STRUCTURE GEOTECHNICAL REPORT
WILLOW ROAD (FAP 305) BRIDGE OVER
LEHIGH AVENUE AND SOO LINE RAILROAD
SN 016-0533, SECTION 1920.01-BR
IDOT JOB D-91-407-11, PTB 159/ITEM 017
COOK COUNTY, ILLINOIS

for

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10. Abstract

The three-span Willow Road (FAP 305) Bridge over Lehigh Avenue and the SOO Line Railroad will be widened and redecked. The bridge will be the same length but approximately 32.6 feet wider than the existing. A retaining wall will be required to support the widening of the southeast approach embankment. This report provides geotechnical recommendations for the design of the widened approach embankments, bridge foundations, and retaining wall.

The existing embankment soils include stiff to very stiff silty clay fill and overlie stiff silty clay loam with traces of organic matter. Deeper foundation soils include very stiff silty clay loam with interbedded sand and silt and hard silty clay loam. The site classifies as Seismic Class C.

The proposed approach embankments will be widened and its heights will increase by about 5 to 10 feet. External stability analyses show satisfactory factors of safety. We predict the total consolidation settlement underneath the widened fill sections off the north and south slopes will amount to less than 0.4 inch.

The abutments should be supported on concrete-filled metal shell piles (14-inch diameter MSP) or steel H-piles (size HP12x53 or HP 14x73); estimated pile lengths and bearing elevations for various loads are included. The piers should be supported on shallow foundations or driven piles with the same sizes as the abutments. The maximum allowable soil bearing capacity is 2,700 psf for a factor of safety of 3.0. The settlement is estimated at approximately 1.0 inch. Geotechnical parameters for pile analyses under lateral loads are also included.

The retaining wall along the southeast embankment has a maximum retained height of about 17 feet. A drilled soldier-pile type wall with a W27x146 section will deform laterally approximately ¾ inch if spaced at 6-feet on center and driven to a depth of about 23 feet below existing grade. The estimated maximum factored geotechnical resistance for an MSE or RCC type wall is 3,600 psf. We estimate the wall has adequate resistance against sliding, overturning, and global stability failure. The estimated long-term consolidation settlement is 1.1 inches.

Steel sheeting may be required for temporary shoring along the abutment widening. If temporary sheeting is required, it should be designed based on the charts included in IDOT *Design Guide 3.13.1.*

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FOR
ZROKA ENGINEERING, INC.

1.0 INTRODUCTION

This report presents the results of our subsurface investigation, laboratory testing, and geotechnical evaluations for widening and reconstruction of the Willow Road (FAP 305) Bridge over Lehigh Avenue and the SOO Line Railroad in Glenview, Cook County, Illinois. A *Site Location Map* is presented as Exhibit 1.

1.1 Proposed Structure

Wang Engineering, Inc. (Wang) understands Zroka Engineering, Inc. (Zroka) envisions reconstructing the 3-span bridge superstructure and widening the existing stub abutment and pier foundations by approximately 37.0 feet. The back-to-back abutment bridge length will measure 290.8 feet; the proposed out-to-out bridge width will amount to 112.6 feet, which includes a 10-foot wide multi-use path along the south edge. The centerline elevation of the bridge will not change; however the widening will add approximately 5 to 10 feet of fill to the existing slopes and require a small retaining wall along the southeast embankment quarter due to right-of-way limitations. The wall will be constructed between Stations 101+30.00 and 103+40.00, offset 103 feet south, and have a maximum retained height of about 17 feet. The end and side slopes will both be graded at 1:2 (V:H). The General Plan and Elevation (GPE) drawing provided by Zroka shows four stages of construction; we anticipate temporary steel sheet piling may be required to facilitate the excavation of the existing embankments to install the new abutments.

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 new bridge.

1.2 Existing Structure

The Willow Road Bridge is a 3-span structure originally built in 1942 and widened in 1969. The bridge has open, abutments supported on pile foundations and two piers on spread footings. The Bridge Condition Report indicates both the abutments and piers appear to be good condition. The existing back-to-back of abutment length is 290.8 feet, and the existing out-to-out width is 80.0 feet. The slopes are graded at 1:2 (V:H). The site physiography is discussed in Section 2.1.

2.0 SITE CONDITIONS AND GEOLOGICAL SETTING

The project area is located in northeastern Cook County, about 3.5 miles east of the Des Plaines River and 2.7 miles west of the Skokie Lagoons and the Chicago River. On the USGS *River Park 7.5 Minute Series* map, the bridge is located in the NE¼ of Section 22, Tier 42 N, Range 12 E of the Third Principal Meridian.

The following review of 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 present subsurface investigation results. For the study of the regional geologic framework, Wang considered northeastern Illinois in general and Cook County in particular. Exhibit 2 illustrates the *Site and Regional Geology*.

2.1 Physiography

The general topography of the project area slopes gently toward the south. The bridge is situated just 750 yards west of the West Fork North Branch which runs southward to join the North Branch of the Chicago River. The creek's floodplain is well developed and extends approximately half a mile west from its channel. No natural wetlands, marshes, or oxbow lakes are present in the vicinity of the bridge. At the bridge site, the elevation measures about 650 feet near Lehigh Avenue and the SOO line Railroad and about 670 feet along Willow Road.

2.2 Surficial Cover

The project area was shaped during the Wisconsinan-age glaciation. An approximately 115-foot thick drift covers the bedrock (Leetaru et al. 2004). 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 (Hansel and Johnson 1996, Kolata and Kimz 2010). The thick glacial

cover is made up predominatly of diamicton attributed to the Wadsworth Formation of Wedron Group. The Wadsworth Formation consists of relatively homogenous, massive, gray till with clay to silty clay matrix, with dolomite and shale clasts and occasional lenses of sorted and stratified silt (Hansel and Johnson 1996). From a geotechnical viewpoint, the Wadsworth diamicton is characterized by low plasticity, medium to low moisture content, medium to very stiff consistency, poor permeability, and low compressibility (Bauer et al. 1991).

2.3 Bedrock

In the project area, the glacigenic deposits unconformably rest over a 200-foot thick Silurian-age dolostone. The top of bedrock may be encountered at approximately 115 feet below ground surface (bgs). (Leetaru et al 2004).

Structurally, the site is located on the eastern flank of the Wisconsin Arch, and approximately two miles north of the Des Plaines Disturbance. No underground mines have been mapped in the area (Kolata and Nimz 2010).

Our subsurface investigation results fit into the local geologic context. The borings drilled in the project area revealed the native sediments consists of silty and clayey diamictons with infrequent silt lenses. None of the borings encountered the top of bedrock.

3.0 METHODS OF INVESTIGATION

The following sections outline the subsurface and laboratory investigations.

3.1 Subsurface Investigation

The subsurface investigation included 11 soil borings, designated as BB-01 through BB-08 and RW-01 through RW-03, and it was performed by Wang in February 2012. The borings were drilled from elevations of 636.4 to 668.4 feet to depths of 30.0 to 100.0 feet bgs. The northing and easting coordinates were acquired with a mapping-grade GPS unit; elevations, stations, and offsets were obtained from design drawings provided by Zroka. The as-drilled boring locations are shown in the *Boring Logs* (Appendix A) and in the *Boring Location Plan* (Exhibit 3).

An ATV-mounted drilling 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 30.0 feet bgs and at 5.0-foot intervals thereafter.

Field boring logs, prepared and maintained by a Wang engineer, included lithological descriptions, visual-manual soil classifications (IDH textural classification), results of pocket penetrometer or Rimac unconfined compressive strength testing on cohesive soils, and Standard Penetration Test (SPT) results recorded as blows per 6 inches of penetration.

Groundwater observations were made during and at the completion of drilling operations. The borings were backfilled with soil cuttings and bentonite chips, and the surface was restored as close as possible to the original condition.

3.2 Laboratory Testing

All soil samples were tested in the laboratory for moisture content (AASHTO T 265). Atterberg limits (AASHTO T 89/T 90) and particle size (AASHTO T 88) analyses were performed on selected samples. The soil samples were classified according to the IDH Soil Classification System. Laboratory test 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

Behind the west abutment, Borings BB-01 and BB-08 encountered 7.0 to 7.5 inches of asphalt pavement overlying 6 to 17 inches of aggregate base. East of the bridge (Borings BB-04 and BB-05) the pavement is made up of a 2 inches of asphalt overlay, 8 to 10 inches of concrete, and 3 to 12 inches of aggregate base. Along Lehigh Avenue, the borings encountered 13 inches of asphalt pavement. Off the pavement, the remaining borings encountered 12 inches of topsoil. In descending order, the general lithologic succession encountered beneath the surface includes 1) man-made ground (fill); 2) very stiff silty clay loam with traces of organic matter; 3) stiff to very stiff silty clay and silty clay loam with

interbedded sily loam; and 4) hard silty clay loam.

1) Man-made ground (fill)

The Willow Road embankments were constructed of stiff to hard, brown, gray, and black silty clay to silty clay loam fill. The fill has unconfined compressive strength (Q_u) values of 1.4 to greater than 4.5 tsf with an average of 2.8 tsf. Moisture content values measure 15 to 24% with an average of 19%.

At the pier locations, beneath the bridge, the borings encountered 5.0 to 10.0 feet of stiff, brown and gray silty clay loam to clay loam and loose, black and brown loam to gravelly sand fill. The cohesive soils have Q_u values averaging 1.7 tsf and moisture content values averaging 24%. The granular material has SPT (N)-values of 5 to 9 blows/foot and moisture contents of 6 and 32%.

2) Very stiff silty clay loam with traces of organic matter

Beneath the embankment materials, the borings drilled behind the abutments advanced through approximately 3.0 to 5.0 feet of very stiff, black silty clay loam with organic matter that marks the boundary between the fill and natural materials. The boundary soils have an average Q_u value of 2.5 tsf and an average moisture content of 28%.

3) Stiff to very stiff silty clay and silty clay loam

At elevations of 631.3 to 636.1 feet, the borings advanced through thick deposits of stif to very stiff, massive, gray silty clay and silty clay loam. This material has Q_u values of 1.3 to greater than 6.0 tsf with an average of 2.4 tsf and moisture content values of 13 to 22% with an average of 18%. Laboratory index testing on two samples shows liquid limit (L_L) values of 22 and 29% and plastic limit (P_L) values of 15 and 16%. The liquidity index is approximately 0.3, indicating the layer is overconsolidated and not prone to excessive deformation.

Several interbedded layers of sand and silt were also encountered within the silty clay and silty clay loam. The granular material has N-values of 20 to 65 blows/foot.

4) Hard silty clay loam

At elevations of 580.1 to 591.6 feet the borings encountered hard, gray silty clay loam continuing to the termination depths of the borings. The hard material has Q_u values greater than 4.5 tsf and moisture content values less than 17%.

4.2 Groundwater Conditions

Groundwater associated with intebedded sand was encountered during the subsurface investigation at elevations of 612.5 to 618.0 feet (19.5 to 23.8 feet bgs) in two of the retaining wall borings. We estimate there is a possibility for perched groundwater in some of these thin layers, but overall the groundwater level is deep-seated.

4.3 Scour Considerations

The bridge is not associated with a waterway and scour is not a concern.

4.4 Seismic Design Considerations

The following seismic data is recommended based on 2002 AASHTO Standard Specification of Highway Bridges

Soil Profile Type: I
Bedrock Acceleration Coefficient (A): 0.035g
The Site Coefficient (S): 1.0
Seismic Performance Category (SPC): A

5.0 FOUNDATION ANALYSIS AND RECOMMENDATIONS

Geotechnical evaluations and recommendations for the approach embankments and structure foundations are included in the following sections. The existing abutments and wingwalls are pile-supported. The proposed abutment widening will be supported on stub abutments at elevations of 660.3 feet with deep foundations. The deep foundations could consist of metal shell piles (MSP), steel H-piles, or drilled shafts. The piers will be supported on shallow foundations. The embankment slopes will be at 1:2 (V:H), and in the widening areas the fill height will reach a maximum height of about 5 to 10 feet. A retaining wall is proposed at the base of the southeast embankment between Stations 101+30.00 and 103+40.00; the wall will be constructed as a drilled, flexible soldier-pile wall. While the soils are adequate for the construction of mechanically-stabilized earth (MSE) and reinforced concrete cantilever (RCC) walls, utility conflicts make these wall types undesirable along the current alignment.

5.1 Approach Embankments and Slabs

Wang has performed settlement and global stability analyses for the approach embankments and slabs based on the soil conditions encountered in the borings and preliminary geometry provided by Zroka. Based on settlement estimates we do not anticipate any issues with long-term performance of the approach slabs, nor do we anticipate downdrag allowances for piles will be required (see Section 5.2.2). Global stability is satisfactory.

5.1.1 Settlement

Evaluations were performed to estimate settlements resulting from the proposed 5.0 to 10-foot high widened embankment section. The low moisture silty foundation soils are overconsolidated materials for which we estimate an OCR value of at least 3.0. Consolidation parameters were obtained by correlations to the measured index properties. Our evaluations show the foundation soils will undergo a total long-term consolidation settlement of less than 0.4 inch.

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5.1.2 Global Stability

The global stability of the side and end slopes was analyzed based on the soil profile described in Section 4.1 and the information provided in the GPE plan. The slopes along the proposed approach embankments will be at 1:2 (V:H). The slopes are considered structure-supporting; therefore, the minimum required FOS for both short and long-term conditions is 1.5 (IDOT, 2012). *Slide v5.0* evaluation exhibits are shown in Appendix C. For the undrained (short-term) conditions, Wang estimates the end slopes have an FOS of 1.9 (Appendix C-1) and the side slopes, including the proposed retaining wall, have a FOS of 2.9 (Appendix C-3). For the drained (long-term) condition, we estimate the end slopes have an FOS of 1.5 (Appendix C-2) and the side slope has a FOS of 1.7 (Appendix C-4). The FOS against global instability along the slopes is satisfactory.

5.2 Structure Foundations

Wang recommends the abutments and wingwalls be supported on MSP, steel H-piles, or drilled shafts. The piers should be supported on shallow foundations or driven piles. The proposed retaining wall along the southeast embankment should be constructed as an MSE or RCC gravity type or flexible soldier-pile type wall.

5.2.1 Shallow Pier Foundations

The piers may be supported on shallow foundations established at elevations of 631.76 feet at Pier 1 and 629.68 feet at Pier 2. At these elevations the piers will be founded above stiff to very stiff silty clay

and silty clay loam with average Q_u values of 1.7 to 2.5 tsf and low moisture contents. We estimate the foundation soils have a maximum allowable bearing capacity of 2,700 psf evaluated for a factor of safety of 3.0 (AASHTO, 2002). We estimate the piers will undergo approximately 1.0 inch of long-term consolidation settlement under 4,000 psf of bearing pressure.

The estimate friction angle between the stiff and very stiff silty clay soil and a cast-in-place concrete pier is 19°; the corresponding friction coefficient is 0.34 (AASHTO, 2012). The pier foundations should be sized to accommodate a FOS of 1.5 (AASHTO, 2002).

5.2.2 Driven Piles

IDOT specifies the maximum nominal required bearing (R_{NMAX}) for each pile and states the allowable resistance available (R_A) for MSP and steel H-piles in bridge widening should be based on a FOS of 3.0 (IDOT, 2012a). Nominal tip and side resistance were estimated using the methods and empirical equations presented in the latest *AGMU Memorandum 10.2 – Geotechnical Pile Design* (IDOT, 2011). The R_A, R_N, estimated pile tip elevations, and pile lengths for 14-inch diameter MSP, HP12x53 and HP14x73 steel H-piles are summarized in Tables 1 (14-inch MSP), 2 (HP12x53), and 3 (HP14x73). The lengths shown in the tables include a 1-foot pile embedment into the abutments as per the GPE plan.

The settlement analysis performed for the embankment shows post-construction deformations less than 0.4 inch and downdrag allowances will not be required. We also do not estimate scour or liquefaction reductions will be required.

Table 1: Estimated Pile Lengths and Tip Elevations for 14-inch Diameter Metal Shell Piles

Structure Unit	Pile Cap Base Elevation (feet)	Nominal Required Bearing, R_N (kips)	Allowable Geotechnical Loss, ($DD+S_c+L_{iq}$) (kips)	Allowable Geotechnical Loss Load, (DD only) (kips)	Allowable Resistance Available, R_A (kips)	Total Estimated Pile Length (feet)	Estimated Pile Tip Elevation (feet)
West Abutment (BB-01, BB-08)	660.28	240	0.0	0.0	80	24	637.3
		300	0.0	0.0	100	28	633.3
		360	0.0	0.0	120	40	621.3
		420	0.0	0.0	140	47	614.3

Structure Unit	Pile Cap Base Elevation (feet)	Nominal Required Bearing, R_N (kips)	Allowable Geotechnical Loss, ($DD+S_c+L_{iq}$) (kips)	Allowable Geotechnical Loss Load, (DD only) (kips)	Allowable Resistance Available, R_A (kips)	Total Estimated Pile Length (feet)	Estimated Pile Tip Elevation (feet)
Pier #1 (BB-02, BB-07)	631.76	240	0.0	0.0	80	35	597.8
		300	0.0	0.0	100	39	593.8
		360	0.0	0.0	120	39	593.8
		420	0.0	0.0	140	39	593.8
Pier #2 (BB-03, BB-06)	629.68	240	0.0	0.0	80	33	597.7
		300	0.0	0.0	100	40	590.7
		360	0.0	0.0	120	44	586.7
		420	0.0	0.0	140	48	582.7
East Abutment (BB-04, BB-05)	660.28	240	0.0	0.0	80	29	632.3
		300	0.0	0.0	100	35	626.3
		360	0.0	0.0	120	44	617.3
		420	0.0	0.0	140	48	613.3

Table 2: Estimated Pile Lengths and Tip Elevations for HP12x53 Steel Piles

Structure Unit	Pile Cap Base Elevation (feet)	Nominal Required Bearing, R_N (kips)	Allowable Geotechnical Loss, ($DD+S_c+L_{iq}$) (kips)	Allowable Geotechnical Loss Load, (DD only) (kips)	Allowable Resistance Available, R_A (kips)	Total Estimated Pile Length (feet)	Estimated Pile Tip Elevation (feet)
West Abutment (BB-01, BB-08)	660.28	240	0.0	0.0	80	30	631.3
		300	0.0	0.0	100	47	614.3
		360	0.0	0.0	120	59	602.3

Structure Unit	Pile Cap Base Elevation (feet)	Nominal Required Bearing, R_N (kips)	Allowable Geotechnical Loss, ($DD+S_c+L_{iq}$) (kips)	Allowable Geotechnical Loss Load, (DD only) (kips)	Allowable Resistance Available, R_A (kips)	Total Estimated Pile Length (feet)	Estimated Pile Tip Elevation (feet)
		420	0.0	0.0	140	74	587.3
Pier #1 (BB-02, BB-07)	631.76	240	0.0	0.0	80	42	590.8
		300	0.0	0.0	100	60	572.8
		360	0.0	0.0	120	68	564.8
		420	0.0	0.0	140	76	556.8
Pier #2 (BB-03, BB-06)	629.68	240	0.0	0.0	80	42	588.7
		300	0.0	0.0	100	49	581.7
		360	0.0	0.0	120	60	570.7
		420	0.0	0.0	140	75	555.7
East Abutment (BB-04, BB-05)	660.28	240	0.0	0.0	80	41	620.3
		300	0.0	0.0	100	53	608.3
		360	0.0	0.0	120	63	598.3
		420	0.0	0.0	140	75	586.3

Table 3: Estimated Pile Lengths and Tip Elevations for HP14x73 Steel Piles

Structure Unit	Pile Cap Base Elevation (feet)	Nominal Required Bearing, R_N (kips)	Allowable Geotechnical Loss, ($DD+S_c+L_{iq}$) (kips)	Allowable Geotechnical Loss Load, (DD only) (kips)	Allowable Resistance Available, R_A (kips)	Total Estimated Pile Length (feet)	Estimated Pile Tip Elevation (feet)
West Abutment	660.28	240	0.0	0.0	80	25	636.3
		300	0.0	0.0	100	35	626.3

Structure Unit	Pile Cap Base Elevation (feet)	Nominal Required Bearing, R_N (kips)	Allowable Geotechnical Loss, ($DD+S_c+L_{iq}$) (kips)	Allowable Geotechnical Loss Load, (DD only) (kips)	Allowable Resistance Available, R_A (kips)	Total Estimated Pile Length (feet)	Estimated Pile Tip Elevation (feet)
(BB-01, BB-08)		360	0.0	0.0	120	47	614.3
		420	0.0	0.0	140	56	605.3
		480	0.0	0.0	160	67	594.3
Pier #1 (BB-02, BB-07)	631.76	240	0.0	0.0	80	38	594.8
		300	0.0	0.0	100	43	589.8
		360	0.0	0.0	120	52	580.8
		420	0.0	0.0	140	66	566.8
		480	0.0	0.0	160	74	558.8
Pier #2 (BB-03, BB-06)	629.68	240	0.0	0.0	80	36	594.7
		300	0.0	0.0	100	43	587.7
		360	0.0	0.0	120	49	581.7
		420	0.0	0.0	140	55	575.7
		480	0.0	0.0	160	66	564.7
East Abutment (BB-04, BB-05)	660.28	240	0.0	0.0	80	32	629.3
		300	0.0	0.0	100	42	619.3
		360	0.0	0.0	120	53	608.3
		420	0.0	0.0	140	61	600.3
		480	0.0	0.0	160	70	691.3

5.2.3 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 4.

Table 4: Recommended Soil Parameters for Lateral Load Pile Analysis

Soil Type (Layer)	Unit Weight (pcf)	Undrained Shear Strength, c_u (psf)	Estimated Friction Angle, Φ (°)	Estimated Lateral Soil Modulus Parameter, k (pci)	Estimated Soil Strain Parameter, ε_{50} (%)
Stiff and V Stiff Silty Clay Loam Fill (1)	125	3000	0	2000	0.5
Stiff and V Stiff Silty Clay (2)	125	2500	0	1500	0.6
Hard Silty Clay Loam (3)	130	4000	0	2500	0.4

5.3 Retaining Wall Foundations

Due to right-of-way restrictions along the southeast approach embankment, a retaining wall will be installed between Stations 101+30.00 and 103+40.00, offset 103.0 feet south of the Willow Road centerline. The wall will have a maximum retained height of about 17 feet and will be a fill-type wall. We understand an existing 12-inch diameter water main and an existing 60-inch diameter storm sewer run laterally, immediately behind the proposed wall location. Therefore, a flexible, cantilever, soldier-pile type wall will be constructed and the soldier piles will be installed through pre-cored boreholes. We have also included recommendations for RCC and MSE-type walls, should the offset location be adjusted to avoid the utility conflicts.

5.3.1 Flexible Soldier Pile Wall

A drilled soldier-pile wall should be designed for a FOS of 1.5 against earth pressure failure and should have an estimated lateral deformation of 1.0 inch or less. The earth pressure analysis for a permanent flexible cantilever wall should be performed based on the drained (long-term) soil parameters included below in Table 5; the lateral deformation analysis should be performed based on the lateral soil modulus and strain parameters provided previously in Table 4. The active earth pressure coefficients reflect the 1:2 (V:H) slope behind the wall. We have performed an analysis for a W27x146 soldier-pile installed in a 36-inch diameter borehole, spaced at 6.0-feet on-center and driven to a depth of 26 feet below existing grade (total pile length 43 feet). The analysis accounts

for 3 feet of material removed from the front face of the wall, increasing the total retained height to about 19 to 20 feet. The analysis shows approximately ¾ inch of lateral deflection at the top of the wall with pile tip fixity and an adequate FOS. We estimate the wall can be constructed as a flexible structure and will not require anchorage or tiebacks. The analysis does not include compaction loads from heavy equipment near the wall.

Table 5: Geotechnical Parameters for Design of Flexible Walls

Soil Description	Unit Weight (lbs/ft^3)	Drained Shear Strength Properties		Earth Pressure Coefficients	
		Cohesion (lbs/ft^2)	Friction Angle (°)	Active Pressure	Passive Pressure
New Embankment Fill	125	0	30	0.48	3.00
Stiff and V Stiff Silty Clay Loam Fill (1)	125	0	30	0.48	3.00
Stiff and V Stiff Silty Clay (2)	125	0	30	0.48	3.00
Hard Silty Clay Loam (3)	130	0	32	0.40	3.26

5.3.2 MSE Wall

The retaining wall is a new structure and will be designed in accordance with the AASHTO 2012 *LRFD Bridge Design Specifications* (AASHTO 2012, IDOT 2012) The base and leveling pad of an MSE wall should be established 3.5 feet below the finished grade at the front face and the base of a RCC wall should be established 4.0 feet below grade. Both wall types should have a minimum width of 0.7 times the total height of the wall. At the bearing elevations, the walls would be founded above very stiff silty clay with an average Q_u value of 2.0 tsf or loose to medium dense sand with an estimate friction angle of 32°. We estimate the foundation soils have a maximum factored bearing resistance (q_R) of 3,600 psf evaluated for a geotechnical resistance factor (ϕ_b) of 0.45 (AASHTO, 2012). The estimated settlement under the maximum factored bearing resistance is 1.1 inches.

The estimated minimum friction angle between the foundation soil and select MSE wall backfill is 30°, while the friction angle between the soil and a cast-in-place RCC base is 22°; the corresponding

friction coefficients are 0.57 and 0.40 (AASHTO, 2012). The MSE wall foundation should be sized to accommodate the geotechnical sliding resistance factor (ϕ_τ) of 0.90 and the RCC should be sized for a ϕ_τ of 0.85 (AASHTO, 2012). Both wall types should include a lateral earth pressure coefficient of 0.48 within the proposed fill to account for the 1:2 (V:H) slope behind the wall. Our analysis shows adequate sliding and overturning resistance. The global stability of the side slope and retaining wall are discussed in Section 5.1.

5.4 Temporary Shoring Design

The GPE plan provided by Zroka shows four stages of construction involving various removal and replacement of the existing bridge deck. The south portion of the widened deck and abutments will be constructed in Stage One; the north portion of the widening is scheduled for Stage Two. We anticipate the widening of the abutments and construction of new wingwalls may require about 7 to 8 feet of temporary shoring to support the existing embankment. If temporary shoring is required, we estimate temporary steel sheet piling designed based on the charts provided in IDOT *Design Guide 3.13.1*, will provide a feasible shoring method.

6.0 CONSTRUCTION CONSIDERATIONS

6.1 Site Preparation

All vegetation, surface topsoil, existing pavement, and debris should be cleared and stripped where approach embankment fills will be placed. The exposed subgrade should be proofrolled. To aid in locating unstable and unsuitable materials, the proofrolling should be observed by a qualified engineer. Any unstable or unsuitable materials should be removed and replaced with compacted structural fill as described in Section 6.3.

6.2 Excavation and Dewatering

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. Several utilities were cleared during the subsurface investigation that may require coordination during construction. Most notably, an MWRD sewer line running along the south side of the bridge and beneath Lehigh Avenue may pose concerns during the construction of Pier 1.

The subsurface investigation encountered deep-seated groundwater with small potential for perched water within the upper sand interbeds. If perched groundwater or precipitation is allowed to enter the

excavation, it should be immediately removed via sump-pump. Any soil allowed to soften in standing water should be removed and replaced with structural fill material.

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 (2012). 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* (2012). The onsite cohesive soil (**Layer 1**) could be considered as fill material assuming it has an organic content less than 10%.

All backfill materials must be pre-approved by the Resident Engineer. To backfill the abutments we recommend porous granular material, such as crushed stone or crushed gravel that conforms to the gradation requirements specified in IDOT Articles 1004.01 or 1004.05 (2012b). Backfill material should be placed and compacted in accordance with the IDOT Section 205, *Embankment* (2012b) and the IDOT *Bridge Manual* (2012b). Estimated design parameters for granular structural backfill materials are presented in Table 6.

Table 6: Estimated Granular Backfill Parameters

Soil Description	Porous Granular Material Backfill
Unit Weight	125 pcf
Angle of Effective Internal Friction	32°
Active Earth Pressure Coefficient	0.31
Passive Earth Pressure Coefficient	3.26
At-Rest Earth Pressure Coefficient	0.5

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.

It is recommended that an experienced geotechnical engineer be retained to inspect the exposed subgrade, monitor earthwork operations, and provide material inspection services during the construction phase of this project.

6.5 Piling

Driven piles shall be furnished and installed according to the requirements of Section 512, *Piling* (IDOT, 2012b) and steel H-piles shall be according to AASHTO M270, Grade 50. We do not anticipate conditions that would require the piles to be driven with a metal shoe. Wang recommends a minimum of one test pile be performed at each substructure location. Test piles should be driven to 110 percent of the nominal required bearing indicated above in Tables 1, 2, and 3 of Section 5.2.2.

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 Zroka Engineering 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

Jerry W.H. Wang, PhD., P.E.
QA/QC Reviewer

REFERENCES

AASHTO (2002) Standard Specifications for Highway Bridges, Washington, D.C., American Association of State Highway and Transportation Officials.

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

BAUER, R.A., CURRY, B.B., GRAESE, A.M., VAIDEN, R.C., SU, W.J., and HASEK, M.J., 1991, Geotechnical Properties of Selected Pleistocene, Silurian, and Ordovician Deposits of Northeastern Illinois: Environmental Geology 139, Illinois State Geological Survey, 69 p.

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: Champaign, Illinois State Geological Survey, 116 p.

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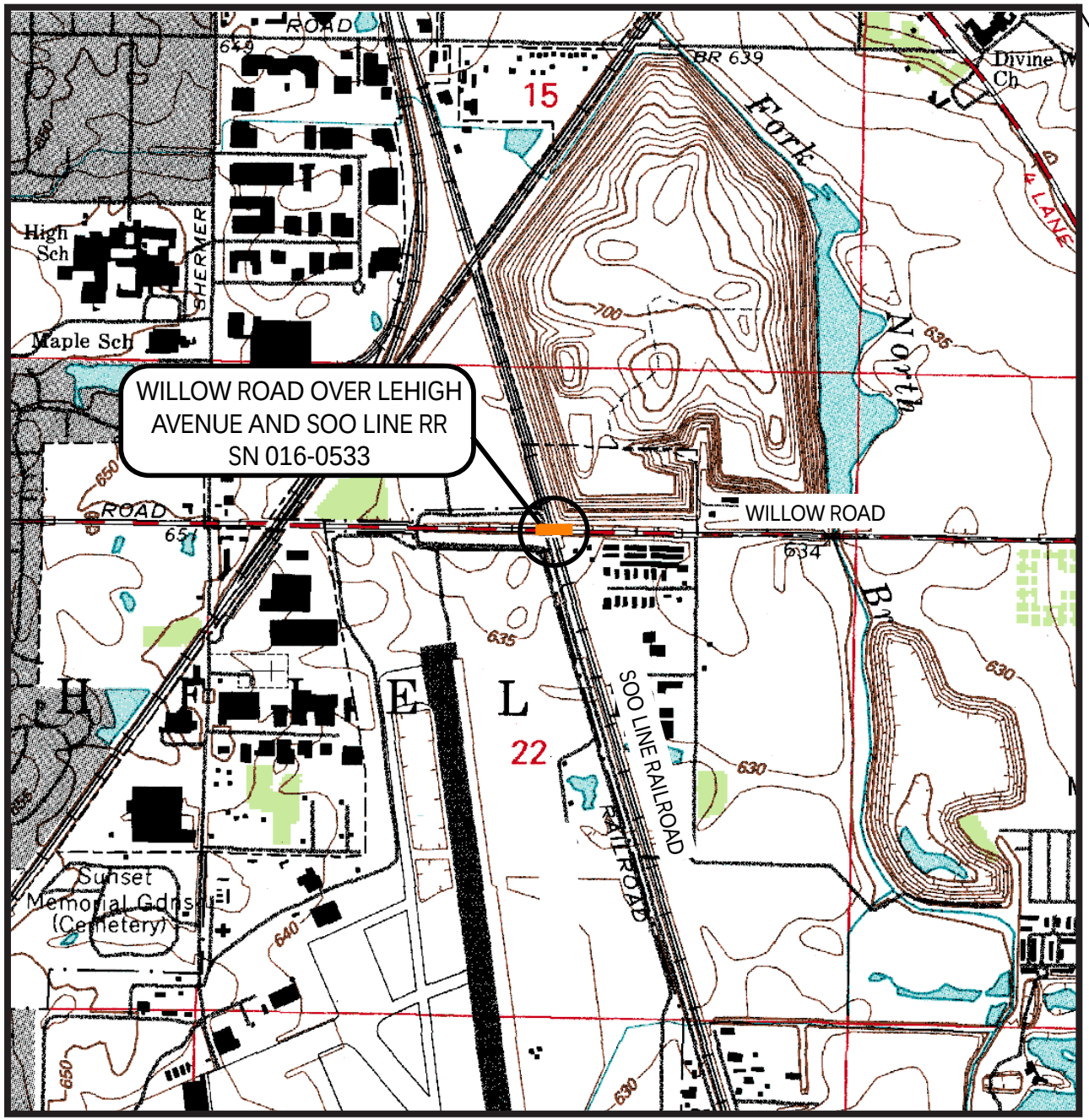
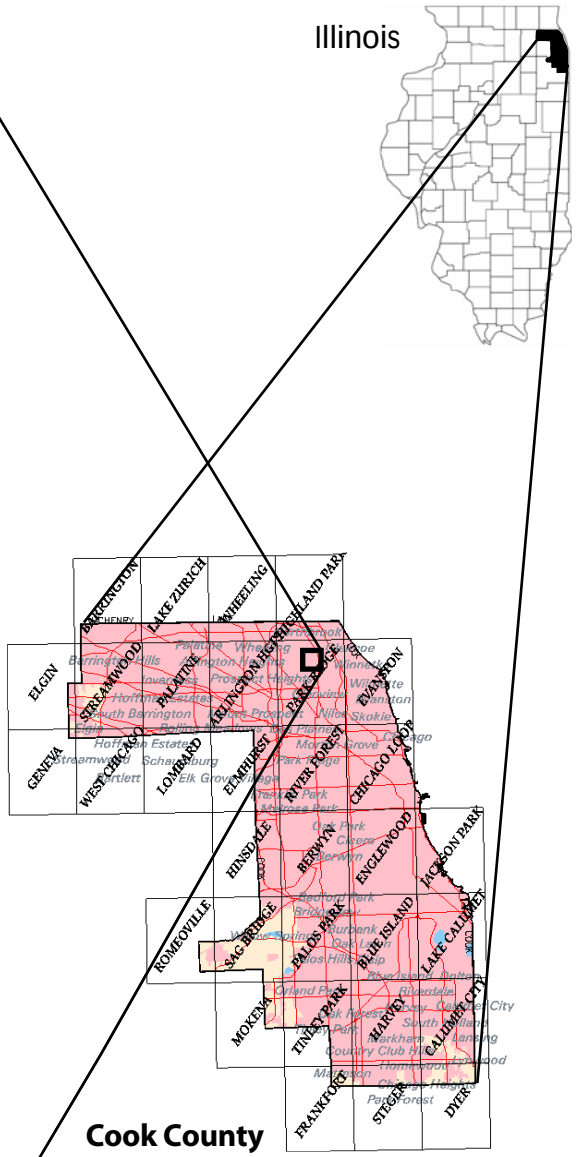
IDOT (2012b) Standard Specifications for Road and Bridge Construction, Illinois Department of Transportation, 1098 p.

KOLATA, D.R. AND NIMZ, C.K. (2010) Geology of Illinois; University of Illinois, Urbana, ISGS, IL

LEETARU, H.E., SARGENT, M.L., AND KOLATA, D.R (2004) *Geologic Atlas of Cook County for Planning Purposes,* ISGS, Champaign, IL

EXHIBITS





SITE LOCATION MAP: WILLOW ROAD OVER THE SOO LINE RAILROAD, SN 016-0533, SEC 1920.01-BR, COOK COUNTY

SCALE: GRAPHIC	EXHIBIT 1	DRAWN BY: C. Marin CHECKED BY: M. Snider

Wang Engineering
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Lombard, IL 60148
www.wangeng.com

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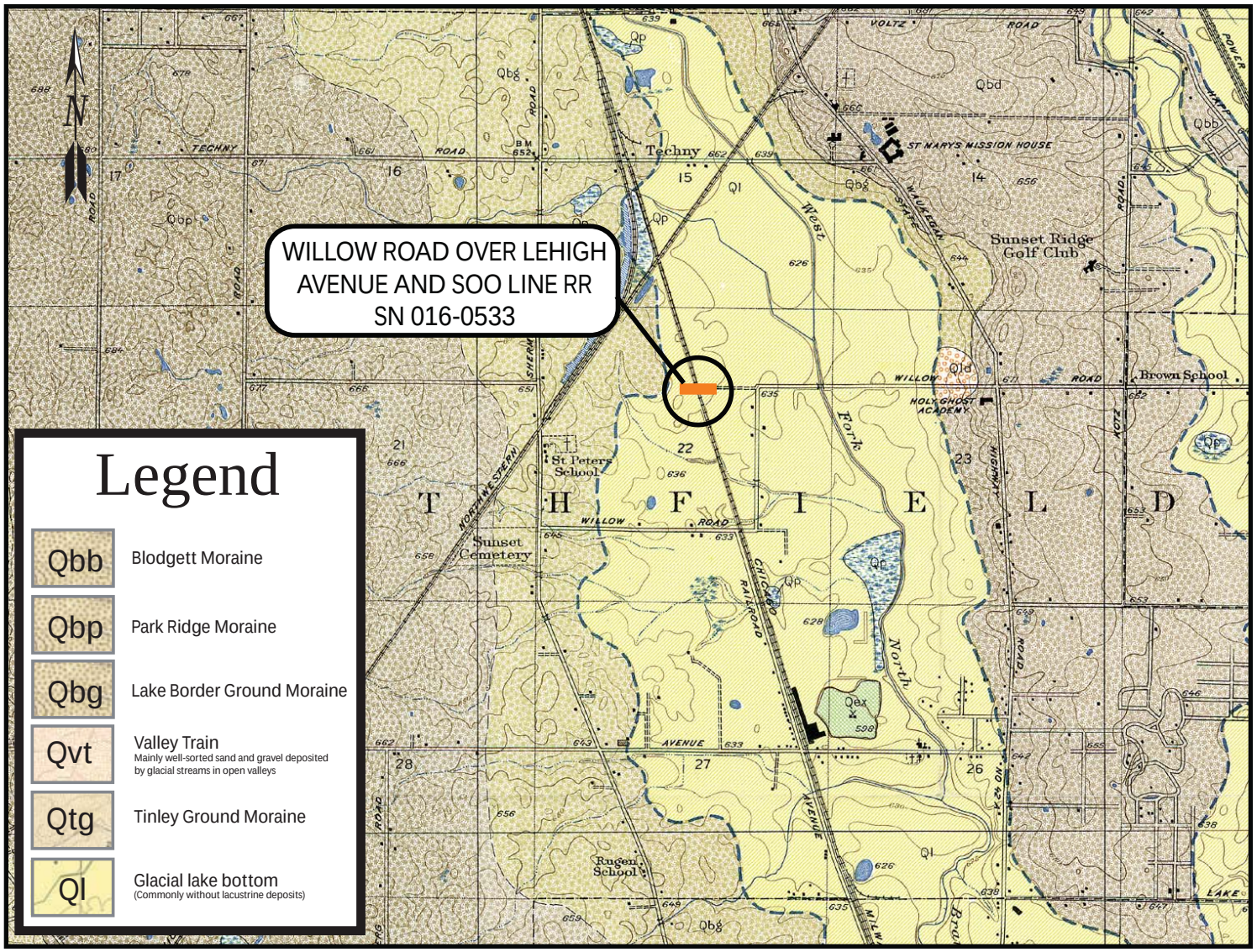


Modified after Bretz (1926)

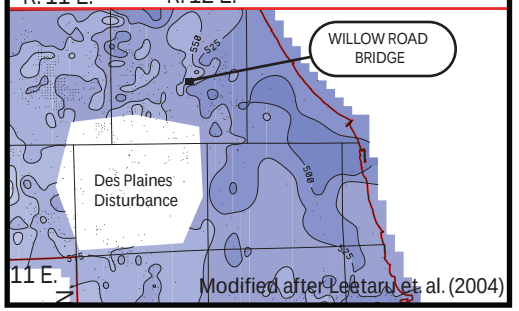
REGIONAL GEOLOGY

Wedron Group

- Wadsworth Formation
- Lemont Formation
- Tiskilwa Formation

Modified after Hansel and Johnson (1996)

BEDROCK TOPOGRAPHY



Modified after Leetaru et al. (2004)

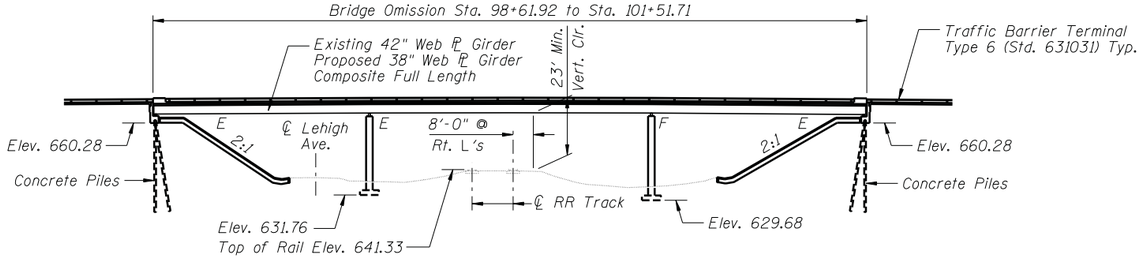
SITE AND REGIONAL GEOLOGY: WILLOW ROAD OVER THE SOO LINE RAILROAD, SN 016-0533, SEC 1920.01-BR, COOK COUNTY		
SCALE: GRAPHICAL	EXHIBIT 2	DRAWN BY: C. Marin CHECKED BY : E. Datz
Wang Engineering		1145 N. Main Street Lombard, IL 60148 www.wangeng.com
FOR ZROKA ENGINEERING		703-03-01

Bench Mark:

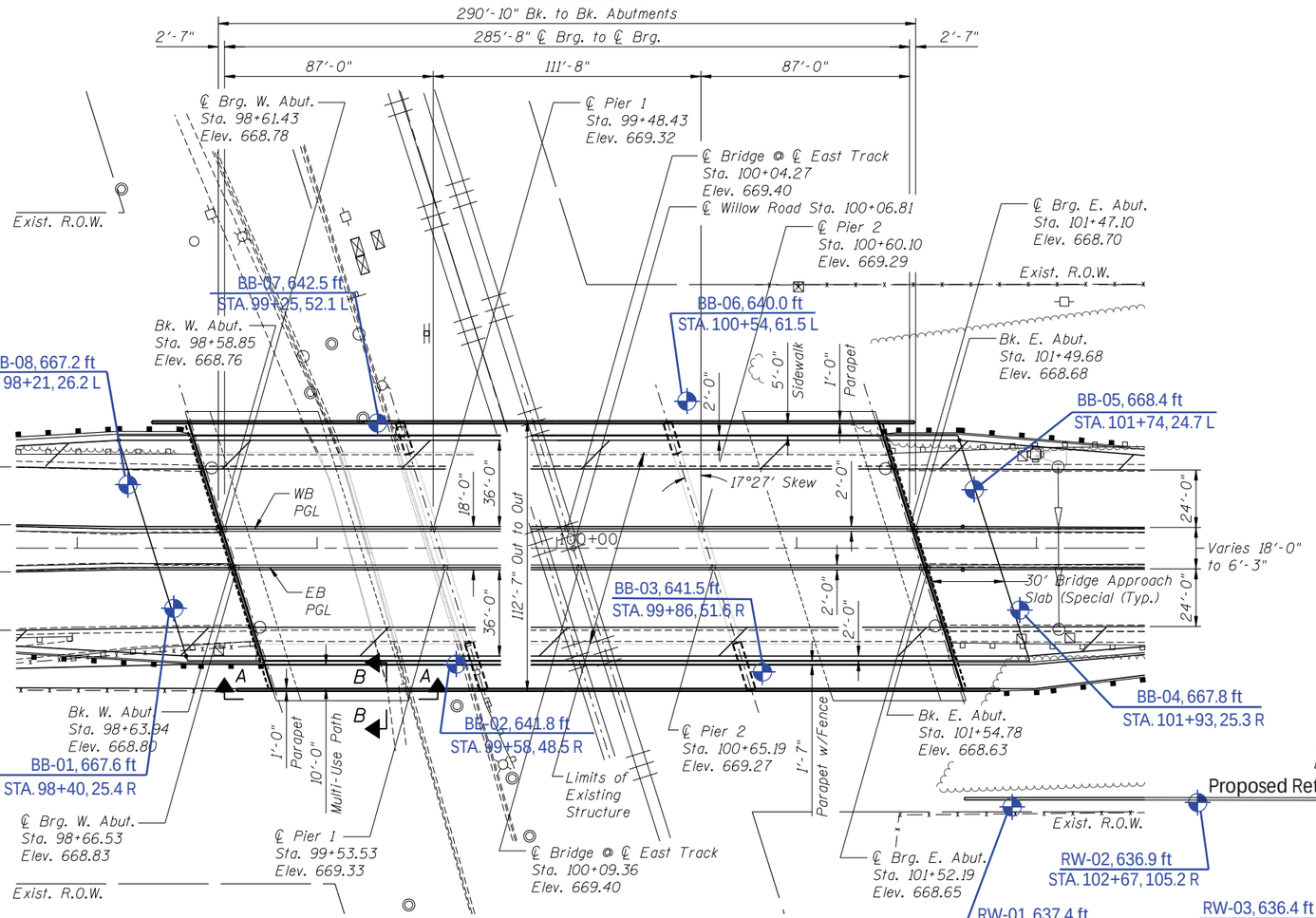
Existing Structure: S.N. 016-0533 originally constructed in 1942 as CH Route 110. The structure was reconstructed and widened in 1969 as County Highway 110. The existing structure consists of a 3 span open abutment continuous steel beam bridge. The back to back of abutment length is 290'-10" and out to out of deck is 80'-0". The existing deck is to be removed and the structure widened on both sides.

Traffic to be maintained utilizing stage construction.

No Salvage.

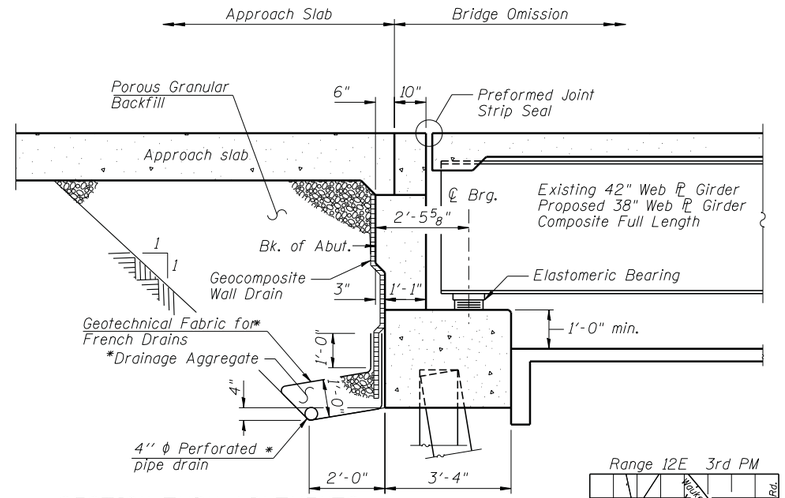


ELEVATION



Notes:
For Traffic Staging see Sheets 2 & 3 of 3.
For Slopewall Sections A-A & B-B, see Sheet 3 of 3.

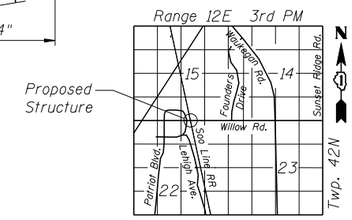
PLAN



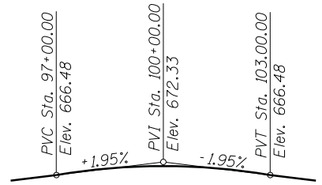
SECTION THRU ABUTMENTS

(Horiz. dim. @ Rt. L's)

*Included in the cost of Pipe Underdrains for Structures.



LOCATION SKETCH



PROFILE GRADE

(located at 8.1' off of ℄ Willow Road)

LOADING HS20-44

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

DESIGN SPECIFICATIONS

2002 AASHTO

DESIGN STRESSES

FIELD UNITS (New Construction)

f'_c = 3,500 psi
f_y = 60,000 psi (reinforcement)
f_y = 36,000 psi (M270 Grade 36)

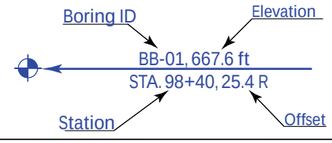
FIELD UNITS (Existing Construction)

f_c = 1,400 psi
f_s = 20,000 psi (reinforcement)
f_s = 20,000 psi (structural steel)

SEISMIC DATA

Seismic Performance Zone (SPZ) = _
Design Spectral Acceleration @ 1.0 sec S_{D1} = ___
Design Spectral Acceleration @ 0.2 sec S_{DS} = ___
Soil Site Class = _

Legend



HIGHWAY CLASSIFICATION

Route: FAP 305 (Willow Road)
Functional Class: Other Principal Arterial
ADT: 35,400 (2006), 50,200 (2020)
DHV = 1475
ADTT = 9%
Design Speed: 45 mph
Posted Speed: 45 mph
Directional Distribution: 50/50
Two Way Traffic

GENERAL PLAN
WILLOW ROAD OVER LEHIGH AVENUE & SOO LINE RAILROAD
FAP 305 SEC. 1920.01-BR
COOK COUNTY
STA. 100+06.81
STRUCTURE NO. 016-0533

BORING LOCATION PLAN: WILLOW ROAD OVER THE SOO LINE RAILROAD, SN 016-0533, SEC 1920.01-BR, COOK COUNTY

SCALE: SEE PLAN | EXHIBIT 3 | DRAWN BY: C. MARIN, CHECKED BY: M. SNIDER

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FOR ZROKA ENGINEERING | 703-03-01

FILE NAME = ...\016x083-SN016-0533-TSLI.dgn

ZROKA engineering
Zroka Engineering, P.C.
4216 North Hermitage
Chicago, IL 60613

USER NAME = SAW	DESIGNED - LAS	REVISED -
	CHECKED - DAZ	REVISED -
PLOT SCALE = 60.0012 ' / IN.	DRAWN - SAW	REVISED -
PLOT DATE = 3/30/2012	CHECKED - LAS	REVISED -

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

GENERAL PLAN
S.N. 016-0533
SHEET NO. 1 OF 3 SHEETS

F.A.P. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
305	1920.01-BR	COOK	3	1
			CONTRACT NO.	
	ILLINOIS FED. AID PROJECT			

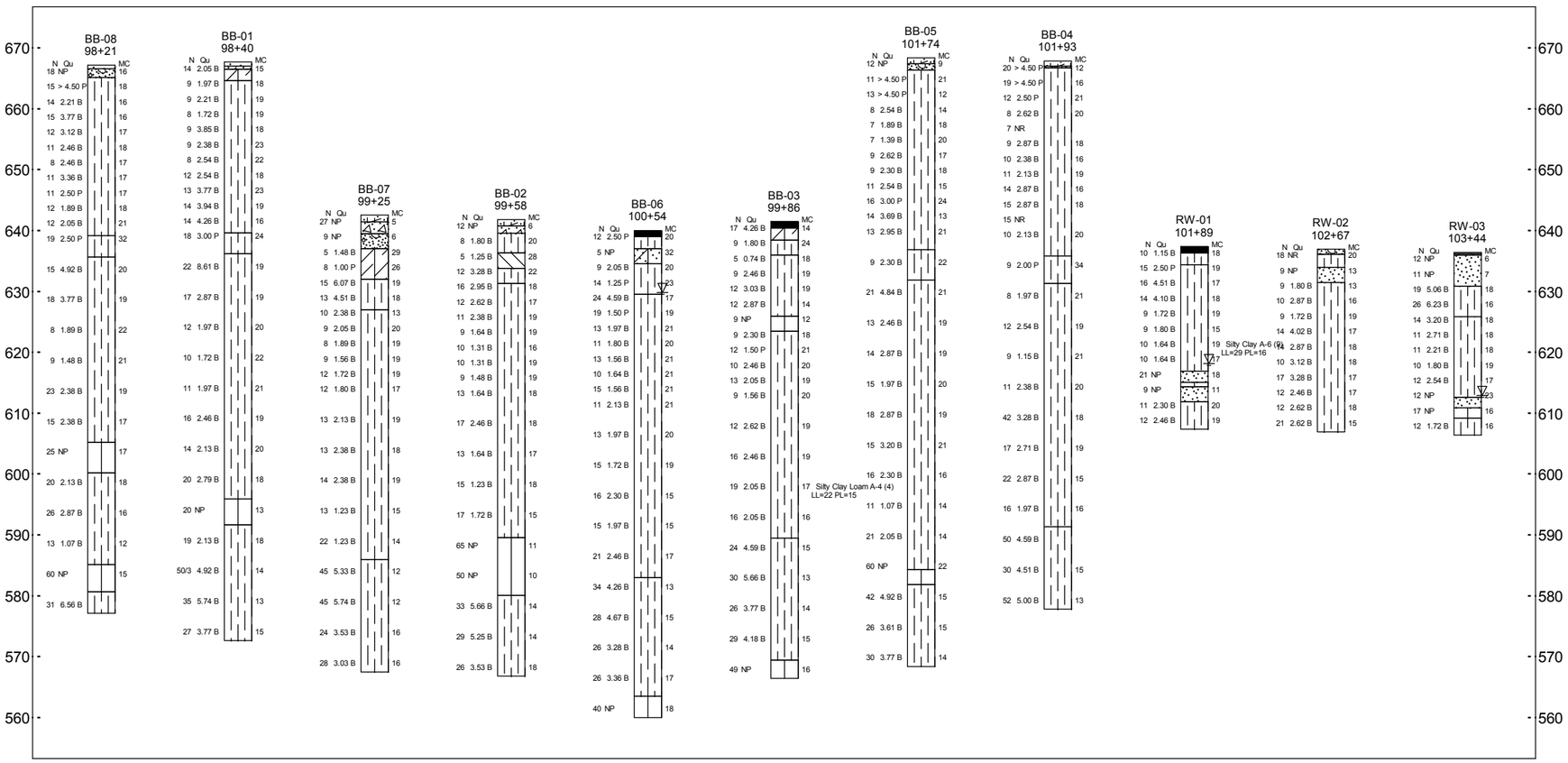
W

A

E

A'

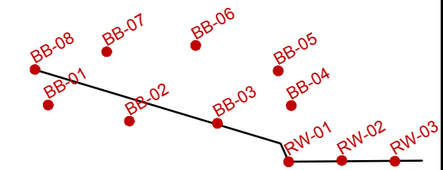
N



DISTANCE ALONG PROFILE (feet)

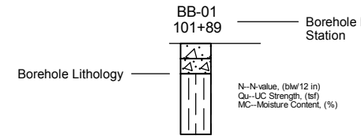
Lithology Graphics

- Concrete
- Crushed stone
- IDH Clay Loam
- IDH Silty Clay, Silty Clay Loam
- IDH Silt, Silty Loam
- Pavement
- IDH Clay
- Topsoil
- Gravelly sand, sandy gravel
- IDH Loam
- IDH Sand, Sandy Loam



Site Map Scale 1 inch equals 220 feet

Explanation:



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

0 — 60

Horizontal Scale (feet)

Vertical Exaggeration: 2.5x

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Lombard, IL 60148

Soil Profile A-A'
SN 016-0533, SEC 1920.01-BR

Willow Road Over Lehigh Ave and SOO Line RR
Glenview, IL

JOB NUMBER	PLATE NUMBER
703-03-01	EXHIBIT 4

WEI 11X17 7030301.GPJ WANGENG.GDT 4/23/12

APPENDIX A

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BORING LOG BB-01

WEI Job No.: 703-03-01

Client: **Zroka Engineering**
Project: **Willow Road Over Lehigh Ave and SOO Line RR**
Location: **Glenview, IL**

Datum: NGVD
Elevation: 667.65 ft
North: 1981445.85 ft
East: 1123655.74 ft
Station: 98+40
Offset: 25.37 RT

Profile	Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample Type / recovery	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
	667.0	7.5-inch thick CONCRETE --PAVEMENT--						
	666.5	6-inch thick, CRUSHED STONE --AGGREGATE BASE--						
		Very stiff, brown and gray CLAY LOAM with trace gravel			1	6 6 8	2.05 B	15
	664.6	--FILL--						
		Stiff to hard, brown and gray SILTY CLAY to SILTY CLAY LOAM with trace gravel			2	3 4 5	1.97 B	18
		--FILL--	5		3	2 4 5	2.21 B	19
					4	2 3 5	1.72 B	19
			10		5	2 4 5	3.85 B	18
					6	2 3 6	2.38 B	23
			15		7	2 3 5	2.54 B	22
					8	3 5 7	2.54 B	18
			20					
					9	4 6 7	3.77 B	23
			25		10	4 6 8	3.94 B	19
					11	6 6 8	4.26 B	16
	639.6	Very stiff, black SILTY CLAY LOAM with trace organic matter --BURIED TOPSOIL--			12	3 8 10	3.00 P	24
			30					
	636.1	Stiff to hard, gray SILTY CLAY with trace gravel			13	9 9 13	8.61 B	19
			35					
					14	5 7 10	2.87 B	19
			40					

GENERAL NOTES

Begin Drilling: **02-14-2012** Complete Drilling: **02-14-2012**
Drilling Contractor: **Wang Testing Service** Drill Rig: **D-50 ATV**
Driller: **K&K** Logger: **F. Bozga** Checked by:
Drilling Method: **3.25" IDA HSA upto 30' followed by 3" roller bit mud rotary; Boring backfill upon completion**

WATER LEVEL DATA

While Drilling: **DRY**
At Completion of Drilling: **MUD**
Time After Drilling: **NA**
Depth to Water: **NA**

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

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BORING LOG BB-01

WEI Job No.: 703-03-01

Client: **Zroka Engineering**
Project: **Willow Road Over Lehigh Ave and SOO Line RR**
Location: **Glenview, IL**

Datum: NGVD
Elevation: 667.65 ft
North: 1981445.85 ft
East: 1123655.74 ft
Station: 98+40
Offset: 25.37 RT

Depth (ft)	Elevation (ft)	Profile	SOIL AND ROCK DESCRIPTION	Sample Type / recovery	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
45					15	4 5 7	1.97 B	20
50					16	3 4 6	1.72 B	22
55					17	4 5 6	1.97 B	21
60					18	7 7 9	2.46 B	19
65					19	5 6 8	2.13 B	20
70					20	5 8 12	2.79 B	18
75					21	8 9 11	NP	13
80					22	6 8 11	2.13 B	18
	595.9		Medium dense, gray SILTY LOAM with trace gravel					
	591.6		Very stiff to hard, gray SILTY CLAY LOAM with trace gravel					

GENERAL NOTES

Begin Drilling: **02-14-2012** Complete Drilling: **02-14-2012**
Drilling Contractor: **Wang Testing Service** Drill Rig: **D-50 ATV**
Driller: **K&K** Logger: **F. Bozga** Checked by:
Drilling Method: **3.25" IDA HSA upto 30' followed by 3" roller bit mud rotary; Boring backfill upon completion**

WATER LEVEL DATA

While Drilling: **DRY**
At Completion of Drilling: **MUD**
Time After Drilling: **NA**
Depth to Water: **NA**

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

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Telephone: 630 953-9928
Fax: 630 953-9938

BORING LOG BB-01

WEI Job No.: 703-03-01

Client **Zroka Engineering**
Project **Willow Road Over Lehigh Ave and SOO Line RR**
Location **Glenview, IL**

Datum: NGVD
Elevation: 667.65 ft
North: 1981445.85 ft
East: 1123655.74 ft
Station: 98+40
Offset: 25.37 RT

Profile	Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample Type / recovery	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
		--rock fragments, possible cobbles--	85		23	8 15 50/3	4.92 B	14
			90		24	12 13 22	5.74 B	13
	572.6		95		25	6 11 16	3.77 B	15
		Boring terminated at 95.00 ft						
			100					

Profile	Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample Type / recovery	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)

GENERAL NOTES

Begin Drilling **02-14-2012** Complete Drilling **02-14-2012**
Drilling Contractor **Wang Testing Service** Drill Rig **D-50 ATV**
Driller **K&K** Logger **F. Bozga** Checked by
Drilling Method **3.25" IDA HSA upto 30' followed by 3" roller bit mud rotary; Boring backfill upon completion**

WATER LEVEL DATA

While Drilling ▽ **DRY**
At Completion of Drilling ▼ **MUD**
Time After Drilling **NA**
Depth to Water ▼ **NA**

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

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BORING LOG BB-02

WEI Job No.: 703-03-01

Client: **Zroka Engineering**
Project: **Willow Road Over Lehigh Ave and SOO Line RR**
Location: **Glenview, IL**

Datum: NGVD
Elevation: 641.81 ft
North: 1981422.53 ft
East: 1123773.70 ft
Station: 99+58
Offset: 48.51 RT

Profile	Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample Type / recovery	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
		13-inch thick ASPHALT --PAVEMENT--						
	640.7							
		Medium dense, gray CRUSHED STONE			1	8 7 5	NP	6
	639.6	--AGGREGATE BASE--						
		Stiff, brown and black SILTY CLAY --FILL--			2	4 3 5	1.80 B	20
	636.3		5					
		Stiff, brown and gray CLAY with trace gravel			3	1 2 3	1.25 B	28
	633.8							
		Stiff to very stiff, brown SILTY CLAY with trace gravel			4	4 6 6	3.28 B	22
	631.3		10					
		Stiff to very stiff, gray SILTY CLAY with trace gravel			5	4 6 10	2.95 B	18
					6	3 5 7	2.62 B	17
			15					
					7	3 4 7	2.38 B	19
					8	2 4 5	1.64 B	19
			20					
			25		9	4 4 6	1.31 B	16
					10	3 4 6	1.31 B	19
					11	3 4 5	1.48 B	19
			30		12	3 5 8	1.64 B	18
			35		13	5 7 10	2.46 B	18
			40		14	4 5 8	1.64 B	17

GENERAL NOTES

Begin Drilling: **02-10-2012** Complete Drilling: **02-10-2012**
Drilling Contractor: **Wang Testing Service** Drill Rig: **D-50 ATV**
Driller: **K&K** Logger: **F. Bozga** Checked by:
Drilling Method: **3.25" IDA HSA upto 30' followed by 3" roller bit mud rotary; Boring backfill upon completion**

WATER LEVEL DATA

While Drilling: **DRY**
At Completion of Drilling: **MUD**
Time After Drilling: **NA**
Depth to Water: **NA**

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

WANGENGINC 7030301.GPJ WANGENG.GDT 4/23/12

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Lombard, IL 60148
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Fax: 630 953-9938

BORING LOG BB-02

WEI Job No.: 703-03-01

Client: **Zroka Engineering**
Project: **Willow Road Over Lehigh Ave and SOO Line RR**
Location: **Glenview, IL**

Datum: NGVD
Elevation: 641.81 ft
North: 1981422.53 ft
East: 1123773.70 ft
Station: 99+58
Offset: 48.51 RT

Profile	Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample Type / recovery	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
			45		15	4 6 9	1.23 B	18
			50		16	5 7 10	1.72 B	15
	589.6	Very dense, gray SILTY LOAM with some gravel, sand, and rock fragments	55		17	24 34 31	NP	11
			60		18	22 22 28	NP	10
	580.1	Very stiff to hard, gray SILTY CLAY LOAM with trace gravel	65		19	9 11 22	5.66 B	14
			70		20	8 12 17	5.25 B	14
	566.8	Boring terminated at 75.00 ft	75		21	7 10 16	3.53 B	18
			80					

GENERAL NOTES

Begin Drilling: **02-10-2012** Complete Drilling: **02-10-2012**
Drilling Contractor: **Wang Testing Service** Drill Rig: **D-50 ATV**
Driller: **K&K** Logger: **F. Bozga** Checked by:
Drilling Method: **3.25" IDA HSA upto 30' followed by 3" roller bit mud rotary; Boring backfill upon completion**

WATER LEVEL DATA

While Drilling: **DRY**
At Completion of Drilling: **MUD**
Time After Drilling: **NA**
Depth to Water: **NA**

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

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BORING LOG BB-03

WEI Job No.: 703-03-01

Client: **Zroka Engineering**
Project: **Willow Road Over Lehigh Ave and SOO Line RR**
Location: **Glenview, IL**

Datum: NGVD
Elevation: 641.46 ft
North: 1981419.26 ft
East: 1123901.43 ft
Station: 99+86
Offset: 51.58 RT

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample Type / recovery	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
640.5	12-inch thick, black CLAY LOAM --TOPSOIL--						
	Hard, brown CLAY LOAM with little gravel --FILL--			1	6 8 9	4.26 B	14
638.5	Stiff, brown SILTY CLAY LOAM with little gravel and traces of woods and roots --FILL--	5		2	3 3 6	1.80 B	24
636.0	Medium stiff to very stiff, brown and gray SILTY CLAY with trace gravel			3	2 2 3	0.74 B	18
		10		4	3 3 6	2.46 B	19
				5	3 5 7	3.03 B	19
		15		6	4 6 6	2.87 B	14
626.0	Loose, gray SILTY LOAM with trace gravel			7	4 4 5	NP	12
623.5	Stiff to hard, gray SILTY CLAY LOAM with trace gravel			8	3 4 5	2.30 B	18
		20					

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample Type / recovery	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
				9	5 5 7	1.50 P	21
		25		10	4 4 6	2.46 B	20
				11	5 6 7	2.05 B	19
		30		12	3 4 5	1.56 B	20
		35		13	5 5 7	2.62 B	19
		40		14	5 7 9	2.46 B	19

GENERAL NOTES

Begin Drilling: **02-08-2012** Complete Drilling: **02-08-2012**
Drilling Contractor: **Wang Testing Service** Drill Rig: **D-50 ATV**
Driller: **K&K** Logger: **B. Wilson** Checked by:
Drilling Method: **3.25" IDA HSA upto 20' followed by 3" roller bit mud rotary; Boring backfill upon completion**

WATER LEVEL DATA

While Drilling: **DRY**
At Completion of Drilling: **MUD**
Time After Drilling: **NA**
Depth to Water: **NA**

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

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BORING LOG BB-03

WEI Job No.: 703-03-01

Client: **Zroka Engineering**
Project: **Willow Road Over Lehigh Ave and SOO Line RR**
Location: **Glenview, IL**

Datum: NGVD
Elevation: 641.46 ft
North: 1981419.26 ft
East: 1123901.43 ft
Station: 99+86
Offset: 51.58 RT

Profile	Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample Type / recovery	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
		--L_L = 22%, P_L = 15%--						
		--% Gravel = 0.7%--						
		--% Sand = 6.2%--						
		--% Silt = 70.9%--	45		15	7 8 11	2.05 B	17
		--% Clay = 22.2%--						
			50		16	5 7 9	2.05 B	16
	589.5	Hard, gray SILTY CLAY LOAM with trace gravel						
			55		17	7 10 14	4.59 B	15
			60		18	10 15 15	5.66 B	13
			65		19	8 10 16	3.77 B	14
			70		20	6 12 17	4.18 B	15
	569.5	Dense, gray SILT						
			75		21	33 22 27	NP	16
	566.5	Boring terminated at 75.00 ft						
			80					

GENERAL NOTES

Begin Drilling: **02-08-2012** Complete Drilling: **02-08-2012**
Drilling Contractor: **Wang Testing Service** Drill Rig: **D-50 ATV**
Driller: **K&K** Logger: **B. Wilson** Checked by:
Drilling Method: **3.25" IDA HSA upto 20' followed by 3" roller bit mud rotary; Boring backfill upon completion**

WATER LEVEL DATA

While Drilling: **DRY**
At Completion of Drilling: **MUD**
Time After Drilling: **NA**
Depth to Water: **NA**

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

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BORING LOG BB-04

WEI Job No.: 703-03-01

Client: **Zroka Engineering**
Project: **Willow Road Over Lehigh Ave and SOO Line RR**
Location: **Glenview, IL**

Datum: NGVD
Elevation: 667.82 ft
North: 1981445.15 ft
East: 1124008.71 ft
Station: 101+93
Offset: 25.25 RT

Profile	Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample Type / recovery	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
	667.0	2-inch thick ASPHALT over 8-inch thick CONCRETE --PAVEMENT--						
	666.7	3-inch thick, brown, GRAVELLY SAND --AGGREGATE BASE--						
		Very stiff to hard, brown, gray and black SILTY CLAY to SILTY CLAY LOAM with trace gravel --FILL--						
					1	7 9 11	> 4.50 P	12
			5		2	8 10 9	> 4.50 P	16
					3	5 6 6	2.50 P	21
			10		4	4 3 5	2.62 B	20
					5	2 3 4	NR	
			15		6	3 4 5	2.87 B	18
					7	3 4 6	2.38 B	16
			20		8	3 5 6	2.13 B	19
			25		9	5 6 8	2.87 B	16
					10	5 6 9	2.87 B	18
			30		11	5 6 9	NR	
					12	3 4 6	2.13 B	20
	635.8	Very stiff, black SILTY CLAY LOAM with trace organic matter --BURIED TOPSOIL--	35		13	3 4 5	2.00 P	34
	631.3	Stiff to very stiff, brown and gray SILTY CLAY with trace gravel						
			40		14	3 3 5	1.97 B	21

GENERAL NOTES

Begin Drilling: **02-15-2012** Complete Drilling: **02-15-2012**
Drilling Contractor: **Wang Testing Service** Drill Rig: **D-50 ATV**
Driller: **K&K** Logger: **F. Bozga** Checked by:
Drilling Method: **3.25" IDA HSA upto 30' followed by 3" roller bit mud rotary; Boring backfill upon completion**

WATER LEVEL DATA

While Drilling: **DRY**
At Completion of Drilling: **MUD**
Time After Drilling: **NA**
Depth to Water: **NA**

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

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BORING LOG BB-04

WEI Job No.: 703-03-01

Client: **Zroka Engineering**
Project: **Willow Road Over Lehigh Ave and SOO Line RR**
Location: **Glenview, IL**

Datum: NGVD
Elevation: 667.82 ft
North: 1981445.15 ft
East: 1124008.71 ft
Station: 101+93
Offset: 25.25 RT

Profile	Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample Type / recovery	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
			45		15	3 5 7	2.54 B	19
			50		16	3 3 6	1.15 B	21
			55		17	4 4 7	2.38 B	20
			60		18	8 15 27	3.28 B	18
			65		19	6 7 10	2.71 B	19
			70		20	7 9 13	2.87 B	15
			75		21	5 6 10	1.97 B	16
	591.3	Hard, gray SILTY CLAY LOAM with trace gravel	80		22	7 15 35	4.59 B	

GENERAL NOTES

Begin Drilling: **02-15-2012** Complete Drilling: **02-15-2012**
Drilling Contractor: **Wang Testing Service** Drill Rig: **D-50 ATV**
Driller: **K&K** Logger: **F. Bozga** Checked by:
Drilling Method: **3.25" IDA HSA upto 30' followed by 3" roller bit mud rotary; Boring backfill upon completion**

WATER LEVEL DATA

While Drilling: **DRY**
At Completion of Drilling: **MUD**
Time After Drilling: **NA**
Depth to Water: **NA**

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

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BORING LOG BB-04

WEI Job No.: 703-03-01

Client **Zroka Engineering**
Project **Willow Road Over Lehigh Ave and SOO Line RR**
Location **Glenview, IL**

Datum: NGVD
Elevation: 667.82 ft
North: 1981445.15 ft
East: 1124008.71 ft
Station: 101+93
Offset: 25.25 RT

Profile	Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample Type / recovery	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
			85		23	10 13 17	4.51 B	15
	577.8		90		24	12 16 36	5.00 B	13
		Boring terminated at 90.00 ft	95					
			100					

Profile	Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample Type / recovery	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)

GENERAL NOTES

Begin Drilling **02-15-2012** Complete Drilling **02-15-2012**
Drilling Contractor **Wang Testing Service** Drill Rig **D-50 ATV**
Driller **K&K** Logger **F. Bozga** Checked by
Drilling Method **3.25" IDA HSA upto 30' followed by 3" roller bit mud rotary; Boring backfill upon completion**

WATER LEVEL DATA

While Drilling ▽ **DRY**
At Completion of Drilling ▼ **MUD**
Time After Drilling **NA**
Depth to Water ▼ **NA**

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BORING LOG BB-05

WEI Job No.: 703-03-01

Client: **Zroka Engineering**
Project: **Willow Road Over Lehigh Ave and SOO Line RR**
Location: **Glenview, IL**

Datum: NGVD
Elevation: 668.36 ft
North: 1981495.43 ft
East: 1123989.75 ft
Station: 101+74
Offset: 24.72 LT

Depth (ft)	Elevation (ft)	Soil and Rock Description	Sample Type / recovery	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
0	667.4	2-inch thick ASPHALT over 10-inch thick CONCRETE --PAVEMENT--					
	666.4	12-inch thick, brown, GRAVELLY SAND --AGGREGATE BASE--					
		Stiff to hard, brown, gray and black SILTY CLAY LOAM with trace gravel --FILL--					
				1	6 5 7	NP	9
5				2	5 5 6	> 4.50 P	21
				3	4 6 7	> 4.50 P	12
10				4	3 4 4	2.54 B	14
				5	2 3 4	1.89 B	18
15				6	2 3 4	1.39 B	20
				7	3 4 5	2.62 B	17
20				8	3 4 5	2.30 B	18
				9	3 5 6	2.54 B	15
25				10	4 7 9	3.00 P	24
				11	5 6 8	3.69 B	13
30				12	4 5 8	2.95 B	21
	636.9	Very stiff, brown and gray SILTY CLAY LOAM with trace organic matter --BURIED TOPSOIL--					
35				13	3 3 6	2.30 B	22
	631.9	Stiff to hard, gray SILTY CLAY to SILTY CLAY LOAM with trace gravel					
40				14	7 9 12	4.84 B	21

GENERAL NOTES

Begin Drilling: **02-16-2012** Complete Drilling: **02-16-2012**
Drilling Contractor: **Wang Testing Service** Drill Rig: **D-50 ATV**
Driller: **K&K** Logger: **F. Bozga** Checked by:
Drilling Method: **3.25" IDA HSA upto 30' followed by 3" roller bit mud rotary; Boring backfill upon completion**

WATER LEVEL DATA

While Drilling: **DRY**
At Completion of Drilling: **MUD**
Time After Drilling: **NA**
Depth to Water: **NA**

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

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BORING LOG BB-05

WEI Job No.: 703-03-01

Client: **Zroka Engineering**
Project: **Willow Road Over Lehigh Ave and SOO Line RR**
Location: **Glenview, IL**

Datum: NGVD
Elevation: 668.36 ft
North: 1981495.43 ft
East: 1123989.75 ft
Station: 101+74
Offset: 24.72 LT

Profile	Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample Type / recovery	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
			45		15	4 6 7	2.46 B	19
			50		16	5 7 7	2.87 B	19
			55		17	4 7 8	1.97 B	20
			60		18	5 6 12	2.87 B	19
			65		19	4 6 9	3.20 B	21
			70		20	5 7 9	2.30 B	16
			75		21	4 5 6	1.07 B	14
			80		22	7 8 13	2.05 B	14

GENERAL NOTES

Begin Drilling: **02-16-2012** Complete Drilling: **02-16-2012**
Drilling Contractor: **Wang Testing Service** Drill Rig: **D-50 ATV**
Driller: **K&K** Logger: **F. Bozga** Checked by:
Drilling Method: **3.25" IDA HSA upto 30' followed by 3" roller bit mud rotary; Boring backfill upon completion**

WATER LEVEL DATA

While Drilling: **DRY**
At Completion of Drilling: **MUD**
Time After Drilling: **NA**
Depth to Water: **NA**

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

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BORING LOG BB-05

WEI Job No.: 703-03-01

Client **Zroka Engineering**
Project **Willow Road Over Lehigh Ave and SOO Line RR**
Location **Glenview, IL**

Datum: NGVD
Elevation: 668.36 ft
North: 1981495.43 ft
East: 1123989.75 ft
Station: 101+74
Offset: 24.72 LT

Profile	Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample Type / recovery	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
	584.4	Very dense, gray SILT	85		23	13 24 36	NP	22
	581.9	Very stiff to hard, gray SILTY CLAY LOAM with trace gravel	90		24	9 17 25	4.92 B	15
			95		25	7 10 16	3.61 B	15
	568.4	Boring terminated at 100.00 ft	100		26	10 12 18	3.77 B	14

GENERAL NOTES

Begin Drilling **02-16-2012** Complete Drilling **02-16-2012**
Drilling Contractor **Wang Testing Service** Drill Rig **D-50 ATV**
Driller **K&K** Logger **F. Bozga** Checked by
Drilling Method **3.25" IDA HSA upto 30' followed by 3" roller bit mud rotary; Boring backfill upon completion**

WATER LEVEL DATA

While Drilling ▽ **DRY**
At Completion of Drilling ▼ **MUD**
Time After Drilling **NA**
Depth to Water ▼ **NA**

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

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BORING LOG BB-06

WEI Job No.: 703-03-01

Client: **Zroka Engineering**
Project: **Willow Road Over Lehigh Ave and SOO Line RR**
Location: **Glenview, IL**

Datum: NGVD
Elevation: 640.00 ft
North: 1981532.35 ft
East: 1123869.85 ft
Station: 100+54
Offset: 61.46 LT

Profile	Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample Type / recovery	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
	639.0	12-inch thick brown SILTY CLAY --TOPSOIL--						
		Very stiff, brown SILTY CLAY with crushed asphalt --FILL--			1	9 8 4	2.50 P	20
	637.0	Loose, black LOAM --FILL-- --MOIST--	5		2	2 2 3	NP	32
	634.5	Stiff to very stiff, gray and brown SILTY CLAY with trace gravel			3	2 4 5	2.05 B	20
			10		4	4 7 7	1.25 P	23
	629.5	Stiff to very stiff, gray SILTY CLAY with trace gravel			5	8 9 15	4.59 B	17
			15		6	6 8 11	1.50 P	19
					7	5 6 7	1.97 B	21
			20		8	6 4 7	1.80 B	20
			25		9	4 6 7	1.56 B	21
					10	4 4 6	1.64 B	21
					11	4 6 9	1.56 B	21
			30		12	4 5 6	2.13 B	21
			35		13	6 6 7	1.97 B	20
			40		14	6 7 8	1.72 B	19

GENERAL NOTES

Begin Drilling: **02-08-2012** Complete Drilling: **02-09-2012**
Drilling Contractor: **Wang Testing Service** Drill Rig: **D-50 ATV**
Driller: **K&K** Logger: **B. Wilson** Checked by:
Drilling Method: **3.25" IDA HSA upto 30' followed by 3" roller bit mud rotary; Boring backfill upon completion**

WATER LEVEL DATA

While Drilling: **10.50 ft**
At Completion of Drilling: **MUD**
Time After Drilling: **NA**
Depth to Water: **NA**

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

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BORING LOG BB-06

WEI Job No.: 703-03-01

Client: **Zroka Engineering**
Project: **Willow Road Over Lehigh Ave and SOO Line RR**
Location: **Glenview, IL**

Datum: NGVD
Elevation: 640.00 ft
North: 1981532.35 ft
East: 1123869.85 ft
Station: 100+54
Offset: 61.46 LT

Profile	Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample Type / recovery	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
	583.0	Very stiff to hard, gray SILTY CLAY LOAM with little gravel	45		15	6 8 8	2.30 B	15
			50		16	4 6 9	1.97 B	15
			55		17	7 8 13	2.46 B	17
			60		18	10 15 19	4.26 B	13
	563.5	Dense, gray SILT	65		19	10 11 17	4.67 B	15
			70		20	8 11 15	3.28 B	14
			75		21	7 11 15	3.36 B	17
	560.0	Boring terminated at 80.00 ft	80		22	15 17 23	NP	18

GENERAL NOTES

Begin Drilling: **02-08-2012** Complete Drilling: **02-09-2012**
Drilling Contractor: **Wang Testing Service** Drill Rig: **D-50 ATV**
Driller: **K&K** Logger: **B. Wilson** Checked by:
Drilling Method: **3.25" IDA HSA upto 30' followed by 3" roller bit mud rotary; Boring backfill upon completion**

WATER LEVEL DATA

While Drilling: **10.50 ft**
At Completion of Drilling: **MUD**
Time After Drilling: **NA**
Depth to Water: **NA**

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

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BORING LOG BB-07

WEI Job No.: 703-03-01

Client: **Zroka Engineering**
Project: **Willow Road Over Lehigh Ave and SOO Line RR**
Location: **Glenview, IL**

Datum: NGVD
Elevation: 642.50 ft
North: 1981523.19 ft
East: 1123740.76 ft
Station: 99+25
Offset: 52.09 LT

Profile	Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample Type / recovery	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
	641.4	13-inch thick ASPHALT --PAVEMENT--						
		Medium dense, gray CRUSHED STONE --AGGREGATE BASE--			1	12 15 12	NP	5
	639.5	Loose, brown and gray, coarse GRAVELLY SAND --FILL--	5		2	7 5 4	NP	6
	637.0	Stiff, brown and gray CLAY LOAM --FILL-- --MOIST--			3	2 2 3	1.48 B	29
			10		4	1 3 5	1.00 P	26
	632.0	Hard, brown SILTY CLAY with trace gravel			5	4 6 9	6.07 B	19
			15		6	3 5 8	4.51 B	18
	627.0	Stiff to very stiff, gray SILTY CLAY with trace gravel			7	4 4 6	2.38 B	13
			20		8	2 4 5	2.05 B	20
			25		9	2 3 5	1.89 B	19
					10	3 4 5	1.56 B	19
			30		11	3 5 7	1.72 B	19
					12	5 5 7	1.80 B	17
			35		13	4 5 8	2.13 B	19
			40		14	4 5 8	2.38 B	18

GENERAL NOTES

Begin Drilling: **02-13-2012** Complete Drilling: **02-13-2012**
Drilling Contractor: **Wang Testing Service** Drill Rig: **D-50 ATV**
Driller: **K&K** Logger: **F. Bozga** Checked by:
Drilling Method: **3.25" IDA HSA upto 30' followed by 3" roller bit mud rotary; Boring backfill upon completion**

WATER LEVEL DATA

While Drilling: **DRY**
At Completion of Drilling: **MUD**
Time After Drilling: **NA**
Depth to Water: **NA**

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

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BORING LOG BB-07

WEI Job No.: 703-03-01

Client: **Zroka Engineering**
Project: **Willow Road Over Lehigh Ave and SOO Line RR**
Location: **Glenview, IL**

Datum: NGVD
Elevation: 642.50 ft
North: 1981523.19 ft
East: 1123740.76 ft
Station: 99+25
Offset: 52.09 LT

Profile	Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample Type / recovery	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
			45		15	4 6 8	2.38 B	19
		--trace sand--	50		16	4 6 7	1.23 B	15
		--possible cobbles--	55		17	6 8 14	1.23 B	14
	586.0	Very stiff to hard, gray SILTY CLAY LOAM with trace gravel	60		18	12 14 31	5.33 B	12
			65		19	10 15 30	5.74 B	12
			70		20	6 10 14	3.53 B	16
	567.5	Boring terminated at 75.00 ft	75		21	10 13 15	3.03 B	16
			80					

GENERAL NOTES

Begin Drilling: **02-13-2012** Complete Drilling: **02-13-2012**
Drilling Contractor: **Wang Testing Service** Drill Rig: **D-50 ATV**
Driller: **K&K** Logger: **F. Bozga** Checked by:
Drilling Method: **3.25" IDA HSA upto 30' followed by 3" roller bit mud rotary; Boring backfill upon completion**

WATER LEVEL DATA

While Drilling: **DRY**
At Completion of Drilling: **MUD**
Time After Drilling: **NA**
Depth to Water: **NA**

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

WANGENGINC 7030301.GPJ WANGENG.GDT 4/23/12

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BORING LOG BB-08

WEI Job No.: 703-03-01

Client: **Zroka Engineering**
Project: **Willow Road Over Lehigh Ave and SOO Line RR**
Location: **Glenview, IL**

Datum: NGVD
Elevation: 667.17 ft
North: 1981497.45 ft
East: 1123636.62 ft
Station: 98+21
Offset: 26.19 LT

Profile	Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample Type / recovery	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
	666.6	7-inch thick CONCRETE --PAVEMENT--						
	665.2	17-inch thick, brown, GRAVELLY SAND --AGGREGATE BASE--						
		Very stiff to hard, brown and gray SILTY CLAY LOAM with trace gravel --FILL--						
					1	16 10 8	NP	16
			5		2	5 7 8	> 4.50 P	18
					3	5 6 8	2.21 B	16
			10		4	4 6 9	3.77 B	16
					5	3 5 7	3.12 B	17
			15		6	3 4 7	2.46 B	18
					7	2 4 4	2.46 B	17
			20		8	3 5 6	3.36 B	17
			25		9	3 4 7	2.50 P	17
					10	4 4 8	1.89 B	18
					11	3 5 7	2.05 B	21
	639.2	Very stiff, black SILTY CLAY LOAM with organic matter --BURIED TOPSOIL--	30		12	5 8 11	2.50 P	32
	635.7	Stiff to hard, brown and gray SILTY CLAY with trace gravel						
			35		13	6 7 8	4.92 B	20
			40		14	6 8 10	3.77 B	19

GENERAL NOTES

Begin Drilling: **02-17-2012** Complete Drilling: **02-17-2012**
Drilling Contractor: **Wang Testing Service** Drill Rig: **D-50 ATV**
Driller: **K&K** Logger: **F. Bozga** Checked by:
Drilling Method: **3.25" IDA HSA upto 30' followed by 3" roller bit mud rotary; Boring backfill upon completion**

WATER LEVEL DATA

While Drilling: **DRY**
At Completion of Drilling: **MUD**
Time After Drilling: **NA**
Depth to Water: **NA**

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

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BORING LOG BB-08

WEI Job No.: 703-03-01

Client **Zroka Engineering**
Project **Willow Road Over Lehigh Ave and SOO Line RR**
Location **Glenview, IL**

Datum: NGVD
Elevation: 667.17 ft
North: 1981497.45 ft
East: 1123636.62 ft
Station: 98+21
Offset: 26.19 LT

Profile	Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample Type / recovery	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
			45		15	3 3 5	1.89 B	22
			50		16	3 4 5	1.48 B	21
			55		17	4 10 13	2.38 B	19
			60		18	6 7 8	2.38 B	17
	605.2	Medium dense, gray SILTY LOAM	65		19	10 12 13	NP	17
	600.2	Stiff to very stiff, gray SILTY CLAY with trace gravel	70		20	7 9 11	2.13 B	18
			75		21	8 10 16	2.87 B	16
			80		22	4 6 7	1.07 B	12

GENERAL NOTES

Begin Drilling **02-17-2012** Complete Drilling **02-17-2012**
Drilling Contractor **Wang Testing Service** Drill Rig **D-50 ATV**
Driller **K&K** Logger **F. Bozga** Checked by
Drilling Method **3.25" IDA HSA upto 30' followed by 3" roller bit mud rotary; Boring backfill upon completion**

WATER LEVEL DATA

While Drilling ▽ **DRY**
At Completion of Drilling ▼ **MUD**
Time After Drilling **NA**
Depth to Water ▼ **NA**

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

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BORING LOG BB-08

WEI Job No.: 703-03-01

Client **Zroka Engineering**
Project **Willow Road Over Lehigh Ave and SOO Line RR**
Location **Glenview, IL**

Datum: NGVD
Elevation: 667.17 ft
North: 1981497.45 ft
East: 1123636.62 ft
Station: 98+21
Offset: 26.19 LT

Profile	Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample Type / recovery	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
	585.2							
		Very dense, gray SILTY LOAM						
			85		23	12 21 39	NP	15
	580.7							
		Hard, gray SILTY CLAY LOAM with trace gravel						
			90		24	10 14 17	6.56 B	
	577.2							
		Boring terminated at 90.00 ft						
			95					
			100					

GENERAL NOTES

Begin Drilling **02-17-2012** Complete Drilling **02-17-2012**
Drilling Contractor **Wang Testing Service** Drill Rig **D-50 ATV**
Driller **K&K** Logger **F. Bozga** Checked by
Drilling Method **3.25" IDA HSA upto 30' followed by 3" roller bit mud rotary; Boring backfill upon completion**

WATER LEVEL DATA

While Drilling ▽ **DRY**
At Completion of Drilling ▼ **MUD**
Time After Drilling **NA**
Depth to Water ▼ **NA**

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

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BORING LOG RW-01

WEI Job No.: 703-03-01

Client: **Zroka Engineering**
Project: **Willow Road Over Lehigh Ave and SOO Line RR**
Location: **Glenview, IL**

Datum: NGVD
Elevation: 637.36 ft
North: 1981363.49 ft
East: 1124004.85 ft
Station: 101+89
Offset: 107.19 RT

Elevation (ft)	Depth (ft)	SOIL AND ROCK DESCRIPTION	Sample Type / recovery	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
636.4	0	12-inch thick, brown LOAM --TOPSOIL--					
		Stiff, brown and gray SILTY CLAY LOAM		1	3 5 5	1.15 B	18
634.4		Stiff to hard, brown and gray SILTY CLAY with trace gravel					
	5			2	5 6 9	2.50 P	19
				3	4 7 9	4.51 B	17
	10			4	5 6 8	4.10 B	18
				5	3 4 5	1.72 B	19
	15			6	3 4 5	1.80 B	15
		--L_L = 29%, P_L = 16%-- --% Gravel = 5.4%-- --% Sand = 12.0%-- --% Silt = 49.0%-- --% Clay = 33.7%--		7	3 4 6	1.64 B	19
	20	▽		8	4 4 6	1.64 B	17
616.9		Medium dense, gray, medium to coarse SAND --WET--		9	5 8 13	NP	18
615.1		Very stiff, gray SILTY CLAY with trace gravel					
614.4		Loose, gray, fine to medium SAND					
	25			10	3 4 5	NP	11
611.9		Very stiff, gray SILTY CLAY with trace gravel					
				11	3 4 7	2.30 B	20
				12	3 5 7	2.46 B	19
607.4	30	Boring terminated at 30.00 ft					
	35						
	40						

GENERAL NOTES

Begin Drilling: **02-07-2012** Complete Drilling: **02-07-2012**
Drilling Contractor: **Wang Testing Service** Drill Rig: **D-50 ATV**
Driller: **K&K** Logger: **B. Wilson** Checked by:
Drilling Method: **3.25" IDA HSA; Boring backfill upon completion**

WATER LEVEL DATA

While Drilling ▽: **19.50 ft**
At Completion of Drilling ▼: **DRY**
Time After Drilling: **NA**
Depth to Water ▼: **NA**

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BORING LOG RW-02

WEI Job No.: 703-03-01

Client: **Zroka Engineering**
Project: **Willow Road Over Lehigh Ave and SOO Line RR**
Location: **Glenview, IL**

Datum: NGVD
Elevation: 636.94 ft
North: 1981365.34 ft
East: 1124082.10 ft
Station: 102+67
Offset: 105.22 RT

Profile	Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample Type / recovery	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
	636.1	10-inch thick SAND and GRAVEL						
		Black and brown SILTY CLAY LOAM with little gravel --FILL--			1	6 9 9	NR	20
	633.9							
		Loose, brown, fine SAND --FILL-- --MOIST--			2	4 4 5	NP	13
	631.4		5					
		Stiff to very stiff, gray SILTY CLAY with trace gravel			3	4 4 5	1.80 B	13
					4	2 4 6	2.87 B	16
			10					
					5	3 4 5	1.72 B	19
					6	6 6 8	4.02 B	17
			15					
					7	3 6 8	2.87 B	18
					8	3 4 6	3.12 B	18
			20					
					9	5 8 9	3.28 B	17
			25		10	4 5 7	2.46 B	17
					11	3 5 7	2.62 B	18
	606.9		30		12	5 8 13	2.62 B	15
		Boring terminated at 30.00 ft						
			35					
			40					

GENERAL NOTES

Begin Drilling: **02-07-2012** Complete Drilling: **02-07-2012**
Drilling Contractor: **Wang Testing Service** Drill Rig: **D-50 ATV**
Driller: **K&K** Logger: **B. Wilson** Checked by:
Drilling Method: **3.25" IDA HSA; Boring backfill upon completion**

WATER LEVEL DATA

While Drilling: **DRY**
At Completion of Drilling: **DRY**
Time After Drilling: **NA**
Depth to Water: **NA**

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

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BORING LOG RW-03

WEI Job No.: 703-03-01

Client: **Zroka Engineering**
Project: **Willow Road Over Lehigh Ave and SOO Line RR**
Location: **Glenview, IL**

Datum: NGVD
Elevation: 636.39 ft
North: 1981364.12 ft
East: 1124159.21 ft
Station: 103+44
Offset: 106.32 RT

Depth (ft)	Elevation (ft)	SOIL AND ROCK DESCRIPTION	Sample Type / recovery	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
0	636.22	2-inch thick ASPHALT					
	636.0	--PAVEMENT--					
		3-inch thick CRUSHED STONE --AGGREGATE BASE--					
		Medium dense, brown, medium SAND with little gravel --FILL-- --MOIST--		1	6 6 6	NP	6
5				2	6 5 6	NP	7
	630.9	Hard, brown SILTY CLAY with trace gravel		3	5 7 12	5.06 B	18
10				4	8 12 14	6.23 B	16
	625.9	Stiff to very stiff, gray SILTY CLAY with trace gravel		5	5 6 8	3.20 B	18
15				6	4 4 7	2.71 B	18
				7	3 4 7	2.21 B	18
20				8	3 4 6	1.80 B	19
	612.6	Medium dense, gray, coarse SAND --WET--		9	3 5 7	2.54 B	17
25				10	8 6 6	NP	23
	610.9	Medium dense, gray SILT --WET--		11	12 12 5	NP	16
	609.1	Stiff, gray SILTY CLAY with trace gravel		12	4 5 7	1.72 B	16
30	606.4	Boring terminated at 30.00 ft					
35							
40							

GENERAL NOTES

Begin Drilling: **02-07-2012** Complete Drilling: **02-07-2012**
Drilling Contractor: **Wang Testing Service** Drill Rig: **D-50 ATV**
Driller: **K&K** Logger: **B. Wilson** Checked by:
Drilling Method: **3.25" IDA HSA; Boring backfill upon completion**

WATER LEVEL DATA

While Drilling: **23.75 ft**
At Completion of Drilling: **DRY**
Time After Drilling: **NA**
Depth to Water: **NA**

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

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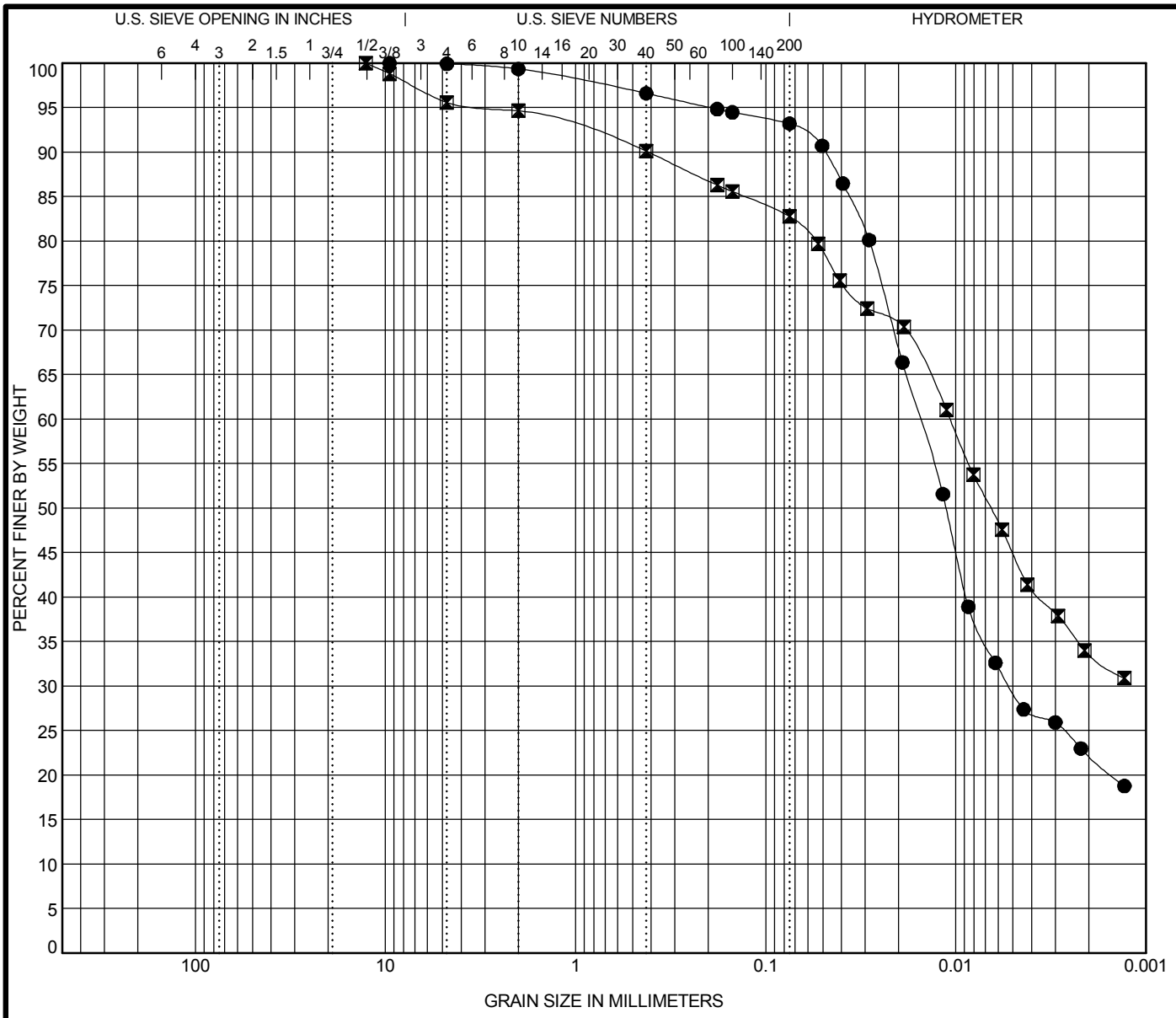
APPENDIX B



COBBLES	GRAVEL	SAND		SILT AND CLAY
		coarse	fine	

	Specimen Identification		IDH Classification	LL	PL	PI	Cc	Cu
●	BB-03#15	43.5 ft	**Silty Clay Loam**	**22**	**15**	**7**		
⊠	RW-01#7	16.0 ft	**Silty Clay**	**29**	**16**	**13**		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	BB-03#15	43.5 ft	**9.5**	**0.015**	**0.005**		**0.7**	**6.2**	**70.9**	**22.2**
⊠	RW-01#7	16.0 ft	**12.7**	**0.011**			**5.4**	**12.0**	**49.0**	**33.7**

WEI SINCE 1982
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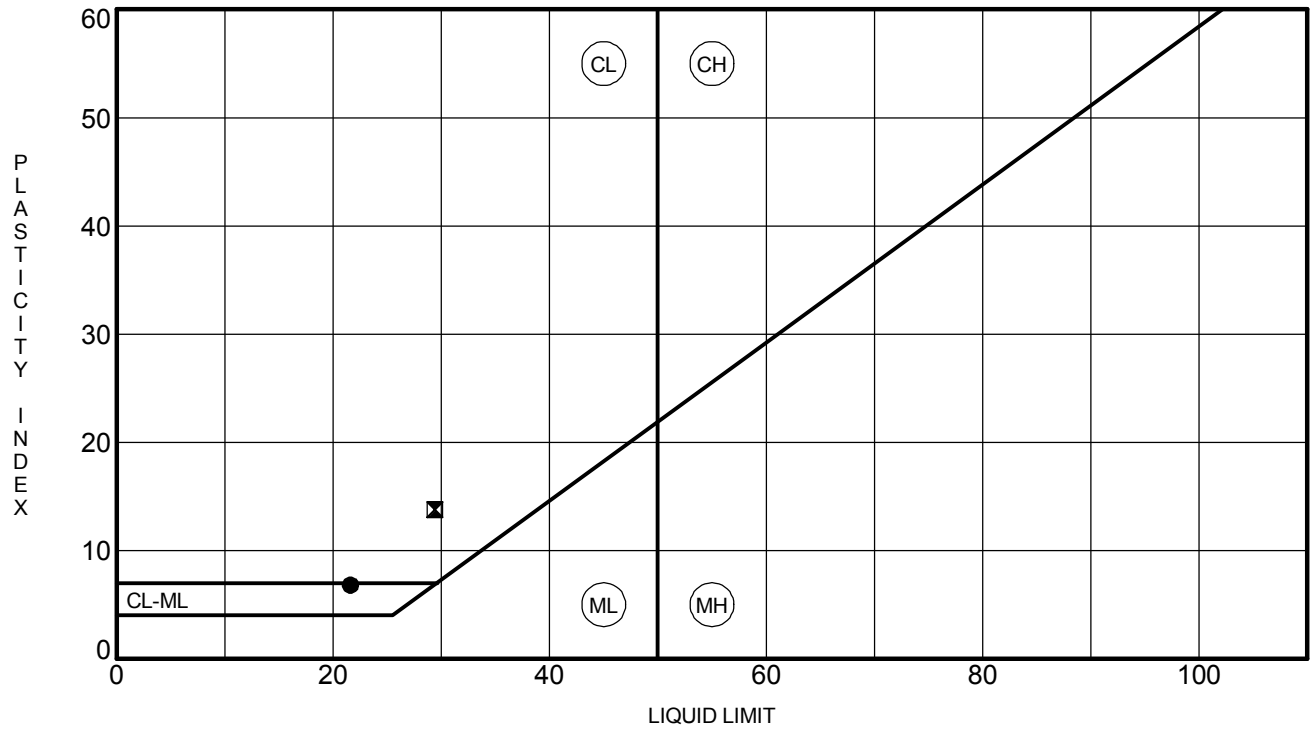
GRAIN SIZE DISTRIBUTION

Project: Willow Road Over Lehigh Ave and SOO Line RR

Location: Glenview, IL

Number: 703-03-01



	Specimen Identification		LL	PL	PI	Fines	IDH Classification
●	**BB-03#15**	**43.5 ft**	**22**	**15**	**7**	**93**	**Silty Clay Loam**
⊠	**RW-01#7**	**16.0 ft**	**29**	**16**	**13**	**83**	**Silty Clay**

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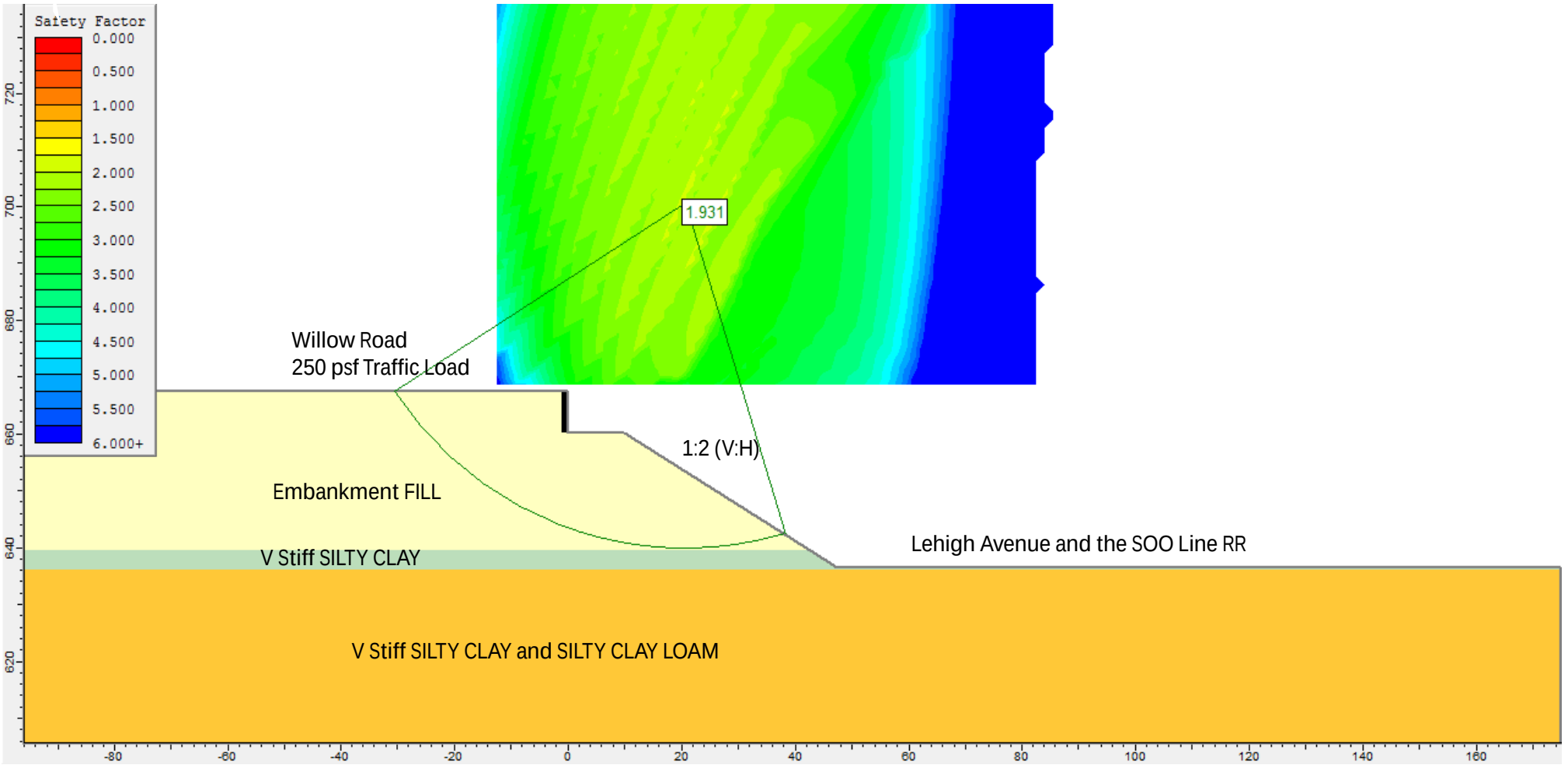
ATTERBERG LIMITS' RESULTS

Project: Willow Road Over Lehigh Ave and SOO Line RR

Location: Glenview, IL

Number: 703-03-01

APPENDIX C



Undrained Analysis for End Slope, Ref Borings BB-01 and BB-08

Layer ID	Description	Unit Weight (pcf)	Undrained Cohesion (psf)	Undrained Friction Angle (degrees)
1	Embankment FILL	125	1000	0
2	V Stiff SILTY CLAY	120	2500	0
3	V Stiff SILTY CLAY to SI CLAY LOAM	120	2400	0

GLOBAL STABILITY ANALYSIS: WILLOW ROAD BRIDGE OVER LEHIGH AVENUE AND SOO RR, SN 016-0533, SEC 1920.01-BR, COOK COUNTY

SCALE: AS SHOWN | APPENDIX C-1 | DRAWN BY: MLS CHECKED BY: LMI

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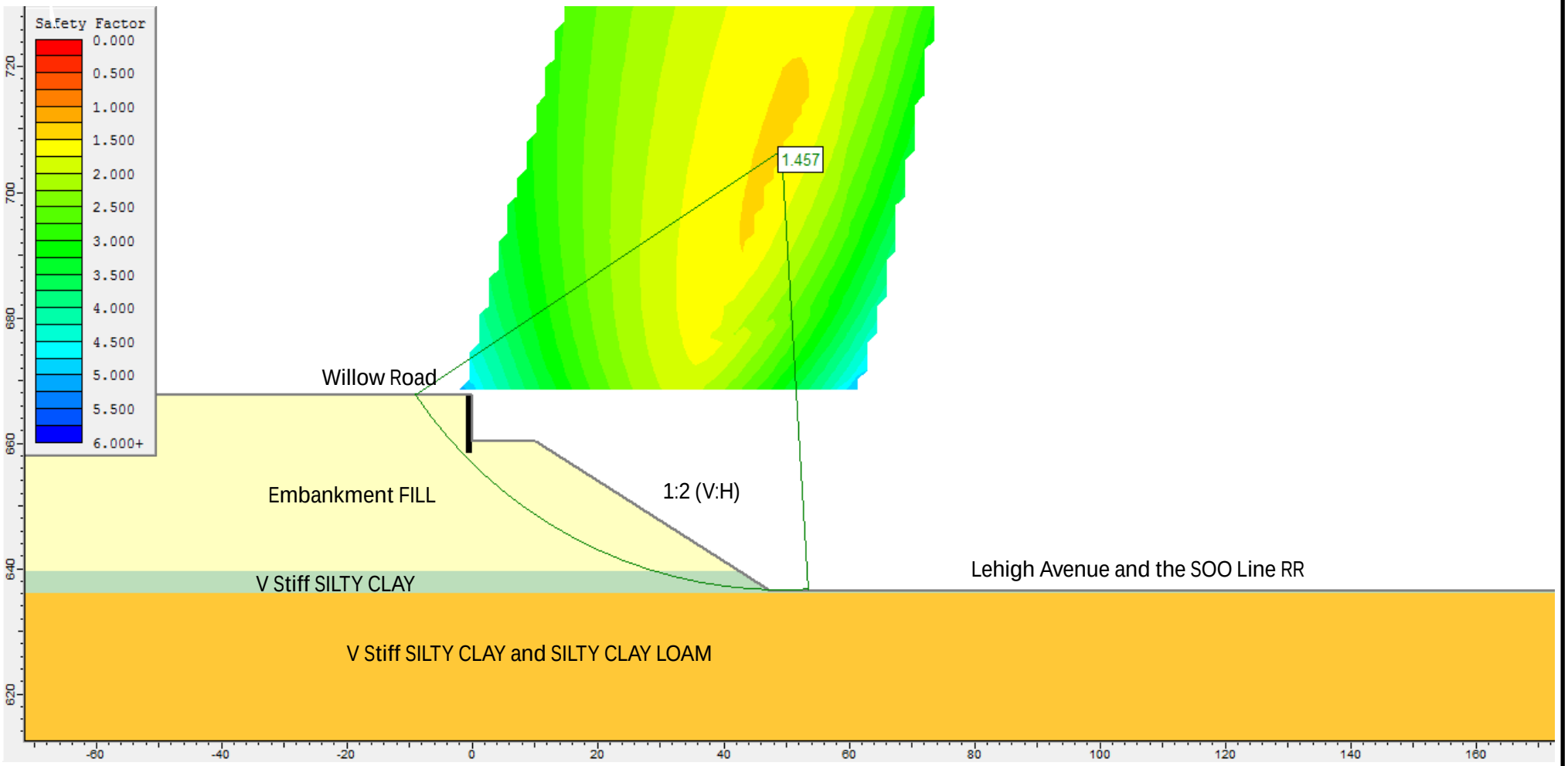
FOR ZROKA ENGINEERING | 703-03-01



Drained Analysis for End Slope, Ref Borings BB-01 and BB-08

Layer ID	Description	Unit Weight (pcf)	Drained Cohesion (psf)	Drained Friction Angle (degrees)
1	Embankment FILL	125	100	30
2	V Stiff SILTY CLAY	120	100	30
3	V Stiff SILTY CLAY to SI CLAY LOAM	120	100	30

GLOBAL STABILITY ANALYSIS: WILLOW ROAD BRIDGE OVER LEHIGH AVENUE AND SOO RR, SN 016-0533, SEC 1920.01-BR, COOK COUNTY

SCALE: AS SHOWN | APPENDIX C-2 | DRAWN BY: MLS CHECKED BY: LMI

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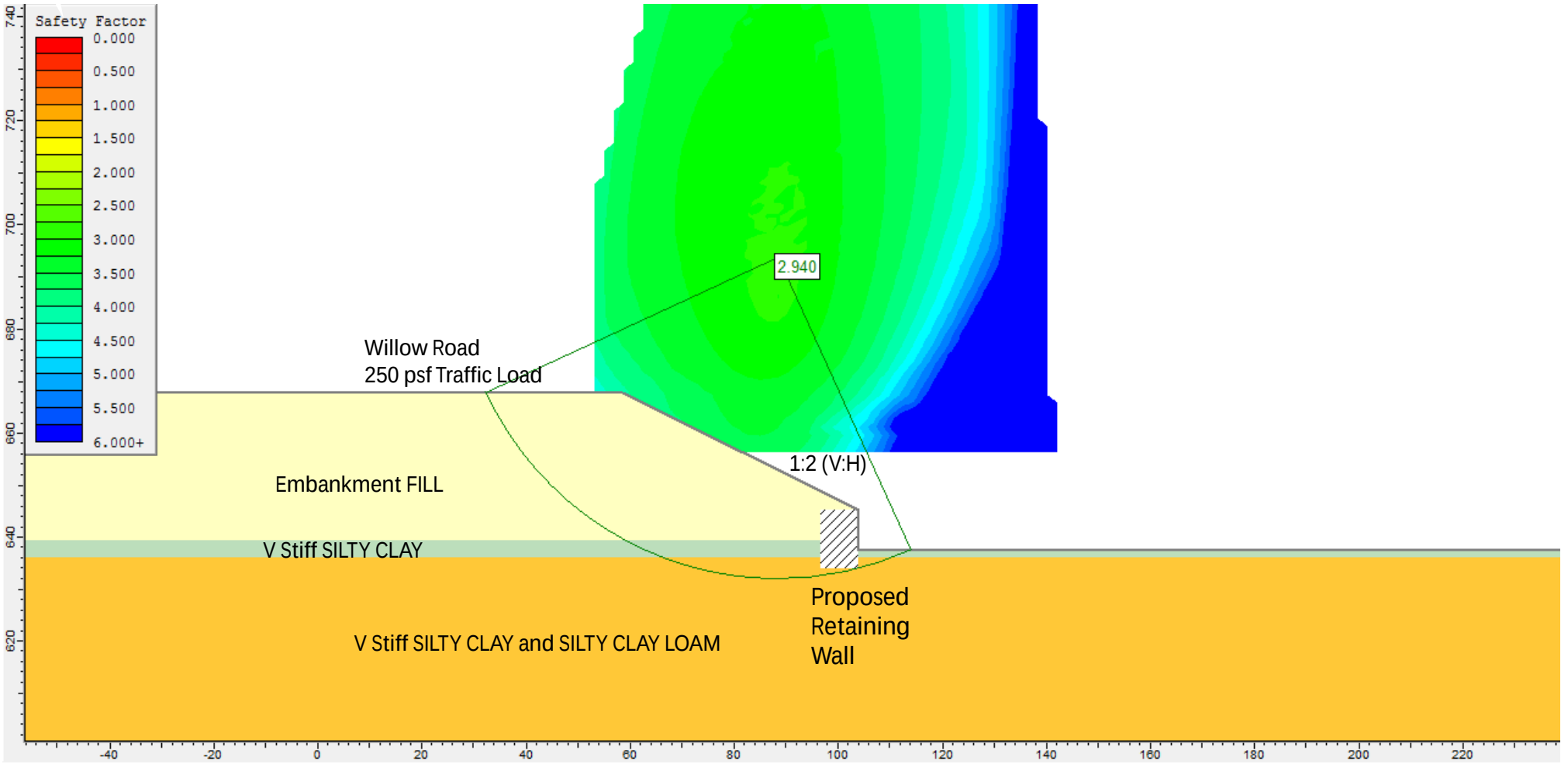
FOR ZROKA ENGINEERING | 703-03-01



Undrained Analysis for Side Slope and Retaining Wall, Ref Borings BB-04 and BB-05

Layer ID	Description	Unit Weight (pcf)	Undrained Cohesion (psf)	Undrained Friction Angle (degrees)
1	Embankment FILL	125	1000	0
2	V Stiff SILTY CLAY	120	2500	0
3	V Stiff SILTY CLAY to SI CLAY LOAM	120	2400	0

GLOBAL STABILITY ANALYSIS: WILLOW ROAD BRIDGE OVER LEHIGH AVENUE AND SOO RR, SN 016-0533, SEC 1920.01-BR, COOK COUNTY

SCALE: AS SHOWN | APPENDIX C-3 | DRAWN BY: MLS CHECKED BY: LMI

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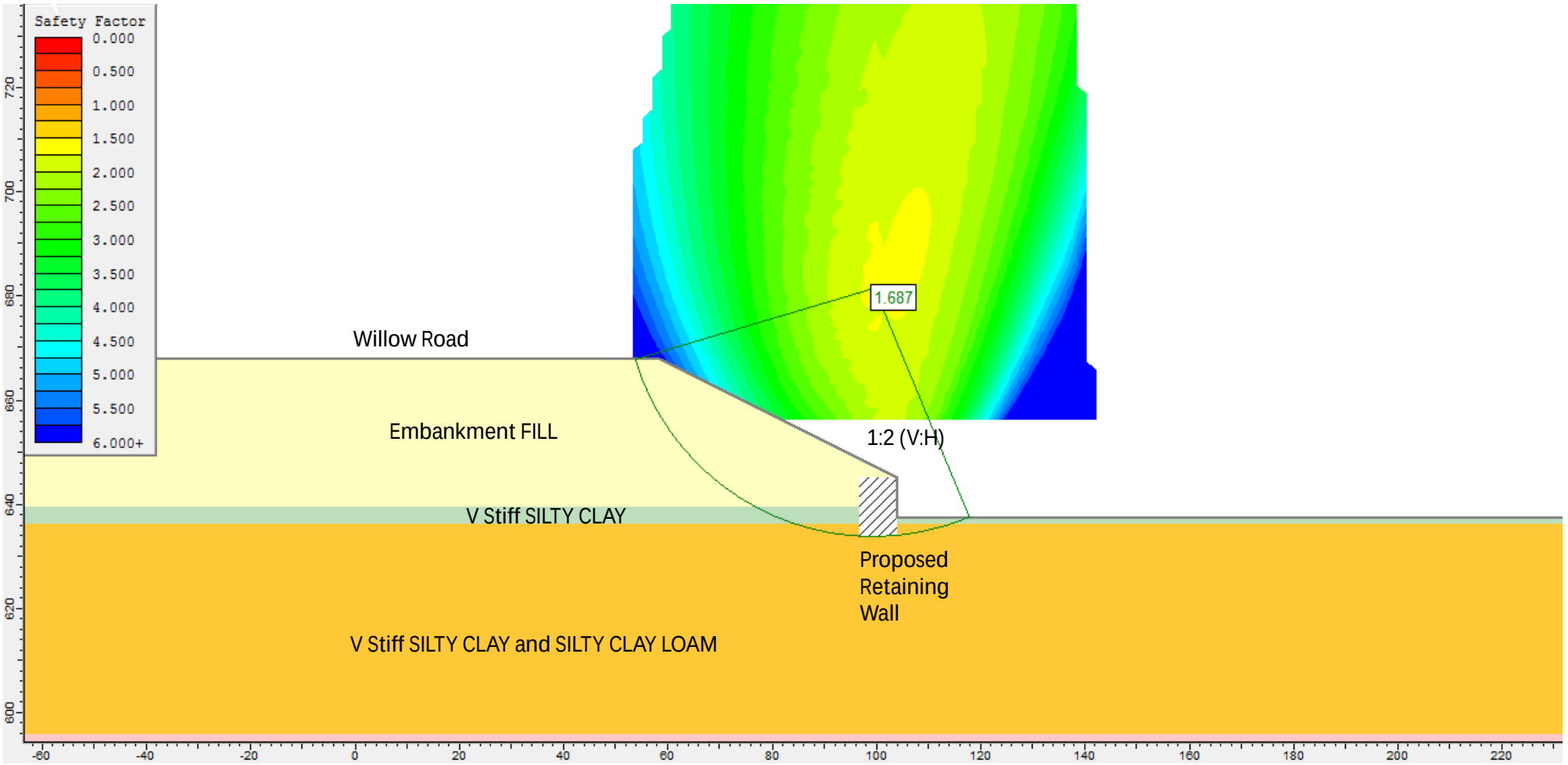

Drained Analysis for Side Slope and Retaining Wall, Ref Borings BB-04 and BB-05

Layer ID	Description	Unit Weight (pcf)	Drained Cohesion (psf)	Drained Friction Angle (degrees)
1	Embankment FILL	125	100	30
2	V Stiff SILTY CLAY	120	100	30
3	V Stiff SILTY CLAY to SI CLAY LOAM	120	100	30

GLOBAL STABILITY ANALYSIS: WILLOW ROAD BRIDGE OVER LEHIGH AVENUE AND SOO RR, SN 016-0533, SEC 1920.01-BR, COOK COUNTY

SCALE: AS SHOWN | APPENDIX C-4 | DRAWN BY: MLS CHECKED BY: LMI

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FOR ZROKA ENGINEERING | 703-03-01