STRUCTURE GEOTECHNICAL REPORT
MAIN STREET BRIDGE OVER BLACKBERRY CREEK
EXISTING SN 045-0049, PROPOSED SN 045-3069
FAS 107, SECTION 107N-4
IDOT JOB NO. D-91-309-12, PTB 171/004
KANE COUNTY, ILLINOIS

For

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11. Abstract

A new single span bridge will replace the existing structure carrying Main Street over Blackberry Creek. The new bridge will be wider and longer than the existing one to accommodate new right turn lane. The proposed closed abutment bridge will have wingwalls at all corners except southwest corner where a retaining wall is proposed along the Main Street. The profile grade elevations along Main Street will be raised by 4.5 feet at the bridge location and the approach embankments will be widened to accommodate the bridge widening. This report provides geotechnical recommendations for the design of proposed bridge foundations and widening of approach embankments.

Beneath the medium stiff clay fill, the soil is made up of loose to medium dense silty loam to sand or stiff silty clay to clay loam followed by alternating layers of medium dense sandy gravel to sand and silty loam and very stiff to hard silty clay to clay loam. The site classifies in the Seismic Class D. The Q100 and Q500 event scour losses ranges from 0.3 to 9.3 feet below the proposed pile cap base elevation.

The abutments could be supported on steel H-piles or metal shell piles. Tables are provided for each pile size with Q100 year scour loss. We also provide geotechnical parameters for pile analysis under lateral loads. We estimate the foundation soil undergo settlement of 1 inch or less under the new embankment loads and will be completed by the end of construction. Global stability analyses show suitable factors of safety for the proposed 1:2.2 (V:H) side slope.

A temporary steel sheet piling according to IDOT Design Guide 3.13.1 is not feasible to accommodate stage construction due to the fill nature of temporary retention. Therefore, a *Temporary Soil Retention System* will be required.

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MILHOUSE ENGINEERING & CONSTRUCTION, INC.

1.0 INTRODUCTION

This report presents the results of our subsurface investigation, laboratory testing, and geotechnical evaluations and recommendations for the proposed replacement of the existing bridge carrying Main Street over Blackberry Creek in Kane County, Illinois. A *Site Location Map* is presented as Exhibit 1.

1.1 Proposed Structure

Wang Engineering, Inc. (Wang) understands Milhouse Engineering & Construction, Inc. (Milhouse) envisions a new single span bridge structure over Blackberry Creek. A final type, size, and location (TSL) plan provided by Milhouse on August 4, 2016 indicates the bridge will have a back-to-back abutment length of 45.2 feet (from Station 198+56.52 to Station 199+01.68). The out-to-out deck width will measure 68.2 feet. The proposed closed abutments will have wingwalls at all corners except southwest corner where a retaining wall is proposed along the Main Street alignment. The proposed bridge will be wider and longer than the existing one to accommodate a new right turn lane. Therefore, north and south widening of embankments will be required. The profile grade elevations along Main Street will be raised approximately 4.5 feet.

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 foundations.

1.2 Existing Structure

Based on a Bridge Condition Report (BCR) dated December 2011 prepared by Teng & Associates, Inc. and the final TSL plan, the existing structure carrying Main Street over Blackberry Creek was constructed in 1925 and reconstructed in 1975. The structure was repaired in 2003. The existing structure is a two-span continuous concrete slab bridge supported on closed abutment and a solid pier. The length of the bridge is 36.0 feet measured back-to-back of abutments and an out-to-out deck width of 40.5 feet. The structure will be removed and replaced using stage construction to maintain traffic on Main Street.

2.0 SITE CONDITIONS AND GEOLOGICAL SETTING

The project area is located in Blackberry Township in southern Kane County. On the USGS *Sugar Grove Quadrangle 7.5 Minute Series* map, the project is located in the SW ¼ of Section 20, Tier 39 N, Range 7 East 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, 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 Kane County in particular. Exhibit 2 illustrates the *Site and Regional Geology*.

2.1 Physiography

Southern Kane County is situated within the Bloomington Ridge Plain Subsection of the Till Plains Physiographic Section of Illinois (Leighton et al. 1948). Continental glaciers and their associated lakes and meltwater streams deposited most of the surficial deposits within the project area. Wisconsin-age deposits of the Elburn Complex form an array of landforms that are typically associated with stagnating ice, including kames, kettles, and eskers (Curry et al. 2001). Blackberry Creek flows from the northeast to the southwest forming a valley through the center of the project area. Surface elevations range from 720 feet at Blackberry Creek and rise to the east and west up to 750 feet.

2.2 Surficial Cover

The surficial cover within the project area is mainly the result of Wisconsin-age glacial activity. The glacigenic deposits were emplaced during pulsating advances and retreats of an ice sheet lobe responsible for the formation of end moraines and associated low-relief till and lake plains (Hansel and Johnson 1996). Along the Blackberry Creek drainageway, organic deposits of peat, muck, and organic silt and clay, known as the Grayslake Peat, have accumulated since the last glaciation.

Underlying the Grayslake Peat, large volumes of glacial meltwater deposited thick sand and gravel outwash deposits of Henry Formation. Major glacial events, during the Wisconsin Episode and the preceding Illinois Episode, created a complex stratigraphy that includes diamictons of the Batestown Member of the Lemont Formation, the Tiskilwa Formation, and the Glasford Formation. The Lemont and Tiskilwa Formations (Wisconsin Episode) are characterized by sandy loam to clay loam diamictons with lenses of sand and gravel. The Glasford Fomation (Illinois Episode) is characterized by a compact sandy and bouldery diamicton with abundant lenses of coarse sand and gravel (Curry et al. 2001). Glacial drift thickness along the project alignments ranges from 100 to 120 feet thick (Curry 2002).

2.3 Bedrock

In the project area, the glacigenic deposits unconformably rest over Silurian and Ordivician dolostone and shaly dolostone between 100 to 120 feet below ground surface (bgs), at elevations of 600 to 625 feet (Curry 2002). The project is located approximately 15 miles northeast of the inactive Sandwich Fault Zone. No underground mines have been mapped in the area (ISGS 2014).

Our subsurface investigation results fit into the local geologic context. The borings drilled in the project area revealed the native sediments consist of organic silt and clay of the Grayslake Peat, sand and gravel outwash deposits of the Henry Formation, sandy loam to clay loam diamicton of the Lemont and Tiskilwa Formations, and sand and gravel of the Glasford Formation. The bedrock was not encountered during this investigation.

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 April and May 2015. The investigation consisted of two structure borings. The borings, designated as BB-01 and BB-02, were drilled from elevations of 724.7 and 728.1 feet to depths of 74.5 and 75.0 feet below ground surface (bgs). Boring coordinates were surveyed by Wang using a mapping-grade GPS unit; stations and offsets were obtained from a plan drawing provided by Milhouse. The as-drilled boring locations are shown in the *Boring Logs* (Appendix A) and in the *Boring Location Plan* (Exhibit 3).

A truck mounted drilling rig, equipped with hollow stem auger and mud rotary drilling equipment, 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). Particle size (AASHTO T 88) analysis was 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

Boring BB-01, drilled through the existing roadway pavement, revealed 8 inches of asphalt over 6 inches of concrete and 4 inches of crushed stone pavement structure. Boring BB-02, drilled at the southeast corner of the bridge, encountered 12 inches of silty loam topsoil. In descending order, the general lithologic succession encountered beneath the surface includes 1) man-made ground (fill); 2) stiff silty clay to clay loam and loose to medium dense silty loam to sandy loam with organic matter; and 3) alternating medium dense to very dense silty loam to sandy gravel and stiff to hard silty clay to clay loam.

1) Man-made ground(fill)

In Boring BB-01, below the pavement structure, the boring revealed 1.7 feet of medium stiff, brown silty clay fill with unconfined compressive strength (Qu) values of 0.5 tsf and moisture content of 27%.

2) Stiff silty clay to clay loam and loose to medium dense silty loam to sandy loam

At elevations of 723.7 and 724.9 feet, the borings advanced through alternating layers of stiff, dark brown silty clay to clay loam and loose to medium dense, dark brown silty loam to sandy loam with organic matter and shells. This layer extends to elevations of 717.6 and 719.2 feet. The cohesive soil has Qu values of 1.0 tsf and moisture content values of 25 and 52%. The granular soils have SPT N-values of 3 to 8 blows/ foot and moisture content values of 33 to 78%. The higher moisture content values are due to the organic matter.

3) Medium dense to very dense silty loam to sandy gravel and stiff to hard silty clay to clay loam

At elevations of 717.6 and 719.2 feet, the borings advanced through alternating layers of medium dense to very dense silty loam to sandy gravel outwash deposits and stiff to hard silty clay to clay loam diamicton. The medium dense to very dense, wet to saturated silty loam to sandy gravel, encountered in deposits as thick as 19 feet extending to the boring termination depths of 74.5 and 75 feet (elevations 650.2 and 653.1 feet), has SPT N-values from 14 to 79 blows/foot with an average of 38 blows/ foot and moisture content values of 4 to 27% with an average of 14%. Hard drilling and heaving sand conditions were encountered during drilling from 43.0 feet bgs (elevation 685.1 feet) to boring termination depths of 74.5 and 75.0 feet bgs (elevations of 653.1 and 650.2 feet).

The stiff to hard, pinkish gray to gray silty clay to clay loam diamicton, encountered in deposits as thick as 16.5 feet, has Qu values of 1.25 to 5.33 tsf with an average of 3.5 tsf and moisture content of 11 to 16% with an average of 12%. Hard drilling conditions were observed during drilling within this diamicton deposits from 18.5 to 21.0 feet bgs (elevations 704.2 to 708.1 feet), and from 50.0 to 53.5 feet bgs (elevations 674.6 to 678.1 feet) indicating possible cobbles.

4.2 Groundwater Conditions

While drilling, the groundwater was first observed at elevations of 719.2 and 722.6 (5.5 feet bgs); a second groundwater bearing layer was then observed at elevations of 670.6 and 664.1 (57.5 and 64.0 feet bgs) in Boring BB-01, and 661.2 feet (63.5feet bgs) in Boring BB-02. This second groundwater layer is confined and the groundwater was observed to be under artesian condition. At the completion of drilling, the water level was recorded at elevations of 718.2 and 724.7 feet (0 to 10.0 feet bgs). Design high water (DHW) elevation of 727.08 feet is shown on the TSL plan which is about 1 to 2 feet below the ground surface elevation at the boring locations.

4.3 Scour Considerations

Information provided by Milhouse indicates a streambed elevation at 716.8 feet. The design scour elevations for the proposed bridge are presented in Table 1. The scour elevations are estimated from scour depth of 5.77 and 2.71 feet for 100 year event (Q100) and 11.72 and 7.57 feet for 500 year event (Q500) at the west and east abutments, respectively. Based on the soil information from our borings, the soils below the streambed are mainly loose to medium dense sand to sandy gravel; therefore, we do not recommend reduction in design scour elevations.

Table 1: Design Scour Elevations

Event/Limit State	Design Scour Elevation (ft)		Item 113
	West Abutment	East Abutment	
Q100	711.03	714.09	5
Q500	705.08	709.23	
Design	711.03	714.09	
Check	705.08	709.23	

The Q100 event scour elevation should be at or below the pile supported footing as per *All Bridge Designers* (ABD) 14.2 (2014). The abutment footing either needs to be lowered to the Q100 scour elevations for each respective abutment, engineered scour countermeasures should be provided, or approval from IDOT BBS for exemption from this requirement should be required.

4.4 Seismic Design Considerations

The seismic site class was determined in accordance with the IDOT *All Geotechnical Manual Users (AGMU) 9.1* (2009) method of analysis. The soils within the top 100 feet have a weighted average N value of 45 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 (AASHTO, 2012). According to IDOT Bridge Manual (IDOT, 2012a), liquefaction analysis is not required for a site located Seismic Performance Zone 1.

Table 2: Seismic Design Parameters

Spectral Acceleration Period (sec)	Spectral Acceleration Coefficient[1)] (% g)	Site Factors	Design Spectrum for Site Class D[2)] (% g)
0.0	PGA= 4.8	F_{pga}= 1.6	**A_s= 7.7**
0.2	S_s= 10.1	F_a= 1.6	**S_{DS}= 16.1**
1.0	S_1= 3.7	F_v= 2.4	**S_{D1}= 8.9**

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

5.0 FOUNDATION ANALYSIS AND RECOMMENDATIONS

The geotechnical evaluations and recommendations for approach embankments, wingwalls, and abutment foundations are included in the following sections. Wang has evaluated possible foundation types that could be considered for the support of the proposed bridge structure.

5.1 Approach Embankments and Slabs

Based on the draft Roadway Plan & Profile Drawing, we understand the roadway profile grade will be raised by an approximately 4.5 feet at the abutment locations. In addition, north side widening will be required to accommodate a new right turn lane with up to 15 feet of new fill; south side widening will be required for the new shoulder with up to 12 feet of new fill.

5.1.1 Settlement

Based on soil conditions encountered, we estimate the foundation soils under the new approach embankment fill loads undergo a total settlement of one inch or less. We estimate most of the settlement will occur during the placement of embankment fill and will be completed by the end of construction. Thus, downdrag load allowances for the piles are not required.

5.1.2 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, 1999). Slope stability evaluation exhibits are shown in Appendix C.

The side slope for the proposed approach embankment is designed at 1:2.2 (V:H). The global stability evaluations were performed at the west abutment based on subsurface soil conditions encountered in Boring BB-01, which represents the critical condition. The total embankment height is approximately 9.5 feet.

Wang estimates a minimum FOS of 2.8 and 1.7 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.

5.2 Foundation Recommendations

The TSL (Exhibit 5) plan shows the pile cap base elevation at 714.4 feet at the west and east abutments. Preliminary service and factored loads for the foundations provided by Milhouse are shown in Table 3.

Table 3: Preliminary Foundation Loads

Substructure ID	Estimated Total Service Load (kips)	Estimated Total Factored Load (kips)
Bridge Abutments	1680	2170

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 high groundwater table and potential scour concerns. Due to the nature of soil conditions, high groundwater table, and presence of artesian water as mentioned in Section 4.2, we do not recommend considering drilled shafts foundations. We recommend driven piles to support the abutments and wingwalls.

5.2.1 Driven Piles

IDOT specifies the maximum nominal required bearing (R_{NMAX}) for each pile and states the factored resistance available (R_F) for a steel H-pile and metal shell pile (MSP) should be based on a geotechnical resistance factor (Φ_G) of 0.55 (IDOT 2012a). Nominal tip and side resistance were estimated using the methods and empirical equations presented in *AGMU Memorandum 10.2 – Geotechnical Pile Design* (IDOT, 2011). Due to anticipated pile spacing variations, we 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 diameter with 0.25-inch wall thickness, MSP 14-inch diameter with 0.25-inch wall thickness, MSP 14-inch diameter with 0.312-inch wall thickness, HP12x53, and HP14x73, are presented in Tables 4 through 7. The lengths shown in the tables include 1 feet pile embedment into 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 2012a). Due to new fill at the abutments, we estimate the residual settlement at the completion of approach embankment construction will be less than 0.4-inch. Therefore, we do not anticipate downdrag loads reduction on the abutment piles. Scour loss for the 100 year event is included in pile tables.

The existing wingwalls are within the proposed abutment footprints; therefore, abutments piles should be spaced to avoid the existing wingwalls foundations.

Table 4: Estimated Pile Lengths and Tip Elevations for MSP 12"ϕ w/ .25" walls w/ Q100 Event Scour Loss

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)
West Abutment (BB-01)	714.4	167	12	0	80	18	697.4
		239	12	0	120	19	696.4
		312	12	0	160	22	693.4
		353	12	0	182	23	692.4
East Abutment (BB-02)	714.4	147	1	0	80	15	700.4
		220	1	0	120	26	689.4
		293	1	0	160	27	688.4

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)
		353	1	0	193	30	685.4

Table 5: Estimated Pile Lengths and Tip Elevations for MSP 14"ϕ w/ .25" walls w/ Q100 Event Scour Loss

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)
West Abutment (BB-01)	714.4	170	14	0	80	15	700.4
		244	14	0	120	19	696.4
		316	14	0	160	20	695.4
		389	14	0	200	23	692.4
		413	14	0	213	23	692.4
East Abutment (BB-02)	714.4	147	1	0	80	15	700.4
		220	1	0	120	16	699.4
		292	1	0	160	25	690.4
		365	1	0	200	26	689.4
		413	1	0	227	28	687.4

Table 6: Estimated Pile Lengths and Tip Elevations for MSP 14"ϕ w/ .312" walls w/ Q100 Event Scour Loss

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)
West Abutment (BB-01)	714.4	170	14	0	80	15	700.4
		244	14	0	120	19	696.4
		316	14	0	160	19	696.4

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)
		388	14	0	200	22	693.4
		461	14	0	240	23	692.4
		513	14	0	268	23	692.4
East Abutment (BB-02)	714.4	147	1	0	80	15	700.4
		220	1	0	120	16	699.4
		292	1	0	160	26	689.4
		365	1	0	200	27	688.4
		438	1	0	240	30	685.4
		513	1	0	281	36	679.4

Table 7: Estimated Pile Lengths and Tip Elevations for HP12x53 Steel H-Piles w/ Q100 Event Scour Loss

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)
West Abutment (BB-01)	714.4	78	3	0	40	14	701.4
		152	3	0	80	20	695.4
		218	3	0	120	28	687.4
		296	3	0	160	33	682.4
		370	3	0	200	49	666.4
		418	3	0	227	53	662.4
East Abutment (BB-02)	714.4	73	0	0	40	14	701.4
		145	0	0	80	27	688.4
		218	0	0	120	43	672.4
		291	0	0	160	53	662.4
		364	0	0	200	63	652.4
		384(*)	0	0	211	65	650.4

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

Table 8: Estimated Pile Lengths and Tip Elevations for HP14x73 Steel H-Piles w/ Q100 Event Scour Loss

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)
West Abutment (BB-01)	714.4	79	3	0	40	12	703.4
		152	3	0	80	18	697.4
		225	3	0	120	26	689.4
		297	3	0	160	29	686.4
		370	3	0	200	34	681.4
		444	3	0	240	44	671.4
		515	3	0	280	53	662.4
		578	3	0	314	55	660.4
East Abutment (BB-02)	714.4	73	0	0	40	11	704.4
		145	0	0	80	26	689.4
		218	0	0	120	35	680.4
		291	0	0	160	48	667.4
		364	0	0	200	60	655.4
		436	0	0	240	62	653.4
		480(*)	0	0	263	65	650.4

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

5.2.2 Lateral Loading

Lateral loads on 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 9 and 10. Group action should be considered for piles in soils calculating total lateral load resistance of the footings.

Table 9: Recommended Soil Parameters for Lateral Load Pile Analysis at West Abutment (BB-01)

Layer Elevation/ Soil Description	Moist 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}
714.4* to 707.6 Sandy Gravel	125	0	34	60	--
707.6 to 691.1 Silty Clay to Silty Clay Loam	120	4,000	0	1,000	0.005
691.1 to 686.1 Sandy Gravel	130	0	36	125	--
686.1 to 676.1 Sand	130	0	35	125	--
676.1 to 671.6 Clay Loam	125	4,500	0	2,000	0.004
671.6 to 656.4 Sandy Gravel	130	0	36	125	--
656.4 to 653.1 Sand	130	0	35	125	--

*Pile Cap Base Elevation.
** Submerged condition for granular soil

Table 10: Recommended Soil Parameters for Lateral Load Pile Analysis at East Abutment (BB-02)

Soil Description	Moist 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}
714.4* to 709.2 Gravelly Sand	125	0	34	60	--
709.2 to 699.2 Silty Clay Loam	120	3,000	0	1,000	0.005
699.2 to 692.9 Sandy Gravel	130	0	36	125	--

Soil Description	Moist 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}
692.9 to 687.9 Silty Clay Loam	120	1,200	0	500	0.007
687.9 to 677.7 Sand	125	0	35	60	--
677.7 to 672.9 Silty Loam	115	0	30	60	--
672.9 to 667.9 Clay Loam	125	3,800	0	1,000	0.005
667.9 to 657.9 Gravelly Loam	130	0	36	125	--
657.9 to 650.2 Sand	125	0	35	125	--

*Pile Cap Base Elevation.

** Submerged condition for granular soil.

5.3 Stage Construction Consideration

The TSL plan shows the bridge construction occurring in two stages: stage two will involve the removal and construction of the westbound portion of the bridge; stage four will include the removal and construction of the eastbound portion of the bridge. A temporary steel sheet piling according to Design Guide 3.13.1 (IDOT 2012a) is not feasible to accommodate stage construction due the fill nature of temporary retention. Therefore, a *Temporary Soil Retention System* should be designed by the Contractor and approved by IDOT prior to construction.

6.0 CONSTRUCTION CONSIDERATIONS

6.1 Site Preparation

All vegetation, surface topsoil, existing pavement, and debris should be cleared and stripped where foundations and fill will be placed. The existing wingwalls are located in the proposed abutment footprints; the existing wingwalls and foundations should be removed. The site shall be prepared as required per IDOT Standard Specification. Any unstable or unsuitable materials should be removed and replaced with compacted fill as described in Section 6.3.

6.2 Excavation and Dewatering

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

During the subsurface investigation, groundwater was encountered at elevations ranging from 719.2 to 722.6 feet. Therefore, groundwater will be encountered about 5 to 8 feet above pile cap base elevation of 714.4 feet and temporary dewatering of foundation excavation will be required. Contractor should be prepared for dewatering measures with use of temporary sheet piling or soil retention system due to highly permeable granular soils at the proposed excavation depth.

A cofferdam will be required due the highly permeable granular soils at the proposed excavation depth. The bottom of the footing will be established at 714.4 feet and the Estimated Water Surface Elevation (EWSE) is 721.05 feet. Since the EWSE is more than 6 feet above the bottom of footing elevation, Type 2 cofferdam will be required. To seal the excavation, the sheeting pile tip elevation should be embedded into the very stiff to hard silty clay to silty clay loam below elevation 707.0 feet. Otherwise, a seal coat will be required. The cofferdam should be designed by the Contractor prior to construction and approved by IDOT. The design of a seal coat should be accordance with *Design Guide 3.13.3- Cofferdam Seal Coat Design* (2006).

Depending upon prevailing climate conditions and the time of the year when bridge construction takes place, control 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.

6.3 Filling and Backfilling

Fill material used to attain the final design elevations should be as per IDOT Standard Specifications. The fill material should be free of organic matter and debris and should be placed in lifts and compacted according to IDOT Section 205, *Embankment* (IDOT, 2016).

All backfill materials must be as per IDOT Standard Specifications.

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 Pile Installation

The driven piles shall be furnished and installed according to the requirements of IDOT Section 512, *Piling* (IDOT, 2016). Wang recommends that at a minimum of one test pile be performed at each substructure location at each construction stage. The test piles shall be driven to 110 percent of the nominal required bearing indicated in Section 5.2.1. Since hard driving is expected, the piles should be installed with metal shoes.

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 Milhouse Engineering & Construction, 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

N. S. Balac

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

Jerry WH Wang/ICTF

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

LICENSED PROFESSIONAL ENGINEER
JERRY W.H. WANG
062-034375
STATE OF ILLINOIS

REFERENCES

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

Curry, B.B., D.A. Grimley, and T.H. Larson, 2001, Surficial Geology Map, Sugar Grove 7.5-minute Quadrangle, Kane County, Illinois: Illinois State Geological Survey, Illinois Geologic Quadrangle Map, IGQ Sugar Grove-SG, 1:24,000.

Curry, B.B., 2002, Topographic Map of the Bedrock Surface, Sugar Grove 7.5-minute Quadrangle, Kane County, Illinois: Illinois State Geological Survey, Illinois Geologic Quadrangle Map, IGQ Sugar Grove-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.

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.

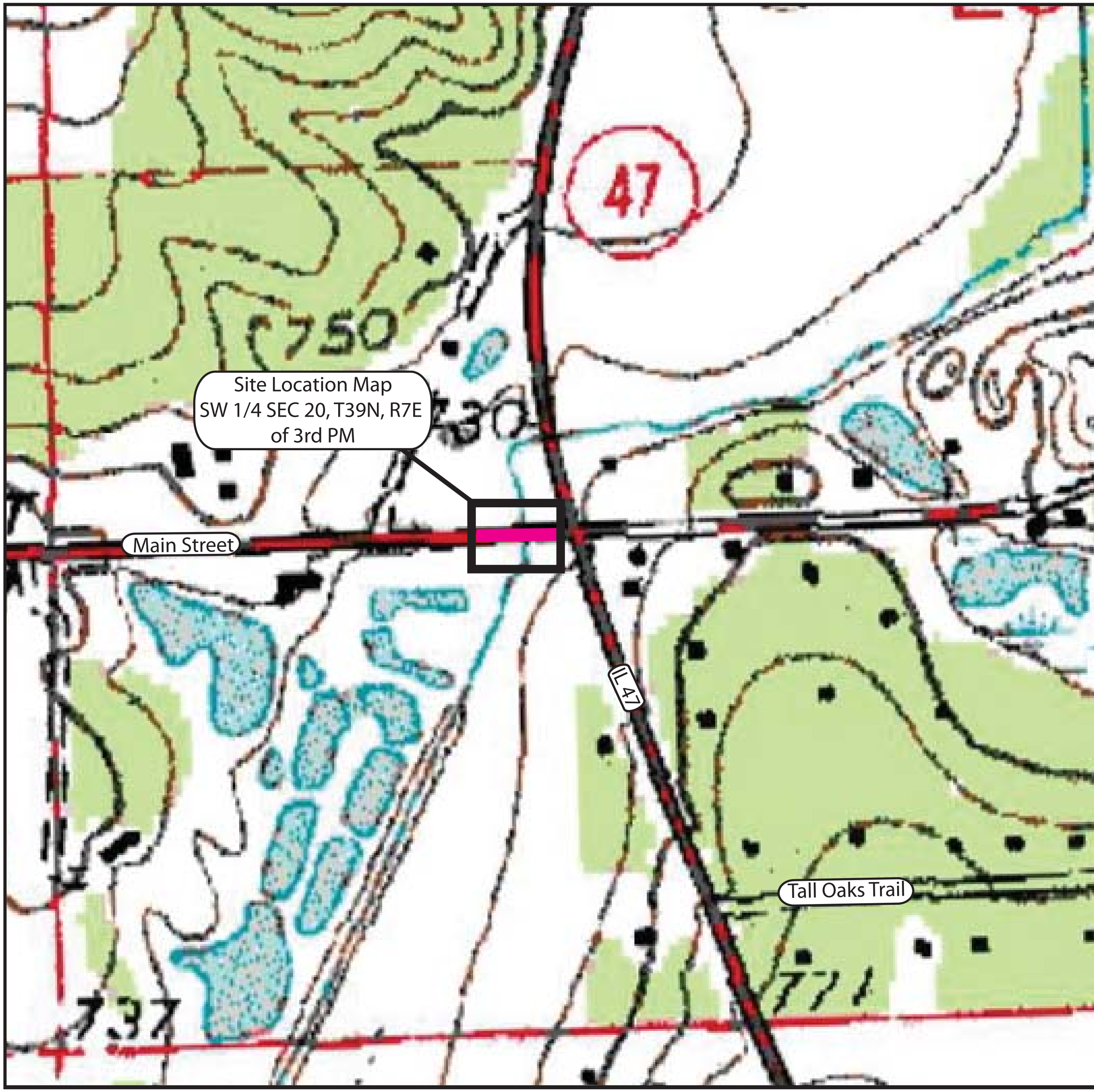
IDOT (2012a) *Bridge Manual*. Illinois Department of Transportation.

IDOT (2016) *Standard Specifications for Road and Bridge Construction*. Illinois Department of Transportation, 1133 pp.

ISGS (2010) *Circluar 576 - G*roundwater flow modelling as a tool to understand watershed geology: Blackberry Creek Watershed, Kane and Kendall Counties in Illinois. Illinois State Geological Survey.

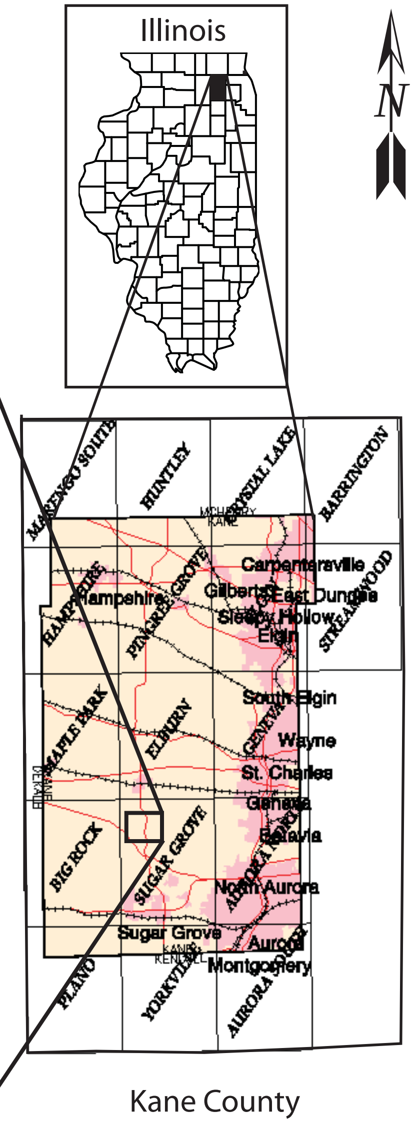
J Leighton, M.M., Ekblaw, G.E., and Horberg, L., 1948, Physiographic Divisions of Illinois. The Journal of Geology, v. 56, p. 16-33.

EXHIBITS



Scale

0 750 1500 Feet



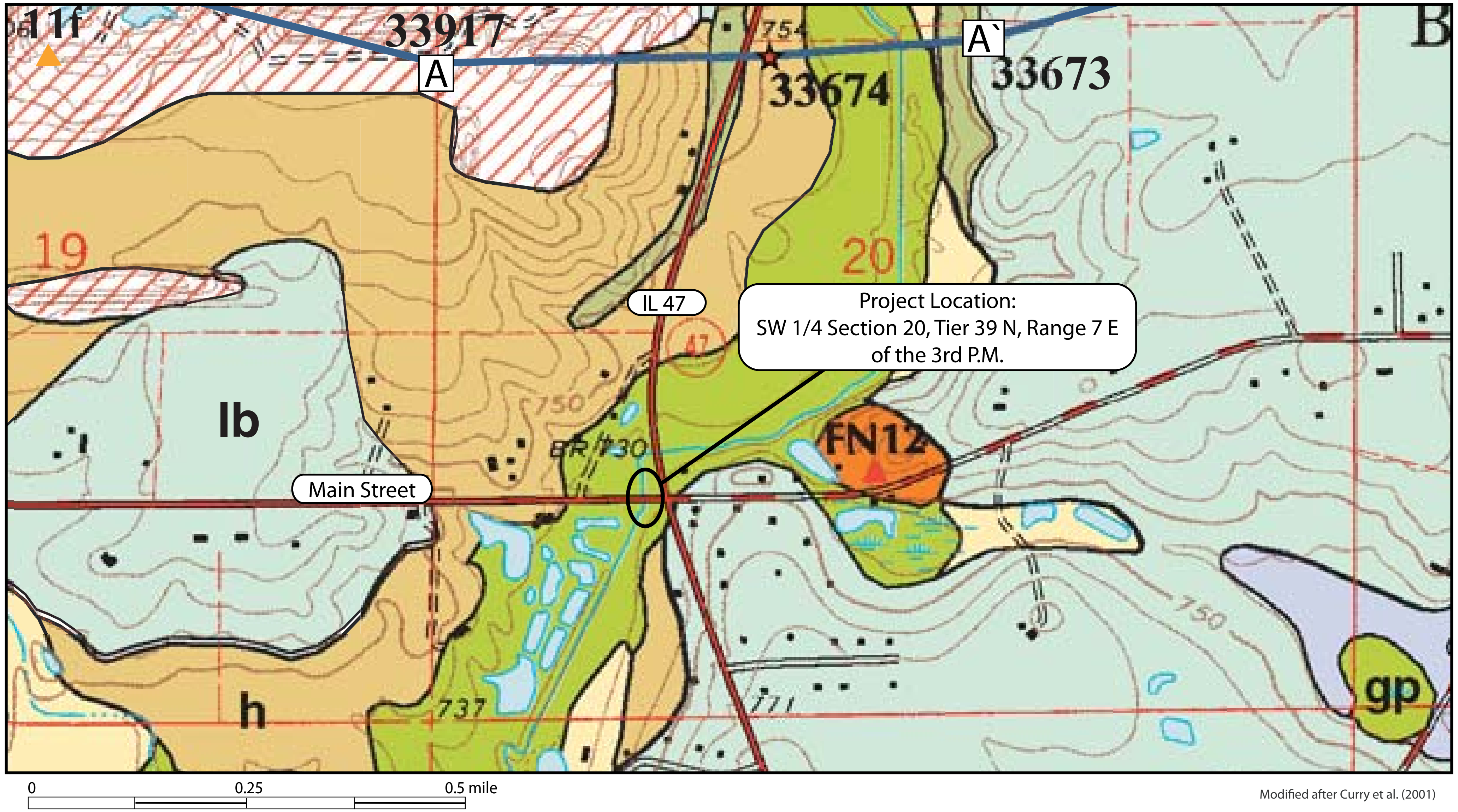
SITE LOCATION MAP: MAIN STREET OVER BLACKBERRY CREEK BRIDGE, IL-47 AT MAIN STREET INTERSECTION IMPROVEMENTS, KANE COUNTY, ILLINOIS

SCALE: GRAPHICAL	EXHIBIT 1	DRAWN BY: R. KC CHECKED BY: A. Kurnia

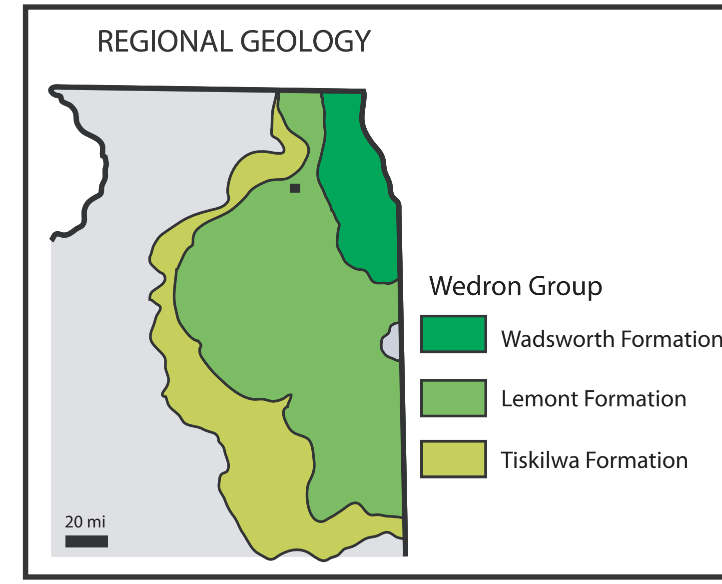
Wang Engineering

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

FOR MILHOUSE ENGINEERING AND CONSTRUCTION, INC. 192-03-01



Modified after Curry et al. (2001)



Modified after Hansel and Johnson (1996)

LEGEND

QUATERNARY DEPOSITS

HUDSON EPISODE (postglacial)

	Disturbed Ground Fill or disturbed earth material in pits and quarries
gp	**Grayslake Peat** Decomposed wetland vegetation and sediment; peat and muck, interbedded sand, silty clay, and marl
c	**Cahokia Formation** Floodplain alluvium along rivers and streams; well-sorted sand and gravel with lenses of peat and fossiliferous silt and clay

WISCONSIN EPISODE (last glaciation)

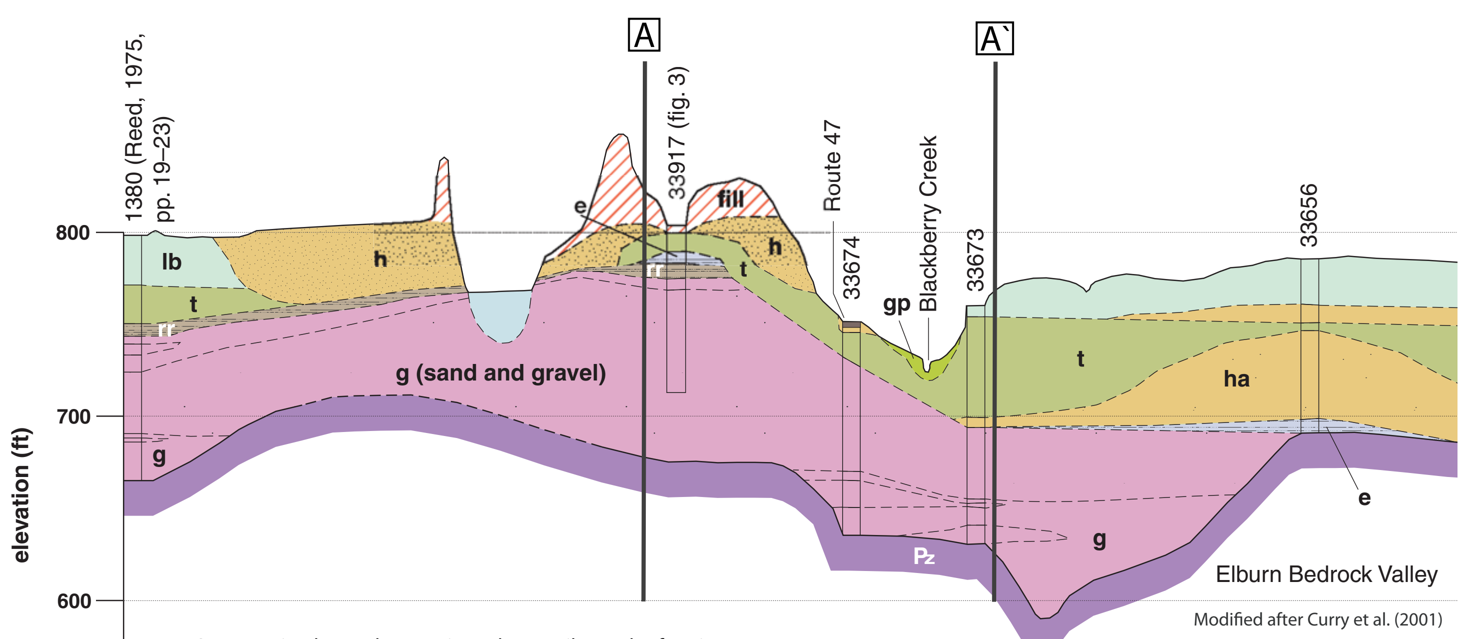
e	**Equality Formation** Lake deposits in kettles and valleys; silt, clay, and fine sand; layered to massive
h	**Henry Formation** Proglacial outwash plains downslope of glacial margins; sand and gravel, or sand; with lenses of silt and clay, or diamicton
h(w)	**Henry Formation (Wasco Facies)** Sorted ice-contact sediment associated with kames and eskers; silty sand and gravel, sand, gravel, and sandy diamicton
l-b	**Batestown Member, Lemont Formation** Diamicton; till, debris flow, and subglacial sand and gravel; sandy loam to loam with abundant cobbles; includes layers of sand and gravel or sorted sediment
t	**Tiskilwa Formation** Diamicton; till, debris flow, and subglacial sand and gravel; loam to clay loam with lenses of sand and gravel
rr	**Robein Member, Roxana Silt (Cross section only)** Weathered loess, slope deposits, and peat; silt and clay, organic-rich, leached of carbonate minerals; contains wood fragments

IILLINOIS EPISODE (next-to-last glaciation)

g	**Glasford Formation (Cross section only)** Diamicton; till, debris flow, lake, outwash, and subglacial sand and gravel deposits; compact, sandy and bouldery with abundant lenses of sand and gravel

PALEOZOIC BEDROCK

Pz	**Kankakee and Joliet Formations (Silurian), Maquoketa Group (Ordivician); (Cross section only)** Dolomite with chert lenses; gray to yellowish brown, fossiliferous, vuggy; also shaly dolomite and brown shale



Modified after Curry et al. (2001)

Note: Cross section located approximately 0.5 mile north of project area

SITE AND REGIONAL GEOLOGY: MAIN STREET OVER BLACKBERRY CREEK BRIDGE; IL 47 AT MAIN STREET IMPROVEMENTS, KANE COUNTY, ILLINOIS

SCALE: GRAPHICAL	EXHIBIT 2	DRAWN BY: B. Wilson CHECKED BY: A. Kurnia

Wang Engineering

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www.wangeng.com

FOR MILHOUSE ENGINEERING AND CONSTRUCTION, INC. | 192-03-01

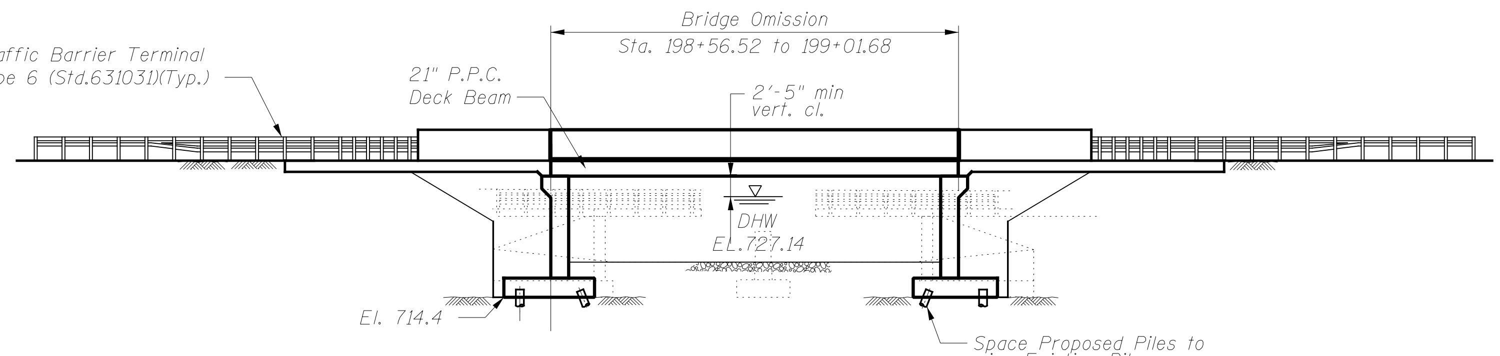
Benchmark: "□" cut on top of Southwest Wingwall on Main St. bridge over Blackberry Creek El. 729.48

Existing Structure: SN045-0049 was originally constructed in 1925 with reconstruction in 1975 under section 50-BR. The structure was repaired in 2003. The existing structure is a two span continuous concrete slab bridge supported on Closed Abutment and a solid concrete pier. The length of the bridge 36'-0" Back to Back of abutments with a out to out deck width of 40'-6"

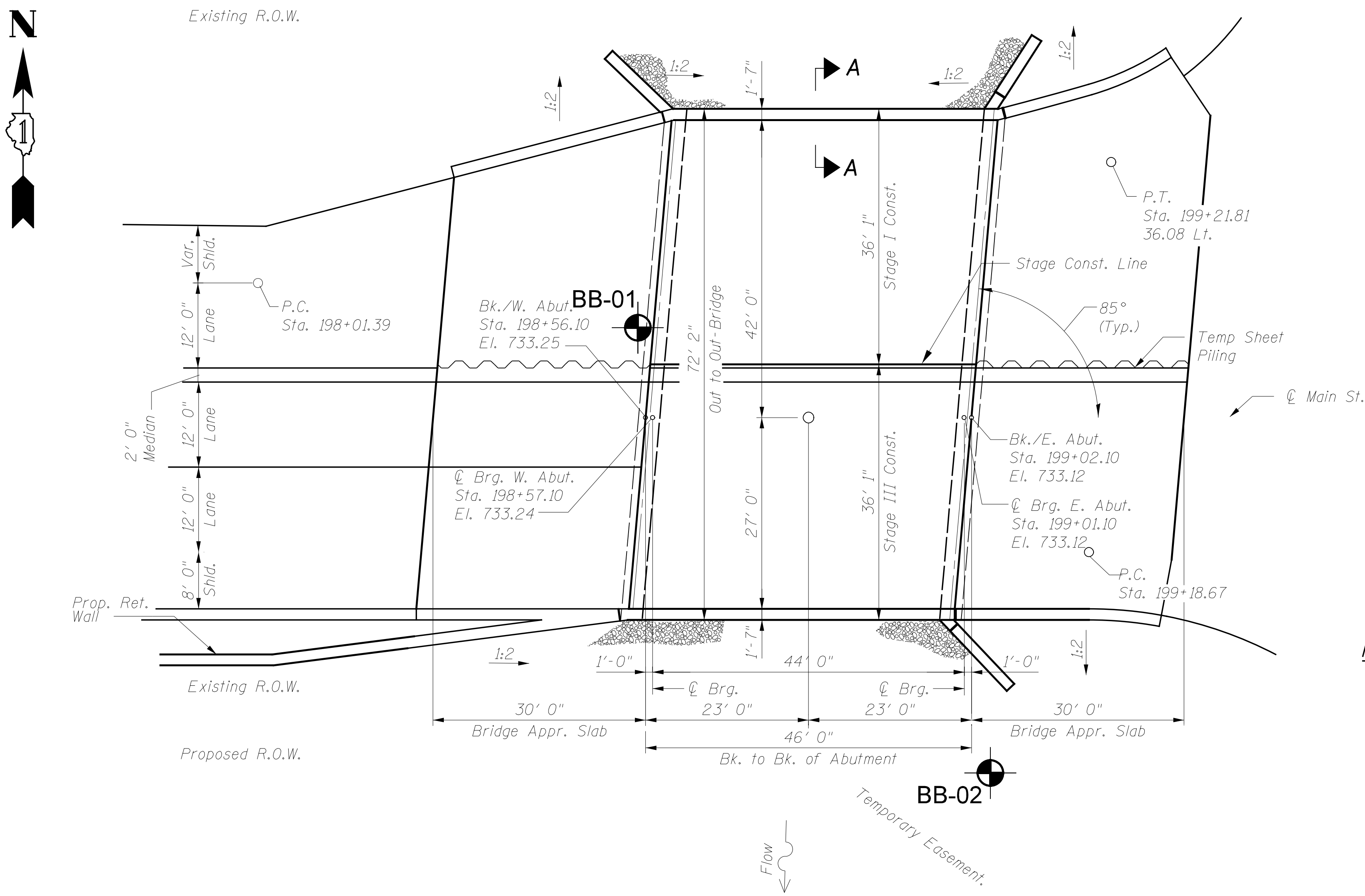
Existing structure is to be removed and replaced. Traffic shall be maintained using stage construction

No Salvage

THIS EXHIBIT IS TO BE USED ONLY FOR BORING LOCATION



ELEVATION



PLAN

SEISMIC DATA

Seismic Performance Zone (SPZ) =
Design Spectral Acceleration @ 1.0 sec (SDI) =
Design Spectral Acceleration @ 0.2 sec (SDS) =
Soil Site Class =

LOADING HL-93

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

DESIGN SPECIFICATIONS

AASHTO LRFD Bridge Design Specifications 7th Edition with 2015 Interims.

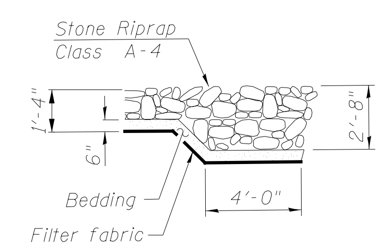
DESIGN STRESSES

FIELD UNITS

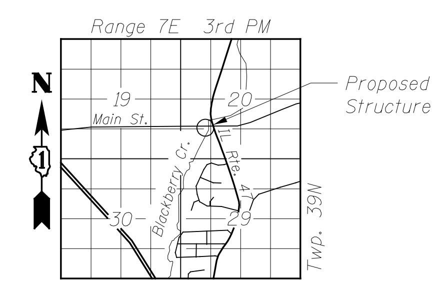
f'_c = 3,500 psi
f_y = 60,000 psi (reinforcement)

PRECAST PRESTRESSED UNITS

f'_c = 6,000 psi
f'_{ci} = 5,000 psi
fpu = 270,000 psi (½"φ low lax strands)
fpbt = 201,960 psi (½"φ low lax strands)



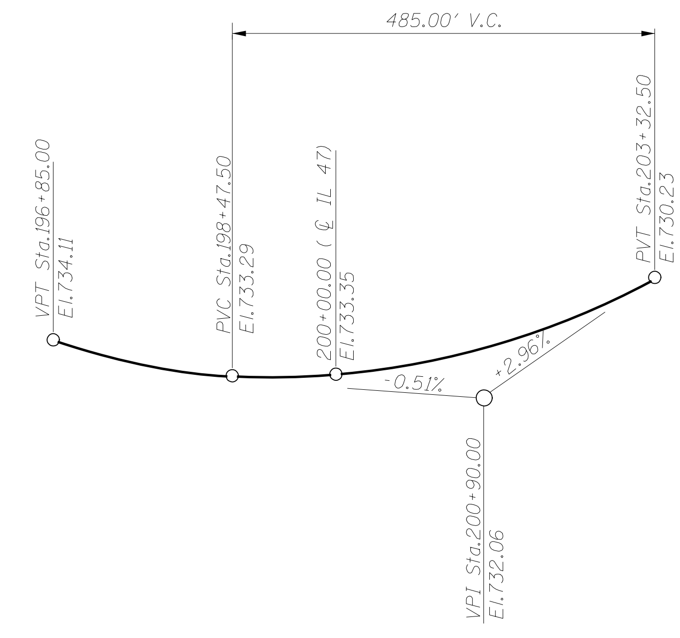
SECTION A-A



LOCATION SKETCH

HIGHWAY CLASSIFICATION

Rte. Main Street (F.A.S. Rte 107)
Functional Class: Other Principal Arterial
ADT: 3700 (2010); 7000 (2040)
ADTT: 25.3%
DHV: 380
Design Speed: 60 m.p.h.
Posted Speed: 55 m.p.h.
Two-Way Traffic
Directional Distribution: 50/50



PROFILE GRADE

Along ℄ Main Street

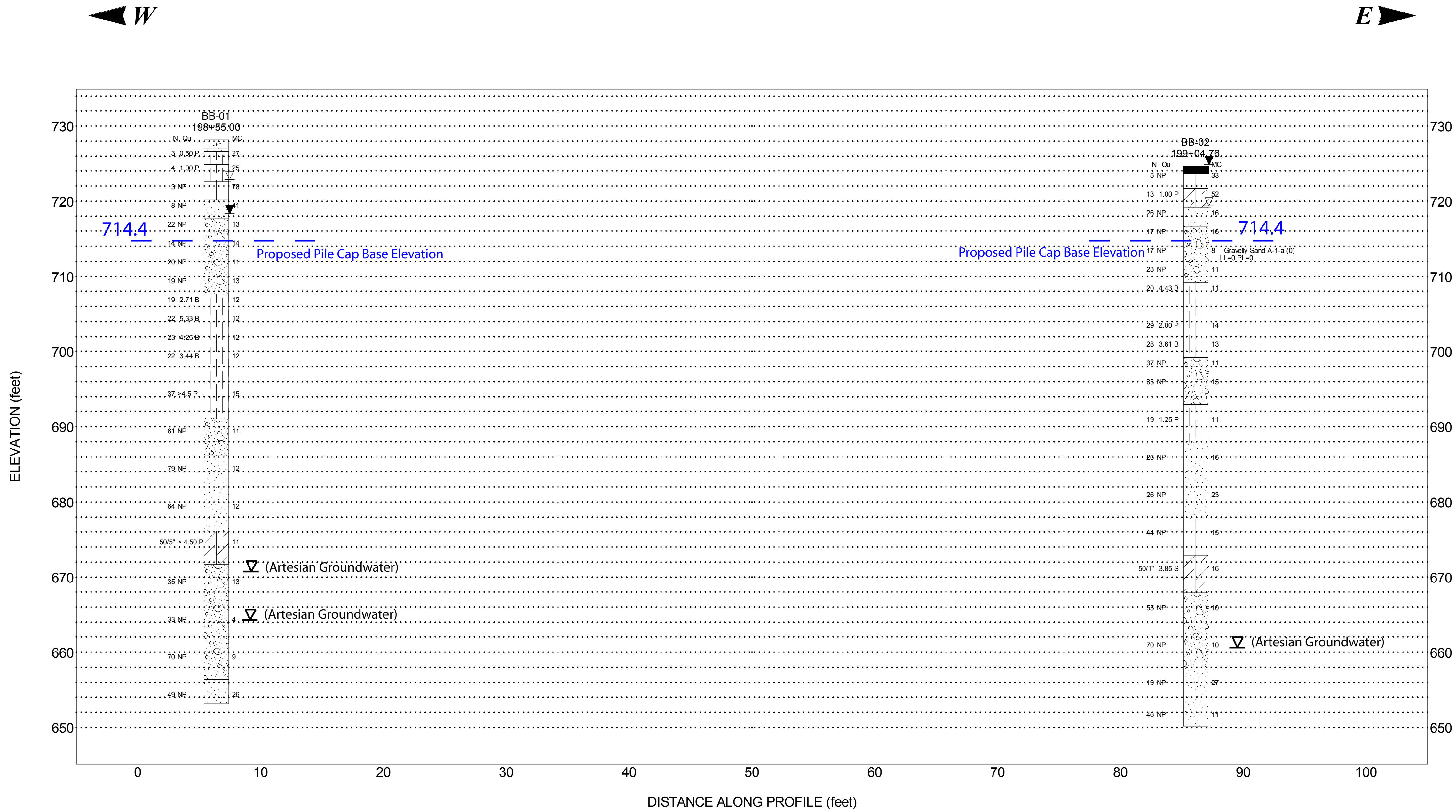
GENERAL PLAN
MAIN ST. OVER BLACKBERRY CREEK
F.A.S. RTE. 107
SECTION 107 N-4
KANE COUNTY
STATION 198+79.10
STRUCTURE NO. 045-3069

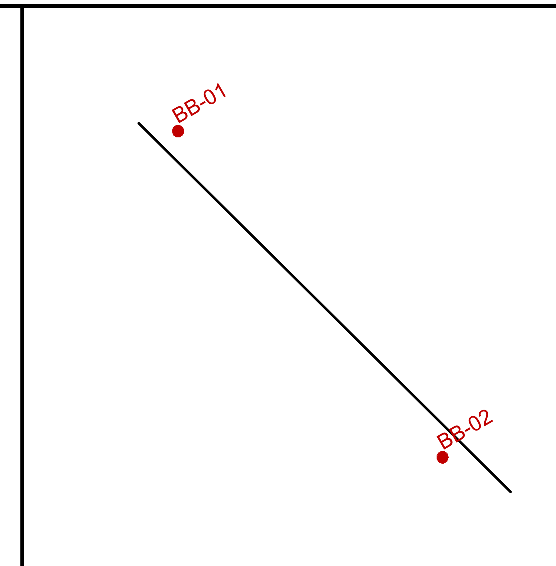
BORING LOCATION PLAN: MAIN STREET OVER BLACKBERRY CREEK BRIDGE; IL 47 AT MAIN STREET IMPROVEMENTS, KANE COUNTY, ILLINOIS		
SCALE: GRAPHICAL	EXHIBIT 3	DRAWN BY: H. Bista CHECKED BY: A. Kurnia
Wang Engineering		1145 N. Main Street Lombard, IL 60148 www.wangeng.com
FOR MILHOUSE ENGINEERING AND CONSTRUCTION, INC.		192-03-01

MILHOUSE ENGINEERING & CONSTRUCTION	USER NAME = $USER$	DESIGNED - LAS	REVISED -	STATE OF ILLINOIS DEPARTMENT OF TRANSPORTATION	GENERAL PLAN SN 045-3069
		CHECKED - DAZ	REVISED -		
	PLOT SCALE = $SCALE$	DRAWN - TCS	REVISED -		
	PLOT DATE = $DATE$	CHECKED - LAS	REVISED -		SHEET NO. 1 OF 2 SHEETS

F.A.S. RTE	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
107	107N-4	KANE		
CONTRACT NO. 60T21				
ILLINOIS FED. AID PROJECT				

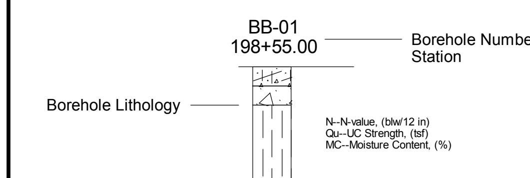
FILE NAME = $FILE$





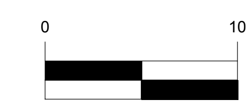
Site Map Scale 1 inch equals 35 feet

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: 0.5x

Lithology Graphics

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

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

Soil Profile
Main Street over Blackberry Creek

WEI SINCE 1982

IL 47 at Main Street Intersection Improvements
Elburn, Kane County, IL

JOB NUMBER	PLATE NUMBER
192-03-01	EXHIBIT 4

WEI 11X17 1920301.GPJ WANGENG.GDT 6/23/15

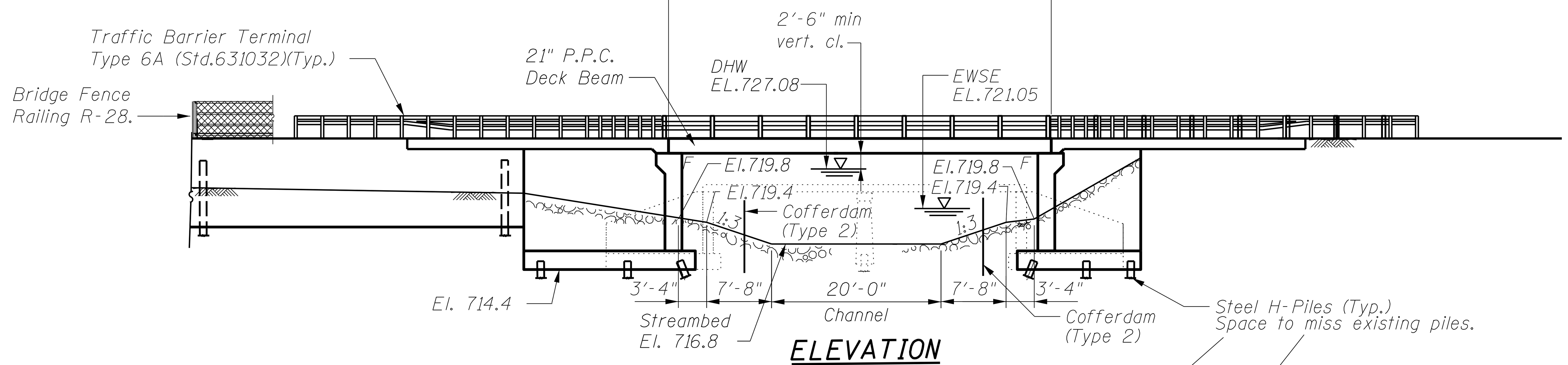
EXHIBIT 5

Benchmark: "□" cut on top of Southwest Wingwall on Main St. bridge over Blackberry Creek El. 728.26

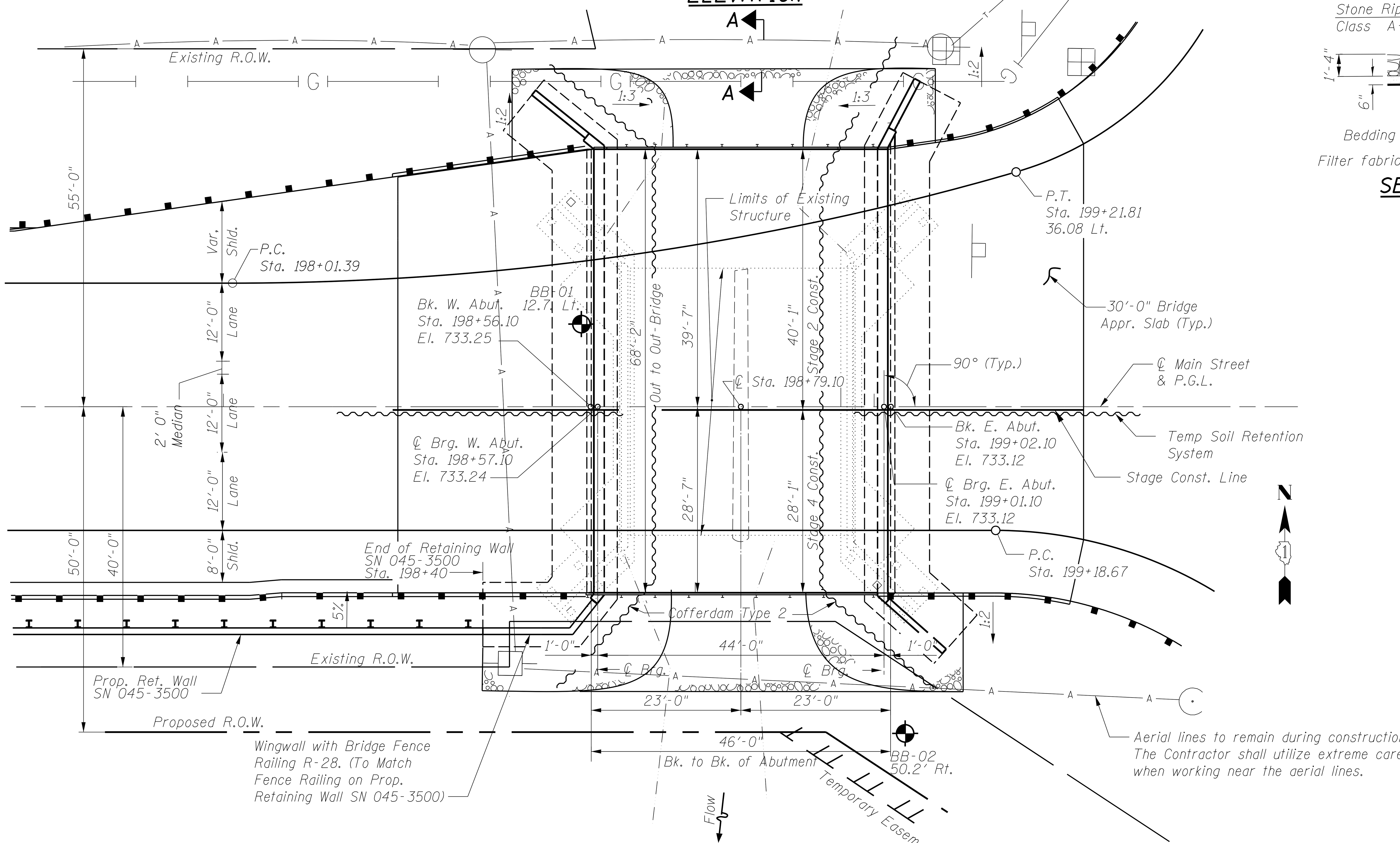
Existing Structure: SN045-0049 was originally constructed in 1925 with reconstruction in 1975 under section 50-BR. The structure was repaired in 2003. The existing structure is a two span continuous concrete slab bridge on pile supported closed abutments and a solid concrete pier. The length of the bridge is 36'-0" back to back of abutments with an out to out deck width of 40'-6". The skew is 0°.

Existing structure is to be removed and replaced. Traffic shall be maintained using stage construction.

No Salvage



ELEVATION



PLAN

SEISMIC DATA

Seismic Performance Zone (SPZ) = 1
Design Spectral Acceleration @ 1.0 sec (SD1) =0.089g
Design Spectral Acceleration @ 0.2 sec (SDS) =0.161g
Soil Site Class = D

LOADING HL-93

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

DESIGN SPECIFICATIONS

AASHTO LRFD Bridge Design Specifications 7th Edition with 2015 and 2016 Interims.

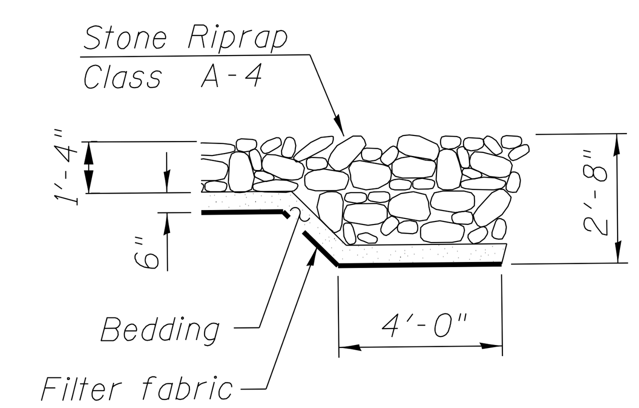
DESIGN STRESSES

FIELD UNITS

f'_c = 3,500 psi (substructure)
f'_c = 5,000 psi (concrete wearing surface)
f_y = 60,000 psi (reinforcement)
f_y = 50,000 psi (M270 Grade 50)

PRECAST PRESTRESSED UNITS

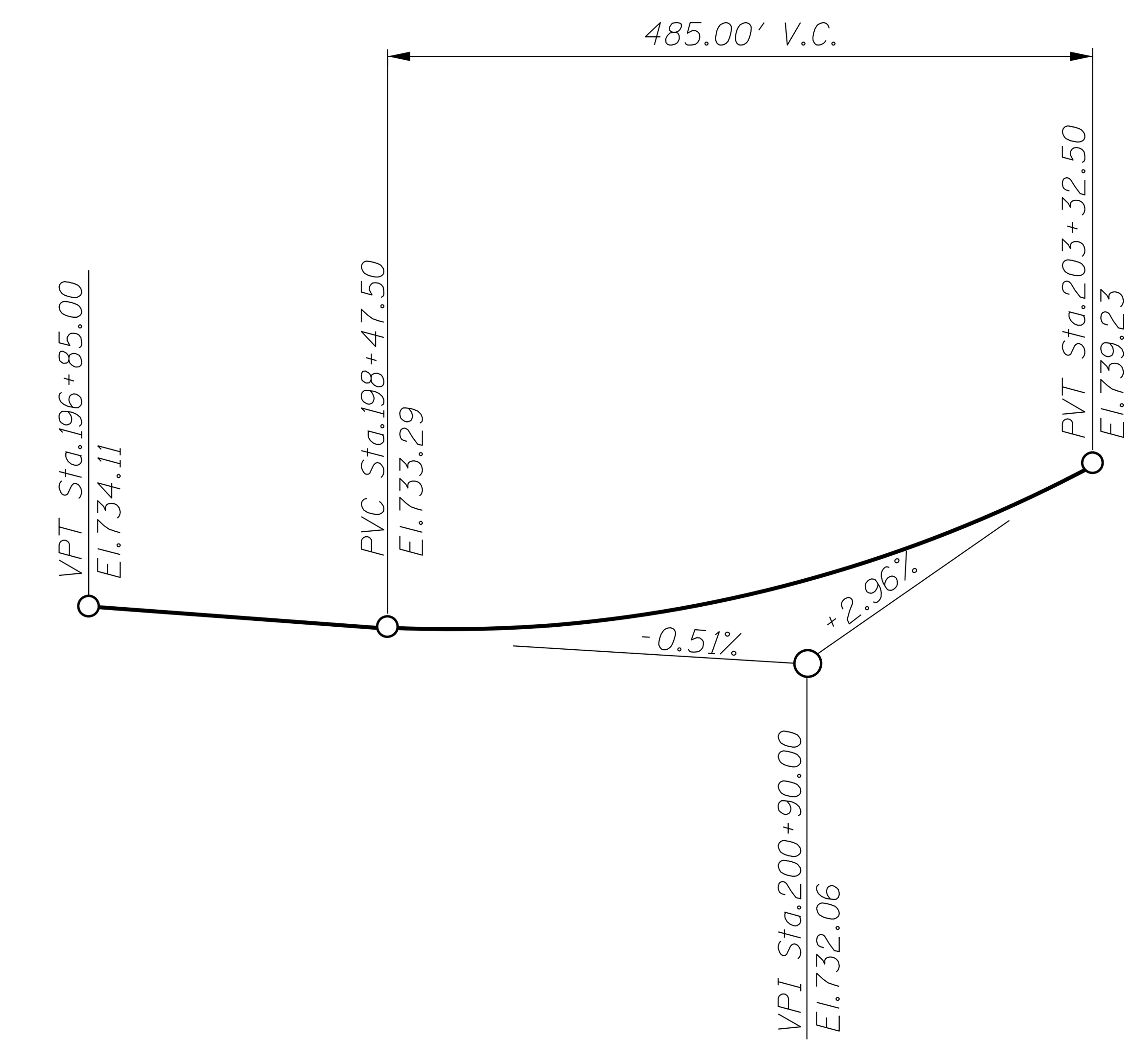
f'_c = 6,000 psi
$f'ci$ = 5,000 psi
fpu = 270,000 psi (½"ϕ low lax strands)
fpbt = 201,960 psi (½"ϕ low lax strands)



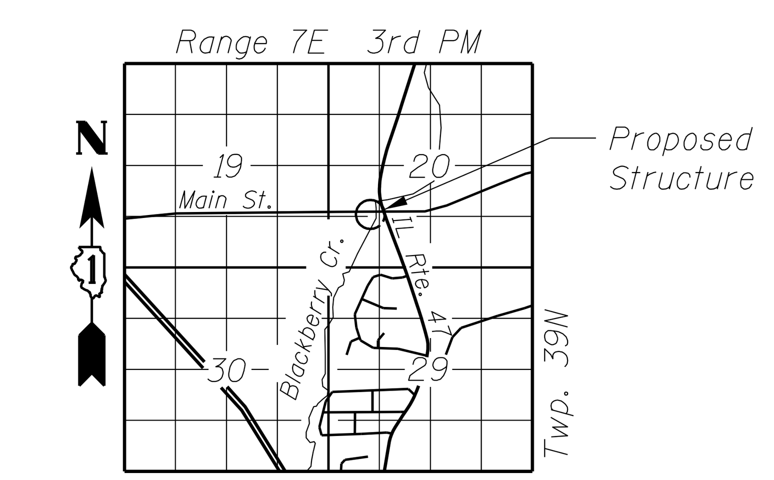
SECTION A-A

HIGHWAY CLASSIFICATION

Rte: Main Street (F.A.S. Rte 107)
Functional Class: Other Principal Arterial
ADT: 3700 (2010); 7000 (2040)
ADTT: 936 (2010), 1771 (2040)
DHV: 380
Design Speed: 60 m.p.h.
Posted Speed: 55 m.p.h.
Two-Way Traffic
Directional Distribution: 50/50



PROFILE GRADE
Along ℄ Main Street

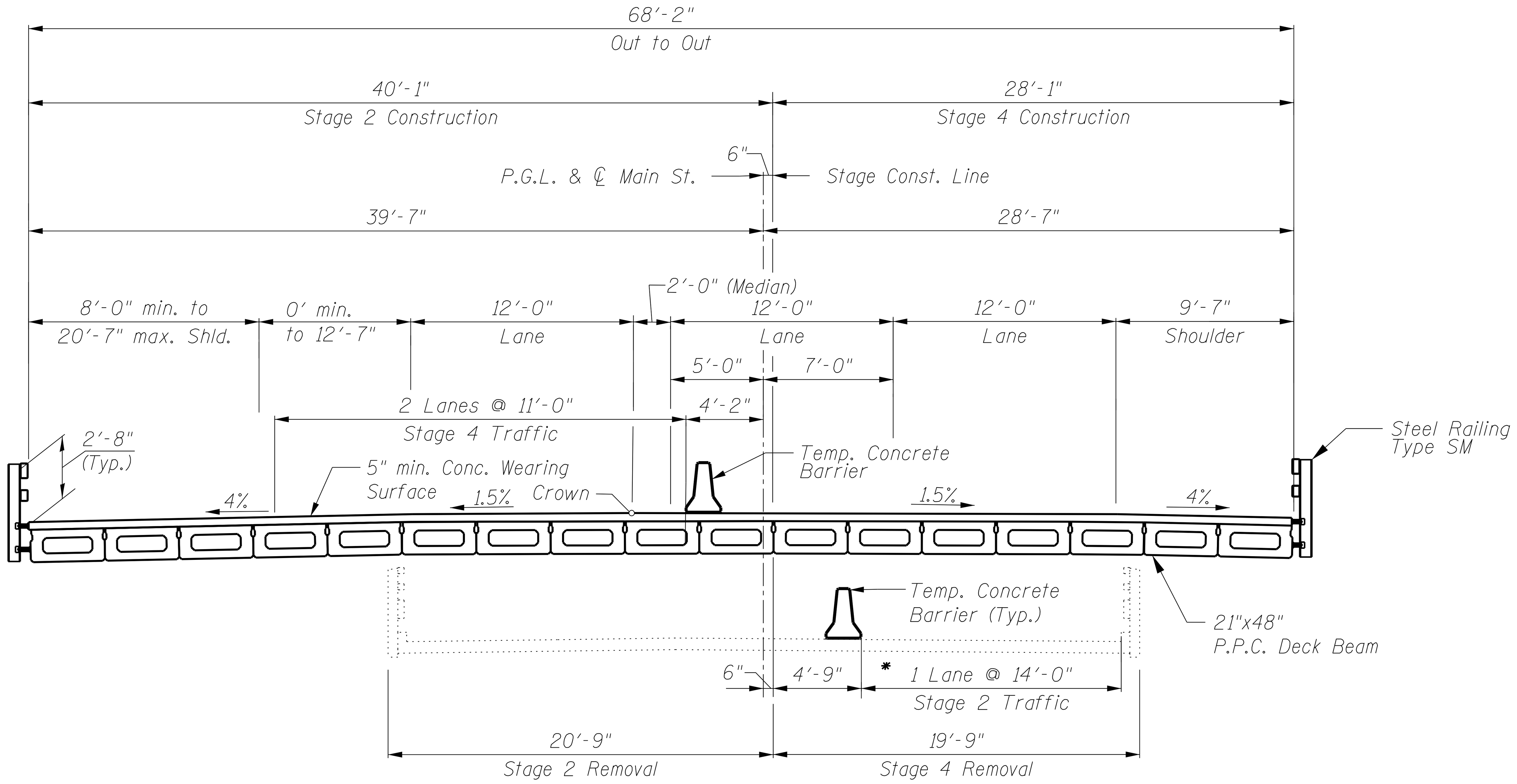


LOCATION SKETCH

GENERAL PLAN
MAIN ST. OVER BLACKBERRY CREEK
F.A.S. RTE. 107
SECTION 107 N-4
KANE COUNTY
STATION 198+79.10
STRUCTURE NO. 045-3069

MILHOUSE ENGINEERING & CONSTRUCTION	USER NAME = tsledge	DESIGNED - LAS	REVISED -	STATE OF ILLINOIS DEPARTMENT OF TRANSPORTATION	GENERAL PLAN STRUCTURE NO. 045-3069	F.A.P. RTE: 326	SECTION: 107N-4
		CHECKED - DAZ	REVISED -			COUNTY: KANE	TOTAL SHEETS: 185 / SHEET NO.: 130
	PLOT SCALE = 10.8333 '/ in.	DRAWN - TCS	REVISED -			CONTRACT NO. 60T21	
	PLOT DATE = 8/4/2016	CHECKED - LAS	REVISED -		SHEET NO. 1 OF 2 SHEETS	ILLINOIS FED. AID PROJECT	

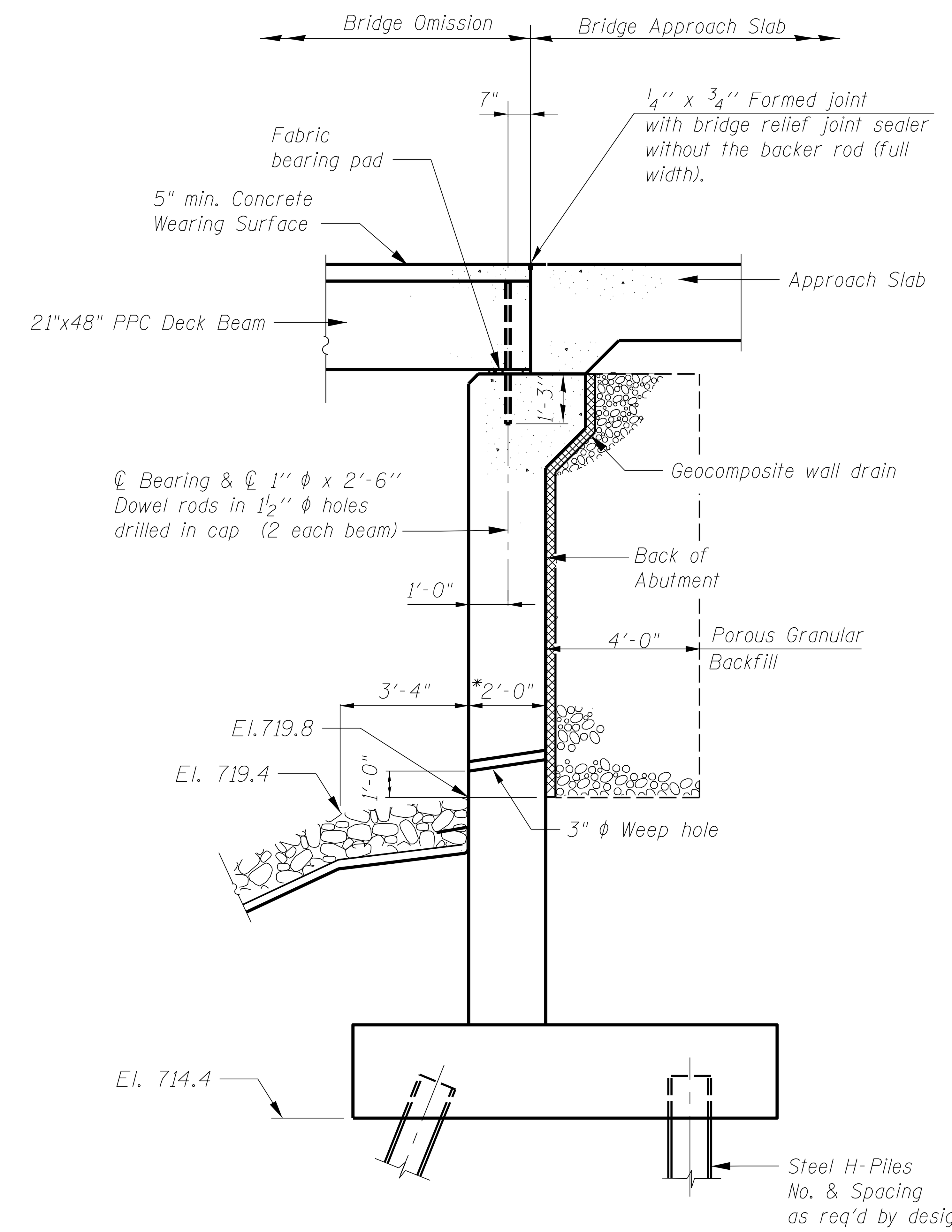
FILE NAME = Pr\2015\0558 IDOT Dist1 IL Route 47 at Main S of Elburn (PTB 171-04)\CADD\dgn\CADD\Bridge\Main St._T.S.& L\General Plan & Elevation.dgn



CROSS SECTION

(Looking East)

*Note:
Temporary Traffic Signal to be erected for Traffic Control Access across Bridge in Stage 2



SECTION THRU ABUTMENT

*Dimensions to be refined during final design

WATERWAY INFORMATION

Drainage Area = 11.68 Square Miles — Max. Recorded H.W.E. = N/A
Existing Low Grade Elev. - 728.61 @ Sta.199+00
Proposed Low Grade Elev. -732.09 @ Sta.198+00

Flood	Freq. Yr.	Discharge C.F.S.	Opening Sq. Ft.		Nat. H.W.E.	Head - Ft.		Headwater El.	
			Exist.	Prop.		Exist.	Prop.	Exist.	Prop.
	10	634	308.04	398.64	725.84	0.12	0.05	725.96	725.89
Design	50	1120	350.20	453.20	727.08	0.40	0.10	727.48	727.18
Base	100	1376	366.18	473.88	727.55	0.38	0.14	727.93	727.69
Max. Calc.	500	2097	400.18	517.88	728.55	1.23	0.31	729.78	728.86

10 Year Velocity thru Existing Bridge= 2.06 fps
10 Year Velocity thru Proposed Bridge= 1.59 fps

DESIGN SCOUR ELEVATION TABLE

Design Scour Elevations (ft.)			
	W. Abut.	E. Abut.	Item 113
Q100	711.03	714.09	5
Q500	705.08	709.23	
Design	711.03	714.09	
Check	705.08	709.23	

FILE NAME = P:\2015\0558 IDOT Distl IL Route 47 at Main S of Elburn (PTB 171-04)\CADD\dgn\CADD\Bridge\Main St..T.S.& L\Wall & X-Section.dgn

MILHOUSE ENGINEERING & CONSTRUCTION

USER NAME = tsledge	DESIGNED - LAS	REVISED -
	CHECKED - DAZ	REVISED -
PLOT SCALE = 10.8333 ' / in.	DRAWN - TCS	REVISED -
PLOT DATE = 8/4/2016	CHECKED - LAS	REVISED -

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

SECTIONS
STRUCTURE NO. 045-3069
SHEET NO. 2 OF 2 SHEETS

F.A.P. RTE	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
326	107N-4	KANE	185	131
		CONTRACT NO. 60T21		
		ILLINOIS FED. AID PROJECT		

APPENDIX A

Wang Engineering

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

BORING LOG BB-01

WEI Job No.: 192-03-01

Client: **Milhouse Engineering & Construction, Inc.**
Project: **IL 47 at Main Street Intersection Improvements**
Location: **Elburn, Kane County, IL**

Datum: NAVD 88
Elevation: 728.14 ft
North: 1884832.56 ft
East: 947436.10 ft
Station: 198+55.00
Offset: 12.69' LT

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
727.4	8-inch thick ASPHALT --PAVEMENT--					
726.9	6-inch thick CONCRETE --PAVEMENT--					
726.6	4-inch thick CRUSHED STONE					
724.9	Medium stiff, brown SILTY CLAY --FILL--		1	4, 2, 1	0.50 P	27
722.6	Stiff, dark brown SILTY CLAY, trace gravel and shells, organic odor	5	2	2, 2, 2	1.00 P	25
720.1	Loose, dark brown SILTY LOAM, interbedded sand and clay, organic matter --Wet--		3	1, 2, 1	NP	78
717.6	Loose, dark brown SANDY LOAM, interbedded silt, trace gravel, organic matter --Saturated--	10	4	1, 5, 3	NP	41
	Medium dense, brown SANDY GRAVEL --Saturated--		5	2, 9, 13	NP	13
	--Saturated--	15	6	4, 6, 8	NP	14
	--Saturated--		7	5, 7, 13	NP	11
707.6	--becomes gray-- --Saturated--	20	8	14, 14, 5	NP	13

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
707.6	Very stiff to hard, pinkish gray SILTY CLAY to SILTY CLAY LOAM, trace gravel, interbedded sand --Hard drilling, 20 to 21 feet--		9	3, 8, 11	2.71 B	12
		25	10	7, 11, 11	5.33 B	12
			11	6, 11, 12	4.25 B	12
		30	12	8, 11, 11	3.44 B	12
691.1	--Interbedded sandy gravel--	35	13	12, 14, 23	>4.5 P	15
	Very dense, brown SANDY GRAVEL --Saturated--	40	14	11, 31, 30	NP	11

GENERAL NOTES

Begin Drilling **05-15-2015** Complete Drilling **05-15-2015**
Drilling Contractor **Wang Testing Services** Drill Rig **CME-55 TMR**
Driller **R & N** Logger **D. Kolpacki** Checked by **B. Wilson**
Drilling Method **3.25" IDA HSA, auto hammer, boring backfilled upon completion**

WATER LEVEL DATA

While Drilling ▽ **5.50 ft**
At Completion of Drilling ▼ **10.00 ft**
Time After Drilling **NA**
Depth to Water ▼ **NA**

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

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BORING LOG BB-01

WEI Job No.: 192-03-01

Client **Milhouse Engineering & Construction, Inc.**
Project **IL 47 at Main Street Intersection Improvements**
Location **Elburn, Kane County, IL**

Datum: NAVD 88
Elevation: 728.14 ft
North: 1884832.56 ft
East: 947436.10 ft
Station: 198+55.00
Offset: 12.69' LT

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample Type recovery	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
686.1	Very dense, gray fine SAND, trace gravel --Heaving sand-- --Wet--						
		45		15	25 39 40	NP	12
		50		16	14 29 35	NP	12
676.1	Hard, gray CLAY LOAM, some gravel --Hard drilling, 50 to 53.5 feet --						
		55		17	59 50/5"	> 4.50 P	11
671.6	Dense to very dense, SANDY GRAVEL --ARTESIAN GROUNDWATER BEARING LAYER--						
		60		18	5 15 20	NP	13
	--ARTESIAN GROUNDWATER BEARING LAYER-- --Heaving sand--	65		19	13 13 20	NP	4
	--Heaving sand and gravel--	70		20	25 32 38	NP	9
656.4	Dense, gray, medium SAND, trace gravel --Heaving sand and gravel-- --Saturated--						
653.1		75		21	13 23 26	NP	26
	Boring terminated at 75.00 ft						
		80					

GENERAL NOTES

Begin Drilling **05-15-2015** Complete Drilling **05-15-2015**
Drilling Contractor **Wang Testing Services** Drill Rig **CME-55 TMR**
Driller **R & N** Logger **D. Kolpacki** Checked by **B. Wilson**
Drilling Method **3.25" IDA HSA, auto hammer, boring backfilled upon completion**

WATER LEVEL DATA

While Drilling **5.50 ft**
At Completion of Drilling **10.00 ft**
Time After Drilling **NA**
Depth to Water **NA**

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

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BORING LOG BB-02

WEI Job No.: 192-03-01

Client **Milhouse Engineering & Construction, Inc.**
Project **IL 47 at Main Street Intersection Improvements**
Location **Elburn, Kane County, IL**

Datum: NAVD 88
Elevation: 724.68 ft
North: 1884770.28 ft
East: 947486.61 ft
Station: 199+04.76
Offset: 50.19' RT

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
	12-inch thick, brown SILTY LOAM --TOPSOIL--					
723.7	Loose, dark brown SILTY LOAM, trace gravel and roots --Moist--		1	1 2 3	NP	33
721.7	Stiff, dark brown CLAY LOAM, trace gravel, organic matter	5	2	2 6 7	1.00 P	52
719.2	Medium dense, brown, fine SAND --Saturated--		3	4 6 20	NP	16
716.7	Medium dense, brown GRAVELLY SAND --Saturated--	10	4	5 8 9	NP	16
	--becomes gray-- --%Gravel=65.1-- --%Sand=28.8-- --%Silt=5.0-- --%Clay=1.1-- --A-1-a (0)--		5	11 9 8	NP	8
		15	6	11 13 10	NP	11
709.2	Very stiff to hard, pinkish gray SILTY CLAY LOAM, trace to little gravel		7	9 9 11	4.43 B	11
	--Hard drilling, 18.5 to 20.5 feet-- --Possible Cobbles--	20				
			9	10 12 17	2.00 P	14
		25	10	10 12 16	3.61 B	13
699.2	Dense, gray SANDY GRAVEL --Saturated--		11	10 16 21	NP	11
		30	12	14 16 17	NP	15
692.9	Stiff, pinkish gray SILTY CLAY LOAM and GRAVEL	35	13	5 9 10	1.25 P	11
687.9	Medium dense, gray medium to coarse SAND, trace to some gravel -- Saturated--	40	14	13 12 14	NP	16

GENERAL NOTES

Begin Drilling **04-22-2015** Complete Drilling **04-23-2015**
Drilling Contractor **Wang Testing Services** Drill Rig **D-50 TMR**
Driller **R & J** Logger **D. Kolpacki** Checked by **B. Wilson**
Drilling Method **2.25" IDA SSA to 10', Mud rotary from 10', auto hammer, boring backfilled upon completion**

WATER LEVEL DATA

While Drilling ▽ **5.50 ft**
At Completion of Drilling ▼ **0.00 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 BB-02

WEI Job No.: 192-03-01

Client **Milhouse Engineering & Construction, Inc.**
Project **IL 47 at Main Street Intersection Improvements**
Location **Elburn, Kane County, IL**

Datum: NAVD 88
Elevation: 724.68 ft
North: 1884770.28 ft
East: 947486.61 ft
Station: 199+04.76
Offset: 50.19' RT

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
		45	15	8 12 14	NP	23
677.7	Dense, gray SILTY LOAM, interbedded, very stiff (3.0P), clay --Wet--	50	16	18 19 25	NP	15
672.9	Very stiff, pinkish gray CLAY LOAM, little gravel --Interbedded silt-- --Wet--	55	17	17 31 50/1"	3.85 S	16
667.9	Very dense, gray GRAVELLY LOAM --Moist--	60	18	14 20 35	NP	10
	--HARD DRILLING-- --ARTESIAN GROUNDWATER BEARING LAYER--	65	19	43 43 27	NP	10
657.9	Medium dense to very dense, gray and brownish gray, medium to coarse SAND, trace to some gravel --Washed out sample-- --Saturated--	70	20	17 7 12	NP	27
			21	6 18 28 29	NP	11
650.2	Boring terminated at 74.50 ft	75				
		80				

GENERAL NOTES

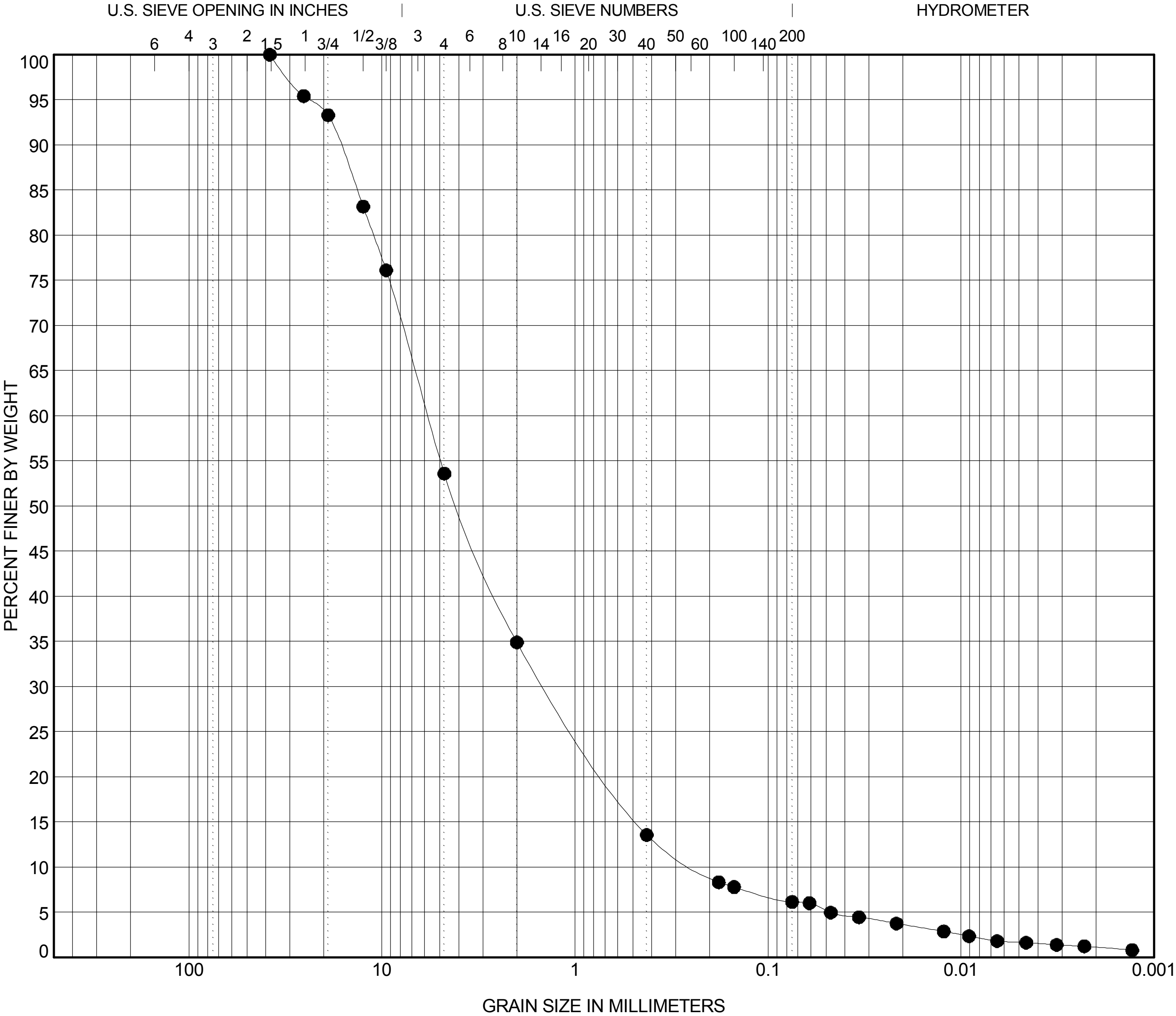
Begin Drilling **04-22-2015** Complete Drilling **04-23-2015**
Drilling Contractor **Wang Testing Services** Drill Rig **D-50 TMR**
Driller **R & J** Logger **D. Kolpacki** Checked by **B. Wilson**
Drilling Method **2.25" IDA SSA to 10', Mud rotary from 10', auto hammer, boring backfilled upon completion**

WATER LEVEL DATA

While Drilling **5.50 ft**
At Completion of Drilling **0.00 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 coarse	SAND fine	SILT AND CLAY

	Specimen Identification		IDH Classification	LL	PL	PI	Cc	Cu
●	BB-02#5	11.0 ft	**Gravelly Sand**	**NP**	**NP**	**NP**	**1.43**	**24.43**

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	BB-02#5	11.0 ft	**38.1**	**5.784**	**1.401**	**0.237**	**65.1**	**28.8**	**5.0**	**1.1**

WEI GRAIN SIZE IDH 1920301.GPJ US LAB.GDT 6/22/15

WEI SINCE 1982

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GRAIN SIZE DISTRIBUTION

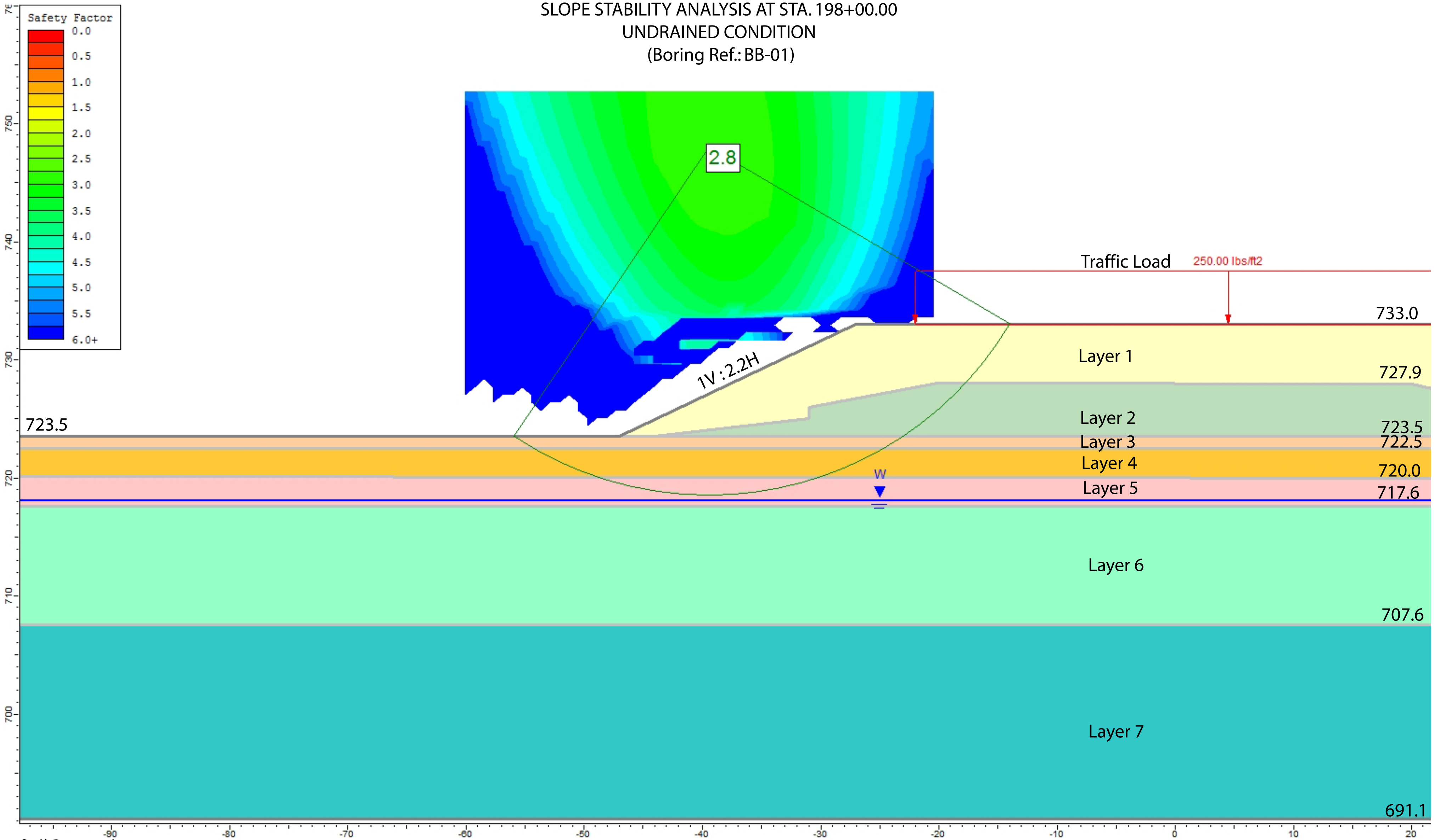
Project: IL 47 at Main Street Intersection Improvements

Location: Elburn, Kane County, IL

Number: 192-03-01

APPENDIX C

SLOPE STABILITY ANALYSIS AT STA. 198+00.00
UNDRAINED CONDITION
(Boring Ref.: BB-01)



Soil Properties

Layer ID	Soil Type	Unit Weight (pcf)	Undrained Parameter C_u (psf)	Undrained Parameter ϕ (deg.)
1	IDOT Fill	125	1000	0
2	Medium Stiff Silty Clay (Fill)	110	500	0
3	Stiff Silty Clay	110	1000	0
4	Loose Silty Loam	105	0	27
5	Loose Sandy Loam	115	0	28
6	Medium Dense Sandy Gravel	125	0	32
7	Very Stiff to Hard Silty Clay to Silty Clay Loam	120	3400	0

SLOPE STABILITY ANALYSIS: MAIN STREET OVER BLACKBERRY CREEK BRIDGE, IL-47 AT MAIN STREET INTERSECTION IMPROVEMENTS, KANE COUNTY, ILLINOIS

SCALE: GRAPHICAL

APPENDIX C-1

DRAWN BY: R. KC
CHECKED BY: A. KURNIA

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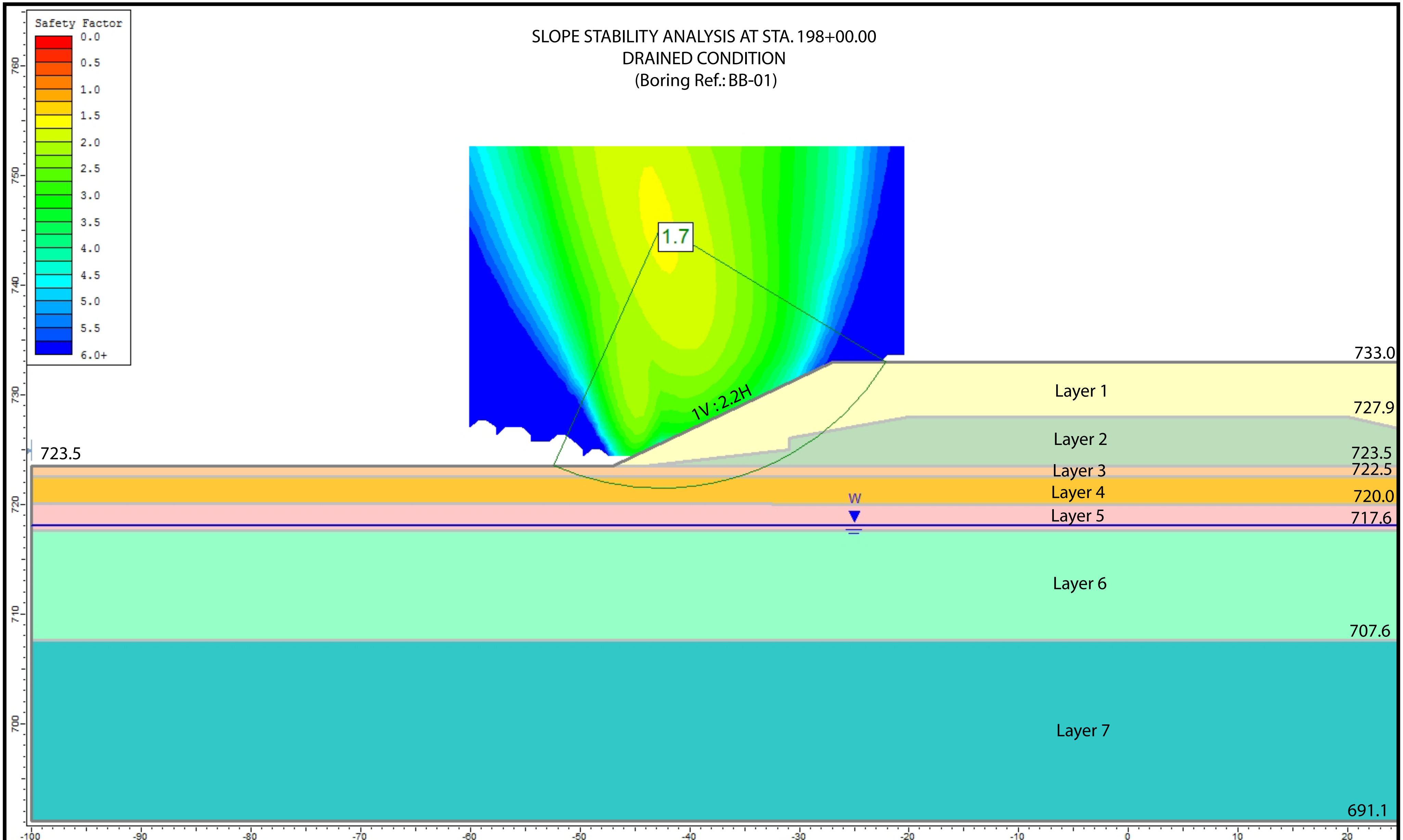
FOR MILHOUSE ENGINEERING AND CONSTRUCTION, INC.

192-03-01

SLOPE STABILITY ANALYSIS AT STA. 198+00.00
DRAINED CONDITION
(Boring Ref.: BB-01)



Soil Properties

Layer ID	Soil Type	Unit Weight (pcf)	Drained Parameter C' (psf)	Drained Parameter ϕ (deg.)
1	IDOT Fill	125	100	30
2	Medium Stiff Silty Clay (Fill)	110	0	28
3	Stiff Silty Clay	110	0	28
4	Loose Silty Loam	105	0	27
5	Loose Sandy Loam	115	0	28
6	Medium Dense Sandy Gravel	125	0	32
7	Very Stiff to Hard Silty Clay to Silty Clay Loam	120	100	30

SLOPE STABILITY ANALYSIS: MAIN STREET OVER BLACKBERRY CREEK BRIDGE, IL-47 AT MAIN STREET INTERSECTION IMPROVEMENTS, KANE COUNTY, ILLINOIS

SCALE: GRAPHICAL | APPENDIX C-2 | DRAWN BY: R. KC | CHECKED BY: A. KURNIA

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