STRUCTURE GEOTECHNICAL REPORT
US ROUTE 6 (FAU 0297) BRIDGE OVER MARLEY CREEK (EAST), STATION 414+79.00
PR SN 099-0542, SECTION 33B (B-R)
IDOT D-91-130-12, PTB 162/ITEM 010
WILL COUNTY, ILLINOIS

for

Civiltech Engineering, Inc.

450 East Devon Avenue, Suite 300

Itasca, IL 60143

(630) 773-3900

submitted by

Wang Engineering, Inc.

1145 North Main Street

Lombard, IL 60148

(630) 953-9928

Original Report: November 5, 2014
Revised Report: April 7, 2016

Technical Report Documentation Page

1. Title and Subtitle Structure Geotechnical Report, US Route 6 Bridge over Marley Creek (East), Station 414+79.00		**2. Report Date** April 7, 2016 **3. Report Type** ☒ SGR ☐ RGR ☐ Draft ☐ Final ☒ Revised
4. Route / Section / County FAU 0297 / 33B (B-R) /Will		**5. IDOT Project Number(s)** Job D-91-130-12
6. PTB / Item No. 162/010	**7. Existing Structure Number(s)** SN 099-0148	**8. Proposed Structure Number(s)** SN 099-0542
9. Prepared by Wang Engineering, Inc. 1145 N Main Street Lombard, IL 60148	**Contributor(s)** Author: Mickey L. Snider, PE Project Manager: Liviu Iordache, PG QA/QC: Corina T. Farez, PE, PG	**Contact Phone Number** (630) 953-9928 x 1027 MSnider@wangeng.com
10. Prepared for Civiltech Engineering, Inc. 450 E Devon Avenue, Ste 300 Itasca, Illinois 60143	**Contact(s)** Greg Hatlestad, PE, SE Gary Blazek, PE	**Contact Phone Number** (630) 773-3900 Ghatlestad@civiltechinc.com GBlazek@civiltechinc.com

11. Abstract

The existing, single-span bridge carrying US Route 6 over Marley Creek will be removed and lengthened with a new, four-span structure with integral abutments and solid wall piers. The new back-to-back length will be 270.5 feet and the out-to-out width will be 66.2 feet. The centerline of US 6 will be raised by about 6 feet with fill sections along the widening areas raised by approximately 9 feet. This report provides geotechnical recommendations for the design of proposed bridge foundations and embankments.

The existing embankments consist of soft to medium stiff silty clay fill underlain by soft silty loam floodplain deposits. Deeper soils include medium dense to dense sandy outwash overlying loose to dense silt and strong, very poor to fair quality dolostone. The bedrock was encountered approximately 47 to 49 feet below the existing roadway grade. We recommend no reduction to the scour depths at the piers. The site classifies in the Seismic Class D and is in Seismic Performance Zone 1.

The profile grade at the roadway centerline will be increased by about 9 feet over soft and compressible floodplain soils. We estimate the new embankments will undergo approximately 3.0 inches of long-term consolidation settlement. The fill sections will have side slopes graded at 1:2 (V:H) and the FOS against global instability is 2.5 to 1.6.

The proposed abutments and piers should be supported on driven piles. At the abutments, losses are required for the potential downdrag on the piles. At the piers, the design should include losses for the Q100 scour event. We estimate the abutments could be designed for either 14-inch shell piles or steel H-piles; however, the shell piles will require a precore to an elevation of 657 feet prior to driving. Steel H-Piles at the abutments and piers will achieve less than 100 kips of axial capacity immediately above the bedrock and should be driven to maximum nominal bearing at the top of bedrock at each substructure with lengths of 46 to 50 feet to achieve factored resistances of 150 to 390 kips.

The bridge will include stage construction, with temporary sheet piling required along the stage line. The temporary sheet piling should be designed according to IDOT *Design Guide 3.13.1*. The pier construction will require the use of Type 2 Cofferdams and Seal Coat at each location to control groundwater.

12. Path to archived file

S:\Netprojects\4010501\Reports\SGR\East Bridge\RPT_Wang_MLS_4010501US6EastRev_20150501.pdf

TABLE OF CONTENTS

LIST OF TABLES

1145 North Main Street
Lombard, Illinois 60148
Phone (630) 953-9928
www.wangeng.com

STRUCTURE GEOTECHNICAL REPORT
US ROUTE 6 (FAU 0297) BRIDGE OVER
MARLEY CREEK (EAST), STATION 414+79.00
PR SN 099-0542, SECTION 33B (B-R)
IDOT D-91-130-12, PTB 162/ITEM 010
WILL COUNTY, ILLINOIS
FOR
CIVILTECH ENGINEERING, INC.

1.0 INTRODUCTION

This report presents the results of our subsurface investigation, laboratory testing, and geotechnical evaluations for the reconstruction of the US Route 6 (FAU 0297) East Bridge over Marley Creek in Mokena, Will County, Illinois. A *Site Location Map* is presented as Exhibit 1.

1.1 Proposed Structure

Wang Engineering, Inc. (Wang) understands Civiltech Engineering, Inc. envision a new, four-span structure with pile-supported integral abutments and pile-supported solid wall piers replacing the existing simple-span bridge at Station 414+79.00. The TSL Plan provided by Civiltech shows the bridge with a back-to-back length of 270.5 feet with two spans of 66.5-feet, one spam of 84.0 feet, and one span of 48 feet. The out-to-out width will measure 66.2 feet to accommodate two 12-foot wide traffic lanes, two 8-foot wide shoulders, a variable width median, a 10-foot wide path, and two parapets. The bridge will be on a 45° skew. As part of the bridge reconstruction, the centerline of US 6 will be raised by approximately 6 feet behind both abutments and the widening area will be filled with embankment material to a level 9 feet above existing grade. The embankments will be sloped at 1:2 (V:H) along the approach slab, but quickly grade down to 1:4 behind the slab. Extensive removal of existing ground is planned into the creek-bank material behind the existing abutments. The excavation on the north side of the channel will extend about 70 feet behind the existing north abutment and the excavation on the south side will extend 150 feet behind the south abutment. These cuts will provide increased streambed and floodplain area needed to compensate for the floodplain loss resulting from the proposed US 6 grade increase. The cuts will, however, also present stage construction and excavation challenges with regards to the pier construction.

The purpose of our investigation was to characterize the site soil and groundwater conditions, perform geotechnical analyses, and provide recommendations for the design and construction of the bridge foundations and approach embankments.

1.2 Existing Structure

Existing bridge plans provided by Civiltech indicate the structure was constructed in 1930 and reconstructed in 1980. The bridge, which is significantly shorter than the proposed structure, has a single-span supported on closed-wall abutments on spread footings with a total back-to-back length of 39.8 feet and an out-to-out width of 42.0 feet.

2.0 SITE CONDITIONS AND GEOLOGICAL SETTING

The project area is located in northwest Mokena, which spans New Lenox and Homer Townships in northeast Will County. On the USGS *Mokena Quadrangle 7.5 Minute Series* map, the bridge is located in the NE ¼ of Section 2, Tier 35N, Range 11E of the Third Principal Meridian.

The following review of the published geologic data, with emphasis on factors that might influence the design and construction of the proposed engineering works, is meant to place the project area within a geological framework and confirm the dependability and consistency of the subsurface investigation results. For the study of the regional geologic framework, Wang considered the northern Illinois area in general and northeast Will County in particular. Exhibit 2 illustrates the *Site and Regional Geology*.

2.1 Physiography

In northeastern Will County, the Marley Creek runs southwest, cutting a valley through the Westmont and Keeneyville Moraines before it outlets to Hickory Creek and subsequently, the Des Plaines River. This section of US 6 also runs to the southwest along the Marley Creek Valley and within the floodplain. The meandering creek crosses the road twice prior to the Hickory Creek outlet approximately one mile south of the proposed bridge replacement. Marley Creek runs through a 20-foot wide, well defined channel cut near the north edge of its floodplain.

Across the half-mile wide floodplain, surface elevations range from 674 feet (NAVD88) on the northwest side of the creek to as high as 680 feet on the southeast side. Along the creek valley, elevations vary from 655 feet downstream to 670 feet upstream. At the east bridge, the elevations of the roadway are about 665 to 670 feet.

2.2 Surficial Cover

The surficial cover is mainly the result of Wisconsin-age glacial activity (Hansel and Johnson, 1996). The glacigenic deposits were emplaced during pulsating advances and retreats of an icesheet lobe responsible for the formation of end moraines and associated low-relief till and lake plains and valley. Outwash valleys and other low-lying areas that scar the Westmont and Keeneyville Moraines are filled with post-glacial and glacial deposits. Located along Marley Creek that runs through a former outwash valley, the site is underlain by post-glacial fine, sorted sediment of the Cahokia Alluvium and discontinuous presence of peat and marl of the Grayslake Peat. Glacial clayey deposits of the Equality Formation over the coarser sandy and gravelly outwash of the Henry Formation fill the outwash valley that cuts into the silty clayey diamictons of the Wadsworth Formation that make the Westmont and Keeneyville Moraines. Older diamictons underlain the Wadsworth Formation and rest unconformably over the bedrock (Willman and Lineback 1970). An approximately 50-foot thick drift covers the bedrock.

2.3 Bedrock

The surficial cover rests unconformably on top of Silurian-age dolostone. In the project area the bedrock may be encountered at elevations of approximately 600 feet, or approximately 50 feet below ground surface (bgs).

Our subsurface investigation results fit into the local geologic context. The soil borings reveal the native sediments consist of silty and loamy floodplain deposits with organic debris of the Cahokia Alluvium, overlying gravelly sand and sand of the Henry Formation. The borings encountered bedrock at 621 to 627 feet.

3.0 METHODS OF INVESTIGATION

The following sections outline the subsurface and laboratory investigations performed by Wang.

3.1 Subsurface Investigation

The subsurface investigation consisted of five structure borings, designated as BSB-05 through BSB-09, drilled in May 2014 and . The borings were drilled from elevations of 667.4 to 668.0 feet to depths of 46.0 to 65.0 feet bgs. Northings, eastings, and elevations were surveyed by Wang with a mapping-grade GPS unit; stations and offsets were taken from design drawings provided by Civiltech. The boring location data are shown in the *Boring Logs* (Appendix A), and the as-drilled locations are shown in the *Boring Location Plan* (Exhibit 3).

A truck-mounted drill rig, equipped with hollow stem augers, was used to advance and maintain an open borehole. Soil sampling was performed according to AASHTO T 206, "*Penetration Test and Split Barrel Sampling of Soils*." The soil was sampled at 2.5-foot intervals to 30 feet bgs and at 5.0-foot intervals to the top of bedrock. The bedrock was cored in Borings BSB-06 and BSB-07 with a NWD4-sized barrel in 5- and 10-foot runs. Soil samples from each interval were placed in sealed jars for further laboratory testing.

Field boring logs, prepared and maintained by a Wang geologist, include lithological descriptions, visual-manual soil classifications (IDH Textural Classification), results of Rimac and pocket penetrometer unconfined compressive strength tests, and results of Standard Penetration Tests (SPT), recorded as blows per 6 inches of penetration.

Groundwater observations were made during and after drilling operations. The borings were backfilled with soil cuttings and bentonite after completion. The surface along US 6 was restored as close as possible to the original condition.

3.2 Laboratory Testing

The soil samples were tested in the laboratory for moisture content (AASHTO T 265). Selected soils were also chosen for Atterberg limits (AASHTO T 89/90) and particle size (AASHTO T 88) analyses. The soils were classified according to the IDH Textural Classification system and field visual-manual descriptions were verified in the laboratory. The laboratory results are shown in the *Boring Logs* (Appendix A) and in the *Laboratory Test Results* (Appendix B).

4.0 RESULTS OF FIELD AND LABORATORY INVESTIGATIONS

Detailed descriptions of the soil conditions encountered during the subsurface investigation are presented in the attached *Boring Logs* (Appendix A) and in the *Soil Profile* (Exhibit 4). Please note that strata contact lines represent approximate boundaries between soil types. The actual transition between soil types in the field may be gradual in horizontal and vertical directions.

4.1 Soil Conditions

The existing shoulder along US 6 includes 6 to 12 inches of sandy gravel shoulder aggregate. In descending order, the general lithologic succession includes: 1) man-made ground (fill); 2) soft to medium stiff silty loam to loam; 3) loose to dense sand; 4) loose to dense silt; and 5) strong, very poor to fair quality dolostone.

(1) Man-made ground (Fill)

Immediately beneath the pavement section, the borings encountered 3 to 7 feet of very soft to very stiff, brown silty clay and silty clay loam fill. The fill has unconfined compressive strength (Q_u) values of 0.3 to 2.5 tsf with an average of 0.5 tsf and relatively low moisture content values of 12 to 26%. The soil also measures high N-values of 6 to 10 blows/foot in contrast to the low Q_u values.

(2) Soft to medium stiff silty loam to loam

At elevations of 660 to 655 feet, the borings encountered 4 to 7 feet of soft to medium stiff, black silty loam and loam with traces of gravel and organic debris; these soils are floodplain deposits from the Marley Creek channel and they are laminated with saturated fine sand and silt. The loamy soils have Qu values of 0.3 to 1.2 tsf with an average of 0.6 tsf and moisture content values of 36 to 74% with an average of 45%. The elevated moisture contents are a result of the saturated silt and fine lamination of these deposits. Laboratory index testing on two samples of this layer shows a liquid limit (L_L) value of 58% and plastic limit (P_L) values of 34% in one sample and a non-plastic material in the other; the liquidity index (L_I) of these samples indicate materials close to the L_L that will be prone to deformation under additional embankment loading.

(3) Loose to dense sand

Below the soft floodplain soils, the borings advanced through 20 feet of medium dense to dense, brown, fine to coarse, well-graded sand and gravelly sand. The sand, which represents to primary soil type along the existing Marley Creek streambed, has an N-value of 12 to 45 blows/foot. This layer was encountered wet in each of the borings.

(4) Loose to dense silt

At elevations of 640 to 634 feet, the borings encountered loose to very dense, gray silty with trace to some gravel extending to the top of bedrock. The silt has N-values ranging from 6 to 67 blows/foot and was generally recovered moist to dry.

(5) Strong, very poor to fair quality dolostone

The top of sound bedrock was encountered at elevations of 619 to 621 feet, rising slightly in elevation from west to east. The bedrock cores revealed strong, gray dolostone with very poor to fair rock quality designations (RQD) from 20 to 54%. The jointing is generally horizontal, slightly weathered, and spaced at an average of about 3 inches. Uniaxial compressive strength values of the rock measured 11 to 12 ksi.

4.2 Groundwater Conditions

Groundwater was encountered at a high elevation of 662 feet in Boring BSB-08 and a low elevation of 657 feet in Boring BSB-09. The Estimated Water Surface Elevation (EWSE) shown in the TSL is 664.8 feet which corresponds well to the levels recorded in the borings. The evaluations for stability and settlement along the abutments account for a groundwater elevation at 658 feet.

4.3 Scour Considerations

Results of the hydraulic study have been provided by Civiltech and the TSL plan provides scour estimates for the 100- and 500-year flood events. The abutment end slopes, as well as the piers and channel bottom, will be armored with riprap. The D_{50} value of the streambed soil is approximately 0.2 mm and we do not recommend any reductions to the design pier scour depths. At the abutments, the design scour elevations should be taken at the base of the abutment, per IDOT policy for abutments protected by riprap (IDOT 2012). The design high water elevation (DHWE) is 666.78 feet. The proposed streambed elevation varies from 662.50 feet along the portion of the channel to be excavated to 660.10 feet along the primary creek channel streambed between the Center and East Piers.

Table 1: Design Scour Elevations

Event / Limit State	West Abut.	Pier 1	Pier 2	Pier 3	East Abut.	Item 113
Q100 (feet)	665.21	657.75	657.75	658.40	665.25	8
Q200 (feet)	665.21	657.54	657.54	658.30	665.25	
Design (feet)	665.21	657.75	657.75	658.40	665.25	
Check (feet)	665.21	657.54	657.54	658.30	665.25	

4.4 Seismic Design Considerations

The soils within the top 100 feet have a weighted average N-value of 44 blows/foot (AASHTO 2012; Method B controlling). These results classify the site in Seismic Site Class D in accordance with IDOT *All Geotechnical Manual Users (AGMU) 9.1* (2010); the project location belongs to Seismic

Performance Zone 1. The seismic spectral acceleration parameters recommended for design in accordance with the 2012 AASHTO *LRFD Design Specifications* are summarized in Table 1 (AASHTO 2012). The factor of safety (FOS) against liquifacton for the saturated sandy soils along the bridge site is greater than the AASHTO-required value of 1.1 (AASHTO 2012).

Table 2: Seismic Design Parameters

Spectral Acceleration Period (sec)	Spectral Acceleration Coefficient[1)] (% g)	Site Factors	Design Spectrum for Site Class D[2)] (% g)
0.0	PGA= 4.8	F_{pga}= 1.6	**A_s= 7.6**
0.2	S_S= 10.2	F_a= 1.6	**S_{DS}= 16.3**
1.0	S_1= 3.9	F_v= 2.4	**S_{D1}= 9.4**

1) Base spectral acceleration coefficients from AASHTO (2012)

2) Site Class D values to be presented on plans (A_s = PGA*F_{pga}; S_{DS}= S_S*F_a; S_{D1}= S_1*F_v)

5.0 FOUNDATION ANALYSIS AND RECOMMENDATIONS

Geotechnical evaluations and recommendations for the approach embankment, approach slab, and structure foundations are included in the following sections. We estimate the global stability of the structure and foundations is adequate; however, the long-term consolidation settlement of the embankment will result in downdrag losses to the deep foundations. Wang recommends supporting the proposed abutments and piers on driven piles.

The TSL plan shows the proposed north abutment constructed about 70 feet behind the existing and the south abutment approximately 150 feet behind the existing. The significant lengthening of the bridge is to facilitate relatively large excavation into the existing creek banks on both sides. These cuts are necessary to provide additional floodplain compensation due to the proposed raise in profile grade along US 6. The centerline profile grade behind each abutment will be raised by about 6 feet, from an existing elevation of about 667.5 feet to a proposed elevation of 673.5 feet. The widening areas behind the abutments will be filled from the existing elevations of 664 feet to a proposed edge-of-shoulder elevation of 673 feet. The material will be sloped at 1:2 (V:H) along the approach slabs.

5.1 Approach Embankments and Slabs

Wang has performed evaluations of the settlement and global stability for the approach embankments and slabs based on the soil conditions encountered in the borings. The global stability meets the IDOT-required FOS; however, we do anticipate the new embankment fill will induce long-term settlements large enough to require downdrag allowances on the abutment piles.

5.1.1 Settlement

We understand the profile grade in the areas proposed for widening will be raised by approximately 9 feet behind the abutments. The grade changes will result in additional embankment loads of about 1000 psf beneath the pavement and 950 psf on the foundation soils in the widening areas.

The foundation soil within the zone of influence beneath the embankment is the soft and compressible floodplain soils overlying granular outwash material. The loamy soils will be subjected to long-term consolidation settlement. The consolidation properties of these soils have been estimated by correlation to the measured index properties. We estimate total long-term settlement along the 9-foot centerline grade increase is 3.0 inches. Along the widening areas, we estimate the settlement will be approximately 3.5 inches. Under the anticipated one-way drainage down into the sandy soils, the time to 50% of total primary settlement will be about 30 days, with 90% of primary consolidation occurring in 120 days. With estimates greater than 0.4 inch occurring at the abutments, the piles will require downdrag allowances. For the approach slab construction and ensure that there is no separation between the slab and adjacent roadway section, we recommend staging the construction of the bridge such that a 30 day period is allowed between the completion of the embankment fill placement and placement of the HMA pavement. Settlement monitoring plates should be placed at the outside edges of the roadway pavement behind each abutment, at Stations 412+85 (west abutment) and 415+90 (east abutment) to measure the progress of the settlement. The plates should be monitored bi-weekly and when the monitoring indicates that the settlement has reached 1-inch of residual movement, the pavement can be placed.

5.1.2 Global Stability

We have analyzed the global stability of the east embankment at Station 415+72. The embankment has a total estimated height of about 9 feet and side slopes graded at 1:2 (V:H). The global stability was analyzed using *Slide 6.0* for both short-term (undrained) and long-term (drained) soil conditions and the results of the analyses are shown in Appendix C. We estimate the embankment has a short-term FOS of 2.5 (Appendix C-1) and a long-term FOS of 1.6 (Appendix C-2). Both FOS meet the IDOT requirement of 1.5.

5.2 Structure Foundations

Wang recommends supporting the abutments and piers on driven piles. The soil conditions include relatively thick deposits of granular soils, primarily below the groundwater level; therefore, we do not recommend drilled shaft foundations. The bedrock elevation at the site is relatively shallow and steel H-Piles will be most economical if driven to their maximum nominal bearing at the top of bedrock. We estimate concrete-filled metal shell piles can be utilized at the abutments. The estimated service and factored loads provided by Civiltech are summarized in Table 3.

Table 3: Summary of Foundation Loads

Substructure ID	Boring ID	Service I Load (kips)	Factored Strength I Load (kips)
West Abutment	BSB-09	1470	1993
Pier 1	BSB-05	1968	2694
Pier 2	BSB-06	2117	2888
Pier 3	BSB-07	1975	2703
East Abutment	BSB-08	1266	1717

5.2.1 Driven Piles

IDOT specifies the maximum nominal required bearing (R_{NMAX}) for each pile and states the factored resistance available (R_F) should be based on a geotechnical resistance factor (Φ_G) of 0.55 (IDOT, 2012a). Nominal tip and side resistance were estimated using the methods and empirical equations presented in *AGMU Memorandum 10.2 – Geotechnical Pile Design* (IDOT, 2011). Based on ABD Memo 12.3 (2012), the effective expansion length and skew combination indicates 14-inch diameter MSP and steel piles HP12x53 and lighter are not feasible options for integral abutments. The 14-inch MSP, HP10x42, and HP12x53 options included in Table 4 and 5 are only applicable for abutment types other than integral.

The R_F, R_N, estimated pile tip elevations, and pile lengths for 14-inch diameter MSP with 0.312-inch shells (non-integral abutments only), HP10x42 (non-integral abutments), HP12x53 (non-integral abutments), HP12x63 (abutments and piers), HP14x73 (abutments and piers), and HP14x89 (abutments and piers) are summarized in Tables 4 (14-inch MSP) and 5 (all HP sections). We estimate steel pile capacities terminated immediately above the top of bedrock will achieve less than 100 kips of factored capacity; therefore, steel H-pile sections should be driven to their maximum nominal bearing at the top of bedrock and designed as end bearing piles.

The R_F estimates are governed by the relationship $R_F = \phi_G R_N - \phi_G(DD_R+S_C+L_{iq})I_G - (\gamma_p)(\lambda_{IS})DD_L$ (IDOT, 2012a). The changes to the proposed profile grade are over soft and deformable loamy soils that will result in long-term settlements greater than 0.4 inches; we estimate that downdrag losses should be considered along the abutment piles (IDOT 2012a). The steel H-Pile sections in Table 5 should have the downdrag reductions applied to reduce the factored capacity. The 14-inch MSP, however, will lose a significant amount of capacity due to the downdrag. If the MSP are chosen, they will require precoring to an elevation of 657 feet at both abutments. The pile locations should be precored with a 16-inch diameter auger and the piles should be driven from the base of the precore. The capacities provided in Table 4 include the effects of precoring. The annular space between the pile and soil is backfilled with loose, dry sand. The factored capacity evaluations along the piers account for the scour effects between the cap base elevations and the Q100 scour elevations.

Table 4: Estimated Pile Lengths and Tip Elevations for Precored 14-inch MSP, 0.312-inch Shell Abutment Piles

Structure Unit	Pile Cutoff Elevations (feet)	Required Nominal Bearing, R_N (kips)	Factored Geotechnical Loss $Sc + DD_R$ (kips)	Factored Geotechnical Load Loss DD_L (kips)	Factored Resistance Available, R_F (kips)	Total Estimated Pile Length (feet)	Estimated Pile Tip Elevation (feet)
West Abutment (BSB-09)	667.21	318	0	0	175	27	640
		227	0	0	125	24	643
		182	0	0	100	23	644
East Abutment (BSB-08)	667.25	318	0	0	175	22	645
		227	0	0	125	20	647
		182	0	0	100	19	648

Table 5: Estimated Pile Lengths and Tip Elevations for Steel H-Piles Driven to Bedrock

Structure Unit	Pile Cutoff Elevation (feet)	Pile Size	Max Nom. Required Bearing, R_N (kips)	Factored DD and Sc Losses (kips)	Factored Resistance Available, R_F (kips)	Total Estimated Pile Length (feet)	Estimated Pile Tip Elevation (feet)
West Abutment (BSB-09)	667.21	HP10x42	335	27	157	45	622
		HP12x53	418	33	197	45	622
		HP12x63	497	33	240	46	621
		HP14x73	578	39	279	46	621
		HP14x89	705	39	349	46	621
Pier 1 (BSB-05)	667.94	HP12x63	497	0	273	50	618
		HP14x73	578	0	318	50	618
		HP14x89	705	0	388	50	618
Pier 2 (BSB-06)	668.27	HP12x63	497	0	273	50	618
		HP14x73	578	0	318	50	618
		HP14x89	705	0	388	50	618
Pier 3 (BSB-07)	667.87	HP12x63	497	0	273	50	618
		HP14x73	578	0	318	50	618
		HP14x89	705	0	388	50	618
East Abutment (BSB-08)	667.25	HP10x42	335	15	169	46	621
		HP12x53	418	18	212	47	620
		HP12x63	497	18	255	47	620
		HP14x73	578	21	297	47	620
		HP14x89	705	21	367	47	620

5.2.2 Lateral Loading

Lateral loads on piles should be analyzed for maximum moments and lateral deflections. Recommended lateral soil modulus and strain parameters required for analysis via the p-y curve method are included in Table 6.

Table 6: Recommended Soil Parameters for Lateral Load Analysis

Soil Type (Layer)	Unit Weight, γ (pcf)	Undrained Shear Strength, c_u (psf)	Estimated Friction Angle, Φ (°)	Estimated Lateral Soil Modulus Parameter, k (pci)	Estimated Soil Strain Parameter, ε_{50} (%)
V Soft to M Stiff SILTY CLAY FILL (1)	115	500	0	500	1.0
Soft to M Stiff SILTY LOAM (2)	115	500	0	500	1.5
Loose to Dense SAND (3)	63	0	34	60	--
Loose to Dense SILT (4)	63	0	32	50	--

5.3 Stage Construction Design Recommendations

The bridge construction will be performed in two stages. According to the TSL plan, Stage One will include the removal of the northern 45 feet of existing bridge and construction of the northern 36.9 feet. There will be a 7.8-foot offset between the stage removal and stage construction lines; we anticipate the pay item *Temporary Sheet Piling* will be required along the stage construction line to support the embankments behind the proposed abutments, as well as the excavations proposed through the existing embankments. The temporary sheet piling should be designed in accordance with the IDOT *Design Guide 3.13.1* (2012a); preliminary design evaluations show the temporary sheet piling is feasible.

At the piers, the EWSE is 664.8 feet, or about 6.5 feet above the base of the pier cap excavations. The preliminary construction plan includes installing the piers prior to excavating the new channel to 662.5 feet. The excavations will, however, extend to within 6 to 12 inches of the granular material and groundwater encountered in the borings at elevations of about 657 feet. We anticipate the excavations will encounter significant groundwater infiltration that may rise to the EWSE of the creek and will require a sealcoat to control. Therefore, we recommend the contract should include the pay item *Type 2 Cofferdam* and the plans and specifications should indicate the need for a seal coat at each pier location. The absence of the seal coat will cause significant difficulties is construction of the piers. The cofferdam and seal coat should be designed by the Contractor prior to construction and approved by IDOT or the design engineer. The design of a seal coat should be in accordance with Design Guide 3.13.3- *Cofferdam Seal Coat Design (2006).*

6.0 CONSTRUCTION CONSIDERATIONS

6.1 Site Preparation

Vegetation, topsoil, existing pavement, and debris should be cleared and stripped where foundations and structural fills will be placed. The existing slopes, where new fill materials are to be placed, should be benched or deeply plowed prior to fill placement. The benching should follow the dimensions shown in the IDOT standard detail for benching. During excavation, the engineer should check for any unstable or unsuitable materials within the existing embankments. Unstable soils should be removed and replaced with compacted structural fill as described in Section 6.3.

6.2 Excavation and Dewatering

Foundation excavations should be performed in accordance with local, state, and federal regulations. The potential effect of ground movements upon nearby utilities should be considered during construction.

Groundwater was encountered very close to the base elevation of the proposed piers and the EWSE is above the base elevation of the pier caps. The material at the base of the excavation will be sandy with gravel and the Contract should include pay items for *Type 2 Cofferdam* with a seal coat as discussed in Section 5.3. For any other excavations, run-off water accumulations should be immediately removed via sump pump. Any soil allowed to soften under standing water should be removed and replaced with structural fill as described below in Section 6.3.

6.3 Filling and Backfilling

Fill material required to attain the final design elevations should be structural fill material and should be pre-approved prior to placement. Compacted cohesive or granular soil conforming to IDOT Section 204 would be acceptable as structural fill (2012b). The fill material should be free of organic matter and debris. Structural fill should be placed in lifts and compacted according to IDOT Section 205, *Embankment* (2012b). The onsite soils encountered by borings between 0 and 12 feet should not be considered as new fill material, as they may contain organic debris from the floodplain soils beneath.

Backfill materials must be pre-approved by the Resident Engineer. To backfill the abutment and piers we recommend the porous granular material conforming to the requirements specified in the IDOT Special Provision, *Granular Backfill for Structures* (2013). Backfill material should be placed and compacted in accordance with the Special Provision.

6.4 Earthwork Operations

The required earthwork can be accomplished with conventional construction equipment. Moisture and traffic will cause deterioration of exposed subgrade soils. Precautions should be taken by the Contractor to prevent water erosion of the exposed subgrade. A compacted subgrade will minimize water runoff erosion.

Earth moving operations should be scheduled to not coincide with excessive cold or wet weather (early spring, late fall or winter). Any soil allowed to freeze or soften due to the standing water should be removed. Wet weather can cause problems with subgrade compaction.

6.5 Pile Installation

The driven piles shall be furnished and installed according to the requirements of IDOT Section 512, *Piling* (IDOT 2012b). Due to the slight variability in bedrock depth from the west to east of the structure we recommend including one test pile at each abutment location to confirm top of rock prior to ordering production piles. The test piles shall be driven to 110 percent of the nominal required bearing indicated in Section 5.2.1, Tables 4 and 5. The piles driven to maximum nominal bearing at the top of bedrock should be driven with metal shoes. We do **not** recommend driving the MSP with shoes; however, the MSP should not be driven beyond the capacities shown in Table 4 to avoid the possibility of damage during driving. The H-piles shall be according to AASHTO M270M, Grade 50.

7.0 QUALIFICATIONS

The analysis and recommendations submitted in this report are based upon the data obtained from the borings drilled at the locations shown on the boring logs and in Exhibit 3. This report does not reflect any variations that may occur between the borings or elsewhere on the site, variations whose nature and extent may not become evident until the course of construction. In the event that any changes in the design and/or location of the bridge are planned, we should be timely informed so that our recommendations can be adjusted accordingly.

It has been a pleasure to assist Civiltech Engineering, Inc. and the Illinois Department of Transportation on this project. Please call if there are any questions, or if we can be of further service.

Respectfully Submitted,

WANG ENGINEERING, INC.

Mickey L. Snider, P.E.
Senior Geotechnical Engineer

Corina T. Farez, P.E., P.G.
QA/QC Reviewer

REFERENCES

AASHTO (2012) *LRFD Bridge Design Specifications*. American Association of State Highway and Transportation Officials, Washington, D.C.

HANSEL, A.K. AND JOHNSON, W.H. (1996) *Wedron and Mason Groups: Lithostratigraphic Reclassification of the Wisconsin Episode, Lake Michigan Lobe Area*. ISGS Bulletin 104. Illinois State Geological Survey, Champaign, 116 pp.

IDOT (1999) *Geotechnical Manual*. Illinois Department of Transportation.

IDOT (2006) Design Guide 3.13.3- *Cofferdam Seal Coat Design*, Illinois Department of Transportation.IDOT (2011) *All Geotechnical Manual Users Memorandum 10.2 - Static Method of Estimating Pile Length*

IDOT (2012a) *Bridge Manual*. Illinois Department of Transportation.

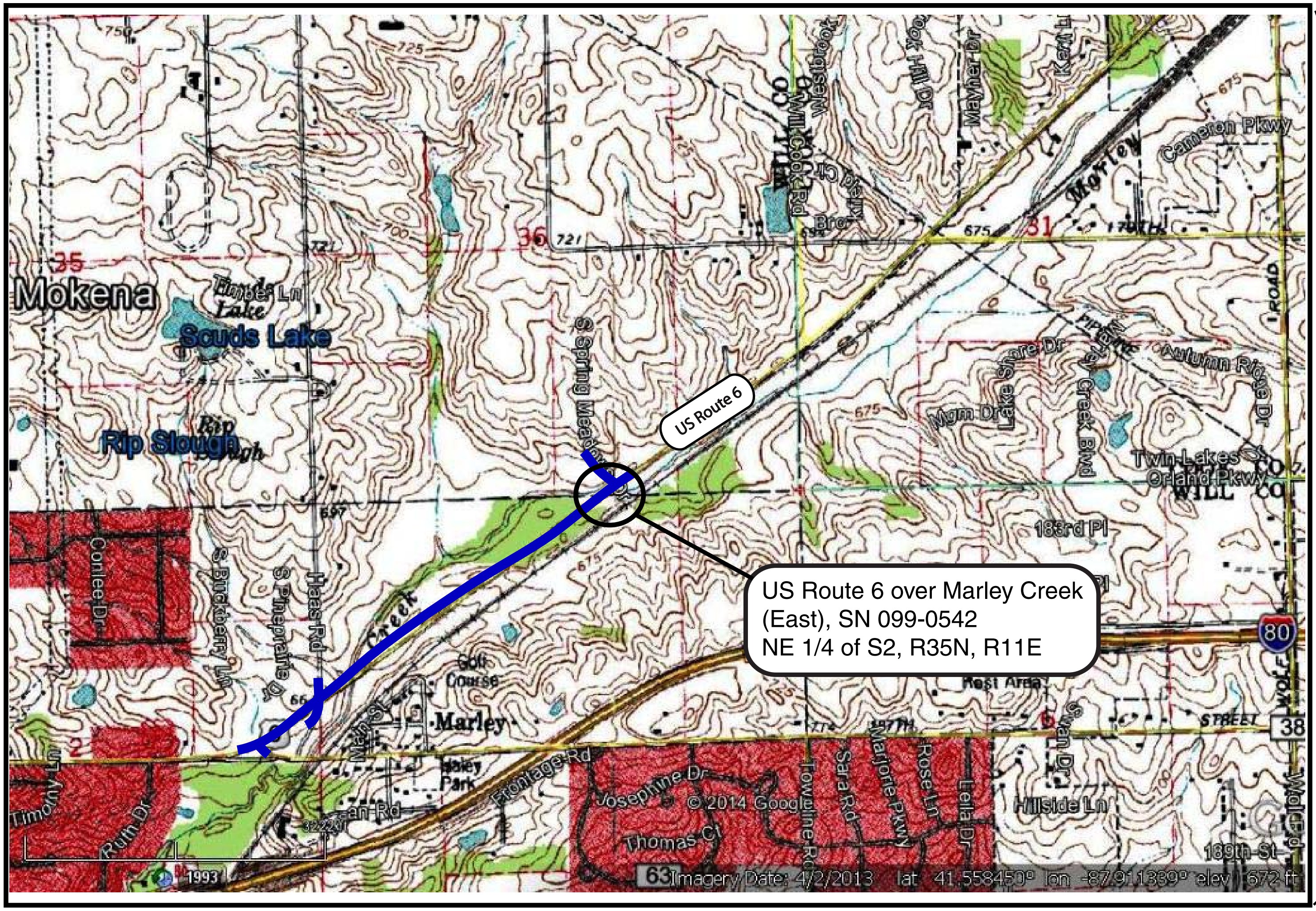
IDOT (2012b) *Standard Specifications for Road and Bridge Construction*. Illinois Department of Transportation, 1098 pp.

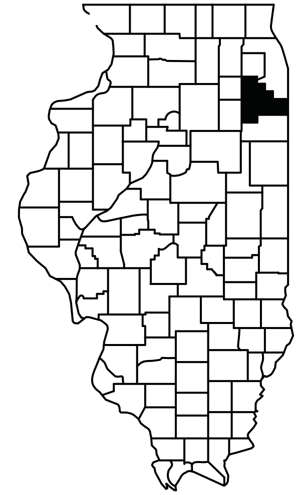
IDOT (2013) *Guide Bridge Special Provisions*

WILLMAN, H.B. (1971) *Summary of the Geology of the Chicago Area*. ISGS Circular C460. Illinois State Geological Survey, Urbana, 77 pp.

WILLMAN, H.B., AND LINEBACK, J.A. (1970) *Surficial Geology the Chicago Region*. Illinois State Geological Survey, Sc. 1:250,000.

EXHIBITS





0 0.25 0.50 0.75 1.0 Miles

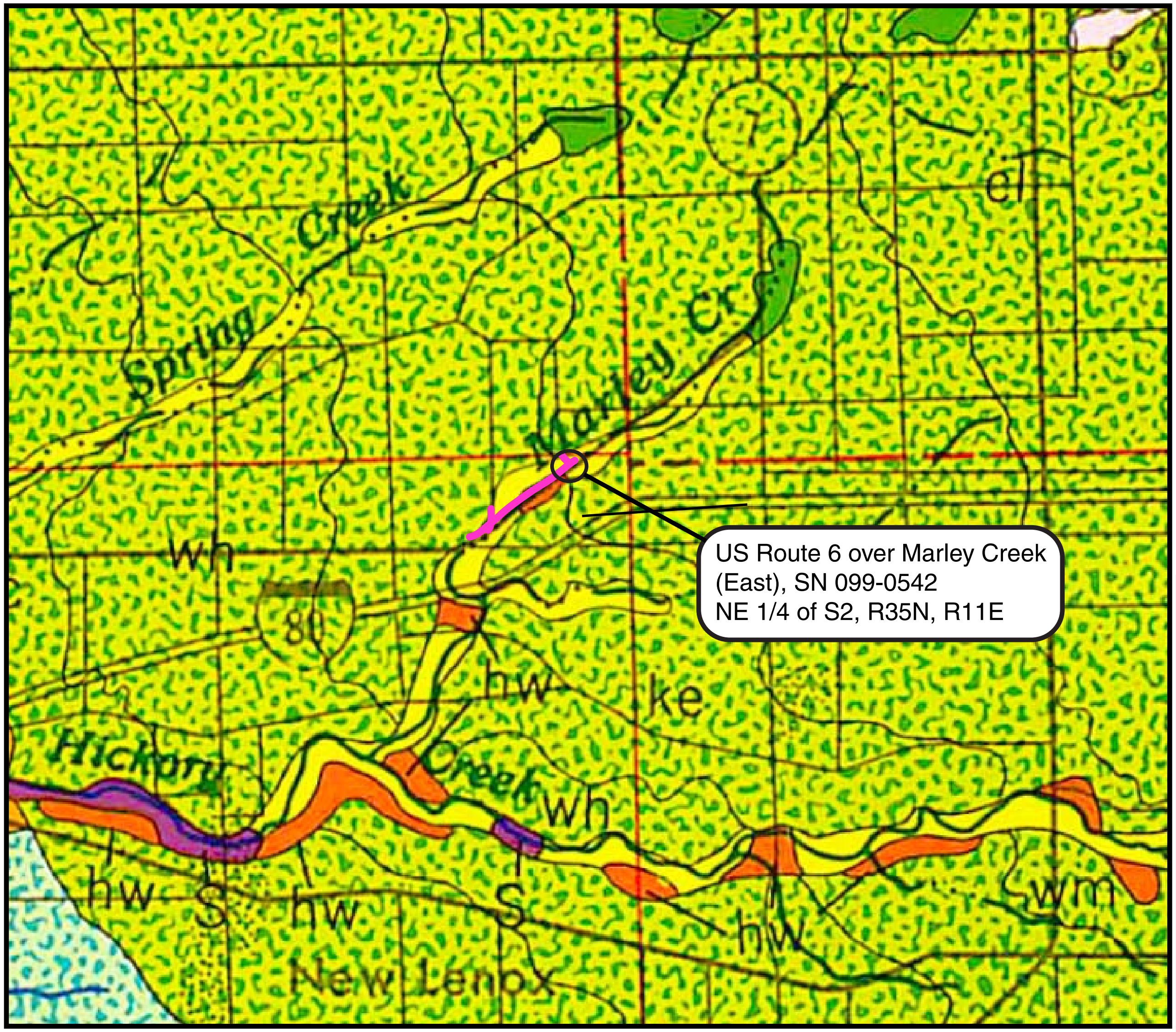
SITE LOCATION MAP: US ROUTE 6 BRIDGE OVER MARLEY CREEK
SN 099-0542, SECTION 33B (B-R), WILL COUNTY, ILLINOIS

SCALE: GRAPHICAL	EXHIBIT 1	DRAWN BY: END CHECKED BY: MLS

Wang Engineering

1145 N. Main Street
Lombard, IL 60148
www.wangeng.com

FOR CIVILTECH ENGINEERING, INC. | 401-05-01



Modif ed after Willman and Lineback (1970)

0 1.0 2.0 3.0 4.0 5.0 Miles

REGIONAL GEOLOGY

Wedron Group

- Wadsworth Formation
- Lemont Formation
- Tiskilwa Formation

20 mi

Modified after Hansel and Johnson (1996)

LEGEND

Postglacial Cover

c — **Cahokia Alluvium**
Deposits in floodplains and channels of modern rivers and streams; mosly poorly sorted silt and sand containing local deposits of sandy gravel;

Glacial Cover

Mason Group

Henry Formation
Sand and gravel, generally well sortedand evenly bedded; Glacial outwash deposits;

hm — **Mackinaw facies**
Sand and gravel, generally well sorted and evenly bedded, deposits in valley.

hw — **Wasco facies**
Sand and gravel, unevenly sorted, irregularly bedded, with various grain size; glacial ice-contact deposits in kames, eskers, and kame terraces

Wedron Group

Wadsworth Formation
Mostly gray pebbly silty clayey till; contains local lenses of silt laminae and sand.

Valparaiso Morainic System

- cl — **Clarendon Moraine**
- wm — **Westmont Moraine**
- ke — **Keeneyville Moraine**
- wh — **Wheaton Moraine**
- wc — **West Chicago Moraine**

Bedrock

S — **Silurian**
Largely Dolomite, slightly to moderately argillaceous with scattered chert nodules

Modifed after Willman and Lineback (1970)

SITE AND REGIONAL GEOLOGY: US ROUTE 6 BRIDGE OVER MARLEY CREEK, SN 099-0542, SECTION 33B (B-R), WILL COUNTY, ILLINOIS		
SCALE: GRAPHICAL	EXHIBIT 2	DRAWN BY: C. Marin CHECKED BY: L. Iordache
Wang Engineering		1145 N. Main Street Lombard, IL 60148 www.wangeng.com
FOR CIVILTECH ENGINEERING, INC		401-05-01

Benchmark: Box "□" cut at the north end of the east abutment backwall of the existing US Route 6 over Marley Creek bridge (Existing SN 099-0148); Station 414+76.71, Offset 23.65' Lt., Elevation 667.85

Existing Structure: SN 099-0148 was originally built in 1930 under SAR 38, Section 33B-15D. It was a single span reinforced concrete tee beam superstructure on closed wall abutments supported on spread footings. In 1980, the structure was reconstructed as FAS 1294, Section 33-B2. Precast prestressed concrete deck beams (17"x36") replaced the concrete tee beam superstructure, and part of the substructure was removed and replaced. The out-to-out width of the superstructure is 42'-0", and the structure length is 39'-7½" measured back-to-back of abutments.

One lane of traffic in alternating directions will be maintained utilizing temporary traffic signals and staged construction.

Salvage: None.

DESIGN SCOUR ELEVATION TABLE

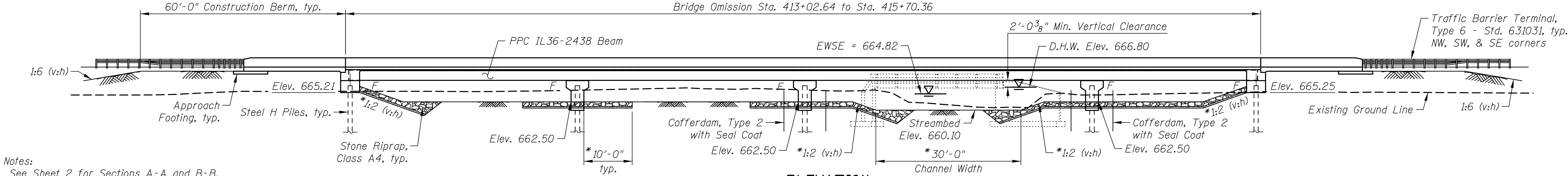
Event/Limit State	Design Scour Elevations (ft.)					Item 113
	W. Abut.	W. Pier	Center Pier	E. Pier	E. Abut.	
Q100	665.21	657.75	657.75	658.40	665.25	8
Q200	665.21	657.54	657.54	658.30	665.25	
Design	665.21	657.75	657.75	658.40	665.25	
Check	665.21	657.54	657.54	658.30	665.25	

WATERWAY INFORMATION

Drainage Area = 10.5 sq. mi. Low Grade Elev. 666.0 @ Sta. 420+50.00

Flood	Freq. Yr.	Q C.F.S.	Opening Sq. Ft.		Nat. H.W.E.	Head - Ft.		Headwater El.	
			Exist.	Prop.		Exist.	Prop.	Exist.	Prop.
	10	1199	137	678	666.1	1.4	0.3	667.5	666.4
Design	50	2258	147	800	666.8	1.1	0.4	667.9	667.2
Base	100	2815	147	870	667.2	1.1	0.5	668.3	667.7
Scour Design Check	200	3071	147	888	667.3	1.1	0.6	668.4	667.9
Overtopping (Ex.)	<2	450	118	-	665.3	0.6	-	665.9	-
Overtopping (Pr.)	5	814	-	610	665.7	-	0.3	-	666.0
Max Calc.	500	3838	147	905	667.4	1.4	0.9	668.8	668.3

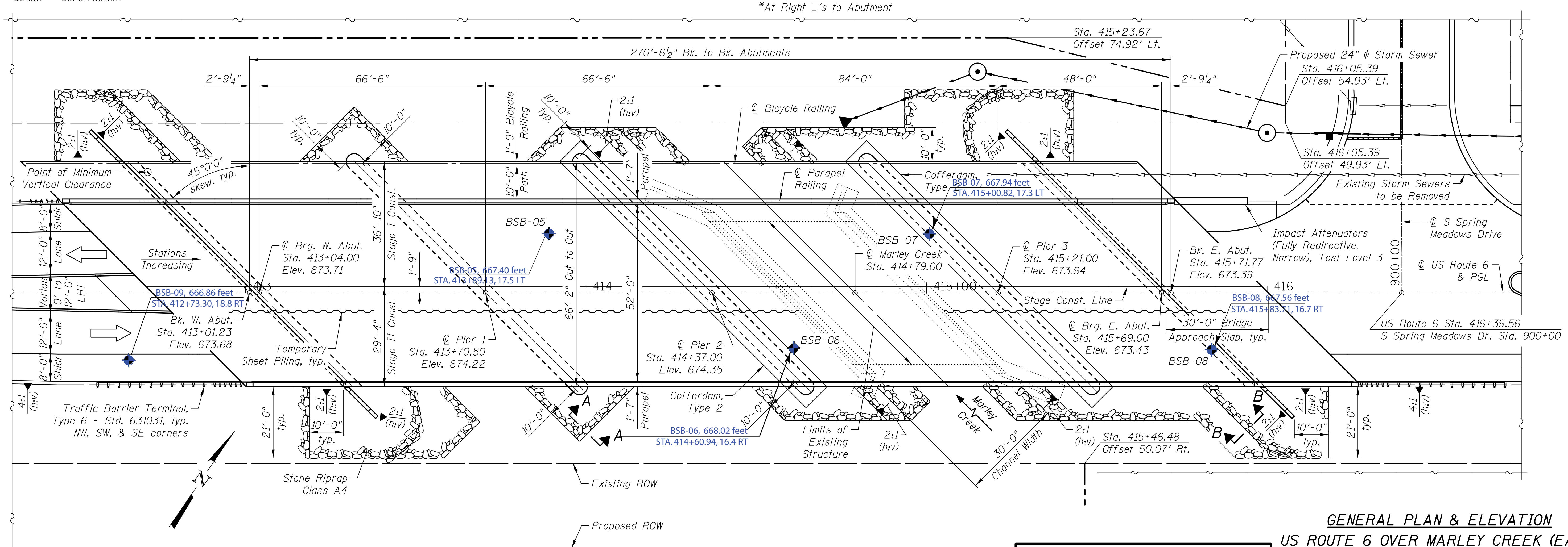
10 Year Velocity through Existing Bridge = 8.8 ft/sec
10 Year Velocity through Proposed Bridge = 1.8 ft/sec



Notes:
See Sheet 2 for Sections A-A and B-B.
Const. = Construction

ELEVATION

*At Right ∟'s to Abutment



PLAN

LOADING HL-93

Allow 50#/sq. ft. for future wearing surface.

DESIGN SPECIFICATIONS

AASHTO LRFD Bridge Design Specifications, 7th Edition

SEISMIC DATA

Seismic Performance Zone (SPZ) = 1
Design Spectral Acceleration at 1.0 sec. (S_{D1}) = 0.094g
Design Spectral Acceleration at 0.2 sec. (S_{DS}) = 0.163g
Soil Site Class = D

BORING LOCATION PLAN: US ROUTE 6 BRIDGE OVER MARLEY CREEK
SN 099-0542, SECTION 33B (B-R), WILL COUNTY, ILLINOIS
SCALE: GRAPHICAL | EXHIBIT 3 | DRAWN BY: END CHECKED BY: MLS

Wang Engineering
1145 N. Main Street
Lombard, IL 60148
www.wangeng.com

FOR CIVILTECH ENGINEERING, INC. | 401-05-01

GENERAL PLAN & ELEVATION
US ROUTE 6 OVER MARLEY CREEK (EAST)
FAU ROUTE 0297 - SECTION 33B (B-R)
WILL COUNTY
STA. 414+79.00
STRUCTURE NO. 099-0542

CIVILTECH
450 E Devon Ave, Suite 300
Itasca, Illinois 60143
Tel: 630.773.3900 Fax: 630.773.3975
www.civiltechinc.com

DRAWN	- K. KOMPARE
DESIGNED	- M. LANGE
CHECKED	- G. HATLESTAD
DATE	- JANUARY 6, 2016

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

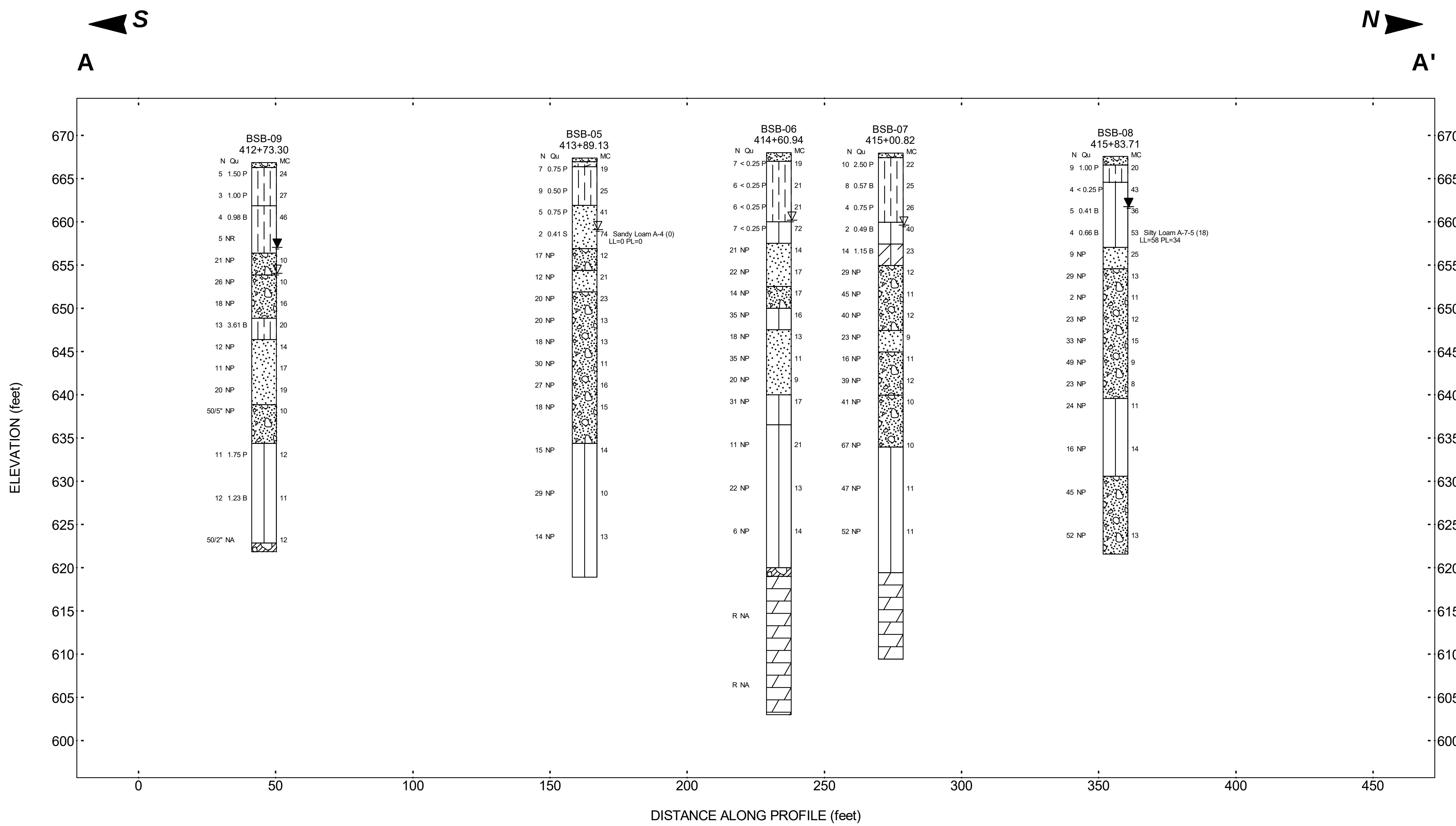
US ROUTE 6 OVER MARLEY CREEK

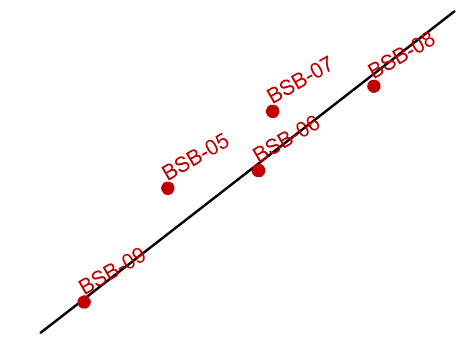
SHEET NO. 1 OF 2 SHEETS

F.A.U. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
0297	33B (B-R)	WILL	126	90

CONTRACT NO.
ILLINOIS FED. AID PROJECT

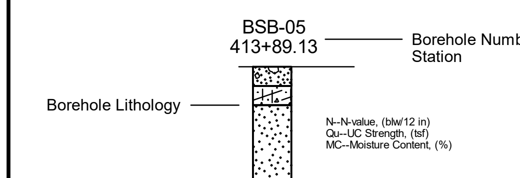
c:\pw_working\civiltech_production\klk\dms07643\01_GPE_SN099-0542_TSL.dgn
10:22:29 AM
klk 1/7/2016





Site Map Scale 1 inch equals 165 feet

Explanation:



Water Level Reading at time of drilling.

Water Level Reading 24-hr after drilling or at end of drilling

Horizontal Scale (feet)

Vertical Exaggeration: 3x

Lithology Graphics

- Gravelly sand, sandy gravel
- Pavement
- IDH Silty Clay, Silty Clay Loam
- IDH Sand, Sandy Loam
- IDH Silt, Silty Loam
- Weathered bedrock
- Dolomite or Dolomitic Limestone
- IDH Clay Loam

Wang Engineering, Inc.
1145 N Main Street
Lombard, IL 60148

Soil Profile A-A'
SN 099-0542
East Bridge, Marley Creek

WEI SINCE 1982

US Route 6 over Marley Creek
New Lenox, Will County, IL

JOB NUMBER	PLATE NUMBER
401-05-01	EXHIBIT 4

WEI 11X17 4010501.GPJ WANGENG.GDT 1/13/16

APPENDIX A

Wang Engineering
wangeng@wangeng.com
1145 N Main Street
Lombard, IL 60148
Telephone: (630) 953-9928
Fax:

BORING LOG BSB-05

WEI Job No.: 401-05-01

Client: **Civiltech Engineering, Inc.**
Project: **US Route 6 over Marley Creek**
Location: **New Lenox, Will County, IL**

Datum: NAVD88
Elevation: 667.40 ft
North: 1781256.94 ft
East: 1098093.57 ft
Station: 413+89.13
Offset: 17.51 LT

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
666.9	5.5-inch thick SANDY GRAVEL --SHOULDER AGGREGATE--					
666.4	6.5-inch thick ASPHALT --PAVEMENT--					
	Medium stiff, brown and black SILTY CLAY LOAM, little gravel --FILL--		1	2, 3, 4	0.75 P	19
		5	2	1, 5, 4	0.50 P	25
661.9	Soft to medium stiff, black SANDY LOAM, silt lamination, trace organic matter --%Gravel = 2.2%-- --%Sand = 53.1%-- --%Silt = 34.6%-- --%Clay = 10.1%--		3	2, 2, 3	0.75 P	41
		10	4	1, 1, 1	0.41 S	74
656.9	Medium dense, grayish brown GRAVELLY SANDY LOAM --saturated--		5	7, 9, 8	NP	12
654.4	Medium dense, brown, fine SAND, trace gravel --saturated--	15	6	6, 5, 7	NP	21
651.9	Medium dense to dense, grayish brown GRAVELLY SANDY LOAM --saturated--		7	6, 8, 12	NP	23
	--saturated--	20	8	21, 10, 10	NP	13
	--saturated--		9	9, 9, 9	NP	13
	--saturated--	25	10	25, 15, 15	NP	11
	--saturated--		11	13, 16, 11	NP	16
	--saturated--	30	12	13, 9, 9	NP	15
634.4	Medium dense, gray SILT to SILTY LOAM, trace to some gravel --moist--	35	13	4, 6, 9	NP	14
	--moist--	40	14	7, 14, 15	NP	10

GENERAL NOTES

Begin Drilling **06-09-2014** Complete Drilling **06-10-2014**
Drilling Contractor **Wang Testing Service** Drill Rig **D50 TMR**
Driller **R&J** Logger **S. Woods** Checked by **M. Snider**
Drilling Method **2.25 SSA to 10 feet, mud rotary below 10 feet; 140 lb auto hammer; boring backfilled upon completion**

WATER LEVEL DATA

While Drilling **8.50 ft**
At Completion of Drilling **NA**
Time After Drilling **NA**
Depth to Water **NA**

The stratification lines represent the approximate boundary between soil types; the actual transition may be gradual.

BORING LOG BSB-05

Wang Engineering
wangeng@wangeng.com
1145 N Main Street
Lombard, IL 60148
Telephone: (630) 953-9928
Fax:

WEI Job No.: 401-05-01

Client: **Civiltech Engineering, Inc.**
Project: **US Route 6 over Marley Creek**
Location: **New Lenox, Will County, IL**

Datum: NAVD88
Elevation: 667.40 ft
North: 1781256.94 ft
East: 1098093.57 ft
Station: 413+89.13
Offset: 17.51 LT

Profile	Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample Type recovery	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
		--moist--	45		15	7 9 5	NP	13
	618.9	--ROLLER BIT REFUSAL-- Boring terminated at 48.50 ft						
			50					
			55					
			60					

GENERAL NOTES

Begin Drilling **06-09-2014** Complete Drilling **06-10-2014**
Drilling Contractor **Wang Testing Service** Drill Rig **D50 TMR**
Driller **R&J** Logger **S. Woods** Checked by **M. Snider**
Drilling Method **2.25 SSA to 10 feet, mud rotary below 10 feet; 140 lb auto hammer; boring backfilled upon completion**

WATER LEVEL DATA

While Drilling ▽ **8.50 ft**
At Completion of Drilling ▼ **NA**
Time After Drilling **NA**
Depth to Water ▼ **NA**

The stratification lines represent the approximate boundary between soil types; the actual transition may be gradual.

Wang Engineering

wangeng@wangeng.com
1145 N Main Street
Lombard, IL 60148
Telephone: (630) 953-9928
Fax:

BORING LOG BSB-06

WEI Job No.: 401-05-01

Client: **Civiltech Engineering, Inc.**
Project: **US Route 6 over Marley Creek**
Location: **New Lenox, Will County, IL**

Datum: NAVD88
Elevation: 668.02 ft
North: 1781272.11 ft
East: 1098171.51 ft
Station: 414+60.94
Offset: 16.37 RT

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
	12-inch thick, brown SANDY GRAVEL --SHOULDER AGGREGATE--					
667.0	Very soft, black and brown SILTY CLAY LOAM, trace gravel --FILL--		1	3, 3, 4	< 0.25 P	19
		5	2	4, 3, 3	< 0.25 P	21
			3	2, 3, 3	< 0.25 P	21
660.0	Very soft, black SILTY LOAM, sand lamination, trace organic matter	10	4	1, 2, 5	< 0.25 P	72
657.5	Medium dense, brown, fine to medium SAND and SANDY LOAM, little gravel --saturated--		5	9, 10, 11	NP	14
	--saturated--	15	6	6, 11, 11	NP	17
652.5	Medium dense, brown, SANDY GRAVEL --saturated--		7	6, 6, 8	NP	17
650.0	Dense, gray SILTY LOAM and gravel --saturated--	20	8	8, 17, 18	NP	16

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
647.5	Medium dense to dense, brown, medium to coarse SAND and SANDY LOAM, some gravel --saturated--		9	9, 9, 9	NP	13
	--saturated--	25	10	28, 18, 17	NP	11
	--saturated--		11	14, 14, 6	NP	9
640.0	Dense, gray SILTY LOAM, with gravel --saturated--	30	12	9, 13, 18	NP	17
636.5	Loose to medium dense, gray SILT, trace gravel --dry--	35	13	4, 5, 6	NP	21
		40	14	7, 11, 11	NP	13

GENERAL NOTES

Begin Drilling **05-28-2014** Complete Drilling **05-30-2014**
Drilling Contractor **Wang Testing Service** Drill Rig **D50 TMR**
Driller **R&J** Logger **S. Woods** Checked by **M. Snider**
Drilling Method **2.25 SSA to 10 feet, mud rotary below 10 feet; 140 lb auto hammer; boring backfilled upon completion**

WATER LEVEL DATA

While Drilling ▽ **8.00 ft**
At Completion of Drilling ▼ **NA**
Time After Drilling **NA**
Depth to Water ▼ **NA**

The stratification lines represent the approximate boundary between soil types; the actual transition may be gradual.

Wang Engineering

wangeng@wangeng.com
1145 N Main Street
Lombard, IL 60148
Telephone: (630) 953-9928
Fax:

BORING LOG BSB-06

WEI Job No.: 401-05-01

Client **Civiltech Engineering, Inc.**
Project **US Route 6 over Marley Creek**
Location **New Lenox, Will County, IL**

Datum: NAVD88
Elevation: 668.02 ft
North: 1781272.11 ft
East: 1098171.51 ft
Station: 414+60.94
Offset: 16.37 RT

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample Type recovery	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
		45		15	2 2 4	NP	14
620.0	Weathered DOLOSTONE						
619.0	Strong, light gray, poor to fair quality DOLOSTONE, slightly weathered rock and joints, hard joint wall with slicken to slightly rough joint wall surface, <0.05 in joint openings, horizontal and vertical orientation, 2.5 to 3.1 in joint spacing, infill is grayish white in color and <0.02in thick, dry --Run#1: 49 to 59 feet-- --Recovery = 99%-- --RQD = 33%-- --Q_u = 12,390 psi--	50 55		16	CORE		
	--Run #2: 59 to 65 feet-- --Recovery = 97%-- --RQD = 54%--	60		17	CORE		
603.0	Boring terminated at 65.00 ft	65					
		70 75 80					

GENERAL NOTES

Begin Drilling **05-28-2014** Complete Drilling **05-30-2014**
Drilling Contractor **Wang Testing Service** Drill Rig **D50 TMR**
Driller **R&J** Logger **S. Woods** Checked by **M. Snider**
Drilling Method **2.25 SSA to 10 feet, mud rotary below 10 feet; 140 lb auto hammer; boring backfilled upon completion**

WATER LEVEL DATA

While Drilling **8.00 ft**
At Completion of Drilling **NA**
Time After Drilling **NA**
Depth to Water **NA**

The stratification lines represent the approximate boundary between soil types; the actual transition may be gradual.

Wang Engineering
wangeng@wangeng.com
1145 N Main Street
Lombard, IL 60148
Telephone: (630) 953-9928
Fax:

BORING LOG BSB-07

WEI Job No.: 401-05-01

Client: **Civiltech Engineering, Inc.**
Project: **US Route 6 over Marley Creek**
Location: **New Lenox, Will County, IL**

Datum: NAVD88
Elevation: 667.94 ft
North: 1781322.87 ft
East: 1098183.73 ft
Station: 415+00.82
Offset: 17.32 LT

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
667.4	6-inch thick SANDY GRAVEL --SHOULDER AGGREGATE--					
	Medium stiff to very stiff, brown and black SILTY CLAY LOAM, trace to some gravel --FILL--		1	2, 5, 5	2.50 P	22
		5	2	1, 2, 6	0.57 B	25
			3	1, 2, 2	0.75 P	26
659.9	Soft, black SILTY LOAM, sand lamination, trace gravel	10	4	0, 1, 1	0.49 B	40
657.4	Stiff, black CLAY LOAM, little gravel --saturated--		5	1, 3, 11	1.15 B	23
654.9	Medium dense to dense, brown GRAVELLY SANDY LOAM --saturated--	15	6	15, 12, 17	NP	12
	--saturated--		7	16, 31, 14	NP	11
	--saturated--	20	8	16, 22, 18	NP	12
647.4	Medium dense, brown, medium to coarse SAND, some gravel --saturated--		9	11, 10, 13	NP	9
644.9	Medium dense to dense, brown, coarse SANDY GRAVEL --wet--	25	10	24, 9, 7	NP	11
	--wet--		11	60, 22, 17	NP	12
639.9	Dense, grayish brown, GRAVELLY SANDY LOAM --saturated--	30	12	16, 22, 19	NP	10
633.9	Dense to very dense, gray SILT, little to some gravel --dry--	35	13	30, 33, 34	NP	10
		40	14	20, 21, 26	NP	11

GENERAL NOTES

Begin Drilling **06-06-2014** Complete Drilling **06-09-2014**
Drilling Contractor **Wang Testing Service** Drill Rig **D50 TMR**
Driller **R&J** Logger **S. Woods** Checked by **M. Snider**
Drilling Method **2.25 SSA to 10 feet, mud rotary below 10 feet; 140 lb auto hammer; boring backfilled upon completion**

WATER LEVEL DATA

While Drilling ▽ **8.50 ft**
At Completion of Drilling ▼ **NA**
Time After Drilling **NA**
Depth to Water ▼ **NA**

The stratification lines represent the approximate boundary between soil types; the actual transition may be gradual.

Wang Engineering

wangeng@wangeng.com
1145 N Main Street
Lombard, IL 60148
Telephone: (630) 953-9928
Fax:

BORING LOG BSB-07

WEI Job No.: 401-05-01

Client: **Civiltech Engineering, Inc.**
Project: **US Route 6 over Marley Creek**
Location: **New Lenox, Will County, IL**

Datum: NAVD88
Elevation: 667.94 ft
North: 1781322.87 ft
East: 1098183.73 ft
Station: 415+00.82
Offset: 17.32 LT

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample Type (recovery)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
		45	SS	15	28 25 27	NP	11
619.4	Strong, very poor quality, grayish and green DOLOSTONE, dry, slightly weathered, no infill, vertically and horizontally jointed, joint spacing approximately 2 inches, hard joint walls, slicken to slightly rough joint wall surface, joint openings < 0.05 in --Run#1: 48.5 to 58.5 feet-- --Recovery = 98%-- --RQD = 20%-- --Q_u = 11,140 psi--	50, 55					
609.4	Boring terminated at 58.50 ft	60					

GENERAL NOTES

Begin Drilling **06-06-2014** Complete Drilling **06-09-2014**
Drilling Contractor **Wang Testing Service** Drill Rig **D50 TMR**
Driller **R&J** Logger **S. Woods** Checked by **M. Snider**
Drilling Method **2.25 SSA to 10 feet, mud rotary below 10 feet; 140 lb auto hammer; boring backfilled upon completion**

WATER LEVEL DATA

While Drilling **8.50 ft**
At Completion of Drilling **NA**
Time After Drilling **NA**
Depth to Water **NA**

The stratification lines represent the approximate boundary between soil types; the actual transition may be gradual.

Wang Engineering
wangeng@wangeng.com
1145 N Main Street
Lombard, IL 60148
Telephone: (630) 953-9928
Fax:

BORING LOG BSB-08

WEI Job No.: 401-05-01

Client: **Civiltech Engineering, Inc.**
Project: **US Route 6 over Marley Creek**
Location: **New Lenox, Will County, IL**

Datum: NAVD88
Elevation: 667.56 ft
North: 1781344.50 ft
East: 1098270.66 ft
Station: 415+83.71
Offset: 16.67 RT

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
	12-inch thick SANDY GRAVEL --SHOULDER AGGREGATE--					
666.6	Stiff, black and brown SILTY CLAY LOAM, trace gravel --FILL--		1	4 3 6	1.00 P	20
664.6	Very soft to medium stiff, black SILTY LOAM, sand lamination --L_L(%) = 58, P_L(%) = 34-- --%Gravel = 0.5%-- --%Sand = 28.5%-- --%Silt = 51.8%-- --%Clay = 19.2%--	5	2	1 2 2	< 0.25 P	43
			3	1 2 3	0.41 B	36
		10	4	1 2 2	0.66 B	53
657.1	Loose, brown, fine SAND, trace gravel --saturated--		5	4 4 5	NP	25
654.6	Medium dense to dense, gray and brown SAND and GRAVEL --saturated--	15	6	13 15 14	NP	13
	--saturated--		7	12 10- 8	NP	11
	--saturated--	20	8	8 11 12	NP	12
	--saturated--		9	11 20 13	NP	15
	--saturated--	25	10	13 22 27	NP	9
	--saturated--		11	18 12 11	NP	8
639.6	Medium dense, brown and gray SILTY LOAM, trace to little gravel --moist--	30	12	22 18 6	NP	11
	--moist--	35	13	9 8 8	NP	14
630.6	Very dense to dense, brown SAND and GRAVEL, some dolostone fragments --wet--	40	14	19 21 24	NP	

GENERAL NOTES

Begin Drilling **06-12-2014** Complete Drilling **06-12-2014**
Drilling Contractor **Wang Testing Service** Drill Rig **D50 TMR**
Driller **R&J** Logger **S. Woods** Checked by **M. Snider**
Drilling Method **2.25 SSA to 10 feet, mud rotary below 10 feet; 140 lb auto hammer; boring backfilled upon completion**

WATER LEVEL DATA

While Drilling ▽ **6.00 ft**
At Completion of Drilling ▼ **6.00 ft**
Time After Drilling **NA**
Depth to Water ▽ **NA**

The stratification lines represent the approximate boundary between soil types; the actual transition may be gradual.

Wang Engineering

wangeng@wangeng.com
1145 N Main Street
Lombard, IL 60148
Telephone: (630) 953-9928
Fax:

BORING LOG BSB-08

WEI Job No.: 401-05-01

Client: **Civiltech Engineering, Inc.**
Project: **US Route 6 over Marley Creek**
Location: **New Lenox, Will County, IL**

Datum: NAVD88
Elevation: 667.56 ft
North: 1781344.50 ft
East: 1098270.66 ft
Station: 415+83.71
Offset: 16.67 RT

Profile	Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample Type *recovery*	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
		--saturated--			15	24 30 22	NP	13
			45					
	621.6	--ROLLER BIT REFUSAL--						
		Boring terminated at 46.00 ft						
			50					
			55					
			60					

GENERAL NOTES

Begin Drilling **06-12-2014** Complete Drilling **06-12-2014**
Drilling Contractor **Wang Testing Service** Drill Rig **D50 TMR**
Driller **R&J** Logger **S. Woods** Checked by **M. Snider**
Drilling Method **2.25 SSA to 10 feet, mud rotary below 10 feet; 140 lb auto hammer; boring backfilled upon completion**

WATER LEVEL DATA

While Drilling ▽ **6.00 ft**
At Completion of Drilling ▼ **6.00 ft**
Time After Drilling **NA**
Depth to Water ▼ **NA**

The stratification lines represent the approximate boundary between soil types; the actual transition may be gradual.

Wang Engineering
wangeng@wangeng.com
1145 N Main Street
Lombard, IL 60148
Telephone: (630) 953-9928
Fax:

BORING LOG BSB-09

WEI Job No.: 401-05-01

Client: **Civiltech Engineering, Inc.**
Project: **US Route 6 over Marley Creek**
Location: **New Lenox, Will County, IL**

Datum: NAVD88
Elevation: 666.86 ft
North: 1781159.16 ft
East: 1098021.63 ft
Station: 412+73.30
Offset: 18.76 RT

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
666.3	7-inch thick GRAVELLY LOAM --SHOULDER AGGREGATE--					
	Stiff, brown SILTY CLAY LOAM, trace gravel --FILL--		1	4 2 3	1.50 P	24
			2	1 1 2	1.00 P	27
661.9	Medium stiff, black SILTY CLAY LOAM, organics	5	3	1 2 2	0.98 B	46
		10	4	3 2 3	NR	
656.4	Medium dense, brown GRAVELLY SANDY LOAM --moist--		5	5 9 12	NP	10
653.9	Medium dense, gray SANDY GRAVEL --saturated--	15	6	12 13 13	NP	10
			7	6 8 10	NP	16
648.9	Very stiff, gray SILTY CLAY, trace gravel	20	8	4 6 7	3.61 B	20
646.4	Medium dense, gray GRAVELLY SAND to SAND --saturated--		9	7 6 6	NP	14
	--saturated--	25	10	4 5 6	NP	17
	--saturated--		11	6 9 11	NP	19
638.9	Very dense, gray GRAVELLY LOAM --hard drilling 29.0 to 32.5 feet-- --possible cobbles--	30	12	15 19 50/5"	NP	10
634.4	Stiff, gray SILTY LOAM to SILTY CLAY LOAM, little to some gravel	35	13	5 5 6	1.75 P	12
		40	14	4 5 7	1.23 B	11

GENERAL NOTES

Begin Drilling **10-13-2015** Complete Drilling **10-13-2015**
Drilling Contractor **Wang Testing Service** Drill Rig **D50 TMR**
Driller **R&N** Logger **F. Bozga** Checked by **NSB**
Drilling Method **3.25 HSA to termination; boring backfilled upon completion**

WATER LEVEL DATA

While Drilling **13.00 ft**
At Completion of Drilling **10.00 ft**
Time After Drilling **NA**
Depth to Water **NA**

The stratification lines represent the approximate boundary between soil types; the actual transition may be gradual.

Wang Engineering

wangeng@wangeng.com
1145 N Main Street
Lombard, IL 60148
Telephone: (630) 953-9928
Fax:

BORING LOG BSB-09

WEI Job No.: 401-05-01

Client: **Civiltech Engineering, Inc.**
Project: **US Route 6 over Marley Creek**
Location: **New Lenox, Will County, IL**

Datum: NAVD88
Elevation: 666.86 ft
North: 1781159.16 ft
East: 1098021.63 ft
Station: 412+73.30
Offset: 18.76 RT

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample Type recovery	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
622.9	WEATHERED ROCK FRAGMENTS			15	2 35 50/2"		12
621.9	--hard drilling 44.0 to 45.0 feet-- --ROLLER BIT REFUSAL--	45					
	Boring terminated at 45.00 ft						
		50					
		55					
		60					

GENERAL NOTES

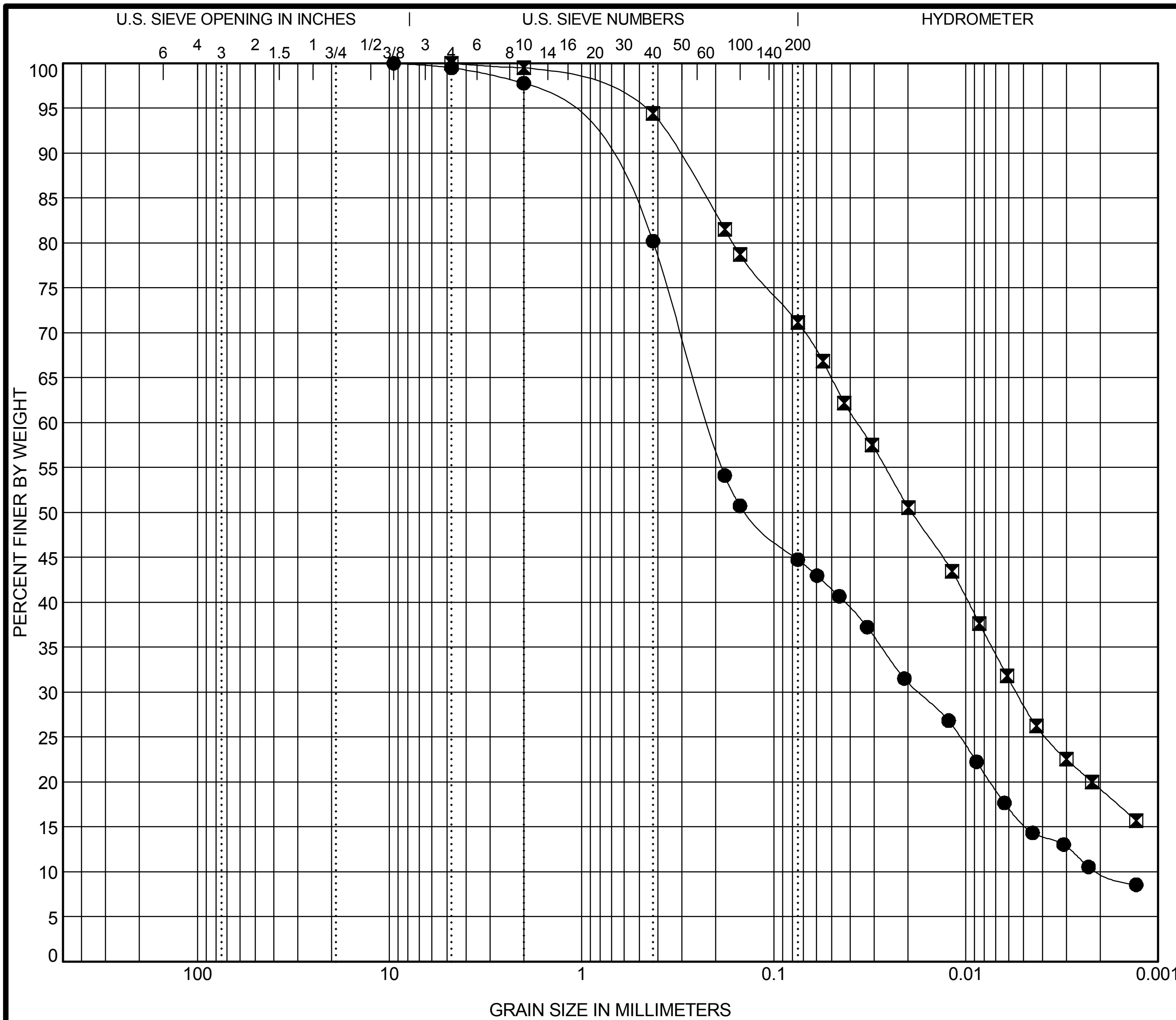
Begin Drilling **10-13-2015** Complete Drilling **10-13-2015**
Drilling Contractor **Wang Testing Service** Drill Rig **D50 TMR**
Driller **R&N** Logger **F. Bozga** Checked by **NSB**
Drilling Method **3.25 HSA to termination; boring backfilled upon completion**

WATER LEVEL DATA

While Drilling **13.00 ft**
At Completion of Drilling **10.00 ft**
Time After Drilling **NA**
Depth to Water **NA**

The stratification lines represent the approximate boundary between soil types; the actual transition may be gradual.

APPENDIX B



COBBLES	GRAVEL	SAND		SILT AND CLAY
		coarse	fine	

	Specimen Identification		IDH Classification	LL	PL	PI	Cc	Cu
●	BSB-05#4	8.5 ft	**Sandy Loam**	NP	NP	NP	0.72	111.20
⊠	BSB-08#4	8.5 ft	**Silty Loam**	58	34	24		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	BSB-05#4	8.5 ft	9.5	0.219	0.018	0.002	2.2	53.1	34.6	10.1
⊠	BSB-08#4	8.5 ft	4.75	0.037	0.005		0.5	28.5	51.8	19.2

Wang Engineering, Inc.
1145 N Main Street
Lombard, IL 60148
Telephone: 630 953-9928
Fax: 630 953-9938

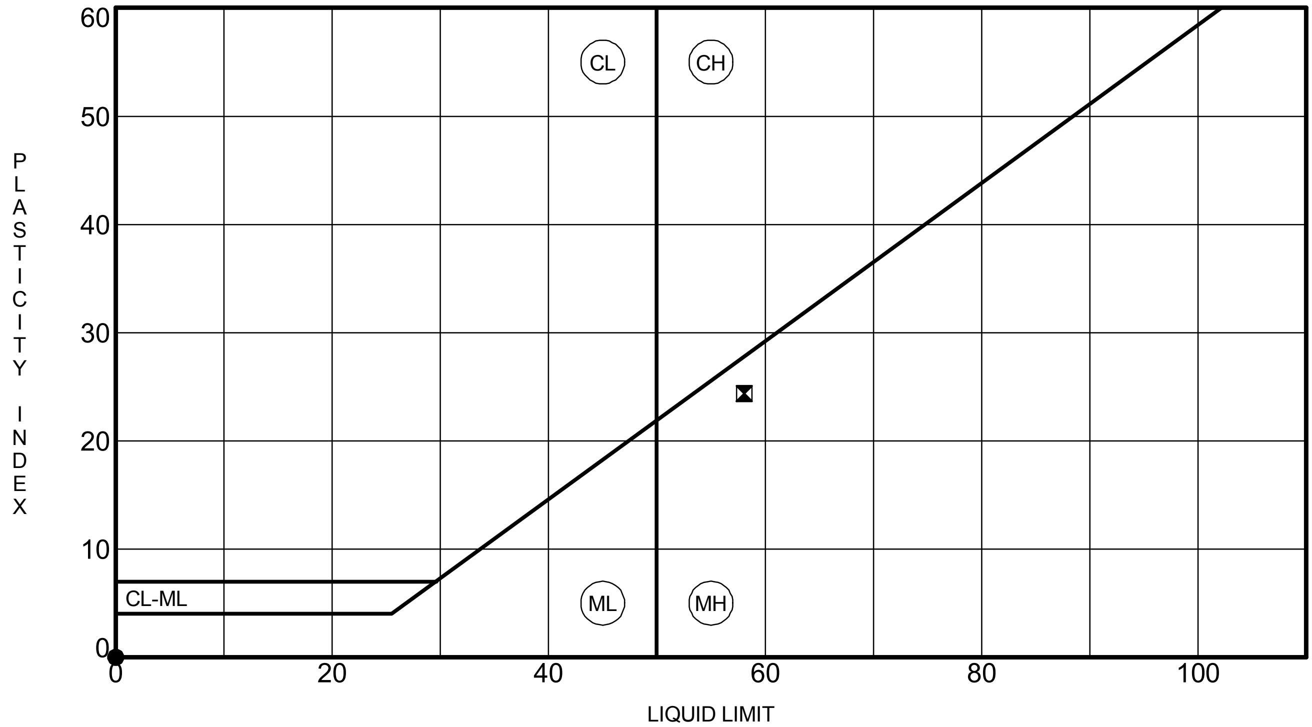
GRAIN SIZE DISTRIBUTION

Project: US Route 6 over Marley Creek

Location: New Lenox, Will County, IL

Number: 401-05-01

WEI GRAIN SIZE IDH 4010501.GPJ US LAB.GDT 10/27/14



	Specimen Identification		LL	PL	PI	Fines	IDH Classification
●	**BSB-05#4**	**8.5 ft**	**NP**	**NP**	**NP**	**45**	**Sandy Loam**
⧗	**BSB-08#4**	**8.5 ft**	**58**	**34**	**24**	**71**	**Silty Loam**

WEI SINCE 1982
Wang Engineering, Inc.
1145 N Main Street
Lombard, IL 60148
Telephone: 630 953-9928
Fax: 630 953-9938

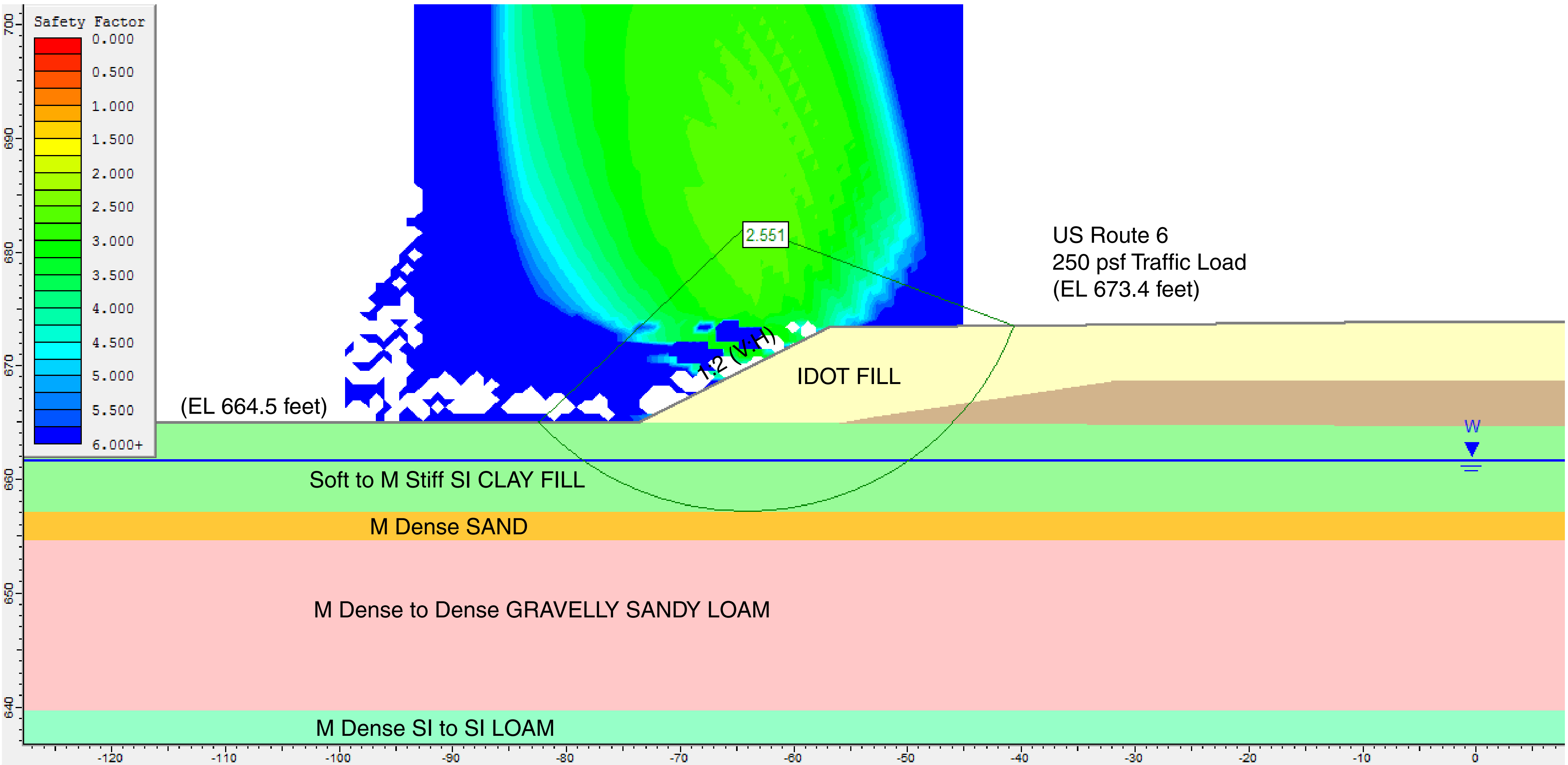
ATTERBERG LIMITS' RESULTS

Project: US Route 6 over Marley Creek

Location: New Lenox, Will County, IL

Number: 401-05-01

APPENDIX C



Undrained Analysis for Side Slope, Station 415+72, Ref Boring BSB-08

Layer ID	Description	Unit Weight (pcf)	Undrained Cohesion (psf)	Undrained Friction Angle (degrees)
1	IDOT FILL	125	1000	0
2	Soft to M Stiff SI CLAY FILL	115	450	0
3	M Dense SAND	120	0	30
4	M Dense to Dense SANDY LOAM	125	0	32
5	M Dense SI to SI LOAM	120	0	30

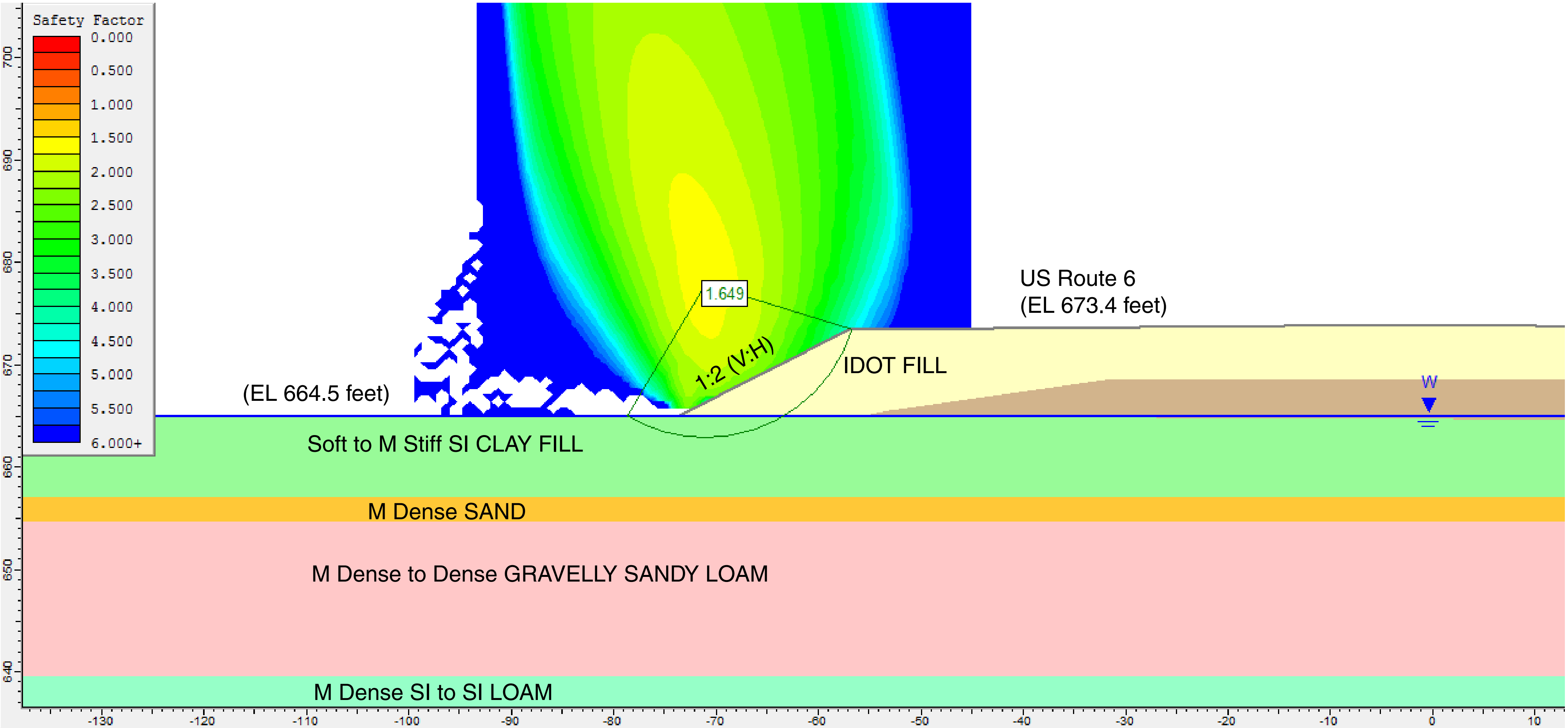
GLOBAL STABILITY: US ROUTE 6 BRIDGE OVER MARLEY CREEK
SN 099-0542, SECTION 33B (B-R), WILL COUNTY, ILLINOIS

SCALE: GRAPHICAL | APPENDIX C-1 | DRAWN BY: HKB | CHECKED BY: MLS

Wang Engineering

1145 N. Main Street
Lombard, IL 60148
www.wangeng.com

FOR CIVILTECH ENGINEERING, INC. | 401-05-01



Drained Analysis for Side Slope, Station 415+72, Ref Boring BSB-08

Layer ID	Description	Unit Weight (pcf)	Drained Cohesion (psf)	Drained Friction Angle (degrees)
1	IDOT FILL	125	100	30
2	Soft to M Stiff SI CLAY FILL	115	0	28
3	M Dense SAND	120	0	30
4	M Dense to Dense SANDY LOAM	125	0	32
5	M Dense SI to SI LOAM	120	0	30

GLOBAL STABILITY: US ROUTE 6 BRIDGE OVER MARLEY CREEK
SN 099-0542, SECTION 33B (B-R), WILL COUNTY, ILLINOIS

SCALE: GRAPHICAL | APPENDIX C-2 | DRAWN BY: HKB | CHECKED BY: MLS

Wang Engineering

1145 N. Main Street
Lombard, IL 60148
www.wangeng.com

FOR CIVILTECH ENGINEERING, INC. | 401-05-01

APPENDIX D

Boring BSB-06:
Run #1: 49' to 59.0', RECOVERY = 99%, RQD = 33%
Run #2: 59.0' to 65.0', RECOVERY = 97%, RQD = 54%

BEDROCK CORE: US ROUTE 6 BRIDGE OVER MARLEY CREEK SN 099-0542, SECTION 33B (B-R), WILL COUNTY, ILLINOIS		
SCALE : GRAPHIC	APPENDIX D-1	DRAWN BY: MDLR CHECKED BY: MLS
Wang Engineering		1145 N. Main Street Lombard, IL 60148 www.wangeng.com
FOR CIVILTECH ENGINEERING, INC.		401-05-01

Boring BSB-07:
Run #1: 48.5′ to 58.5′, RECOVERY = 98%, RQD = 20%

BEDROCK CORE: US ROUTE 6 BRIDGE OVER MARLEY CREEK SN 099-0542, SECTION 33B (B-R), WILL COUNTY, ILLINOIS		
SCALE : GRAPHIC	APPENDIX D-2	DRAWN BY: MDLR CHECKED BY: MLS
Wang Engineering		1145 N. Main Street Lombard, IL 60148 www.wangeng.com
FOR CIVILTECH ENGINEERING, INC.		401-05-01