STRUCTURE GEOTECHNICAL REPORT
US ROUTE 45 (FAP 344) OVER MILBURN CREEK
EXISTING SN NONE, PROPOSED SN 049-0610
SECTION 39R, CONTRACT 60T75
IDOT PROJECT D-91-424-12, PTB 164/04
LAKE COUNTY, ILLINOIS

for

Parsons Transportation Group, Inc.

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11. Abstract

A new three-sided arch culvert will carry the proposed Bypass of US Route 45 over the Milburn Creek. The proposed structure is a precast concrete arch structure with a length of 104'-2", measured out-to-out of the structure headwalls. The total span length will be 44'-4" with a clear span of 42'-0". The both ends of headwalls will be a Mechanically Stabilized Earth (MSE) wall with total lengths of 120 and 115 feet for east and west walls, respectively. This report provides geotechnical recommendations for the design of proposed structure foundations and MSE walls.

At the site, the general soil profile consists of up to 48-inch thick black loam topsoil overlying up to 48 feet thick of stiff to hard clay to silty clay loam containing medium stiff / medium dense silt to silty loam layers followed by medium dense to very dense gravelly sand to sand. Groundwater was encountered at depths of 15.5 to 45 feet below the existing grade, or elevations ranging from 678 to 708 feet. The site classifies in the Seismic Class D and is in Seismic Performance Zone 1.

The proposed structure could be supported on spread footings or driven metal shell piles. Based on our analyses for spread footings, we recommend a factored bearing resistance of 6.0 ksf considering a resistance factor of 0.5. We recommend removing 6 inches of soil below the footing and replacing with compacted crushed stone. Our settlement analyses show the foundation soils will undergo settlement of 1.0 inch, and differential settlement of less than 0.5 inches. The piles could be 12-inch or 14-inch diameter metal shells. Piles lengths will be about 16 to 38 feet long to provide 60 to 180 kips of factored resistance.

The roadway will require 8 to 9 feet of fill at the structure approach sections, and about 3 to 4 feet of fill on the roof of arch culvert. The proposed MSE walls will have a maximum supported height of about 19.1 feet. The MSE wall sections to the southeast of the structure have FOS against global instability of 3.4 and 2.0 for the short-term and long-term conditions, and will experience total long-term post-construction consolidation settlement of 1.0 inch or less. We recommend the MSE walls be designed based on a factored bearing resistance of 7.8 ksf.

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FOR
PARSONS TRANSPORTATION GROUP, INC.

1.0 INTRODUCTION

This report presents the results of Wang Engineering, Inc. (Wang) subsurface investigation, laboratory testing, geotechnical evaluations, and recommendations for the design and construction of the proposed structure over Milburn Creek included in construction of Realignment of US Route 45 in the Lake County, Illinois. A *Site Location Map* is presented as Exhibit 1.

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 structure foundations and associated retaining walls.

1.1 Project Description

The project includes realignment of new roadway US Route 45 (US 45 Bypass) approximately 1,000 feet to the west of the existing US Route 45. The US 45 Bypass will be constructed from County Place on the south to 1,500 feet north of Independence Boulevard on the north, a length of 7,200 feet. In addition, Grass Lake Road will be realigned south of its current location to form the west leg of the intersection of US 45 and Milburn Road. The project lies within the municipal boundaries of the Village of Lindenhurst on the west, and the Village of Old Mill Creek on the east. The project also lies within unincorporated areas of Lake County within Lake Villa and Newport Townships.

The proposed improvements include construction of a new US 45 Bypass roadway, a three-sided structure and a series of box culverts to carry US 45 Bypass over Milburn Creek and Unnamed Tributaries to Milburn Creek, retaining walls, and detention ponds.

1.2 Proposed Structure

Wang understands Parsons Transportation Group, Inc. (Parsons) envision a new arch culvert supported on spread footings or driven piles for the US 45 Bypass over Milburn Creek. The type, size, and location (TSL) Plan provided by Parsons shows a precast concrete arch structure with a length of 104'-2", measured out-to-out of the structure headwalls. The total span length will be 44'-4" with a clear span of 42'-0". The TSL Plan dated November 4, 2015 received on November 5, 2015 is included in Appendix D.

The roadway will require 8 to 9 feet of fill at the structure approach sections, and about 3 to 4 feet of vertical fill on the roof of arch culvert, both will be supported by the Mechanically Stabilized Earth (MSE) walls. The proposed MSE walls will have a maximum supported height of 19.1 feet. The length of east and west MSE walls is 120 and 115 feet, respectively.

The stage construction is not required due to a new roadway construction.

1.3 Existing Structure

There is no existing structure at this location.

2.0 SITE CONDITIONS AND GEOLOGICAL SETTING

The project area is located in northcentral Lake County along the border of the Villages of Lindenhurst and Old Mill Creek. On the USGS Antioch Quadrangle 7.5 Minute Series map, the proposed structure is located in the SE ¼ of Section 36, Tier 46 North, and Range 10 East of the 3rd Principal Meridian. A Site Location Map is presented as Exhibit 1

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

2.1 Physiography

Northcentral Lake County, part of the Wheaton Morainal Country within the Great Lake Physiographic Section (Leighton et al. 1948), is characterized by hummocky topography as a result of numerous advances and retreats of ice sheets during the Wisconsin Episode of glaciation. The project site is located along the north to south trending Valparaiso Moraine, which contains abundant kettle lakes and wetland areas. Millburn Creek drains from McDonald Lake, located west of the project area, and crosses the existing US Route 45 flowing east toward North Mill Creek. Ground elevations at the project site are approximately 720 to 726 feet.

2.2 Surficial Cover

The surficial cover is primarily the result of Wisconsin-age glacial activity (Hansel and Johnson, 1996). 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. Many kettle depressions and other low-lying areas that scar the Valparaiso Moraine were filled with peat and marl of the Grayslake Peat. The Valparaiso Moraine contains diamicton of the Wadsworth Formation, consisting of clay to silty clay loam and includes lenses of sand, silt, and clay (Hansel and Johnson 1996). The Wadsworth Formation is underlain by sand and gravel outwash deposits of the Henry Formation. The drift thickness along the project alignment ranges from 200 to 260 feet (Dixon-Warren and O'Malley 2004).

2.3 Bedrock

In northcentral Lake County the surficial cover rests unconformably on top of nearly horizontal Silurian-age dolomite. The top of the bedrock lies approximately 200 to 260 feet below the ground surface (bgs) at approximately 500 to 520 feet elevation (Dixon-Warren and O'Malley 2004).

Our subsurface investigation results fit into the local geologic context. In descending order, the borings drilled in the project area revealed that the native sediments along the site consist of clay, silty clay, and silty clay loam diamicton of the Wadsworth Formation overlying sand and gravel outwash of the Henry Formation. None of the borings drilled for this investigation encountered organic soils of the Grayslake Peat or bedrock.

3.0 METHODS OF INVESTIGATION

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

3.1 Subsurface Investigation

The subsurface investigation performed by Wang consisted of seven structure borings, designated as BSB1-01 through BSB1-03 for the three sided structure, RWB1-01 and RWB1-02 for the west wall, and RWB2-01 and RWB2-02 for the east wall. The borings were drilled in September 2014 from elevations of 721.5 to 725.8 feet to depths of 30.0 and 60.0 feet below ground surface (bgs). Boring locations proposed by Wang and approved by Parsons were staked in the field using a mapping-grade GPS. The as-drilled boring locations were surveyed by Dynasty Group and stations and offsets were provided by Parsons. The boring location data are shown in the *Boring Logs* (Appendix A), and the as-drilled locations are shown in the *Boring Location Plan* (Exhibit 3).

An ATV-mounted drill rig, equipped with hollow stem augers, was used to advance and maintain an open borehole. Soil sampling was performed according to AASHTO T 206, "*Penetration Test and Split Barrel Sampling of Soils*." The soil was sampled at 2.5-foot intervals to 30 feet bgs and at 5.0-foot intervals, thereafter. Soil samples from each interval were placed in sealed jars for further laboratory testing.

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

Groundwater observations were made during and after drilling operations. The borings were backfilled with soil cuttings and bentonite chips after completion.

3.2 Laboratory Testing

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

4.0 RESULTS OF FIELD AND LABORATORY INVESTIGATIONS

Detailed descriptions of the soil conditions encountered during the subsurface investigation are presented in the attached *Boring Logs* (Appendix A) and in the *Soil Profiles* (Exhibits 4-1 through 4-3). 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

At the surface, the borings sampled 12- to 48-inch thick black loam topsoil. In descending order, the general lithologic succession encountered in the borings includes 1) stiff to hard clay and silty clay to silty clay loam; and 2) medium dense to very dense sand to gravelly sandy loam.

1) Stiff to hard clay to silty clay loam

Beneath the topsoil, the borings encountered up to 46 feet of stiff to hard clay to silty clay loam to depths of 45.5 to 46.8 feet bgs (elevation 676.0 to 677.8 feet) or to the boring termination depth of 30 feet (elevations 688.5 to 695.8). The soils consist of brown, grayish brown, and gray clay to silty clay loam. Generally, this unit has unconfined compressive strength (Q_u) values of 0.3 to 6.8 tsf with an average of 2.5 tsf and moisture content values of 15 to 33% with an average of 22%. Laboratory index testing on samples shows liquid limit (L_L) value ranging from 36 to 41% and plastic limit (P_L) value ranging from 17 to 19%. According to the AASHTO soil classification, the soils belong to A-6 and A-7 groups.

A discontinuous layer of medium stiff to stiff silty loam to medium dense silt measuring 1.0 to 6.0 feet in thickness was interbedded within the clay to silty clay layer. The silty loam has Q_u values of 0.9 to 2.3 tsf and moisture content values of 15 and 20%. The silt has SPT N-value of 12 blows/foot and moisture content value of 19%. Laboratory index testing on sample from this layer shows L_L value of 17% and P_L value of 12%. This soil is AASHTO classified as A-4 group.

2) Medium dense to very dense sand to gravelly sandy loam

Underlying the cohesive soils, at elevations of 676 to 678 feet, the deeper borings encountered medium dense to very dense, brown and gray, sand, sandy gravel, and gravelly sandy loam extending to the boring termination depth of 60 feet (elevations 661.5 to 663.3). These granular soils have SPT N-values ranging from 12 to 64 blows/foot with an average of 27 blows/foot and moisture contents values of 10 to 20% with an average of 16%.

4.2 Groundwater Conditions

Groundwater was encountered within the granular soils while drilling between elevations of 676 and 708 feet (15.5 to 46.8 feet bgs). Upon completion of drilling, groundwater was measured between elevations of 678 and 708 feet (15.5 to 45 feet bgs). For our analysis for the structure, the groundwater was considered at elevation of 676 feet.

4.3 Scour Considerations

Based on the TSL plan, Wang understands that the flow line elevations at the upstream and downstream face of the structure are 718.27 and 716.88 feet, respectively.

The design scour elevations for the proposed structure provided by Parsons are presented in Table 1. Based on the soil information from our borings, the soils below the streambed are mainly stiff to very stiff silty clay to silty clay loam interbedded with sand and silt; therefore, we do not recommend reduction in design scour elevations.

Table 1: Design Scour Elevations

Event/Limit State	Design Scour Elevation (ft)		Item 113
	Upstream	Downstream	
Q100	714.71	715.72	8
Q500	713.21	714.19	
Design	711.20	711.20	
Check	711.20	711.20	

4.4 Seismic Design Consideration

Seismic analyses in accordance with IDOT *All Geotechnical Manual Users (AGMU) 9.1* (2010) classify the site in Seismic Site Class D; the project location belongs to Seismic Performance Zone 1. The seismic spectral acceleration parameters recommended for design in accordance with the 2012 AASHTO *LRFD Design Specifications* are summarized in Table 2 (AASHTO 2012). Per IDOT (2012a), structures within Seismic Performance Zone 1 do not require a liquefaction analysis.

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= 3.6	F_{pga}= 1.6	**A_s= 5.7**
0.2	S_S= 7.7	F_a= 1.6	**S_{DS}= 12.3**
1.0	S_1= 3.1	F_v= 2.4	**S_{D1}= 7.5**

1) Base spectral acceleration coefficients from AASHTO (2012)

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

5.0 FOUNDATION ANALYSIS AND RECOMMENDATIONS

Geotechnical evaluations and recommendations for the three-sided arch structure foundations and retaining walls are included in the following sections. Wang has evaluated possible foundation types that could be considered for the support of the proposed arch culvert.

5.1 Structure Foundations

The foundation soil conditions include very stiff silty clay to silty clay loam. Since minimal scour anticipated at the proposed structure location, structure foundations may be founded on spread footings.

5.1.1 Spread Footings

The estimated service and factored loads provided by Parsons are summarized in Table 3.

Table 3: Summary of Foundation Dead Plus Live Loads

Structure ID	Axial Service Load (kips/foot)	Lateral Service Load (kips/foot)	Axial Factored Load (kips/foot)	Lateral Factored Load (kips/foot)
049-0610	32.8	14.1	45.9	20.1

The construction of the structure footings will require excavation up to a depth of 12 feet below the existing grade at boring location. We recommend a factored bearing resistance of 6.0 ksf considering a resistance factor of 0.5. We estimate that the structure footings will undergo a total settlement of 1 inch with differential settlement less than 0.5 inches considering footing width of 8 feet. The nominal sliding resistance (ultimate value) between foundation soil and spread footing can be calculated considering frictional resistance provided by the foundation soil with coefficient of friction of 0.40. Sliding resistance factor as per 2014 LRFD AASHTO should be 0.80.

5.1.2 Driven Piles

As an alternative to spread footings, the structure could also be supported on driven piles. We recommend either 12 or 14 inch diameter metal shell piles (MSP) since they are more economical than H piles.

IDOT specifies the maximum nominal required bearing (R_{NMAX}) for each pile and states the factored resistance available (R_F) should be based on a geotechnical resistance factor (Φ_G) of 0.55 (IDOT, 2012a). Nominal tip and side resistance were estimated using the methods and empirical equations presented in *AGMU Memorandum 10.2 – Geotechnical Pile Design* (IDOT, 2011).

The base of the pile cap is assumed to be at elevation 711.2 feet. The R_F, R_N, estimated pile tip elevations, and pile lengths for 12-inch diameter MSP and 14-inch diameter MSP are summarized in Tables 4 and 5. The lengths shown in the tables assume a 1-foot pile embedment into the cap.

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). Long-term settlement estimates show less than 0.4-inch and downdrag losses will not be required.

Table 4: Estimated Pile Lengths and Tip Elevations for 12-inch MSP

Structure Unit	Assumed Pile Cap Base Elevation (feet)	Required Nominal Bearing, R_N (kips)	Factored Geotechnical Loss (kips)	Factored Geotechnical Load Loss (kips)	Factored Resistance Available, R_F (kips)	Total Estimated Pile Length (feet)	Estimated Pile Tip Elevation (feet)
North and South Footings	711.2	108	0.0	0.0	60	19	693
		146	0.0	0.0	80	26	686
		182	0.0	0.0	100	32	680
		219	0.0	0.0	120	34	678
		255	0.0	0.0	140	37	675

Table 5: Estimated Pile Lengths and Tip Elevations for 14-inch MSP

Structure Unit	Assumed Pile Cap Base Elevations (feet)	Required Nominal Bearing, R_N (kips)	Factored Geotechnical Loss (kips)	Factored Geotechnical Load Loss (kips)	Factored Resistance Available, R_F (kips)	Total Estimated Pile Length (feet)	Estimated Pile Tip Elevation (feet)
North and South Footings	711.2	109	0.0	0.0	60	16	696
		146	0.0	0.0	80	21	691
		181	0.0	0.0	100	27	685
		218	0.0	0.0	120	32	680
		254	0.0	0.0	140	34	678
		290	0.0	0.0	160	35	677
		327	0.0	0.0	180	38	674

5.1.3 Lateral Loading

Lateral loads on the 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. The lateral load pile capacity analysis can be performed using computer program such as

COMP 624P, L-Pile or any other programs. The estimated soil parameters that may be used for the analysis of stresses and deflection under lateral loads are presented in Table 6. Group action should be considered for piles in soils calculating total lateral load resistance of the footings.

Table 6: Recommended Soil Parameters for Lateral Load Pile Analysis (Boring BSB1-03)

Soil Type (Layer)	Unit Weight, γ (pcf)	Undrained Shear Strength, c_u (psf)	Estimated Friction Angle, Φ (°)	Estimated Lateral Soil Modulus Parameter, k (pci)	Estimated Soil Strain Parameter, ε_{50} (%)
Very Stiff Silty Clay to Silty Clay Loam 711.8*-711.2	125	2,200	0	750	0.60
Silt 711.2 -709.8	110	0	28	60	--
Very Stiff Silty Clay 709.8-708.8	125	2,100	0	750	0.60
Medium Dense Silt 708.8 -705.3	110	0	29	75	--
Medium Stiff Silty Loam 705.3-702.8	115	900	0	140	0.85
Very Stiff Silty Clay 702.8-686.6	125	2,200	0	750	0.60
Stiff Silty Clay 686.6-677.8	120	1,600	0	550	0.70
Medium Dense Sand 677.8-669.0	65	0	30	60	--
Dense Sandy Gravel 669.0-666.3	75	0	35	125	--
Dense Sand 666.3-663.3	70	0	35	125	--

* Assumed bottom of pile cap base elevation of the footings.

5.2 MSE Walls

We understand the headwalls on both ends of the arch culvert, east and west walls will be MSE walls. The selected MSE type wall is feasible and economical.

The 120-foot long **east** wall begins at Station 127+65.00 and ends at Station 128+85.00 and top of sidewalk elevations range 732.46 to 731.03 feet.

The 115-foot long **west** wall begins at Station 127+65.00 and ends at Station 128+80.00 and top of sidewalk elevations range 732.61 to 731.96 feet .

The retained height for both walls ranges from 3 to 19 feet.

5.2.1 Bearing Resistance and Sliding

The top of leveling pad should be at or below the Q500 design scour elevation for both MSE walls at the culvert side walls. It should remain at Q500 elevation at a minimum of 15 feet away from culvert side walls. The top of levelling pad in the remaining portion can be at a minimum of 3.5 feet below the finished grade at front face of the wall. It is recommended that a nominal bearing resistance of 12.0 ksf be considered for the design of MSE wall. Considering a bearing resistance factor of 0.65 (AASTHO, 2012), the factored bearing resistance will be 7,800 psf. We estimate the walls will apply a maximum factored equivalent uniform bearing pressure of about 5,250 psf at the highest wall sections adjacent to the structure.

The nominal sliding resistance (ultimate value) between the foundation soil and the MSE wall mass can be calculated considering the frictional resistance provided by a foundation soil with an angle of 34 degrees. Sliding resistance factor, as per Table 11.5.7-1 of 2012 AASHTO, should be 1.0. Design lateral pressure from surcharge loads due to roadway traffic and construction equipment should be added to the lateral earth pressure load. Our analysis shows the walls with reinforced zone widths of 0.7 times the total height will be stable in sliding. The eccentricity lies within the middle third of the walls, and we estimate the resistance against overturning is also sufficient.

5.2.2 Settlement Analysis

We evaluated the potential consolidation settlements resulting from the proposed fill for the wall using *IDOT Cohesive Soil Settlement Estimate (2014)*. Our evaluations show the foundation soils will undergo long-term settlement of 1.0 inch or less which is acceptable.

5.2.3 Global Stability

The global stability of the proposed walls was analyzed based on the soil profile and the information provided in the cross section drawings. We analyzed one section at Station 127+98 for the west retaining wall where the wall reaches a maximum height of about 19 feet. Wang calculated a FOS of 3.4 (Appendix C-1) in undrained soil conditions (short-term) and FOS of 2.0 (Appendix C-2) in drained soil conditions (long-term). The minimum required factor of safety (FOS) for both short- and long- term conditions is 1.5 (IDOT, 1999). Since the borings drilled for the east wall shows similar soil condition as along the west wall, and similar geometry we conclude there are no global stability concerns for the east wall too.

6.0 CONSTRUCTION CONSIDERATIONS

6.1 Site Preparation

Vegetation, topsoil, and debris should be cleared and stripped where foundations and structural fills will be placed. During excavation, the engineer should check for any unstable or unsuitable materials within the structure and MSE wall foundations. Unstable and unsuitable soils should be removed and replaced with compacted structural fill as described in Section 6.3.

6.2 Excavation and Dewatering

Foundation excavations should be performed in accordance with local, state, and federal regulations. The potential effect of ground movements upon nearby utilities should be considered during construction. Any excavation that cannot be graded 1:2 (V: H) should be properly shored with temporary sheet piling or soil retention systems.

The groundwater was encountered at the site 4 to 35 feet below the proposed footing excavation and the Contractor should be prepared for temporary dewatering of the foundation excavations.

Depending upon prevailing climatic conditions and the time of the year when construction takes place, control of runoff and maintenance of existing flows will require temporary water diversion and control. Any precipitation allowed to enter excavations should be immediately removed via sump pump. Any soil allowed to soften under standing water should be removed and replaced with structural fill.

6.3 Filling and Backfilling

Fill material required to attain the final design subgrade elevations should be in accordance with Section 205, *Embankment* (IDOT 2012b). All fill and backfill materials should be pre-approved by the site engineer. The fill should be free of organic materials and debris.

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

6.4 Earthwork Operations

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

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

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 2012b). Wang recommends including one test pile per footing. The test piles shall be driven to 110 percent of the nominal required bearing indicated in Section 5.1.2, Tables 4 and 5.

6.6 MSE Wall Construction

MSE walls should be constructed using the IDOT special provision GBSP38 developed by IDOT.

7.0 QUALIFICATIONS

The analyses 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 structure are planned, we should be timely informed so that our recommendations can be adjusted accordingly.

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

Respectfully Submitted,

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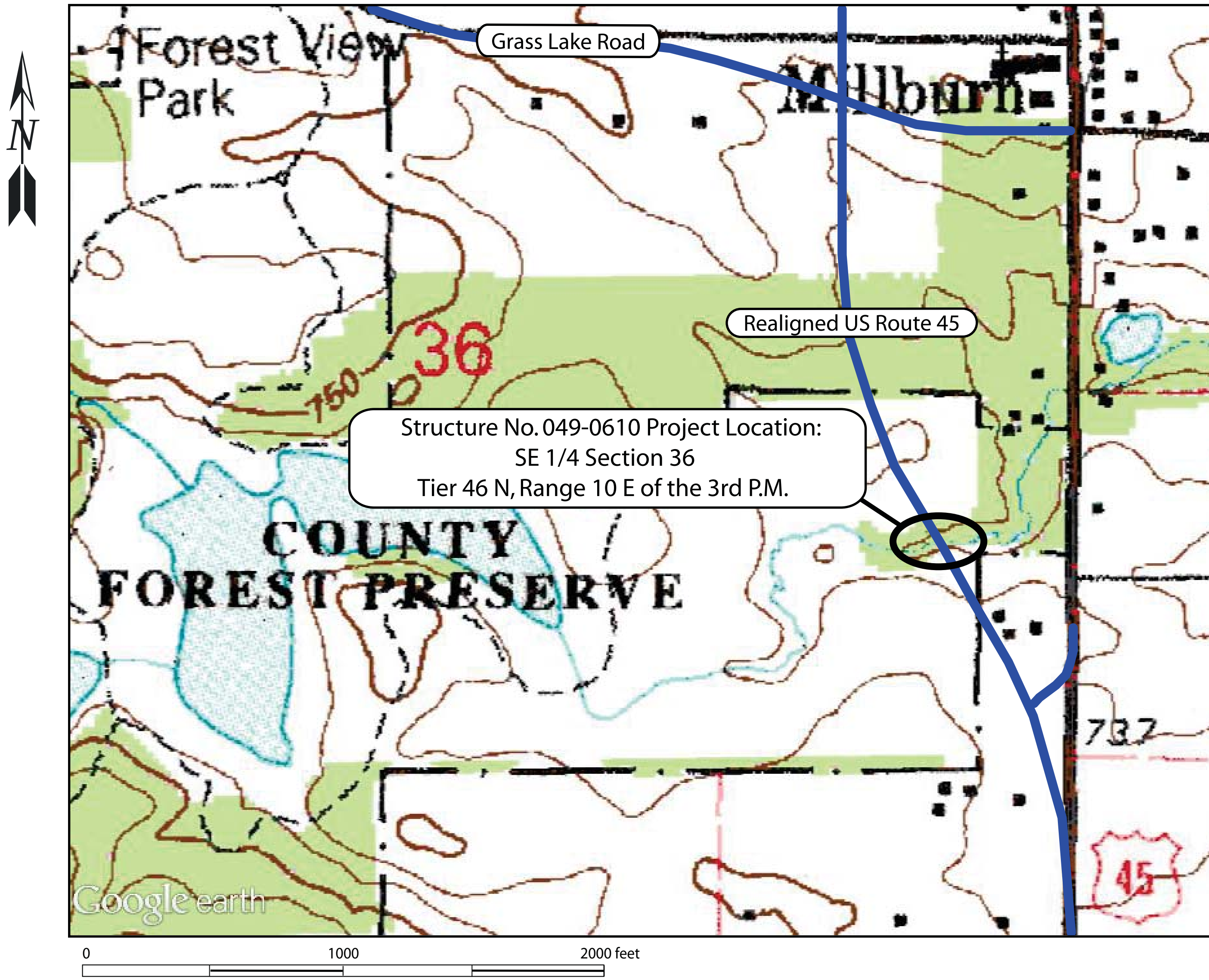
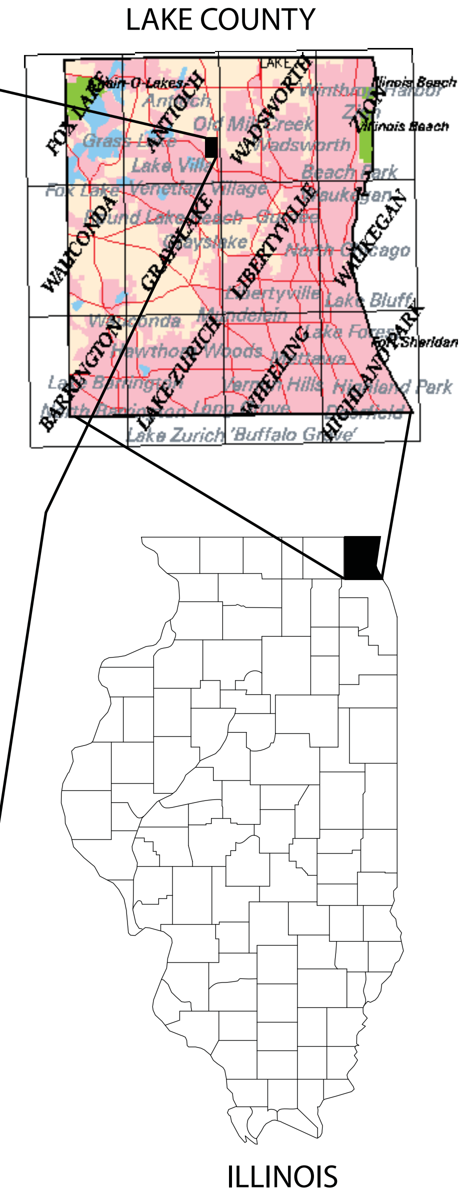
EXHIBITS

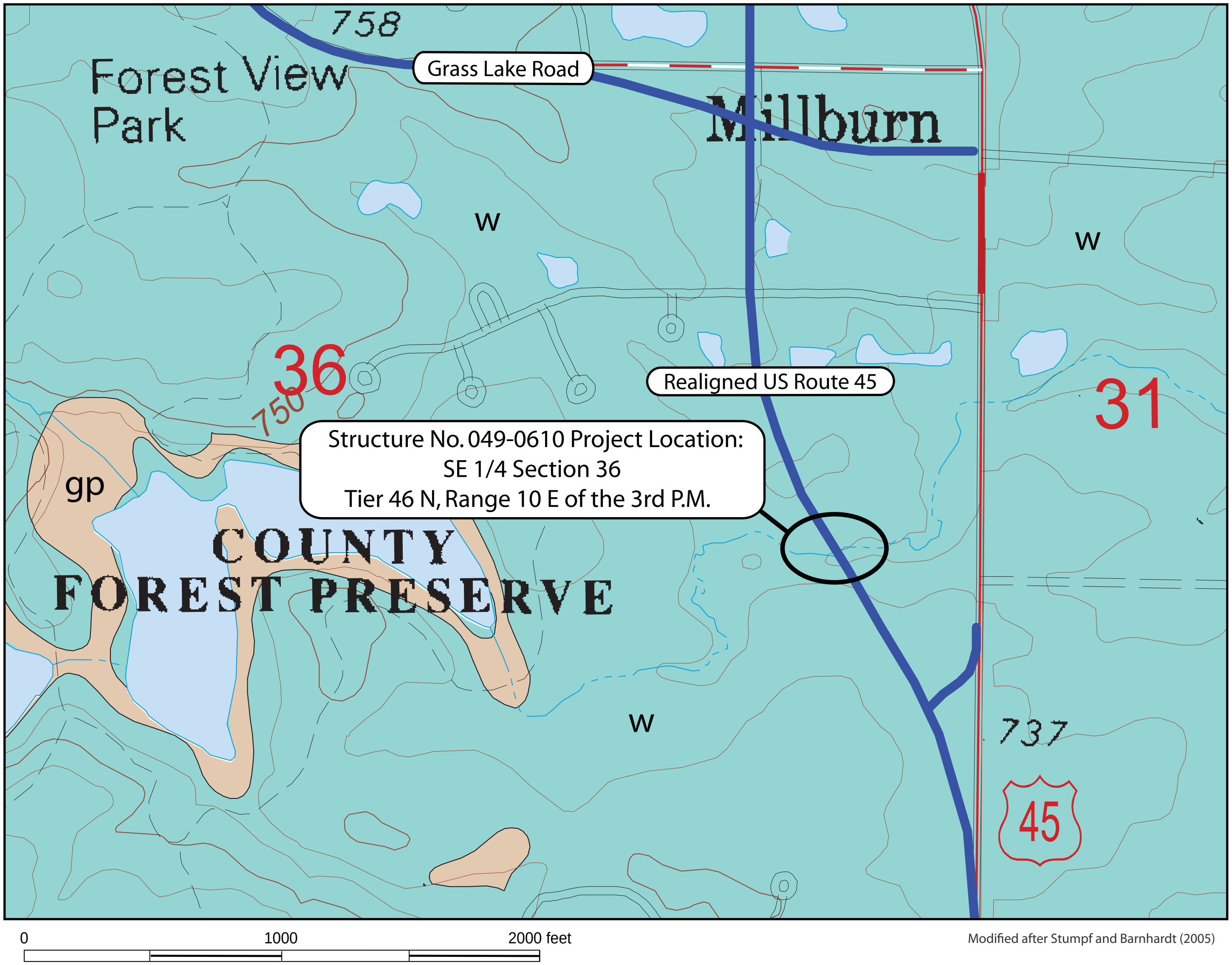




LEGEND

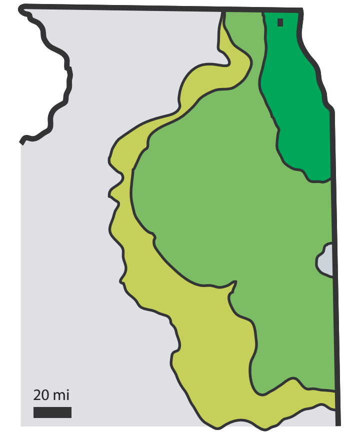
Project Alignment

SITE LOCATION MAP: US ROUTE 45, MILLBURN BYPASS STRUCTURE NO. 049-0610, LAKE COUNTY, ILLINOIS		
SCALE: GRAPHICAL	EXHIBIT 1	DRAWN BY: B. Wilson CHECKED BY: N. Balakumaran
Wang Engineering		1145 N. Main Street Lombard, IL 60148 www.wangeng.com
FOR PARSONS TRANSPORTATION GROUP, INC.		342-08-01



Modified after Stumpf and Barnhardt (2005)

REGIONAL GEOLOGY



Wedron Group

- Wadsworth Formation
- Lemont Formation
- Tiskilwa Formation

Modified after Hansel and Johnson (1996)

LEGEND

QUATERNARY DEPOSITS

HUDSON EPISODE

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

WISCONSIN EPISODE

w — **Wadsworth Formation**
Subglacial till, channel and lake deposites; silty clay loam to silty clay, pebbly with ocassional cobbles and boulders, silt and sand inclusions, sand and or gravel lenses common

Project Alignment

SITE AND REGIONAL GEOLOGY: US ROUTE 45, MILLBURN BYPASS
STRUCTURE NO. 049-0610, LAKE COUNTY, ILLINOIS

SCALE: GRAPHICAL	EXHIBIT 2	DRAWN BY: B. Wilson CHECKED BY: M. Kothawala

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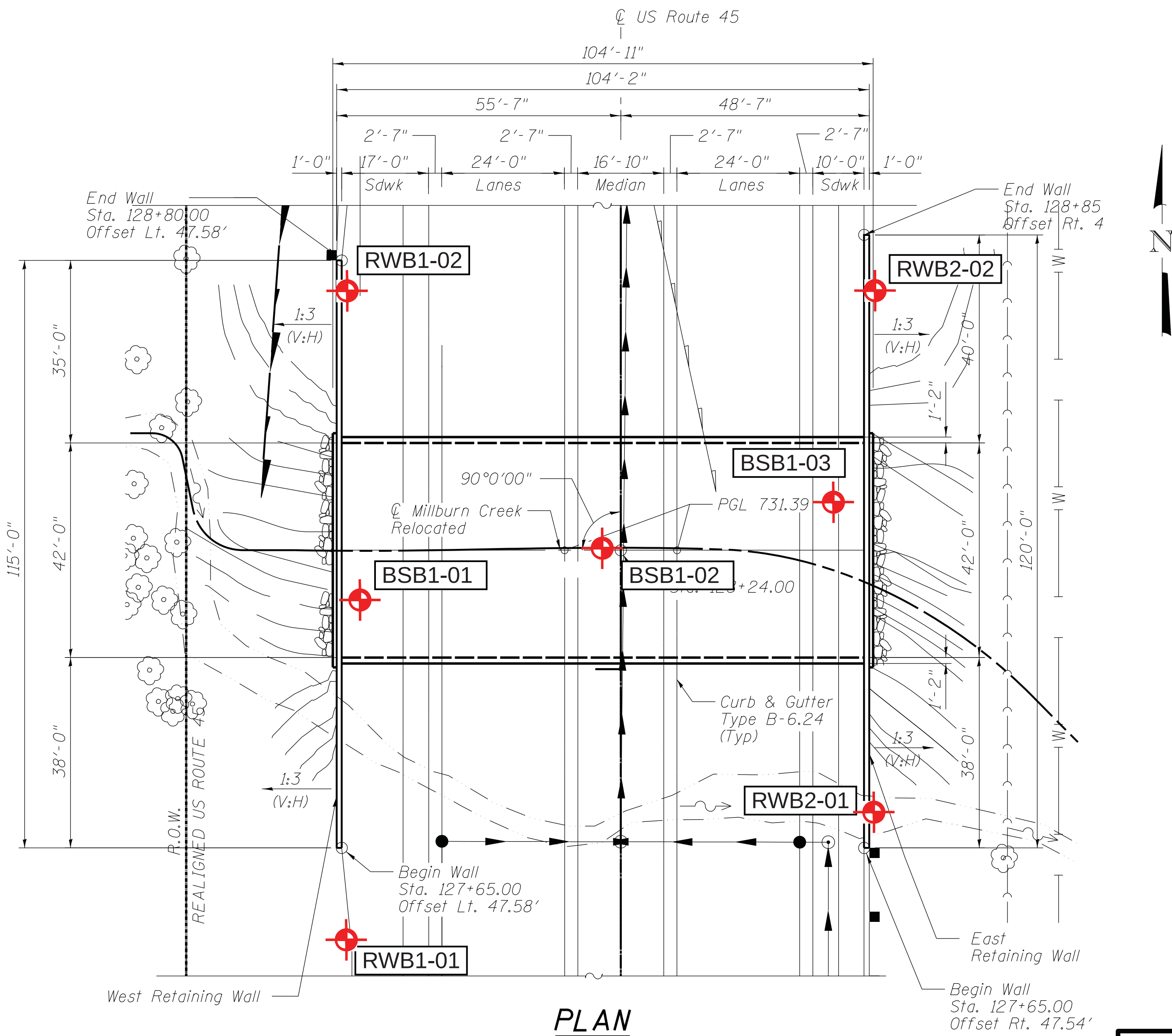
FOR PARSONS TRANSPORTATION GROUP, INC. — 342-08-01

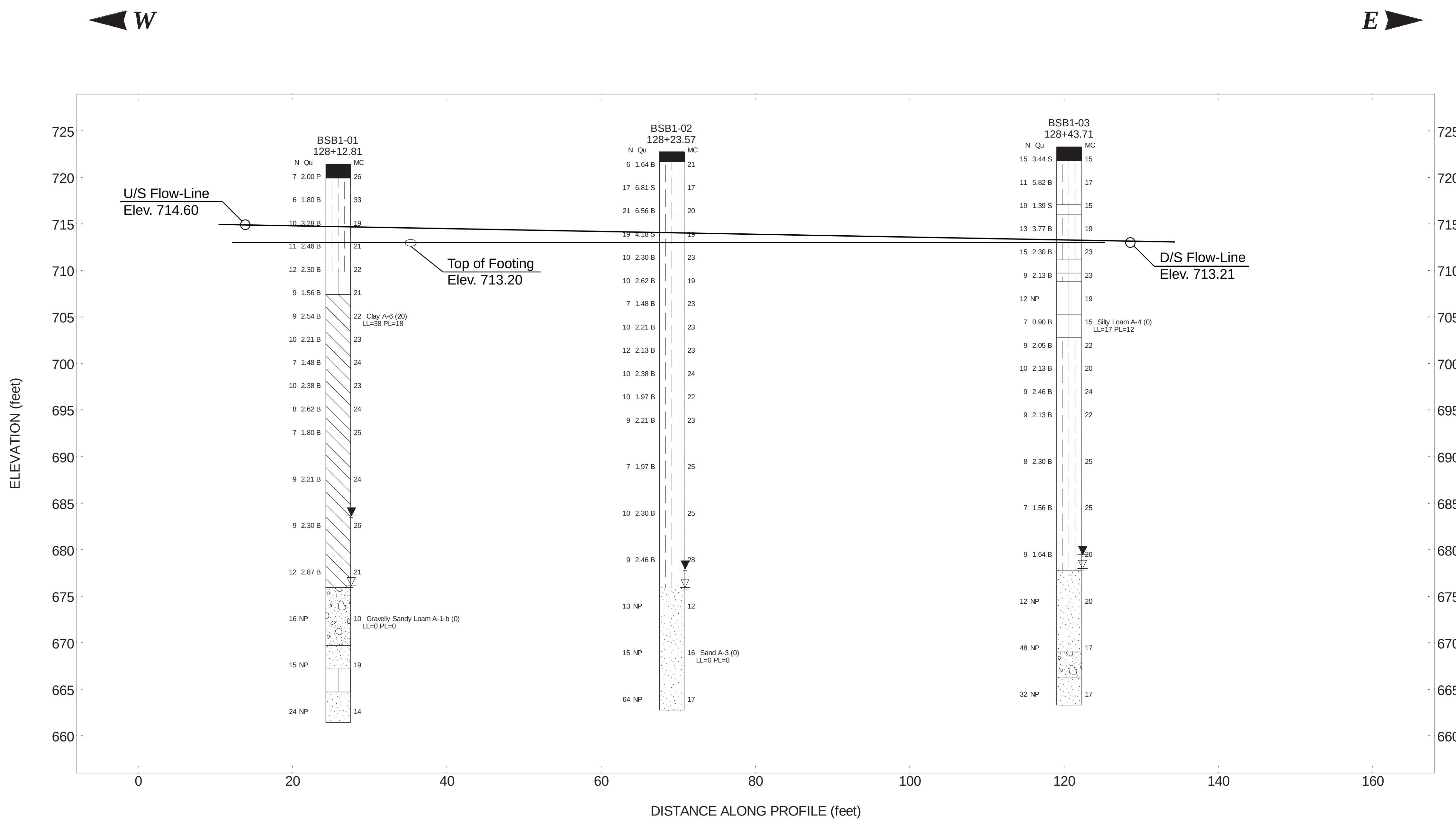


Legend

Soil Boring

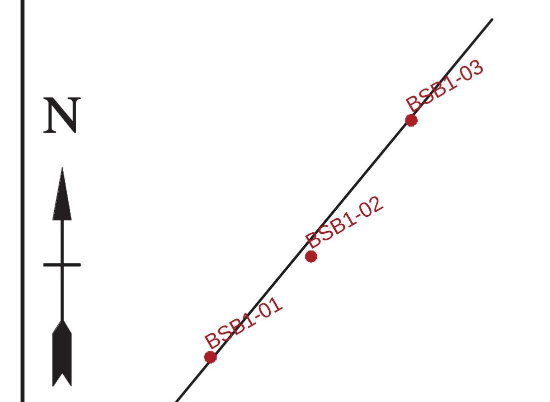
BORING LOCATION PLAN:US ROUTE 45, MILLBURN BYPASS STRUCTURE NO. 049-0610 AT STA. 128+24.00, LAKE COUNTY, ILLINOIS

SCALE: GRAPHIC	EXHIBIT 3	DRAWN BY: R. KC CHECKED BY: N. Balakumaran
Wang Engineering		1145 N. Main Street Lombard, IL 60148 www.wangeng.com
FOR PARSONS TRANSPORTATION GROUP, INC.		342-08-01



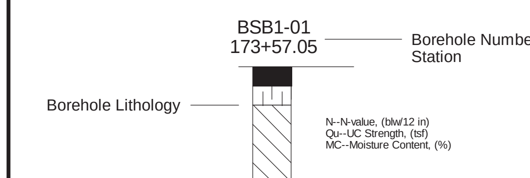
Lithology Graphics

Topsoil
IDH Silty Clay, Silty Clay Loam
IDH Silt, Silty Loam
IDH Clay
Gravelly sand, sandy gravel
IDH Sand, Sandy Loam



Site Map Scale 1 inch equals 60 feet

Explanation:



▽ Water Level Reading at time of drilling.

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

0 16

Horizontal Scale (feet)

Vertical Exaggeration: 1x

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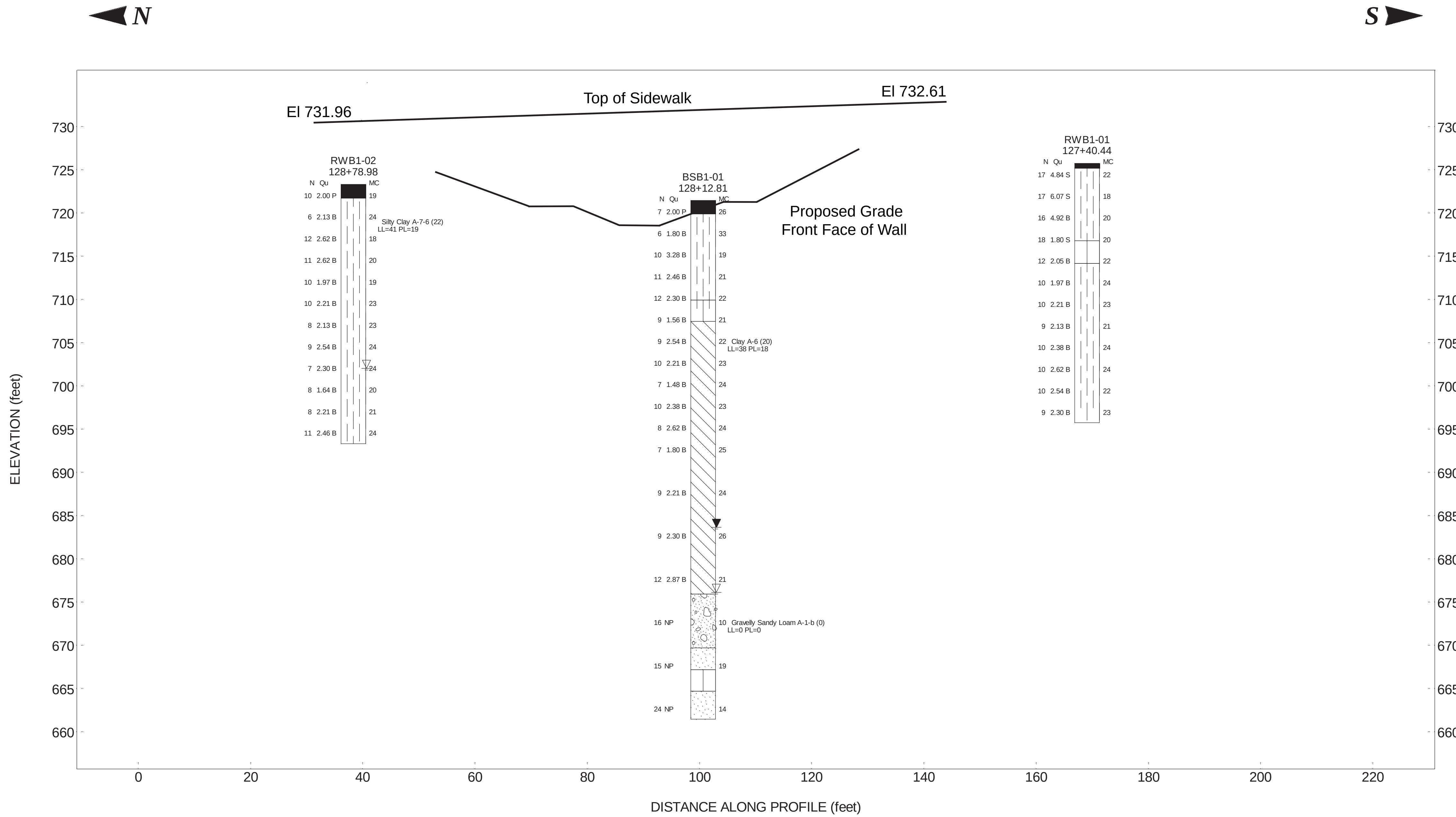
Structure No. 049-0610, Station 128+24.00
Soil Profile

WEI SINCE 1982

US 45 - Millburn Bypass
Lake County, Illinois

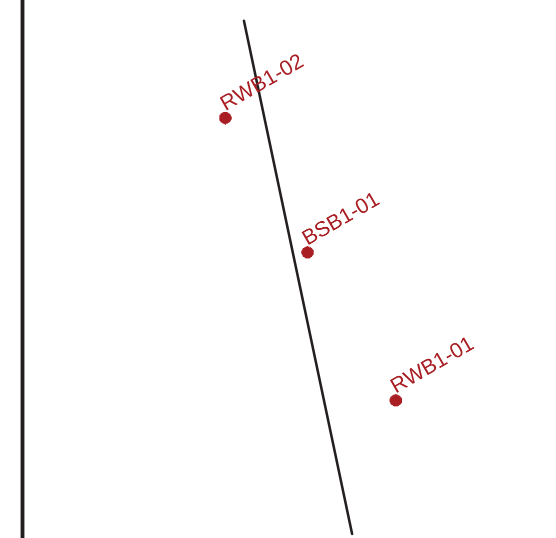
JOB NUMBER	PLATE NUMBER
342-08-01	EXHIBIT 4-1

WEI 11X17 3420801.GPJ WANGENG.GDT 5/26/15



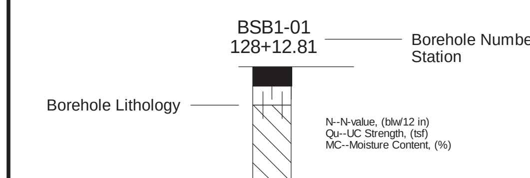
Lithology Graphics

- Topsoil
- IDH Silty Clay, Silty Clay Loam
- IDH Silt, Silty Loam
- IDH Clay
- Gravelly sand, sandy gravel
- IDH Sand, Sandy Loam



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: 1.5x

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Lombard, IL 60148

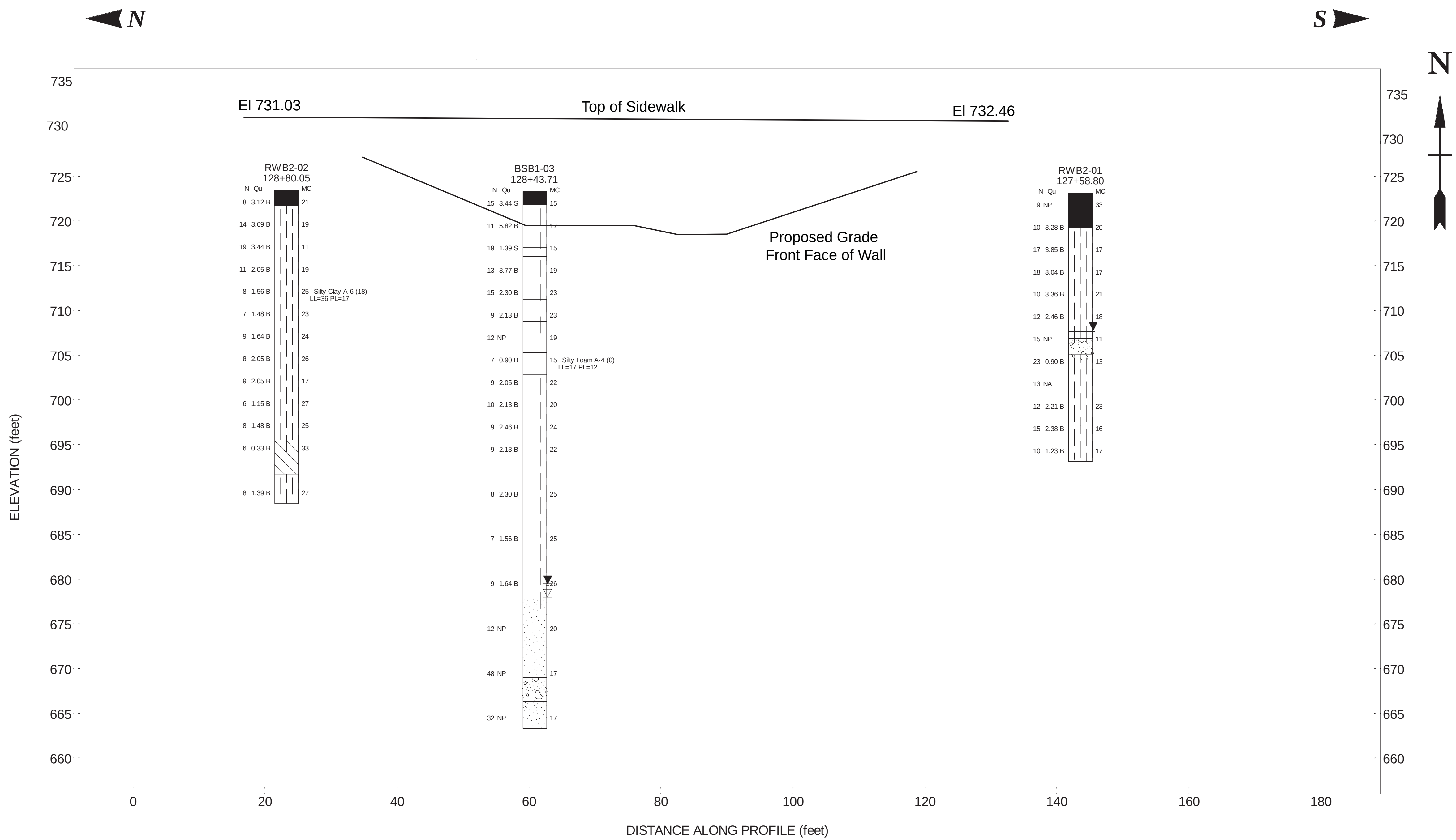
Soil Profile
West Retaining Wall

WEI SINCE 1982

US 45 - Millburn Bypass
Lake County, Illinois

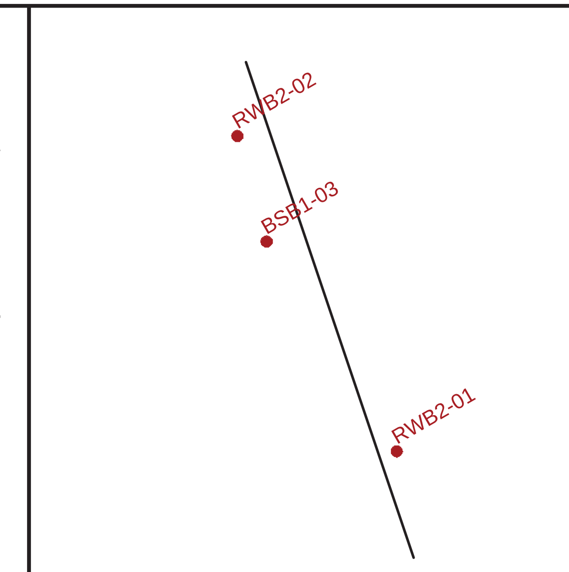
JOB NUMBER	PLATE NUMBER
342-08-01	EXHIBIT 4-2

WEI 11X17 3420801.GPJ WANGENG.GDT 5/29/15



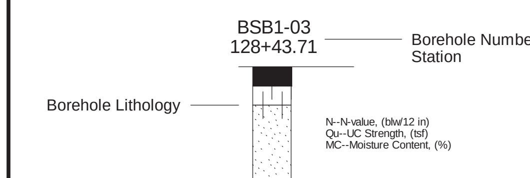
Lithology Graphics

- Topsoil
- IDH Silty Clay, Silty Clay Loam
- IDH Silt, Silty Loam
- IDH Sand, Sandy Loam
- Gravelly sand, sandy gravel
- IDH Clay



Site Map Scale 1 inch equals 65 feet

Explanation:



▽ Water Level Reading at time of drilling.

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

Horizontal Scale (feet): 0 – 18

Vertical Exaggeration: 1.5x

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Soil Profile
East Retaining Wall

WEI SINCE 1982

US 45 - Millburn Bypass
Lake County, Illinois

JOB NUMBER	PLATE NUMBER
342-08-01	EXHIBIT 4-3

WEI 11X17 3420801.GPJ WANGENG.GDT 5/29/15

APPENDIX A

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BORING LOG BSB1-01

WEI Job No.: 342-08-01

Client: **Parsons Transportation Group, Inc.**
Project: **US 45 - Millburn Bypass**
Location: **Lake County, Illinois**

Datum: NGVD
Elevation: 721.46 ft
North: 2096102.41 ft
East: 1072596.82 ft
Station: 128+12.81
Offset: 47.27' LT

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
	17-inch thick, black LOAM, with roots					
720.0	--TOPSOIL--					
	Stiff to very stiff, gray SILTY CLAY to SILTY CLAY LOAM, trace gravel		1	2 3 4	2.00 P	26
		5	2	2 2 4	1.80 B	33
			3	2 4 6	3.28 B	19
		10	4	3 4 7	2.46 B	21
710.0	Medium dense, gray SILT --Moist--		5	2 4 8	2.30 B	22
707.5	Stiff to very stiff, gray CLAY to SILTY CLAY, trace gravel	15	6	2 4 5	1.56 B	21
	--L_L(%)=38, P_L(%)=18-- --%Gravel=0.5-- --%Sand=2.7-- --%Silt=48.7-- --%Clay=48.1-- --A-6 (20)--		7	2 4 5	2.54 B	22
		20	8	3 4 6	2.21 B	23
	--Interbedded SILT-- --Moist--		9	2 3 4	1.48 B	24
		25	10	2 4 6	2.38 B	23
			11	2 3 5	2.62 B	24
		30	12	2 3 4	1.80 B	25
		35	13	3 4 5	2.21 B	24
		40	14	3 4 5	2.30 B	26
		45	15	4 5 7	2.87 B	21
676.0	Medium dense, gray GARVELLY SANDY LOAM --Saturated-- --%Gravel=45.3-- --%Sand=41.5-- --%Silt=9.8-- --%Clay=3.3-- --A-1-b (0)--	50	16	4 7 9	NP	10

GENERAL NOTES

Begin Drilling **09-29-2014** Complete Drilling **09-29-2014**
Drilling Contractor **Wang Testing Services** Drill Rig **D-50 ATV**
Driller **K&K** Logger **S. Woods** Checked by **B. Wilson**
Drilling Method **3.25" HSA; Boring backfilled upon completion**

WATER LEVEL DATA

While Drilling ▽ **45.50 ft**
At Completion of Drilling ▼ **38.00 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 BSB1-01

WEI Job No.: 342-08-01

Client: **Parsons Transportation Group, Inc.**
Project: **US 45 - Millburn Bypass**
Location: **Lake County, Illinois**

Datum: NGVD
Elevation: 721.46 ft
North: 2096102.41 ft
East: 1072596.82 ft
Station: 128+12.81
Offset: 47.27' LT

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
669.7	Gray, medium SAND --Saturated--					
667.2	Medium dense, gray SILT to very fine SAND -Saturated--	55	17	5 5 10	NP	19
664.7	Medium dense, gray, fine SAND -Saturated--		18	5 10 14	NP	14
661.5	Boring terminated at 60.00 ft	60				

GENERAL NOTES

Begin Drilling **09-29-2014** Complete Drilling **09-29-2014**
Drilling Contractor **Wang Testing Services** Drill Rig **D-50 ATV**
Driller **K&K** Logger **S. Woods** Checked by **B. Wilson**
Drilling Method **3.25" HSA; Boring backfilled upon completion**

WATER LEVEL DATA

While Drilling **45.50 ft**
At Completion of Drilling **38.00 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 BSB1-02

WEI Job No.: 342-08-01

Client: **Parsons Transportation Group, Inc.**
Project: **US 45 - Millburn Bypass**
Location: **Lake County, Illinois**

Datum: NGVD
Elevation: 722.77 ft
North: 2096133.14 ft
East: 1072627.55 ft
Station: 128+23.57
Offset: 5.17' LT

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
721.8	12-inch thick, black LOAM, trace gravel --TOPSOIL--					
	Stiff to hard, grayish brown, brown and gray SILT CLAY to SILTY CLAY LOAM, trace gravel		1	2 3 3	1.64 B	21
		5	2	4 7 10	6.81 S	17
			3	5 8 13	6.56 B	20
	--Interbedded SAND--	10	4	4 8 11	4.18 S	19
			5	2 4 6	2.30 B	23
		15	6	2 4 6	2.62 B	19
			7	2 3 4	1.48 B	23
		20	8	2 4 6	2.21 B	23
			9	3 5 7	2.13 B	23
		25	10	2 4 6	2.38 B	24
			11	2 4 6	1.97 B	22
		30	12	2 4 5	2.21 B	23
		35	13	2 3 4	1.97 B	25
		40	14	2 4 6	2.30 B	25
		45	15	3 4 5	2.46 B	28
676.0	Medium dense to very dense, brown, fine to coarse SAND --Saturated--					
		50	16	3 6 7	NP	12

GENERAL NOTES

Begin Drilling: **09-26-2014** Complete Drilling: **09-26-2014**
Drilling Contractor: **Wang Testing Services** Drill Rig: **D-50 ATV**
Driller: **K&K** Logger: **S. Woods** Checked by: **B. Wilson**
Drilling Method: **3.25" HSA; Boring backfilled upon completion**

WATER LEVEL DATA

While Drilling: **47.00 ft**
At Completion of Drilling: **45.00 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 BSB1-02

WEI Job No.: 342-08-01

Client: **Parsons Transportation Group, Inc.**
Project: **US 45 - Millburn Bypass**
Location: **Lake County, Illinois**

Datum: NGVD
Elevation: 722.77 ft
North: 2096133.14 ft
East: 1072627.55 ft
Station: 128+23.57
Offset: 5.17' LT

Profile	Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample Type *recovery*	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
		--%Gravel=2.6-- --%Sand=88.5-- --%Silt=7.0-- --%Clay=1.9-- --A-3 (0)--	55		17	8 8 7	NP	16
	662.8		60		18	23 27 37	NP	17
		Boring terminated at 60.00 ft	65 70 75					

GENERAL NOTES

Begin Drilling **09-26-2014** Complete Drilling **09-26-2014**
Drilling Contractor **Wang Testing Services** Drill Rig **D-50 ATV**
Driller **K&K** Logger **S. Woods** Checked by **B. Wilson**
Drilling Method **3.25" HSA; Boring backfilled upon completion**

WATER LEVEL DATA

While Drilling **47.00 ft**
At Completion of Drilling **45.00 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.

BORING LOG BSB1-03

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WEI Job No.: 342-08-01

Client: **Parsons Transportation Group, Inc.**
Project: **US 45 - Millburn Bypass**
Location: **Lake County, Illinois**

Datum: NGVD
Elevation: 723.33 ft
North: 2096174.67 ft
East: 1072658.11 ft
Station: 128+43.71
Offset: 42.30' RT

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
	15-inch thick, black LOAM, with organic matter					
721.8	--TOPSOIL--					
	Very stiff to hard, brown SILTY CLAY to SILTY CLAY LOAM, trace gravel		1	5 7 8	3.44 S	15
		5	2	3 4 7	5.82 B	17
717.1	Stiff, brown SILTY LOAM, trace gravel		3	5 9 10	1.39 S	15
716.1	Very stiff, gray SILTY CLAY to SILTY CLAY LOAM, trace gravel					
		10	4	3 6 7	3.77 B	19
			5	3 6 9	2.30 B	23
711.2	Gray SILT --Moist--					
709.8	Very stiff, gray SILTY CLAY, trace gravel		6	2 3 6	2.13 B	23
708.8	Medium dense, gray SILT --Saturated--	15				
			7	3 6 6	NP	19
705.3	Medium stiff, gray SILTY LOAM, trace gravel --Moist-- --L_L(%)=17, P_L(%)=12-- --%Gravel=2.6-- --%Sand=30.0-- --%Silt=55.0-- --%Clay=12.5-- --A-4 (0)--	20	8	2 2 5	0.90 B	15
702.8	Stiff to very stiff, gray SILTY CLAY, trace gravel		9	2 4 5	2.05 B	22
		25	10	3 4 6	2.13 B	20
			11	2 4 5	2.46 B	24
		30	12	2 4 5	2.13 B	22
		35	13	2 3 5	2.30 B	25
		40	14	1 3 4	1.56 B	25
		45	15	2 4 5	1.64 B	26
677.8	Medium dense, gray, fine to medium SAND --Saturated--					
		50	16	2 5 7	NP	20

GENERAL NOTES

Begin Drilling: **09-29-2014** Complete Drilling: **09-29-2014**
Drilling Contractor: **Wang Testing Services** Drill Rig: **D-50 ATV**
Driller: **K&K** Logger: **S. Woods** Checked by: **B. Wilson**
Drilling Method: **3.25" HSA; Boring backfilled upon completion**

WATER LEVEL DATA

While Drilling: **45.50 ft**
At Completion of Drilling: **44.00 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 BSB1-03

WEI Job No.: 342-08-01

Client: **Parsons Transportation Group, Inc.**
Project: **US 45 - Millburn Bypass**
Location: **Lake County, Illinois**

Datum: NGVD
Elevation: 723.33 ft
North: 2096174.67 ft
East: 1072658.11 ft
Station: 128+43.71
Offset: 42.30' RT

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample Type (recovery)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
			X	17	17 21 27	NP	17
669.0	Dense, gray, SANDY GRAVEL --Saturated-- --Hard drilling 55' to 57', possible cobbles--	55					
666.3	Dense, gray, very fine SAND --Saturated--						
			X	18	11 13 19	NP	17
663.3	Boring terminated at 60.00 ft	60					
		65					
		70					
		75					

GENERAL NOTES

Begin Drilling **09-29-2014** Complete Drilling **09-29-2014**
Drilling Contractor **Wang Testing Services** Drill Rig **D-50 ATV**
Driller **K&K** Logger **S. Woods** Checked by **B. Wilson**
Drilling Method **3.25" HSA; Boring backfilled upon completion**

WATER LEVEL DATA

While Drilling ▽ **45.50 ft**
At Completion of Drilling ▼ **44.00 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 RWB1-01

WEI Job No.: 342-08-01

Client: **Parsons Transportation Group, Inc.**
Project: **US 45 - Millburn Bypass**
Location: **Lake County, Illinois**

Datum: NGVD
Elevation: 725.75 ft
North: 2096040.28 ft
East: 1072633.92 ft
Station: 127+40.44
Offset: 47.04' LT

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
725.3	6-inch thick, black LOAM, roots --TOPSOIL--					
	Very stiff to hard, brown SILTY CLAY to SILTY CLAY LOAM, trace gravel		1	5 7 10	4.84 S	22
		5	2	5 7 10	6.07 S	18
			3	5 7 9	4.92 B	20
716.8	Stiff, brown SILT to SILTY LOAM --Moist--	10	4	4 9 9	1.80 S	20
714.2	Stiff to very stiff, gray SILTY CLAY, trace gravel		5	3 7 5	2.05 B	22
		15	6	3 4 6	1.97 B	24
			7	2 4 6	2.21 B	23
	--Interbedded SAND-- --Moist--	20	8	4 4 5	2.13 B	21
			9	3 4 6	2.38 B	24
		25	10	3 4 6	2.62 B	24
			11	3 5 5	2.54 B	22
695.8		30	12	3 4 5	2.30 B	23
	Boring terminated at 30.00 ft	35, 40, 45, 50				

GENERAL NOTES

Begin Drilling **09-30-2014** Complete Drilling **09-30-2014**
Drilling Contractor **Wang Testing Services** Drill Rig **D-50 ATV**
Driller **K&K** Logger **S. Woods** Checked by **B. Wilson**
Drilling Method **2.25" HSA; Boring backfilled upon completion**

WATER LEVEL DATA

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

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

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BORING LOG RWB1-02

WEI Job No.: 342-08-01

Client: **Parsons Transportation Group, Inc.**
Project: **US 45 - Millburn Bypass**
Location: **Lake County, Illinois**

Datum: NGVD
Elevation: 723.34 ft
North: 2096158.84 ft
East: 1072562.25 ft
Station: 128+78.98
Offset: 48.23' LT

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
	19-inch thick, black LOAM, roots --TOPSOIL--					
721.8	Very stiff, brown and gray SILTY CLAY to SILTY CLAY LOAM, trace gravel		1	3 4 6	2.00 P	19
	--L_L(%)=41, P_L(%)=19-- --%Gravel=0.3-- --%Sand=5.7-- --%Silt=54.9-- --%Clay=39.0-- --A-7-6 (22)--	5	2	2 3 3	2.13 B	24
			3	5 5 7	2.62 B	18
		10	4	4 5 6	2.62 B	20
			5	2 4 6	1.97 B	19
		15	6	3 4 6	2.21 B	23
			7	3 3 5	2.13 B	23
		20	8	2 4 5	2.54 B	24
	--Interbedded SILT-- --Saturated--		9	3 3 4	2.30 B	24
	--Interbedded SILT-- --Saturated--	25	10	3 3 5	1.64 B	20
	--Interbedded SILT-- --Saturated--		11	3 4 4	2.21 B	21
693.3	--Interbedded SILT-- --Saturated--	30	12	3 5 6	2.46 B	24
	Boring terminated at 30.00 ft					

GENERAL NOTES

Begin Drilling **09-26-2014** Complete Drilling **09-26-2014**
Drilling Contractor **Wang Testing Services** Drill Rig **D-50 ATV**
Driller **K&K** Logger **S. Woods** Checked by **B. Wilson**
Drilling Method **2.25" HSA; Boring backfilled upon completion**

WATER LEVEL DATA

While Drilling **21.50 ft**
At Completion of Drilling **DRY**
Time After Drilling **NA**
Depth to Water **NA**

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

Wang Engineering
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BORING LOG RWB2-01

WEI Job No.: 342-08-01

Client: **Parsons Transportation Group, Inc.**
Project: **US 45 - Millburn Bypass**
Location: **Lake County, Illinois**

Datum: NGVD
Elevation: 723.16 ft
North: 2096102.48 ft
East: 1072702.85 ft
Station: 127+58.80
Offset: 43.97' RT

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
	Loose, black LOAM, trace roots --TOPSOIL-- --LOI=10%--		1	2 4 5	NP	33
719.2	Very stiff to hard, dark brown to gray SILTY CLAY to SILTY CLAY LOAM, trace gravel		2	3 4 6	3.28 B	20
		5				
			3	4 7 10	3.85 B	17
			4	5 8 10	8.04 B	17
		10				
			5	3 4 6	3.36 B	21
			6	3 5 7	2.46 B	18
		15				
707.7	Gray SILTY LOAM, trace gravel --Saturated--					
706.9	Medium dense, gray SANDY GRAVEL --Saturated--		7	5 7 8	NP	11
705.2	Medium stiff to Very stiff, gray SILTY CLAY to SILTY CLAY LOAM, trace gravel		8	6 11 12	0.90 B	13
		20				
			9	7 6 7		
			10	3 5 7	2.21 B	23
		25				
	--Interbedded SILT-- --Moist--		11	3 6 9	2.38 B	16
			12	4 5 5	1.23 B	17
693.2	Boring terminated at 30.00 ft	30				
		35				
		40				
		45				
		50				

GENERAL NOTES

Begin Drilling **09-30-2014** Complete Drilling **09-30-2014**
Drilling Contractor **Wang Testing Services** Drill Rig **D-50 ATV**
Driller **K&K** Logger **S. Woods** Checked by **B. Wilson**
Drilling Method **2.25" HSA; Boring backfilled upon completion**

WATER LEVEL DATA

While Drilling **15.50 ft**
At Completion of Drilling **15.50 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 RWB2-02

WEI Job No.: 342-08-01

Client: **Parsons Transportation Group, Inc.**
Project: **US 45 - Millburn Bypass**
Location: **Lake County, Illinois**

Datum: NGVD
Elevation: 723.48 ft
North: 2096210.96 ft
East: 1072648.07 ft
Station: 128+80.05
Offset: 52.17' RT

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
	21-inch thick, black LOAM, trace roots --TOPSOIL--					
721.7	Stiff to very stiff, orange brown to gray SILTY CLAY to SILTY CLAY LOAM, trace gravel		1	2 3 5	3.12 B	21
		5	2	3 6 8	3.69 B	19
			3	5 9 10	3.44 B	11
		10	4	4 5 6	2.05 B	19
	--L_L(%)=36, P_L(%)=17-- --%Gravel=0.9-- --%Sand=4.3-- --%Silt=51.0-- --%Clay=43.7-- --A-6 (18)--		5	3 3 5	1.56 B	25
		15	6	2 3 4	1.48 B	23
			7	3 4 5	1.64 B	24
		20	8	2 4 4	2.05 B	26
			9	2 4 5	2.05 B	17
		25	10	2 3 3	1.15 B	27
			11	3 4 4	1.48 B	25
695.5	Soft, gray CLAY, trace grace					
		30	12	3 3 3	0.33 B	33
691.7	Stiff, gray SILTY CLAY, trace gravel					
		35	13	2 4 4	1.39 B	27
688.5	Boring terminated at 35.00 ft					
		40				
		45				
		50				

GENERAL NOTES

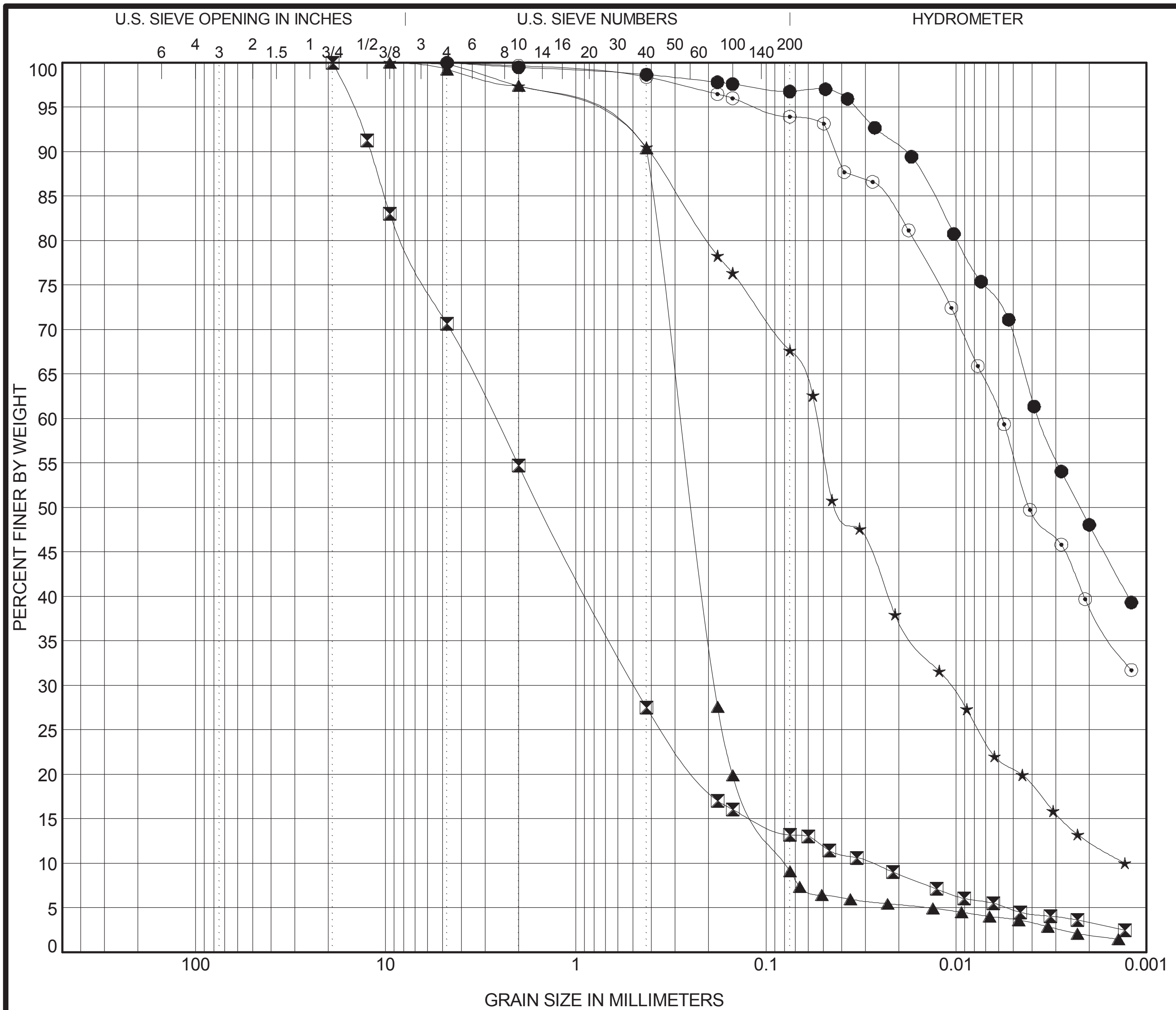
Begin Drilling	**09-25-2014**	Complete Drilling	**09-25-2014**
Drilling Contractor	**Wang Testing Services**	Drill Rig	**D-50 ATV**
Driller	**K&K**	Logger	**S. Woods**
Checked by	**B. Wilson**		
Drilling Method	**2.25" HSA; Boring backfilled upon completion**		

WATER LEVEL DATA

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

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

APPENDIX B



COBBLES	GRAVEL	SAND		SILT AND CLAY
		coarse	fine	

	Specimen Identification		IDH Classification	LL	PL	PI	Cc	Cu
●	BSB1-01#7	16.0 ft	**Clay**	38	18	20		
⧗	BSB1-01#16	48.5 ft	**Gravelly Sandy Loam**	NP	NP	NP	3.21	94.82
▲	BSB1-02#17	53.5 ft	**Sand**	NP	NP	NP	1.56	3.54
★	BSB1-03#8	18.5 ft	**Silty Loam**	17	12	5		
⊙	RWB1-02#2	3.5 ft	**Silty Clay**	41	19	22		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	BSB1-01#7	16.0 ft	4.75	0.004			0.5	2.7	48.7	48.1
⧗	BSB1-01#16	48.5 ft	19	2.663	0.49	0.028	45.3	41.5	9.8	3.3
▲	BSB1-02#17	53.5 ft	9.5	0.28	0.186	0.079	2.6	88.5	7.0	1.9
★	BSB1-03#8	18.5 ft	9.5	0.054	0.011		2.6	30.0	55.0	12.5
⊙	RWB1-02#2	3.5 ft	4.75	0.006			0.3	5.7	54.9	39.0

WEI SINCE 1982

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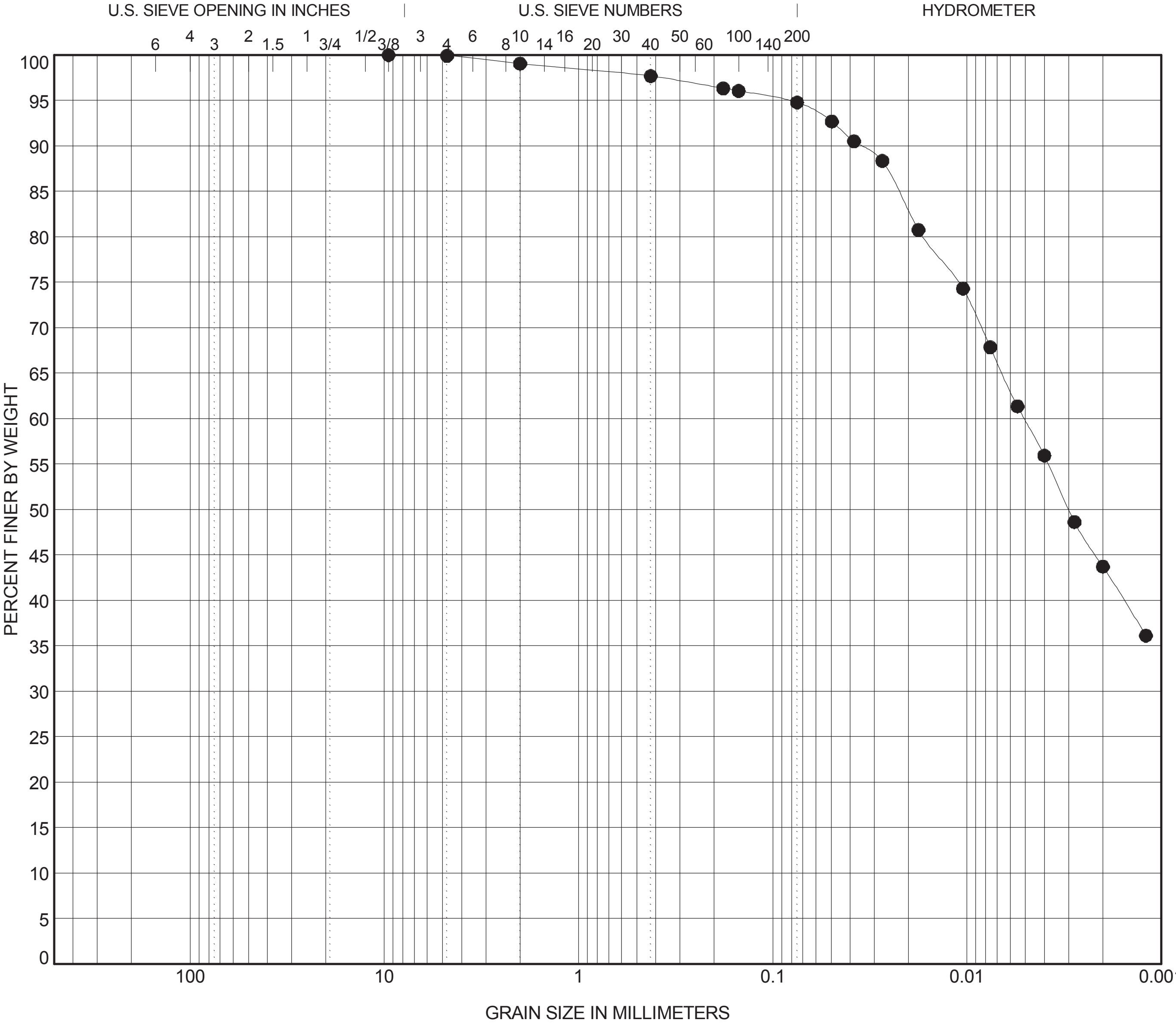
GRAIN SIZE DISTRIBUTION

Project: US 45 - Millburn Bypass

Location: Lake County, Illinois

Number: 342-08-01

WEI GRAIN SIZE IDH 3420801.GPJ US LAB.GDT 5/29/15



COBBLES	GRAVEL	SAND		SILT AND CLAY
		coarse	fine	

	Specimen Identification		IDH Classification	LL	PL	PI	Cc	Cu
●	RWB2-02#5	11.0 ft	**Silty Clay**	**36**	**17**	**19**		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	RWB2-02#5	11.0 ft	**9.5**	**0.005**			**0.9**	**4.3**	**51.0**	**43.7**

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Project: US 45 - Millburn Bypass

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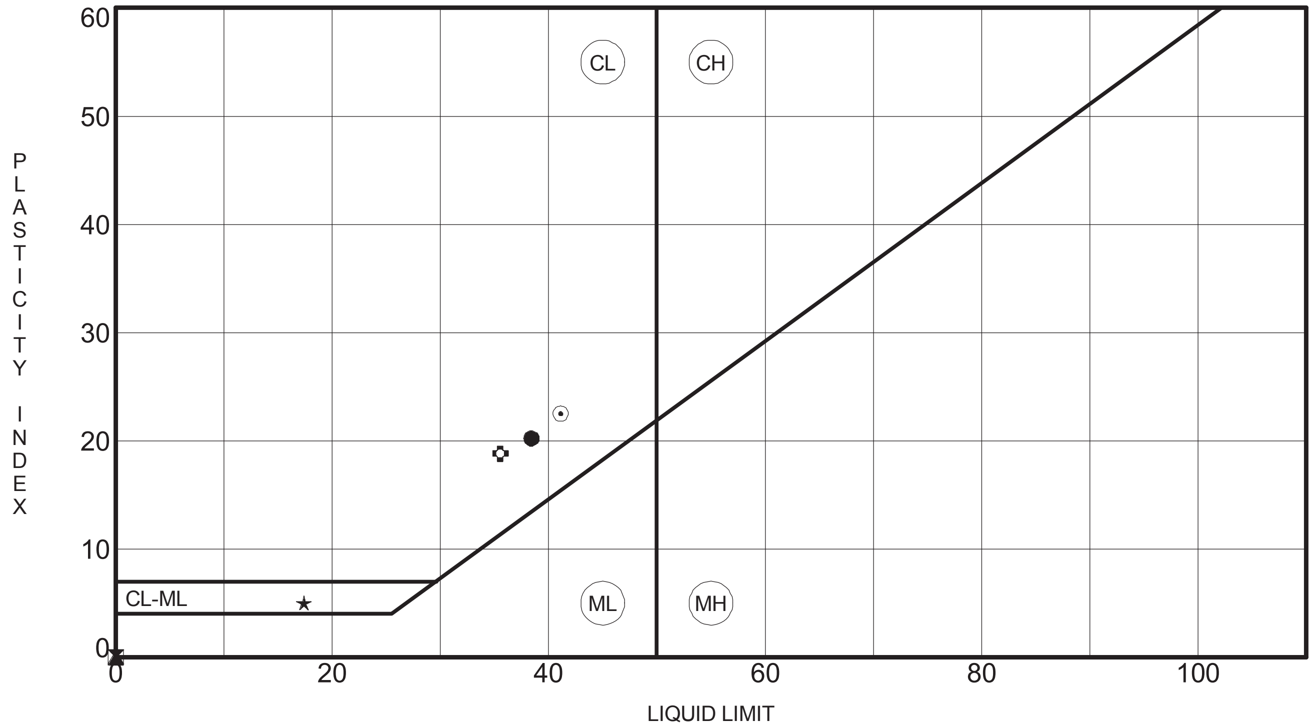

	Specimen Identification		LL	PL	PI	Fines	IDH Classification
●	BSB1-01#7	16.0 ft	38	18	20	97	Clay
⧗	BSB1-01#16	48.5 ft	NP	NP	NP	13	Gravelly Sandy Loam
▲	BSB1-02#17	53.5 ft	NP	NP	NP	9	Sand
★	BSB1-03#8	18.5 ft	17	12	5	68	Silty Loam
⊙	RWB1-02#2	3.5 ft	41	19	22	94	Silty Clay
✿	RWB2-02#5	11.0 ft	36	17	19	95	Silty Clay

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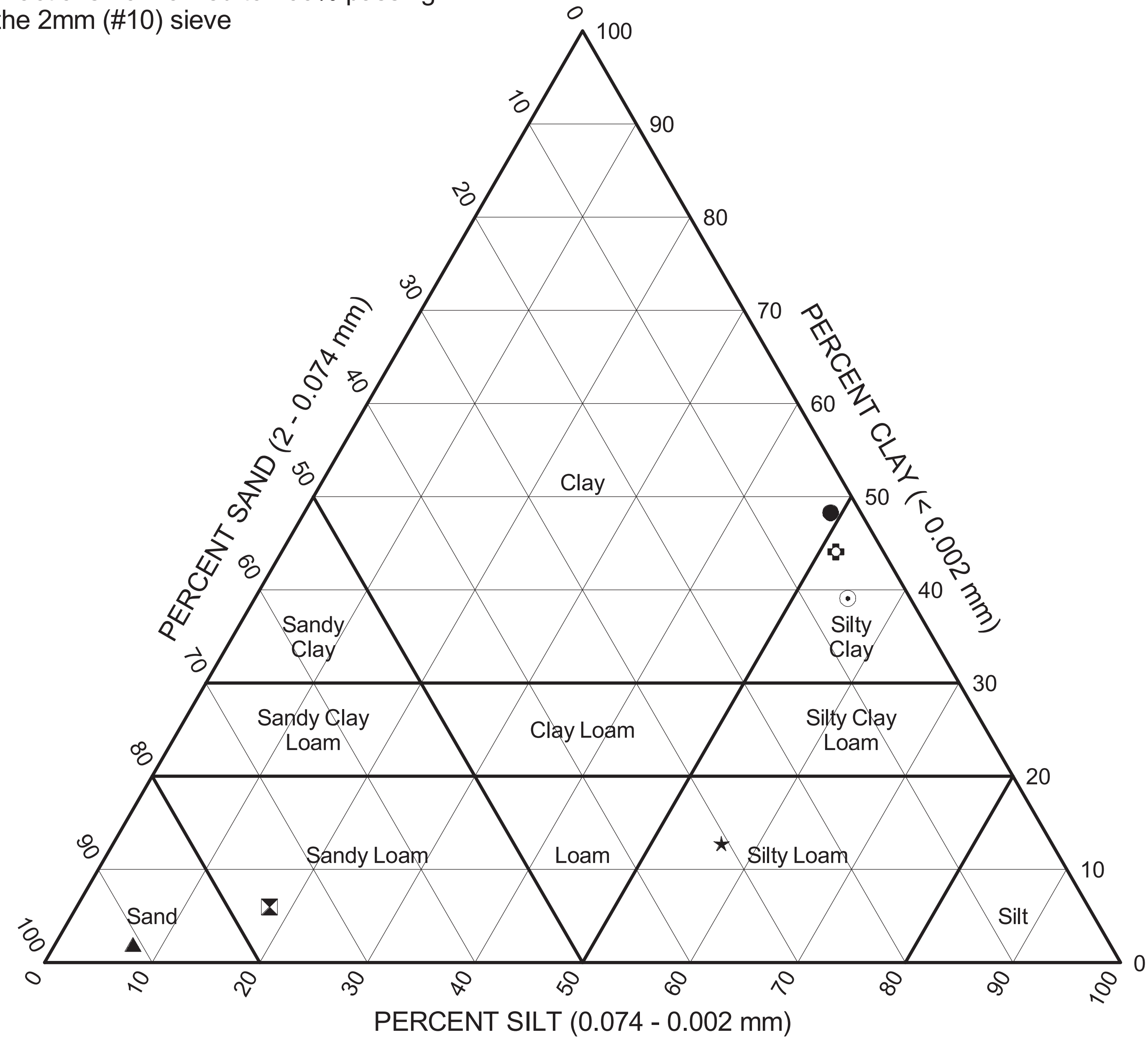
ATTERBERG LIMITS' RESULTS

Project: US 45 - Millburn Bypass

Location: Lake County, Illinois

Number: 342-08-01

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



	Sample	Depth (ft)	Sand (%)	Silt (%)	Clay (%)	Classification		
						IL DOT	AASHTO	ASTM
●	**BSB1-01#7**	**16.0**	**2.7**	**48.9**	**48.3**	**Clay**	**A-6 (20)**	**CL**
⧗	**BSB1-01#16**	**48.5**	**75.9**	**17.9**	**6.0**	**Gravelly Sandy Loam**	**A-1-b (0)**	**SM**
▲	**BSB1-02#17**	**53.5**	**90.9**	**7.2**	**2.0**	**Sand**	**A-3 (0)**	**SP-SM**
★	**BSB1-03#8**	**18.5**	**30.8**	**56.5**	**12.8**	**Silty Loam**	**A-4 (0)**	**CL-ML**
⊙	**RWB1-02#2**	**3.5**	**5.7**	**55.1**	**39.1**	**Silty Clay**	**A-7-6 (22)**	**CL**
✿	**RWB2-02#5**	**11.0**	**4.3**	**51.5**	**44.1**	**Silty Clay**	**A-6 (18)**	**CL**

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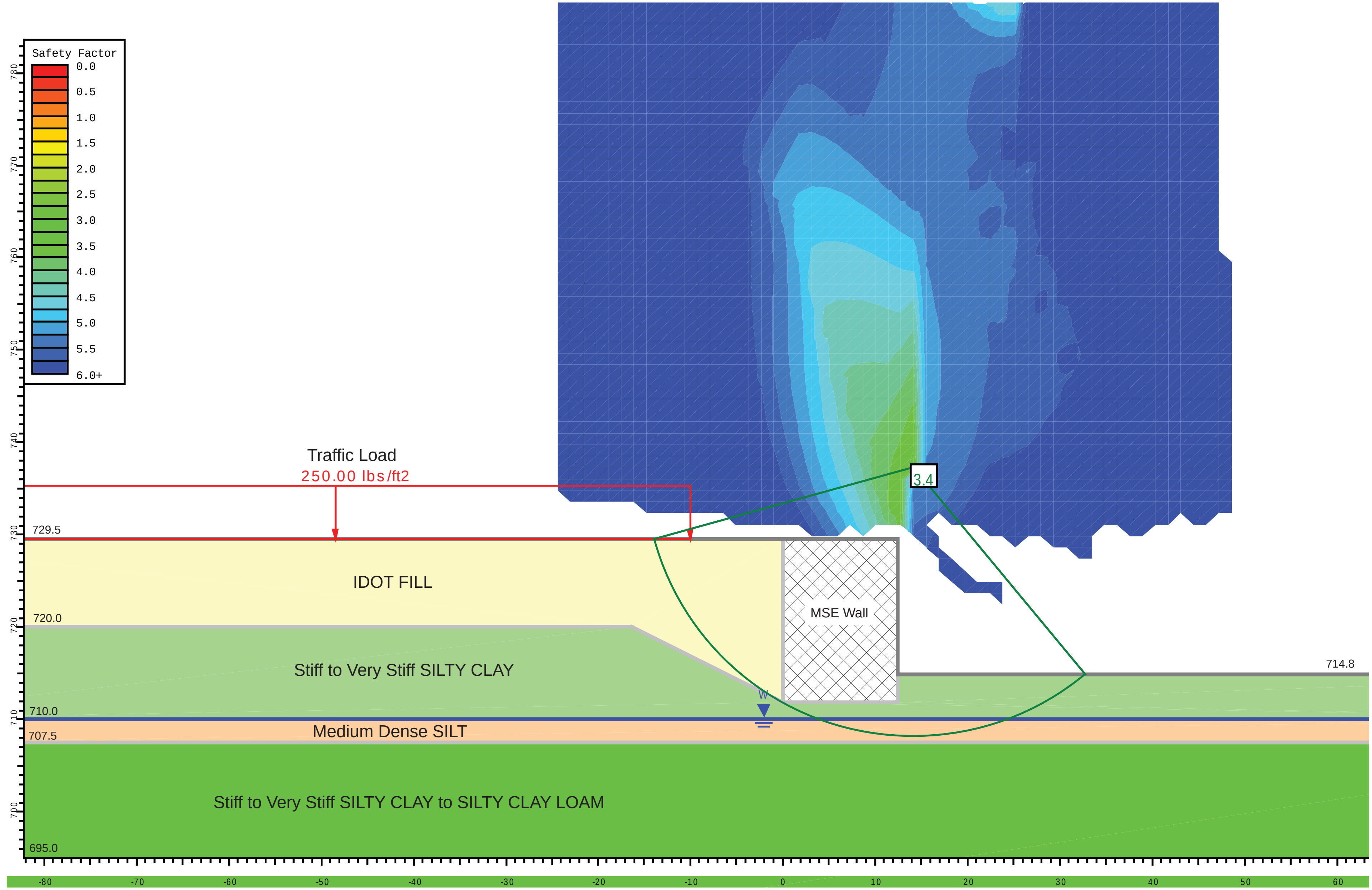
IDH Textural Classification Chart

Project: US 45 - Millburn Bypass

Location: Lake County, Illinois

Number: 342-08-01

APPENDIX C



Undrained Analysis for West MSE Wall, Ref Boring BSB1-01

Layer ID	Soil Type	Unit Weight (pcf)	Undrained Parameter C_u (psf)	Undrained Parameter ϕ(deg.)
1	IDOT FILL	125	1000	0
2	Stiff to V Stiff SILTY CLAY	120	2000	0
3	Medium Dense SILT	115	0	29
4	Stiff to V Stiff SILTY CLAY to SILTY CLAY LOAM	120	2200	0

SLOPE STABILITY ANALYSIS: US ROUTE 45, MILLBURN BYPASS, WEST RETAINING WALL, LAKE COUNTY, ILLINOIS

SCALE: GRAPHICAL

APPENDIX C-1

DRAWN BY: H. Bista
CHECKED BY:N. Balakumaran

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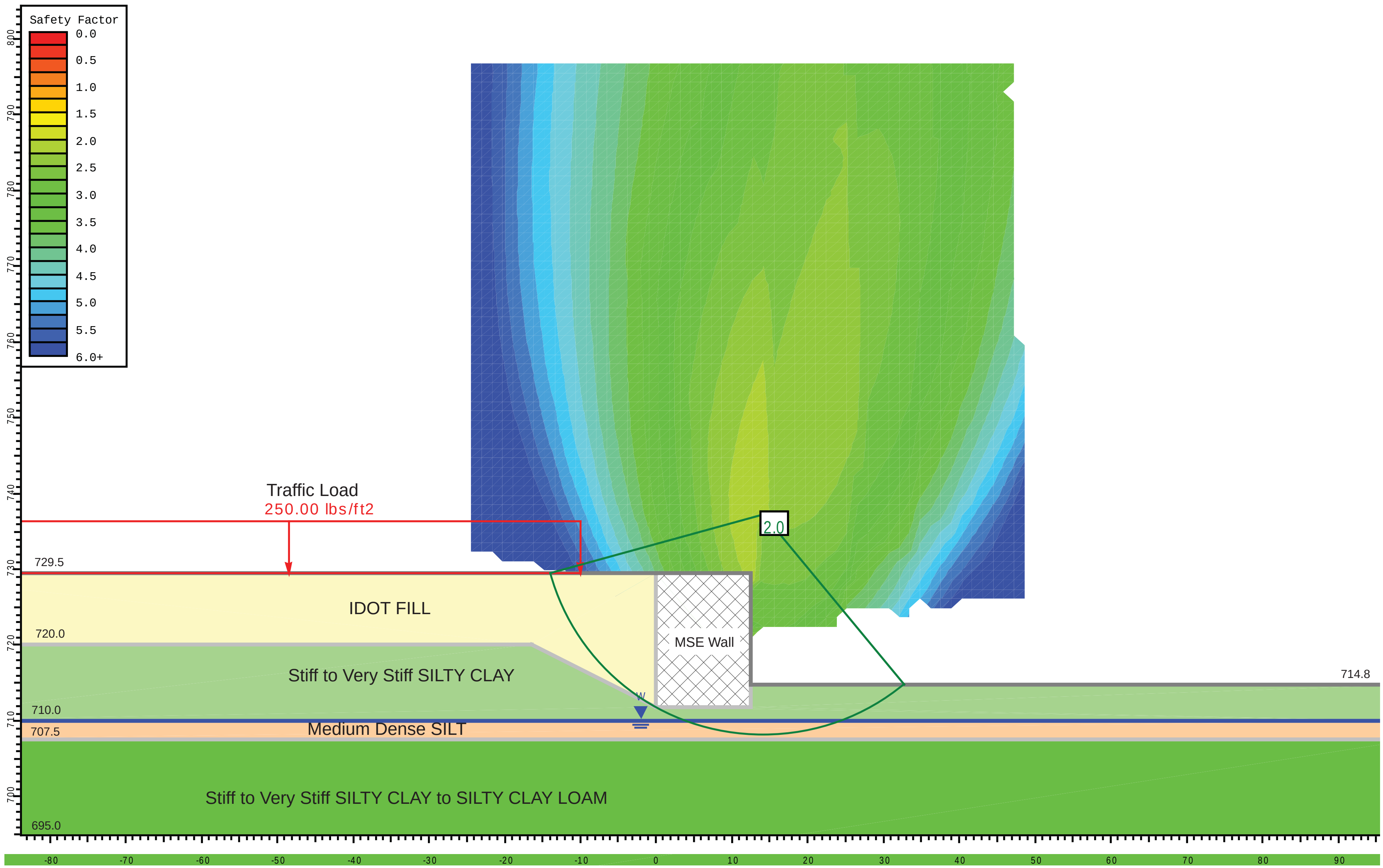
FOR PARSONS TRANSPORTATION GROP, INC.

342-08-01



Drained Analysis for West MSE Wall, Ref Boring BSB1-01

Layer ID	Soil Type	Unit Weight (pcf)	Drained Parameter C' (psf)	Drained Parameter ϕ' (deg.)
1	IDOT FILL	125	100	30
2	Stiff to V Stiff SILTY CLAY	120	0	32
3	Medium Dense SILT	115	100	30
4	Stiff to V Stiff SILTY CLAY to SILTY CLAY LOAM	120	100	30

SLOPE STABILITY ANALYSIS: US ROUTE 45, MILLBURN BYPASS, WEST RETAINING WALL, LAKE COUNTY, ILLINOIS

SCALE: GRAPHICAL

APPENDIX C-2

DRAWN BY: H. Bista
CHECKED BY: N. Balakumaran

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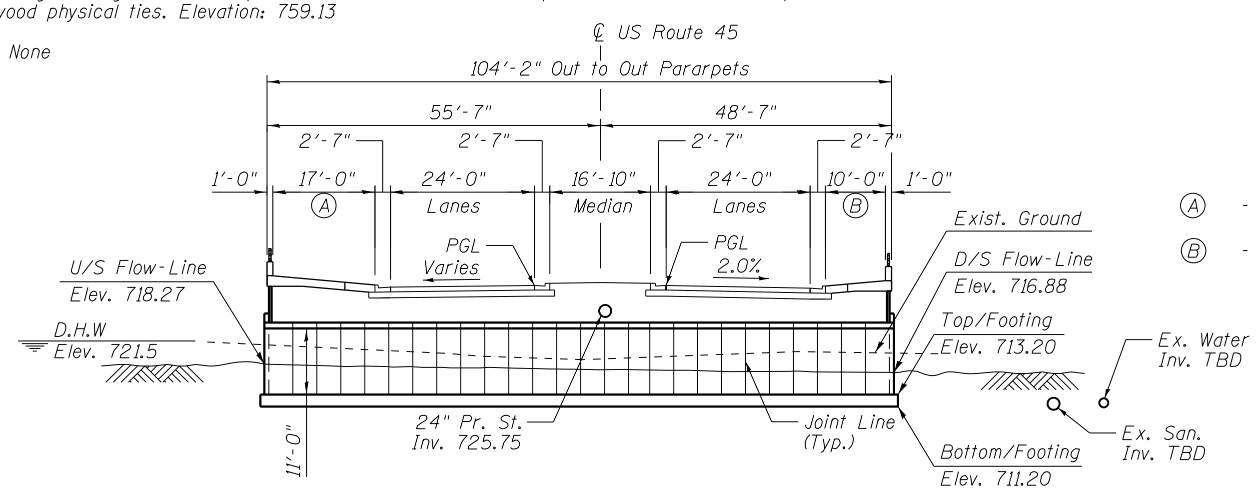
FOR PARSONS TRANSPORTATION GROP, INC.

342-08-01

APPENDIX D

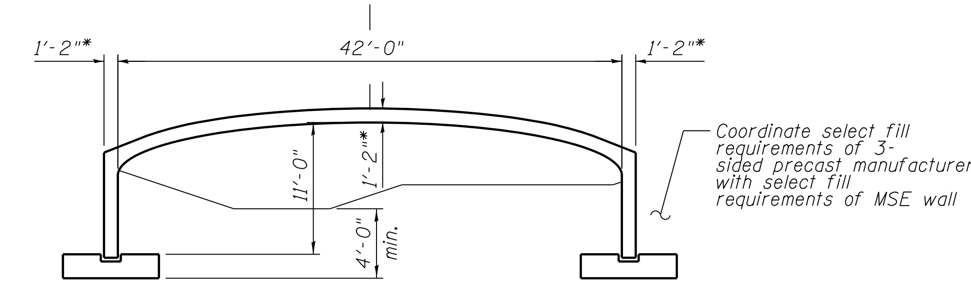
Benchmark: LAK45 1A
Station is located 2.8 mi North of Lindenhurst, 1.9 mi Northwest Old Mill Creek in Section 24, T46N, R10E. To reach from the junction of US Rt 45 and IL Rt 173 proceed south on US Rt 45 for 1.10 mi to the station located 53.5 ft east of the centerline of US Rt 45. Station is located 0.1 mi north of Miller Rd. 369.1 ft southeast of end of guardrail, 123.9 ft north of power pole (PP), 119.4 ft south of PP, 111.7 ft east of PP, and 2 ft west of orange fiberglass witness post. Note - Access to datum point is 0.50 ft below cap. PK nails were set in wood physical ties. Elevation: 759.13

Existing Structure: None



LONGITUDINAL SECTION

Ⓐ - 12'-0" Anchorage & sidewalk slab @ 2% and 5'-0" parkway @ 4%
Ⓑ - 6'-0" Anchorage slab @ 2% and 4'-0" parkway @ 4%



SECTION THRU BARREL
(At Right Angle to ℄ Structure)
* Slab and wall thickness and shape may vary as per manufacturer's design.

WATERWAY INFORMATION

Drainage Area = 0.99 Sq. Mi.
Existing Low Grade Elev. = N/A
Proposed Low Grade Elev. = N/A ft. @ N/A

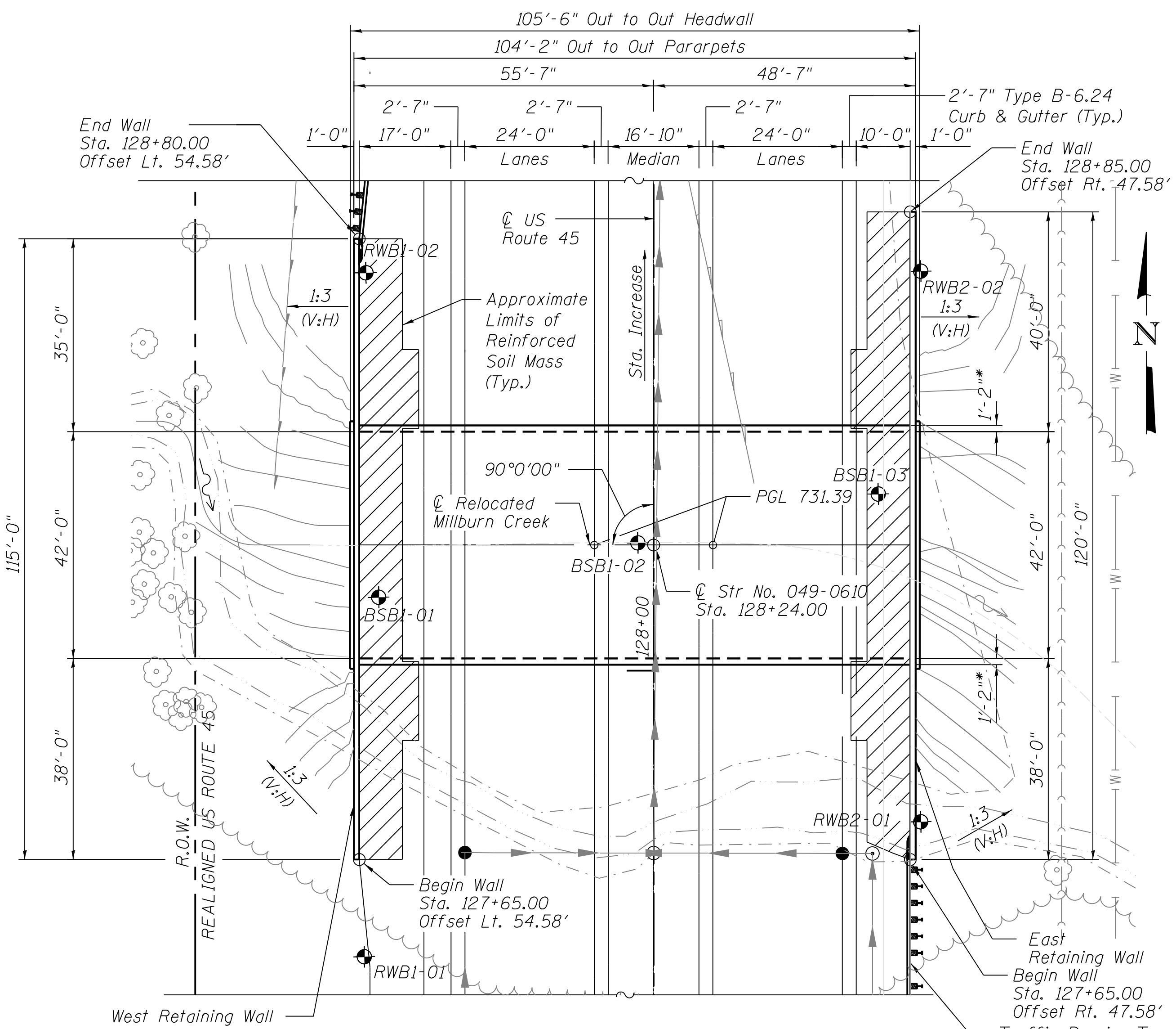
Flood	Freq. Yr.	Q C.F.S.	Opening Sq. Ft. Exist.	Opening Sq. Ft. Prop.	Natural H.W.E.	Head - Ft. Exist.	Head - Ft. Prop.	Headwater El. Exist.	Headwater El. Prop.
	2	40	N/A	22	720.7	N/A	0	720.7	720.7
	10	66	N/A	31	721.0	N/A	0	721.0	721.1
Design	50	110	N/A	45	721.5	N/A	0	721.5	721.5
Base	100	138	N/A	50	721.7	N/A	0	721.7	721.7
Overtopping	N/A								
Max. Calc.	500	188	N/A	62	722.0	N/A	0.1	722.0	722.1

SB LANES TRANSITIONS

	Station	Cross slope
Begin Tan Runout	127+65.00	-2.0%
Begin Super Runoff	128+37.00	0.0%
Reverse Crown	129+09.35	+2.0%

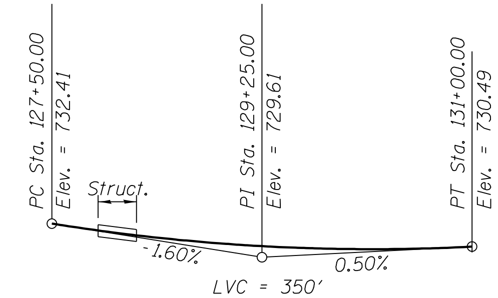
DESIGN SCOUR ELEVATION TABLE

Event / Limit State	Design Scour Elevation (ft.) West Wall	Design Scour Elevation (ft.) East Wall	Item 113
Q100	714.71	715.72	
Q500	713.21	714.19	8
Design	711.20	711.20	
Check	711.20	711.20	



Note: Wall offsets are measured from ℄ US 45 to inside face of concrete parapet.

PLAN



PROFILE GRADE
(Along inside edge of pavement)

LEGEND

- Prop. St. Sewer
- Prop. Field Tile
- Exist. Field Tile (Abandon)
- Exist. San. Sewer
- Exist. Water
- Exist. Creek
- Prop. Manhole
- Prop. Catch Basin

HIGHWAY CLASSIFICATION

F.A.P. Route 344, US Route 45
Functional Class: Other Principal Arterial
ADT: 16000 (2009) 34000 (2040)
ADTT: 2890 (2040)
DHV: 3400 (2040)
Design Speed: 50 mph
Posted Speed 45 mph
2-Way Traffic
Directional Distribution: NB:44 : SB:56

DESIGN SPECIFICATIONS

2014 AASHTO LRFD Bridge Design Specifications, 7th Edition with 2015 Interims

LOADING HL-93

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

DESIGN STRESSES

FIELD UNITS

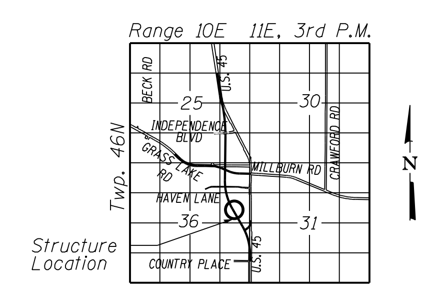
f'c = 3,500 psi
fy = 60,000 psi (Reinforcement)

PRECAST UNITS

f'c = 5,000 psi
fy = 65,000 psi (Welded wire fabric)
f'c = 4,500 psi (Precast Panels)

SEISMIC DATA

Seismic Performance Zone (SPZ) = 1
Design Spectral Acceleration at 1.0 sec. (SD1) 0.075g
Design Spectral Acceleration at 0.2 sec. (SDs) 0.123g
Soil Site Class = D



LOCATION SKETCH

GENERAL PLAN
US RTE 45 OVER
MILLBURN CREEK
F.A.P. RTE 344 - SEC 39 R
LAKE COUNTY
STATION 128+24.00
STRUCTURE NO. 049-0610

FILE NAME =	USER NAME =	DESIGNED - J.W.	REVISED -
PARSONS		CHECKED - T.C.U.	REVISED -
	PLOT SCALE =	DRAWN - S.R.	REVISED -
	PLOT DATE =	CHECKED - J.W.	REVISED -

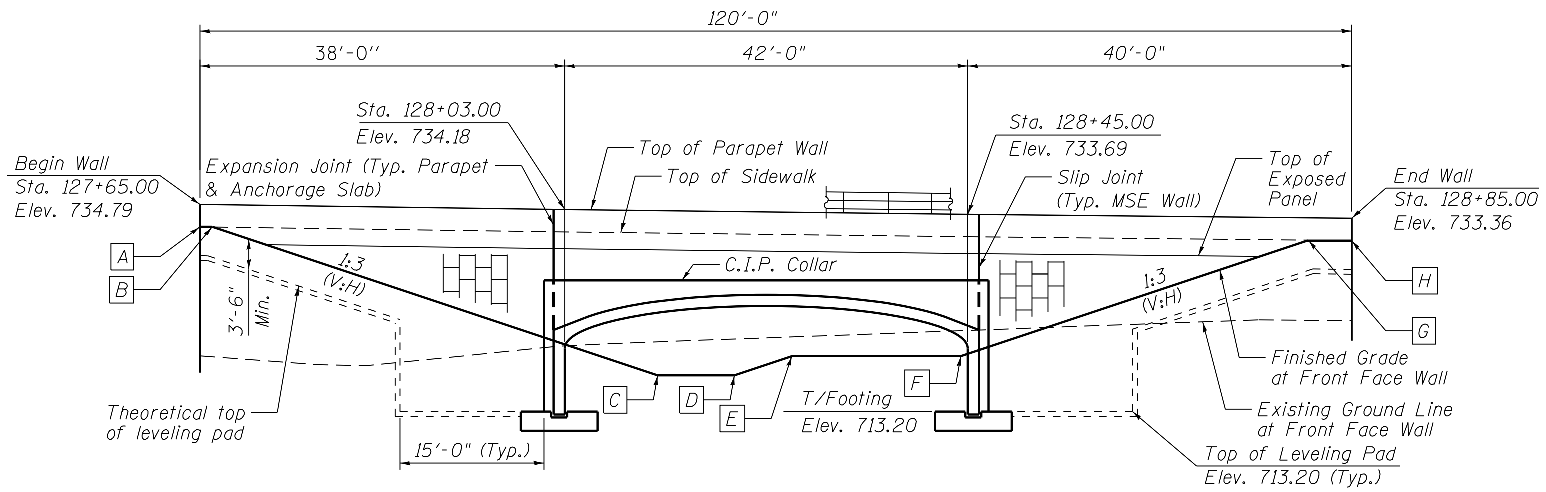
STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

SHEET NO. 254 OF STOTAL SHEETS 430

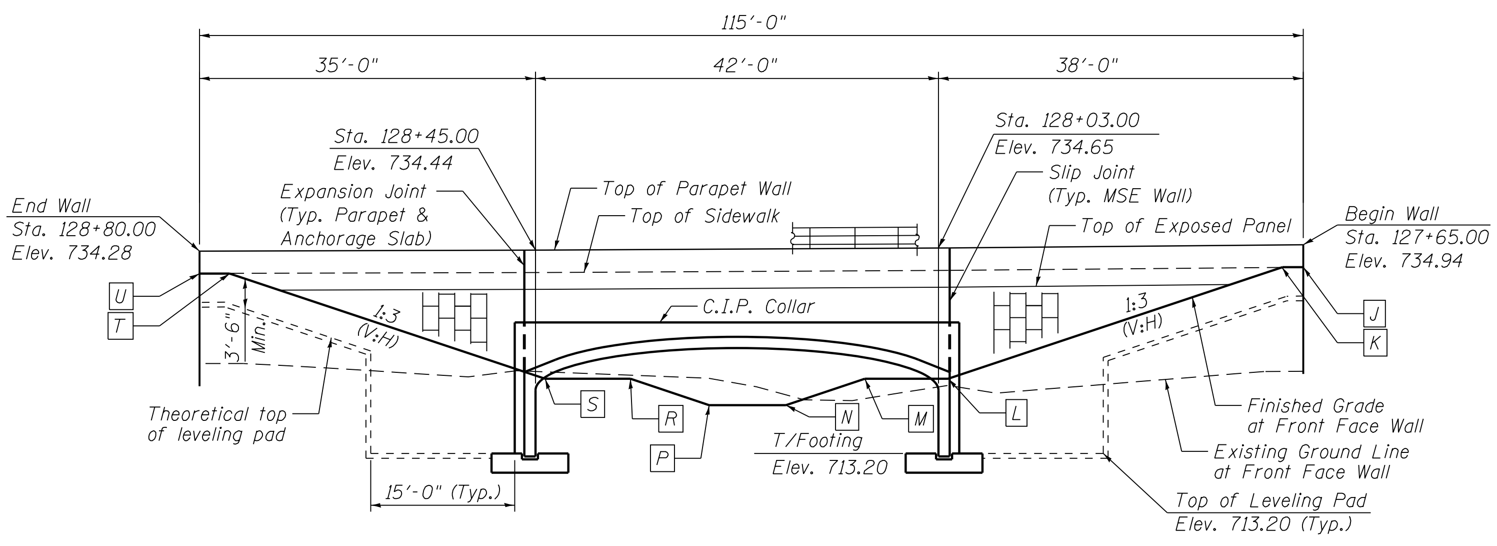
F.A.P. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
344	39 R	LAKE	430	254

CONTRACT NO. 60T75
ILLINOIS FED. AID PROJECT

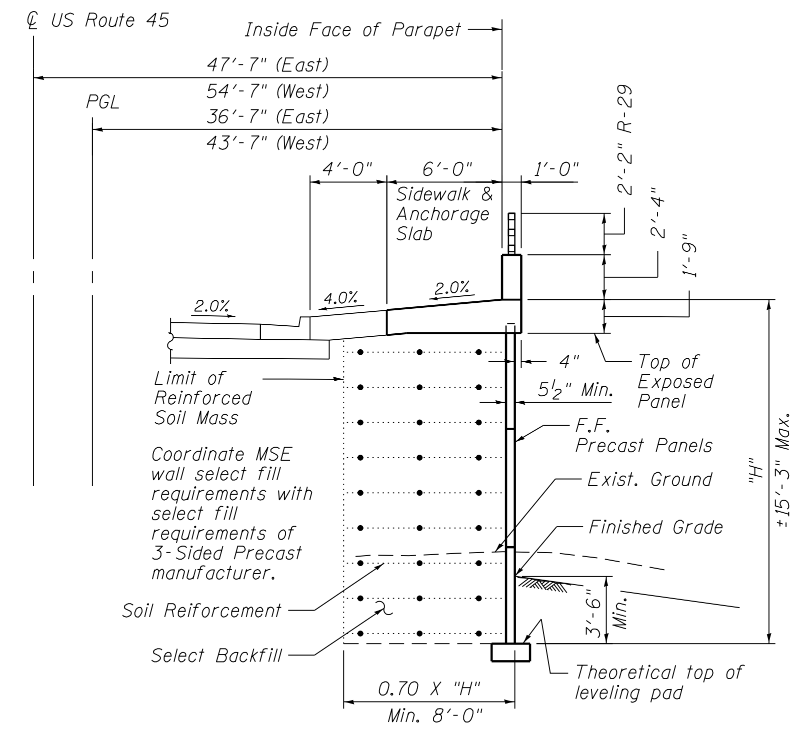
11/4/2015 8:38:00 AM p002694C pw:\\txplo02pwint01.parsons.com:Illinois State\Documents\US45 - 647965\40 - Design\CAD\Bridge\TSL\Sheets\US 45_647965_TS&L1.dgn



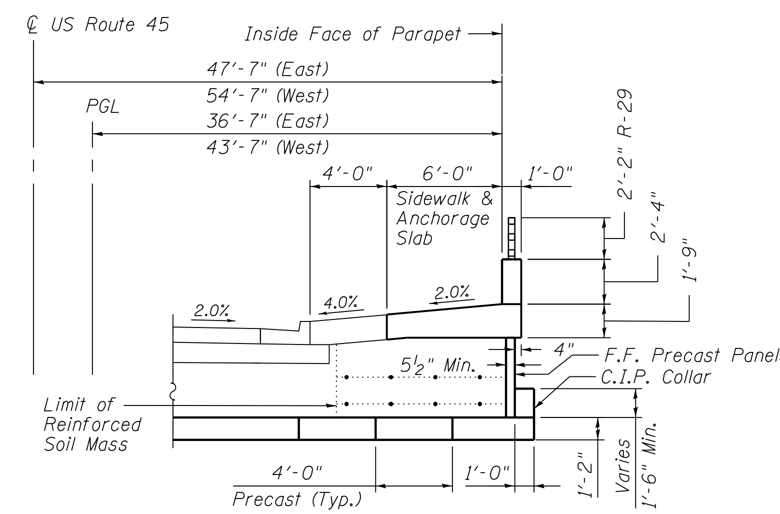
EAST WALL ELEVATION
(Looking West)



WEST WALL ELEVATION
(Looking East)



TYPICAL WALL SECTION
East wall shown.
West wall similar except as noted in Longitudinal Section.



TYPICAL WALL SECTION AT THREE SIDED PRECAST
East wall shown.
West wall similar except as noted in Longitudinal Section.

TABLE OF CONTROL POINTS

POINT	STA. ℄ US ROUTE 45	ELEVATION	POINT	STA. ℄ US ROUTE 45	ELEVATION
A	127+65.00	732.46	J	127+65.00	732.61
B	127+66.29	732.46	K	127+67.13	732.61
C	128+12.67	717.00	L	128+01.97	721.00
D	128+20.67	717.00	M	128+10.66	721.00
E	128+26.67	719.00	N	128+18.87	718.27
F	128+44.26	719.00	P	128+26.87	718.27
G	128+80.37	731.03	R	128+35.09	721.00
H	128+85.00	731.03	S	128+43.97	721.00
			T	128+76.85	731.96
			U	128+80.00	731.96

DETAILS
US RTE 45 OVER
MILLBURN CREEK
F.A.P. RTE 344 - SEC 39 R
LAKE COUNTY
STATION 128+24.00
STRUCTURE NO. 049-0610

FILE NAME =	USER NAME =	DESIGNED - J.W.	REVISED -	STATE OF ILLINOIS DEPARTMENT OF TRANSPORTATION
PARSONS		CHECKED - T.C.U.	REVISED -	
	PLOT SCALE =	DRAWN - S.R.	REVISED -	
	PLOT DATE =	CHECKED - J.W.	REVISED -	SHEET NO. 255 OF STOTAL SHEETS 430

F.A.P. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
344	39 R	LAKE	430	255

CONTRACT NO. 60T75

ILLINOIS FED. AID PROJECT