The Mannik & Smith Group, Inc.
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P: 734-397-3100 * F: 734-397-3131 * www.MannikSmithGroup.com

August 29, 2012

Mr. Richard Kent
Washtenaw County Parks and Recreation Commission
2330 Platt Road
Ann Arbor, MI 48107-8645

RE: Geotechnical Investigation - Michigan Avenue Pedestrian Bridge over the Huron River
Ypsilanti, Michigan

Dear Mr. Kent:

The Mannik & Smith Group, Inc. (MSG) was retained by the Washtenaw County Parks and Recreation Commission to perform a geotechnical investigation to assist in the design of the proposed pedestrian bridge that will connect Michigan Avenue (US-12) to Riverside Park over the Huron River. The proposed bridge will be located just east of the Michigan Avenue Bridge over the Huron River in Ypsilanti, Michigan. This work has been performed in accordance with the modification to our Agreement for Professional Services dated August 8, 2012.

PROJECT DESCRIPTION

The purpose of this geotechnical investigation is to provide site-specific subsurface soil data to assist in the design of the foundations of the proposed pedestrian bridge. MSG is currently performing the design work for this bridge. At the time of this submittal, Bridge Concept No. 2 was the preferred alignment for the bridge. The bridge is proposed to be single span approximately 145 feet long with the approach on the north side of the bridge consisting of an elevated platform to assist in minimizing the slope of the bridge due to the elevation differences between the two sides of the river.

FIELD AND LABORATORY PROGRAM

The boring locations were selected and field-marked by MSG personnel. Two (2) borings, termed SB-01 and SB-02, were completed for this investigation at the approximate locations shown on *Figure 1: Soil Boring Location Map.* The borings were performed using a track-mounted drill rig with samples collected at various intervals to analyze the properties of the soil visually. Split spoon samples, or "disturbed" samples, were recovered to obtain representative samples suitable for visual classification. Standard penetration testing was conducted in accordance with ASTM D1586. For the standard penetration testing and sampling, the soil samples were obtained with a standard 2-inch outer diameter split spoon sampler driven 18 inches into the soil with blows of a 140-pound hammer falling 30 inches. The number of hammer blows required to drive the sampler the final foot was recorded and designated the "standard penetration resistance" or blow count. The standard penetration resistance or "N" value, when properly evaluated, is an index of the soil's strength, density and ability to support foundations. The disturbed samples recovered by the split spoon sampler were visually classified in the field, logged, sealed in sample jars and returned to MSG's office for examination by a geotechnical engineer. The borings were advanced to a maximum depth of 32 feet below ground surface (bgs). All borings were backfilled with auger cuttings and granular bentonite pellets to the ground surface.

Each of the split spoon samples recovered from the borings was examined and visually classified by a geotechnical professional. This examination was performed to verify conditions identified within the field boring logs, perform visual-manual classification of samples not subjected to further laboratory testing and select samples for laboratory

testing. Based on the review of the test boring logs and visual examination of the collected samples, we completed a laboratory testing program on selected samples. Our laboratory testing program consisted of the following:

- Three moisture content tests performed in accordance with ASTM D2216,
- Two sieve analyses performed in accordance with ASTM D422,
- Two hydrometer tests performed in accordance with ASTM D422, and,
- Three Atterberg limit tests performed in accordance with ASTM D4318.

Soil boring logs, indicating soil descriptions, standard penetration resistance, and ground water observations are included in the Attachments. Split spoon samples are designated as SS. The geotechnical laboratory test data are also contained in the Attachments.

SUBSURFACE CONDITIONS

The subsurface soil and groundwater conditions encountered in the bore holes drilled at the site are shown in detail on the soil boring logs contained in the Attachments. The following sections have been simplified in terms of major soil strata for the purposes of geotechnical design. The soil boundaries indicated are inferred from non-continuous sampling, drilling observations and/or sampling resistance. The subsurface conditions discussed in the following paragraphs and those shown on the boring logs represent an estimate of the subsurface conditions based on interpretation of the field and laboratory data using normally accepted geotechnical engineering judgments. The subsurface conditions described herein may vary between and beyond the borings.

At SB-01, approximately 4 inches of asphalt was encountered at the ground surface. At SB-02, approximately 4 inches of topsoil was encountered. Beneath the asphalt or topsoil, the subsurface strata can generally be described in descending order as follows:

Elevation (El.) 698 to 691	Medium dense to dense brown silty SAND (SM) with gravel;
El. 693.5 to 683.5	Very loose to loose brown SAND with variable amounts of silt and clay (SC, ML, SM and/or SP);
El. 683.5 to 673.5	Medium dense brown SAND with variable amounts of silt, clay and gravel (SP, SM). Boring SB-01 was terminated in this layer;
El. 676 to 666	Dense gray silty SAND (SM); and,
El. 666 to 659	Very dense gray silty SAND (SM). Boring SB-02 was terminated in this layer.

Groundwater was encountered during drilling at about El. 689.5 and El. 685.3 at SB-01 and SB-02, respectively. The river elevation at the time of the survey, performed in August 2012 by MSG, was at about El. 684.6.

PRELIMINARY FOUNDATION RECOMMENDATIONS

MSG has performed a preliminary evaluation using LRFD methodology of the foundations for both the abutments for the proposed bridge and the planned foundations for the elevated platform. The calculations are included in the Attachments.

Bridge Abutment Foundations

Due to the high potential for scour in the sandy soils encountered in the borings, the foundations for the bridge abutments would need to bear below the maximum anticipated scour depth beneath the river bottom. As such, large

excavations, extensive dewatering of the excavations and cofferdams for the river would likely be required in order to construct the foundations. Therefore, it is recommended that the bridge abutments be supported on deep foundations consisting of driven piles. At the time of this evaluation, the bridge profile had not been finalized. Therefore, based on discussions with the MSG design team, it has been assumed that the base of the pile caps will be located at El. 696 and El. 687 at the south and north abutments, respectively. It is recommended that either 12-inch diameter pipe piles (closed-end) or HP 10x42 piles be used to support the abutments. Based on the static analysis of the pile capacity using the nominal (ultimate) capacities for these piles as listed in Section 7.03.09 of the MDOT LRFD Bridge Design Manual and the subsurface conditions encountered in the borings, a static analysis was performed using the computer program DRIVEN 1.2. Table 1.0 provides a summary of the results.

TABLE 1.0

SUMMARY OF DRIVEN PILE ANALYSIS RESULTS			
Abutment Location	Pile Type	Nominal Capacity (R_{ndr}, kips)	Estimated Pile Tip Elev. (ft)
South (SB-01)	12" Pipe	250	666
	HP 10x42	275	661
North (SB-02)	12" Pipe	250	657
	HP 10x42	275	652

The nominal pile capacity needs to be reduced (multiplied) by a resistance factor (φ_{dyn}) which is based on the pile certification method as listed in the MDOT Bridge Design Manual and ranges between 0.5 and 0.9. For this bridge type and anticipated pile driving costs, is anticipated that a resistance factor of 0.5 is applicable.

Elevation Platform Foundations – North Approach

The elevated platform foundations will be located behind the proposed north abutment and thus the exposure to scour is anticipated to be minimal. Therefore, the elevated platform foundations can be supported on shallow foundations bearing in natural medium dense silty sand or engineered fill. At SB-02, a 2.5-foot thick layer of very loose gray sandy silt with clay was encountered to about a depth of 5 feet bgs. It is recommended that any soft or very-loose soils and any other unsuitable bearing materials be overexcavated and replaced with engineered fill. It has been assumed the foundations will bear approximately 42 inches below existing grade or at approximately El. 687.5. The shallow foundation analyses were performed in accordance with Article 10.6 of AASHTO LRFD Bridge Design Specifications manual. Table 2.0 provides a summary of the results.

TABLE 2.0

SUMMARY OF SHALLOW FOUNDATION ANALYSIS RESULTS			
Limit State	Nominal Bearing Resistance (ksf)	Resistance Factor	Factored B earing Resistance (ksf)
Service	5.0	1.0	5.0
Strength	13.5	0.45	6.0

It is anticipated the total and differential settlements of the elevated platform foundations will be limited to one (1) inch and ½-inch, respectively, provided the foundation subgrades are properly prepared and evaluated by the on-site geotechnical engineer or his designated representative during construction.

CLOSING

We appreciate the opportunity to be of continued service on this project. Feel free to contact us with any questions concerning this submittal.

Sincerely,

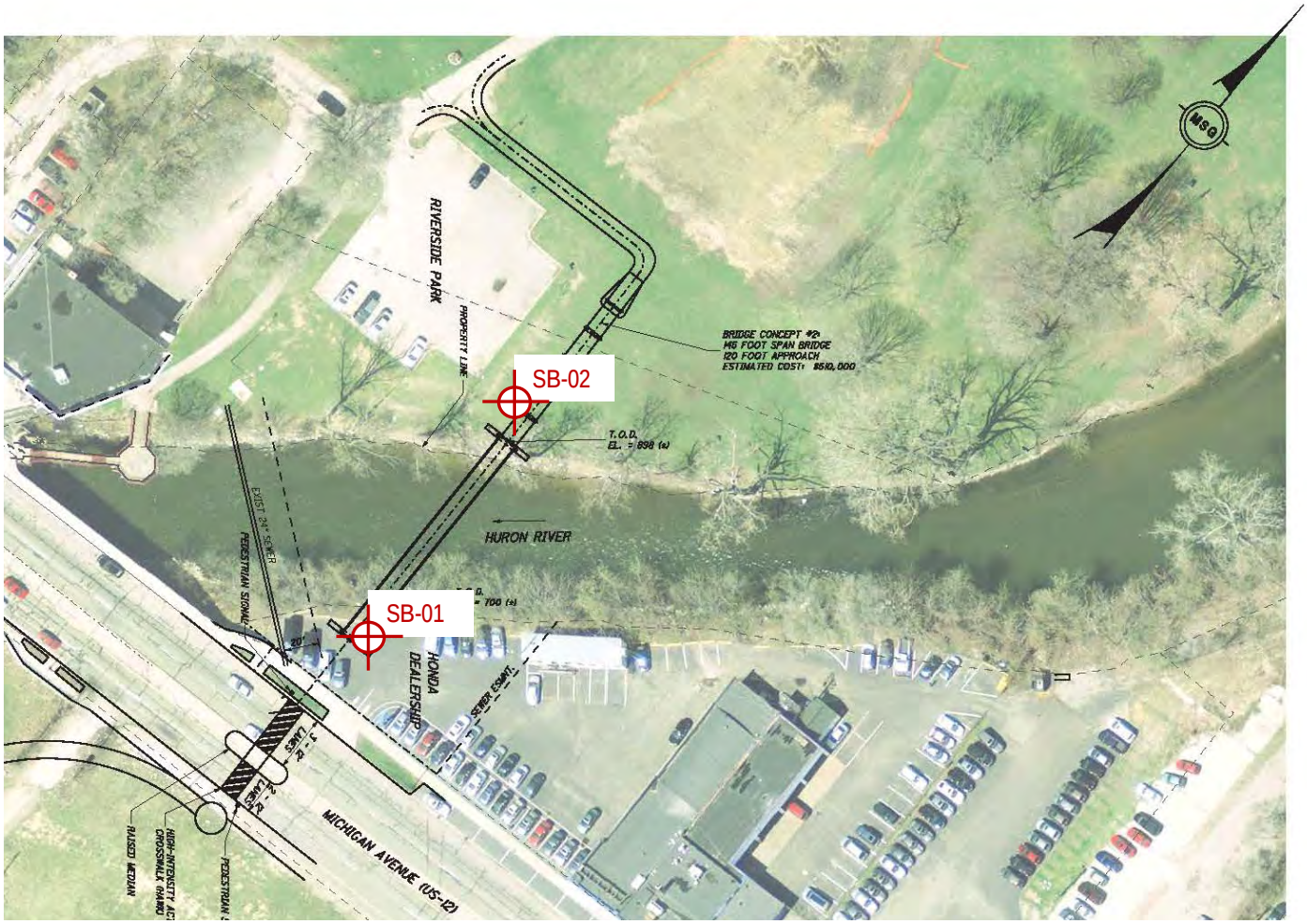
Jeffrey L. Snyder, PE
Geotechnical Engineer

Walter J. Bolt, CPG
Senior Vice President

cc: C. Zangara (MSG)

Attachments

- Figure 1 – Soil Boring Location Map
- Soil Boring Logs (SB-01 and SB-02)
- Geotechnical Laboratory Test Data (4 sheets)
- Calculations (12 sheets)



Mannik & Smith Group, Inc.

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Civil Engineering, Surveying and Environmental Consulting
Toledo ♦ Cleveland ♦ Columbus ♦ Canton ♦ Lansing ♦ Monroe

Figure 1: Soil Boring Location Map

Michigan Avenue Pedestrian Bridge over the Huron River
Ypsilanti, Michigan

Notes: Boring Locations Shown are Approximate

Drawing Not to Scale

BORING NUMBER SB-01

The Mannik & Smith Group, Inc.
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The Mannik & Smith Group, Inc.
2365 Haggerty Road South, Canton, MI 48188
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CLIENT Washtenaw County Parks and Recreation Commission
PROJECT NAME Huron River Bridge Survey & Design
PROJECT NUMBER WASP0059
PROJECT LOCATION Ann Arbor, MI
DATE STARTED 8/4/12 **COMPLETED** 8/4/12
GROUND ELEVATION 698.5 FEET **BORING DIAMETER:** 3.25
DRILLING CONTRACTOR MSG
WELL SURVEY INFORMATION: N/A
DRILLING METHOD Split Spoon
AT TIME OF DRILLING: 9 FEET
LOGGED BY AJB **CHECKED BY** JLS
AT END OF DRILLING: N/A
NOTES Boring terminated at 25' bgs due to heaving sands.
AFTER DRILLING: N/A

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	▲ SPT N VALUE ▲ 20 40 60 80 / PL MC LL 20 40 60 80 / ☐ FINES CONTENT (%) ☐ 20 40 60 80
0		Asphalt 698.2						
		(SM) Dense, brown silty SAND with gravel, dry 696.0	SS 1	33	9-18-14 (32)			
		(SM) Medium dense, brown silty SAND with organics, damp 693.5	SS 2	55	8-9-6 (15)			
5		(SM) Very loose, brown silty SAND, damp 691.0	SS 3	55	4-2-2 (4)			
		(SP) Loose, brown SAND with gravel and trace of organics, damp 688.5	SS 4	67	5-3-3 (6)			
10		(SM) Very loose, brown silty SAND with trace of clay and gravel, wet 683.5	SS 5	67	1-1-2 (3)			
15		(SP) Medium dense, brown SAND with gravel 673.5	SS 6	78	13-14-12 (26)			
20								
25								

Bottom of borehole at 25.0 feet.

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BORING NUMBER SB-02

The Mannik & Smith Group, Inc.
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CLIENT Washtenaw County Parks and Recreation Commission
PROJECT NAME Huron River Bridge Survey & Design
PROJECT NUMBER WASP0059
PROJECT LOCATION Ann Arbor, MI
DATE STARTED 8/4/12 **COMPLETED** 8/4/12
GROUND ELEVATION 691.3 FEET **BORING DIAMETER:** 3.25
DRILLING CONTRACTOR MSG
WELL SURVEY INFORMATION: N/A
DRILLING METHOD Split Spoon
AT TIME OF DRILLING: 6 FEET
LOGGED BY AJB **CHECKED BY** JLS
AT END OF DRILLING: N/A
NOTES
AFTER DRILLING: N/A

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	SPT N VALUE / PL MC LL / FINES CONTENT (%)
0		Topsoil 691.0						
		(SC) Loose, brown clayey SAND with organics, damp 688.8	SS 1	33	6-4-4 (8)			
		(ML) Very loose, gray sandy SILT with clay, wet 686.3	SS 2	100	0-1-0 (1)			
5		(SM) Medium dense, brown silty SAND with trace of clay and gravel, wet 683.8	SS 3	50	3-6-7 (13)			
		(SM) Medium dense, gray silty SAND with trace of clay and gravel, wet	SS 4	0	9-14-13 (27)			
10								
		676.3	SS 5	100	12-13-12 (25)			
15		(SM) Dense, gray silty SAND, wet 671.3	SS 6	100	15-17-17 (34)			
20		(SM) Dense, gray silty SAND, wet 666.3	SS 7	100	20-21-25 (46)			
25								

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BORING NUMBER SB-02

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CLIENT Washtenaw County Parks and Recreation Commission
PROJECT NAME Huron River Bridge Survey & Design
PROJECT NUMBER WASP0059
PROJECT LOCATION Ann Arbor, MI

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	▲ SPT N VALUE ▲ 20 40 60 80 / PL MC LL 20 40 60 80 / ☐ FINES CONTENT (%) ☐ 20 40 60 80
25		(SM) Very dense, gray silty SAND, wet						
30			SS 8	100	35-40-41 (81)			▲
		659.3 Bottom of borehole at 32.0 feet.						

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SUMMARY OF LABORATORY RESULTS

The Mannik & Smith Group, Inc.
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CLIENT Washtenaw County Parks and Recreation Commission

PROJECT NAME Huron River Bridge Survey & Prelim Design

PROJECT NUMBER WASP0059

PROJECT LOCATION Ann Arbor, MI

Borehole	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Maximum Size (mm)	%<#200 Sieve	Class-ification	Water Content (%)	Bulk Density (pcf)	Satur-ation (%)	Specific Gravity
SB-01	13.5	NP	NP	NP	19	34	SM	22.9			
SB-02	3.5	NP	NP	NP				59.4			
SB-02	23.5	NP	NP	NP	2	28	SM	20.3			

LAB SUMMARY - GINT STD US LAB GDT - 8/13/12 16:35 - W:\PROJECTS\PROJECTS U-Z\WASP0059\ADMINISTRATION\BORING LOGS 080412 THR.GPJ

Clr
8/13/12

ATTERBERG LIMITS' RESULTS

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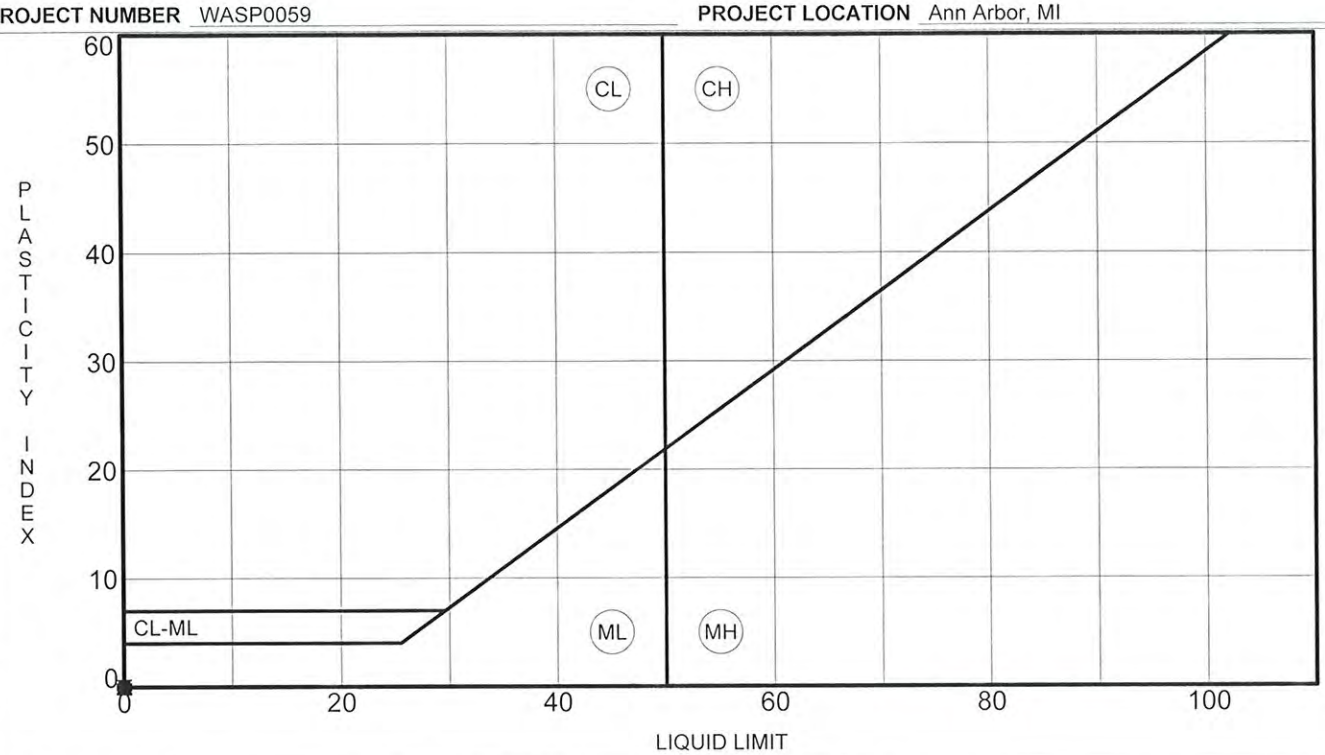
CLIENT Washtenaw County Parks and Recreation Commission
PROJECT NAME Huron River Bridge Survey & Prelim Design
PROJECT NUMBER WASP0059
PROJECT LOCATION Ann Arbor, MI



	Specimen Identification		LL	PL	PI	Fines	Classification
●	SB-01	13.5	NP	NP	NP	34	SILTY SAND(SM)
⧗	SB-02	3.5	NP	NP	NP		
▲	SB-02	23.5	NP	NP	NP	28	SILTY SAND(SM)

Clw 8/13/12

GRAIN SIZE DISTRIBUTION

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CLIENT Washtenaw County Parks and Recreation Commission

PROJECT NAME Huron River Bridge Survey & Prelim Design

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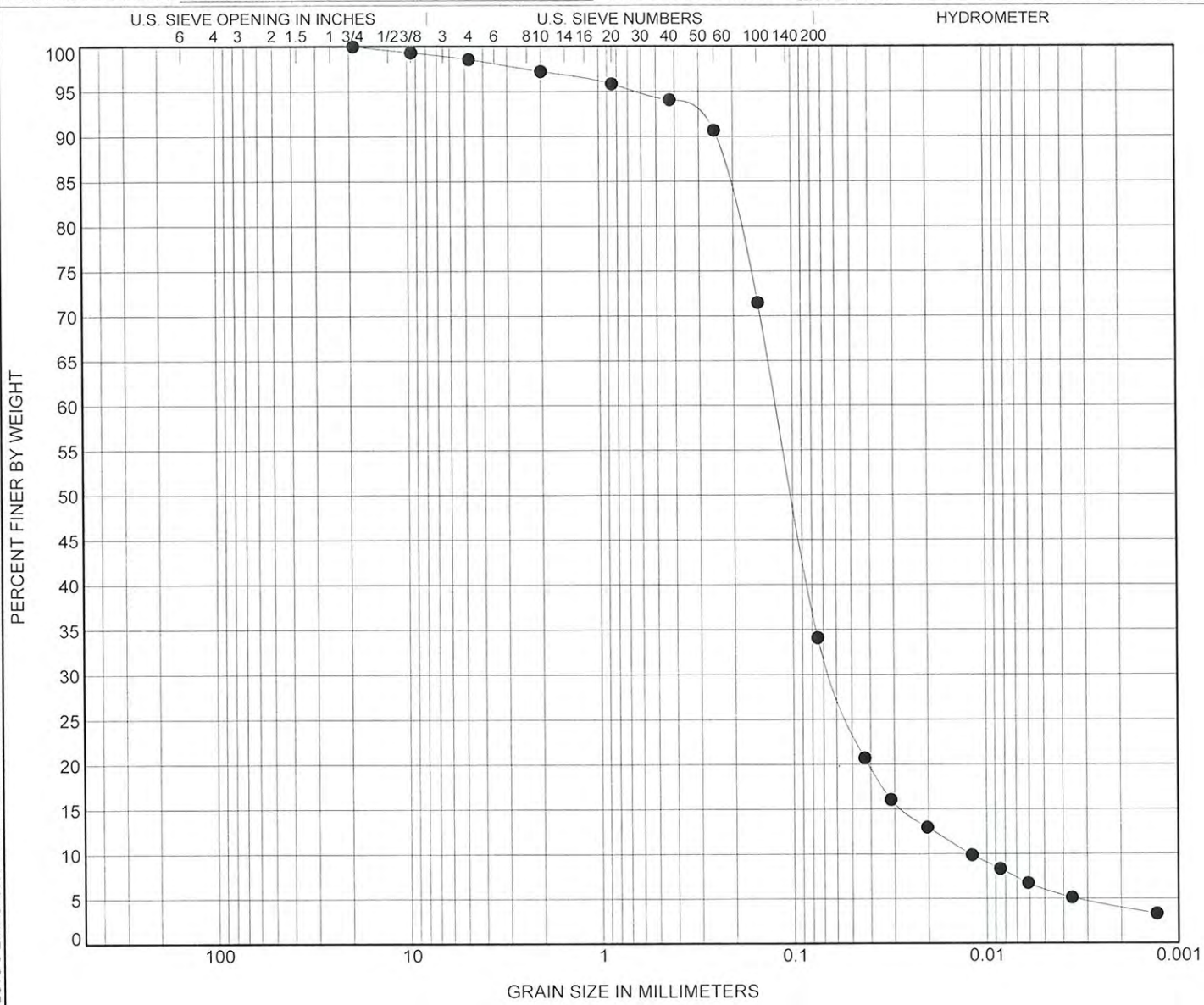
PROJECT LOCATION Ann Arbor, MI



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification		Classification	LL	PL	PI	Cc	Cu
● **SB-01**	**13.5**	**SILTY SAND(SM)**	**NP**	**NP**	**NP**	**2.72**	**9.97**

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● **SB-01**	**13.5**	**19**	**0.121**	**0.063**	**0.012**	**1.4**	**64.5**	**30.0**	**4.1**

Clw 8/13/12

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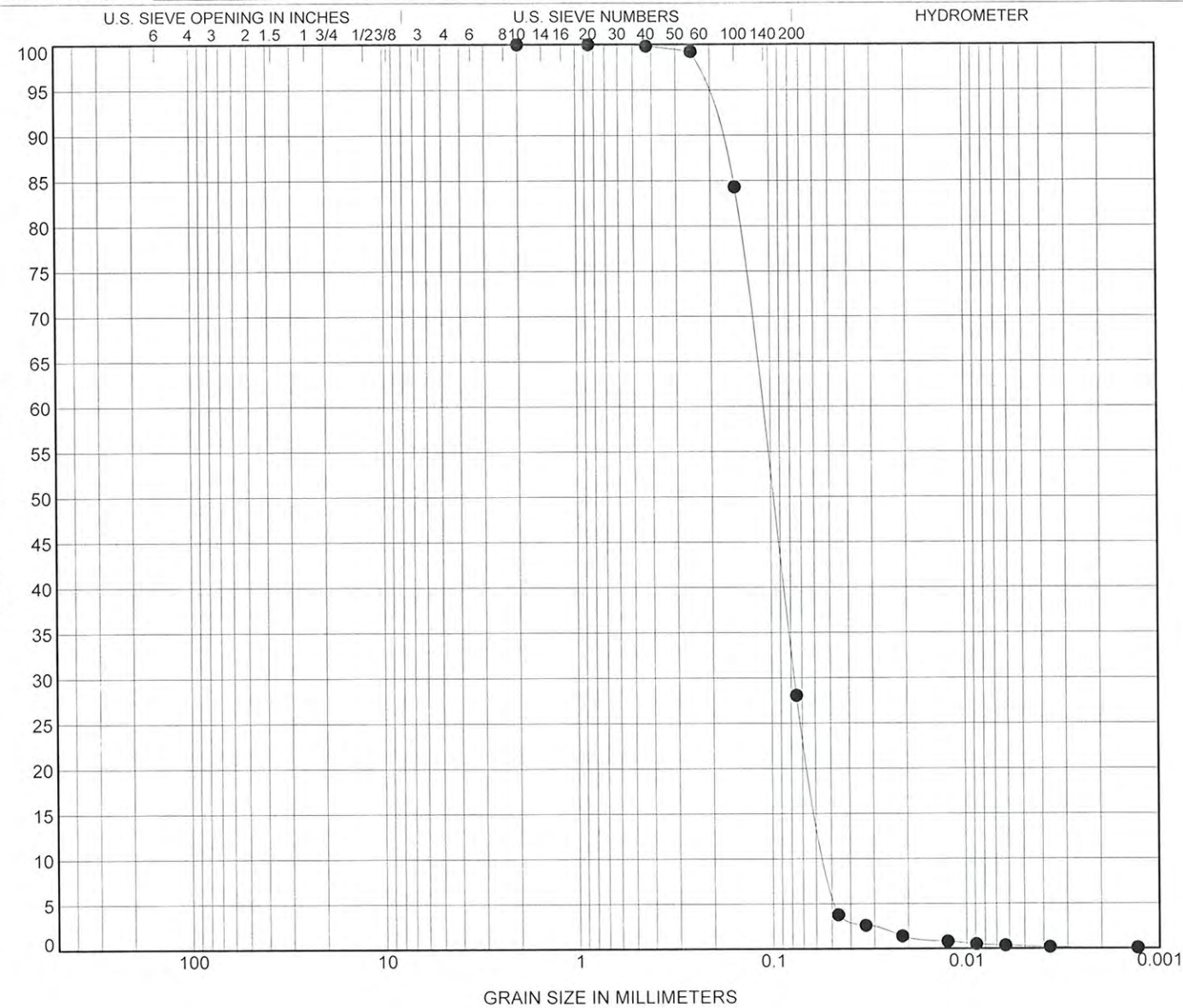
CLIENT Washtenaw County Parks and Recreation Commission
PROJECT NAME Huron River Bridge Survey & Prelim Design
PROJECT NUMBER WASP0059
PROJECT LOCATION Ann Arbor, MI



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification		Classification	LL	PL	PI	Cc	Cu
● SB-02	23.5	SILTY SAND(SM)	NP	NP	NP	1.01	2.13

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● SB-02	23.5	2	0.111	0.077	0.052	0.0	71.9	27.9	0.1

8/13/12

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Detroit, MI 313-961-9500 | Lansing, MI 517-316-9232 | Monroe, MI 734-289-2200 | Traverse City, MI 231-929-7330

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JOB Michigan Ave. Ped. Bridge (WACP0059)

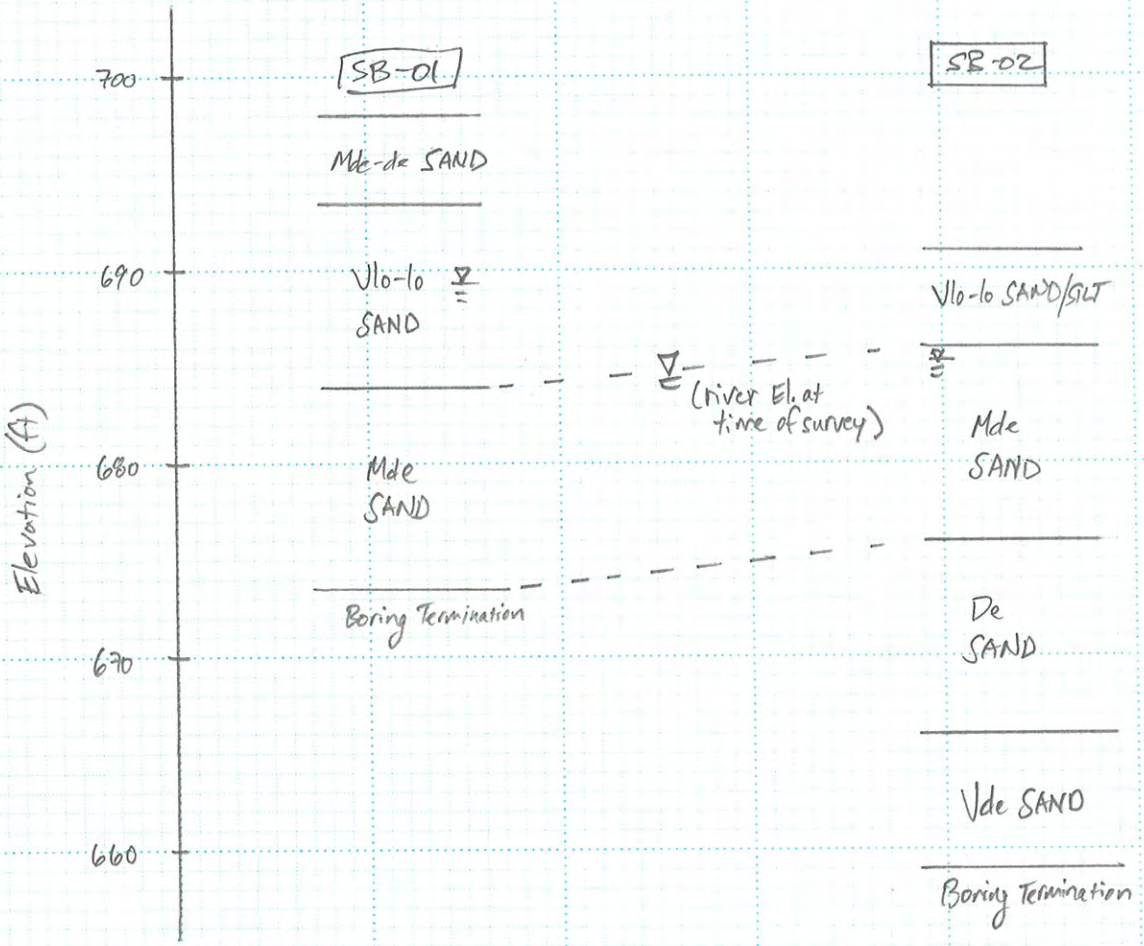
SHEET NO. 1 OF 12

CALCULATED BY JLS DATE 8/27/12

CHECKED BY _____ DATE _____

SCALE _____

Idealized Soil Profile



Assumptions

- South Abutment - base of pile cap ≈ 696 (4' below final grade)
- North Abutment - base of pile cap ≈ 687 (" " " ")
- Elevated Platform Foundations - Bearing Elev. ≈ 687.5 (42" below grade)

DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: W:\PROJECTS\PR6045~1\WASP0059\ADMINI~1\GEOTECH\DRIVEN\SB1_12C.DVN
Project Name: Michigan Ave. Ped. Bridge
Project Date: 08/27/2012
Project Client: Washtenaw Cty ParksRec
Computed By: JLS
Project Manager: WJB

PILE INFORMATION

Pile Type: Pipe Pile - Closed End
Top of Pile: 0.00 ft
Diameter of Pile: 12.00 in

South Abutment (SB-01)

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	6.50 ft
	- Driving/Restrike	6.50 ft
	- Ultimate:	6.50 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesionless	2.50 ft	0.00%	120.00 pcf	32.0/32.0	Nordlund
2	Cohesionless	10.00 ft	0.00%	115.00 pcf	29.0/29.0	Nordlund
3	Cohesionless	8.50 ft	0.00%	120.00 pcf	34.0/34.0	Nordlund
4	Cohesionless	9.00 ft	0.00%	125.00 pcf	37.0/37.0	Nordlund
5	Cohesionless	10.00 ft	0.00%	130.00 pcf	40.0/40.0	Nordlund

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.02 Kips	0.02 Kips
2.49 ft	0.40 Kips	5.93 Kips	6.33 Kips
2.51 ft	0.40 Kips	3.48 Kips	3.89 Kips
6.49 ft	2.10 Kips	8.78 Kips	10.88 Kips
6.51 ft	2.11 Kips	8.80 Kips	10.91 Kips
12.49 ft	6.51 Kips	10.46 Kips	16.97 Kips
12.51 ft	6.53 Kips	31.15 Kips	37.68 Kips
20.99 ft	20.95 Kips	45.16 Kips	66.10 Kips
21.01 ft	20.99 Kips	79.35 Kips	100.35 Kips
29.99 ft	51.13 Kips	107.84 Kips	158.97 Kips
30.01 ft	51.22 Kips	200.68 Kips	251.90 Kips
39.01 ft	104.70 Kips	258.02 Kips	362.72 Kips
39.99 ft	111.34 Kips	264.26 Kips	375.60 Kips

South Abutment (SB-01) - 12" Pipe

$R_{ult} = 250^k$ @ 30 ft (El. 696 - 30 = El. 666)

Est. Tip El ≈ El. 666

DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: W:\PROJECTS\PR6045~1\WASP0059\ADMINI~1\GEOTECH\DRIVEN\SB1_H10.DVN
Project Name: Michigan Ave. Ped. Bridge
Project Date: 08/27/2012
Project Client: Washtenaw Cty ParksRec
Computed By: JLS
Project Manager: WJB

PILE INFORMATION

Pile Type: H Pile - HP10X42
Top of Pile: 0.00 ft
Perimeter Analysis: Box
Tip Analysis: Box Area

South Abutment (SB-01)

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	6.50 ft
	- Driving/Restrike	6.50 ft
	- Ultimate:	6.50 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesionless	2.50 ft	0.00%	120.00 pcf	32.0/32.0	Nordlund
2	Cohesionless	10.00 ft	0.00%	115.00 pcf	29.0/29.0	Nordlund
3	Cohesionless	8.50 ft	0.00%	120.00 pcf	34.0/34.0	Nordlund
4	Cohesionless	9.00 ft	0.00%	125.00 pcf	37.0/37.0	Nordlund
5	Cohesionless	10.00 ft	0.00%	130.00 pcf	40.0/40.0	Nordlund

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.02 Kips	0.02 Kips
2.49 ft	0.42 Kips	5.13 Kips	5.54 Kips
2.51 ft	0.42 Kips	3.01 Kips	3.44 Kips
6.49 ft	2.29 Kips	7.59 Kips	9.88 Kips
6.51 ft	2.31 Kips	7.60 Kips	9.91 Kips
12.49 ft	7.17 Kips	9.04 Kips	16.21 Kips
12.51 ft	7.19 Kips	26.92 Kips	34.11 Kips
20.99 ft	21.94 Kips	38.58 Kips	60.52 Kips
21.01 ft	21.99 Kips	68.57 Kips	90.56 Kips
29.99 ft	50.92 Kips	93.19 Kips	144.10 Kips
30.01 ft	51.00 Kips	173.41 Kips	224.41 Kips
39.01 ft	100.27 Kips	222.96 Kips	323.23 Kips
39.99 ft	106.38 Kips	228.36 Kips	334.73 Kips

South Abutment (SB-01) - HP10x42

$R_{ultr} = 275^k$ @ 35 ft (El. 696 - 35 = 661)

Est. Tip El. ≈ 661

DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: W:\PROJECTS\PR6045~1\WASP0059\ADMINI~1\GEOTECH\DRIVEN\SB2_12C.DVN
Project Name: Michigan Ave. Ped. Bridge
Project Date: 08/27/2012
Project Client: Washtenaw Cty ParksRec
Computed By: JLS
Project Manager: WJB

PILE INFORMATION

Pile Type: Pipe Pile - Closed End
Top of Pile: 0.00 ft
Diameter of Pile: 12.00 in

North Abutment (SB-02)

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	2.00 ft
	- Driving/Restrike	2.00 ft
	- Ultimate:	2.00 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesionless	1.00 ft	0.00%	115.00 pcf	28.0/28.0	Nordlund
2	Cohesionless	10.00 ft	0.00%	120.00 pcf	34.0/34.0	Nordlund
3	Cohesionless	10.00 ft	0.00%	125.00 pcf	37.0/37.0	Nordlund
4	Cohesionless	9.00 ft	0.00%	130.00 pcf	40.0/40.0	Nordlund

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.01 Kips	0.01 Kips
0.99 ft	0.04 Kips	1.09 Kips	1.13 Kips
1.01 ft	0.04 Kips	3.36 Kips	3.41 Kips
1.99 ft	0.26 Kips	6.77 Kips	7.03 Kips
2.01 ft	0.27 Kips	6.82 Kips	7.09 Kips
10.99 ft	5.98 Kips	21.79 Kips	27.77 Kips
11.01 ft	6.01 Kips	38.21 Kips	44.22 Kips
20.01 ft	22.95 Kips	66.76 Kips	89.71 Kips
20.99 ft	25.35 Kips	69.87 Kips	95.22 Kips
21.01 ft	25.41 Kips	130.07 Kips	155.47 Kips
29.99 ft	62.32 Kips	187.28 Kips	249.61 Kips

North Abutment (SB-02) - 12" pipe

$R_{ndr} = 250^K$ @ 30 ft (El. 687 - 30 = 657)

Est. Tip El. = El. 657

DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: W:\PROJECTS\PR6045~1\WASP0059\ADMINI~1\GEOTECH\DRIVEN\SB2_H10.DVN
Project Name: Michigan Ave. Ped. Bridge
Project Date: 08/27/2012
Project Client: Washtenaw Cty ParksRec
Computed By: JLS
Project Manager: WJB

PILE INFORMATION

Pile Type: H Pile - HP10X42
Top of Pile: 0.00 ft
Perimeter Analysis: Box
Tip Analysis: Box Area

North Abutment (SB-02)

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	2.00 ft
	- Driving/Restrike	2.00 ft
	- Ultimate:	2.00 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesionless	1.00 ft	0.00%	115.00 pcf	28.0/28.0	Nordlund
2	Cohesionless	10.00 ft	0.00%	120.00 pcf	34.0/34.0	Nordlund
3	Cohesionless	10.00 ft	0.00%	125.00 pcf	37.0/37.0	Nordlund
4	Cohesionless	15.00 ft	0.00%	130.00 pcf	40.0/40.0	Nordlund

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.01 Kips	0.01 Kips
0.99 ft	0.05 Kips	0.94 Kips	0.99 Kips
1.01 ft	0.05 Kips	2.91 Kips	2.96 Kips
1.99 ft	0.28 Kips	5.85 Kips	6.12 Kips
2.01 ft	0.28 Kips	5.89 Kips	6.17 Kips
10.99 ft	6.13 Kips	18.83 Kips	24.95 Kips
11.01 ft	6.15 Kips	33.02 Kips	39.17 Kips
20.01 ft	22.41 Kips	57.69 Kips	80.10 Kips
20.99 ft	24.71 Kips	60.38 Kips	85.09 Kips
21.01 ft	24.77 Kips	112.40 Kips	137.16 Kips
30.01 ft	58.87 Kips	161.94 Kips	220.81 Kips
35.99 ft	88.34 Kips	194.87 Kips	283.20 Kips

North Abutment (SB-02) - HP 10x42

R_{ndr} = 275^k @ 35ft (El. 687 - 35 = El. 652)

Est. Tip El. = 652

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DRIVEN Summary

- Evaluate 12" dia pipe piles (closed end) and HP10x42 piles
- Per 7.03.09 of MDOT Bridge Design Manual

Nominal (Ultimate) Capacity (R_{ndr}) = 250^k for 12" Pipe
= 275^k for HP10x42

- Assume soil plug for HP10x42 piles

Location	Pile Type	R_{ndr} (kips)	Est. Tip El. (ft)	Pile Length (ft)
South (SB-01)	12" Pipe	250	666	30
South (SB-01)	HP10x42	275	661	35
North (SB-02)	12" Pipe	250	657	30
North (SB-02)	HP10x42	275	652	35

Shallow Foundation Calculations - Elevated Platforms (AASHTO LRFD)

- At SB-02, assume very loose Sandy Silt is overexcavated and replaced with engineered fill (approximate 1.5 foot undercut below bearing depth)

- Service Limit State

Presumptive Bearing Resistance ≈ 5 ksf (Table C10.6.2.6.1-1)

Resistance Factor(φ) = 1.0

Factored Bearing Resistance = 5^{ksf} (service)

- Strength Limit State (10.6.3.1.2)

$$q_u = c\cancel{N_{cm}}^{\,0\ \text{(cohesionless soils)}} + \gamma D_f N_{qm} C_{wq} + 0.5\gamma B N_{\gamma m} C_{w\gamma}$$

$N_{qm} = N_q s_q d_q i_q$ ($i_q = 1$, $s_q = 1 + \frac{3}{3}\tan 34° = 1.67$, $d_q = 1.2$, $N_q = 29.4$)

$N_{\gamma m} = N_\gamma s_\gamma i_\gamma$ ($i_\gamma = 1$, $s_\gamma = 1 - 0.4(\frac{3}{3}) = 0.6$, $N_\gamma = 41.1$)

$\gamma = 120$ pcf $\phi = 34°$ (Assume 3'x3' footings)

$C_{wq} = 1.0$, $C_{w\gamma} = 0.5$ (assume water table at bottom of footing)

$$q_u = (0.120\text{kcf})(3.5\text{ft})\underbrace{(1)(1.67)(1.2)(29.4)}_{N_{qm}}(1.0) + 0.5(0.120\text{pcf})(3\text{ft})\underbrace{(1.0)(0.6)(41.1)}_{N_{\gamma m}}(0.5)$$

$= 24.7$ ksf $+ 2.2$ ksf
$= 26.9$ ksf

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JOB Michigan Ave. Ped. Bridge (WASP0059)

SHEET NO. 11 OF 12

CALCULATED BY JLS DATE 8/27/12

CHECKED BY _____ DATE _____

SCALE _____

$q_n = 24.7\,ksf + 2.2\,ksf$
$= 26.9\,ksf$

ϕ_b (resistance factor) $= 0.45$ (Table 10.5.5.2.2-1)

$q_R = 0.45(26.9\,ksf) = 12.1\,ksf$

- Check alternate method of computing q_n (see spreadsheet, sheet 12)

$q_n = 13.4\,ksf$

$\therefore q_n = 13.5\,ksf$

$q_R = 0.45(13.5\,ksf) = \underline{6.0\,ksf}$

- Settlement Check (10.6.2.4.2)

$$S_e = \frac{q_o(1-\nu^2)\sqrt{A'}}{144\,E_s\,\beta_z} \quad \text{(Equation 1)}$$

$q_o = 5.0\,ksf$ (service limit bearing capacity)
$A' = 3' \times 3'$ (no eccentricity)
$= 9\,ft^2$
$E_s = 4.17\,ksi$ (Table C10.4.6.3-1)
$\nu = 0.25$ (" ")
$\beta_z = 1.06$ (Table 1)

$$S_e = \frac{(5.0)(1-0.25^2)\sqrt{9}}{144(4.17)(1.06)} = 0.022\,ft$$
$$= \underline{0.27\,in} \text{ ok}$$

LOCATION: Elevated Platforms
PROJECT: Michigan Ave. Pedestrian Bridge - Terzaghi Method
JOB NO.: WASP0059

BEARING CAPACITY

Strip Ftg	X	***Check ONLY One***
Spread Ftg		
Circle Ftg		

N =	26		
ϕ =	34	degrees	
N_γ =	28.00		
N_q =	28.00		
D_f =	3.5	ft	
B =	3	ft	
γ_1 =	120	pcf	<--Average eff. unit weight above ftg
γ_2 =	60	pcf	<--Average eff. unit weight below ftg
$q_{u,gross}$ =	13776.0	psf	
F.S. =	1		← want ultimate (nominal) bearing resistance
$q_{a,gross}$ =	13.78	ksf	
$q_{a,net}$ =	13.36	ksf	

N	ϕ	Nq	N_γ
4	28.0	7.0	4.0
6	29.0	8.0	4.5
10	30.0	10.0	7.0
13	31.0	13.5	11.0
16.5	32.0	17.0	15.0
20	33.0	18.0	17.0
23	34.0	28.0	28.0
26.5	35.0	36.0	37.0
30.5	36.0	44.0	48.0
34	37.0	55.0	64.0
38	38.0	67.0	82.0

SETTLEMENT

s_{max} =	1	in	<--Max. amount of immediate settlement
Fd =	1.39		
$q_{a,net}$ =	16.00	ksf	
$q_{a,net}$ =	13.36	ksf	<--Use this value

Sheet 12 of 12