STRUCTURE GEOTECHNICAL REPORT
IL ROUTE 47 BRIDGE
OVER KISHWAUKEE RIVER
EXISTING SN 056-0025; PROPOSED SN 056-0316
FAP 326, SECTION (105XB) B-R
IDOT JOB D-91-023-14, PTB 169/018
MCHENRY COUNTY, ILLINOIS

For

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11. Abstract

A new single span bridge, SN 056-0316, will be constructed to the east of the existing structure to carry the proposed realigned IL 47 northbound and southbound lanes. The proposed integral abutments will have wingwalls extending to the west which will meet the abutment wingwalls of the parallel bridge to be constructed with the future widening and reconstruction of IL 47 from Reed Road and IL 176. The proposed approach embankments will require 12 to 14 feet high new fill at the abutments. This report provides geotechnical recommendations for the design of proposed bridge foundations and approach embankments.

Beneath the topsoil, the soil is made up of very loose to loose organic silty loam to loam over stiff to very stiff silty clay to silty clay loam followed by alternating layers of very loose to dense sand to gravelly sand and medium stiff to very stiff clay loam to loam. The site classifies in the Seismic Class D.

With minor foundation soils treatments, we estimate the foundations soils under the new embankment loads will undergo long-term consolidation settlement of 0.2 to 0.5 inch and residual settlement at the end of embankment construction will be 0.4 inch or less. Downdrag load allowances will not be required for new bridge piles. Global stability analyses at the approach embankments show FOS of 3.1 and 2.2 for the short-term and long-term conditions and meet the required FOS of 1.5.

The proposed integral abutments could be supported on steel H-piles or metal shell piles. Tables are provided for each pile size. We provide geotechnical parameters for pile analysis under lateral loads and analyses should be carried out when selecting pile sizes.

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FOR
KNIGHT E/A, INC.

1.0 INTRODUCTION

This report presents the results of our subsurface investigation, laboratory testing, and geotechnical evaluations and recommendations for the proposed replacement bridge carrying IL Route 47 (IL 47) over the Kishwaukee River, in McHenry County, Illinois. A *Site Location Map* is presented as Exhibit 1.

1.1 Existing Structure

The existing structure carrying IL 47 over the Kishwaukee River was constructed in 1936. The existing structure is a two-span continuous concrete slab bridge supported on closed abutments and a solid pier. The length of the bridge is 39.0 feet measured back-to-back of abutments and an out-to-out deck width of 47.0 feet. The site for the proposed replacement bridge is located just east of the existing structure and it is currently a wooded area with a ditch.

1.2 Proposed Structure

The existing structure will be removed. A new single span bridge, SN 056-0316, will be constructed to the east of the existing bridge to carry the proposed realigned IL 47 northbound (NB) and southbound (SB) lanes. The proposed replacement bridge will be supported by integral abutments with horizontal cantilever wingwalls and will have a back-to-back abutment length of 87.9 feet. The out-to-out deck width will measure 59.8 feet.

When the future reconstruction and widening of IL 47 from Reed Road to IL 176 is constructed, a parallel single span bridge, SN 056-0315, will be built to the west of the proposed replacement bridge.

The proposed structure will require new approach embankments. The proposed IL 47 centerline elevations at the approach embankments are 868 to 869 feet and the existing grades lie at approximately 855 to 856 feet; therefore the maximum embankment heights amount to 12 to 14 feet. The proposed embankment side slope is 1:3 (V:H) and the proposed embankment side slope near the abutments is 1:2 (V:H).

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 IL 47 bridge foundations.

2.0 SITE CONDITION AND GEOLOGICAL SETTING

The project area is located in southern McHenry County, within Grafton Township. On the USGS *Huntley Quadrangle 7.5 Minute Series* map, the bridge is located in SE ¼ of Section 4, Township 43 N, Range 7 E of the Third Principal Meridian. We note that there is an existing 6-foot deep ditch running south to north, just east of the existing approach embankments. The diversion of this ditch for the proposed embankment construction is not known at this time.

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, thus, to confirm the dependability and consistency of the present subsurface investigation results. For the study of the regional geologic framework, Wang considered northeastern Illinois area in general and McHenry County in particular.

2.1 Physiography

Eastern two-thirds of McHenry County is part of the Wheaton Morainal Country within the Till Plains Physiographic Section (Leighton et al. 1948). This section is characterized by hummocky topography as a result of numerous advances and retreats of ice sheets (Curry 2005a). The project site is located within the limits of north to south trending Barlina Moraine. Barlina Moraine is fragmented by numerous drainage ways through which today Kishwaukee River and some of its tributaries are running. The Kishwaukee River Valley crosses east to west the Barlina Moraine near the moraine north end.

Our project is located at the IL 47 crossing over the Kishwaukee River valley and the elevations along the proposed roadway alignment vary from 850 to 870 feet. The general site topography slowly increases in elevation from south to north from 850 feet at the river crossing to 920 feet at the moraine ridge. The Kishwaukee River flows westward through an approximately 25 feet wide channel within a floodplain less than one half mile wide.

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. Many kettle depressions and other low-lying areas that scar the Barlina Moraine are filled with deposits of fine, sorted sediment of the Equality Formation and peat and marl of the Grayslake Peat. The Barlina Moraine contains deposits of diamicton and sorted sediments associated with the Yorkville and Batestown Members of the Lemont Formation. They are intercalated with lenses and layers of sorted sands and gravels outwash deposits of the Henry Formation overlying thick deposits of clay loamy diamictons of the Tiskilwa Formation. Multiple advances and retreats of the ice front account for the layers in the moraine (Hansel and Johnson 1996, Curry and Thomason 2012, Curry 2005a). Older, Illinois-age diamicton of the Glasford Formation, with thicknesses of less than 50 feet, discontinuously rests over the bedrock. The Glasford formation is represented by a courser and pebbly till that may include stratified gravel, sand, and silt. The drift thickness along the project alignment is approximately 150 feet (Curry and Thomason 2012). The *Site and Regional Geology* is illustrated in Exhibit 2.

From a geotechnical viewpoint, the Equality Formation sediments are characterized by high plasticity, medium to high moisture content, and moderate to high compresibity. The Henry Formation sediments are characterized by medium to high density and moderate to low compresibility. The Lemont Formation diamicton is characterised by high silt content, low moisture content and higher strength. The Tiskilwa Formation diamicton is characterised by low to very low plasticity, low moisture content, medium to hard consistency, and low compressibility. The Glasford Formation is characterized by high density, and hard consistency (Bauer et al. 1991).

2.3 Bedrock

In southern McHenry County, the surficial cover rests unconformably on top of nearly horizontal Silurian- and Ordovician-age dolomites (Curry 2005c). The top of the bedrock lies approximately

150 feet below the ground surface (bgs). The top of the bedrock lies at about 700 feet elevation (NGVD) (Curry 2012).

Our subsurface investigation results fit into the local geologic context. The borings drilled in the project area revealed that the native sediments at the project site consist of very thin and discontinuous black organic silt of the Grays Lake Peat and clay and silt of the Equality Formation over brown to pinkish gray loamy diamicton with sand and silt lenses of the Tiskilwa Formation interfinger with thick deposits of sand and gravel outwash of the Henry Formation. None of the borings reached the bedrock.

3.0 METHODS OF INVESTIGATION

The following sections outline the subsurface and laboratory investigations performed by Wang. Elevations in this report are in North American Vertical Datum (NAVD) 1988.

3.1 Subsurface Investigation

The subsurface investigation was performed by Wang in January 2016. The investigation consisted of two structure borings. The borings, designated as SB-03 and SB-04, were drilled from elevations of 856.5 and 859.8 feet to a depth of 90.0 feet below ground surface (bgs). Boring coordinates were surveyed by Wang using a mapping-grade GPS unit; stations and offsets were provided by Knight. 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, 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. Soil samples collected from each interval were placed in sealed jars for further examination and laboratory testing.

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

Groundwater observations were made during and at 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

Soil samples were tested in the laboratory for moisture content (AASHTO T 265). Atterberg limits (T 89/T 90) and particle size analyses (T 88) tests were also performed on a selected sample. Field visual descriptions of the soil samples were verified in the laboratory and classified according to the IDH Soil Classification System. Laboratory test results are shown on 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 on 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

Borings revealed 12 inches of dark brown to black silt to silty loam topsoil at the surface. In descending order, the general lithologic succession encountered beneath the surface includes 1) very loose to medium dense organic silty loam to loam; 2) stiff to very stiff silty clay to silty clay loam and loose sand; and 3) alternating very loose to very dense sand to gravelly sand and stiff to very stiff clay loam to loam.

1) Very loose to medium dense organic silty loam to loam

Beneath the topsoil, the borings revealed 2.0 to 5.5 feet of very loose to medium dense, dark brown to black organic silty loam to loam. This layer has SPT N values of 2 to 10 blows/foot with moisture content values of 19 and 25%. A higher moisture content value of 117% was encountered in Boring SB-04 between 3 and 5.5 feet bgs.

2) Stiff to very stiff silty clay to silty clay loam and loose sand

At elevations of 853.5 to 854.3 feet (3.0 to 5.5 feet bgs), the borings encountered 1.0 to 2.5 feet of stiff to very stiff, brown and gray silty clay to silty clay loam and loose, saturated sand. The cohesive soil has unconfined compressive strength (Qu) values of 1.1 and 3.5 tsf with moisture content values of 15 and 18%. The sand layer has SPT N value of 7 blows/foot with moisture content value 20%.

3) *Very loose to very dense sand to gravelly sand and medium stiff to very stiff clay loam to loam*

At elevations of 848.5 to 853.3 feet (6.5 to 8.0 feet bgs), the borings advanced through alternating layers of very loose to very dense sand to gravelly sand outwash deposits and stiff to very stiff clay loam to loam diamicton. The very loose to very dense, saturated sand to gravelly sand, encountered in 1.0 to 48.2 feet thick deposits extending to the boring termination depth of 90 feet (elevations 766.5 and 769.8 feet), has SPT N values of 3 to 57 blows/foot with an average of 20 blows/foot and moisture content values of 5 to 25% with an average of 13%. Heaving sand and hard drilling conditions were encountered during drilling from 47.0 feet bgs to boring termination depth of 90 feet bgs (elevations 809.5 to 766.5 feet) in Boring SB-03 and at 20.5 feet bgs (elevation 839.3 feet) in Boring SB-04.

The medium stiff to very stiff, pinkish brown to pinkish gray clay loam to loam diamicton, encountered in 1.0 to 7.5 feet thick deposits, has Qu values of 0.5 to 3.12 tsf with an average of 1.9 tsf and moisture content of 10 to 16% with an average of 11%.

4.2 Groundwater Conditions

While drilling, the groundwater was first observed at elevations of 853.4 to 853.5 feet (3.0 to 6.4 feet bgs). At completion of drilling, the groundwater was measured at elevations of 844.5 to 852.8 feet (7.0 to 12.0 feet bgs). All granular layers encountered below elevation of 854 feet are considered water-bearing. We estimate the groundwater table was at about elevation of 853 feet (3 to 6 feet bgs) which may correspond to the water level in the Kiswaukee River. We expect that the groundwater levels will fluctuate seasonally.

5.0 FOUNDATION ANALYSIS AND RECOMMENDATIONS

The geotechnical evaluations and recommendations for scour and seismic design considerations, approach embankment analyses, and abutment and wingwalls foundations are included in the following sections.

5.1 Scour Considerations

Information provided by Knight indicates a streambed elevation at 852.2 feet. The hydraulic report indicates total scour depths of 23.04 feet at both abutments for 100 year event (Q100) and 24.13 feet at both abutments for 200 year event (Q200) at the south and north abutments, respectively. Both abutment foundations are shown in the TSL plan with stone riprap for scour protection. For open abutments protected with stone riprap, the design and check scour elevations are set at the bottom of the abutment per IDOT ABD Memo 14.2. The design scour elevations for the proposed bridge are presented in Table 1.

Table 1: Design Scour Elevations

Event/Limit State	Design Scour Elevation (ft.)		Item 113
	South Abutment	North Abutment	
Q100	860.27	860.81	8
Q200	860.27	860.81	
Design	860.27	860.81	
Check	860.27	860.81	

5.2 Seismic Design Considerations

The seismic site class was determined in accordance with Section 6.12 Seismic Analysis (IDOT 2015). The soils within the top 100 feet have a weighted average N value of 16 blows/foot (AASHTO 2012; Method C controlling), and the results classify the site in the Seismic Site Class D in accordance with the IDOT method. The project location belongs to the Seismic Performance Zone 1. The seismic spectral acceleration parameters recommended for design in accordance with AASHTO (2012) are summarized in Table 2. According to IDOT Bridge Manual (IDOT, 2012), liquefaction analysis is not required for a site located Seismic Performance Zone 1.

Table 2: Seismic Design Parameters

Spectral Acceleration Period (sec)	Spectral Acceleration Coefficient1) (% g)	Site Factors	Design Spectrum for Site Class D2) (% g)
0.2	S_s= 8.7	F_a= 1.6	**S_{DS}= 13.9**
1.0	S_1=3.3	F_v= 2.4	**S_{D1}= 8.0**

1) Spectral acceleration coefficients based on Site Class D.
2) Site Class D Spectrum to be included on plans; $A_s = PGA*F_{pga}$; $S_{DS}= S_s*F_a$; $S_{D1}= S_1*F_v$.

5.3 Approach Embankments and Slabs

Based on the centerline profile and cross section drawings, the proposed approach embankment will require about 12 to 14 feet high new fill at the abutment locations and will have a side slope of 1:2 (V:H).

Based on the encountered subsoil conditions, very loose to loose organic silty loam to silty loam is expected to be encountered at the approach embankments. To provide tolerable settlements and stable working platforms, we recommend removing the soils as presented in Table 3.

Table 3: Summary of Foundation Soils Treatment Recommendations

Limits Station to Station	Treatment Width	Foundation Soil Removal Depth*/Elevation (feet)	Replacement Material	Reference Boring, Foundation Concerns
531+36 to 531+66 (South Approach)	Entire width of embankment	1.0 to 5.5/854.3	Fill as per IDOT Specifications	SB-04 (Organic Silty Loam, N=4 blow/foot, MC=117%)
532+54 to 532+84 (North Approach)	Entire width of embankment	3.0/853.5	Fill as per IDOT Specifications	SB-03 (Very Loose Loam, N=2 blow/foot, MC=25%)

* Depth measured from the existing grade at boring locations.

5.3.1 Settlement

Considering the recommended removal and replacement, we estimate the cohesive foundation soils under the new approach embankment fill loads will undergo 0.2 to 0.5 inches of long-term consolidation settlement. The settlement estimates are performed using IDOT *Spreadsheet - Cohesive Soil Settlement Estimate*, dated December 9, 2014. We estimate the residual settlement at the completion of approach embankment construction will be less than 0.4 inch. These settlement estimates are appropriate for the construction of approach slabs and we do not anticipate requiring downdrag load allowances for the new foundation piles.

5.3.2 Global Stability

The global stability of the side slopes was analyzed with *Slide 6.0*. The minimum required factor of safety (FOS) for both short-term and long-term conditions is 1.5 (IDOT, 2015). Slope stability evaluation exhibits are shown in Appendix C.

The global stability evaluations were performed at the north abutment based on subsurface soil conditions encountered in Boring SB-03 and the recommended removal and replacement which represents the critical condition. The total embankment height is approximately 13.5 feet. Wang estimates a minimum FOS of 3.1 and 2.2 at the bridge side slope for undrained and drained conditions (Appendices C-1 and C-2), respectively. The FOS is satisfactory and meets the IDOT required FOS of 1.5.

5.4 Foundation Recommendations

The TSL plan shows the pile cap base elevations for the IL 47 NB Bridge at 860.27 and 860.81 feet at the south and north abutments, respectively. Preliminary service and factored loads for the foundations provided by Knight are shown in Table 4.

Table 4: Preliminary Foundation Loads

Substructure ID	Estimated Total Service Load (kips)	Estimated Total Factored Load (kips)
Bridge Abutments	1630	2385

Wang has evaluated various possible foundation types that can be considered for the support of the proposed bridge. A shallow foundation consisting of spread footings may not be suitable due to encountered subsurface conditions and potential scour concerns. Due to the granular nature of soil conditions and high groundwater table, we do not recommend considering drilled shafts. We recommend driven piles to support the integral abutments. Geotechnical parameters for the design of the deep foundations are presented in the following sections.

Standard integral abutment horizontal cantilever wingwalls are proposed in the median between the NB and SB bridge abutments. The wingwalls should be designed for lateral earth pressure. If the wingwalls do not meet the requirements for horizontal cantilever wingwalls, they should be designed as T-type walls founded at 4 feet below the final grade. We estimate the foundation soil has a maximum factored bearing resistance of 2,500 psf for a resistance factor of 0.45 (AASHTO 2016).

5.4.1 Driven Piles

IDOT specifies the maximum nominal required bearing (R_{NMAX}) for each pile and states the factored resistance available (R_F) for a steel H-pile and metal shell pile (MSP) should be based on a geotechnical resistance factor (Φ_G) of 0.55 (IDOT 2012). Nominal tip and side resistance were estimated using the methods and empirical equations presented in *AGMU Memorandum 10.2 – Geotechnical Pile Design* (IDOT, 2011). Wang performed evaluations for a range of H-pile and MSP sizes and nominal and factored loads. The R_F, R_N, estimated pile tip elevations, and pile lengths for MSP 12-inch and 14-inch diameters, HP12x53, HP12x63, HP 14x73, and HP14x89, are presented in Tables 5 through 12. The lengths shown in the tables include 2 feet pile embedment into the abutments.

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 2012). We estimate the residual settlement at the completion of approach embankment construction will be less than 0.4-inch at abutments and there will be a riprap protection for the abutment piles. Therefore, we do not anticipate downdrag and scour loads reduction for the piles.

Table 5: Estimated Pile Lengths and Tip Elevations for 12-inch Diameter MSP with w/ 0.179” Walls

Structure Unit	Pile Cap Base Elevations (feet)	Nominal Required Bearing, R_N (kips)	Factored Geotechnical Loss, ($DD+S_c+L_{iq}$) (kips)	Factored Geotechnical Loss Load, (DD only) (kips)	Factored Resistance Available, R_F (kips)	Total Estimated Pile Length (feet)	Estimated Pile Tip Elevation (feet)
South Abutment (SB-04)	860.27	145	0	0	80	23	839.3
		218	0	0	120	28	834.3
		256	0	0	141	44	818.3
North Abutment (SB-03)	860.81	145	0	0	80	34	828.8
		218	0	0	120	48	814.8
		256	0	0	141	51	811.8

Table 6: Estimated Pile Lengths and Tip Elevations for 12-inch Diameter MSP with w/ 0.25” Walls

Structure Unit	Pile Cap Base Elevations (feet)	Nominal Required Bearing, R_N (kips)	Factored Geotechnical Loss, $(DD+S_c+L_{iq})$ (kips)	Factored Geotechnical Loss Load, (DD only) (kips)	Factored Resistance Available, R_F (kips)	Total Estimated Pile Length (feet)	Estimated Pile Tip Elevation (feet)
South Abutment (SB-04)	860.27	145	0	0	80	23	839.3
		218	0	0	120	28	834.3
		291	0	0	160	43	819.3
		355	0	0	195	51	811.3
North Abutment (SB-03)	860.81	145	0	0	80	34	828.8
		218	0	0	120	48	814.8
		291	0	0	160	53	809.8
		355	0	0	195	68	794.8

Table 7: Estimated Pile Lengths and Tip Elevations for MSP 14- inch Diameter MSP w/ 0.25” walls

Structure Unit	Pile Cap Base Elevations (feet)	Nominal Required Bearing, R_N (kips)	Factored Geotechnical Loss, $(DD+S_c+L_{iq})$ (kips)	Factored Geotechnical Loss Load, (DD only) (kips)	Factored Resistance Available, R_F (kips)	Total Estimated Pile Length (feet)	Estimated Pile Tip Elevation (feet)
South Abutment (SB-04)	860.27	145	0	0	80	23	839.3
		218	0	0	120	26	836.3
		291	0	0	160	41	821.3
		364	0	0	200	44	818.3
		416	0	0	229	49	813.3
North Abutment (SB-03)	860.81	145	0	0	80	32	830.8
		218	0	0	120	38	824.8
		291	0	0	160	48	814.8
		364	0	0	200	54	808.8
		416	0	0	229	68	794.8

Table 8: Estimated Pile Lengths and Tip Elevations for MSP 14- inch Diameter MSP w/ 0.312" walls

Structure Unit	Pile Cap Base Elevations (feet)	Nominal Required Bearing, R_N (kips)	Factored Geotechnical Loss, ($DD+S_c+L_{iq}$) (kips)	Factored Geotechnical Loss Load, (DD only) (kips)	Factored Resistance Available, R_F (kips)	Total Estimated Pile Length (feet)	Estimated Pile Tip Elevation (feet)
South Abutment (SB-04)	860.27	145	0	0	80	23	839.3
		218	0	0	120	26	836.3
		291	0	0	160	41	821.3
		364	0	0	200	44	818.3
		436	0	0	240	58	804.3
		516	0	0	284	69	793.3
North Abutment (SB-03)	860.81	145	0	0	80	32	830.8
		218	0	0	120	38	824.8
		291	0	0	160	48	814.8
		364	0	0	200	54	808.8
		436	0	0	240	68	794.8
		516	0	0	284	68	794.8

Table 9: Estimated Pile Lengths and Tip Elevations for HP12x53 Steel H-Piles

Structure Unit	Pile Cap Base Elevations (feet)	Nominal Required Bearing, R_N (kips)	Factored Geotechnical Loss, ($DD+S_c+L_{iq}$) (kips)	Factored Geotechnical Loss Load, (DD only) (kips)	Factored Resistance Available, R_F (kips)	Total Estimated Pile Length (feet)	Estimated Pile Tip Elevation (feet)
South Abutment (SB-04)	860.27	145	0	0	80	47	815.3
		218	0	0	120	73	789.3
		249 (*)	0	0	137	93	769.3
North Abutment (SB-03)	860.81	145	0	0	80	48	814.8
		218	0	0	120	88	774.8
		291	0	0	160	93	769.8
		360 (*)	0	0	198	96	766.8

(*) Maximum nominal required bearing at boring termination depth.

Table 10: Estimated Pile Lengths and Tip Elevations for HP12x63 Steel H-Piles

Structure Unit	Pile Cap Base Elevations (feet)	Nominal Required Bearing, R_N (kips)	Factored Geotechnical Loss, ($DD+S_c+L_{iq}$) (kips)	Factored Geotechnical Loss Load, (DD only) (kips)	Factored Resistance Available, R_F (kips)	Total Estimated Pile Length (feet)	Estimated Pile Tip Elevation (feet)
South Abutment (SB-04)	860.27	145	0	0	80	44	818.3
		218	0	0	120	73	789.3
		251 (*)	0	0	138	93	769.3
North Abutment (SB-03)	860.81	145	0	0	80	48	814.8
		218	0	0	120	88	774.8
		291	0	0	160	93	769.8
		368 (*)	0	0	202	96	766.8

(*) Maximum nominal required bearing at boring termination depth.

Table 11: Estimated Pile Lengths and Tip Elevations for HP14x73 Steel H-Piles

Structure Unit	Pile Cap Base Elevations (feet)	Nominal Required Bearing, R_N (kips)	Factored Geotechnical Loss, ($DD+S_c+L_{iq}$) (kips)	Factored Geotechnical Loss Load, (DD only) (kips)	Factored Resistance Available, R_F (kips)	Total Estimated Pile Length (feet)	Estimated Pile Tip Elevation (feet)
South Abutment (SB-04)	860.27	145	0	0	80	40	822.3
		218	0	0	120	69	793.3
		304 (*)	0	0	167	93	769.3
North Abutment (SB-03)	860.81	145	0	0	80	38	824.8
		218	0	0	120	61	801.8
		291	0	0	160	88	774.8
		364	0	0	200	93	769.8
		435 (*)	0	0	239	96	766.8

(*) Maximum nominal required bearing at boring termination depth.

Table 12: Estimated Pile Lengths and Tip Elevations for HP14x89 Steel H-Piles

Structure Unit	Pile Cap Base Elevations (feet)	Nominal Required Bearing, R_N (kips)	Factored Geotechnical Loss, ($DD+S_c+L_{iq}$) (kips)	Factored Geotechnical Loss Load, (DD only) (kips)	Factored Resistance Available, R_F (kips)	Total Estimated Pile Length (feet)	Estimated Pile Tip Elevation (feet)
South Abutment (SB-04)	860.27	145	0	0	80	40	822.3
		218	0	0	120	69	793.3
		308 (*)	0	0	169	93	769.3
North Abutment (SB-03)	860.81	145	0	0	80	38	824.8
		218	0	0	120	61	801.8
		291	0	0	160	88	774.8
		364	0	0	200	93	769.8
		443 (*)	0	0	244	96	766.8

(*) Maximum nominal required bearing at boring termination depth.

5.4.2 Lateral Loading

Lateral loads on all piles should be analyzed for maximum moments and lateral deflections. The geotechnical resistance factor of 1.0 should be used. Batter piles can be considered to resist the lateral loads. Recommended lateral soil modulus parameters and soil strain parameters required for analysis via the p-y curve method are included in Tables 13 and 14.

Table 13: Recommended Soil Parameters for Lateral Load Pile Analysis at South Abutment (SB-04)

Layer Elevation/ Soil Description	Unit Weight, γ_e (lbs/ft^3)	Undrained Shear Strength, c_u (lbs/ft^2)	Friction angle, ϕ (°)	Soil Lateral Modulus Parameter, k (lb/in^3)**	Soil Strain Parameter, ε_{50}
860.27* to 854.3 IDOT Fill	125	1,000	0	500	0.007
854.3 to 853.3 Silty Clay Loam	125	3,000	0	1000	0.005
853.3*** to 851.8 Gravelly Sand	68	0	36	125	--

Layer Elevation/ Soil Description	Unit Weight, γ_e (lbs/ft^3)	Undrained Shear Strength, c_u (lbs/ft^2)	Friction angle, ϕ (°)	Soil Lateral Modulus Parameter, k (lb/in^3)**	Soil Strain Parameter, ε_{50}
851.8 to 849.3 Clay Loam	53	500	0	100	0.010
849.3 to 845.8 Sand / Loam	53	0	28	20	--
845.8 to 844.3 Gravelly Sand	58	0	33	60	--
844.3 to 839.3 Clay Loam to Loam	58	2,000	0	1000	0.005
839.3 to 828.0 Gravelly Sand	63	0	33	60	--
828.0 to 823.0 Sand	63	0	35	60	--
823.0 to 818.0 Clay Loam to Loam	58	1,800	0	500	0.007
818.0 to 806.0 Gravelly Sand	63	0	33	60	--
806.0 to 793.0 Coarse Sand	58	0	31	60	--
793.0 to 783.0 Fine Sand	63	0	35	125	--
783.0 to 769.8 Gravelly Sand	68	0	36	125	--

*Pile Cap Base Elevation.
** Submerged condition for granular soil.
*** Groundwater at elevation 853.3 feet.

Table 14: Recommended Soil Parameters for Lateral Load Pile Analysis at North Abutment (SB-03)

Soil Description	Unit Weight, γ_e (lbs/ft^3)	Undrained Shear Strength, c_u (lbs/ft^2)	Friction angle, ϕ (°)	Soil Lateral Modulus Parameter, k (lb/in^3)**	Soil Strain Parameter, ε_{50}
860.81* to 853.5 IDOT Fill	125	1,000	0	500	0.007
853.5*** to 851.0 Fine Sand	53	0	28	20	--
851.0 to 848.5 Silty Clay	53	1,000	0	500	0.007
848.5 to 844.5 Clay Loam to Loam	58	1,700	0	500	0.007
844.5 to 843.5 Gravelly Sand	58	0	30	60	--
843.5 to 836.0 Loam to Clay Loam	53	0	28	60	--
836.0 to 831.0 Gravelly Sand	58	0	32	60	--
831.0 to 824.8 Clay Loam	63	2,500	0	1000	0.005
824.8 to 819.8 Medium Sand	58	0	32	60	--
819.8 to 814.8 Clay Loam	63	3,100	0	1000	0.005
814.8 to 799.8 Gravelly Sand	58	0	32	60	--
799.8 to 779.8 Fine to Medium Sand	63	0	35	60	--
779.8 to 774.8 Coarse Sand	58	0	31	60	---
774.8 to 766.5 Gravelly Sand	68	0	36	125	--

*Pile Cap Base Elevation.
** Submerged condition for granular soil.
*** Groundwater at elevation 853.5 feet.

5.5 Stage Construction Consideration

Since the proposed IL 47 NB Bridge is a new structure, we do not anticipate stage construction will be required for the construction of the bridge. However, if stage construction is required along the median, assuming an exposed height of about 16 feet, our evaluations indicate temporary steel sheet piling is feasible. The sheet piling should be designed based on Design Guide 3.13.1 (IDOT 2012).

6.0 CONSTRUCTION CONSIDERATIONS

6.1 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.

During the subsurface investigation, groundwater was first encountered at elevations ranging from 853.4 to 853.5 feet. At the abutments, groundwater will be encountered about 7 feet below the pile cap base elevations of 860.27 and 860.81 feet and we do not anticipate the need for special dewatering. Depending upon prevailing climate conditions and the time of the year when bridge construction takes place, control of runoff and maintenance of existing flows may require temporary water diversion and control. Water that does accumulate into the open excavations by seepage or runoff should be immediately removed by the sump/pump method.

As mentioned in Section 2.0, a ditch is running just east of the existing approach embankments. During our field visit in January 2016, there was water standing in this ditch. Therefore, construction of the structure may require water diversion and removal of the soften soil of the existing ditch.

6.2 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.

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 Knight E/A, Inc. on this project. Please call if there are any questions, or if we can be of further service.

Respectfully Submitted,

WANG ENGINEERING, INC.

Andri Kurnia, P.E.
Senior Geotechnical Engineer

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

Nesam S. Balakumaran, P. Eng.
Project Geotechnical Engineer

REFERENCES

AASHTO (2016) *LRFD Bridge Design Specifications*. American Association of State Highway and Transportation Officials, Washington, D.C.

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.

CURRY, B.B., AND J.F. THOMASON, 2012, Surficial Geology of Huntley Quadrangle, McHenry and Kane Counties, Illinois: Illinois State Geological Survey, USGS-STATEMAP contract report, 2 sheets, 1:24,000

CURRY, B.B., 2005a, Surficial Geology of Crystal Lake Quadrangle, McHenry and Kane counties, Illinois: Illinois Geological Survey, Illinois Geologic Quadrangle Map, IGQ Crystal Lake-SG, 1:24,000.

CURRY, B.B., 2005b, Drift Thickness of Crystal Lake Quadrangle, McHenry and Kane counties, Illinois: Illinois Geological Survey, Illinois Geologic Quadrangle Map, IGQ Crystal Lake-DT, 1:24,000.

CURRY, B.B., 2005c, Bedrock Topography of Crystal Lake Quadrangle, McHenry and Kane counties, Illinois: Illinois Geological Survey, Illinois Geologic Quadrangle Map, IGQ Crystal Lake-BT, 1:24,000.

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.

IDOT (2009) *All Geotechnical Manual Users Memorandum 09.1* - Seismic Site Class Definition. Illinois Department of Transportation.

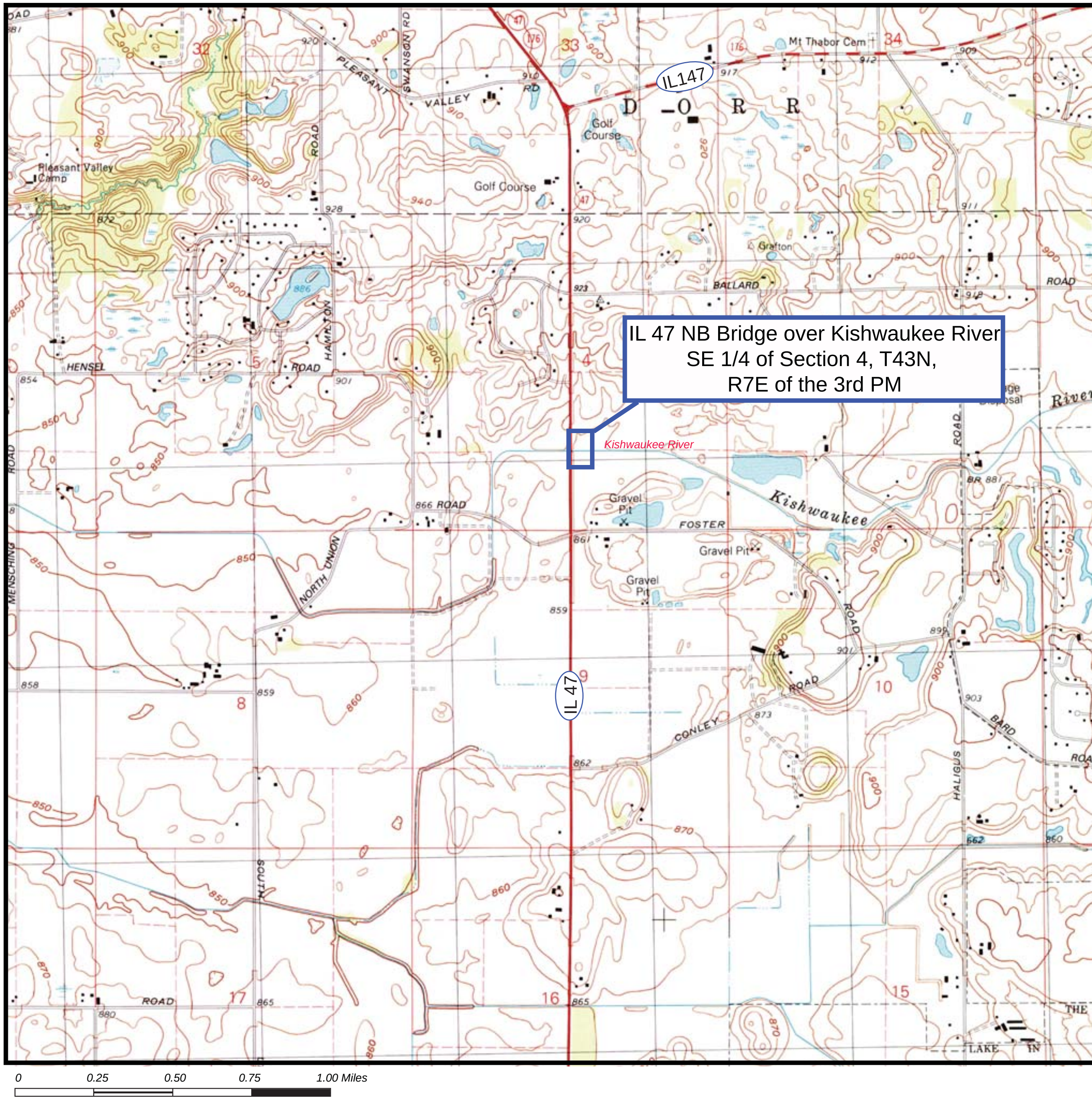
IDOT (2011) *All Geotechnical Manual Users Memorandum 10.2* - Static Method of Estimating Pile Length. Illinois Department of Transportation.

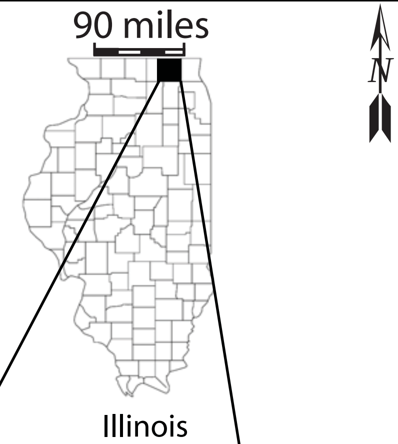
IDOT (2012) *Bridge Manual*. Illinois Department of Transportation.

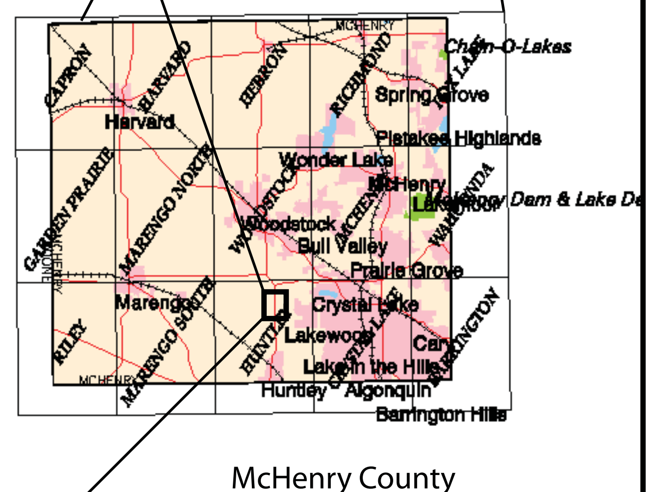
IDOT (2016) *Standard Specifications for Road and Bridge Construction*. Illinois Department of Transportation, 1098 pp.

LEIGHTON, M.M., EKBLAW, G.E., and HORBERG, L., 1948, Physiographic Divisions of Illinois: The Journal of Geology, v. 56, p. 16-33.

EXHIBITS







SITE LOCATION MAP: IL 47 NB BRIDGE OVER KISHWAUKEE RIVER
SN 056-0316, MCHENRY COUNTY, ILLINOIS

SCALE: As Shown	EXHIBIT 1	DRAWN BY: HKB CHECKED BY: NSB

Wang Engineering

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Lombard, IL 60148
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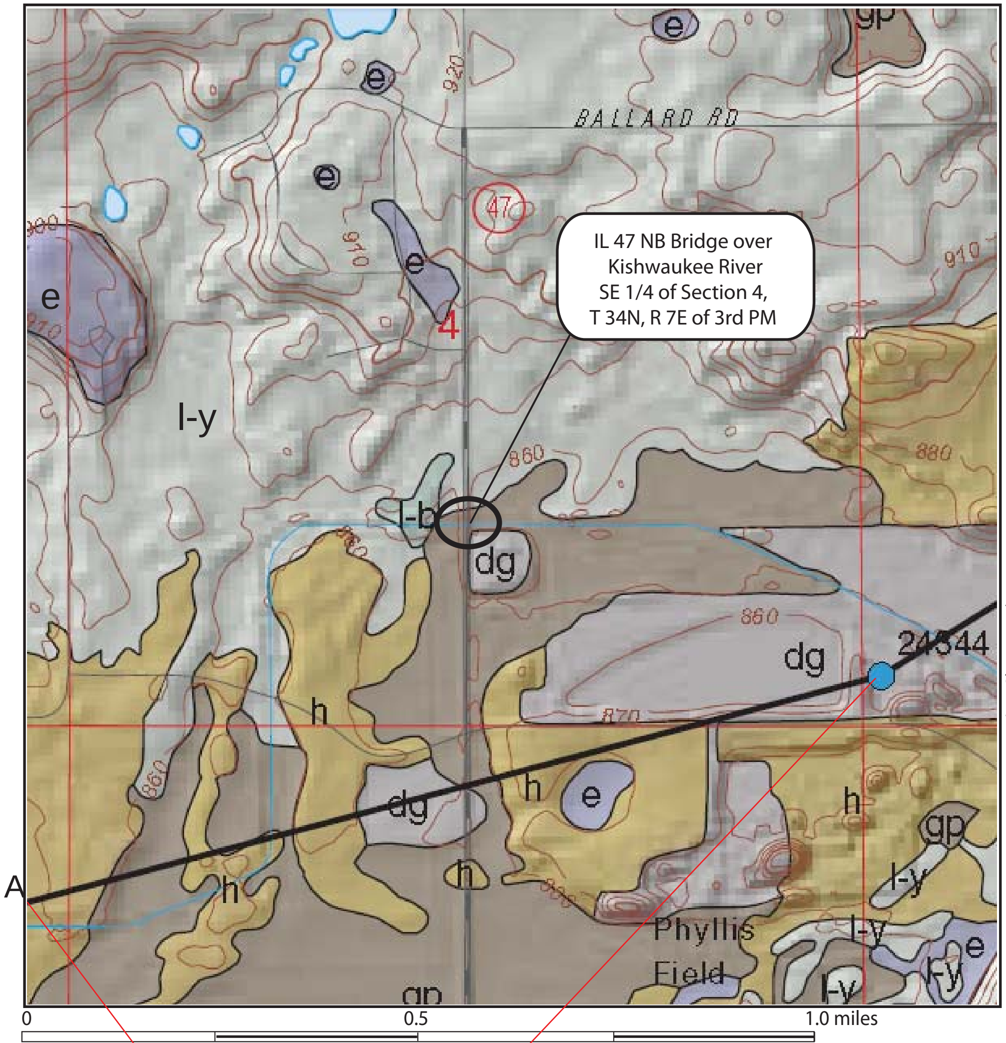
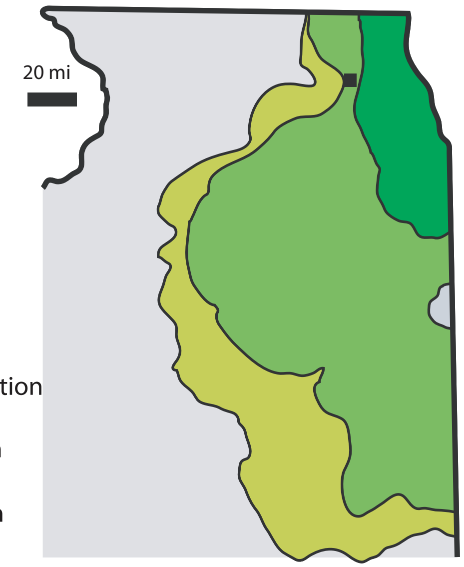


Modified after Curry and Thomason (2012)

REGIONAL GEOLOGY



Wedron Group

- Wadsworth Formation
- Lemont Formation
- Tiskilwa Formation

Modified after Hansel and Johnson (1996)

LEGEND

HUDSON EPISODE

gp	**Grayslake Peat** Decomposed wetland vegetation and sediment; peat and muck, interbedded sand, silty clay, and marl

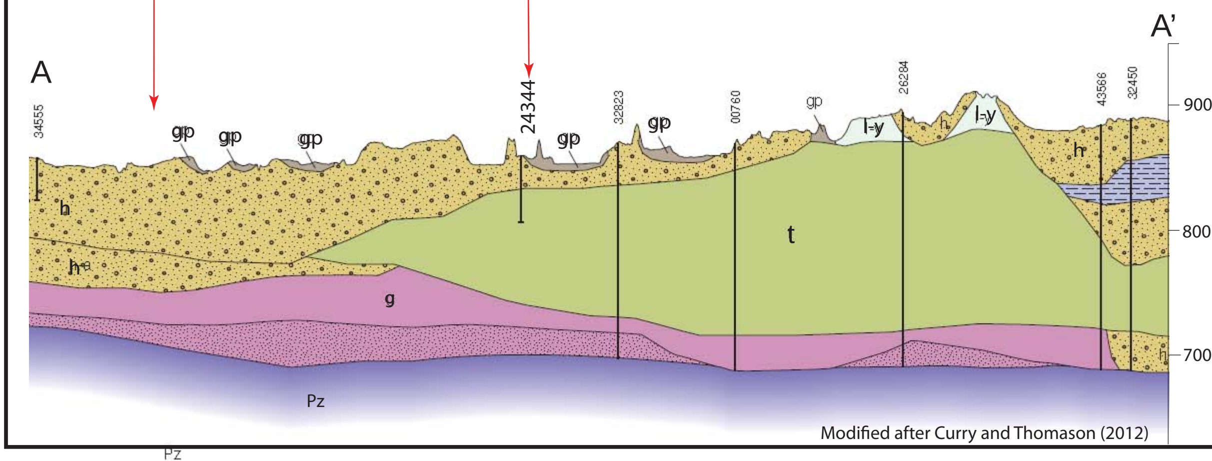
WISCONSIN EPISODE

e	**Equality Formation** Lake deposits in kettles and valleys; silt, clay, and fine sand; layered to massive
h	**Henry Formation** Proglacial outwash plains downslope of glacial margins; sand and gravel, or sand; with lenses of silt and clay, or diamicton
l-y	**Lemont Fornation, Yorkville Member** Debris flow deposits and diamicton; silty clay, silty clay loam, and clay, includes layers of sand and gravel
l-b	**Lemont Formation, Batestown Member (Cross section only)** Debris flow deposits and diamicton; sandy loam to loam with abundant cobbles; includes layers of sand and gravel or silt and sorted sediment
t	**Tiskilwa Formation (Cross section only)** Debris flow deposits and diamicton; clay loam to loam with lenses of sand and gravel

PALEOZOIC BEDROCK

Bedrock (Cross section only)
Dolomite, shaly dolomite, and shale

Modified after Curry and Thomason (2012)



Modified after Curry and Thomason (2012)

SITE AND REGIONAL GEOLOGY: IL 47 NB BRIDGE OVER KISHWAUKEE RIVER, SN 056-0316, MCHENRY COUNTY, ILLINOIS

SCALE: GRAPHICAL	EXHIBIT 2	DRAWN BY: C. Marin CHECKED BY: L. Iordache

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168-05-01

BORING LOCATION PLAN: IL 47 NB BRIDGE OVER KISHWAUKEE RIVER, SN 056-0316, MCHENRY COUNTY, ILLINOIS

SCALE: As Shown	EXHIBIT 3	DRAWN BY: H.KB CHECKED BY: NSB

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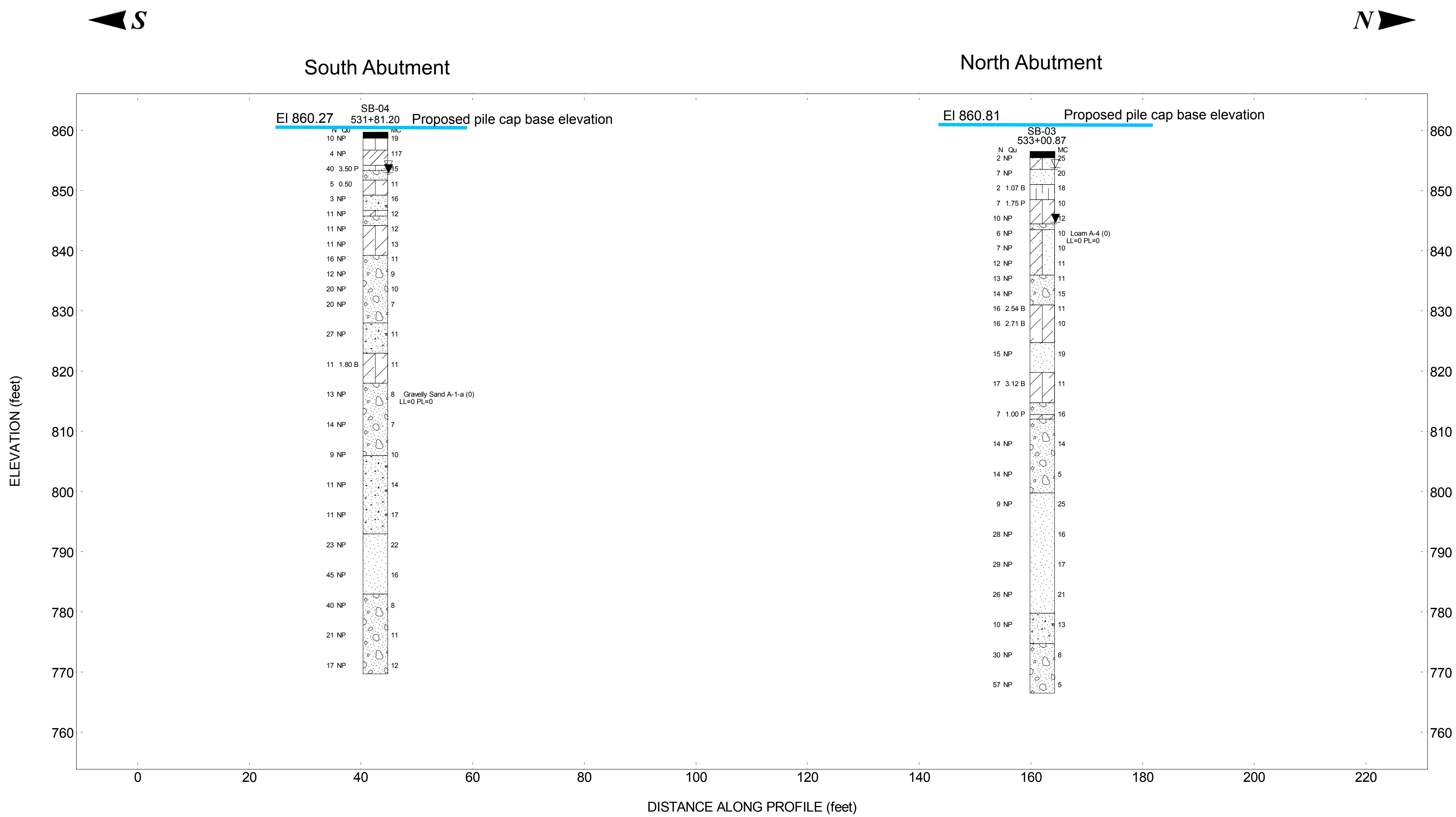
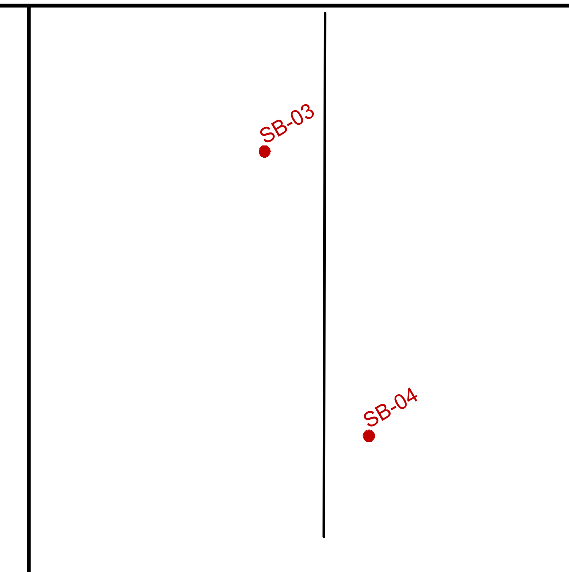
FOR KNIGHT ENGINEERS & ARCHITECTS, INC. 168-05-01



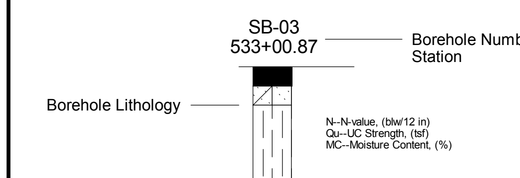
Lithology Graphics

- Topsoil
- IDH Loam
- IDH Sand, Sandy Loam
- IDH Silty Clay, Silty Clay Loam
- IDH Clay Loam
- Gravelly sand, sandy gravel
- Coarse sand
- IDH Silt, Silty Loam
- USCS High Plasticity Organic silt or clay



Site Map Scale 1 inch equals 80 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: 1x

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Soil Profile
IL 47 NB Bridge, SN 056-0316

WEI SINCE 1982

IL 47 from Reed Road to IL 176
McHenry County, Illinois

JOB NUMBER	PLATE NUMBER
168-05-01	EXHIBIT 4

APPENDIX A

BORING LOG SB-03

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WEI Job No.: 168-05-01

Client: **Knight Engineers & Architects, Inc.**
Project: **IL 47 from Reed Road to IL 176**
Location: **McHenry County, Illinois**

Datum: NADV 88
Elevation: 856.52 ft
North: 2026417.94 ft
East: 960151.78 ft
Station: 533+00.87
Offset: 26.70 RT

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
	--frozen swamp--					
855.5	12-inch thick, black SILT --TOPSOIL--					
	Very loose, dark brown LOAM; wet		1	0 0 2	NP	25
853.5	Loose, brown, fine SAND; saturated	5	2	3 3 4	NP	20
851.0	Stiff, gray SILTY CLAY, trace gravel		3	2 1 1	1.07 B	18
848.5	Stiff, pinkish brown CLAY LOAM to LOAM, little gravel	10	4	4 4 3	1.75 P	10
			5	2 5 5	NP	12
844.5	Medium dense, gray GRAVELLY SAND; saturated					
843.5	Loose to medium dense, pinkish gray LOAM to CLAY LOAM, little gravel	15	6	2 2 4	NP	10
	--%Gravel=12.4-- --%Sand=40.9-- --%Silt=37.5-- --%Clay=9.2-- --A-4 (0)--		7	3 2 5	NP	10
		20	8	5 5 7	NP	11
836.0	Medium dense, gray GRAVELLY SAND; saturated		9	8 6 7	NP	11
		25	10	4 6 8	NP	15
831.0	Very stiff, pinkish gray CLAY LOAM, trace to little gravel		11	6 7 9	2.54 B	11
		30	12	3 6 10	2.71 B	10
824.8	Medium dense, gray medium SAND; little gravel; saturated	35	13	7 8 7	NP	19
819.8	Very stiff, pinkish gray CLAY LOAM, little gravel	40	14	6 7 10	3.12 B	11
814.8	Loose, gray GRAVELLY SAND; saturated					
812.8	Stiff, pinkish gray CLAY LOAM, little gravel	45	15	2 3 4	1.00 P	16
812.0	Loose to medium dense, gray GRAVELLY SAND; saturated					
	--heaving sand--	50	16	4 6 8	NP	14

GENERAL NOTES

Begin Drilling **01-15-2016** Complete Drilling **01-15-2016**
Drilling Contractor **Wang Testing Services** Drill Rig **ATV D-50**
Driller **K & R** Logger **D. Kolpacki** Checked by **C. Marin**
Drilling Method **3.25" ID HSA; boring backfilled upon completion**

WATER LEVEL DATA

While Drilling ▽ **3.00 ft**
At Completion of Drilling ▼ **12.00 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.

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BORING LOG SB-03

WEI Job No.: 168-05-01

Client: **Knight Engineers & Architects, Inc.**
Project: **IL 47 from Reed Road to IL 176**
Location: **McHenry County, Illinois**

Datum: NADV 88
Elevation: 856.52 ft
North: 2026417.94 ft
East: 960151.78 ft
Station: 533+00.87
Offset: 26.70 RT

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
	--heaving sand--					
		55	17	3 7 7	NP	5
799.8	Loose to medium dense, gray fine to medium SAND; satutared					
		60	18	3 4 5	NP	25
	--heaving sand--					
		65	19	9 10 18	NP	16
		70	20	12 12 17	NP	17
	--heaving sand--					
	--medium sand--	75	21	5 12 14	NP	21

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
779.8	Medium dense, gray, coarse SAND, little gravel; saturated --heaving sand--					
		80	22	4 5 5	NP	13
774.8	Very dense, gray GRAVELLY SAND; saturated --heaving sand--					
		85	23	12 15 15	NP	8
	--hard drilling, 86 to 88.5 feet-- --possible cobbles--					
	--heaving sand--					
766.5		90	24	10 16 41	NP	5
	Boring terminated at 90.00 ft					
		95				
		100				

GENERAL NOTES

Begin Drilling **01-15-2016** Complete Drilling **01-15-2016**
Drilling Contractor **Wang Testing Services** Drill Rig **ATV D-50**
Driller **K & R** Logger **D. Kolpacki** Checked by **C. Marin**
Drilling Method **3.25" ID HSA; boring backfilled upon completion**

WATER LEVEL DATA

While Drilling **3.00 ft**
At Completion of Drilling **12.00 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.

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BORING LOG SB-04

WEI Job No.: 168-05-01

Client **Knight Engineers & Architects, Inc.**
Project **IL 47 from Reed Road to IL 176**
Location **McHenry County, Illinois**

Datum: NADV 88
Elevation: 859.75 ft
North: 2026298.40 ft
East: 960195.57 ft
Station: 531+81.20
Offset: 70.15 RT

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
	--wooded--					
858.8	12-inch thick, dark brown SILTY LOAM; moist --TOPSOIL--		1	3 5 5	NP	19
856.8	Medim dense, dark brown SILTY LOAM; moist					
854.3	Loose, black organic SILTY LOAM; moist	5	2	2 2 2	NP	117
853.3	Very stiff, brown and gray SILTY CLAY LOAM					
851.8	Dense, brown GRAVELLY SAND; saturated		3	3 14 26	3.50 P	15
849.3	Medium stiff, pinkish brown CLAY LOAM, little gravel	10	4	2 2 3	0.50	11
846.8	Very loose, brownish gray, coarse SAND, little gravel; saturated		5	2 1 2	NP	16
845.8	Pinkish gray LOAM, little gravel; wet					
844.3	Medium dense, gray GRAVELLY SAND; saturated	15	6	4 5 6	NP	12
839.3	Stiff to very stiff, pinkish gray CLAY LOAM to LOAM, little gravel --interbedded coarse sand; saturated--		7	3 5 6	2.00 P	12
		20	8	5 5 6	1.75 P	13
	--heaving sand-- Medium dense, gray GRAVELLY SAND; saturated		9	8 8 8	NP	11
		25	10	5 6 6	NP	9

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
			11	8 9 11	NP	10
		30	12	5 10 10	NP	7
828.0	Medium dense, gray coarse SAND, trace gravel; saturated	35	13	11 13 14	NP	11
823.0	Stiff, pinkish brown CLAY LOAM to LOAM, trace to little gravel	40	14	2 5 6	1.80 B	11
818.0	Medium dense, gray GRAVELLY SAND; saturated --%Gravel=76.1-- --%Sand=20.8-- --%Silt=1.5-- --%Clay=1.5-- --A-1-a (0)--	45	15	3 6 7	NP	8
		50	16	5 7 7	NP	7

GENERAL NOTES

Begin Drilling **01-14-2016** Complete Drilling **01-14-2016**
Drilling Contractor **Wang Testing Services** Drill Rig **ATV D-50**
Driller **K & R** Logger **D. Kolpacki** Checked by **C. Marin**
Drilling Method **3.25" ID HSA; boring backfilled upon completion**

WATER LEVEL DATA

While Drilling **6.40 ft**
At Completion of Drilling **7.00 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.

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BORING LOG SB-04

WEI Job No.: 168-05-01

Client: **Knight Engineers & Architects, Inc.**
Project: **IL 47 from Reed Road to IL 176**
Location: **McHenry County, Illinois**

Datum: NADV 88
Elevation: 859.75 ft
North: 2026298.40 ft
East: 960195.57 ft
Station: 531+81.20
Offset: 70.15 RT

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
806.0	Medium dense, gray coarse SAND, little gravel; saturated					
		55	17	4 3 6	NP	10
		60	18	4 5 6	NP	14
		65	19	11 5 6	NP	17
793.0	Medium dense to dense, gray to pinkish gray, fine SAND, trace gravel; saturated					
	--interbedded silt and clay seams--	70	20	8 9 14	NP	22
		75	21	9 15 30	NP	16
783.0	Medium dense to dense, gray GRAVELLY SAND; saturated					
		80	22	6 17 23	NP	8
		85	23	18 9 12	NP	11
		90	24	9 9 8	NP	12
769.8	Boring terminated at 90.00 ft	90				

GENERAL NOTES

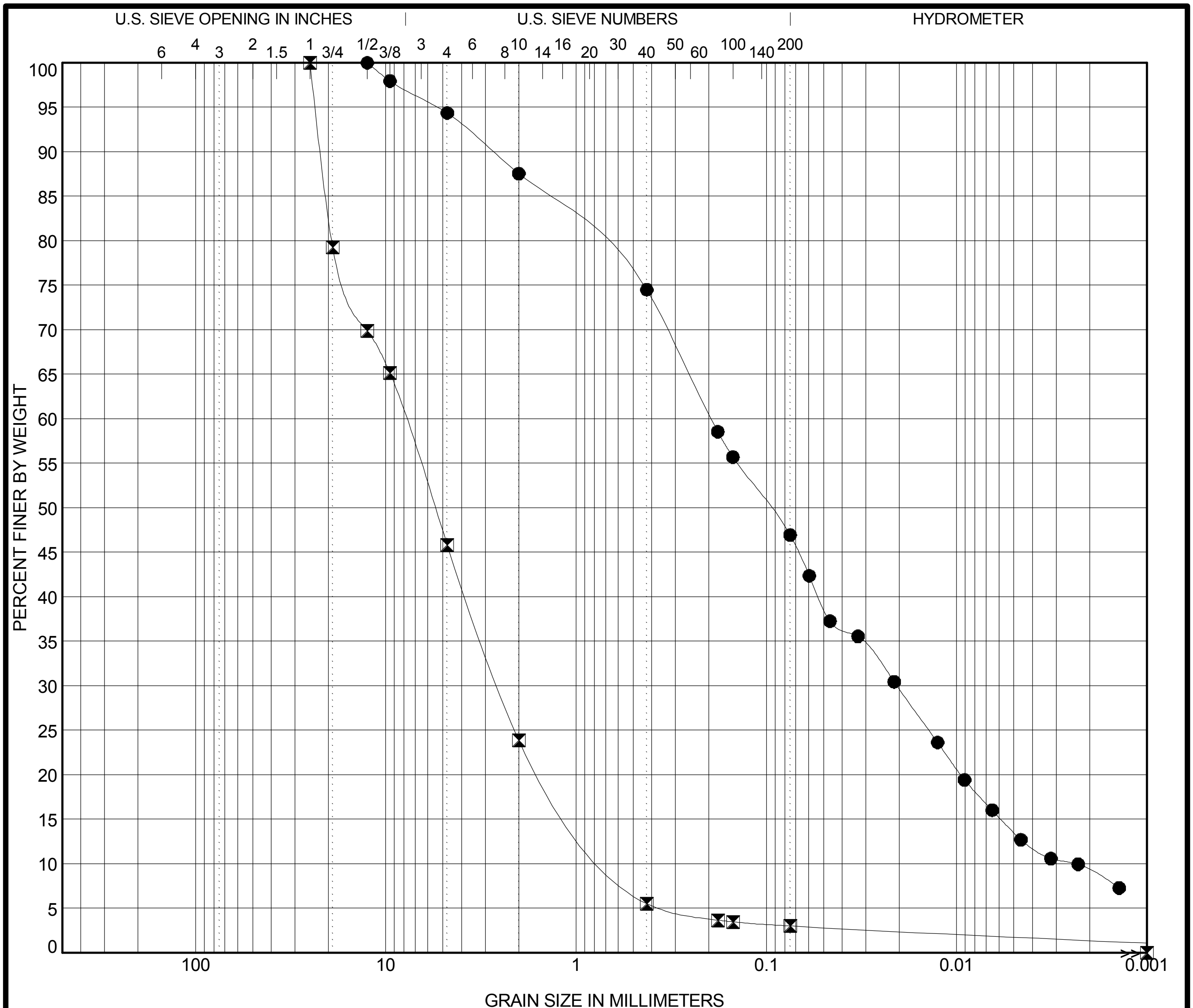
Begin Drilling **01-14-2016** Complete Drilling **01-14-2016**
Drilling Contractor **Wang Testing Services** Drill Rig **ATV D-50**
Driller **K & R** Logger **D. Kolpacki** Checked by **C. Marin**
Drilling Method **3.25" ID HSA; boring backfilled upon completion**

WATER LEVEL DATA

While Drilling ▽ **6.40 ft**
At Completion of Drilling ▼ **7.00 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
●	**SB-03#6**	**13.5 ft**	**Loam**	**NP**	**NP**	**NP**	**0.92**	**82.59**
⧗	**SB-04#15**	**43.5 ft**	**Gravelly Sand**	**NP**	**NP**	**NP**	**1.32**	**12.71**

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**SB-03#6**	**13.5 ft**	**12.5**	**0.195**	**0.021**	**0.002**	**12.4**	**40.9**	**37.5**	**9.2**
⧗	**SB-04#15**	**43.5 ft**	**25**	**7.896**	**2.547**	**0.621**	**76.1**	**20.8**	**1.5 3.0**	**1.5**

WEI SINCE 1982

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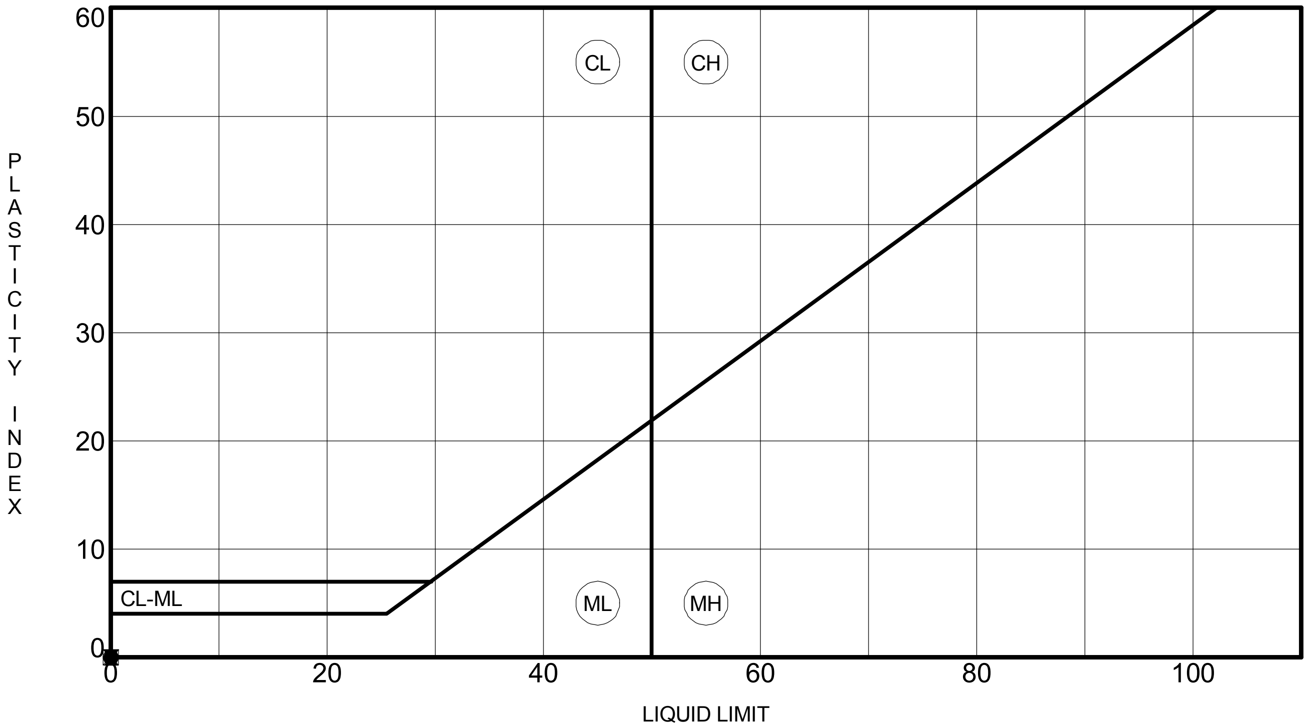
1145 N Main Street
Lombard, IL 60148
Telephone: 630 953-9928
Fax: 630 953-9938

GRAIN SIZE DISTRIBUTION

Project: IL 47 from Reed Road to IL 176

Location: McHenry County, Illinois

Number: 168-05-01



	Specimen Identification		LL	PL	PI	Fines	IDH Classification
●	**SB-03#6**	**13.5 ft**	**NP**	**NP**	**NP**	**47**	**Loam**
⧗	**SB-04#15**	**43.5 ft**	**NP**	**NP**	**NP**	**3**	**Gravelly Sand**

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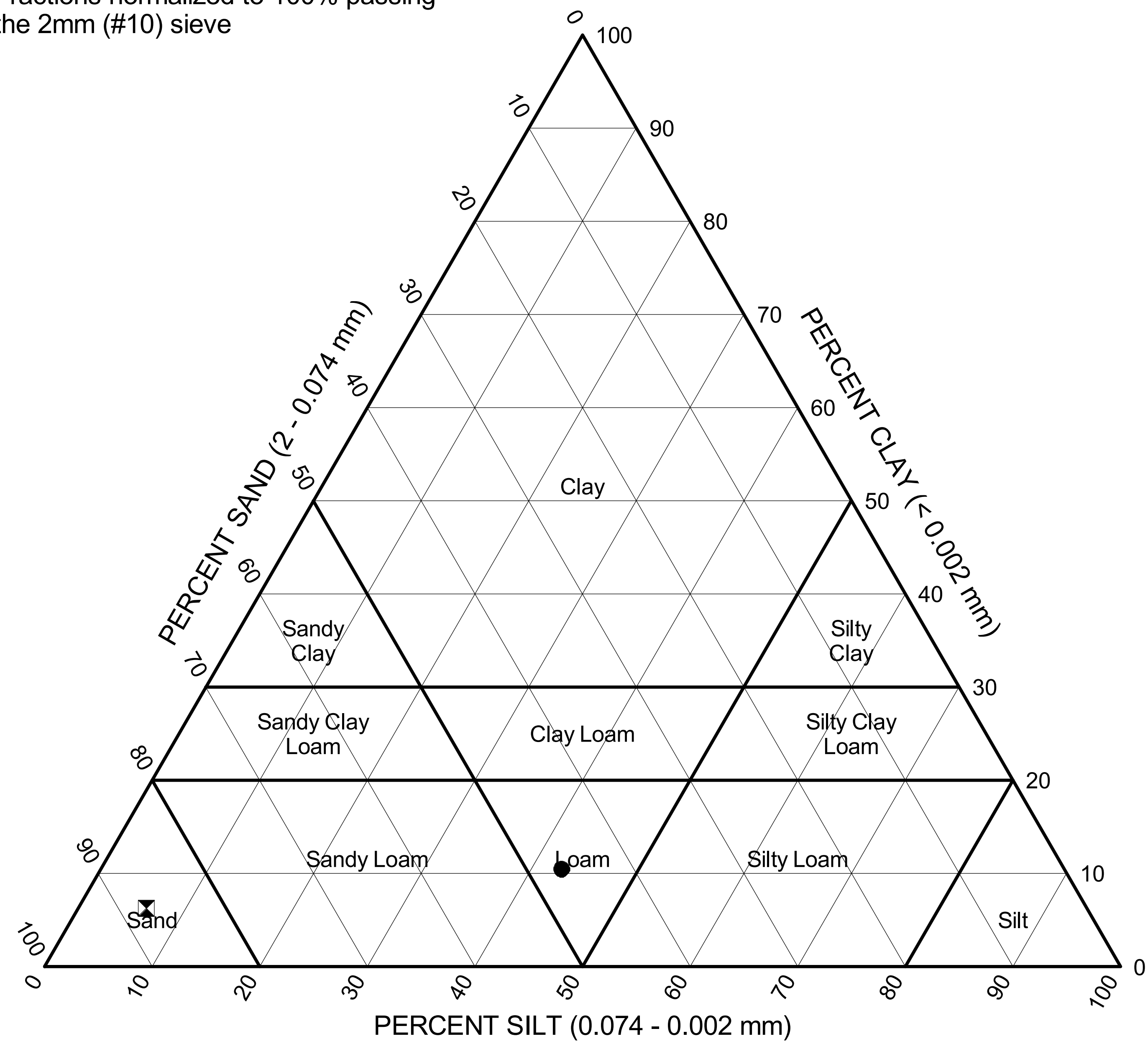
ATTERBERG LIMITS' RESULTS

Project: IL 47 from Reed Road to IL 176

Location: McHenry County, Illinois

Number: 168-05-01

Fractions normalized to 100% passing the 2mm (#10) sieve



	Sample	Depth (ft)	Sand (%)	Silt (%)	Clay (%)	Classification		
						IL DOT	AASHTO	ASTM
●	SB-03#6	13.5	46.7	42.8	10.5	Loam	A-4 (0)	SM
⧗	SB-04#15	43.5	87.0	6.3	6.3	Gravelly Sand	A-1-a (0)	GW

WEI_IDH 1680501.GPJ WANGENG.GDT 5/4/16

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

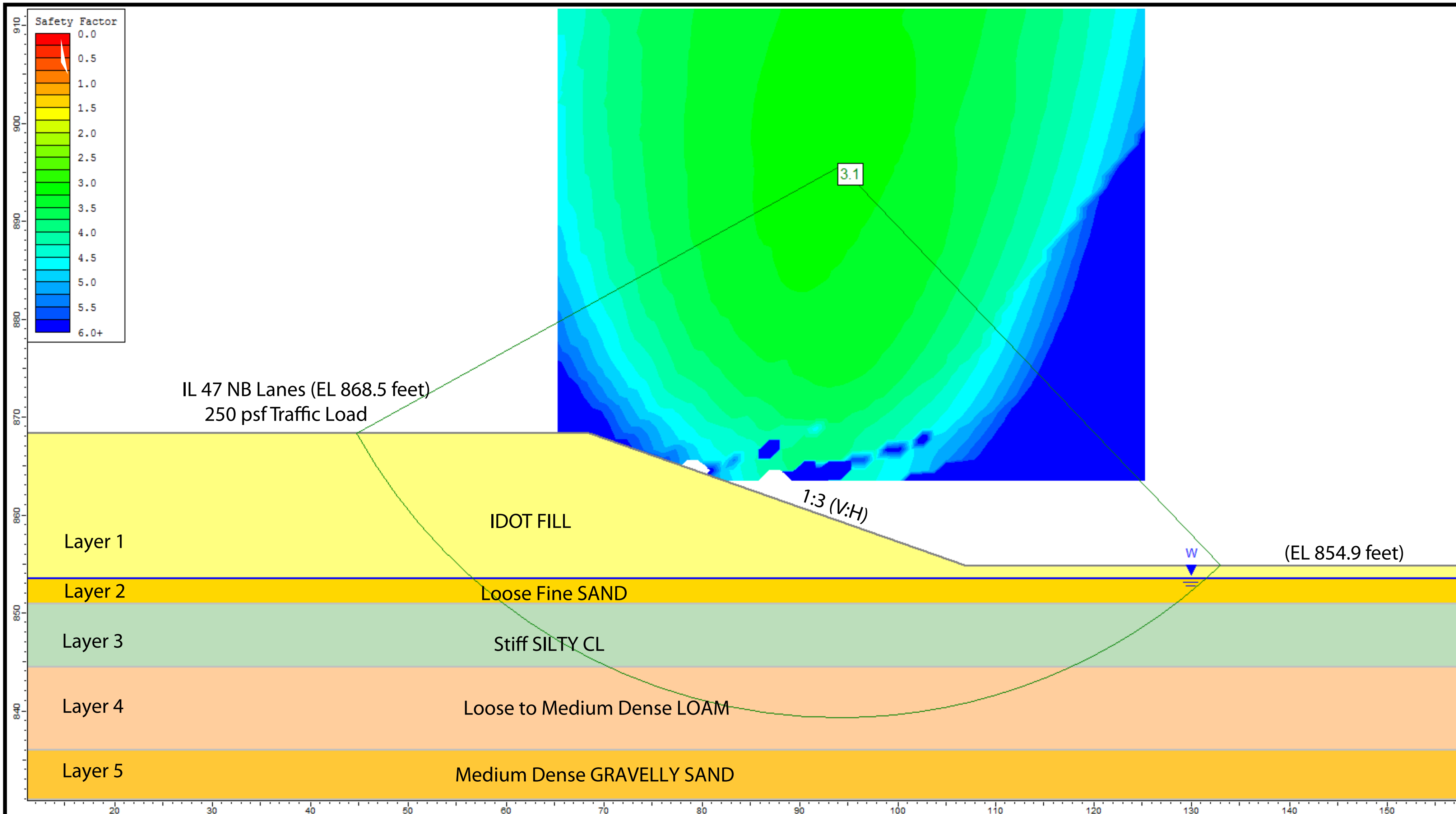
IDH Textural Classification Chart

Project: IL 47 from Reed Road to IL 176

Location: McHenry County, Illinois

Number: 168-05-01

APPENDIX C



Undrained Analysis for Side Slope at Sta. 532+14.59, Ref Boring SB-03

Layer ID	Description	Unit Weight (pcf)	Undrained Cohesion (psf)	Undrained Friction Angle (degrees)
1	IDOT FILL	125	1000	0
2	Loose Fine SAND	110	0	29
3	Stiff SILTY CL	120	1000	0
4	Loose to Medium Dense SAND	115	0	30
5	Medium Dense GRAVELLY SAND	120	0	32

GLOBAL STABILITY ANALYSIS: IL 47 SB BRIDGE OVER KISHWAUKEE RIVER, SN 056-0316, MCHENRY COUNTY, ILLINOIS

SCALE: As Shown | APPENDIX C-1 | DRAWN BY: HKB | CHECKED BY: NSB

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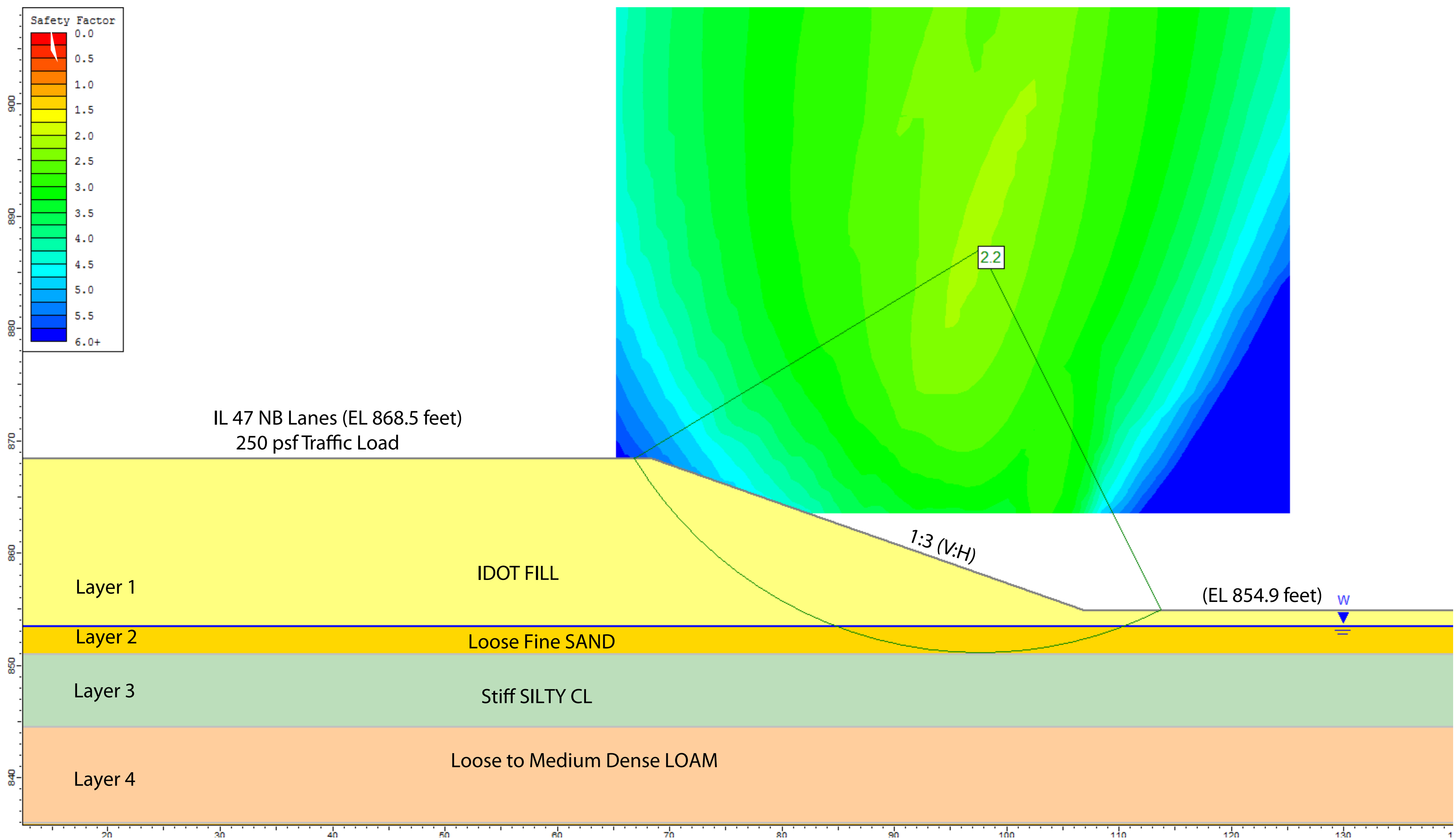

Drained Analysis for Side Slope at Sta. 532+14.59, Ref Boring SB-03

Layer ID	Description	Unit Weight (pcf)	Drained Cohesion (psf)	Drained Friction Angle (degrees)
1	IDOT FILL	125	100	30
2	Loose Fine SAND	110	0	29
3	Stiff SILTY CL	120	100	30
4	Loose to Medium Dense SAND	115	0	30

GLOBAL STABILITY ANALYSIS: IL 47 SB BRIDGE OVER KISHWAUKEE RIVER, SN 056-0316, MCHENRY COUNTY, ILLINOIS

SCALE: As Shown

APPENDIX C-2

DRAWN BY: HKB
CHECKED BY: NSB

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Lombard, IL 60148
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168-05-01

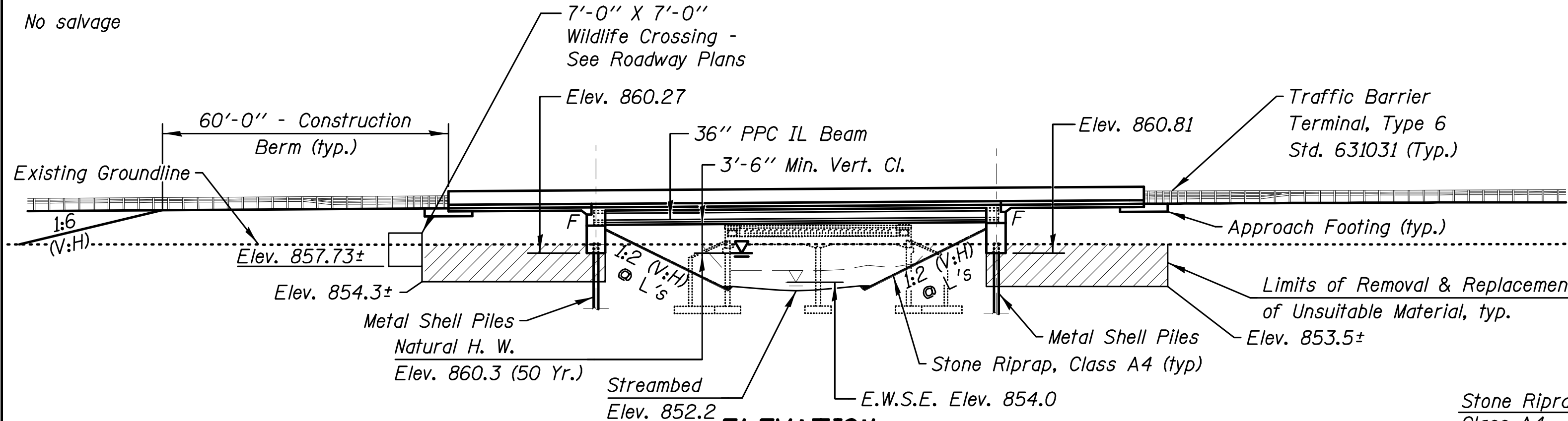
APPENDIX D

Bench Mark: USGS Disk DM014 on top of NE bridge wingwall Sta. 32+35, 4' Lt, Elev. 862.46

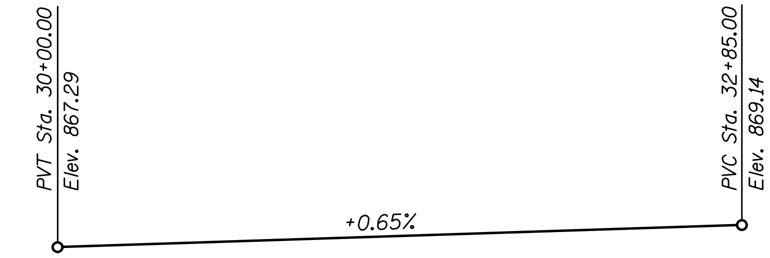
Existing Structure: SN 056-0025 built in 1936 on SBI-47, Section 105X-B is a double span reinforced concrete bridge which carries one northbound and one southbound lane of IL 47 over the Kishwaukee River. The back-to-back of abutments measures 39'-0'' and out-to-out dimension measures 47'-0''. Existing structure is to be removed.

Traffic Control: The new structure will be constructed in Stage 1 on a new alignment. Two-way traffic will be maintained on existing structure during Stages 1, 2 and 3 of construction. See ''Suggested Stages of Construction and Traffic Control'' plans for more information. The existing structure is to be removed in Stage 4.

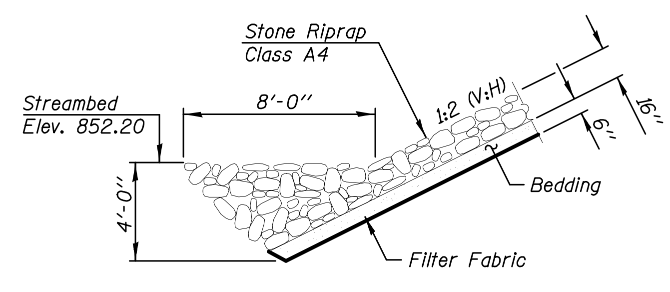
No salvage



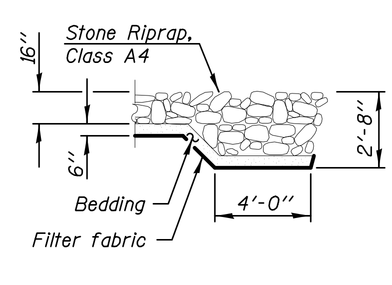
ELEVATION



PROFILE GRADE
(Along PGL of Il. Rte. 47)



SECTION A-A



SECTION B-B

HIGHWAY CLASSIFICATION

F.A.P. Route 326 - IL Rte. 47
Functional Class: Other Principal Arterial (Rural SRA)
ADT: 15,200 (2011); 21,000 (2040)
DHV: 1,340 (2011); 1,770 (2040)
ADTT: 1,325 (2015); 1,533 (2040)
Design Speed: 60 mph
Posted Speed: 55 mph
Directional Distribution: 50:50
Two-Way Traffic

DESIGN SPECIFICATIONS

2017 AASHTO LRFD Bridge Design Specifications, 8th Edition

LOADING HL 93

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

DESIGN STRESSES

FIELD UNITS

f'_c = 3,500 psi
f'_c = 4,000 psi (Superstructure concrete)
f_y = 60,000 psi (Reinforcement)

PRECAST PRESTRESSED UNITS

f'_c = 8,500 psi
f'_{ci} = 7,000 psi
f_{pu} = 270,000 psi (½''ϕ low lax strands)
f_{pbt} = 201,960 psi (½''ϕ low lax strands)

SEISMIC DATA

Seismic Performance Zone (SPZ) = 1
Design Spectral Acceleration at 1.0 sec. (S_{D1}) = 0.08g
Design Spectral Acceleration at 0.2 sec. (S_{DS}) = 0.139g
Soil Site Class = D

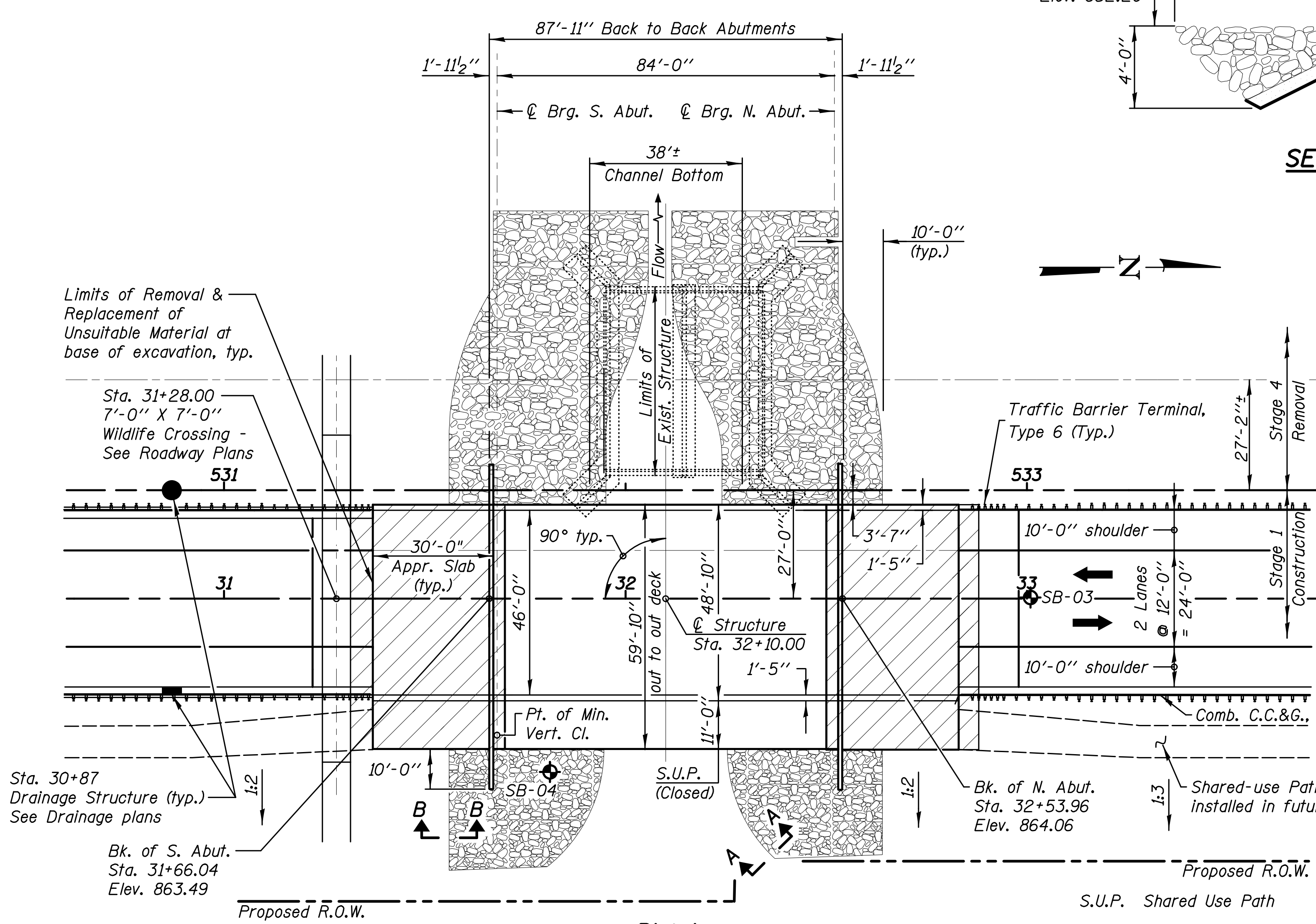
SCOUR ELEVATION TABLE

Design Scour Elevations (ft.)			Item 113
Event/Limit State	SN 056-0316 S. Abut.	N. Abut.	
Q100	860.27	860.81	8
Q200	860.27	860.81	
Design	860.27	860.81	
Check	860.27	860.81	

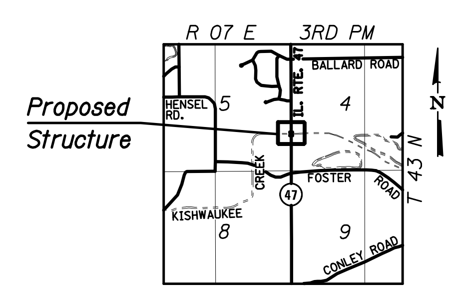
WATERWAY INFORMATION

Drainage Area = 14.47 sq. mi. Low Grade Elev. 865.10 @ Sta. 21+75

Flood	Freq. Yr.	Q (c.f.s.) Exist.	Q (c.f.s.) Prop.	Opening Sq. Ft. Exist.	Opening Sq. Ft. Prop.	Nat. H.W.E.	Head - Ft. Exist.	Head - Ft. Prop.	Headwater El. Exist.	Headwater El. Prop.
-	10	431	431	155	230	858.7	0.6	0.4	859.3	859.1
Design	50	930	930	212	340	860.3	0.7	0.4	860.9	860.7
Base	100	1255	1255	230	379	860.8	0.9	0.6	861.7	861.3
-	200	1400	1400	236	395	861.0	0.8	0.6	861.8	861.6
Max. Calc.	500	1880	1880	247	433	861.5	0.4	0.9	861.9	862.4



PLAN



LOCATION SKETCH

GENERAL PLAN

IL RTE. 47 OVER KISHWAUKEE RIVER
F.A.P. RTE. 326 SEC. (105XB)B-R
MCHENRY COUNTY
STA. 32+10.00
STRUCTURE NO. 056-0316

KNIGHT Engineers & Architects

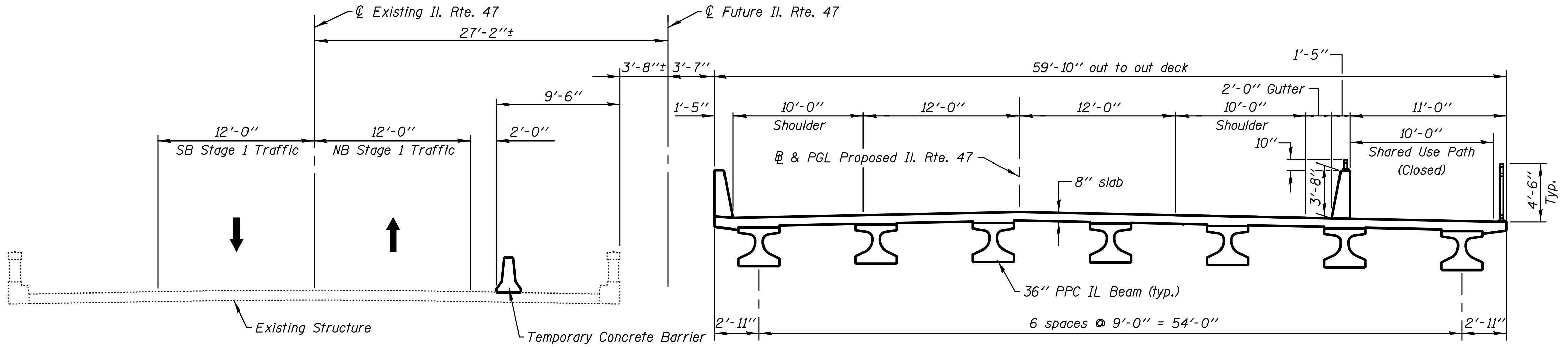
	DESIGNED - JW	REVISED	
	CHECKED - AMD	REVISED	
SCALE - NONE	DRAWN - BK	REVISED	
DATE - 7/11/2018	CHECKED - TB	REVISED	

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

SHEET NO. 1 OF 3 SHEETS

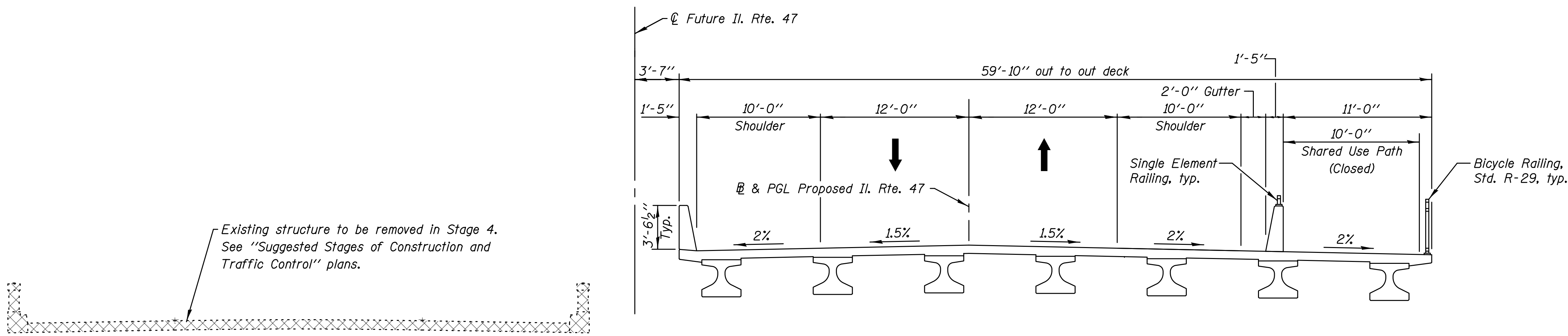
F.A.P. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
326	(105XB)B-R	MCHENRY	3	1

CONTRACT NO. 62A80
ILLINOIS FED. AID PROJECT



STAGE 1 CONSTRUCTION

(Looking North)



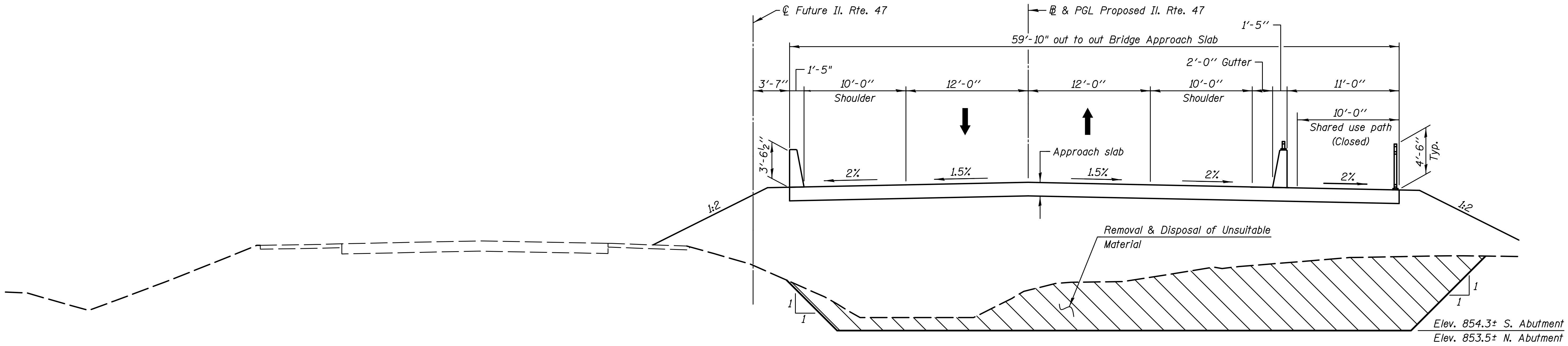
REMOVAL AND PROPOSED CROSS SECTION

(Looking North)

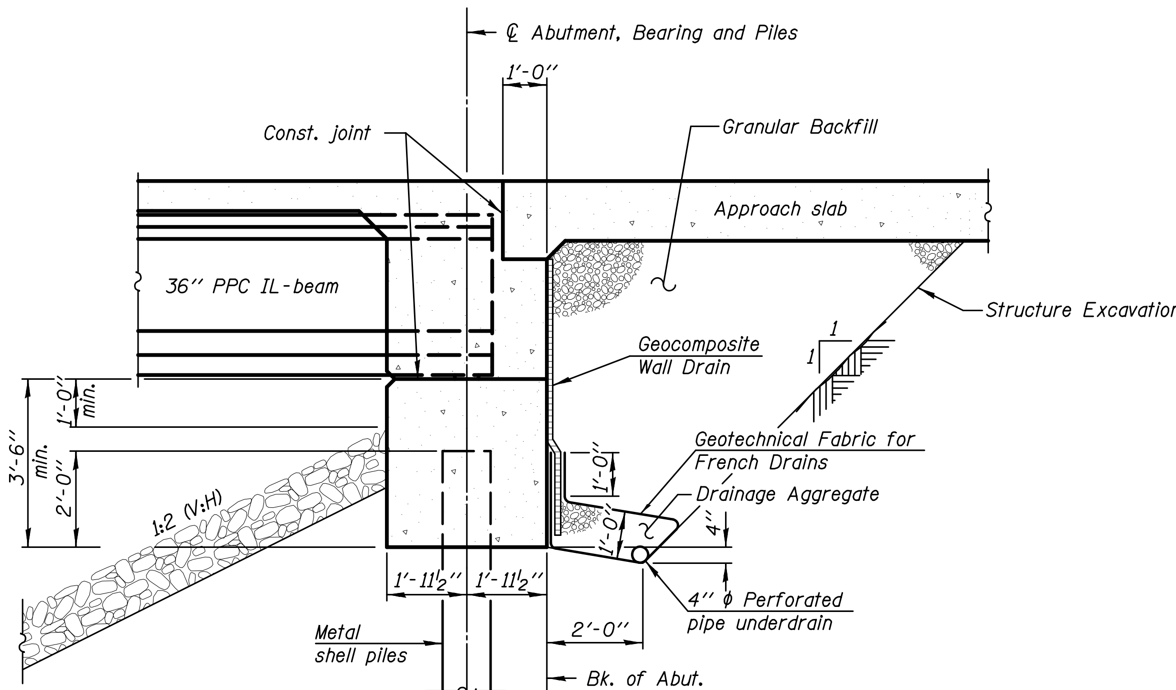
IL RTE. 47 OVER KISHWAUKEE RIVER
F.A.P. RTE. 326 SEC. (105XB)B-R
MCHENRY COUNTY
STA. 32+10.00
STRUCTURE NO. 056-0316

KNIGHT Engineers & Architects		DESIGNED - JW	REVISED	STATE OF ILLINOIS DEPARTMENT OF TRANSPORTATION	
		CHECKED - AMD	REVISED		
	SCALE - NONE	DRAWN - BK	REVISED		
	DATE - 7/11/2018	CHECKED - TB	REVISED		SHEET NO. 2 OF 3 SHEETS

F.A.P. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
326	(105XB)B-R	MCHENRY	3	2
CONTRACT NO. 62A80				
ILLINOIS FED. AID PROJECT				



CROSS SECTION
(Looking North)



SECTION THRU INTEGRAL ABUTMENT

CROSS SECTION
IL RTE. 47 OVER KISHWAUKEE RIVER
F.A.P. RTE. 326 SEC. (105XB)B-R
MCHENRY COUNTY
STA. 32+10.00
STRUCTURE NO. 056-0316

KNIGHT
Engineers & Architects

	DESIGNED - JW	REVISED	
	CHECKED - AMD	REVISED	
SCALE - NONE	DRAWN - BK	REVISED	
DATE - 7/11/2018	CHECKED - TB	REVISED	

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

SHEET NO. 3 OF 3 SHEETS

F.A.P. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
326	(105XB)B-R	MCHENRY	3	3

CONTRACT NO. 62A80

ILLINOIS FED. AID PROJECT