: Standard Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures (ASTM D1557) in accordance with IDOT standard construction requirements.

5.5 Sliding and Overturning Stability

The wall base width should be sufficient to resist sliding. The frictional resistance shall include the friction between granular backfill for the wall and supportive cohesive or granular soils, and the friction between the wall foundation and bearing soils.

The factored resistance against sliding should be calculated using equation 10.6.3.4-1 in the AASHTO LRFD manual. A sliding resistance factor, ϕ, of 1.0 (Table 11.5.7-1) shall be applied to the nominal sliding resistance of soil on soil beneath the MSE walls. A maximum nominal frictional coefficient of 0.53 (tan 28 degrees) could be used for determining the sliding resistance for the soil to soil in-fill interfaces. The width of the MSE wall (length of reinforcing) must be wide enough to resist overturning forces. The location of the resultant of the forces shall be within the middle two thirds of the MSE base width.

5.6 Wall and Embankment Settlement

Settlement of the MSE walls depends on the foundation sizes and bearing pressures, as well as the strength and compressibility characteristics of the underlying bearing soils. Assuming the foundation subgrades have been prepared as recommended above and the service bearing pressures for the west and east abutments as mentioned in **Table 10** are used, the settlement of the MSE walls will be on the order of 1.0 to 2.0 inches. Differential settlement between two points of 100 feet apart along the length of the walls will be ½ inch or less. AASHTO 11.10.4.1 provides guidelines regarding the maximum total and differential tolerable settlements for various facing of MSE walls. The allowable settlement of MSE walls shall be established based on the longitudinal deformability of the facing. It is recommended to provide vertical full-height slip joints if large differential settlements over short horizontal distances is anticipated.

5.7 Overall Stability

Based on the preliminary information provided by Delta Engineering, the retaining walls should be designed for external stability of the wall system as well as internal stability behind the wall facing. The following parameters were used to evaluate the overall stability of the walls.

Table 11 – West and East Abutment MSE Retaining Wall Descriptions

Maximum height of the retaining wall (H)*	24.75 feet
Minimum length of reinforcement 0.7xH	18.0 feet
Unit weight of the retained soil (embankment)	120 pcf
Unit weight of the reinforced soil mass	120 pcf

*Maximum wall height is measured from the top of pavement to the top of leveling pad.

The actual wall width and total height of the walls should be based on structural analysis performed by a Licensed Structural Engineer in the State of Illinois.

5.8 Slope Stability Results

Slide2 program was used to evaluate the global slope stability of the proposed MSE walls for the project based on the limit equilibrium method. The proposed wall systems were analyzed based on the preliminary grading, cross sections as shown in the TSL plans and the soils encountered at the site. Circular failure analyses were evaluated using the simplified Bishop analysis method for the proposed wall and slope geometries.

A circular analysis was evaluated for both a short term (undrained) and long term (drained) conditions for the proposed retaining walls. Based on the TSL plans, the MSE walls for the bridge have a maximum exposed height of 24.75 feet. Geometries of the cross sections for the maximum exposed heights were used in the slope stability analysis. Generalized soil profiles at two (2) different boring locations were analyzed. The bottoms of the MSE walls were assumed to be at elevation 591.5 feet; the elevations of the final new bridge slab surfaces will be near elevation 616.0 feet. The results of the analyses are shown in **Table 12**.

Table 12 –Stability Analyses Results

Analysis Exhibit	Cross Section	Soil Profile	Failure Type	Factor of Safety	Required Minimum Factor of Safety
Exhibit A	West Abutment	Borings BSB-01 & BSB-02	Circular – Short Term	2.4	1.5
Exhibit B			Circular – Long Term	2.2	1.5
Exhibit C	East Abutment	Borings BSB-05 & BSB-06A	Circular – Short Term	2.3	1.5
Exhibit D			Circular – Long Term	2.2	1.5

Based on the analyses performed, the proposed retaining walls meet the minimum factor of safety of 1.5. Copies of the Slope Stability analyses exhibits are included in **Appendix G**.

5.9 Drainage Recommendations

The walls should be designed to prevent the buildup of hydrostatic forces. This can be done with the construction of a base drain and back drain to collect and remove surface water away from the face of the MSE walls.

6.0 CONSTRUCTION CONSIDERATIONS

All work performed for the proposed project should conform to the requirements in the IDOT Standard Specifications for Road and Bridge Construction (2022). Any deviation from the requirements in the manuals above should be approved by the design engineer.

6.1 Existing Utilities

Based on the existing site conditions, significant utilities may exist along the project corridor that may interfere with construction of the proposed bridge and walls. Before proceeding with construction, all existing utility lines that will interfere with construction should be completely relocated from the proposed construction areas.

Where possible, existing utility lines that are to be abandoned in place should be removed and/or plugged with a minimum of 2 feet of cement grout. All excavations resulting from underground utilities removal activities should be cleaned of loose and disturbed materials, including all previously placed backfill, and backfilled with suitable fill materials in accordance with the requirements of this section. During the clearing and stripping operations, positive surface drainage should be maintained to prevent the accumulation of water.

6.2 Site Excavation

The contractor will be responsible for providing a safe excavation during the construction activities of the project. All excavations should be conducted in accordance with applicable federal, state, and local safety regulations, including, but not limited to the Occupational Safety and Health Administration (OSHA) excavation safety standards. Excavation stability and soil pressures on temporary shoring are dependent on soil conditions, depth of excavations, installation procedures, and the magnitude of any surcharge loads on the ground surface adjacent to the excavation. Excavation near existing structures and underground utilities should be performed with extreme care to avoid undermining existing structures. Excavations should not extend below the level of adjacent existing foundations or utilities unless underpinning or other support is installed. It is the responsibility of the contractor for field determinations of applicable conditions and providing adequate shoring for all excavation activities.

6.3 Borrow Material and Compaction Requirements

If borrow material is to be used for onsite construction, it should conform to Section 204 "Borrow and Furnished Excavation" of the current IDOT Construction Manual. The fill material should be free of organic matter and debris. Earth-moving operations should be avoided during excessively cold or wet weather to avoid freezing of softening subgrade soils.

6.4 Drilled Shafts Construction

The drilled shaft construction should be completed in accordance with Section 516, Drilled Shafts, in the IDOT SSRBC. A wet construction method may be necessary for the drilled shafts installation. Temporary casing may be required due to the observed water table elevation and the non-cohesive soil layers encountered in the soil borings. Water should be removed from the base of the drilled shaft base prior to placing any concrete. The placement method of concrete for the drilled shaft foundation should be based on the amount of water present at the base of the shaft just prior to placing the concrete. Concrete may be placed using the free fall method, provided less than 2 inches of water is present at the base of the shaft at the time the concrete is being placed. If more than 2 inches of water is present, a tremie should be used in an effort to displace the water to the surface for removal.

6.5 Pile Installation

IDOT standard practice requires driving one (1) test pile for each substructure element. The test-piles are installed based on the preliminary driving criteria in order to evaluate site conditions and are inspected in accordance with the IDOT Standard for Road and Bridge Construction. All pile installation should be completed in accordance with the IDOT SSRBC Section 512.15.

6.6 Groundwater Management

Based on the color change from brown and gray to gray, it is anticipated that the long-term groundwater level could range between elevations 589 to 592.5 feet. GSG does not anticipate any significant groundwater related issues occur during construction activity, however perched water may be encountered within the existing fill materials. If rainwater run-off or groundwater is accumulated at the base of excavations, the contractor should remove accumulated water using conventional sump pit and pump procedures and maintain a dry and stable excavation. The location of the sump should be determined by the contractor based on field conditions. During earthmoving activities at the site, grading should be performed to ensure that drainage is maintained throughout the construction period. Water should not be allowed to accumulate in the foundation area either during or after construction. Undercut and excavated areas should be sloped toward one corner to facilitate the removal of any collected rainwater or surface run-off. Grades should be sloped away from the excavations to minimize runoff from entering.

6.7 Temporary Earth Retention Systems

Temporary soil retention systems (TSRS) will be required for the installation of either drilled shaft or driven piles, as shown on the preliminary TSL plans. Based on the soil profile, a cantilevered sheet pile system could be used. The sheet pile retaining system should be designed in accordance with the IDOT Bridge Design Manual, Section 3.13.1, Temporary Sheet Piling Design, Temporary Soil Retention Systems. The design of the TSRS is the responsibility of the contractor.

The IDOT Temporary Sheet Piling Design procedures include limitations if the required embedment depths fall below soil layers with a Qu value larger than 4.5 tsf or N-values larger than 45 blows or rock, because the sheet piling may not penetrate these layers. Refer to the soil boring logs for the elevations to the hard stratum. If adequate retained heights cannot be obtained using the IDOT Temporary Sheet Piling Design Guide, then a Temporary Soil Retention System shall be designed by the Contractor. The Temporary Soil Retention Systems should include surcharge loads from the excavated materials, construction equipment and truck traffic as necessary. The retention system should extend to a sufficient depth below excavation bottom to provide the required lateral passive resistance if the active case is used for the design. Embedment depths should be determined based on the principles of force and moment equilibrium.

The retention system shall be designed by an Illinois licensed structural engineer in accordance with the IDOT Bridge Design Manual. The design of the temporary soil retention system (TSRS) is the responsibility of the contractor. The contractor should submit the TSRS plans to the structural design team for review prior to commencing construction of the TSRS.

7.0 LIMITATIONS

This report has been prepared for the exclusive use of the Illinois Department of Transportation (IDOT) and its Design Section Engineer consultant. The recommendations provided in the report are specific to the project described herein and are based on the information obtained at the soil boring locations. The analyses have been performed, and the recommendations have been provided based on subsurface conditions determined at the location of the borings. This report may not reflect all variations that may occur between boring locations or at some other time, the nature and extent of which may not become evident until during the time of construction. If variations in subsurface conditions become evident after submission of this report, it will be necessary to evaluate their nature and review the recommendations presented herein.

APPENDIX A

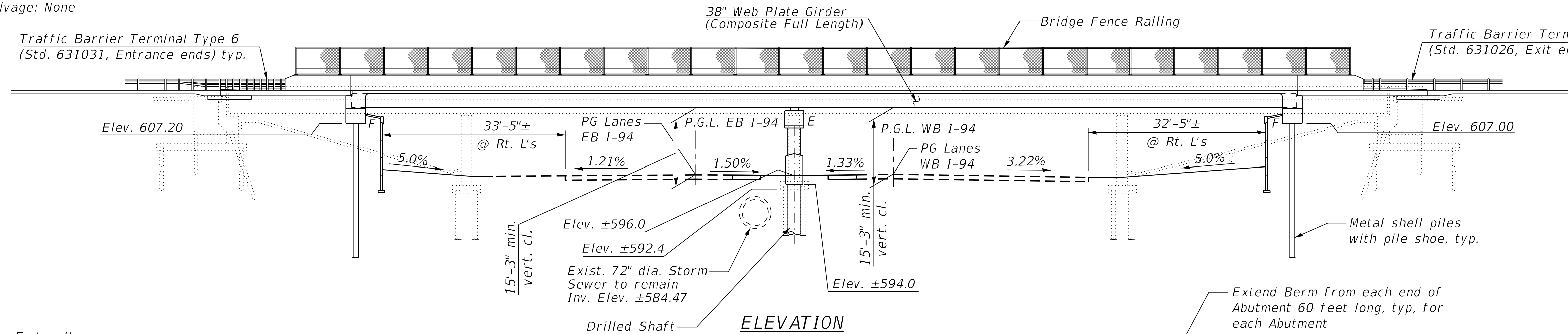
GENERAL PLAN, ELEVATION AND DETAILS

Bench Mark: Chiseled square cut in Northeast corner of wingwall at Northwest corner of Michigan City Road Bridge Deck Elev. 613.98.

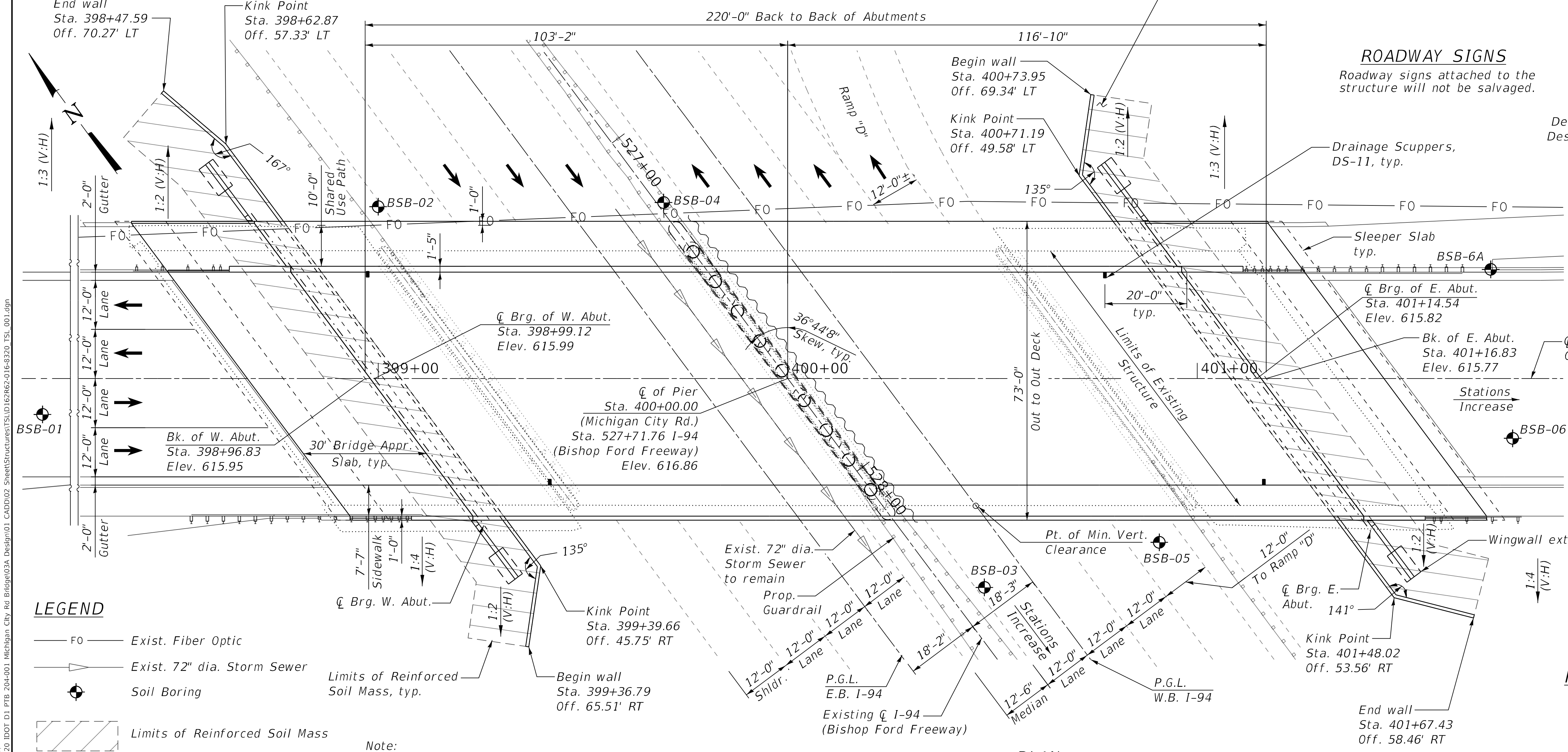
Existing Structures: S.N. 016-1068, Michigan City Road over I-94 originally built in 1948 as FA Route 122, Section 0606.2-HB. The superstructure consist of a 7 1/2" reinforced deck resting on eleven 33WF130 beams that carries 2-12' lanes and 5' sidewalks in both directions. The substructure consist of closed abutments and column piers supported on timber piles. The current bridge is a four span structure (60'-4 13/16", 75'-4 1/2", 75'-6 1/2", 60'-2 3/16") with a total length of 277'-8 3/4" from back to back of abutments, and overall width of 64'-0" out to out of deck and a skew angle of 36°41'00" ahead right. In 1983, a portion of the beam currently designated as beam 10 was replaced over pier 3. In 1990, the existing concrete deck was replaced and widened from 56'-0" to 64'-0". Thw widening included one new rolled steel beam on each side of the bridge and widening of the abutments nad piers. In 1994, steel repairs were performed on beam 10. In 2015, steel repairs were performed on beam 11.

The existing structure will be removed and replaced. Traffic on Michigan City Road will be detoured during construction. Traffic will be staged along I-94 for pier construction.

Salvage: None



ELEVATION



LEGEND

FO — Exist. Fiber Optic

Exist. 72" dia. Storm Sewer

Soil Boring

Limits of Reinforced Soil Mass

Note:
1. The MSE wall offsets are measured from centerline of Michigan CIty Road.

PLAN

HIGHWAY CLASSIFICATION

Michigan City Road (Funding Route)
Functional Class: Major Collector
ADT: 7950 (2022); 13,888 (2046)
ADTT: 405 (2022) ADTT: 415 (2046)
DHV: 795 (2022)
Design Speed: 35 m.p.h.
Posted Speed: 35 m.p.h.
Two-Way Traffic
Directional Distribution: 50:50

I-94, Bishop Ford Freeway (F.A.I. Rte. 94)
Functional Class: Interstate
ADT: 125,400 (2022); 124,432 (2046)
ADTT: 13,650 (2022) ADTT: 13,513 (2046)
DHV: 12,540 (2022)
Design Speed: 55 m.p.h.
Posted Speed: 55 m.p.h.
Two-Way Traffic
Directional Distribution: 50:50

DESIGN STRESSES

FIELD UNITS

f'c = 4,000 psi (Superstructure)
f'c = 3,500 psi (Substructure)
fy = 60,000 psi (Reinforcement)
fy = 50,000 psi (M270 Grade 50)
fy = 36,000 psi (ASTM A709 Grade 60)

PRECAST UNITS

f'c = 4,500 psi (MSE Wall Panels)

ROADWAY SIGNS

Roadway signs attached to the structure will not be salvaged.

SEISMIC DATA

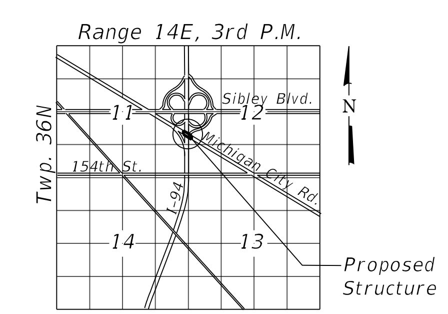
Seismic Performance Zone (SPZ) = 1
Design Spectral Acceleration at 1.0 sec. (SD1) - 0.09 g
Design Spectral Acceleration at 0.2 sec. (SDS) - 0.151 g
Soil Site Class = D

LOADING HL-93

Allow 50#/sq. ft. for future wearing surface.
Live Load Deflection Limit Span/1000

DESIGN SPECIFICATIONS

2020 AASHTO LRFD Bridge Design Specifications, 9th Edition



LOCATION SKETCH

GENERAL PLAN & ELEVATION
MICHIGAN CITY ROAD OVER I-94
(BISHOP FORD FREEWAY)
F.A.U. RTE. 3593 SEC. 0606(2HB)R-86
COOK COUNTY
STATION 400+00.00
STRUCTURE NO. 016-8320

MODEL: $MODELNAME$
FILE NAME: G:\ILP220720 IDOT D1 PTB 204-001 Michigan City Rd Bridge\03A Design\01 CADD\02 Sheets\Structures\TSL\D162R62-016-8320 TSL_001.dgn

DELTA ENGINEERING GROUP, LLC
CONSULTING ENGINEERS, CONSTRUCTION MANAGERS, SURVEYORS
111 W JACKSON BLVD, SUITE 910
CHICAGO, IL 60604
T 312.377.7700, F 312.427.6145

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STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

SCALE: | SHEET OF S-49 SHEETS | STA. TO STA.

F.A.U. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
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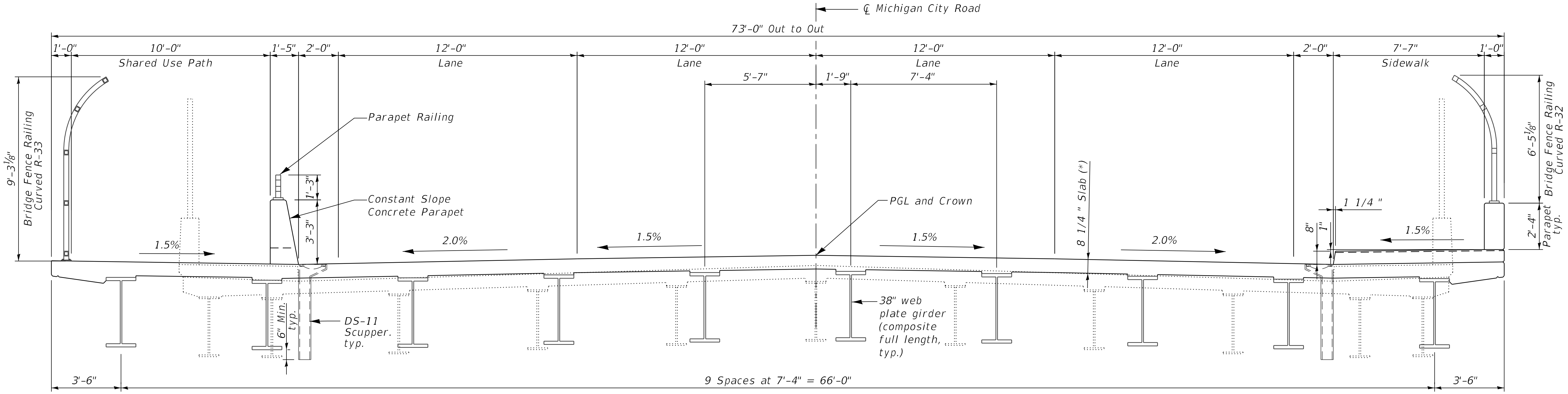
		CONTRACT NO. 62R62		
		ILLINOIS FED. AID PROJECT		



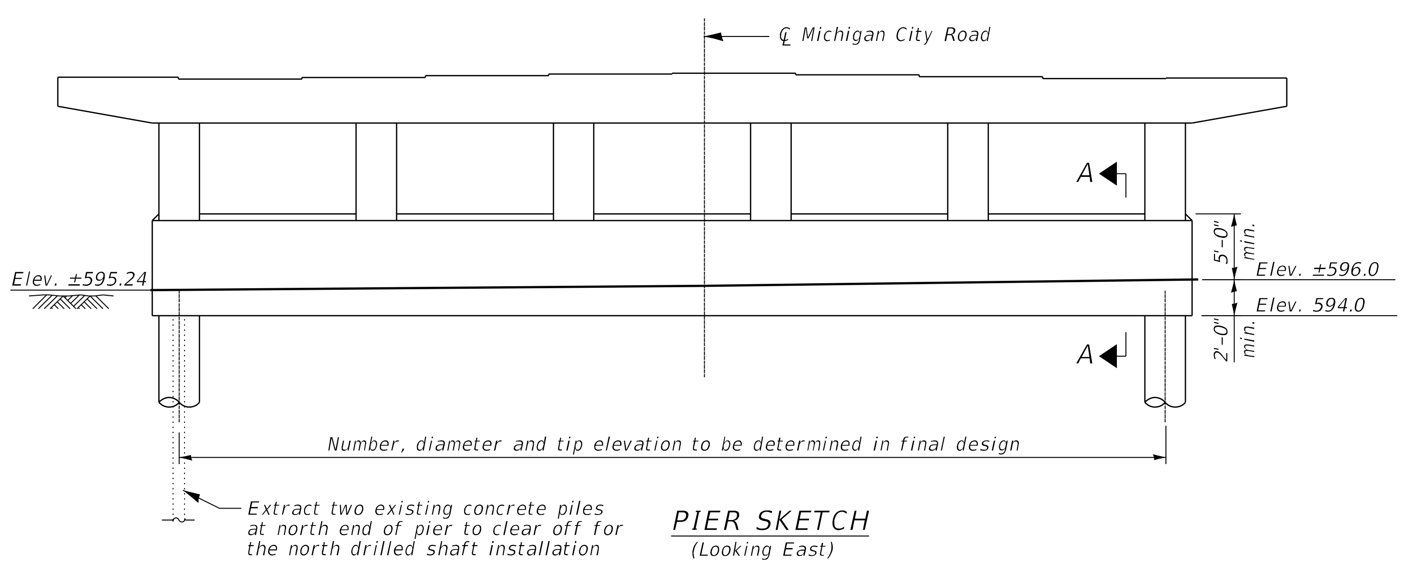
CROSS SECTION
(Looking East)

STEEL ERECTION NOTE

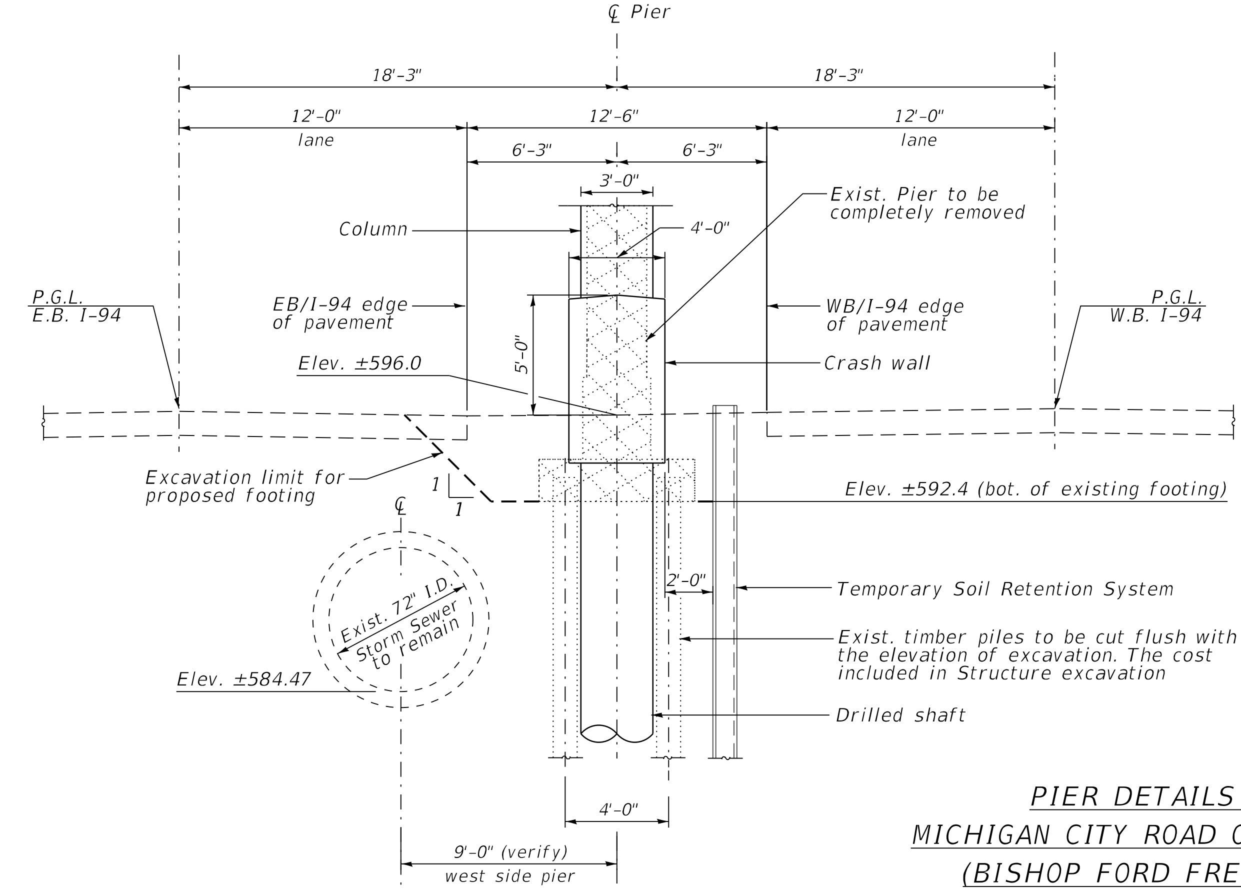
1. Steel erector will be required to provide temporary shoring tower as pivot point for placing the center section steel girder with elastomeric bearing on the pier. The shoring tower will be braced against the pier with counter weight as required

STEEL COATING NOTE

1. The Organic Zinc Rich Primer/Epoxy/Urethane Paint System shall be used for painting of new structural steel except where otherwise noted. The entire system shall be shop applied, with the exception that the exterior surface and the bottom of the bottom flange of fascia beams, masked off connection surfaces, field installed fasteners and damaged areas shall be touched up and finish coated in the field. The color of the final finish coat for all interior steel surfaces shall be Gray, Munsell No. 5B 7/1. The color of the final finish coat for the exterior and bottom flange of the fascia beams shall be gray, Munsell No. 2.5Yr 3/4.
2. The existing structural steel coating contains lead. The Contractor shall take appropriate precautions to address the presence of lead on this project.



PIER SKETCH
(Looking East)



SECTION A-A
(Looking North, Dimensions at right angles to pier)

PIER DETAILS I
MICHIGAN CITY ROAD OVER I-94
(BISHOP FORD FREEWAY)
F.A.U. RTE. 3593 SEC. 0606(2HB)R-86
COOK COUNTY
STATION 400+00.00
STRUCTURE NO. 016-8320

MODEL: $MODELNAME$
FILE NAME: G:\LP220720 IDOT D1 PTB 204-001 Michigan City Rd Bridge\03A Design\01 CADD\02 Sheets\Structures\TSL\D162R62-016-8320 TSL 002.dgn

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STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

SCALE: SHEET OF S-49 SHEETS STA. TO STA.

F.A.U. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
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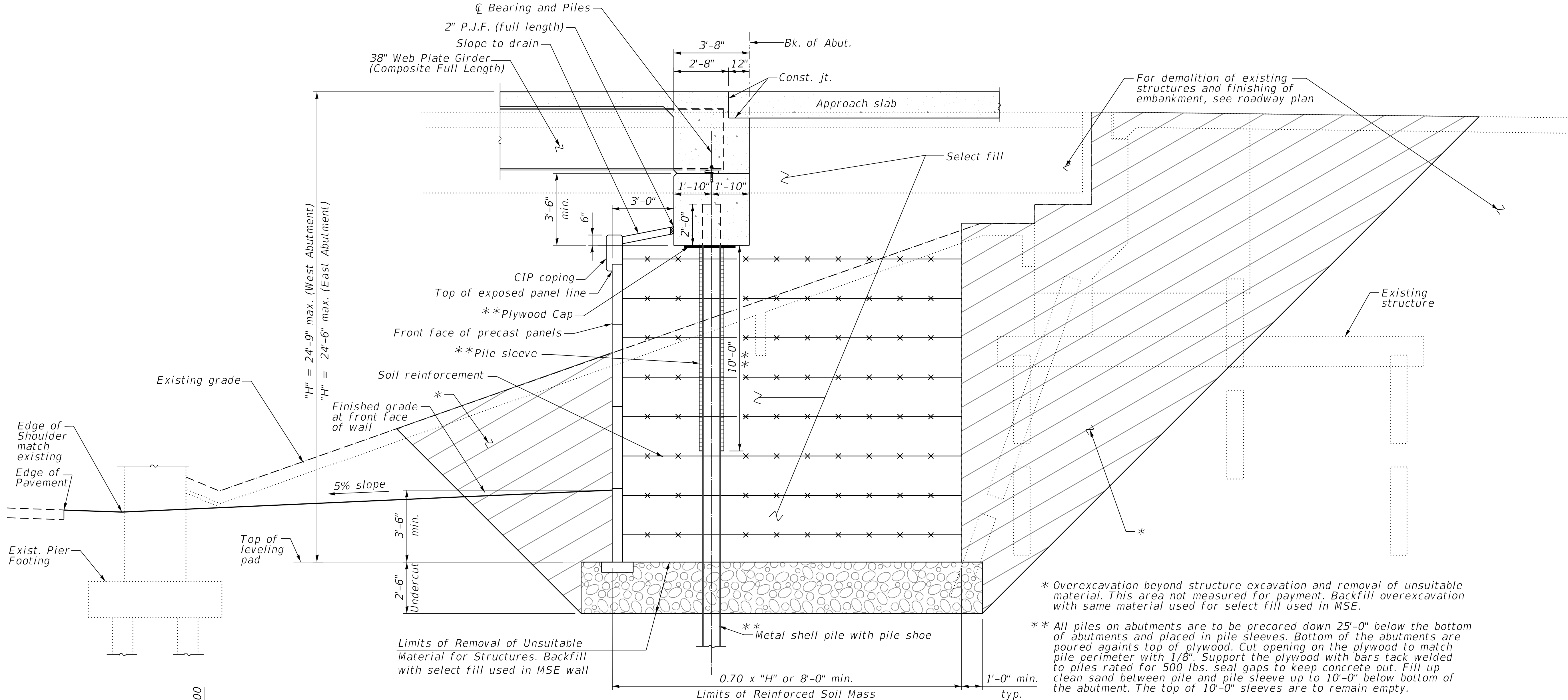
CONTRACT NO. 62R62

ILLINOIS FED. AID PROJECT

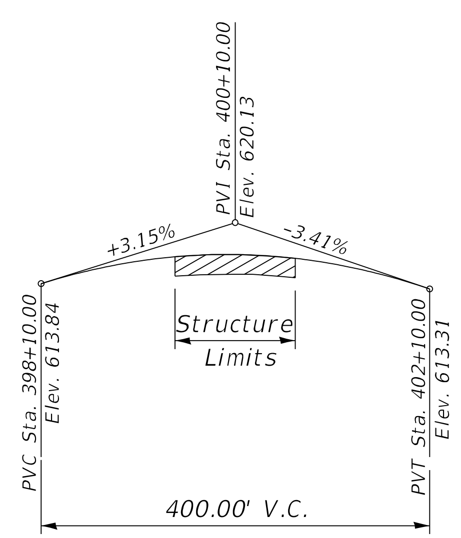


* Overexcavation beyond structure excavation and removal of unsuitable material. This area not measured for payment. Backfill overexcavation with same material used for select fill used in MSE.

** All piles on abutments are to be precored down 25'-0" below the bottom of abutments and placed in pile sleeves. Bottom of the abutments are poured againts top of plywood. Cut opening on the plywood to match pile perimeter with 1/8". Support the plywood with bars tack welded to piles rated for 500 lbs. seal gaps to keep concrete out. Fill up clean sand between pile and pile sleeve up to 10'-0" below bottom of the abutment. The top of 10'-0" sleeves are to remain empty.

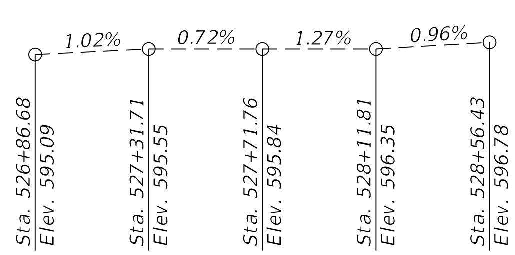
SECTION THRU INTEGRAL ABUTMENT

(Horiz. dim. @ Rt. ∠'s) Typical for West and East Abutment



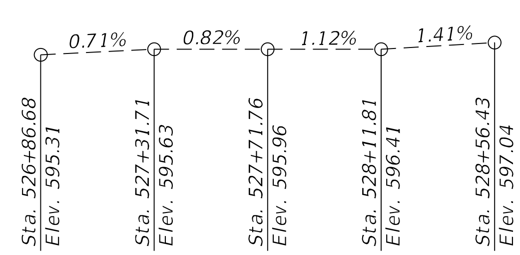
PROFILE GRADE

(Along ℄ Michigan City Road)



PROFILE GRADE

(Along P.G.L. SB I-94)



PROFILE GRADE

(Along P.G.L. NB I-94)

ABUTMENT DETAILS II
MICHIGAN CITY ROAD OVER I-94
(BISHOP FORD FREEWAY)
F.A.U. RTE. 3593 SEC. 0606(2HB)R-86
COOK COUNTY
STATION 400+00.00
STRUCTURE NO. 016-8320

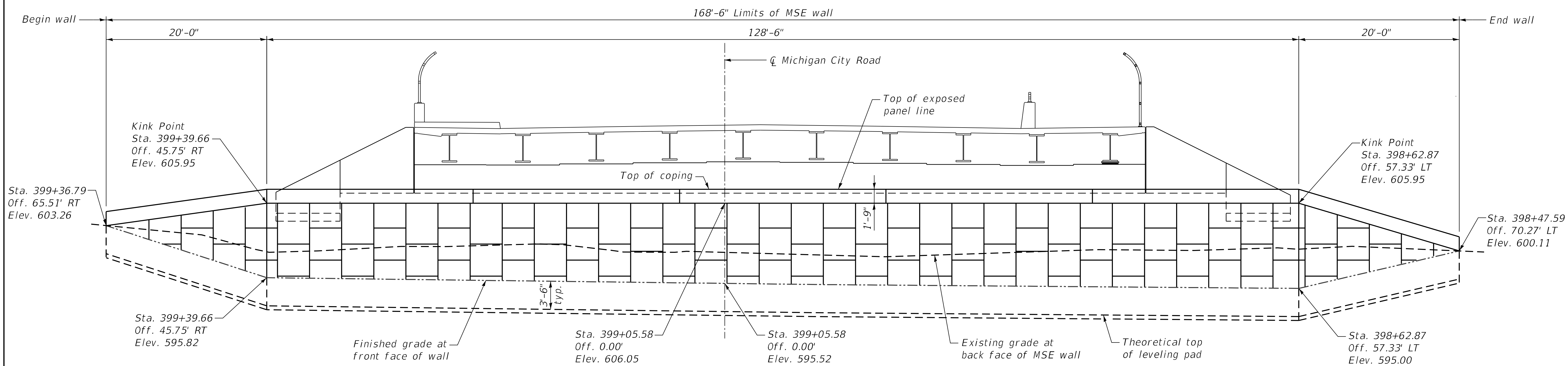
DELTA ENGINEERING GROUP, LLC
CONSULTING ENGINEERS, CONSTRUCTION MANAGERS, SURVEYORS
111 W JACKSON BLVD, SUITE 910
CHICAGO, IL 60604
T 312.377.7700, F 312.427.6145

USER NAME = rmamucod	DESIGNED - RC	REVISED -	
	DRAWN - RM	REVISED -	
PLOT SCALE = 5:4.0000 ':' / in.	CHECKED - SMK	REVISED -	
PLOT DATE = 4/25/2024	DATE - 4/19/2024	REVISED -	

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

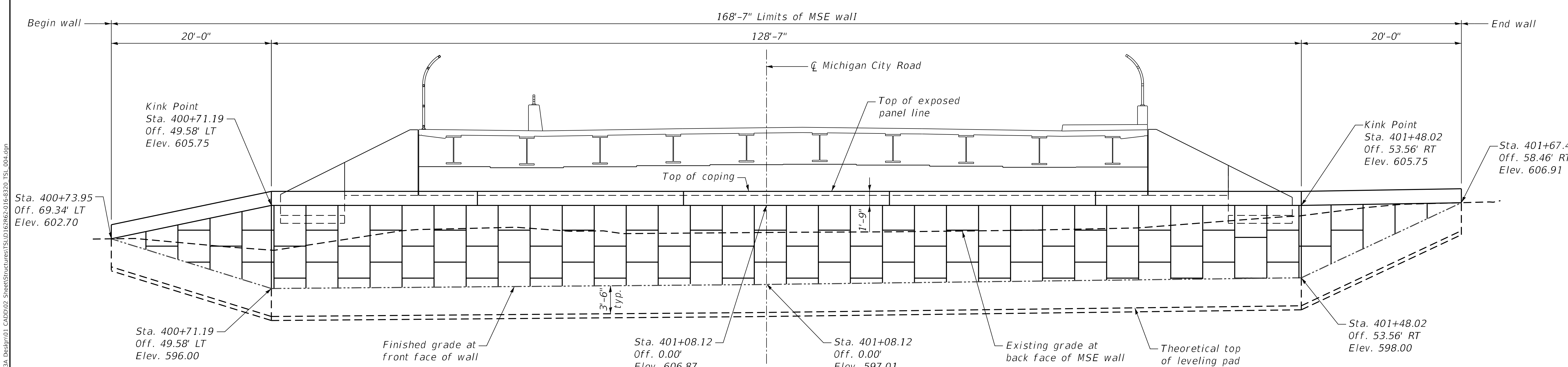
SCALE:	SHEET OF S-49 SHEETS	STA.	TO STA.

F.A.U. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
3593	(0505.4 & 0606.2HB)R-86	COOK	4	3
CONTRACT NO. 62R62				
ILLINOIS	FED. AID PROJECT			



WEST ABUTMENT MSE WALL

(Unfolded elevation along front face of wall)



EAST ABUTMENT MSE WALL

(Unfolded elevation along front face of wall)

Note:
1. The MSE wall offsets are measured from centerline of Michigan CIty Road.

MSE WALL DETAILS
MICHIGAN CITY ROAD OVER I-94
(BISHOP FORD FREEWAY)
F.A.U. RTE. 3593 SEC. 0606(2HB)R-86
COOK COUNTY
STATION 400+00.00
STRUCTURE NO. 016-8320

DELTA ENGINEERING GROUP, LLC
CONSULTING ENGINEERS, CONSTRUCTION MANAGERS, SURVEYORS
111 W JACKSON BLVD, SUITE 910
CHICAGO, IL 60604
T 312.377.7700, F 312.427.6145

USER NAME = rmamucod	DESIGNED - RC	REVISED -
	DRAWN - RM	REVISED -
PLOT SCALE = 12:6.0000 ':" / in.	CHECKED - SMK	REVISED -
PLOT DATE = 4/25/2024	DATE - 4/19/2024	REVISED -

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

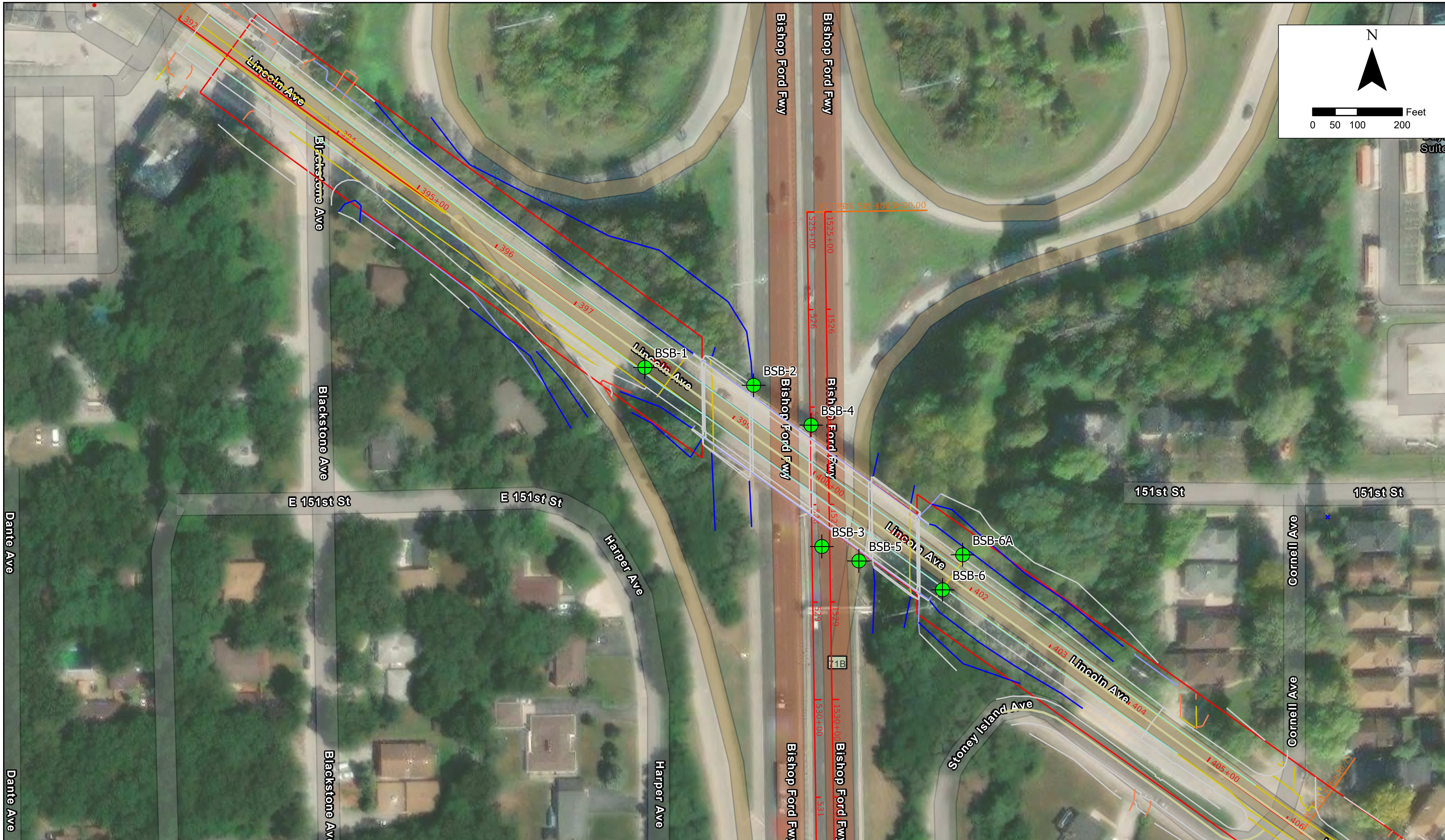
SCALE: | SHEET OF S-49 SHEETS | STA. TO STA.

F.A.U. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
3593	(0505.4 & 0606.2HB)R-86	COOK	4	4
		CONTRACT NO. 62R62		
		ILLINOIS FED. AID PROJECT		

APPENDIX B

SOIL BORING LOCATION PLAN

AND SUBSURFACE PROFILE

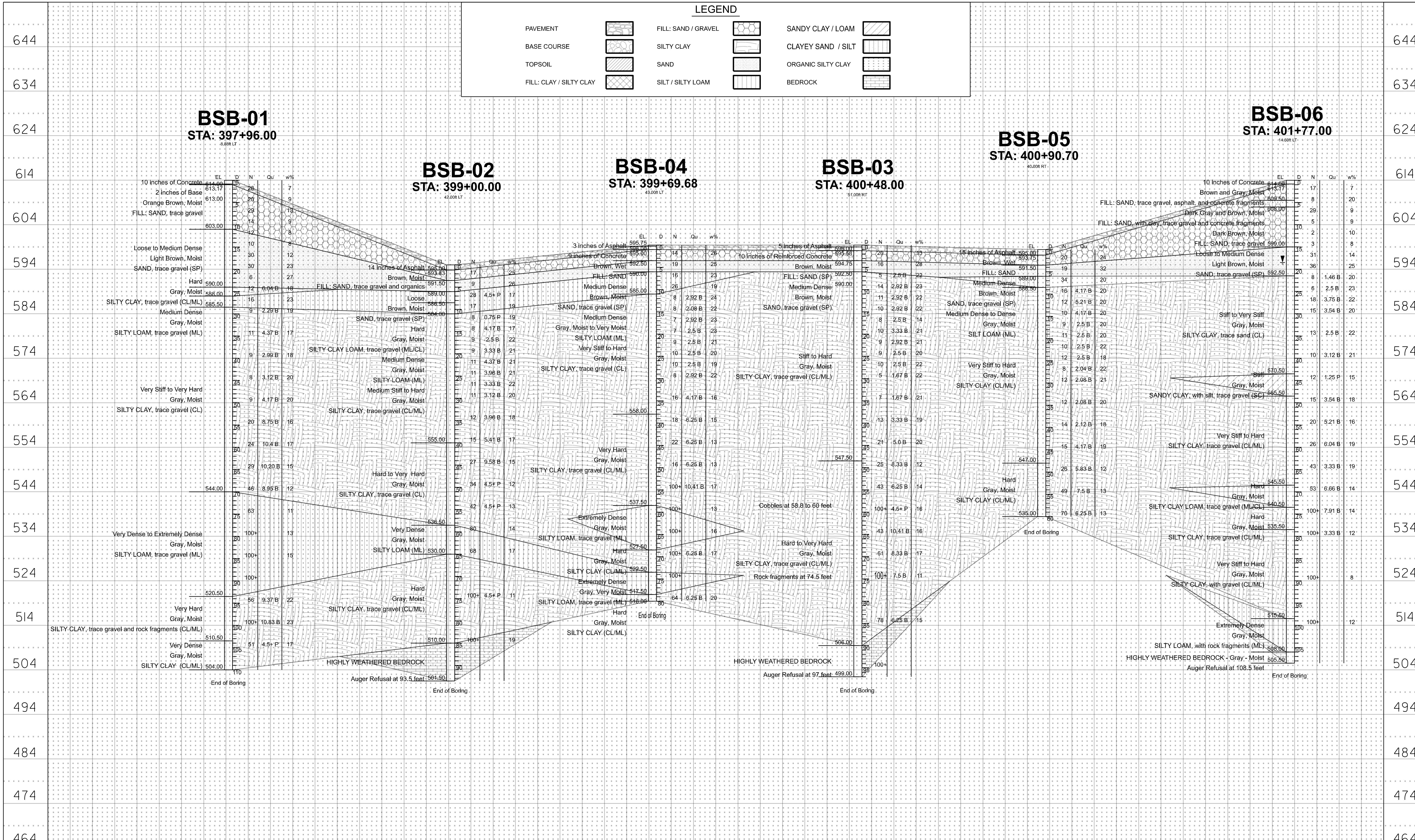


DRAWN BY KN	**DATE** 10/30/2023	GSG CONSULTANTS, INC. 735 Remington Road, Schaumburg, IL 60173 Tel: 630.994.2600, www.gsg-consultants.com	Illinois Department of Transportation; DELTA ENGINEERING GROUP
CHECKED BY MZ	**DATE** 10/30/2023		

MICHIGAN CITY ROAD OVER I-94

EXHIBIT 1: BRIDGE BORING LOCATION PLAN

SHEET NO. -



GSG CONSULTANTS, INC.
735 E. REMINGTON RD, SCHAUMBURG, IL 60173
TEL: +1630.994.2600 | WWW.GSG-CONSULTANTS.COM

USER NAME	= $USER$	DESIGNED	-
SHEET SIZE	= 17x11 (in.)	DRAWN	-
PLOT SCALE	= 0.610 m / in.	CHECKED	-
PLOT DATE	= 9/28/2023	DATE	-

DELTA ENGINEERING 204-001

SUBSURFACE PROFILES
MICHIGAN CITY ROAD OVER I-94

SCALE: ____ SHEET OF SHEETS STA. TO STA.

F.A. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.

CONTRACT NO.
ILLINOIS FED. AID PROJECT

APPENDIX C

SOIL BORING LOGS

SOIL BORING LOG

Illinois Department of Transportation
Division of Highways
GSG

Date 7/26/23

ROUTE Michigan City Rd **DESCRIPTION** Bridge Boring **LOGGED BY** TS

SECTION Michigan City Rd **LOCATION** , SEC. , TWP. , RNG. ,
Latitude 41.6212571, **Longitude** -87.5795654

COUNTY COOK **DRILLING RIG** CME 75 **HAMMER TYPE** AUTO
DRILLING METHOD HSA **HAMMER EFF (%)** 79.8

STRUCT. NO.
Station

BORING NO. BSB-01
Station 397+96.00
Offset 8.90ft RT
Ground Surface Elev. 614.00 ft

Surface Water Elev. N/A ft
Stream Bed Elev. N/A ft

Groundwater Elev.:
First Encounter None ft
Upon Completion N/A ft
After N/A **Hrs.** N/A ft

Description	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
10 inches of Concrete				
613.17				
2 inches of Base				
613.00		11		
Orange Brown, Moist		15		7
FILL: SAND, trace gravel		13		
		9		
		11		9
	-5	9		
		8		
		14		13
		15		
		8		
		8		9
	-10	6		
603.00				
Loose to Medium Dense		4		
Light Brown, Moist		5		8
SAND, trace gravel (SP)		7		
		5		
		5		8
	-15	5		
		10		
		14		12
		16		
		14		
		13		23
	-20	17		

Description	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Loose to Medium Dense				
Light Brown, Moist				
SAND, trace gravel (SP)		5		
(continued)		4		27
		2		
590.00		3		
Hard		5	6.0	18
Gray, Moist		7	B	
SILTY CLAY, trace gravel (CL/ML)	-25			
588.00				
Medium Dense		5		
Gray, Moist		10		23
SILTY LOAM, trace gravel (ML)		6		
585.50				
Very Stiff to Very Hard		3		
Gray, Moist		4	2.3	19
SILTY CLAY, trace gravel (CL)	-30	5	B	
		4		
		6	4.4	17
	-35	5	B	
		4		
		4	3.0	18
	-40	5	B	

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

Illinois Department of Transportation
Division of Highways
GSG

SOIL BORING LOG

Date 7/26/23

ROUTE Michigan City Rd **DESCRIPTION** Bridge Boring **LOGGED BY** TS

SECTION Michigan City Rd **LOCATION** , SEC. , TWP. , RNG. ,
Latitude 41.6212571, **Longitude** -87.5795654

COUNTY COOK **DRILLING RIG** CME 75 **HAMMER TYPE** AUTO
DRILLING METHOD HSA **HAMMER EFF (%)** 79.8

STRUCT. NO.
Station

BORING NO. BSB-01
Station 397+96.00
Offset 8.90ft RT
Ground Surface Elev. 614.00 ft

Surface Water Elev. N/A ft
Stream Bed Elev. N/A ft

Groundwater Elev.:
First Encounter None ft
Upon Completion N/A ft
After N/A **Hrs.** N/A ft

Description	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Very Stiff to Very Hard Gray, Moist SILTY CLAY, trace gravel (CL) *(continued)*				
		3		
	-45	3 5	3.1 B	20
		4		
	-50	4 5	4.2 B	20
		6		
	-55	9 11	8.8 B	16
		9		
	-60	11 13	10.4 B	17

Description	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Very Stiff to Very Hard Gray, Moist SILTY CLAY, trace gravel (CL) *(continued)*				
		9		
	-65	12 17	10.2 B	15
		12		
544.00	-70	17 29	9.0 B	12
Very Dense to Extremely Dense Gray, Moist SILTY LOAM, trace gravel (ML)				
		24		
	-75	26 37		11
		50/4"		
	-80			13

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

Illinois Department of Transportation
Division of Highways
GSG

SOIL BORING LOG

Date 7/26/23

ROUTE Michigan City Rd DESCRIPTION Bridge Boring LOGGED BY TS

SECTION Michigan City Rd LOCATION , SEC. , TWP. , RNG. ,
Latitude 41.6212571, Longitude -87.5795654

COUNTY COOK DRILLING RIG CME 75 HAMMER TYPE AUTO
DRILLING METHOD HSA HAMMER EFF (%) 79.8

STRUCT. NO.
Station

BORING NO. BSB-01
Station 397+96.00
Offset 8.90ft RT
Ground Surface Elev. 614.00 ft

Surface Water Elev. N/A ft
Stream Bed Elev. N/A ft

Groundwater Elev.:
First Encounter None ft
Upon Completion N/A ft
After N/A Hrs. N/A ft

Description	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Very Dense to Extremely Dense Gray, Moist SILTY LOAM, trace gravel (ML) *(continued)*				
		19		
		39		15
	-85	50/5"		
		50/2"		
	-90			
520.50				
Very Hard Gray, Moist SILTY CLAY, trace gravel and rock fragments (CL/ML)		10		
		17	9.4	22
	-95	39	B	
		10		
		25	10.8	23
	-100	50/3"	B	

Description	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Very Hard Gray, Moist SILTY CLAY, trace gravel and rock fragments (CL/ML) *(continued)*				
510.50				
Very Dense Gray, Moist SILTY CLAY (CL/ML)		15		
		24	4.5	17
	-105	27	P	
504.00	-110			
End of Boring				
	-115			
	-120			

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

Illinois Department of Transportation
Division of Highways
GSG

SOIL BORING LOG

Date 8/2/23

ROUTE	Michigan City Rd	**DESCRIPTION**	Bridge Boring	**LOGGED BY**	TS
SECTION	Michigan City Rd	**LOCATION**	, SEC. , TWP. , RNG. , Latitude 41.62120421, Longitude -87.57915855		
COUNTY	COOK	**DRILLING RIG**	CME 75	**HAMMER TYPE**	AUTO
		DRILLING METHOD	HSA	**HAMMER EFF (%)**	79.8

STRUCT. NO.	
Station	
BORING NO.	BSB-02
Station	399+00.00
Offset	42.00ft LT
Ground Surface Elev.	595.00 ft
Surface Water Elev.	N/A ft
Stream Bed Elev.	N/A ft
Groundwater Elev.:	
First Encounter	None ft
Upon Completion	N/A ft
After N/A Hrs.	N/A ft

Description	Elev.	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
14 inches of Asphalt	593.83				
Brown, Moist FILL: SAND, trace gravel and organics	591.50		3 8 9		25
Loose Brown, Moist SAND, trace gravel (SP)	589.00	-5	2 6 3		26
Hard Gray, Moist SILTY CLAY LOAM, trace gravel (ML/CL)	586.50		4 12 16	4.5 P	17
Medium Dense Gray, Moist SILTY LOAM (ML)	584.00	-10	7 9 8		19
Medium Stiff to Hard Gray, Moist SILTY CLAY, trace gravel (CL/ML)			3 3 5	0.8 P	19
		-15	1 4 4	4.2 B	17
			2 4 5	2.5 B	22
		-20	2 4 5	3.3 B	21
Medium Stiff to Hard Gray, Moist SILTY CLAY, trace gravel (CL/ML) *(continued)*			2 5 6	4.4 B	21
		-25	3 5 6	4.0 B	21
			3 4 7	3.3 B	22
		-30	3 4 7	3.1 B	20
		-35	3 6 6	4.0 B	18
	555.00	-40	5 7 8	5.4 B	17

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

Illinois Department of Transportation
Division of Highways
GSG

SOIL BORING LOG

Date 8/2/23

ROUTE Michigan City Rd	**DESCRIPTION** Bridge Boring		**LOGGED BY** TS
SECTION Michigan City Rd	**LOCATION** , SEC. , TWP. , RNG. , Latitude 41.62120421, Longitude -87.57915855		
COUNTY COOK	**DRILLING RIG** CME 75	**DRILLING METHOD** HSA	**HAMMER TYPE** AUTO; **HAMMER EFF (%)** 79.8

STRUCT. NO. ___
Station ___

BORING NO. BSB-02
Station 399+00.00
Offset 42.00ft LT
Ground Surface Elev. 595.00 ft

Surface Water Elev. N/A ft
Stream Bed Elev. N/A ft

Groundwater Elev.:
First Encounter None ft
Upon Completion N/A ft
After N/A **Hrs.** N/A ft

Description	Elev.	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Hard to Very Hard Gray, Moist SILTY CLAY, trace gravel (CL)			8 12 15	9.6 B	15
		-45			
			15 17 17	4.5 P	12
		-50			
			19 19 23	4.5 P	13
		-55			
	536.50				
Very Dense Gray, Moist SILTY LOAM (ML)			24 36 44		14
		-60			

Description	Elev.	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Very Dense Gray, Moist SILTY LOAM (ML) *(continued)*			25 32 36		17
	530.00	-65			
Hard Gray, Moist SILTY CLAY, trace gravel (CL/ML)					
		-70			
			45 50/3"	4.5 P	11
		-75			
		-80			

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

Illinois Department of Transportation
Division of Highways
GSG

SOIL BORING LOG

Date 8/2/23

ROUTE Michigan City Rd DESCRIPTION Bridge Boring LOGGED BY TS

SECTION Michigan City Rd LOCATION , SEC. , TWP. , RNG. ,
Latitude 41.62120421, Longitude -87.57915855

COUNTY COOK DRILLING RIG CME 75 HAMMER TYPE AUTO
DRILLING METHOD HSA HAMMER EFF (%) 79.8

STRUCT. NO.
Station

BORING NO. BSB-02
Station 399+00.00
Offset 42.00ft LT
Ground Surface Elev. 595.00 ft

Surface Water Elev. N/A ft
Stream Bed Elev. N/A ft

Groundwater Elev.:
First Encounter None ft
Upon Completion N/A ft
After N/A Hrs. N/A ft

Description	Elev.	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Hard Gray, Moist SILTY CLAY, trace gravel (CL/ML) *(continued)*			50/4"		19
	510.00	-85			
HIGHLY WEATHERED BEDROCK					
		-90			
Auger Refusal at 93.5 feet	501.50				
End of Boring		-95			
		-100			

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

BBS, form 137 (Rev. 8-99)

Illinois Department of Transportation
Division of Highways
GSG

SOIL BORING LOG

Date 7/26/23

ROUTE Michigan City Rd **DESCRIPTION** Bridge Boring **LOGGED BY** EH

SECTION Michigan City Rd **LOCATION** , SEC. , TWP. , RNG. ,
Latitude 41.620749, Longitude -87.578908

COUNTY COOK **DRILLING RIG** Mobile B57 **HAMMER TYPE** AUTO
DRILLING METHOD HSA **HAMMER EFF (%)** 89.0

STRUCT. NO.
Station

BORING NO. BSB-03
Station 400+48.00
Offset 51.00ft RT
Ground Surface Elev. 596.00 ft

Surface Water Elev. N/A ft
Stream Bed Elev. N/A ft

Groundwater Elev.:
First Encounter None ft
Upon Completion N/A ft
After N/A **Hrs.** N/A ft

Description	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
5 inches of Asphalt 595.58				
10 inches of Reinforced Concrete 594.75		7		
Brown, Moist FILL: SAND (SP)		9		13
		11		
592.50				
Medium Dense Brown, Moist SAND, trace gravel (SP)		5		
		9		28
	-5	7		
590.00				
Stiff to Hard Gray, Moist SILTY CLAY, trace gravel (CL/ML)		2		
		2	2.5	22
		3	B	
		2		
		4	2.9	23
	-10	10	B	
		5		
		5	2.9	22
		6	B	
		2		
		4	2.9	22
	-15	6	B	
		2		
		4	2.5	14
		4	B	
		3		
		4	3.3	21
	-20	6	B	

Description	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Stiff to Hard Gray, Moist SILTY CLAY, trace gravel (CL/ML) *(continued)*		3		
		4	2.9	21
		5	B	
		3		
		3	2.5	20
	-25	6	B	
		3		
		3	2.5	22
		7	B	
		2		
		2	1.7	22
	-30	3	B	
		1		
		2	1.7	21
	-35	5	B	
		3		
		5	3.3	19
	-40	8	B	

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

BBS, form 137 (Rev. 8-99)

Illinois Department of Transportation
Division of Highways
GSG

SOIL BORING LOG

Date 7/26/23

ROUTE Michigan City Rd **DESCRIPTION** Bridge Boring **LOGGED BY** EH

SECTION Michigan City Rd **LOCATION** , SEC. , TWP. , RNG. ,
Latitude 41.620749, **Longitude** -87.578908

COUNTY COOK **DRILLING RIG** Mobile B57 **HAMMER TYPE** AUTO
DRILLING METHOD HSA **HAMMER EFF (%)** 89.0

STRUCT. NO.
Station

BORING NO. BSB-03
Station 400+48.00
Offset 51.00ft RT
Ground Surface Elev. 596.00 ft

Surface Water Elev. N/A ft
Stream Bed Elev. N/A ft

Groundwater Elev.:
First Encounter None ft
Upon Completion N/A ft
After N/A **Hrs.** N/A ft

Description	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Stiff to Hard Gray, Moist SILTY CLAY, trace gravel (CL/ML) *(continued)*				
		6		
		11	5.0	20
	-45	10	B	
547.50				
Hard to Very Hard Gray, Moist SILTY CLAY, trace gravel (CL/ML)		11		
		10	8.3	12
	-50	15	B	
		21		
		21	6.3	14
	-55	22	B	
Cobbles at 58.8 to 60 feet		50/5.5"		
			4.5	16
	-60		P	

Description	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Hard to Very Hard Gray, Moist SILTY CLAY, trace gravel (CL/ML) *(continued)*				
		15		
		16	10.4	16
	-65	27	B	
		18		
		24	8.3	17
	-70	37	B	
		38		
		29	7.5	11
Rock fragments at 74.5 feet	-75	50/3"	B	
	-80			

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

Illinois Department of Transportation
Division of Highways
GSG

SOIL BORING LOG

Date 7/26/23

ROUTE Michigan City Rd **DESCRIPTION** Bridge Boring **LOGGED BY** EH

SECTION Michigan City Rd **LOCATION** , **SEC.** , **TWP.** , **RNG.** ,
Latitude 41.620749, **Longitude** -87.578908

COUNTY COOK **DRILLING RIG** Mobile B57 **HAMMER TYPE** AUTO
DRILLING METHOD HSA **HAMMER EFF (%)** 89.0

STRUCT. NO.
Station

BORING NO. BSB-03
Station 400+48.00
Offset 51.00ft RT
Ground Surface Elev. 596.00 ft

Surface Water Elev. N/A ft
Stream Bed Elev. N/A ft

Groundwater Elev.:
First Encounter None ft
Upon Completion N/A ft
After N/A **Hrs.** N/A ft

Description	Elev.	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Hard to Very Hard Gray, Moist SILTY CLAY, trace gravel (CL/ML) *(continued)*					
			25 28 50	6.3 B	15
		-85			
	506.00	-90			
HIGHLY WEATHERED BEDROCK					
			50/1"		
		-95			
Auger Refusal at 97 feet	499.00				
End of Boring					
		-100			

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

Illinois Department of Transportation
Division of Highways
GSG

SOIL BORING LOG

Date 7/24/23

ROUTE Michigan City Rd **DESCRIPTION** Bridge Boring **LOGGED BY** EH

SECTION Michigan City Rd **LOCATION** , SEC. , TWP. , RNG. ,
Latitude 41.62109073, **Longitude** -87.57894435

COUNTY COOK **DRILLING RIG** Mobile B57 **HAMMER TYPE** AUTO
DRILLING METHOD HSA **HAMMER EFF (%)** 89.0

STRUCT. NO.
Station

BORING NO. BSB-04
Station 399+69.68
Offset 43.00ft LT
Ground Surface Elev. 596.00 ft

Surface Water Elev. N/A ft
Stream Bed Elev. N/A ft

Groundwater Elev.:
First Encounter None ft
Upon Completion N/A ft
After N/A **Hrs.** N/A ft

Description	Elev.	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
3 inches of Asphalt	~~595.75~~				
9 inches of Concrete	595.00				
Brown, Wet FILL: SAND			7 5 9		26
	592.50				
Medium Dense Brown, Moist SAND, trace gravel (SP)		-5	3 9 10		25
	590.00				
Medium Dense Gray, Moist to Very Moist SILTY LOAM (ML)			7 7 9		23
		-10	6 12 14		19
	585.00				
Very Stiff to Hard Gray, Moist SILTY CLAY, trace gravel (CL)			4 3 5	2.9 B	24
		-15	2 4 4	2.1 B	22
			3 3 4	2.9 B	23
		-20	2 3 4	2.5 B	23

Description	Elev.	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Very Stiff to Hard Gray, Moist SILTY CLAY, trace gravel (CL) *(continued)*			2 4 5	2.5 B	21
		-25	2 4 6	2.5 B	20
			3 5 5	2.5 B	19
		-30	3 3 5	2.9 B	22
		-35	4 6 10	4.2 B	16
	558.00				
Very Hard Gray, Moist SILTY CLAY, trace gravel (CL/ML)		-40	6 8 10	6.3 B	15

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

Illinois Department of Transportation
Division of Highways
GSG

SOIL BORING LOG

Date 7/24/23

ROUTE Michigan City Rd DESCRIPTION Bridge Boring LOGGED BY EH

SECTION Michigan City Rd LOCATION , SEC. , TWP. , RNG. ,
Latitude 41.62109073, Longitude -87.57894435

COUNTY COOK DRILLING RIG Mobile B57 HAMMER TYPE AUTO
DRILLING METHOD HSA HAMMER EFF (%) 89.0

STRUCT. NO.
Station

BORING NO. BSB-04
Station 399+69.68
Offset 43.00ft LT
Ground Surface Elev. 596.00 ft

Surface Water Elev. N/A ft
Stream Bed Elev. N/A ft

Groundwater Elev.:
First Encounter None ft
Upon Completion N/A ft
After N/A Hrs. N/A ft

Description	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Very Hard Gray, Moist SILTY CLAY, trace gravel (CL/ML) *(continued)*				
	-45	8 9 13	6.3 B	13
	-50	8 8 8	6.3 B	13
	-55	15 50/5.5"	10.4 B	17
537.50				
Extremely Dense Gray, Moist SILTY LOAM, trace gravel (ML)	-60	48 50/4"		13

Description	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Extremely Dense Gray, Moist SILTY LOAM, trace gravel (ML) *(continued)*				
	-65	24 36 50/5"		16
527.50				
Hard Gray, Moist SILTY CLAY (CL/ML)	-70	13 41 50/5"	6.3 B	17
522.50				
Extremely Dense Gray, Very Moist SILTY LOAM, trace gravel (ML)	-75	50/3"		
517.50				
Hard Gray, Moist SILTY CLAY (CL/ML) 516.00	-80	13 34 30	6.3 B	20

End of Boring

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

Illinois Department of Transportation
Division of Highways
GSG

SOIL BORING LOG

Date 7/23/23

ROUTE Michigan City Rd **DESCRIPTION** Bridge Boring **LOGGED BY** EH

SECTION Michigan City Rd **LOCATION** , SEC. , TWP. , RNG. ,
Latitude 41.62070743, **Longitude** -87.57876953

COUNTY COOK **DRILLING RIG** Mobile B57 **HAMMER TYPE** AUTO
DRILLING METHOD HSA **HAMMER EFF (%)** 89.0

STRUCT. NO.
Station

BORING NO. BSB-05
Station 400+90.70
Offset 40.00ft RT
Ground Surface Elev. 595.00 ft

Surface Water Elev. N/A ft
Stream Bed Elev. N/A ft

Groundwater Elev.:
First Encounter None ft
Upon Completion N/A ft
After N/A **Hrs.** N/A ft

Description	Elev.	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
15 inches of Asphalt	593.75				
Brown, Wet FILL: SAND			4 9 11		24
	591.50				
Medium Dense Brown, Moist SAND, trace gravel (SP)		-5	5 9 10		32
	589.00				
Medium Dense to Dense Gray, Moist SILT LOAM (ML)			7 15 19		20
	586.50				
Very Stiff to Hard Gray, Moist SILTY CLAY (CL/ML)		-10	9 9 7	4.2 B	20
			4 4 8	5.2 B	20
		-15	4 5 5	4.2 B	20
			3 4 5	2.5 B	20
		-20	4 5 6	2.5 B	20

Description	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Very Stiff to Hard Gray, Moist SILTY CLAY (CL/ML) *(continued)*		3 4 6	2.5 B	22
	-25	3 5 7	2.5 B	18
		2 3 5	2.0 B	22
	-30	0 6 6	2.1 B	21
	-35	4 5 7	2.1 B	20
	-40	4 5 9	2.1 B	18

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

Illinois Department of Transportation
Division of Highways
GSG

SOIL BORING LOG

Date 7/23/23

ROUTE Michigan City Rd **DESCRIPTION** Bridge Boring **LOGGED BY** EH

SECTION Michigan City Rd **LOCATION** , **SEC.** , **TWP.** , **RNG.** ,
Latitude 41.62070743, **Longitude** -87.57876953

COUNTY COOK **DRILLING RIG** Mobile B57 **HAMMER TYPE** AUTO
DRILLING METHOD HSA **HAMMER EFF (%)** 89.0

STRUCT. NO.
Station

BORING NO. BSB-05
Station 400+90.70
Offset 40.00ft RT
Ground Surface Elev. 595.00 ft

Surface Water Elev. N/A ft
Stream Bed Elev. N/A ft

Groundwater Elev.:
First Encounter None ft
Upon Completion N/A ft
After N/A **Hrs.** N/A ft

Description	Elev.	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Very Stiff to Hard Gray, Moist SILTY CLAY (CL/ML) *(continued)*			3		
			6	4.2	19
		-45	9	B	
	547.00				
Hard Gray, Moist SILTY CLAY (CL/ML)			11		
			11	5.8	12
		-50	15	B	
			15		
			23	7.5	13
		-55	26	B	
			18		
			30	6.3	13
	535.00	-60	40	B	

End of Boring
The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

Illinois Department of Transportation
Division of Highways
GSG

SOIL BORING LOG

Date 7/31/23

ROUTE Michigan City Rd **DESCRIPTION** Bridge Boring **LOGGED BY** DV/EH

SECTION Michigan City Rd **LOCATION** , SEC. , TWP. , RNG. ,
Latitude 41.6206242, **Longitude** -87.5784571

COUNTY COOK **DRILLING RIG** D-50 ATV **HAMMER TYPE** AUTO
DRILLING METHOD HSA **HAMMER EFF (%)** 91.5

STRUCT. NO. ____
Station ____

BORING NO. BSB-06
Station 401+77.00
Offset 14.60ft RT
Ground Surface Elev. 614.00 ft

Surface Water Elev. N/A ft
Stream Bed Elev. N/A ft

Groundwater Elev.:
First Encounter 595.5 ft ▼
Upon Completion N/A ft
After N/A **Hrs.** N/A ft

Description	Elev. (ft)	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
10 inches of Concrete	613.17				
Brown and Gray, Moist FILL: SAND, trace gravel, asphalt, and concrete fragments			9 9 8		7
			5 4 4		20
	609.50	-5			
Dark Gray and Brown, Moist FILL: SAND, with clay, trace gravel and concrete fragments	608.00				
Dark Brown, Moist FILL: SAND, trace gravel			7 14 15		9
		-10	5 3 2		9
			2 1 1		10
	599.00	-15	1 1 2		8
Loose to Medium Dense Light Brown, Moist SAND, trace gravel (SP)			11 14 17		14
▼		-20	9 18 18		25

Description	Elev. (ft)	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Loose to Medium Dense Light Brown, Moist SAND, trace gravel (SP) *(continued)*	592.50				
Stiff to Very Stiff Gray, Moist SILTY CLAY, trace sand (CL)			5 4 4	1.5 B	20
		-25	2 2 4	2.5 B	23
			4 6 12	3.8 B	22
		-30	4 7 8	3.5 B	20
		-35	3 6 7	2.5 B	22
		-40	3 4 6	3.1 B	21

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

Illinois Department of Transportation
Division of Highways
GSG

SOIL BORING LOG

Date 7/31/23

ROUTE	Michigan City Rd	**DESCRIPTION**	Bridge Boring	**LOGGED BY**	DV/EH
SECTION	Michigan City Rd	**LOCATION**	, **SEC.** , **TWP.** , **RNG.** , **Latitude** 41.6206242, **Longitude** -87.5784571		
COUNTY	COOK	**DRILLING RIG**	D-50 ATV	**HAMMER TYPE**	AUTO
		DRILLING METHOD	HSA	**HAMMER EFF (%)**	91.5

STRUCT. NO.		**Surface Water Elev.**	N/A ft
Station		**Stream Bed Elev.**	N/A ft
BORING NO.	BSB-06	**Groundwater Elev.:**	
Station	401+77.00	**First Encounter**	595.5 ft ▼
Offset	14.60ft RT	**Upon Completion**	N/A ft
Ground Surface Elev.	614.00 ft	**After** N/A **Hrs.**	N/A ft

Description	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Stiff to Very Stiff Gray, Moist SILTY CLAY, trace sand (CL) *(continued)*				
570.50				
Stiff Gray, Moist SANDY CLAY, with silt, trace gravel (SC)	-45	2 5 7	1.3 P	15
565.50				
Very Stiff to Hard SILTY CLAY, trace gravel (CL/ML)	-50	3 6 9	3.5 B	18
	-55	5 8 12	5.2 B	16
	-60	7 11 15	6.0 B	19

Description	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Very Stiff to Hard SILTY CLAY, trace gravel (CL/ML) *(continued)*	-65	9 18 25	3.3 B	19
545.50				
Hard Gray, Moist SILTY CLAY LOAM, trace gravel (ML/CL)	-70	15 21 32	6.7 B	14
540.50				
Hard Gray, Moist SILTY CLAY, trace gravel (CL/ML)	-75	20 34 50/4"	7.9 B	14
535.50				
Very Stiff to Hard Gray, Moist SILTY CLAY, with gravel (CL/ML)	-80	50/5"	3.3 B	12

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

Illinois Department of Transportation
Division of Highways
GSG

SOIL BORING LOG

Date 7/31/23

ROUTE Michigan City Rd **DESCRIPTION** Bridge Boring **LOGGED BY** DV/EH

SECTION Michigan City Rd **LOCATION** , SEC. , TWP. , RNG. ,
Latitude 41.6206242, **Longitude** -87.5784571

COUNTY COOK **DRILLING RIG** D-50 ATV **HAMMER TYPE** AUTO
DRILLING METHOD HSA **HAMMER EFF (%)** 91.5

STRUCT. NO.
Station

BORING NO. BSB-06
Station 401+77.00
Offset 14.60ft RT
Ground Surface Elev. 614.00 ft

Surface Water Elev. N/A ft
Stream Bed Elev. N/A ft

Groundwater Elev.:
First Encounter 595.5 ft
Upon Completion N/A ft
After N/A **Hrs.** N/A ft

Description	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Very Stiff to Hard Gray, Moist SILTY CLAY, with gravel (CL/ML) *(continued)*				
	-85			
		50/3"		8
	-90			
	-95			
515.50				
		50/4"		12
	-100			

Description	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Extremely Dense Gray, Moist SILTY LOAM, with rock fragments (ML) *(continued)*				
	-105			
508.00				
HIGHLY WEATHERED BEDROCK - Gray - Moist				
Auger Refusal at 108.5 feet 505.50				
End of Boring				
	-110			
	-115			
	-120			

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

Illinois Department of Transportation
Division of Highways
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SOIL BORING LOG

Date 10/26/23

ROUTE Michigan City Rd **DESCRIPTION** Bridge Boring **LOGGED BY** DV

SECTION Michigan City Rd **LOCATION** , SEC. , TWP. , RNG. ,
Latitude 41.6207222, Longitude -087.5783806

COUNTY COOK **DRILLING RIG** Mobile B57 **HAMMER TYPE** AUTO
DRILLING METHOD HSA **HAMMER EFF (%)** 89.0

STRUCT. NO.
Station

BORING NO. BSB-6A
Station 401+71.66
Offset 26.64ft LT
Ground Surface Elev. 614.00 ft

Surface Water Elev. N/A ft
Stream Bed Elev. N/A ft

Groundwater Elev.:
First Encounter 590.5 ft ▼
Upon Completion N/A ft
After N/A Hrs. N/A ft

Description	Elev.	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
10 inches of Concrete	613.17				
8 inches of Aggregate Base	612.50		10		
Brown, Moist FILL: SAND, with gravel			15		9
			13		
	610.50				
Brown, Moist FILL: SAND, trace gravel			5		
			7		8
		-5	7		
			3		
			5		10
			6		
			4		
			8		6
		-10	4		
			1		
			1		8
			1		
			1		
			1		9
	599.00	-15	2		
Medium Dense to Dense Light Brown, Moist to Wet SAND, trace gravel (SP)			6		
			8		9
			13		
			12		
			19		22
		-20	16		

Description	Elev.	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
	593.00				
Medium Dense Gray, Wet SAND, trace gravel (SP)			11		
			8		25
			3		
	590.50 ▼				
Very Stiff to Hard Gray, Moist SILTY CLAY, trace gravel (CL/ML)			3		
			5	4.4	20
		-25	10	B	
			5		
			5	5.0	19
			9	B	
			4		
			4	5.8	20
		-30	7	B	
			5		
			7	4.2	20
		-35	10	B	
			3		
			4	3.5	20
		-40	7	B	

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

Illinois Department of Transportation
Division of Highways
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SOIL BORING LOG

Date 10/26/23

ROUTE Michigan City Rd DESCRIPTION Bridge Boring LOGGED BY DV

SECTION Michigan City Rd LOCATION , SEC. , TWP. , RNG. ,
Latitude 41.6207222, Longitude -087.5783806

COUNTY COOK DRILLING RIG Mobile B57 HAMMER TYPE AUTO
DRILLING METHOD HSA HAMMER EFF (%) 89.0

STRUCT. NO.
Station

BORING NO. BSB-6A
Station 401+71.66
Offset 26.64ft LT
Ground Surface Elev. 614.00 ft

Surface Water Elev. N/A ft
Stream Bed Elev. N/A ft

Groundwater Elev.:
First Encounter 590.5 ft
Upon Completion N/A ft
After N/A Hrs. N/A ft

Description	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Very Stiff to Hard Gray, Moist SILTY CLAY, trace gravel (CL/ML) *(continued)*				
	-45	3 4 5	3.8 B	21
	-50	3 5 6	3.5 B	17
	-55	5 6 10	5.0 B	16
555.00				
	-60	9 16 15	7.5 B	14

Description	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Hard Gray, Moist SILTY CLAY LOAM, trace gravel (ML/CL) *(continued)*				
550.50				
Hard to Very Hard Gray, Moist SILTY CLAY, trace gravel (CL/ML)	-65	6 8 9	5.0 B	18
	-70	10 11 14	10.0 B	13
540.50				
Very Hard Gray, Moist SILTY CLAY LOAM, trace gravel (ML/CL)	-75	15 33 40	10.8 B	13
Push Rock at 78.5 feet		50		
534.00	-80			

End of Boring

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

APPENDIX D

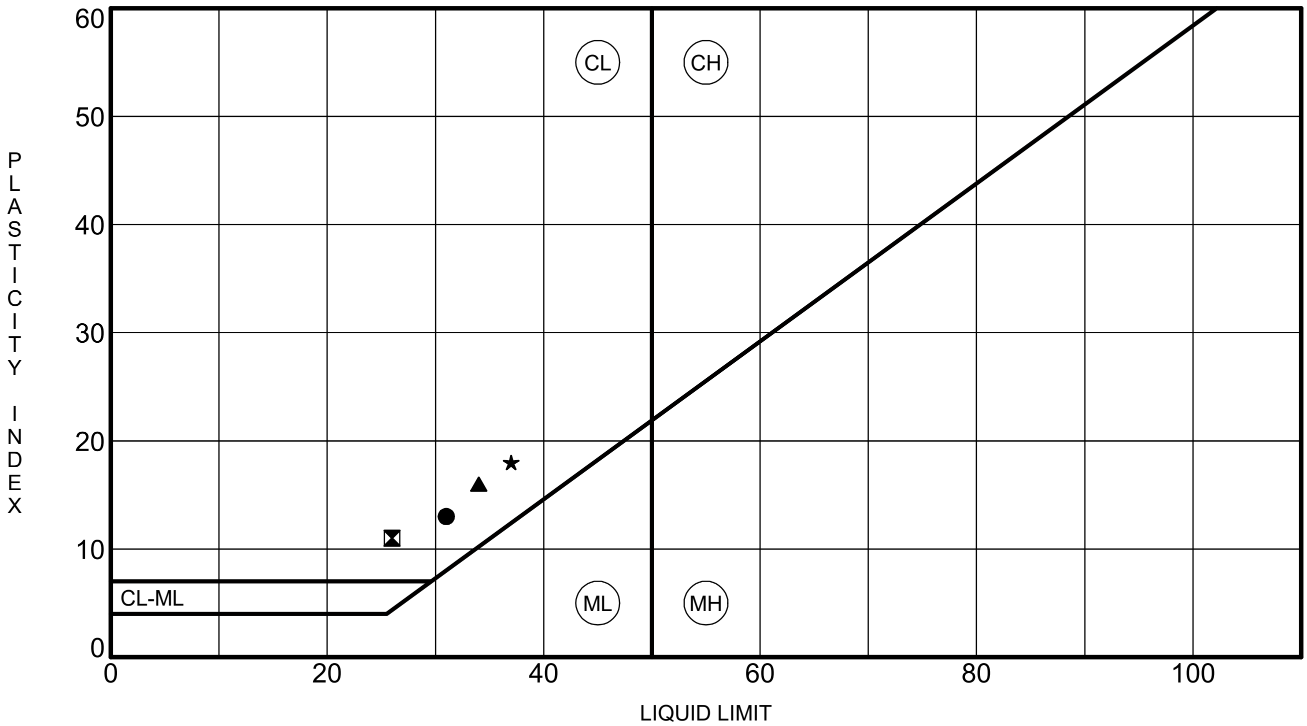
LABORATORY TEST RESULTS

& SUMMARY

GSG CONSULTANTS, INC.
735 Remington Road, Schaumburg, IL 60173
Tel: 630.994.2600, www.gsg-consultants.com

Test Results – Atterberg Limits

Boring ID	Sample Depth (ft)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Soil Classification
BSB-01	28.5-30.0	31.0	18.0	13.0	CL/ML
BSB-02	43.5-45.0	26.0	15.0	11.0	CL/ML
BSB-04	13.5-15.0	34.0	18.0	16.0	CL/ML
BSB-06	21.0-22.5	37.0	19.0	18.0	CL/ML



	Specimen Identification		LL	PL	PI	Fines	Classification
●	**BSB-01**	**28.50**	**31.0**	**18.0**	**13.0**		
⧗	**BSB-02**	**43.50**	**26.0**	**15.0**	**11.0**		
▲	**BSB-04**	**13.50**	**34.0**	**18.0**	**16.0**		
★	**BSB-06**	**21.00**	**37.0**	**19.0**	**18.0**		

Illinois Department of Transportation

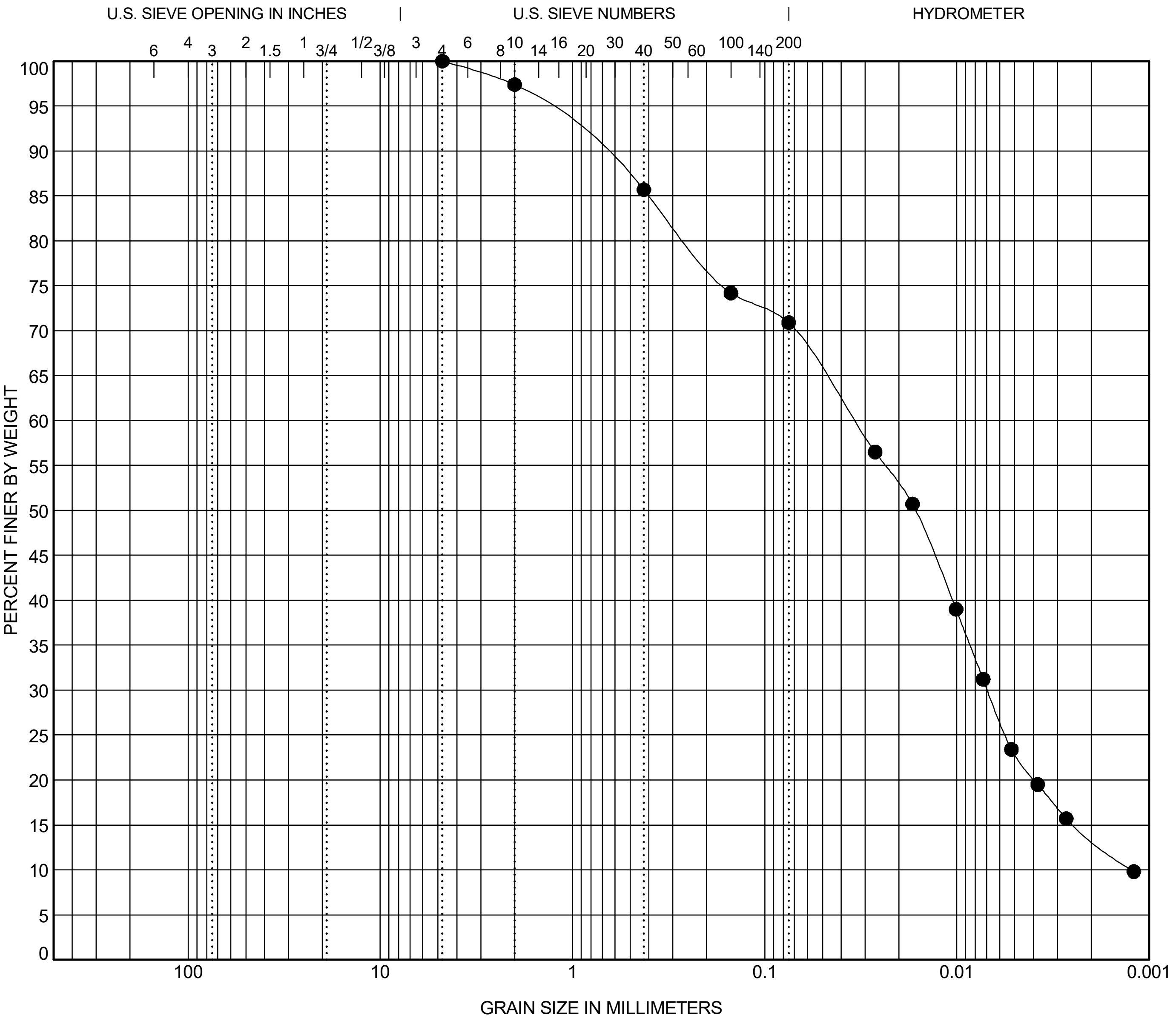
Division of Highways
GSG Consultants, Inc.

ATTERBERG LIMITS' RESULTS

Route: Michigan City Rd

Section: Michigan City Rd

County: COOK



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	BSB-01	73.50	SILTY LOAM				1.14	27.74

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	BSB-01	73.50	4.75	0.034	0.007	0.001	0.0	29.1	70.9	

Illinois Department of Transportation
Division of Highways
GSG

GRAIN SIZE DISTRIBUTION

Route: Michigan City Rd

Section: Michigan City Rd

County: COOK

APPENDIX E

IDOT PILE DESIGN TABLES

Pile Design Table for West Abutment utilizing Boring #BSB-02 with Downdrag

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)		Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)		Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Metal Shell 12"Φ w/.25" walls				**Steel HP 10 X 42**				**Steel HP 12 X 84**			
	161	14	37		97	13	34		123	17	34
	178	23	39		117	24	37		152	33	37
	196	34	42		126	29	39		166	41	39
	223	48	44		138	35	42		180	49	42
	282	81	49		159	47	44		209	65	44
	369	129	54		204	72	49		269	97	49
	380	134	55		264	105	59		341	137	59
	392	141	56		265	105	60		342	138	60
Metal Shell 14"Φ w/.25" walls					281	114	64		365	150	64
	194	20	37		283	115	66		368	152	66
	213	30	39	**Steel HP 10 X 57**					441	192	79
	234	42	42		99	13	34		454	199	84
	267	60	44		120	25	37		467	207	89
	338	99	49		129	30	39		481	214	94
	447	159	54		141	36	42		526	239	99
	459	166	55		163	48	44		574	265	104
Metal Shell 14"Φ w/.312" walls					209	74	49		664	315	108
	194	20	37		270	107	59	**Steel HP 14 X 73**			
	213	30	39		271	108	60		141	20	34
	234	42	42		287	117	64		175	39	37
	267	60	44		290	118	66		199	51	39
	338	99	49		346	149	69		214	60	42
	447	159	54		348	150	79		250	80	44
	459	166	55		359	156	84		321	119	49
	473	173	56		369	162	89		402	163	59
	566	224	59		380	168	94		403	164	60
	570	227	60		413	186	99		432	180	64
Metal Shell 16"Φ w/.312" walls					452	207	104		435	182	66
	202	12	34		454	208	108		520	228	69
	230	27	37	**Steel HP 12 X 53**					522	229	79
	250	38	39		116	15	34		537	238	84
	274	51	42		145	31	37		552	246	89
	313	73	44		159	39	39		567	254	94
	397	119	49		173	46	42	**Steel HP 14 X 89**			
	529	192	54		201	62	44		112	3	32
	543	199	55		258	93	49		144	21	34
	559	208	56		328	132	59		179	40	37
Metal Shell 16"Φ w/.375" walls					329	132	60		201	52	39
	202	12	34		350	144	64		217	61	42
	230	27	37		353	145	66		253	81	44
	250	38	39	**Steel HP 12 X 63**					326	121	49
	274	51	42		119	16	34		408	166	59
	313	73	44		148	32	37		409	166	60
	397	119	49		161	39	39		438	182	64
	529	192	54		175	47	42		441	184	66
	543	199	55		203	62	44		529	232	69
	559	208	56		260	94	49		529	233	79
	675	272	59		331	133	59		544	241	84
	679	274	60		332	134	60		559	249	89
	767	322	64		354	145	64		575	258	94
	782	331	66		357	147	66		634	290	99
Steel HP 8 X 36					428	186	79		689	321	104

Pile Design Table for West Abutment utilizing Boring #BSB-02 with Downdrag

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)		Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)		Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
	90	16	37		441	193	84		705	329	108
	98	21	39		454	200	89	**Steel HP 14 X 102**			
	108	26	42		466	207	94		114	4	32
	124	35	44	**Steel HP 12 X 74**					146	21	34
	159	54	49		121	17	34		181	40	37
	209	82	59		150	33	37		204	53	39
	210	82	60		164	40	39		220	62	42
	221	88	64		177	48	42		257	82	44
	223	90	66		206	64	44		331	123	49
	260	110	69		265	96	49		413	168	59
	268	114	79		336	135	59		414	169	60
	277	119	84		337	136	60		443	185	64
	285	124	89		359	148	64		447	187	66
					362	149	66		534	235	69
					435	189	79		536	236	79
					448	196	84		552	244	84
					461	203	89		567	253	89

Pile Design Table for East Abutment utilizing Boring #BSB-06 with Downdrag

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Metal Shell 12"Φ w/.25" walls			
	183	2	40
	240	33	45
	298	65	50
	348	92	55
Metal Shell 14"Φ w/.25" walls			
	220	5	40
	289	43	45
	358	81	50
	416	113	55
Metal Shell 14"Φ w/.312" walls			
	220	5	40
	289	43	45
	358	81	50
	416	113	55
	564	194	55
	570	198	56
Metal Shell 16"Φ w/.312" walls			
	258	9	40
	340	55	45
	420	99	50
	487	136	55
Metal Shell 16"Φ w/.375" walls			
	258	9	40
	340	55	45
	420	99	50
	487	136	55
	680	242	55
	686	245	56
Steel HP 8 X 36			
	106	4	40
	140	23	45
	173	41	50
	199	55	55
	200	56	56
	215	64	60
	221	67	70
	265	91	75
	273	96	80
	282	101	85

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 10 X 42			
	136	8	40
	181	33	45
	222	56	50
	254	73	55
	255	74	56
	275	85	60
	277	86	70
Steel HP 10 X 57			
	139	9	40
	185	34	45
	228	58	50
	260	75	55
	261	76	56
	282	87	60
	283	88	70
	344	121	75
	354	127	80
	365	133	85
	376	139	90
	386	145	95
	421	164	101
	454	182	104
Steel HP 12 X 53			
	172	14	40
	229	46	45
	281	75	50
	319	95	55
	320	96	56
	340	107	70
Steel HP 12 X 63			
	174	15	40
	232	47	45
	284	76	50
	322	97	55
	323	97	56
	343	108	70
	423	152	75
	436	159	80
	449	166	85
	461	173	90
	474	180	95
Steel HP 12 X 74			
	176	15	40
	235	48	45
	289	77	50
	327	98	55
	329	99	56
	348	110	70
	430	155	75
	443	162	80
	456	169	85
	468	176	90

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 12 X 84			
	179	16	40
	239	49	45
	294	79	50
	332	100	55
	334	101	56
	353	112	70
	436	157	75
	449	164	80
	462	172	85
	475	179	90
	488	186	95
	537	213	101
	664	283	104
Steel HP 14 X 73			
	151	-12	35
	214	23	40
	287	63	45
	351	98	50
	395	122	55
	396	123	56
	413	132	70
	516	189	75
	531	197	80
	546	206	85
	561	214	90
	576	222	95
Steel HP 14 X 89			
	153	-12	35
	217	23	40
	291	64	45
	356	100	50
	400	124	55
	402	125	56
	418	134	70
	523	192	75
	538	200	80
	554	209	85
	569	217	90
	584	225	95
	646	259	101
	705	292	104
Steel HP 14 X 102			
	155	-12	35
	220	24	40
	295	66	45
	361	102	50
	406	126	55
	407	127	56
	423	136	70
	530	195	75
	546	203	80
	561	212	85

Pile Design Table for East Abutment utilizing Boring #BSB-06 with Downdrag

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)		Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)		Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
					481	183	95		576	220	90
					529	209	101		591	228	95
					589	242	104		655	263	101
									792	339	104
								Steel HP 14 X 117			
									157	-12	35
									223	25	40
									300	67	45
									366	104	50
									411	128	55
									413	129	56
									428	138	70
									537	198	75
									553	206	80
									568	215	85
									584	223	90
									599	232	95

Pile Design Table for West Abutment utilizing Boring #BSB-02 with Precore

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Metal Shell 12"Φ w/.25" walls			
	64	35	32
	94	52	34
	116	64	37
	133	73	39
	151	83	42
	178	98	44
	237	130	49
	324	178	54
Metal Shell 14"Φ w/.25" walls			
	52	29	29
	81	44	32
	117	64	34
	142	78	37
	161	88	39
	182	100	42
	215	118	44
	286	157	49
	394	217	54
Metal Shell 14"Φ w/.312" walls			
	52	29	29
	81	44	32
	117	64	34
	142	78	37
	161	88	39
	182	100	42
	215	118	44
	286	157	49
	394	217	54
	513	282	59
	547	301	64
Metal Shell 16"Φ w/.312" walls			
	64	35	29
	98	54	32
	142	78	34
	170	93	37
	190	104	39
	214	118	42
	253	139	44
	337	185	49
	469	258	54
	614	338	59
	654	359	64
Metal Shell 16"Φ w/.375" walls			
	64	35	29
	98	54	32
	142	78	34
	170	93	37
	190	104	39
	214	118	42
	253	139	44
	337	185	49
	469	258	54

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 10 X 42			
	61	33	34
	85	47	37
	102	56	39
	113	62	42
	135	74	44
	179	99	49
	240	132	59
	246	135	64
	256	141	64
	312	172	69
	315	173	79
	326	179	84
Steel HP 10 X 57			
	63	35	34
	87	48	37
	104	57	39
	116	64	42
	138	76	44
	184	101	49
	245	135	59
	251	138	64
	262	144	64
	321	176	69
	323	178	79
	333	183	84
	344	189	89
	355	195	94
	363	200	98
	388	213	99
	427	235	104
	454	250	108
Steel HP 12 X 53			
	73	40	34
	102	56	37
	128	71	39
	143	79	42
	171	94	44
	228	125	49
	299	164	59
	306	168	64
	321	176	64
	386	213	69
	394	217	79
	407	224	84
Steel HP 12 X 63			
	75	41	34
	104	57	37
	131	72	39
	145	80	42
	173	95	44
	231	127	49
	302	166	59

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 12 X 84			
	78	43	34
	108	59	37
	134	74	39
	150	82	42
	179	98	44
	238	131	49
	311	171	59
	318	175	64
	334	184	64
	405	223	69
	411	226	79
	424	233	84
	437	240	89
	450	247	94
	460	253	98
	496	273	99
	544	299	104
	664	365	108
Steel HP 14 X 73			
	58	32	32
	89	49	34
	123	68	37
	155	85	39
	179	98	42
	212	117	44
	281	155	49
	363	200	54
	367	202	59
	376	207	64
	397	218	64
	468	257	69
	487	268	79
	502	276	84
	517	284	89
	532	293	94
	544	299	98
Steel HP 14 X 89			
	60	33	32
	91	50	34
	126	69	37
	158	87	39
	182	100	42
	216	119	44
	286	157	49
	370	203	54
	372	205	59
	381	210	64
	402	221	64
	476	262	69
	494	272	79
	509	280	84
	524	288	89

Pile Design Table for West Abutment utilizing Boring #BSB-02 with Precore

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
	614	338	59
	654	359	64
	707	389	64
Steel HP 8 X 36			
	78	43	39
	88	48	42
	104	57	44
	139	76	49
	189	104	59
	194	107	64
	201	111	64
	240	132	69
	248	136	79
	257	141	84
	265	146	89
	274	151	94
	281	154	98

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
	309	170	64
	324	178	64
	395	217	69
	398	219	79
	411	226	84
	424	233	89
	437	240	94
	447	246	98
	481	264	99
Steel HP 12 X 74			
	77	42	34
	106	58	37
	133	73	39
	147	81	42
	176	97	44
	234	129	49
	306	168	59
	314	173	64
	329	181	64
	400	220	69
	405	223	79
	418	230	84
	430	237	89
	443	244	94
	454	249	98
	488	268	99
	535	294	104
	589	324	108

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
	539	297	94
	551	303	98
	598	329	99
	654	360	104
	705	388	108
Steel HP 14 X 102			
	61	34	32
	93	51	34
	128	71	37
	160	88	39
	184	101	42
	218	120	44
	289	159	49
	375	206	54
	377	207	59
	386	212	64
	408	224	64
	482	265	69
	501	275	79
	516	284	84
	531	292	89
	546	300	94
	559	307	98
	606	334	99
	662	364	104
	810	445	108
Steel HP 14 X 117			
	63	35	32
	96	53	34
	131	72	37
	162	89	39
	187	103	42
	222	122	44
	294	162	49
	382	210	54
	382	210	59
	391	215	64
	413	227	64
	490	270	69
	507	279	79
	523	287	84
	538	296	89
	553	304	94
	566	311	98
	615	338	99

Pile Design Table for East Abutment utilizing Boring #BSB-06 with Precore

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Metal Shell 12"Φ w/.25" walls			
	70	38	35
	110	60	40
	167	92	45
	225	124	50
	275	151	55
	384	211	55
Metal Shell 14"Φ w/.25" walls			
	60	33	30
	83	46	35
	134	74	40
	203	112	45
	272	150	50
	331	182	55
Metal Shell 14"Φ w/.312" walls			
	60	33	30
	83	46	35
	134	74	40
	203	112	45
	272	150	50
	331	182	55
	478	263	55
	541	297	62
Metal Shell 16"Φ w/.312" walls			
	74	41	30
	98	54	35
	160	88	40
	242	133	45
	323	177	50
	390	215	55
	582	320	55
Metal Shell 16"Φ w/.375" walls			
	74	41	30
	98	54	35
	160	88	40
	242	133	45
	323	177	50
	390	215	55
	582	320	55
	654	359	62
Steel HP 8 X 36			
	66	36	40
	100	55	45
	133	73	50
	159	88	55
	168	93	62
	177	97	62
	183	101	72
	227	125	77
	235	129	82
	244	134	87
	253	139	92
	261	144	97

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 10 X 42			
	52	28	35
	83	46	40
	127	70	45
	173	95	50
	205	113	55
	216	119	62
	229	126	62
	230	127	72
	289	159	77
	300	165	82
	310	171	87
	321	177	92
	331	182	97
Steel HP 10 X 57			
	53	29	35
	85	47	40
	130	71	45
	178	98	50
	210	116	55
	222	122	62
	235	129	62
	235	130	72
	296	163	77
	307	169	82
	318	175	87
	329	181	92
	339	187	97
	374	206	103
	454	250	105
Steel HP 12 X 53			
	65	36	35
	99	55	40
	152	83	45
	213	117	50
	260	143	55
	273	150	62
	284	156	72
	363	200	77
	376	207	82
	389	214	87
	401	221	92
	414	228	97
Steel HP 12 X 63			
	66	36	35
	102	56	40
	155	85	45
	218	120	50
	263	144	55
	276	152	62
	287	158	72
	367	202	77
	380	209	82

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 12 X 84			
	68	37	35
	105	58	40
	160	88	45
	223	123	50
	271	149	55
	285	157	62
	296	163	72
	379	208	77
	392	216	82
	405	223	87
	418	230	92
	431	237	97
	479	264	103
	582	320	105
Steel HP 14 X 73			
	35	19	30
	81	45	35
	120	66	40
	184	101	45
	258	142	50
	325	179	55
	341	187	62
	347	191	72
	451	248	77
	465	256	82
	480	264	87
	495	272	92
	510	281	97
	571	314	103
	578	318	105
Steel HP 14 X 89			
	36	20	30
	82	45	35
	123	68	40
	188	103	45
	263	144	50
	330	181	55
	346	190	62
	351	193	72
	457	251	77
	472	260	82
	487	268	87
	502	276	92
	517	284	97
	579	319	103
	684	376	105
Steel HP 14 X 102			
	38	21	30
	83	46	35
	125	69	40
	190	105	45
	266	146	50

Pile Design Table for East Abutment utilizing Boring #BSB-06 with Precore													
	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)			Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)			Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
	286	157	103			393	216	87			334	184	55
	286	157	105			405	223	92			351	193	62
						418	230	97			356	196	72
						465	255	103			463	255	77
						497	273	105			478	263	82
					Steel HP 12 X 74						494	271	87
						67	37	35			509	280	92
						103	57	40			524	288	97
						157	87	45			587	323	103
						221	121	50			693	381	105
						267	147	55		**Steel HP 14 X 117**			
						281	154	62			39	22	30
						291	160	72			84	46	35
						373	205	77			127	70	40
						386	212	82			194	107	45
						399	219	87			270	149	50
						412	226	92			339	186	55
						425	233	97			355	195	62
						472	260	103			360	198	72
						574	316	105			469	258	77
											485	267	82
											500	275	87
											516	284	92
											531	292	97
											595	327	103
											706	388	105
										Precast 14"x 14"			

APPENDIX F

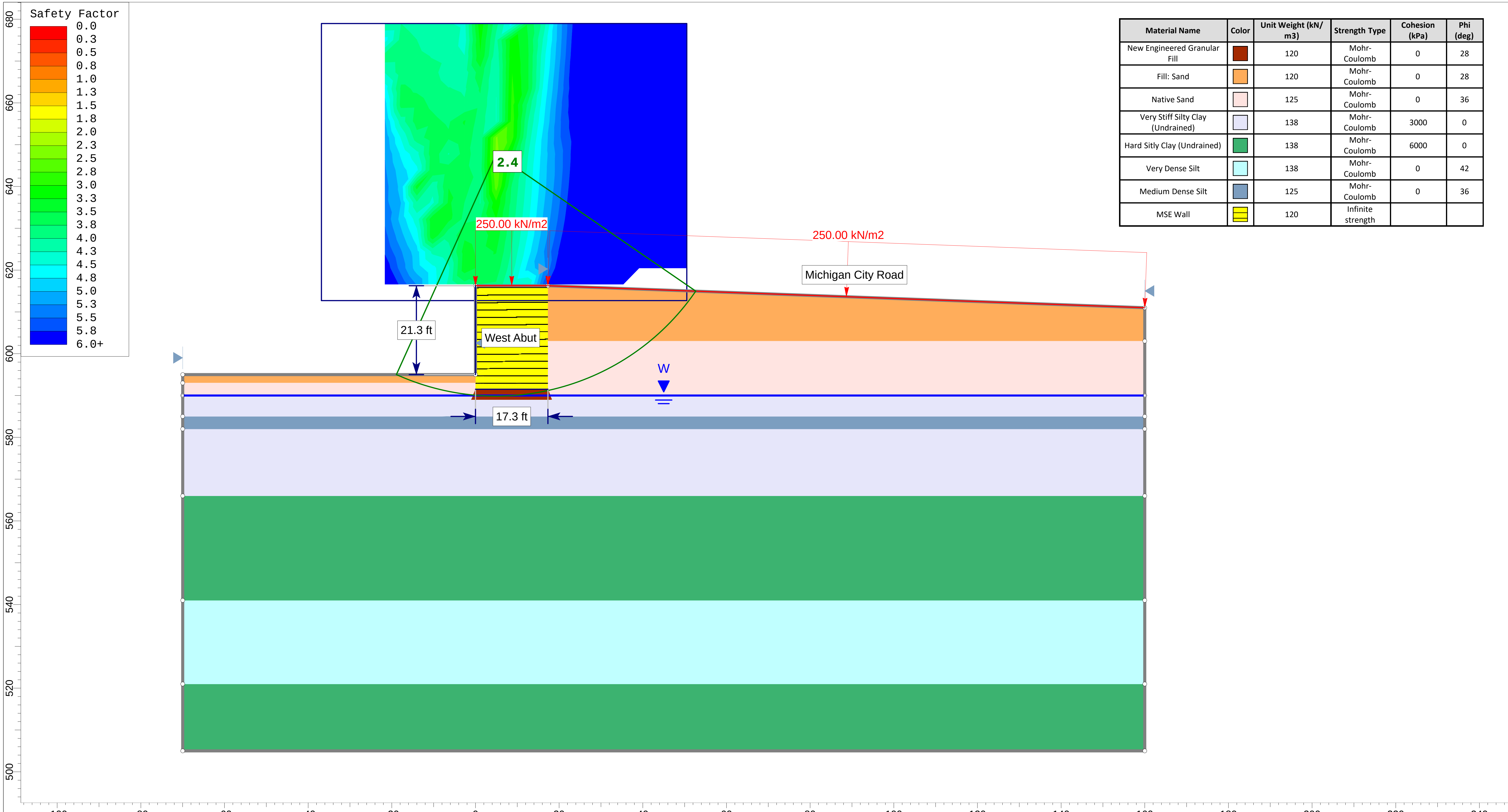
SOIL PARAMETER TABLE

Table G: Summary of Soil Parameters

Elevation Range (ft)	Soil Description	In situ Unit Weight γ (pcf)	Undrained		Drained		Active Earth Pressure Coefficient (K_a)	Passive Earth Pressure Coefficient (K_p)	At Rest Earth Pressure Coefficient (K_o)	Lateral Modulus of Subgrade Reaction (pci)	Soil Strain (ε_{50})
			Cohesion c (psf)	Friction Angle ϕ (°)	Cohesion c (psf)	Friction Angle ϕ (°)					
	New Engineered Clay Fill	125	1,000	0	100	28	0.41	2.46	0.58	500	0.007
	New Engineered Granular Fill	120	0	28	0	28	0.33	3.00	0.50	90	N/A
613.0-602.0	FILL: Brown Sand	120	0	28	0	28	0.36	2.77	0.53	60	N/A
602.0-590	Loose to Dense Light Brown Sand	125	0	36	0	36	0.26	3.85	0.41	60	N/A
590.0-566.0	Gray Medium Stiff to Hard Silty Clay	138	3,000	0	300	28	0.36	2.77	0.53	1,000	0.005
566.0-509.0	Gray Hard to Very Hard Silty Clay	138	6,000	0	600	28	0.36	2.77	0.53	2,000	0.004
608.0-606.5 **BSB-04 & BSB-05 Only**	Gray Medium Dense to Dense Silty Loam	131	0	41	0	41	0.25	4.02	0.40	90	N/A
589.0-585.0 **BSB-01, BSB-02 & BSB-04 Only**	Gray Medium Dense Silty Loam	125	0	36	0	36	0.31	3.25	0.46	60	N/A
537.0-528.0 **BSB-02 & BSB-04 Only**	Gray Very Dense Silty Loam	138	0	42	0	42	0.20	5.04	0.33	125	N/A
544.0-520.5 **BSB-01 Only**	Gray Very Dense Silty Loam	138	0	42	0	42	0.20	5.04	0.33	125	N/A
522-517.5 **BSB-04 Only**	Gray Very Dense Silty Loam	137	0	42	0	42	0.22	4.60	0.36	125	N/A

APPENDIX G

SLOPE STABILITY ANALYSES EXHIBITS



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)
New Engineered Granular Fill		120	Mohr-Coulomb	0	28
Fill: Sand		120	Mohr-Coulomb	0	28
Native Sand		125	Mohr-Coulomb	0	36
Very Stiff Silty Clay (Undrained)		138	Mohr-Coulomb	3000	0
Hard Sitly Clay (Undrained)		138	Mohr-Coulomb	6000	0
Very Dense Silt		138	Mohr-Coulomb	0	42
Medium Dense Silt		125	Mohr-Coulomb	0	36
MSE Wall		120	Infinite strength		

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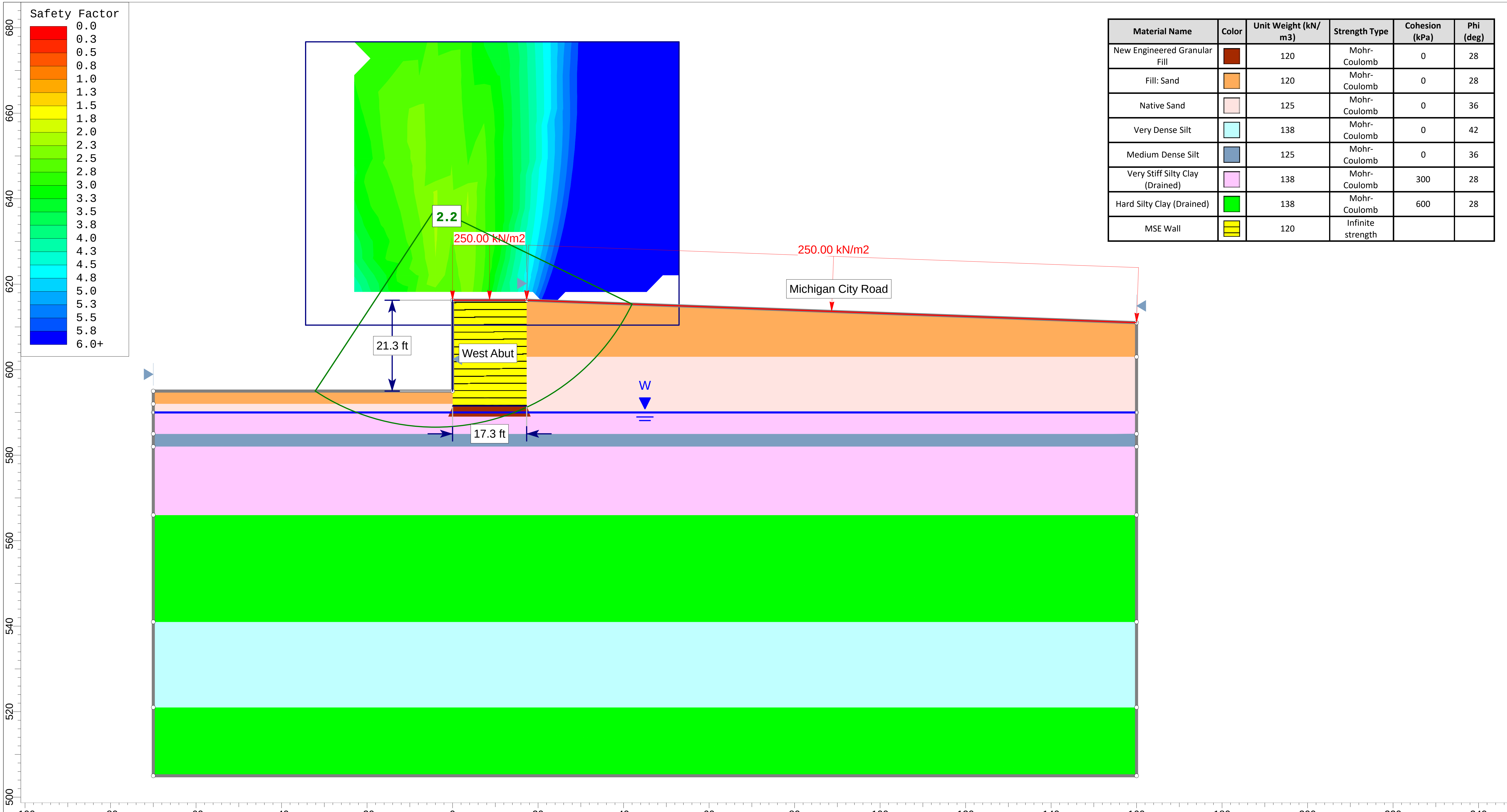
SLIDEINTERPRET 9.018

Project	Michigan City Road - West Retaining Wall		
Analysis Description	Exhibit A - Circular Failure - Undrained - Abutment		
Drawn By	AA	*Company*	GSG Consultants, Inc.
Date	8/31/2023, 8:33:02 AM	*File Name*	RW_West_Abut.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)
New Engineered Granular Fill		120	Mohr-Coulomb	0	28
Fill: Sand		120	Mohr-Coulomb	0	28
Native Sand		125	Mohr-Coulomb	0	36
Very Dense Silt		138	Mohr-Coulomb	0	42
Medium Dense Silt		125	Mohr-Coulomb	0	36
Very Stiff Silty Clay (Drained)		138	Mohr-Coulomb	300	28
Hard Silty Clay (Drained)		138	Mohr-Coulomb	600	28
MSE Wall		120	Infinite strength		

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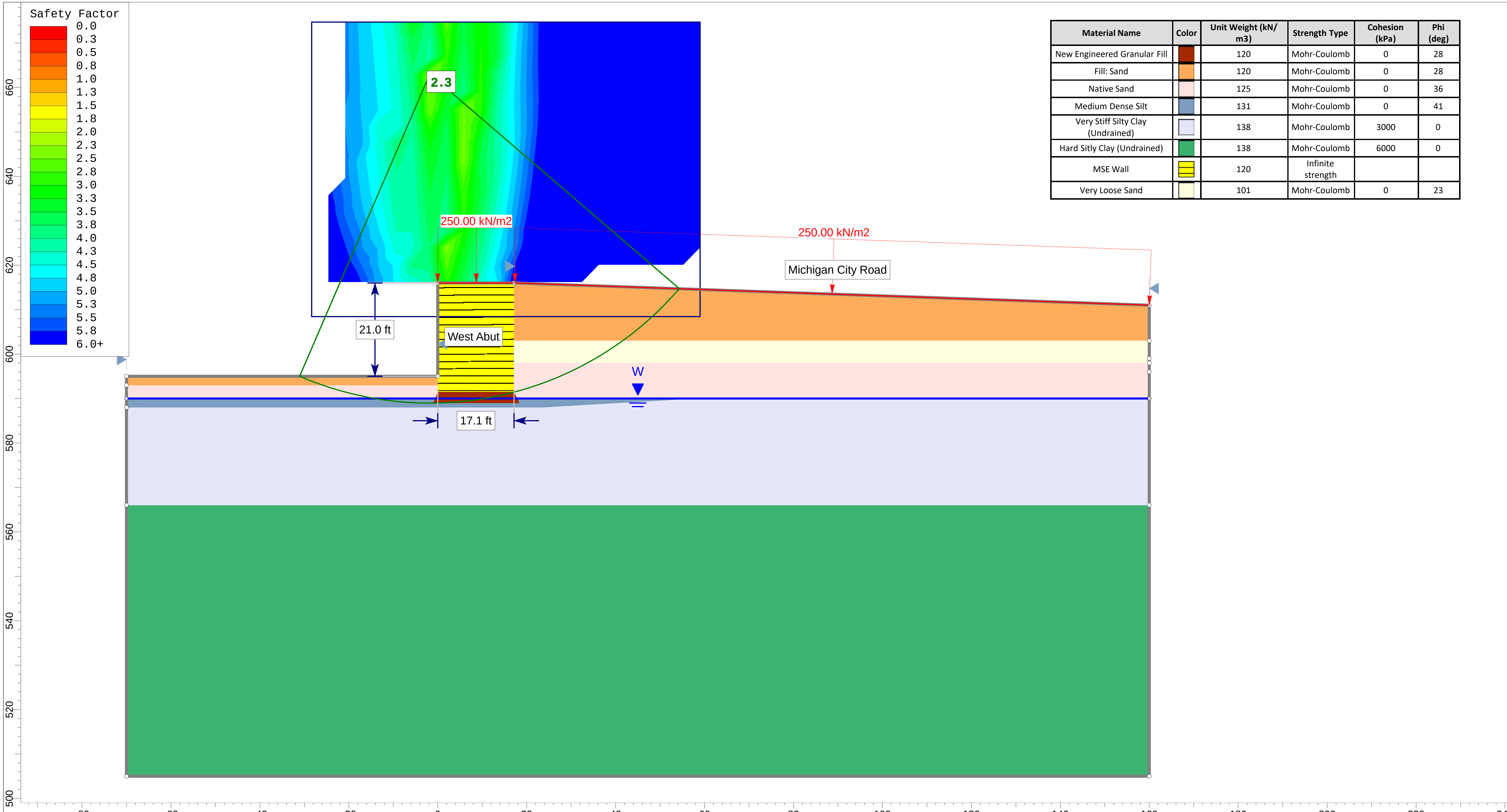
SLIDEINTERPRET 9.018

Project	Michigan City Road - West Retaining Wall		
Analysis Description	Exhibit B - Circular Failure - Drained - Abutment		
Drawn By	AA	*Company*	GSG Consultants, Inc.
Date	8/31/2023, 8:33:02 AM	*File Name*	RW_West_Abut.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)
New Engineered Granular Fill		120	Mohr-Coulomb	0	28
Fill: Sand		120	Mohr-Coulomb	0	28
Native Sand		125	Mohr-Coulomb	0	36
Medium Dense Silt		131	Mohr-Coulomb	0	41
Very Stiff Silty Clay (Undrained)		138	Mohr-Coulomb	3000	0
Hard Sitly Clay (Undrained)		138	Mohr-Coulomb	6000	0
MSE Wall		120	Infinite strength		
Very Loose Sand		101	Mohr-Coulomb	0	23

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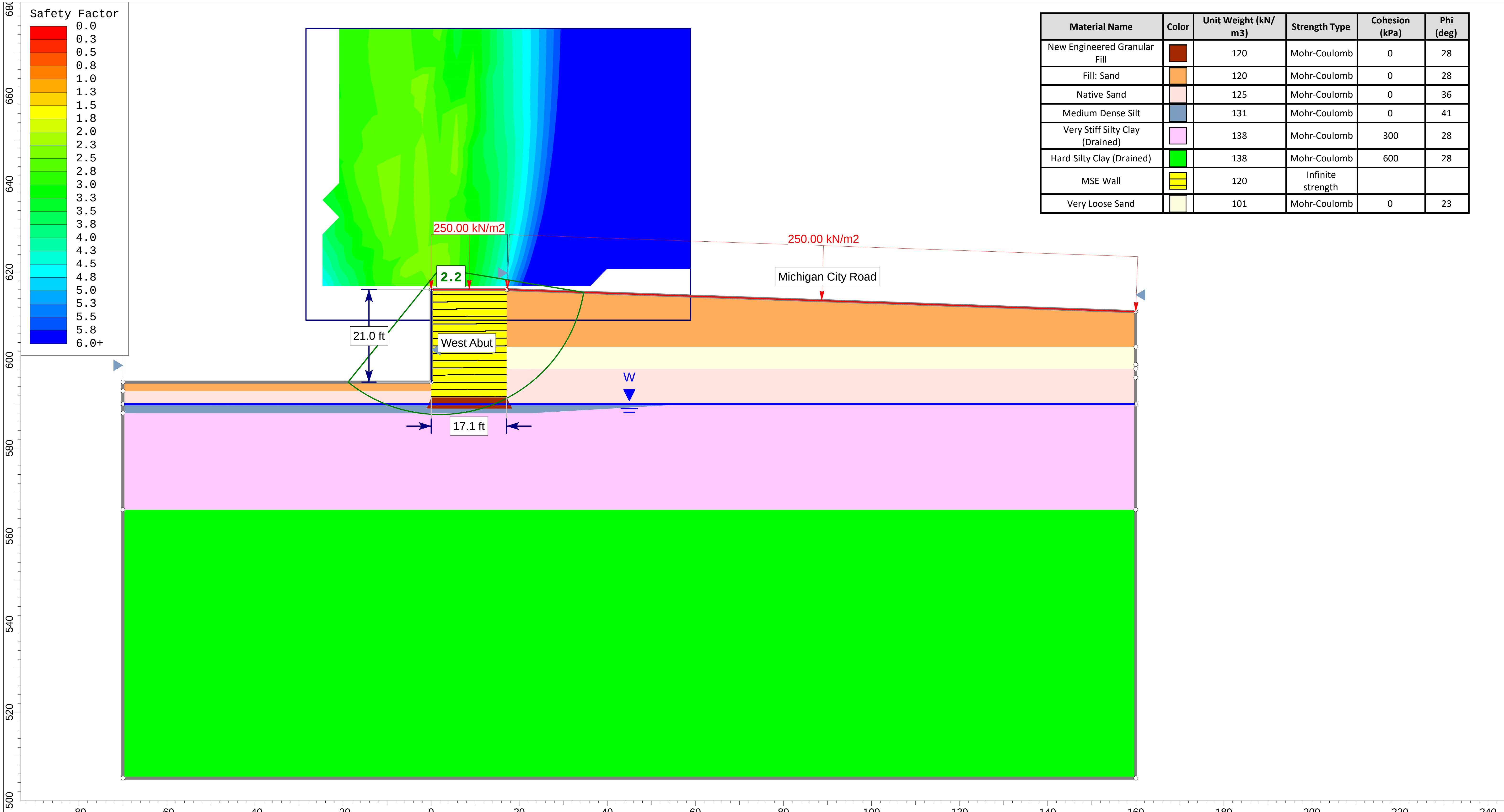
SLIDEINTERPRET 9.018

Project	Michigan City Road - East Retaining Wall		
Analysis Description	Exhibit C - Circular Failure - Undrained - East Abutment		
Drawn By	AA	Company	GSG Consultants, Inc.
Date	8/31/2023, 8:33:02 AM	File Name	RW_East_Abut.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)
New Engineered Granular Fill		120	Mohr-Coulomb	0	28
Fill: Sand		120	Mohr-Coulomb	0	28
Native Sand		125	Mohr-Coulomb	0	36
Medium Dense Silt		131	Mohr-Coulomb	0	41
Very Stiff Silty Clay (Drained)		138	Mohr-Coulomb	300	28
Hard Silty Clay (Drained)		138	Mohr-Coulomb	600	28
MSE Wall		120	Infinite strength		
Very Loose Sand		101	Mohr-Coulomb	0	23

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SLIDEINTERPRET 9.018

Project	Michigan City Road - East Retaining Wall
Analysis Description	Exhibit D - Circular Failure - Drained - East Abutment
Drawn By	AA
Company	GSG Consultants, Inc.
Date	8/31/2023, 8:33:02 AM
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