Minnesota Department of Transportation
Office of Materials & Road Research
1400 Gervais Avenue, Maplewood, MN 55109

Memo

Date: March 25, 2024

To: Eric Peterson, Project Manager
Metro District

From: Zoe Jeske, Graduate Engineer
Geotechnical Section

Zoe Jeske Digitally signed by Zoe Jeske Date: 2024.03.26 09:44:46 -05'00'

Concur: Joe Nietfeld, Principal Engineer
Geotechnical Section

Joseph Nietfeld Digitally signed by Joe Nietfeld Date: 2024.03.26 14:14:57 -05'00'

Subject: S.P. 8825-1155 Metro Wide Overhead Signs
Foundations Analysis and Design Recommendation Report

1.0 Project Description

This letter provides a foundation analysis and recommendations for the construction of 16 overhead signs in the metro district. All signs will be cantilever signs with either design D posts or monotube posts.

2.0 Field Investigation and Foundation Conditions

Twenty-two Cone Penetration Tests (CPT Soundings) were advanced in February and March 2024 at the locations the overhead signs will be placed by MnDOT staff. Groundwater measurements are not conclusive with the CPT soundings because of the dynamic nature of the direct push investigation and therefor are not reported. A copy of the CPT Sounding results is attached to this report.

Interstate 494 (I-494)

Six CPT Soundings, c200, c201, c201a, c202, c203, and c203a, were taken along I-494. Soundings c201a and c203a were taken to confirm the depth to shallow refusal. The soundings generally consisted of medium dense sand followed by dense to very dense sand with scattered layers of medium stiff to stiff clay. CPT Sounding c203 encountered about a 3-foot layer of soft clay and loose sand from about 7 feet to 10 feet. All CPT Soundings except c201a were terminated between 14 and 29 feet upon shallow refusal. c201a was terminated at 49 feet. Nearby historic Standard Penetration Tests (SPT Borings) were reviewed and MnDOT geologists were consulted and determined that rock sockets are not needed for any of the overhead signs at I-494. The shallow refusal may indicate the presence of boulders or other debris which may be encountered during construction. See Section 3.3 for construction considerations for boulder removal.

Minnesota 13 (MN 13)

Five CPT Soundings, c204, c204a, c205, c205a, and c206, were taken along MN 13. Soundings c204a and c205a were taken to confirm the depth to shallow refusal. The soundings generally consisted of loose sand followed by medium dense to dense sand alternating with medium stiff to stiff clay. CPT Sounding c204 encountered alternating layers of soft clay and loose sand from about 9 to 13 feet. All CPT Soundings were terminated between 15 and 32 feet upon shallow refusal. Nearby historic SPT Borings were reviewed and MnDOT geologists were consulted and determined that rock sockets are not needed

for any of the overhead signs at MN 13. The shallow refusal may indicate the presence of boulders or other debris which may be encountered during construction. See Section 3.3 for construction considerations for boulder removal.

Interstate 94 (I-94)

Eight CPT Soundings, c207, c207a, c208, c209, c209a, c210, c211, and c212, were taken along I-94. Soundings c207a and c209a were taken to confirm the depth to shallow refusal. The soundings generally consisted of loose sand followed by dense sand. CPT Soundings c207 and c208 encountered layers of loose to medium stiff clay alternating with loose sand from about 4 feet to 15 feet. All CPT Soundings except c210, c211, and c212 were terminated between 11 feet and 39 feet upon shallow refusal. Soundings c210, c211, and c212 were terminated at 49 feet. Nearby historic SPT Borings were reviewed and MnDOT geologists were consulted and determined that rock sockets are not needed for any of the overhead signs at I-94 **except** OH I35E-312. The historic SPT borings suggest shallow Platteville limestone bedrock at c207 (OH I35E-312). The shallow refusal at the other sites may indicate the presence of boulders or other debris which may be encountered during construction. See Section 3.3 for construction considerations for boulder removal.

Minnesota 36 (MN 36)

One CPT Sounding, c213, was taken along MN 36. The sounding consisted of about 15 feet of loose sand alternating with medium stiff clay, followed by medium dense to dense sand. There was also about 1 foot of dense sand at a depth of 5 feet. The CPT sounding was terminated at 49 feet.

Minnesota 280 (MN 280)

One CPT Sounding, c214, was taken along MN 280. The sounding consisted of about 12 feet of loose sand alternating with medium stiff clay, followed by about 9 feet of dense sand, and then about 9 feet of alternating layers of medium stiff clay and medium dense sand. Next, is about 2 feet of dense sand, followed by stiff clay. The CPT sounding was terminated at 49 feet.

Minnesota 95 (MN 95)

One CPT Sounding, c215, was taken along MN 95. The sounding consisted of medium dense to dense sand for about 30 feet, followed by alternating layers of medium stiff to stiff clay and dense sand. The bottom 5 feet consisted of dense to very dense sand. The CPT Sounding was terminated at 49 feet.

3.0 Foundation Analysis

The foundation analysis consisted of verifying that the foundation soil properties met the minimum parameters as required by MnDOT standard plan 5-297.763 for design D signs and standard plan 5-297.746 for monotube signs. The standards assume foundation granular soils have a friction angle of 30°, a unit weight of 125pcf, and a maximum coefficient of friction of 0.70, and foundation cohesive soils have a minimum shear strength of 1 ksf and a unit weight of 125 +/- 10 pcf. Groundwater elevation is required to be at least 1.5 ft below finished grade for drilled shafts.

Based on review of the existing subsurface conditions at the proposed overhead sign footing locations, we determined that the soils **meet** the minimum requirements of the standard plans except for signs OH I494-516, OH MN13-015, OH I35E-312, and OH MN280-024. A special analysis for these signs is described in Section 3.1. Groundwater was not measured during the subsurface investigation. If groundwater is encountered within 1.5 feet of the surface, this office should be contacted for a revised design.

Table 1. Summary of Overhead Signs

OH Sign	Point	Trunk Highway	Post Type	Shaft Diameter	Shaft Depth	Special Considerations	Nearby Borings
OH I494-514	c200	I-494	5E	4'-3"	29'	Shallow CPT Refusal – possible boulders	T-3- Unique ID 004013
OH I494-515	c201	I-494	6E	4'-3"	29'		
OH I494-516	c202	I-494	6E	4'-3"	29'	Shallow CPT Refusal – possible boulders	T-3-Unique ID 51942
OH I494-517	c203	I-494	6E	4'-3"	29'	Shallow CPT Refusal – possible boulders	T-2-Unique ID 51985
OH MN13-015	c204	TH 13	6E	4'-3"	29'	Shallow CPT Refusal – possible boulders	TC-7-Unique ID 51283
OH MN13-016	c205	TH 13	3E	3'-6"	23'	Shallow CPT Refusal – possible boulders	T6-Unique ID 50350
OH MN13-017	c206	TH 13	3E	3'-6"	23'	Shallow CPT Refusal – possible boulders	T6-Unique ID 50350
OH I35E-312	c207	I-94/I-35E	monotube	3'-0"	18'	Shallow CPT Refusal – Rock Sockets indicated	S21-4-Unique ID 002253
OH I94-836	c208	I-94	6E	4'-3"	29'	Shallow CPT Refusal – possible boulders	T1-Unique ID 003032
OH I94-837	c209	I-94/Lexington	monotube	3'-0"	15'-6"	Shallow CPT Refusal – possible boulders	S36-Unique ID 073860
OH I94-838	c210	I-94/Lexington	monotube	3'-0"	15'-6"		
OH I94-839	c211	I-94/Lexington	monotube	3'-0"	15'-6"		
OH I94-840	c212	I-94/Lexington	monotube	3'-0"	15'-6"		
OH MN36-125	c213	TH 36	5E	4'-3"	29'		
OH MN280-024	c214	TH 280	6E	4'-3"	29'		
OH I94-841	c215	TH95/I-94	5E	4'-3"	29'	Perm. Casing Required	

3.1 Special Designs

3.1.1 Permanent Casing Requirements

OH I94-841 requires a 6-foot permanent casing to ensure that an existing signal service utility within 10 feet of the proposed drilled shaft is not impacted during construction.

3.1.2 Special Design Considerations- OH I35E-312

OH I35E-312 is a monotube sign that requires rock sockets due to the shallow CPT refusal and historic boring data suggesting shallow bedrock near elevation 795 (see attached historic boring log).

We performed a special design for OH I35E-312 due to loose sands, soft clay, and shallow bedrock encountered that **do not** meet the minimum requirements for unit weight based on standard plan 5-297.746. The sand and clay encountered unit weights between 115 and 120 pcf, and bedrock was encountered at approximately 11 feet, requiring a rock socket. MnDOT Bridge Office staff provided us service and extreme event limit state loads for the overhead sign below:

Table 2. OH I35E-312 loads.

Limit State	Vertical (kips)	Horizontal (kips)	Mx (ft-lbs)
Service Limit State	8.6	2.89	51,915
Extreme Event I	9.46	7.22	129,465

3.1.2.1 Geotechnical Strength Limit State with Extreme Event Limit State loads

We modeled the shaft in Lpile 2022.12.07 and used the Sand (Reese) p-y curve to model the upper 0-7 feet of loose sand, we used the Soft Clay (Matlock) to model 7-9 feet, Sand (Reese) to model the dense sand from 9-12 feet, and Strong Rock (Vuggy Limestone) to model the encountered bedrock. The Lpile analysis shows that a shaft length of 17' feet is stable and the deflection curve is headed back towards zero. Also, after 17 feet an increase in shaft length does not decrease the deflection. Based on the historic information, we estimate competent bedrock will be encountered near 13 feet, therefore we recommend a 5-foot rock socket. A copy of the Bending Moment vs. Depth Graph is attached to this report.

3.1.2.2 Horizontal movement at the top of the shaft at the Service Limit State.

For the service limit state, we calculated the horizontal movement at the top of the shaft with a length of 18 feet to be less than 0.l in. which meets the maximum lateral movement criteria of 1 in. for this structure. A copy of the Top Deflection vs. Pile Length Graph is attached to this report.

3.1.3 Special Design Considerations- OH I494-516, OH MN13-015, and OH MN280-024

CPT's near the proposed signs OH I494-516, OH MN13-015, and OH MN280-024 indicated areas of loose sand and soft clay. To verify the embedment depth in the standard plan is acceptable, we used the program LPile (v2022) with estimated loading of the overhead signs provided by MnDOT Bridge Office, and determined that, for post type 6E, the standard depth of 29 feet and shaft diameter 4'-3" from MnDOT Standard Plan 5-297.763 are acceptable.

3.2 Settlement

We estimated the settlement of the new overhead sign based on the following assumptions:

A. The final grade at the overhead sign will not be raised.
B. Drilled shafts are constructed to the depth recommended in Table 1.

We evaluated the settlement using the program Settle3 for all the overhead signs and determined that all signs will meet the minimum criteria of 1 inch or less.

3.3 Construction Considerations

For OH I494-514, OH I494-516, OH I494-517, OH MN13-015, OH MN13-016, OH MN13-017, OH I35E-312, OH I94-836, and OH I94-837 cobbles and boulders will likely be encountered during drilled shaft excavation. Modified single-helix augers, coring and/or impact hammers tooling may be needed to remove the cobbles and boulders. Also cobble mixtures where the soil matrix is loose and granular, may be susceptible to caving and sloughing, and usually require temporary casing to stabilize the drilled shaft side walls. MnDOT and the contractor should incorporate the extra tooling, temporary casing, and time require to remove the cobbles and boulders into the schedule and bid for this project.

4.0 Foundation Recommendations

Based on the existing conditions along with an analysis of the project soils, we recommend that:

1. The overhead signs be constructed in accordance with MnDOT standard plan 5-297.763 for design D signs and 5-297.746 for monotube signs.

2. OH I35E-312 be constructed to a depth of 18 feet with the bottom 5 feet rock socketed into competent bedrock. We estimate competent bedrock will be encountered at elevation 793.

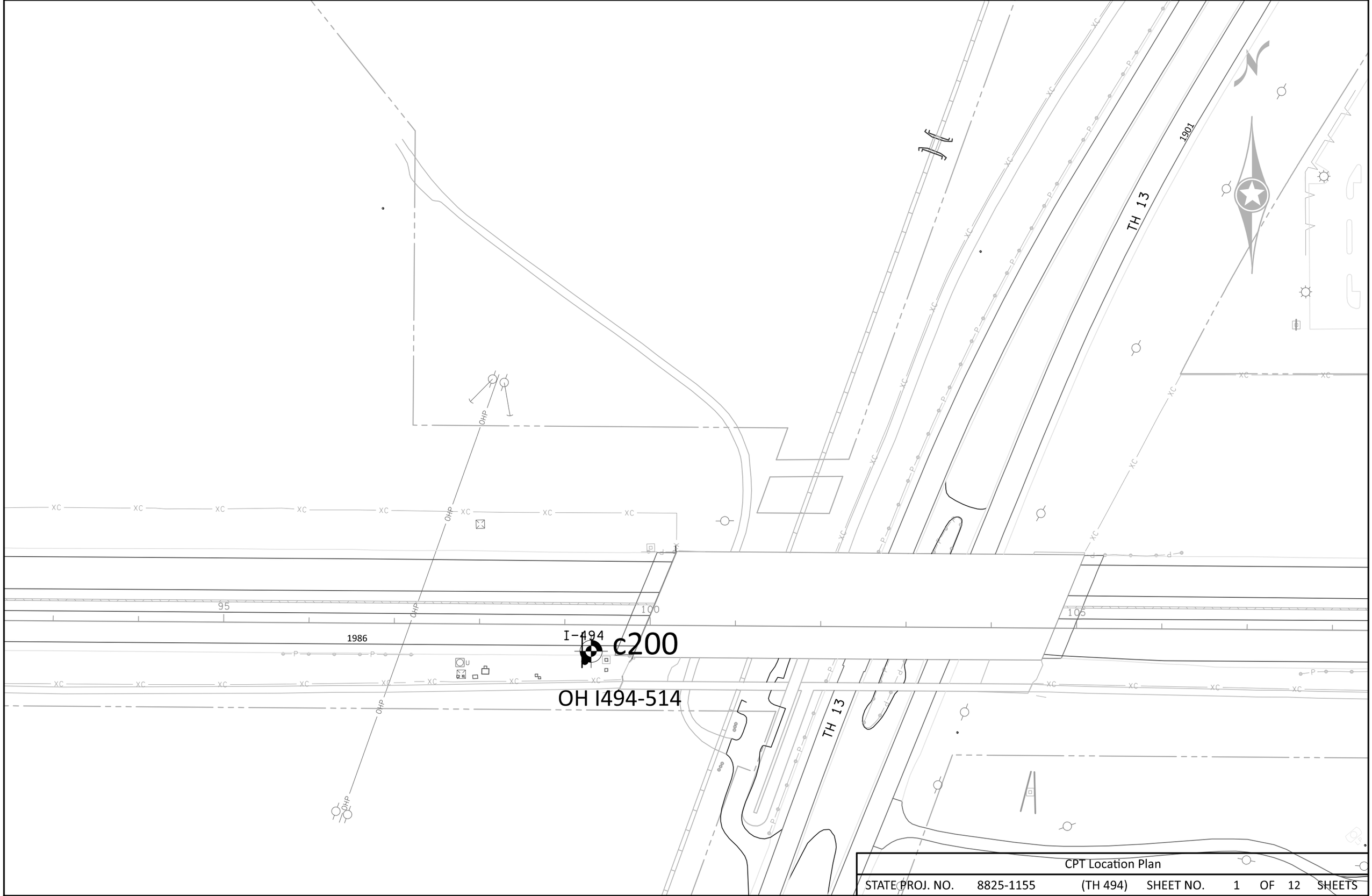
3. OH I94-841 be constructed per MnDOT standard plan 5-297.763 but include a 6-foot permanent casing for signal service utility protection.

4. The contractor is notified of the subsurface conditions for this site, specifically the cobbles and boulders that will likely be encountered during drilled shaft excavation for OH I494-514, OH I494-516, OH I494-517, OH MN13-015, OH MN13-016, OH MN13-017, OH I35E-312, OH I94-836, and OH I94-837. At a minimum, this Foundation Analysis and Design Report should be included in the reference information documents (RID) for the project.

5. This office be contacted for revised foundation recommendations if the foundation soils or groundwater elevations differ from those described in this report.

Attachments: CPT Location Plan
OH Sign Profile Plan
CPT Index
CPT Sounding Logs
Historic SPT Boring
Bending Moment vs. Depth Graph
Top Deflection vs. Pile Length Graph

cc: Shelly Pederson (Metro District Soils Engineer)
Dave Van Deusen (Metro District Materials Engineer)
Lars Impola (Metro District Traffic Engineer)
Brad Skow (Geotechnical Unit Manager)
Jason Hedeen (Geotechnical Asset Manager)



CPT Location Plan

STATE PROJ. NO. 8825-1155 (TH 494) SHEET NO. 1 OF 12 SHEETS

BABCOCK TRAIL

I-494

1985

I-494

OH I494 515

c201

c201a

265

270

275

52ND ST.EAST

CUL END

GREYSTONE DR.

COUNTY ROAD NO. 73

POT. 277+45.82

CPT Location Plan

STATE PROJ. NO.	8825-1155	(TH 494)	SHEET NO.	2	OF	12	SHEETS

50TH STREET E.

50TH ST. EAST

BLAINE AVE.

I-494

1985

CURVE BA2640
PI 296+29.05
X 567,457.222
Y 247,047.478
Δ 0° 53' 42.75" (LT)
D 0° 15' 00.00"
T 179.05
L 358.08
R 22,918.32
PC 294+50.00
PT 298+08.08

CURVE BA2645
PI 303+22.54
X 568,150.657
Y 247,057.311
Δ 4° 42' 32.75" (RT)
D 1° 59' 59.90"
T 117.80
L 235.46
R 2,864.83
PC 302+04.75
PT 304+40.21

OH I494-516

c202

295 300 295 300 305

PC. 294+50.00 PT. 298+08.08 PC. 302+04.75 PT. 304+40.21

CPT Location Plan

STATE PROJ. NO. 8825-1155 (TH 494) SHEET NO. 3 OF 12 SHEETS

BRENT AVE.

50TH ST. EAST

9TH AVE. SOUTH

8TH AVE. SOUTH

7TH AVE. SOUTH

LILAC LN

CURVE BA2050
PI 325+10.23
X 570,338.520
Y 246,930.294
Δ 4° 15' 32.12" (RT)
D 0° 29' 59.36"
T 426.24
L 852.09
R 11,463.23
PC 320+84.05
PT 329+36.14

EQ. STA.329+36.14 R2 = STA.329+42.14 R3

I-494

320

325

330

1985

OH I494-517

c203

c203a

52ND ST. EAST

BRENT AVE.

BRYCE AVE.

PC 320+84.05

52ND ST. EAST

9TH AVE. SOUTH

EQUATION PT. 329+36.14 BK = STA 329+42.14 AH

8TH AVE. SOUTH

CPT Location Plan

STATE PROJ. NO.	8825-1155	(TH 494)	SHEET NO.	4	OF	12	SHEETS

Hwy 13

1901

OH MN13-015

c204a

c204

77 SB Ramp

Diffley Rd

TH 13

TH 13

OLD SIBLEY MEMORIAL HWY.

OLD SIBLEY HWY.

CEDAR BRIDGE AVE.

DIFFLEY RD.

OLD SIBLEY HWY.

CPT Location Plan								
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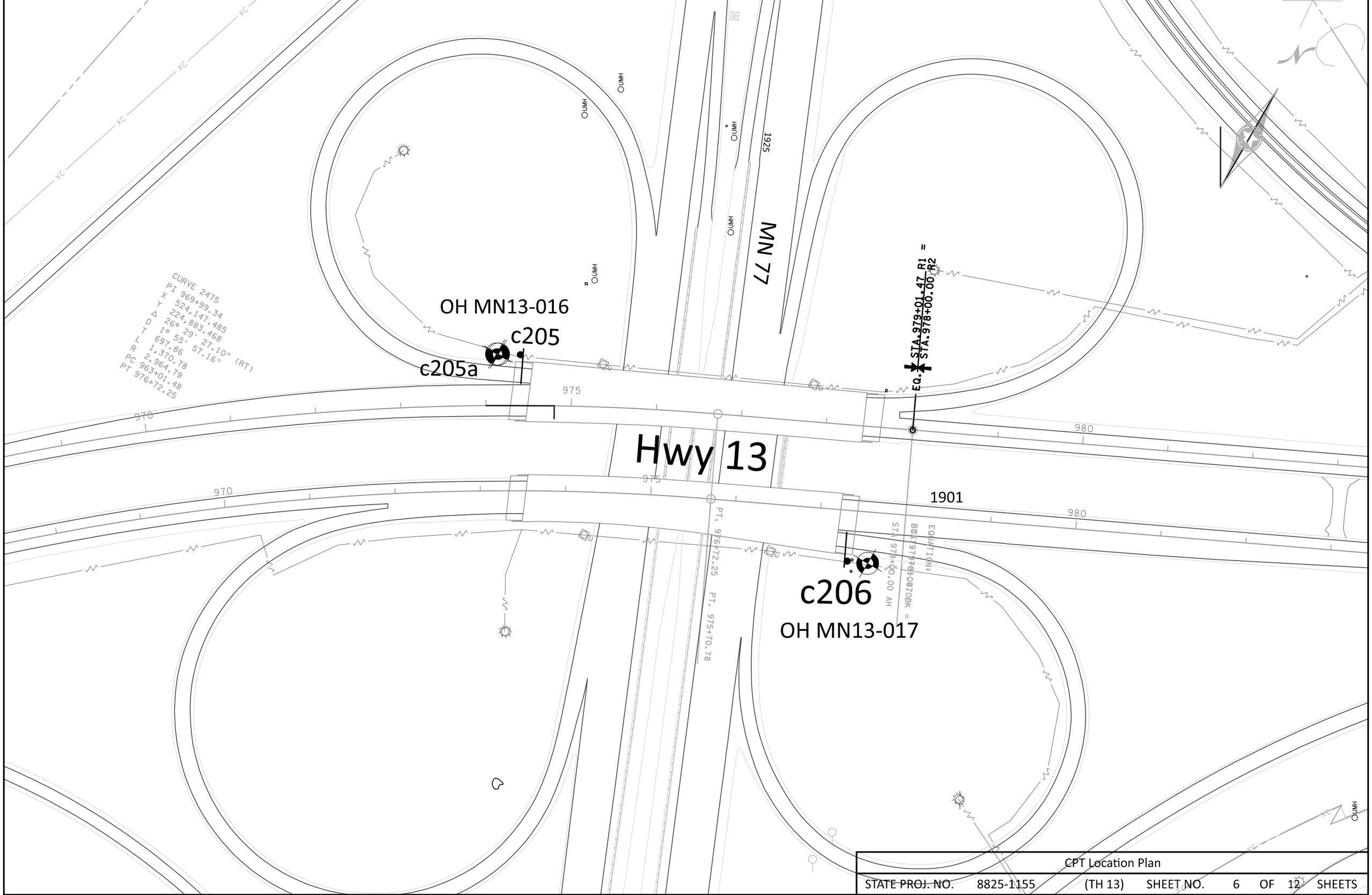


CPT Location Plan								
STATE PROJ. NO.	8825-1155	(TH 13)	SHEET NO.	6	OF	12	SHEETS	

E 12th St

I-94/35E

6280

Cedar St

POT. 30+11.87

c207

c207a

OH I35E-312

Wabasha St N

POT. 33+98.82

CPT Location Plan								
STATE PROJ. NO.	8825-1155	(TH 94)	SHEET NO.	7	OF	12	SHEETS

GILBERT AVE.

c208

OH I94-836

94 WB

6282

94 EB

N. CRETIN AVE.

BEVERLY RD.

ST. ANTHONY AVE.

F/O -BUR

CPT Location Plan

STATE PROJ. NO.	8825-1155	(TH 94)	SHEET NO.	8	OF	12	SHEETS

OH I94-838

c210

c209

c209a

OH I94-837

OH I94-839

c211

c212

OH I94-840

Lexington Pkwy

LEXINGTON PKWY.

LEXINGTON PKWY.

CONCORDIA AVE.

ST. ANTHONY AVE.

94 EB

94 WB

6282

POT. 190+26.61

PI . 56+83.00

PI . 61+90.32

PI . 66+00.32

PI . 68+59.94

PI . 56+82.90

PI . 60+90.34

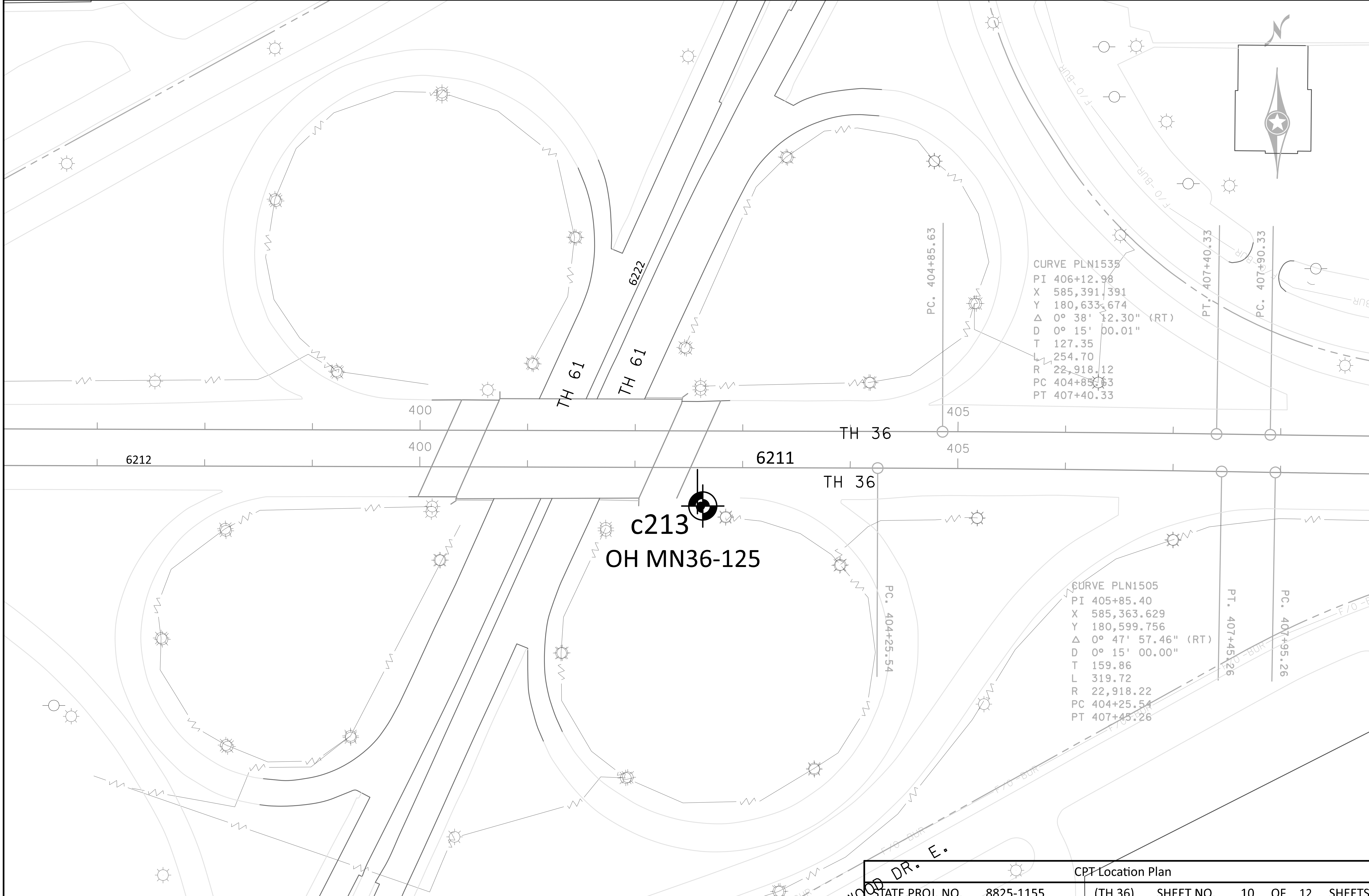
PI . 65+85.34

PI . 69+22.26

SIG-BUR

CPT Location Plan

STATE PROJ. NO. 8825-1155 (TH 94) SHEET NO. 9 OF 12 SHEETS



CPT Location Plan

STATE PROJ. NO.	8825-1155	(TH 36)	SHEET NO.	10	OF	12	SHEETS

TH 280

6242

130

c214

OH MN280-024

Sourcewell Technology

ENERGY PARK DR.

CURVE 2810
PI 134+55.59
X 546,860.876
Y 167,322.011
Δ 9° 11' 03.44" (LT)
D 1° 44' 26.15"
T 264.39
L 527.65
R 3,291.73
PC 131+91.20
PT 137+18.85

PT. 137+18.85

PC 131+91.20

OHP

F/O -BUR

CPT Location Plan

STATE PROJ. NO. 8825-1155 (TH 280) SHEET NO. 11 OF 12 SHEETS

Hudson Blvd

8282

TH 94

TH 94

TH 95 SB

TH 95 NB

8th ST N

8th ST N

c215

OH I94-841

CURVE 2965
PI 875+06.05
X 515,367.192
Y 178,538.486
Δ 47° 10' 59.80" (RT)
D 3° 22' 06.00"
T 742.86
L 1,400.79
R 1,701.01
PC 867+63.20
PT 881+63.99

CURVE AE2940
PI 1019+91.78
X 515,447.065
Y 178,582.437
Δ 44° 59' 29.94" (RT)
D 3° 30' 00.00"
T 677.94
L 1,285.48
R 1,637.02
PC 1013+13.85
PT 1025+99.32

PC. 867+63.20

PC. 1013+13.85

PT. 881+63.99

1025+99.32

875

880

870

1015

1020

1025

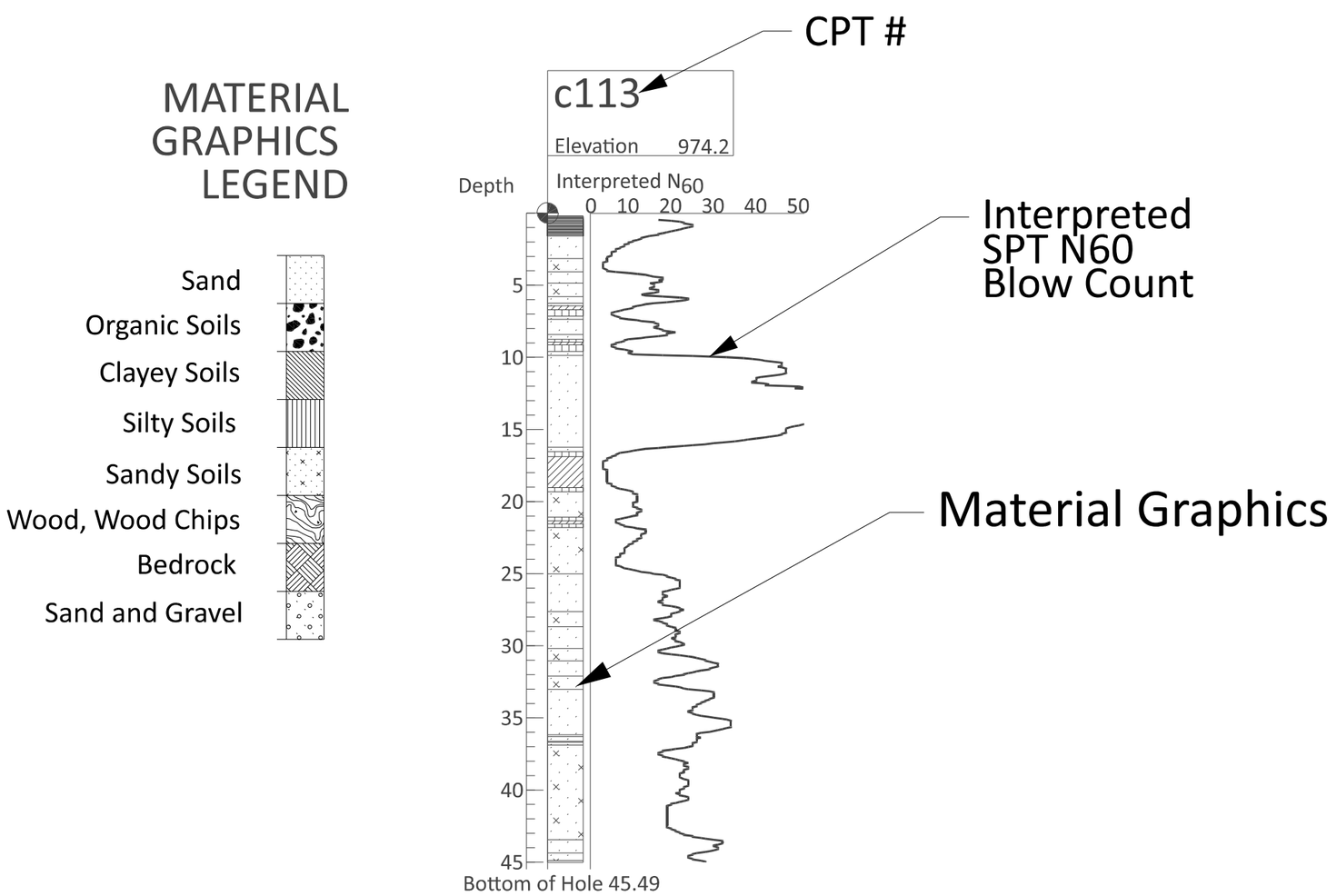
8209

XC

UMH

CPT Location Plan

STATE PROJ. NO. 8825-1155	(TH 95)	SHEET NO. 12 OF 12 SHEETS



CPT Materials Legend

OH Sign Profile Plan								
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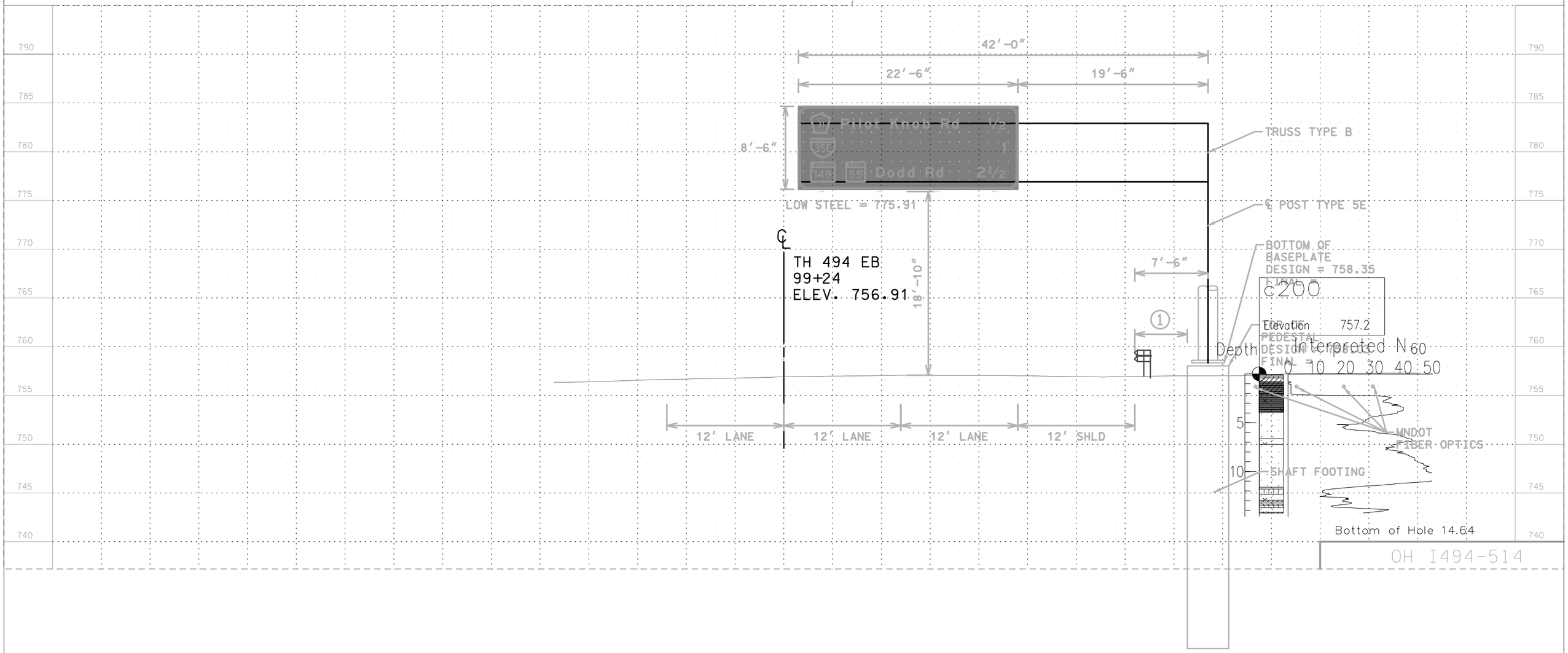

OH I494-514

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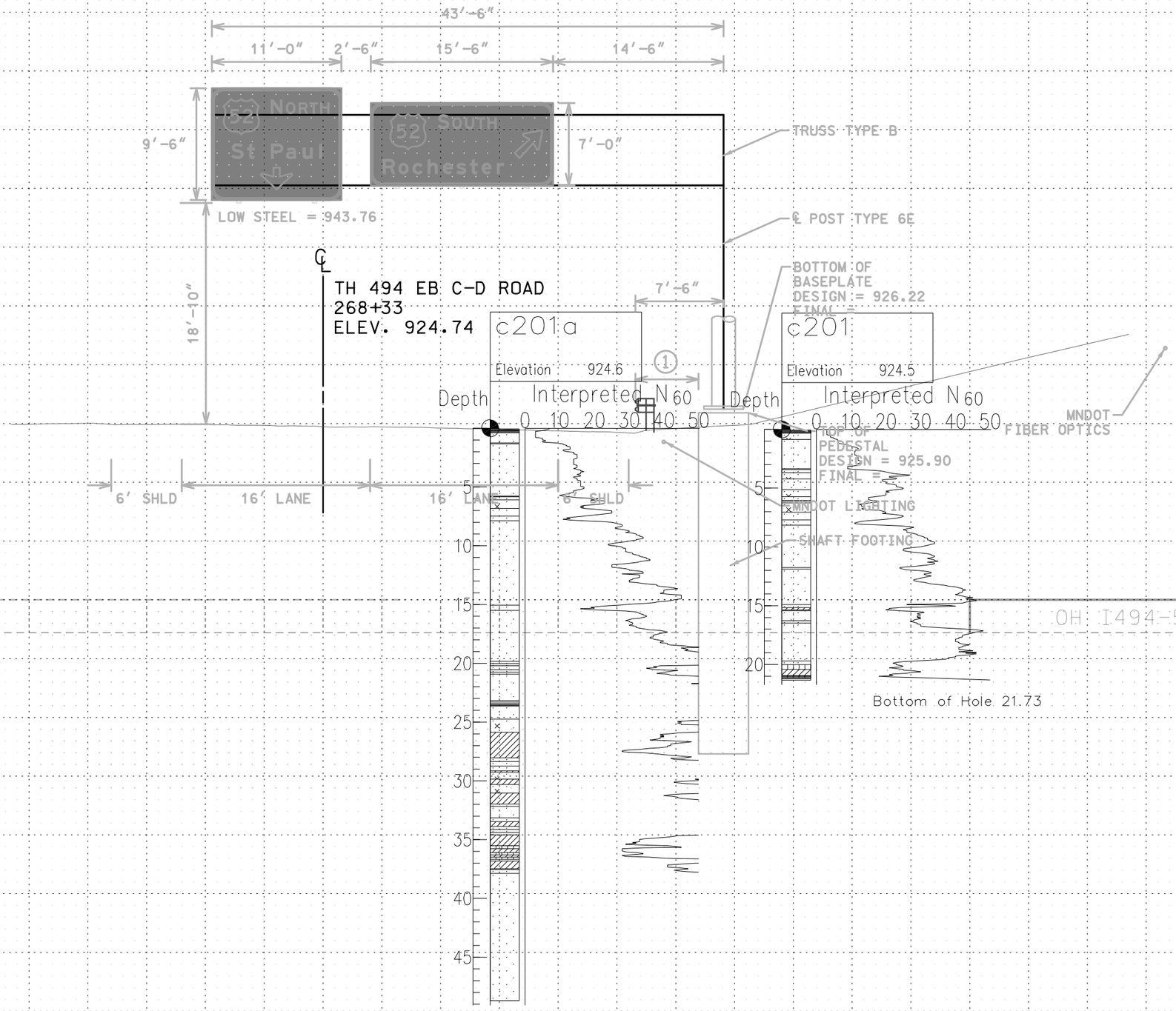

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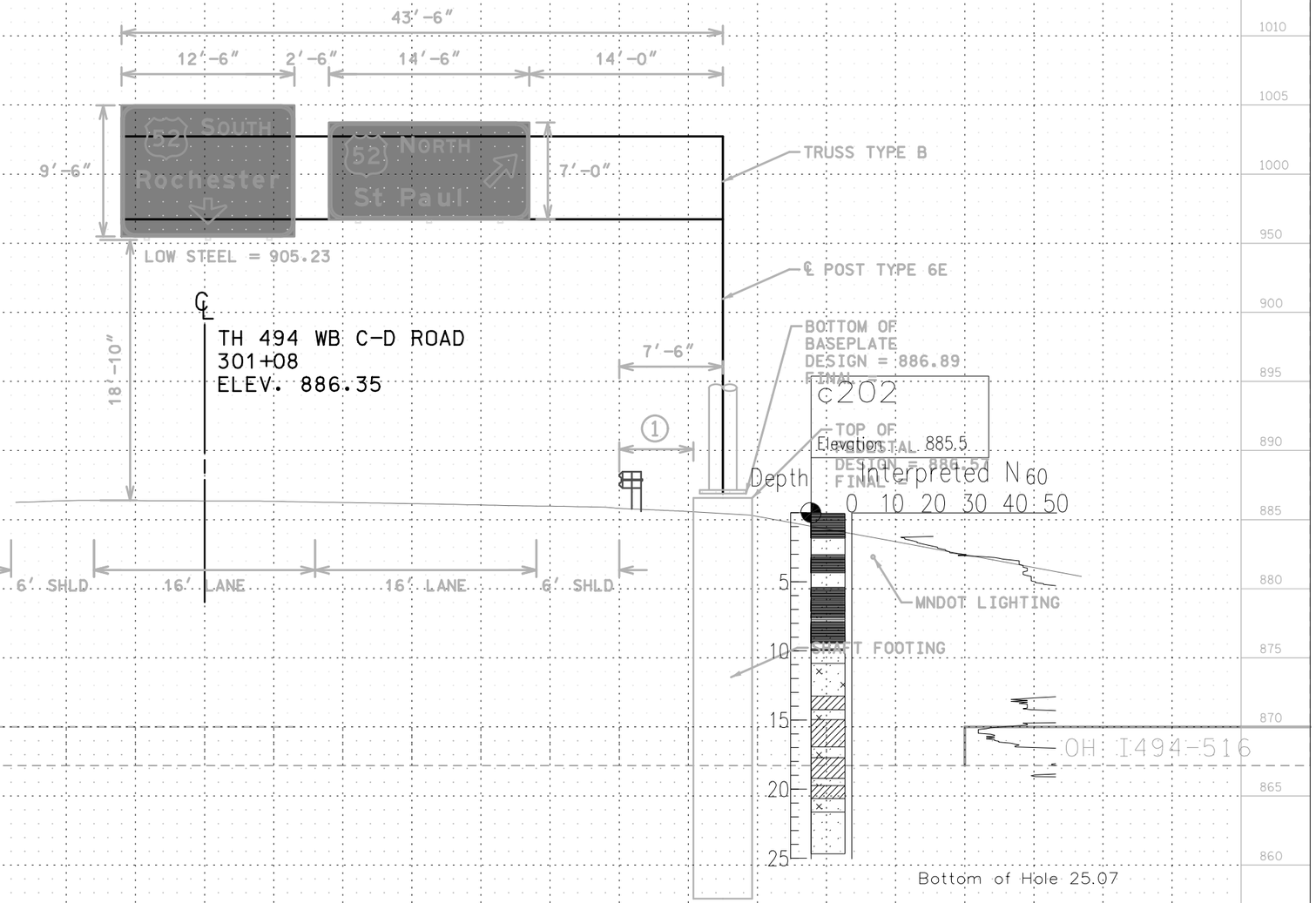

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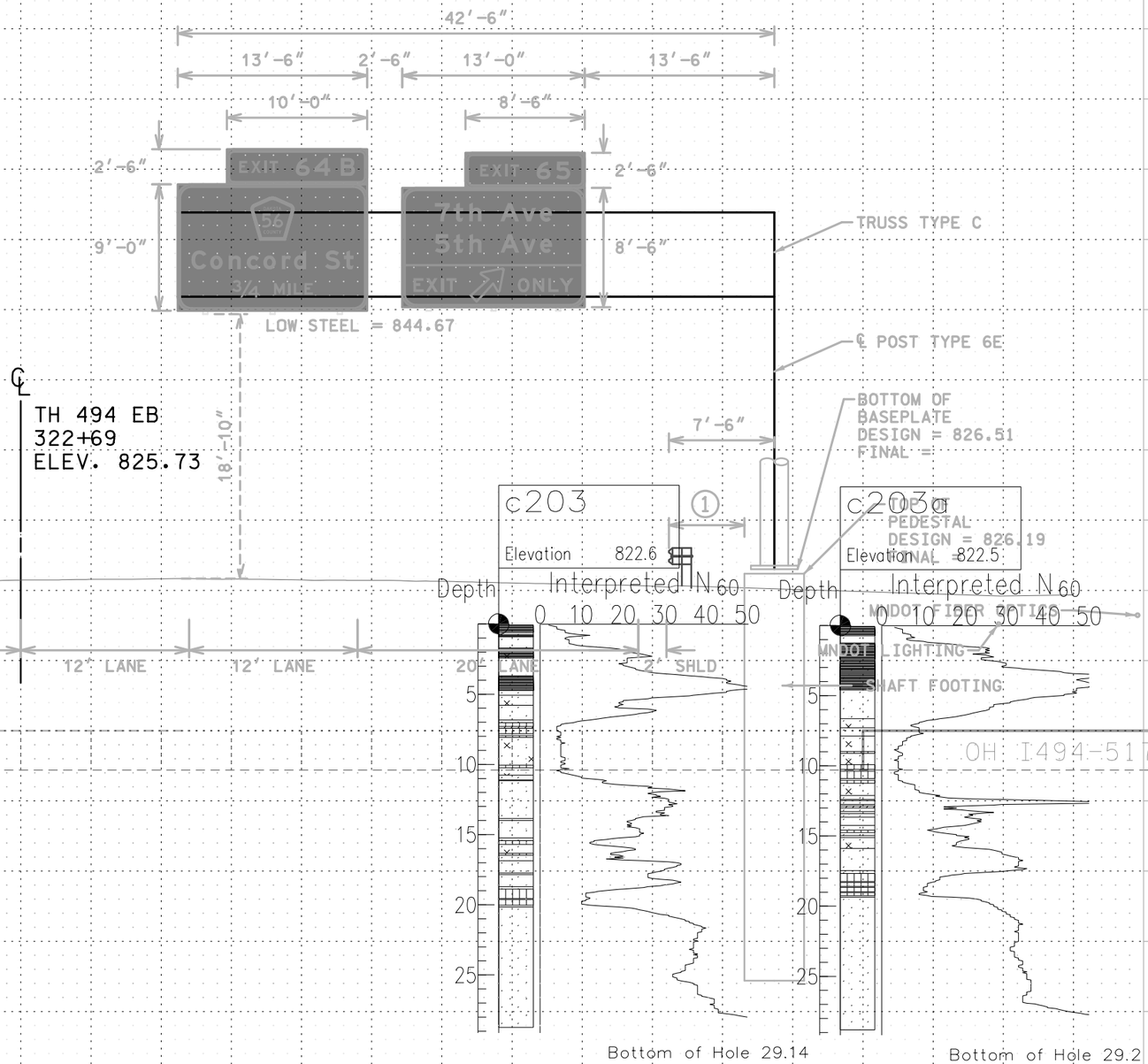

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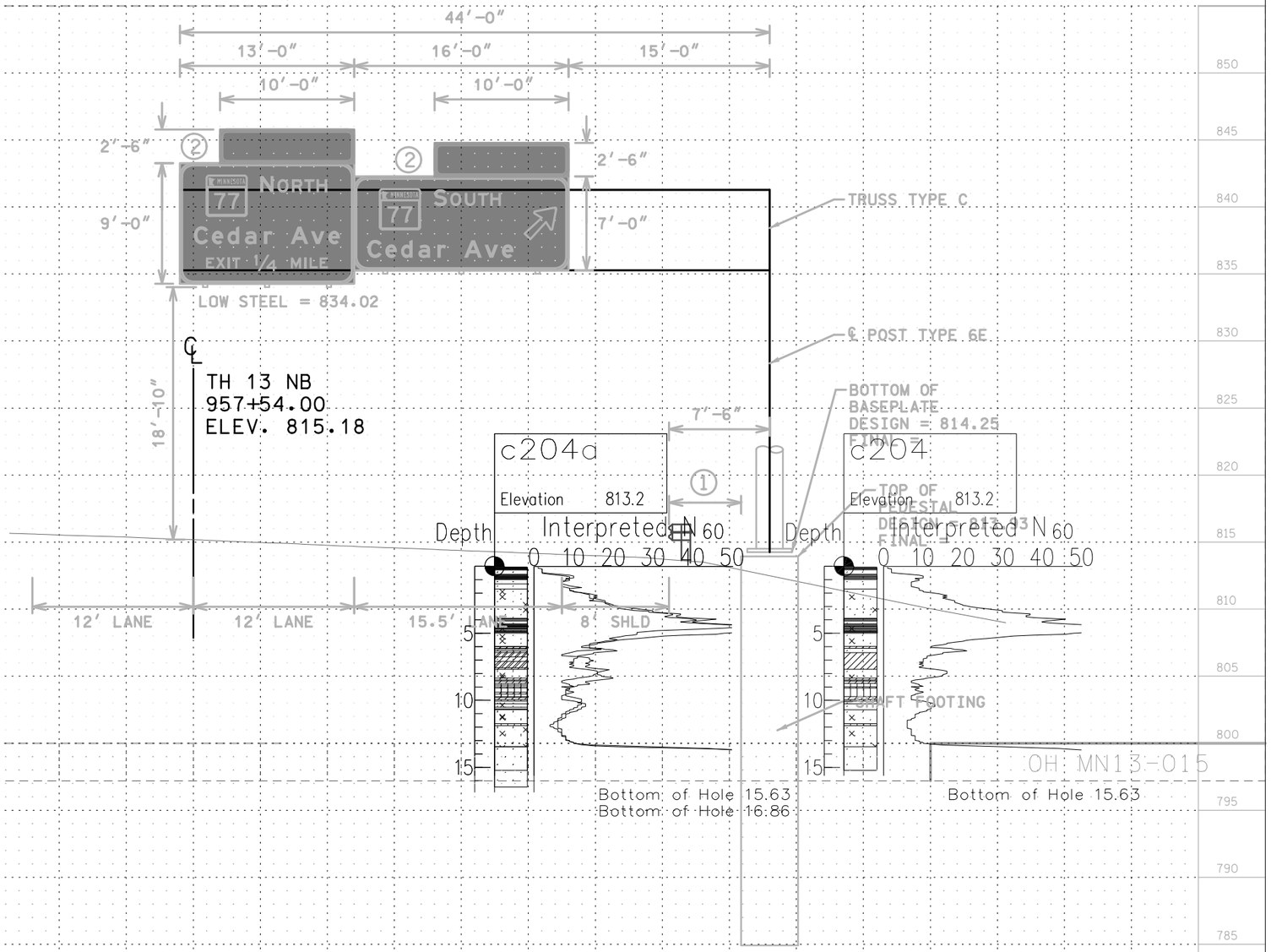

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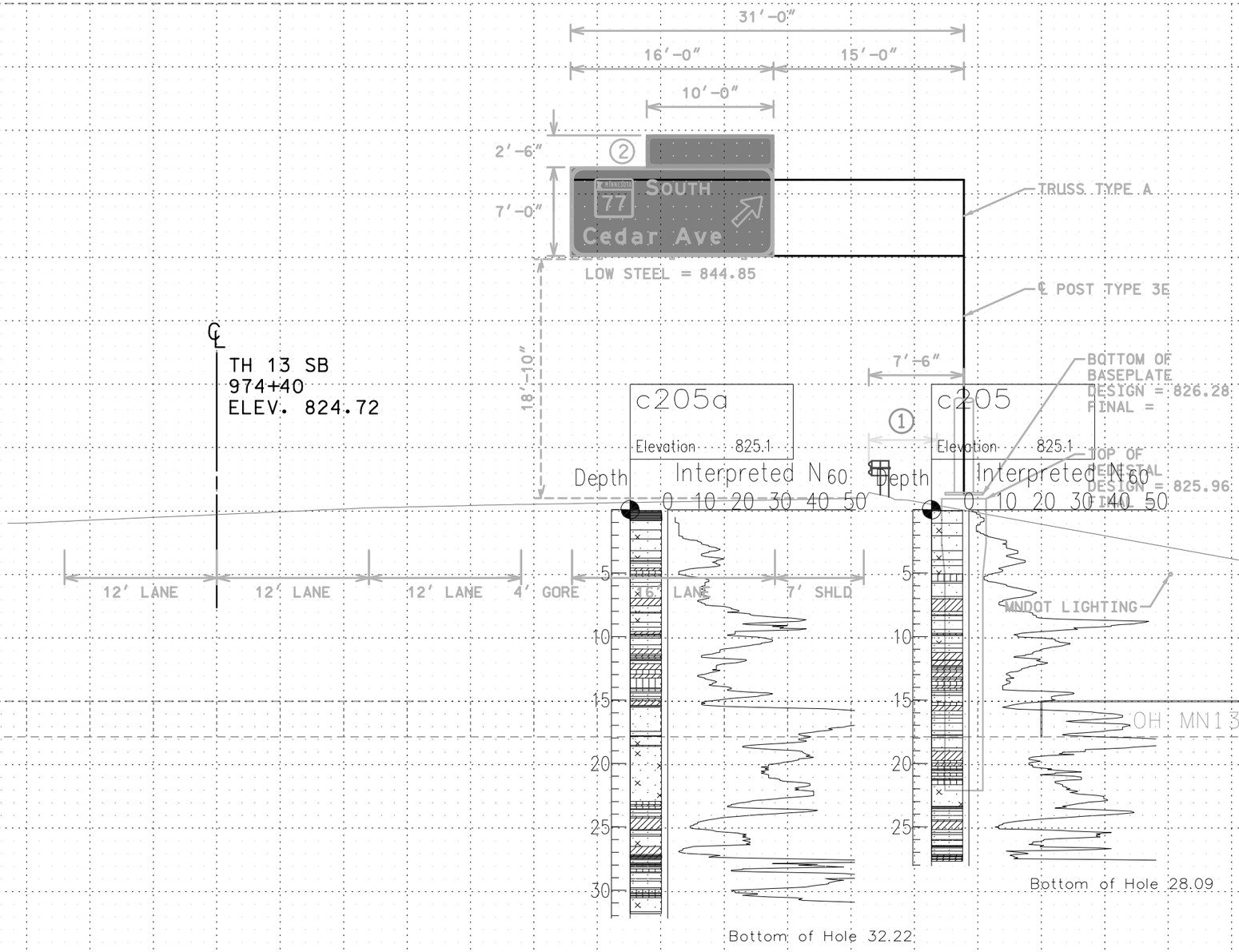

OH Sign Profile Plan

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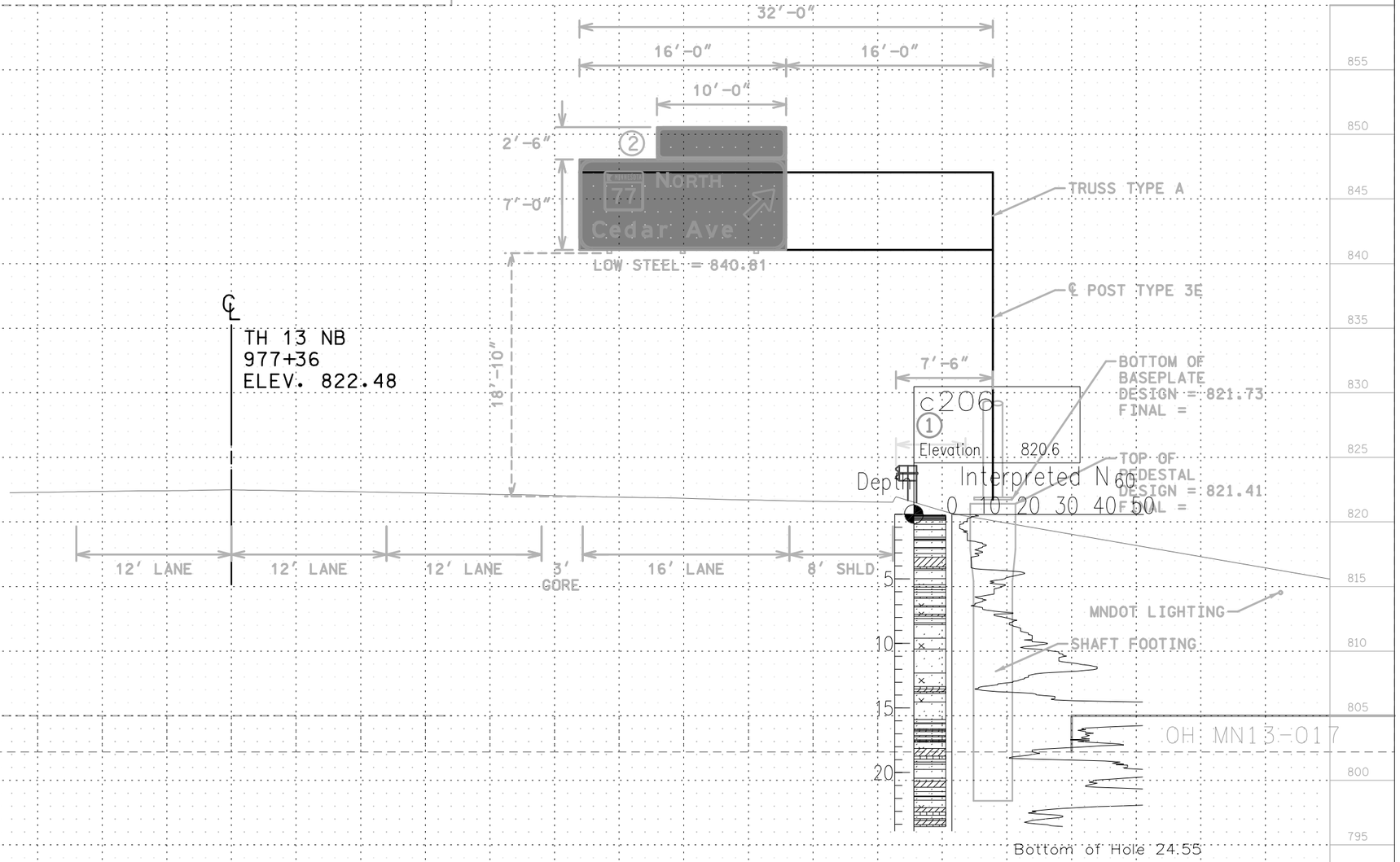

OH Sign Profile Plan

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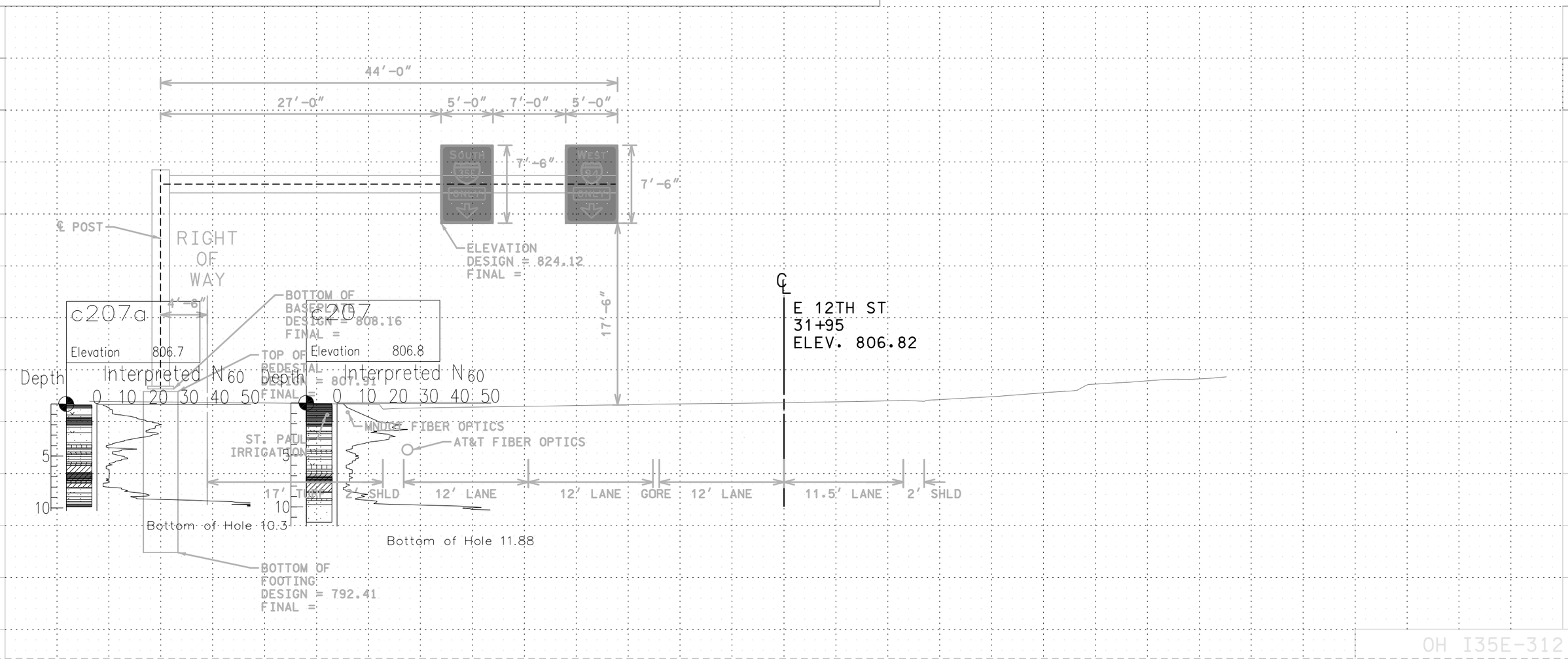

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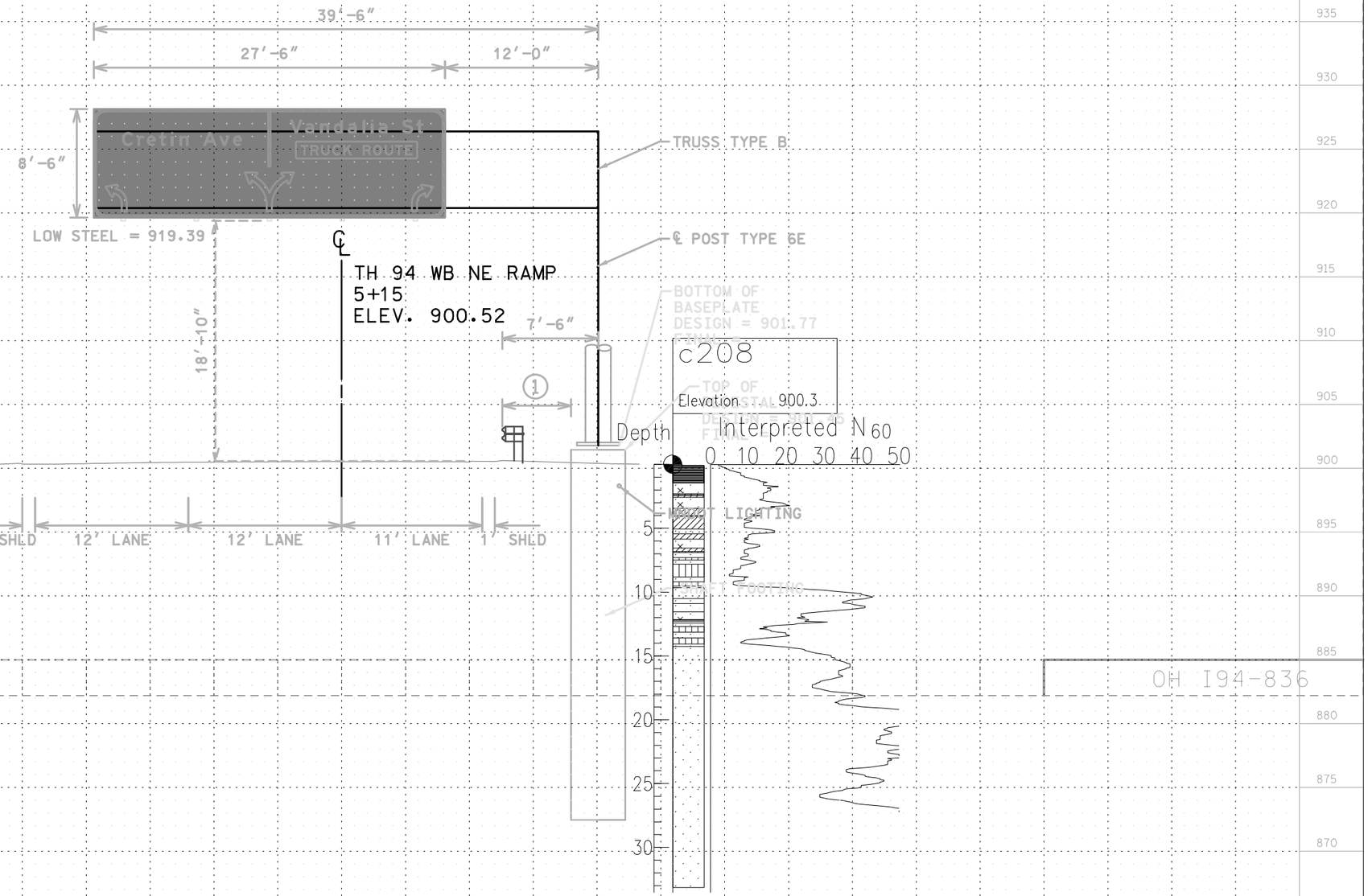
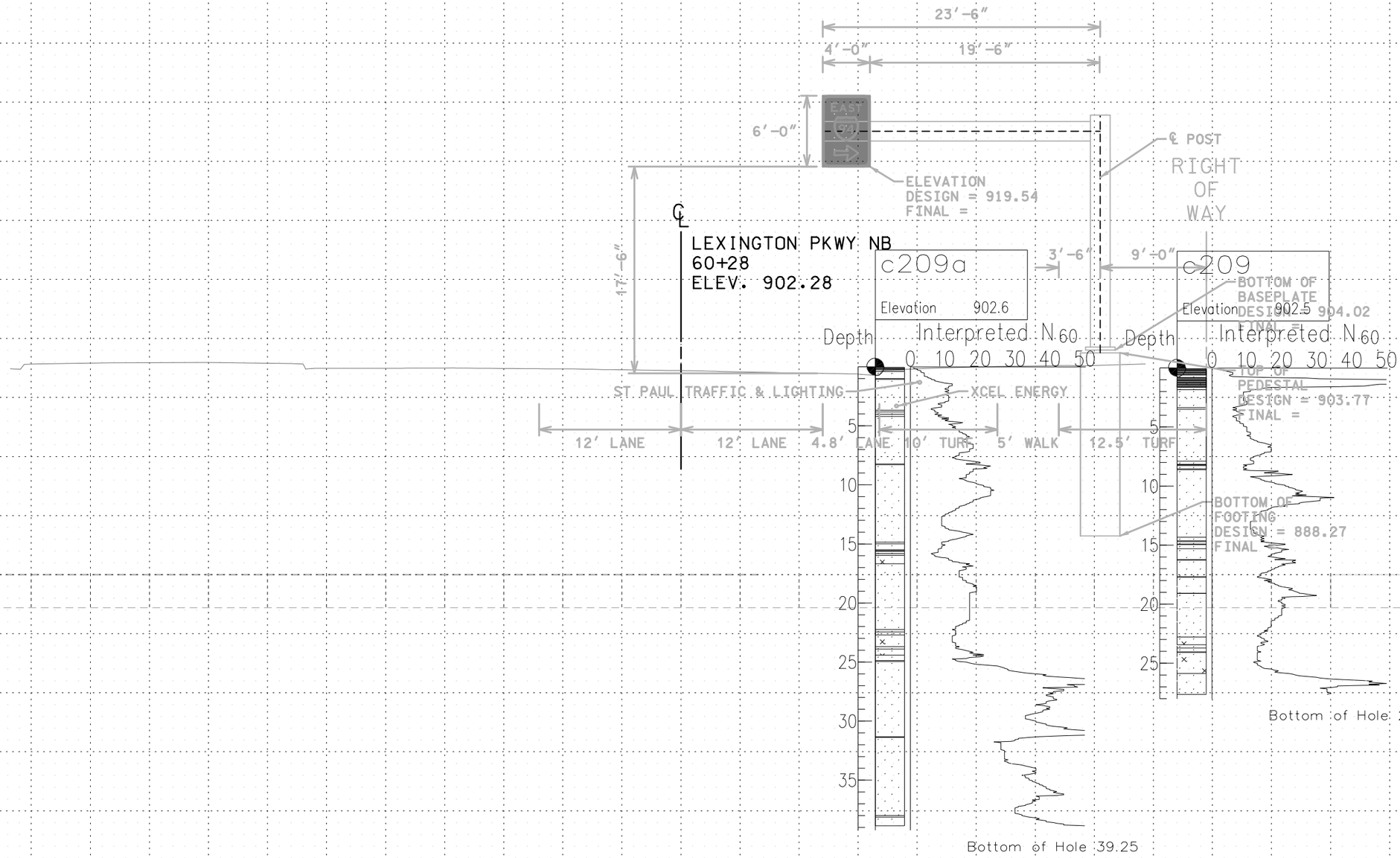


OH Sign Profile Plan

STATE PROJ. NO. 8825-1155 (TH 94) SHEET NO. 10 OF 17 SHEETS



OH Sign Profile Plan

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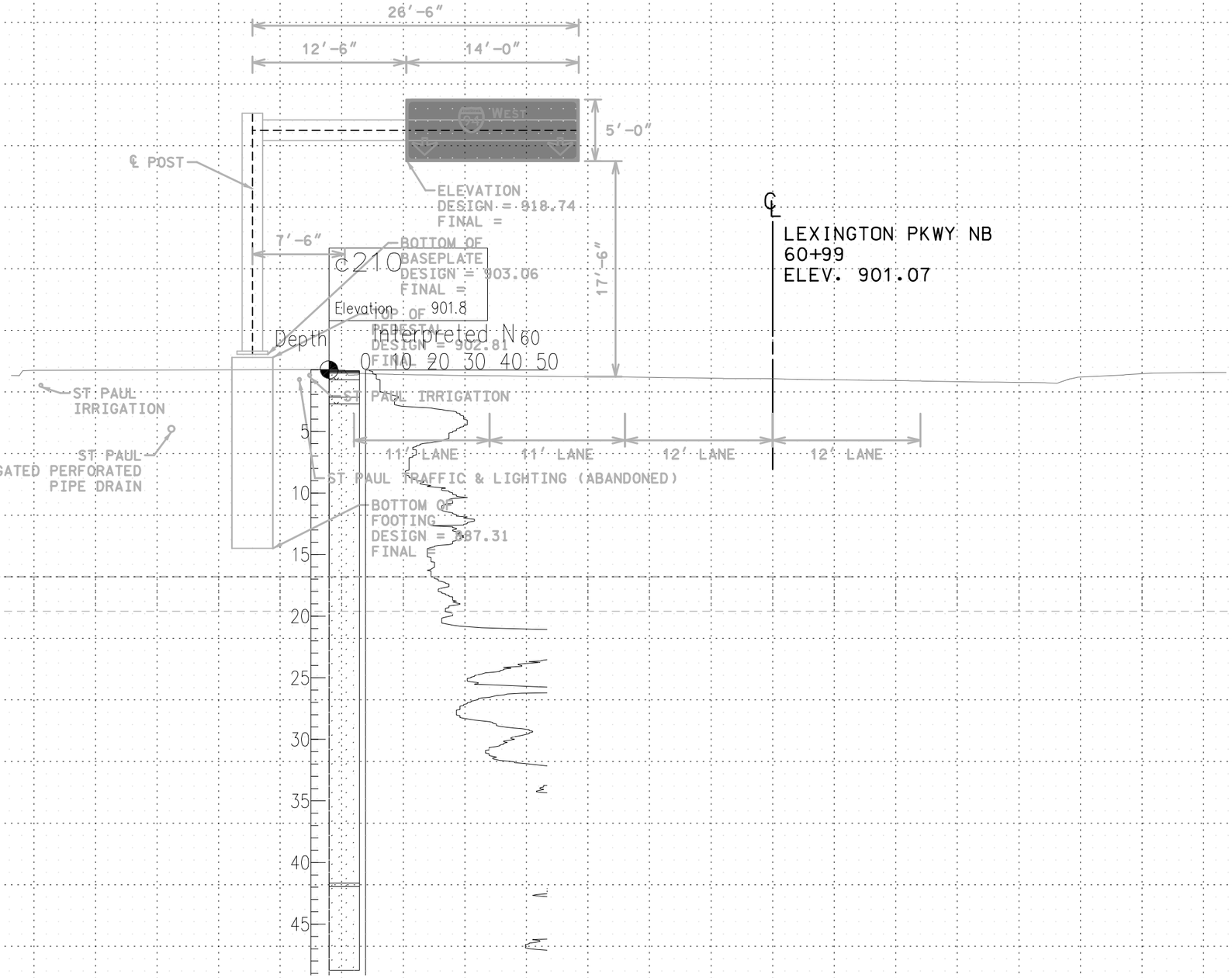

OH I94-838

OH Sign Profile Plan								
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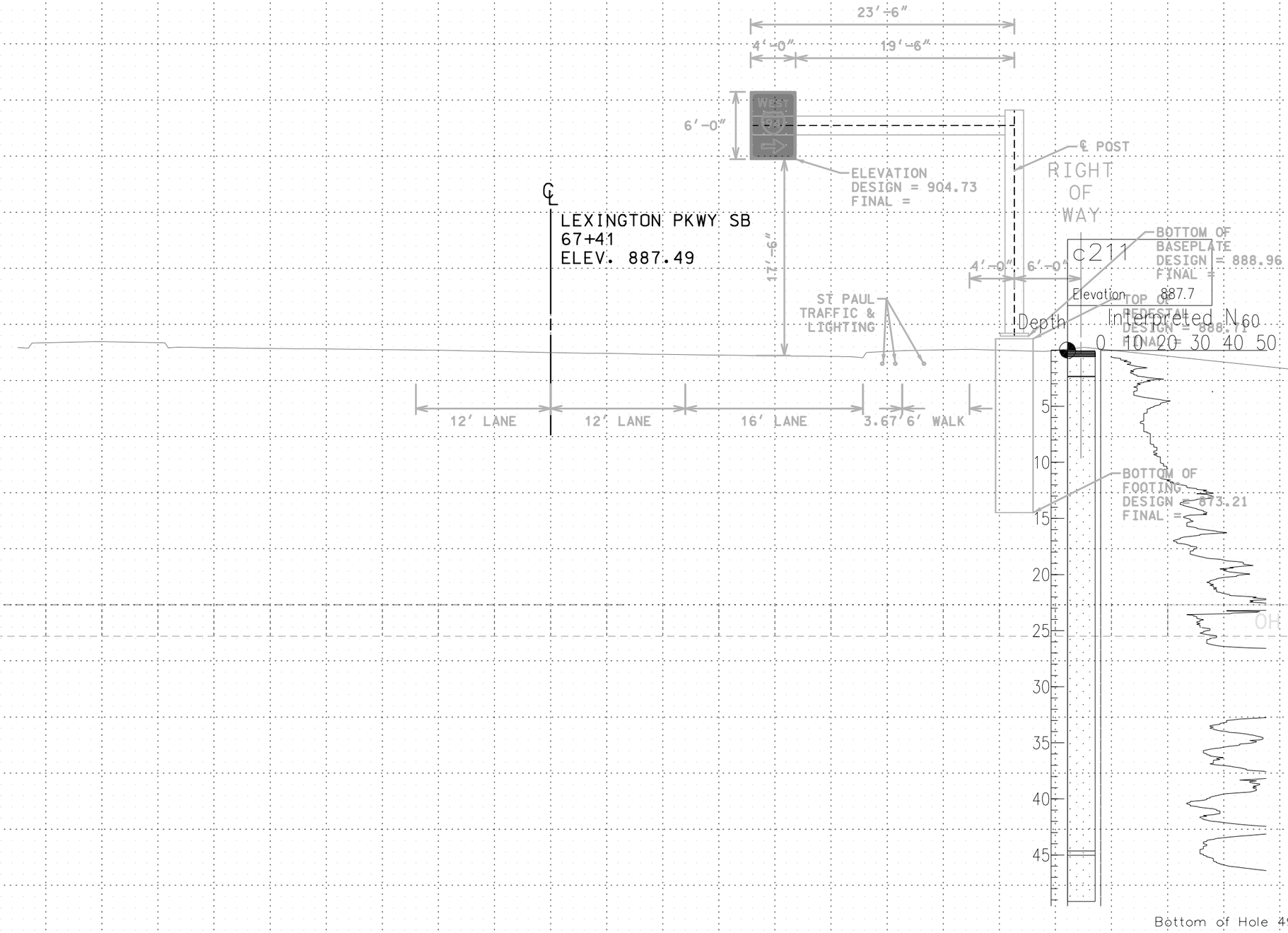
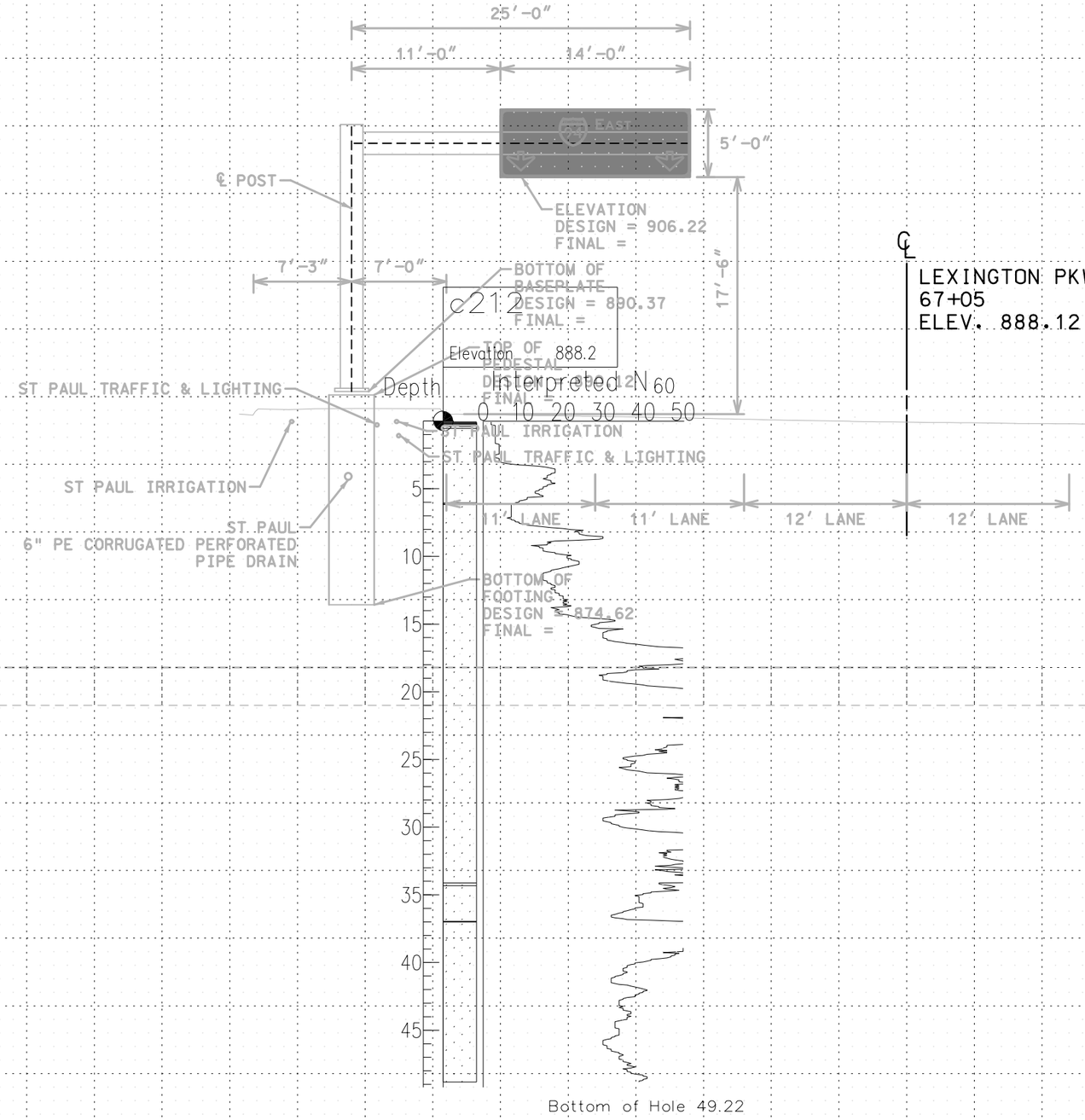


OH Sign Profile Plan

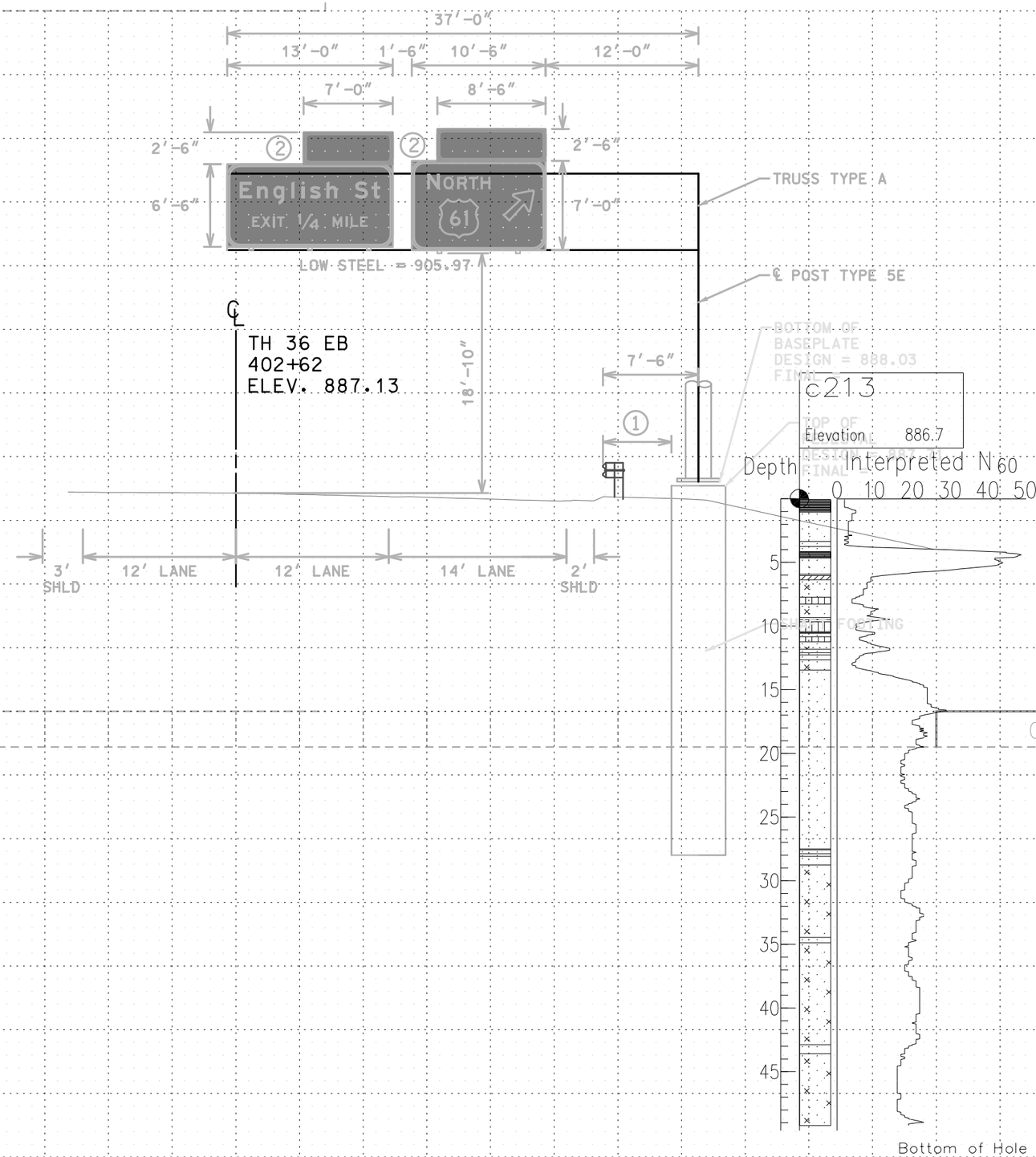
STATE PROJ. NO. 8825-1155 (TH 94) SHEET NO. 13 OF 17 SHEETS



OH I94-840

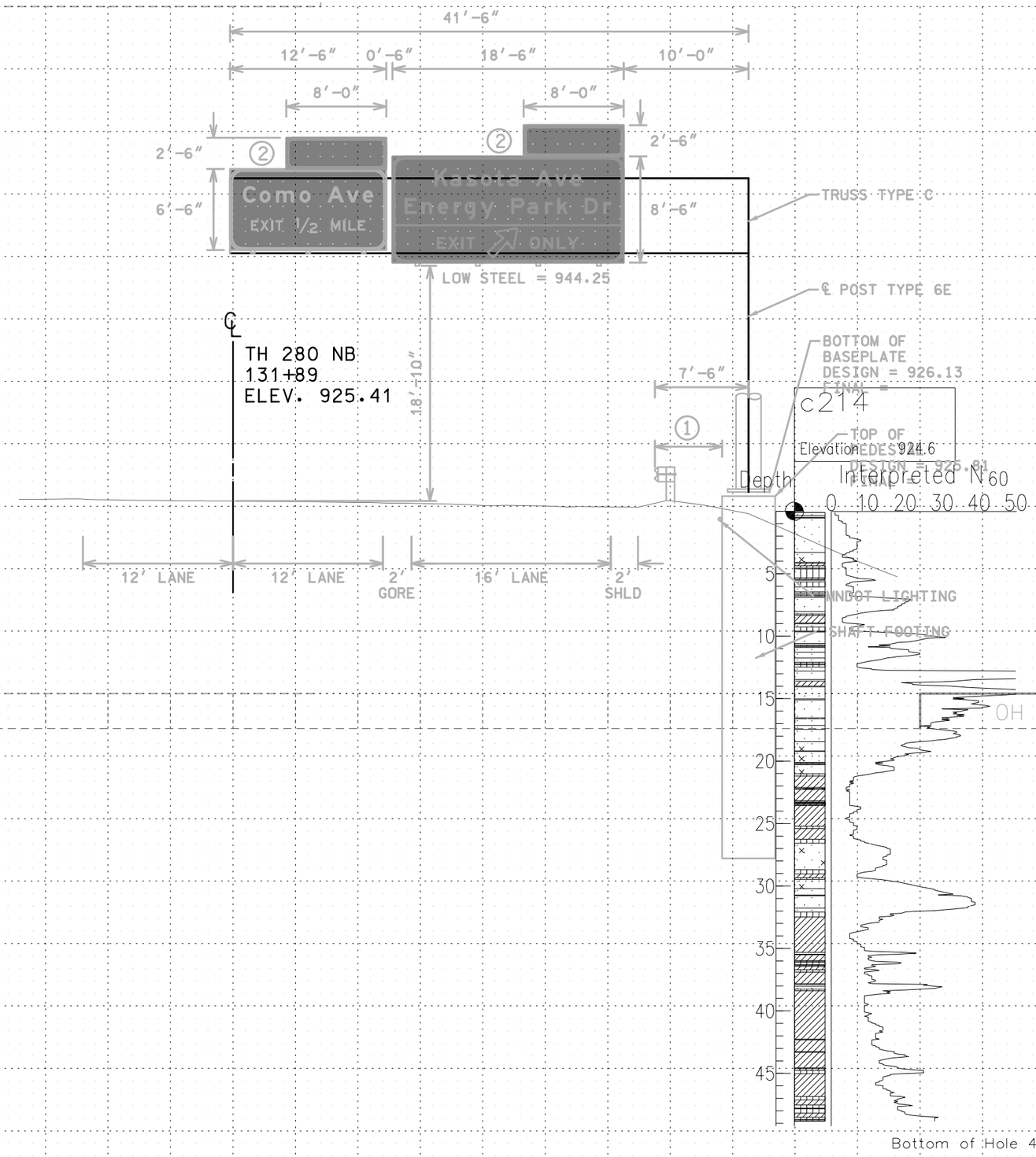
7'-6"

OH Sign Profile Plan								
STATE PROJ. NO.	8825-1155	(TH 94)	SHEET NO.	14	OF	17	SHEETS	



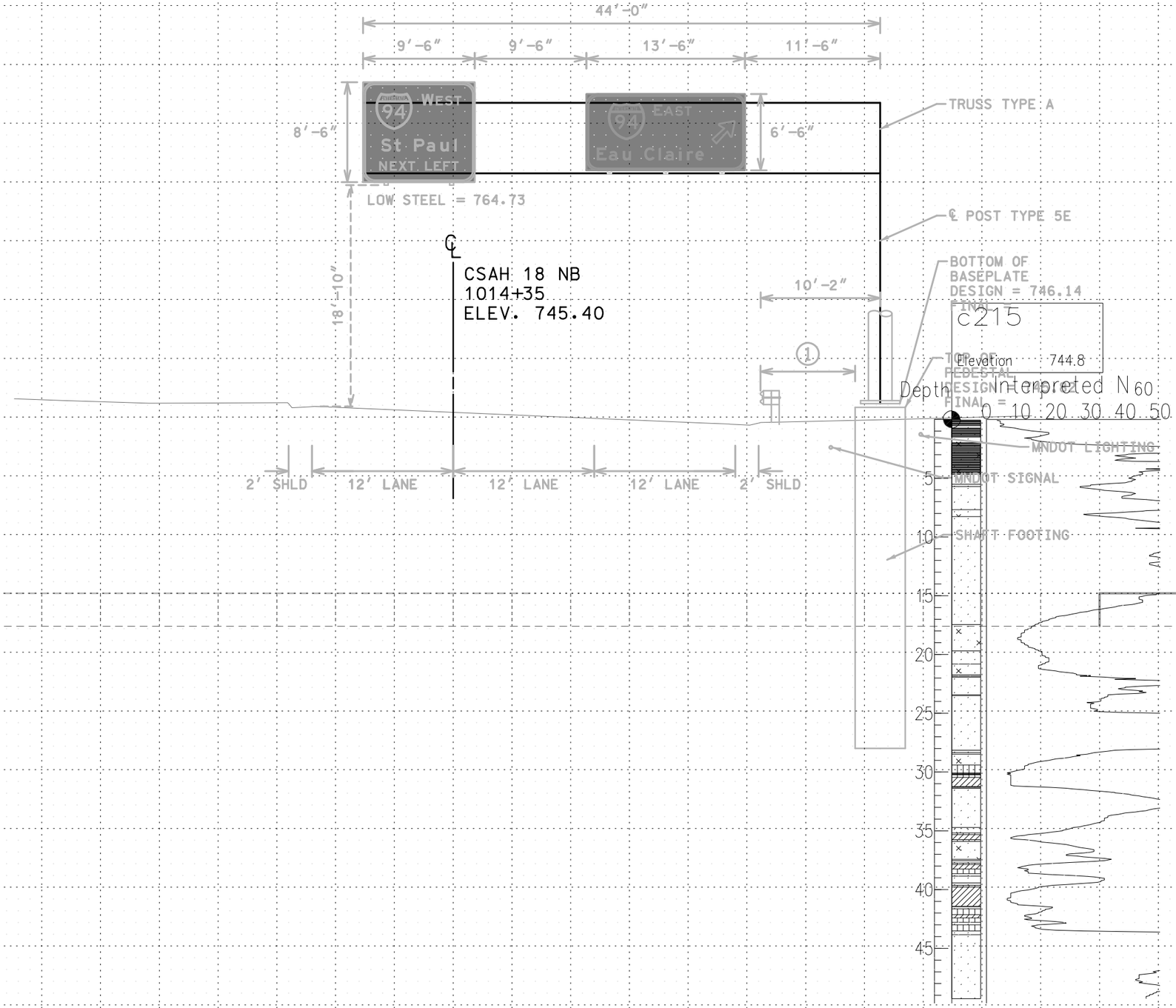
OH Sign Profile Plan

STATE PROJ. NO. 8825-1155 (TH 36) SHEET NO. 15 OF 17 SHEETS



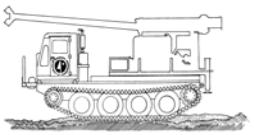
OH Sign Profile Plan

STATE PROJ. NO. 8825-1155 (TH 280) SHEET NO. 16 OF 17 SHEETS



OH Sign Profile Plan								
STATE PROJ. NO.	8825-1155	(TH 94)	SHEET NO.	17	OF	17	SHEETS	

Minnesota Department of Transportation
Geotechnical Section
Cone Penetration Test Index Sheet 1.0 (CPT 1.0)



USER NOTES, ABBREVIATIONS AND DEFINITIONS

This Index sheet accompanies Cone Penetration Test Data. Please refer to the Boring Log Descriptive Terminology Sheet for information relevant to conventional boring logs.

This Cone Penetration Test (CPT) Sounding follows ASTM D 5778 and was made by ordinary and conventional methods and with care deemed adequate for the Department's design purposes. Since this sounding was not taken to gather information relating to the construction of the project, the data noted in the field and recorded may not necessarily be the same as that which a contractor would desire. While the Department believes that the information as to the conditions and materials reported is accurate, it does not warrant that the information is necessarily complete. This information has been edited or abridged and may not reveal all the information which might be useful or of interest to the contractor. Consequently, the Department will make available at its offices, the field logs relating to this sounding.

Since subsurface conditions outside each CPT Sounding are unknown, and soil, rock and water conditions cannot be relied upon to be consistent or uniform, no warrant is made that conditions adjacent to this sounding will necessarily be the same as or similar to those shown on this log. Furthermore, the Department will not be responsible for any interpretations, assumptions, projections or interpolations made by contractors, or other users of this log.

Water pressure measurements and subsequent interpreted water levels shown on this log should be used with discretion since they represent dynamic conditions. Dynamic Pore water pressure measurements may deviate substantially from hydrostatic conditions, especially in cohesive soils. In cohesive soils, water pressures often take extended periods of time to reach equilibrium and thus reflect their true field level. Water levels can be expected to vary both seasonally and yearly. The absence of notations on this log regarding water does not necessarily mean that this boring was dry or that the contractor will not encounter subsurface water during the course of construction.

CPT Terminology

CPT ..... Cone Penetration Test
CPTU..... Cone Penetration Test with Pore Pressure measurements
SCPTU..... Cone Penetration Test with Pore Pressure and Seismic measurements
Piezocone...Common name for CPTU test

(Note: This test is not related to the Dynamic Cone Penetrometer DCP)

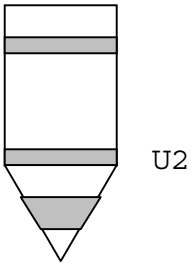
q_T TIP RESISTANCE
The resistance at the cone corrected for water pressure. Data is from cone with 60 degree apex angle and a 10 cm^2 end area.

f_s SLEEVE FRICTION RESISTANCE
The resistance along the sleeve of the penetrometer.

FR Friction Ratio
Ratio of sleeve friction over corrected tip resistance.
FR = fs/qt

V_s Shear Wave Velocity
A measure of the speed at which a siesmic wave travels through soil/rock.

PORE WATER MEASUREMENTS
Pore water measurements reported on CPT Log are representative of water pressures measured at the U2 location, just behind the cone tip, prior to the sleeve, as shown in the figure below. These measurements are considered to be dynamic water pressures due to the local disturbance caused by the cone tip. Dynamic water pressure decay and Static water pressure measurements are reported on a Pore Water Pressure Dissipation Graph.



SBT SOIL BEHAVIOR TYPE
Soil Classification methods for the Cone Penetration Test are based on correlation charts developed from observations of CPT data and conventional borings. Please note that these classification charts are meant to provide a guide to Soil Behavior Type and should not be used to infer a soil classification based on grain size distribution.

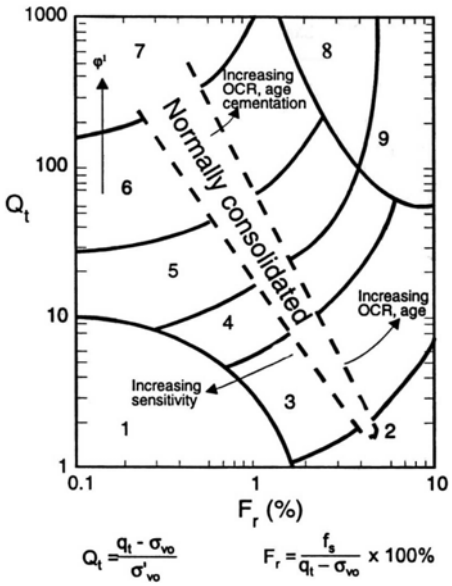
The numbers corresponding to different regions on the charts represent the following soil behavior types:

1. Sensitive, Fine Grained
2. Organic Soils - Peats
3. Clays - Clay to Silty Clay
4. Silt Mixtures - Clayey Silt to Silty Clay
5. Sand Mixtures - Silty Sand to Sandy Silt
6. Sands - Clean Sand to Silty Sand
7. Gravelly Sand to Sand
8. Very Stiff Sand to Clayey Sand
9. Very Stiff, Fine Grained

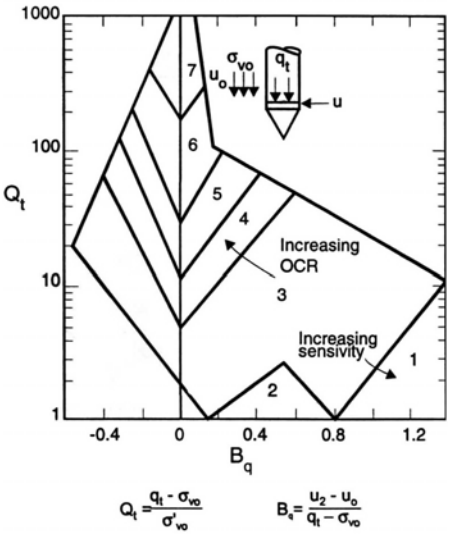
Note that engineering judgment, and comparison with conventional borings is especially important in the proper interpretation of CPT data in certain geo-materials.

The following charts are used to provide a Soil Behavior Type for the CPT Data.

Robertson CPT 1990
Soil Behavior type based on friction ratio



Robertson CPTU 1990
Soil Behavior type based on pore pressure



where ...
Q_T ..... normalized cone resistance
B_q ..... pore pressure ratio
F_r ..... Normalized friction ratio
σ_{vo} ..... overburden pressure
σ'_{vo} ..... effective over burden pressure
u_2 ..... measured pore pressure
u_0 ..... equilibrium pore pressure

DEPARTMENT OF TRANSPORTATION

MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

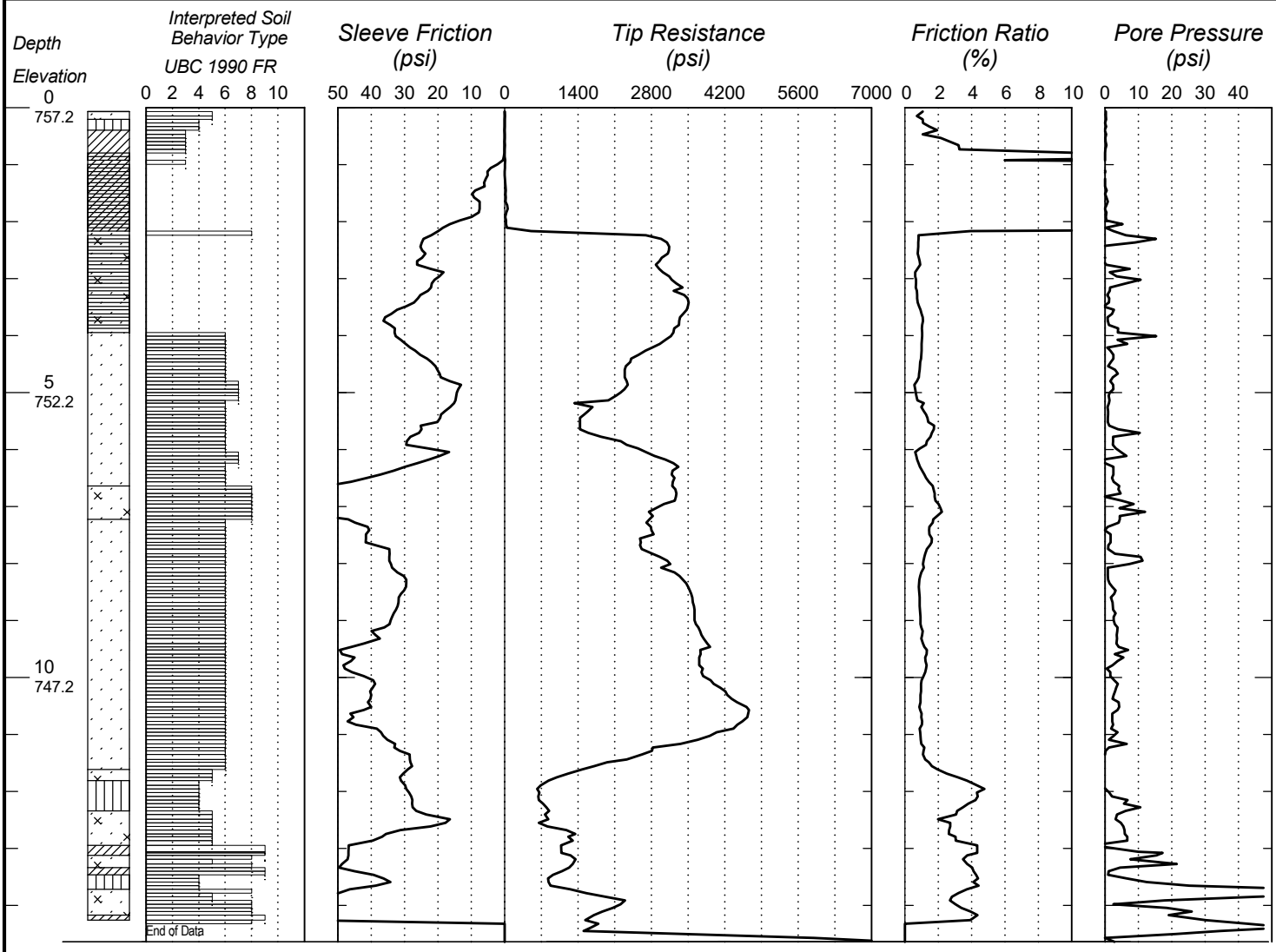
CONE PENETRATION TEST RESULTS

UNIQUE NUMBER 89204

(MDH H400281)

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Sounding No.	Ground Elevation
8825-1155	**Overhead Sign**	**280 NB at ramp to Energy Park**	**c200**	**757.2** *(DTM)*

Location	CPT Machine	Sheet
Dakota County Coordinate System **X=536093 Y=241900** *Latitude (North)=44.861056° Longitude (West)=-93.177483°*	**219328 CPT Western Star** CPT Operator **ODonnel** Hole Type **CPT-STD**	*SHEET 1 of 1* Date Completed **2/20/2024**



Bottom of Hole 14.64

DEPARTMENT OF TRANSPORTATION

MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

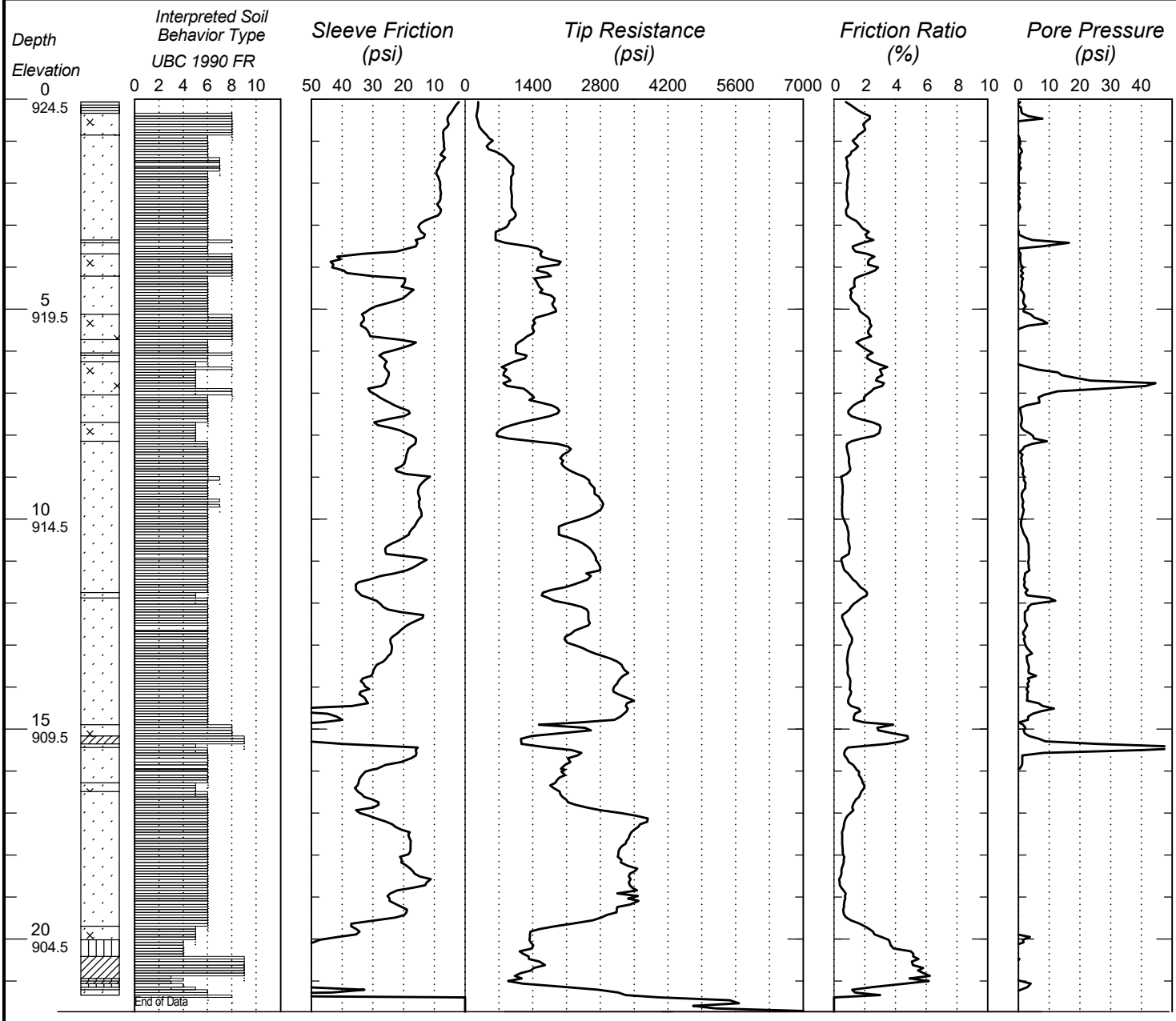
CONE PENETRATION TEST RESULTS

UNIQUE NUMBER 89205

(MDH H400280)

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Sounding No.	Ground Elevation
8825-1155	**Overhead Sign**	**280 NB at ramp to Energy Park**	**c201**	**924.5** *(DTM)*

Location	CPT Machine	SHEET 1 of 1
Dakota County Coordinate System	**219328 CPT Western Star**	
X=564666 Y=246878	*CPT Operator* **ODonnel**	*Date Completed*
Latitude (North)=44.874522° Longitude (West)=-93.067239°	*Hole Type* **CPT-STD**	**2/20/2024**



Bottom of Hole 21.73

DEPARTMENT OF TRANSPORTATION

MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

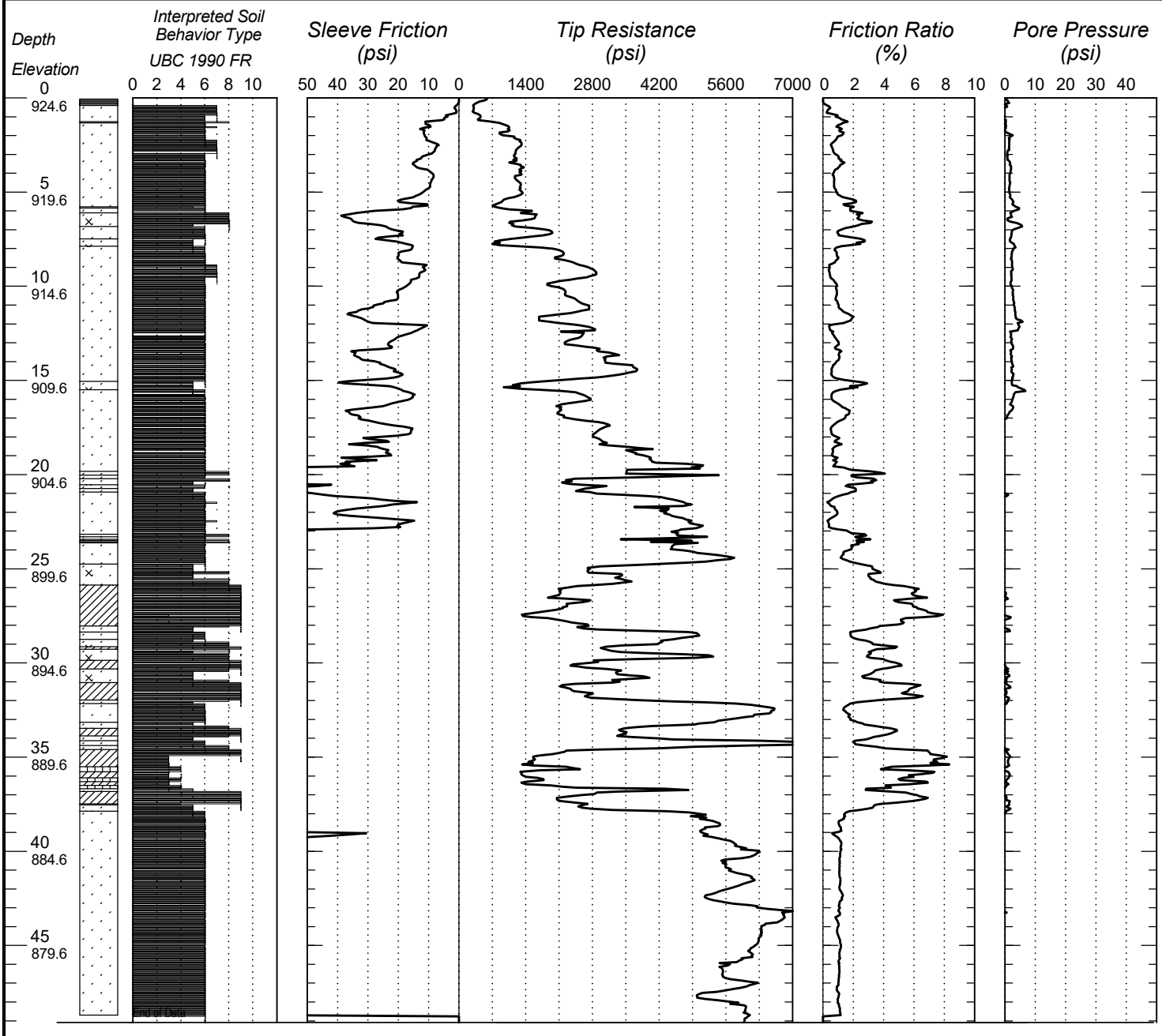
CONE PENETRATION TEST RESULTS

UNIQUE NUMBER 89206

(MDH H400280)

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Sounding No.	Ground Elevation
8825-1155	**Overhead Sign**	**280 NB at ramp to Energy Park**	**c201a**	**924.6** *(DTM)*

Location	CPT Machine	Sheet
Dakota County Coordinate System	**219328 CPT Western Star**	*SHEET 1 of 1*
X=564662 Y=246879	*CPT Operator* **ODonnel**	*Date Completed*
Latitude (North)=44.874525° Longitude (West)=-93.067256°	*Hole Type* **CPT-STD**	**2/20/2024**



Bottom of Hole 49.09

DEPARTMENT OF TRANSPORTATION

MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

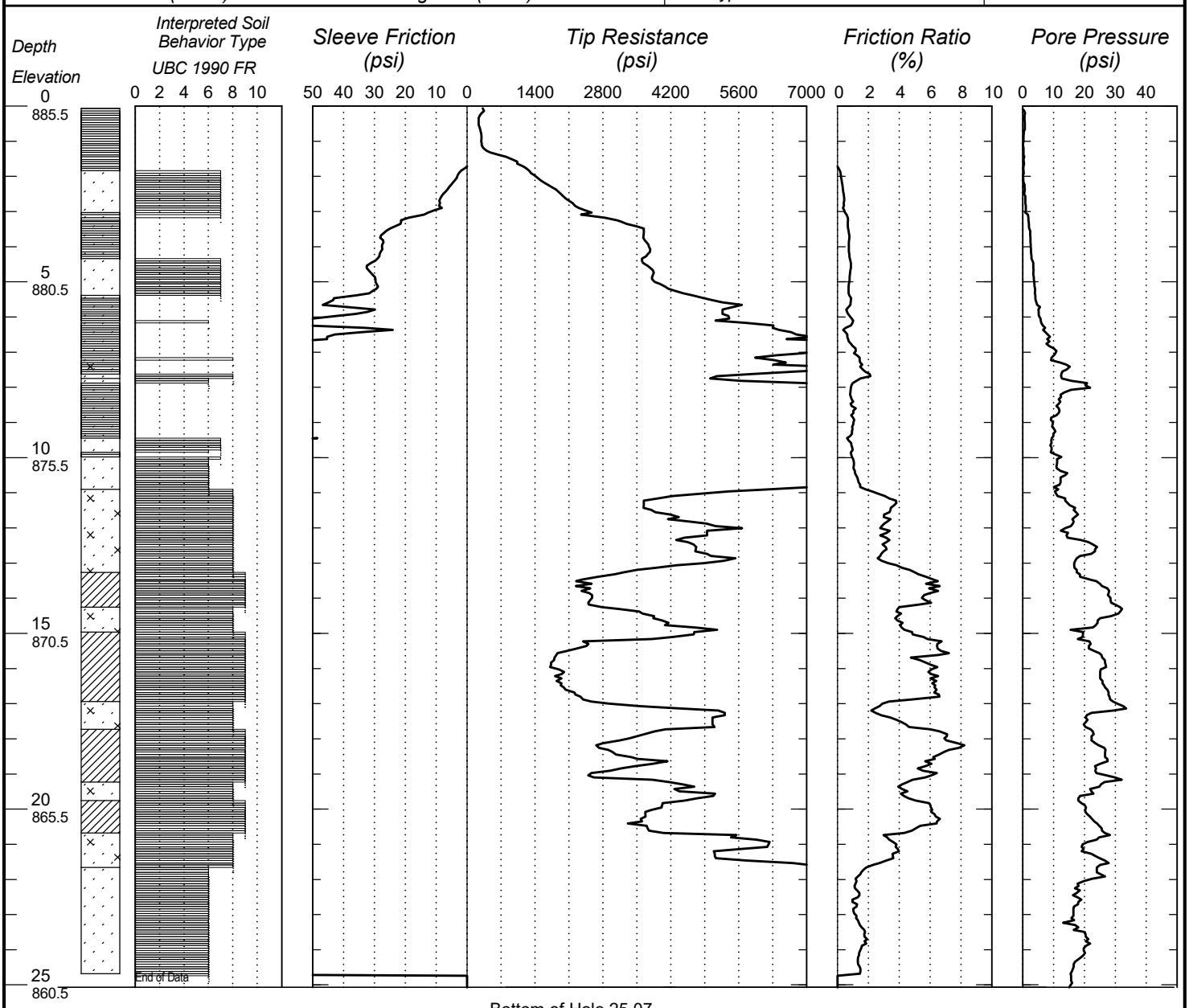
CONE PENETRATION TEST RESULTS

UNIQUE NUMBER 89207

(MDH H400280)

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Sounding No.	Ground Elevation
8825-1155	**Overhead Sign**	**280 NB at ramp to Energy Park**	**c202**	**885.5** *(DTM)*

Location	CPT Machine	SHEET 1 of 1
Dakota County Coordinate System	**219328 CPT Western Star**	
X=567931 Y=247092	CPT Operator **ODonnel**	Date Completed
Latitude (North)=44.875081° Longitude (West)=-93.054642°	Hole Type **CPT-STD**	**2/20/2024**



Bottom of Hole 25.07

DEPARTMENT OF TRANSPORTATION

MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

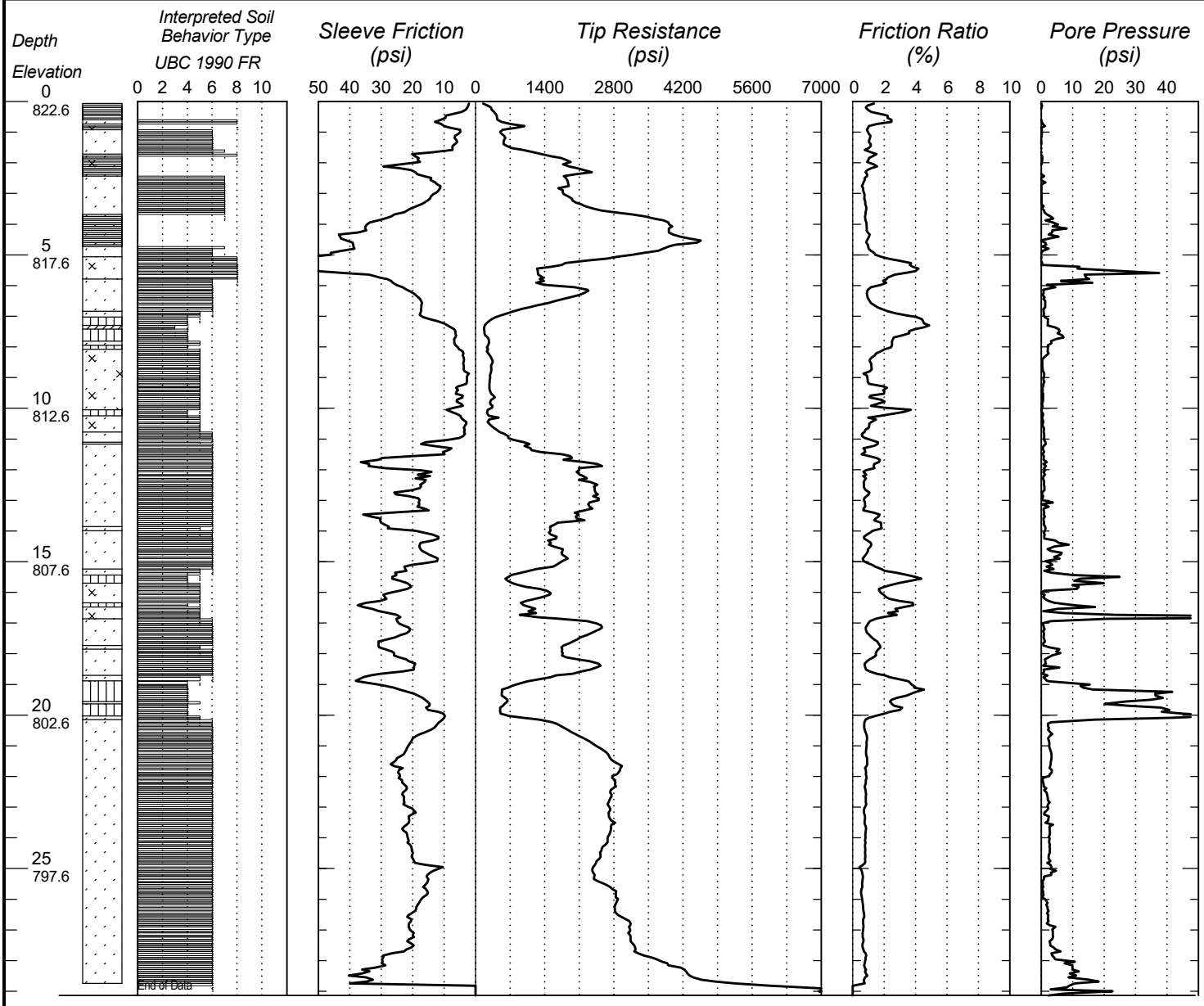
CONE PENETRATION TEST RESULTS

UNIQUE NUMBER 89208

(MDH H400280)

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Sounding No.	Ground Elevation
8825-1155	**Overhead Sign**	**280 NB at ramp to Energy Park**	**c203**	**822.6** *(DTM)*

Location	CPT Machine	Sheet
Dakota County Coordinate System **X=570186 Y=246876** *Latitude (North)=44.874467° Longitude (West)=-93.045950°*	**219328 CPT Western Star** CPT Operator **ODonnel** Hole Type **CPT-STD**	*SHEET 1 of 1* Date Completed **2/20/2024**



Bottom of Hole 29.14

DEPARTMENT OF TRANSPORTATION

MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

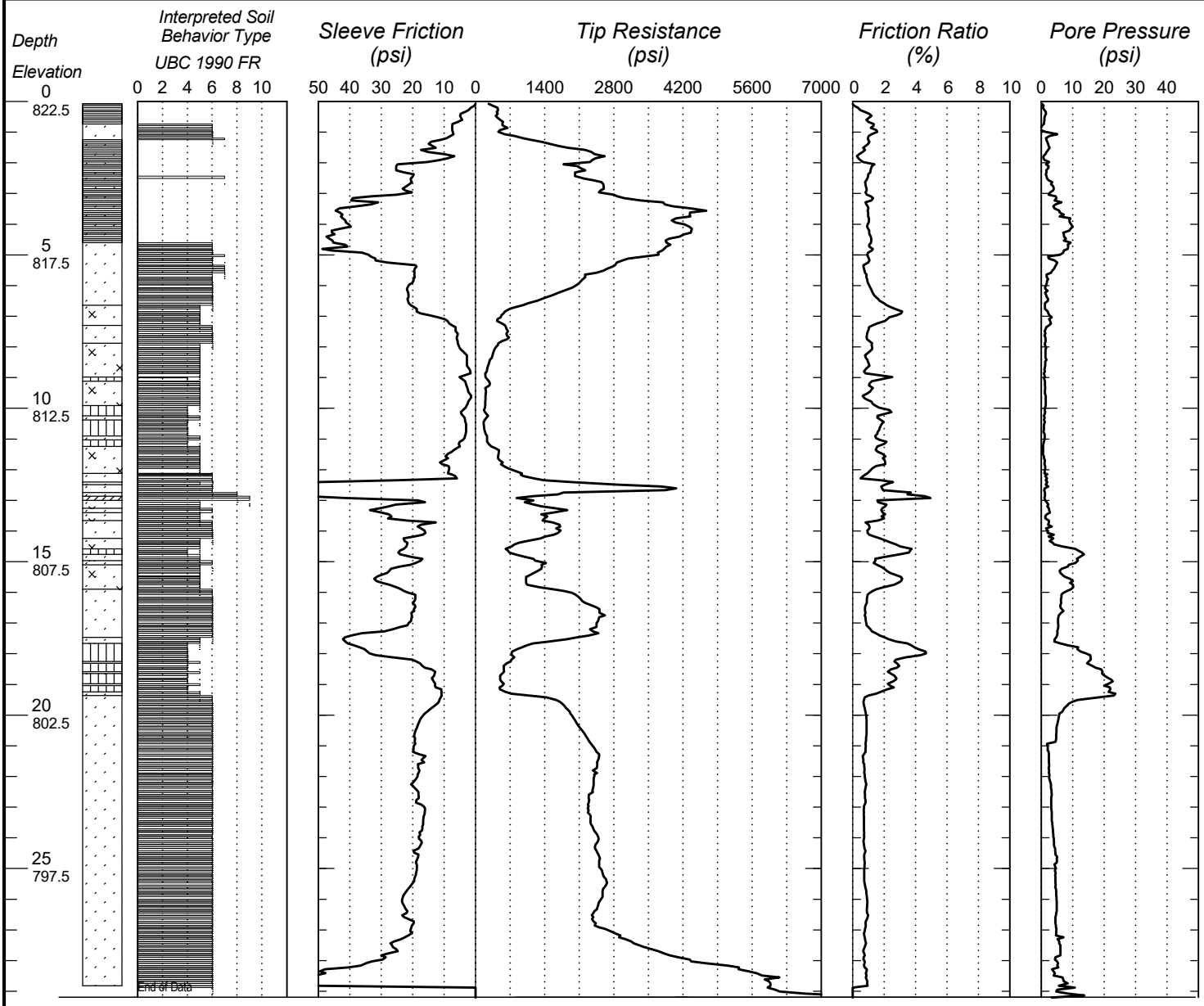
CONE PENETRATION TEST RESULTS

UNIQUE NUMBER 89209

(MDH H400280)

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Sounding No.	Ground Elevation
8825-1155	**Overhead Sign**	**280 NB at ramp to Energy Park**	**c203a**	**822.5** *(DTM)*

Location	CPT Machine	SHEET 1 of 1
Dakota County Coordinate System	**219328 CPT Western Star**	
X=570191 Y=246876	*CPT Operator* **ODonnel**	*Date Completed*
Latitude (North)=44.874467° Longitude (West)=-93.045931°	*Hole Type* **CPT-STD**	**2/20/2024**



Bottom of Hole 29.2

DEPARTMENT OF TRANSPORTATION

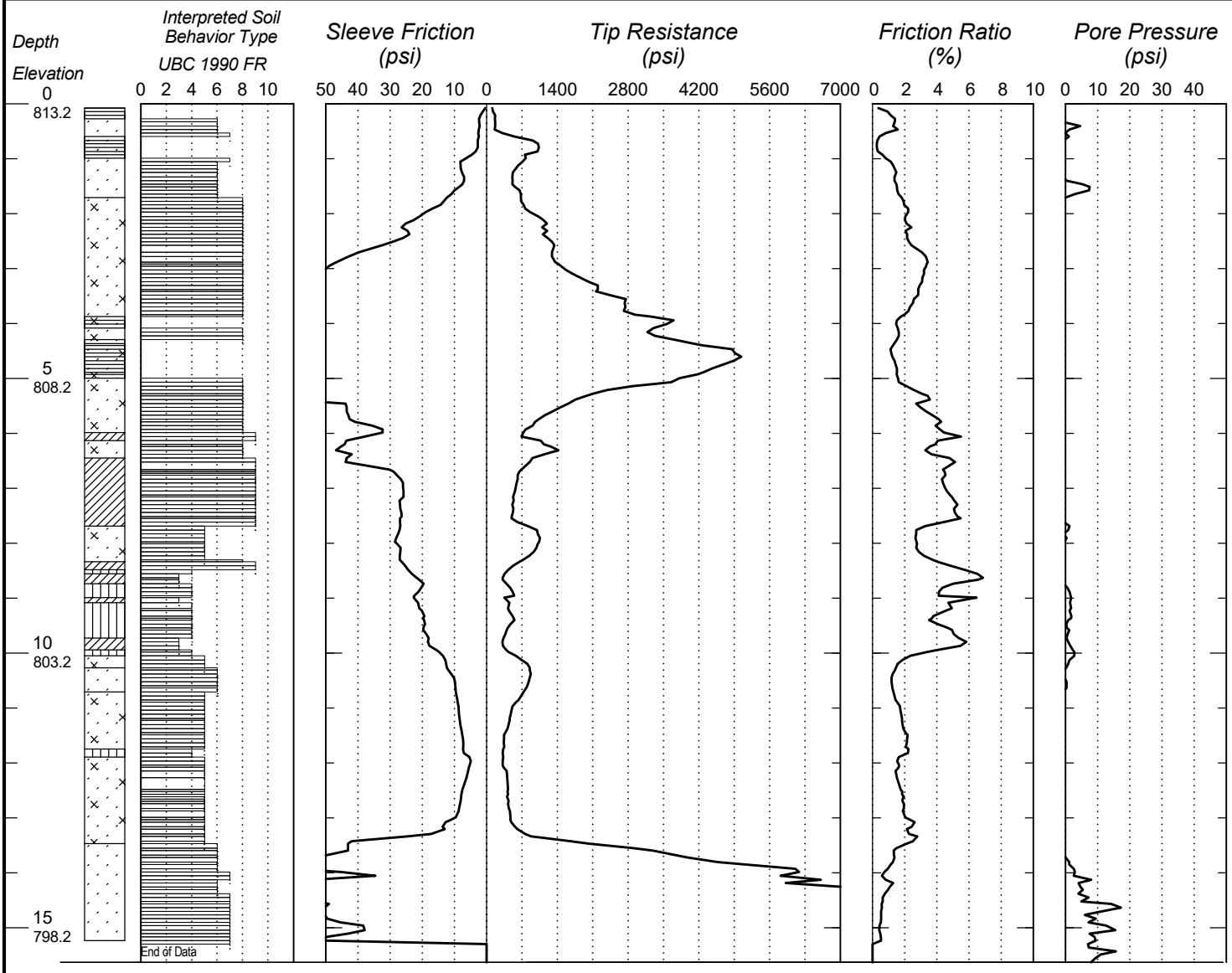
MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

CONE PENETRATION TEST RESULTS

UNIQUE NUMBER 89234

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Sounding No.	Ground Elevation
8825-1155	**Overhead Sign**	**280 NB at ramp to Energy Park**	**c204**	**813.2** *(DTM)*

Location	CPT Machine	SHEET 1 of 1
Dakota County Coordinate System	**219328 CPT Western Star**	
X=523558 Y=223842	*CPT Operator* **ODonnel**	*Date Completed*
Latitude (North)=44.811578° Longitude (West)=-93.225900°	*Hole Type* **CPT-STD**	**2/28/2024**



Bottom of Hole 15.63

DEPARTMENT OF TRANSPORTATION

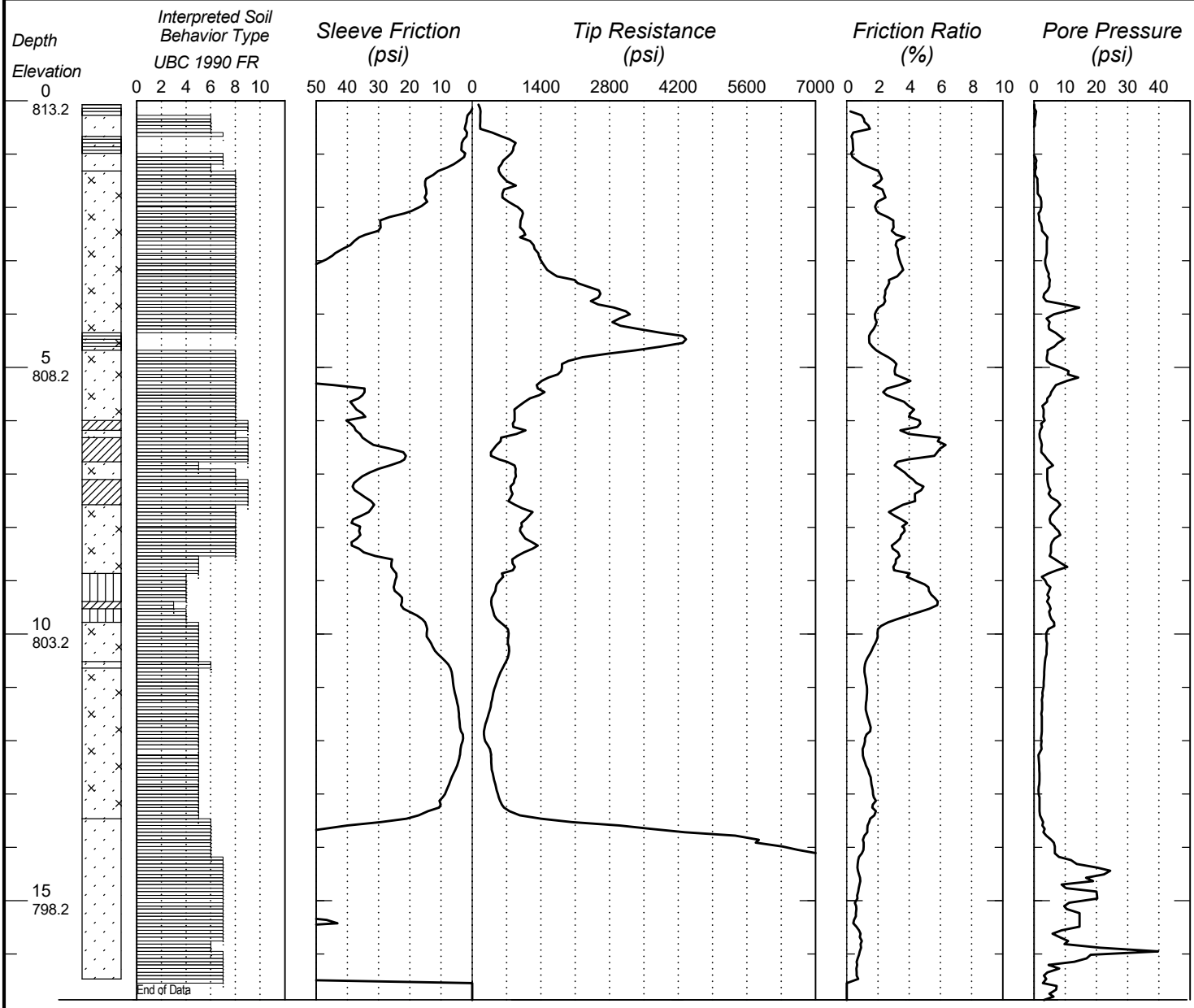
MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

CONE PENETRATION TEST RESULTS

UNIQUE NUMBER 89235

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Sounding No.	Ground Elevation
8825-1155	**Overhead Sign**	**280 NB at ramp to Energy Park**	**c204a**	**813.2** *(DTM)*

Location	CPT Machine	Sheet
Dakota County Coordinate System	**219328 CPT Western Star**	*SHEET 1 of 1*
X=523555 Y=223838	*CPT Operator* **ODonnel**	*Date Completed*
Latitude (North)=44.811567° Longitude (West)=-93.225908°	*Hole Type* **CPT-STD**	**2/28/2024**



Bottom of Hole 16.86

DEPARTMENT OF TRANSPORTATION

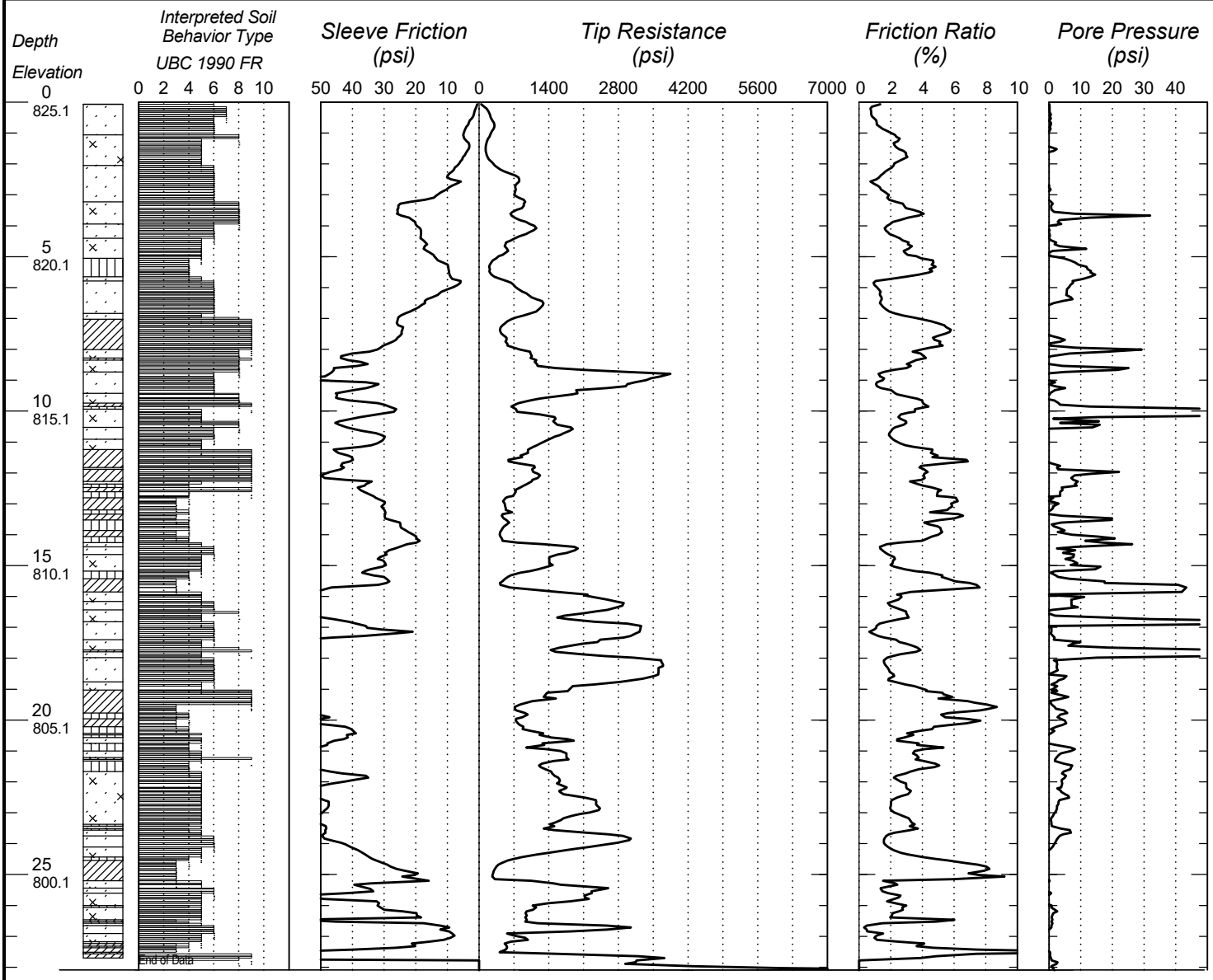
MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

CONE PENETRATION TEST RESULTS

UNIQUE NUMBER 89236

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Sounding No.	Ground Elevation
8825-1155	**Overhead Sign**	**280 NB at ramp to Energy Park**	**c205**	**825.1** *(DTM)*

Location	CPT Machine	SHEET 1 of 1
Dakota County Coordinate System	**219328 CPT Western Star**	
X=524521 Y=225114	CPT Operator **ODonnel**	Date Completed
Latitude (North)=44.815061° Longitude (West)=-93.222183°	Hole Type **CPT-STD**	**2/27/2024**



Bottom of Hole 28.09

DEPARTMENT OF TRANSPORTATION

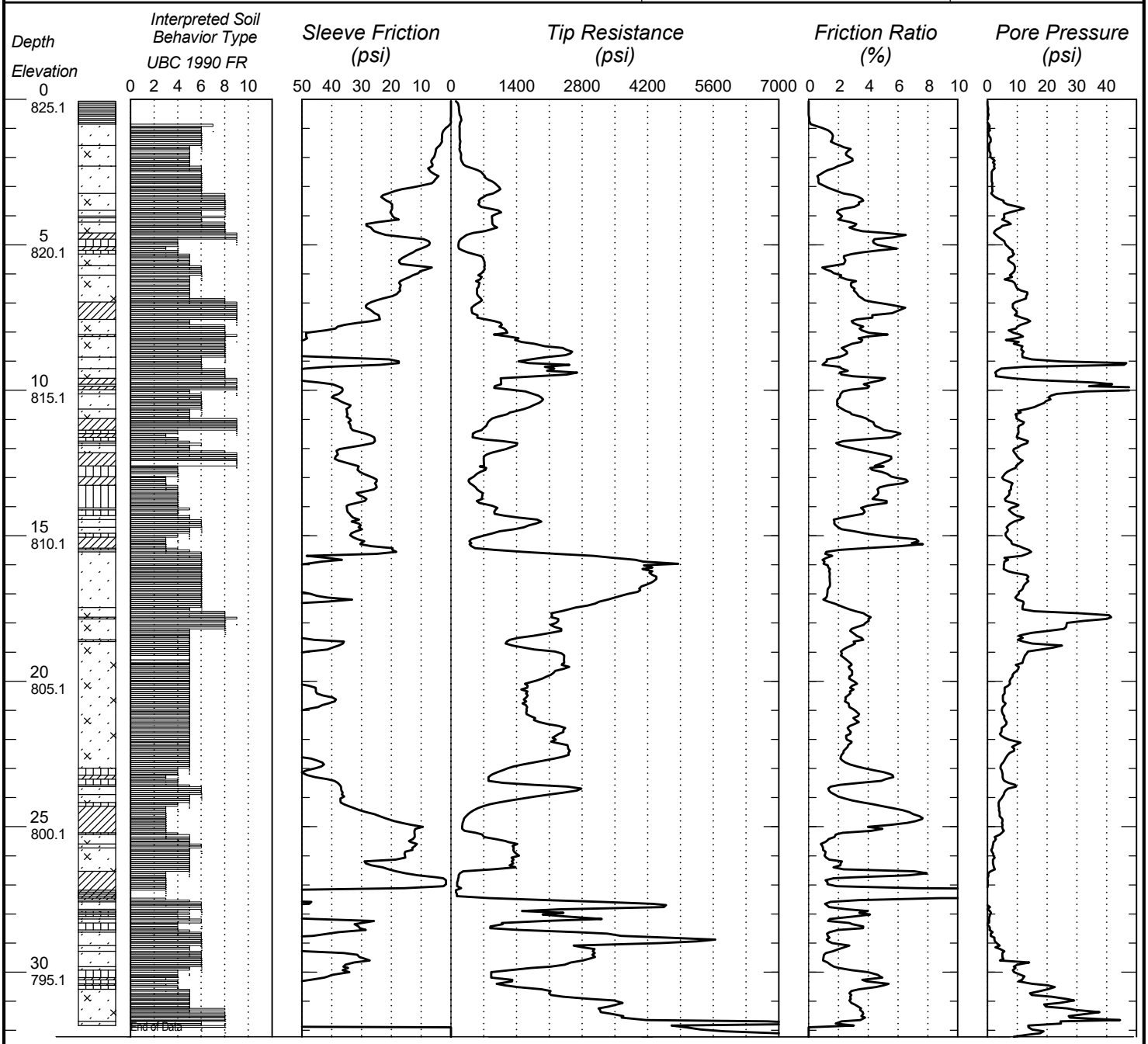
MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

CONE PENETRATION TEST RESULTS

UNIQUE NUMBER 89237

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Sounding No.	Ground Elevation
8825-1155	**Overhead Sign**	**280 NB at ramp to Energy Park**	**c205a**	**825.1** *(DTM)*

Location	CPT Machine	SHEET 1 of 1
Dakota County Coordinate System	**219328 CPT Western Star**	
X=524519 Y=225113	CPT Operator **ODonnel**	Date Completed
Latitude (North)=44.815058° Longitude (West)=-93.222192°	Hole Type **CPT-STD**	**2/27/2024**



Bottom of Hole 32.22

DEPARTMENT OF TRANSPORTATION

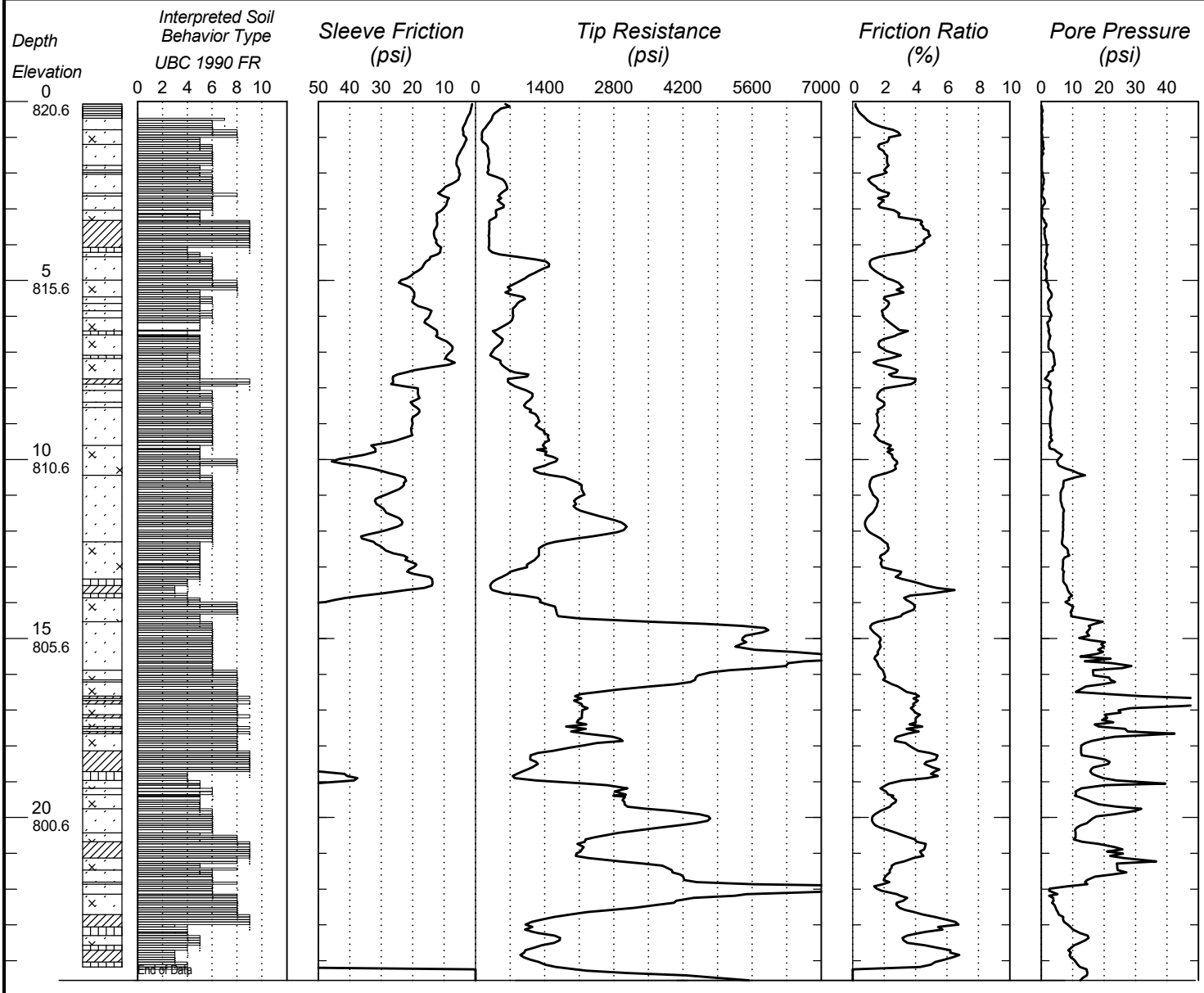
MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

CONE PENETRATION TEST RESULTS

UNIQUE NUMBER 89238

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Sounding No.	Ground Elevation
8825-1155	**Overhead Sign**	**280 NB at ramp to Energy Park**	**c206**	**820.6** *(DTM)*

Location Dakota County Coordinate System	*CPT Machine* **219328 CPT Western Star**	*SHEET 1 of 1*
X=525018 Y=225117	*CPT Operator* **ODonnel**	*Date Completed*
Latitude (North)=44.815069° Longitude (West)=-93.220267°	*Hole Type* **CPT-STD**	**2/28/2024**



Bottom of Hole 24.55

DEPARTMENT OF TRANSPORTATION

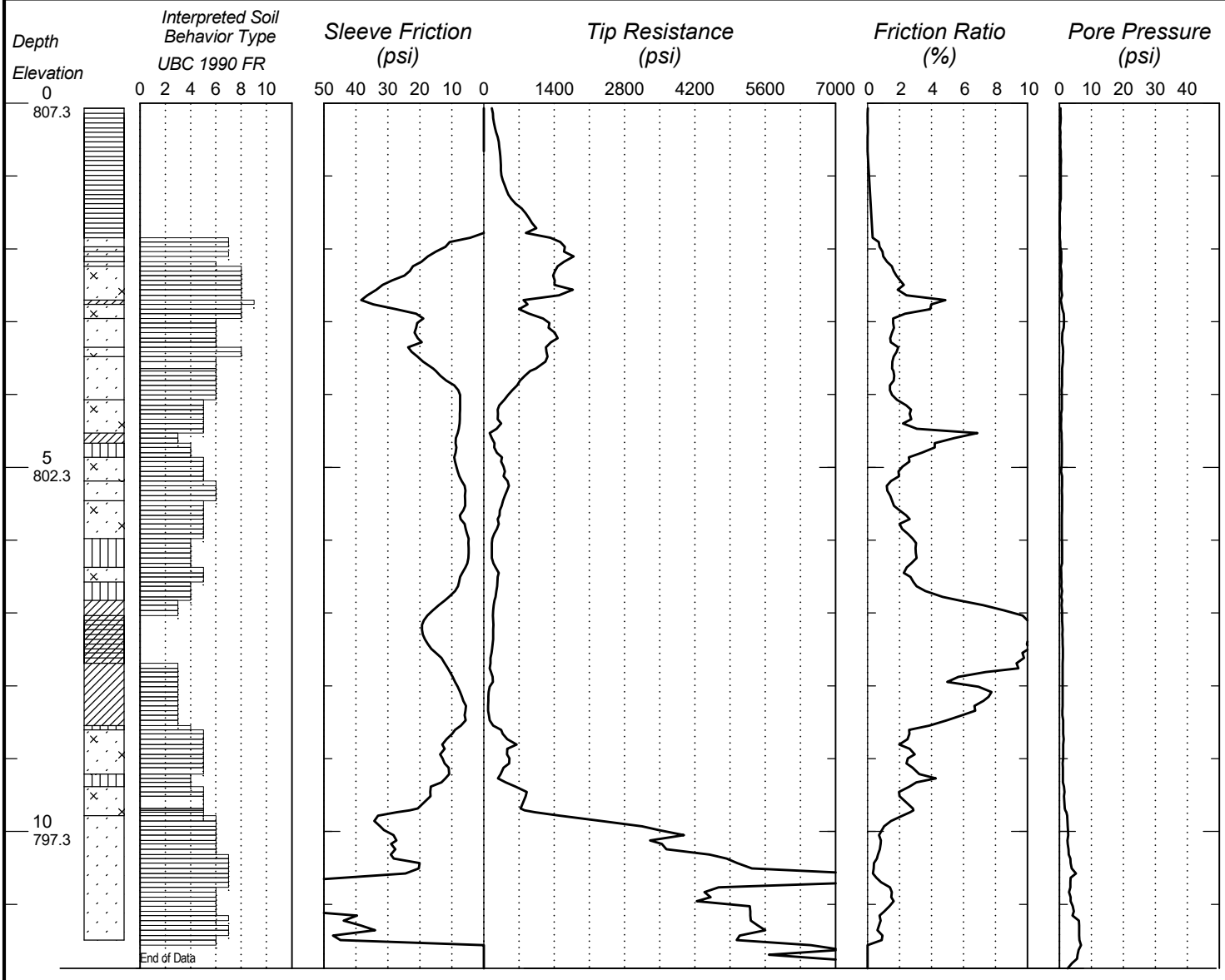
MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

CONE PENETRATION TEST RESULTS

UNIQUE NUMBER 89254

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Sounding No.	Ground Elevation
8825-1155	**Overhead Sign**	**280 NB at ramp to Energy Park**	**c207**	**807.3** *(GeoXH(DC))*

Location	CPT Machine	
Ramsey County Coordinate System	**219328 CPT Western Star**	*SHEET 1 of 1*
X=573526 Y=158597	*CPT Operator* **ODonnel**	*Date Completed*
Latitude (North)=44.951467° Longitude (West)=-93.099353°	*Hole Type* **CPT-STD**	**3/5/2024**



Bottom of Hole 11.88

DEPARTMENT OF TRANSPORTATION

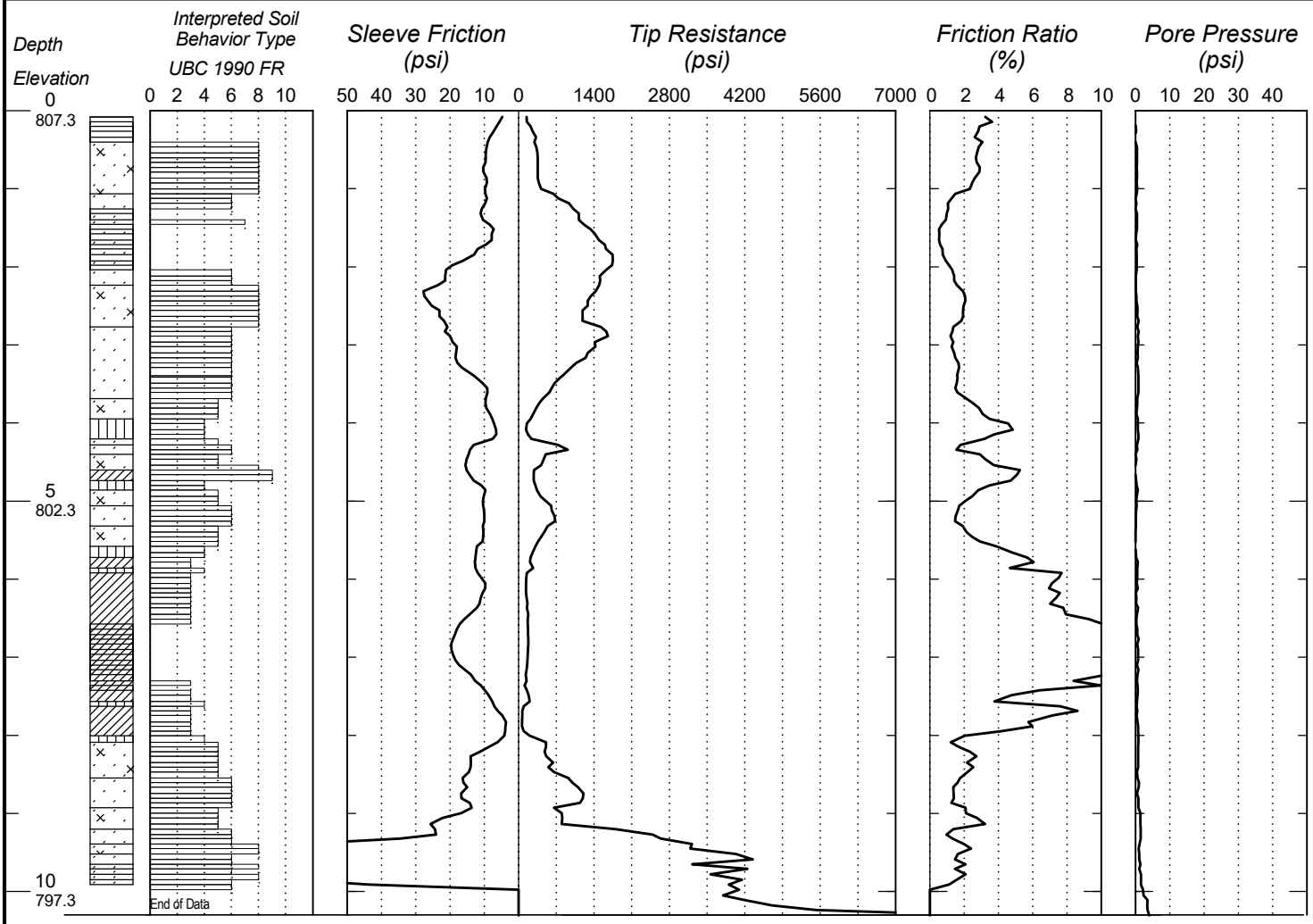
MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

CONE PENETRATION TEST RESULTS

UNIQUE NUMBER 89255

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Sounding No.	Ground Elevation
8825-1155	**Overhead Sign**	**280 NB at ramp to Energy Park**	**c207a**	**807.3** *(GeoXH(DC))*

Location	CPT Machine	SHEET 1 of 1
Ramsey County Coordinate System	**219328 CPT Western Star**	
X=573531 Y=158599	*CPT Operator* **ODonnel**	*Date Completed*
Latitude (North)=44.951472° Longitude (West)=-93.099333°	*Hole Type* **CPT-STD**	**3/5/2024**



Bottom of Hole 10.3

DEPARTMENT OF TRANSPORTATION

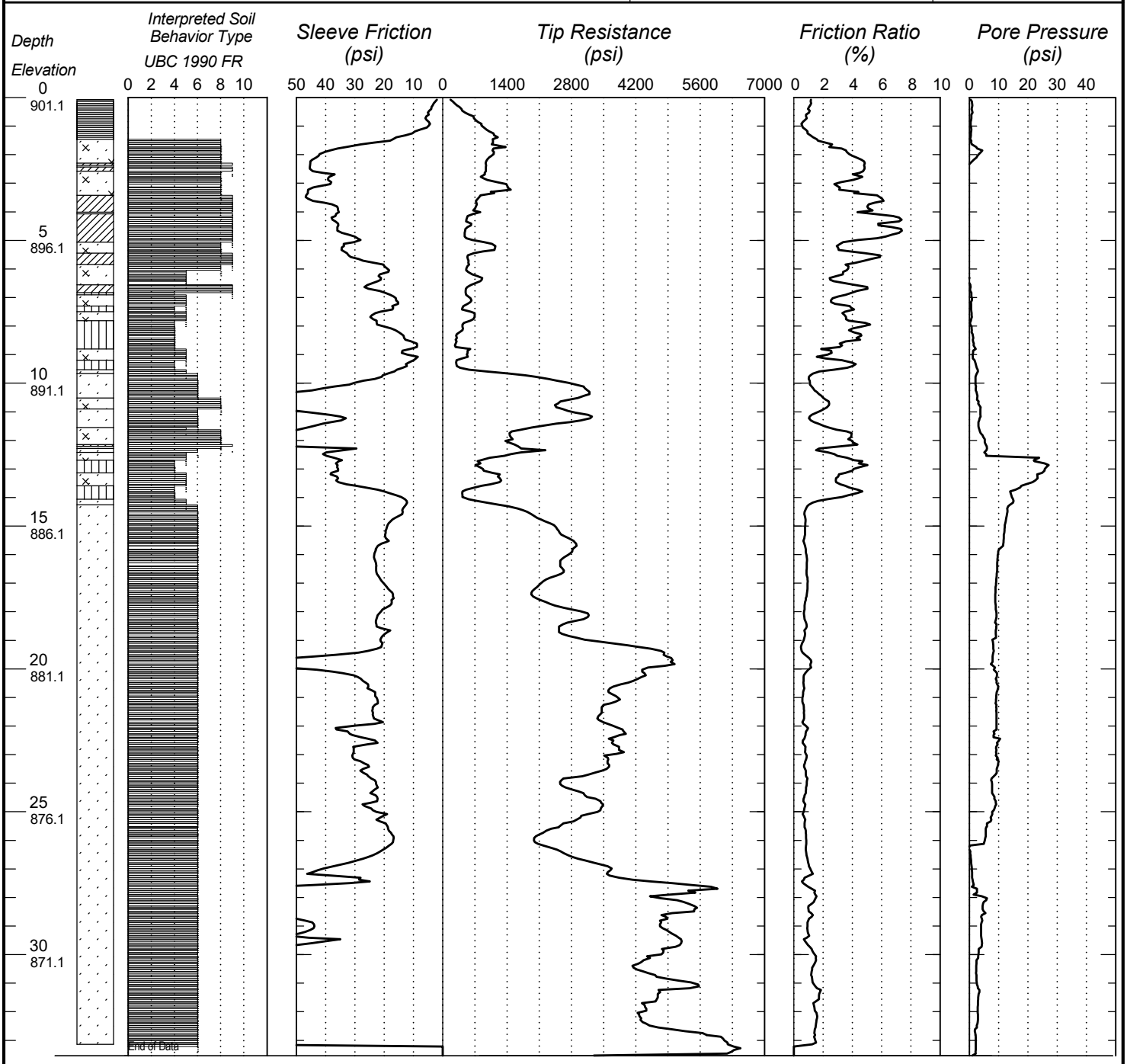
MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

CONE PENETRATION TEST RESULTS

UNIQUE NUMBER 89256

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Sounding No.	Ground Elevation
8825-1155	**Overhead Sign**	**280 NB at ramp to Energy Park**	**c208**	**901.1** *(GeoXH(DC))*

Location	CPT Machine	SHEET 1 of 1
Ramsey County Coordinate System **X=549880 Y=160203** *Latitude (North)=44.956064° Longitude (West)=-93.190667°*	**219328 CPT Western Star** CPT Operator **ODonnel** Hole Type **CPT-STD**	Date Completed **3/5/2024**



Bottom of Hole 33.54

Library:G:\GINT\SYSTEM_FILES\CURRENT\MNDOT_GLB_20190619.GLB Report Format:CPT LOG *G:\GINT\PROJECTS-ACTIVE\8825-1155 METRO WIDE OH SIGNS.GPJ*

DEPARTMENT OF TRANSPORTATION

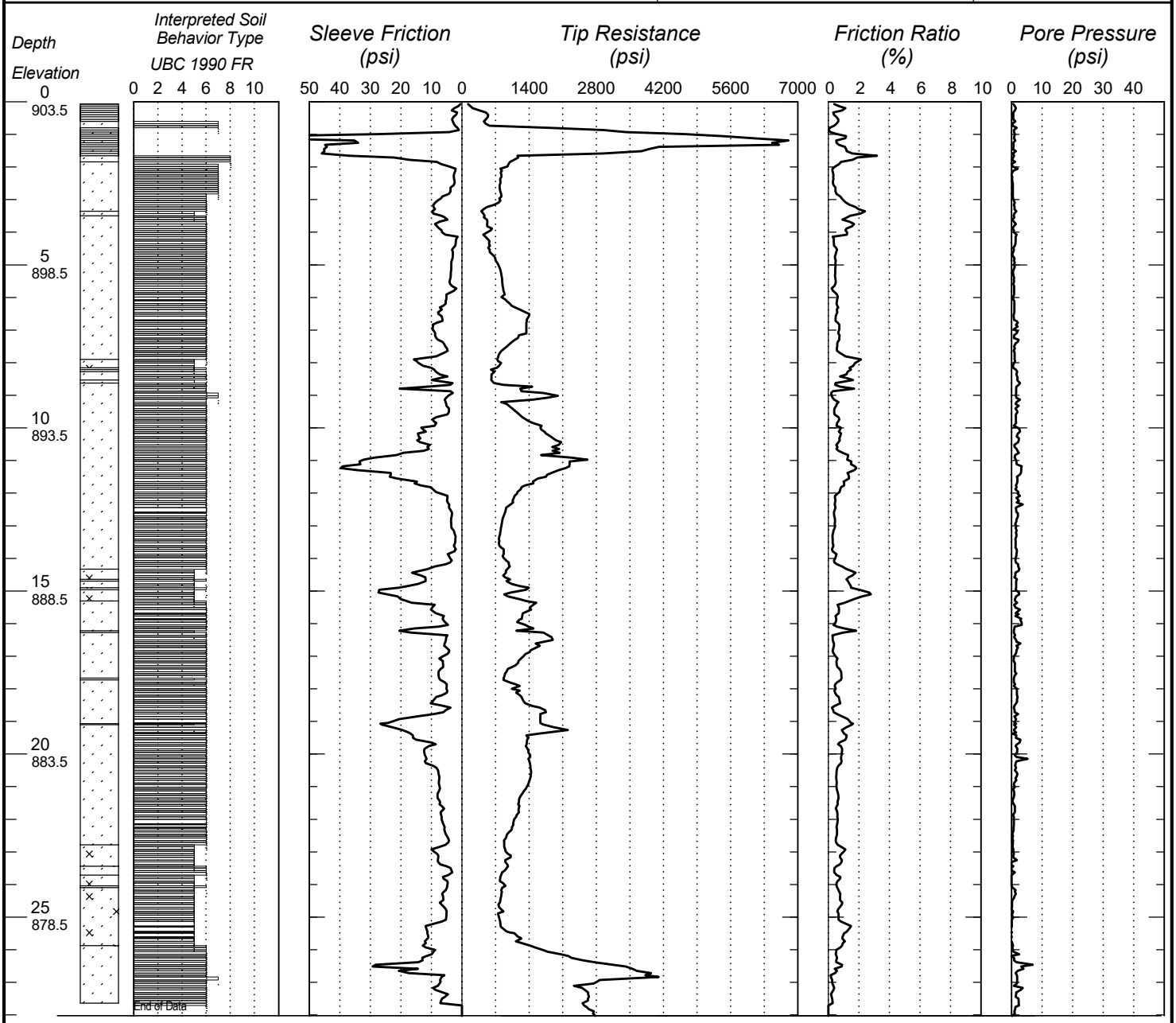
MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

CONE PENETRATION TEST RESULTS

UNIQUE NUMBER 89257

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Sounding No.	Ground Elevation
8825-1155	**Overhead Sign**	**280 NB at ramp to Energy Park**	**c209**	**903.5** *(GeoXH(DC))*

Location	CPT Machine	SHEET 1 of 1
Ramsey County Coordinate System **X=561347 Y=158282** *Latitude (North)=44.950711° Longitude (West)=-93.146397°*	*CPT Operator* **ODonnel** *Hole Type* **CPT-STD**	*Date Completed* **3/6/2024**



Bottom of Hole 28.02

DEPARTMENT OF TRANSPORTATION

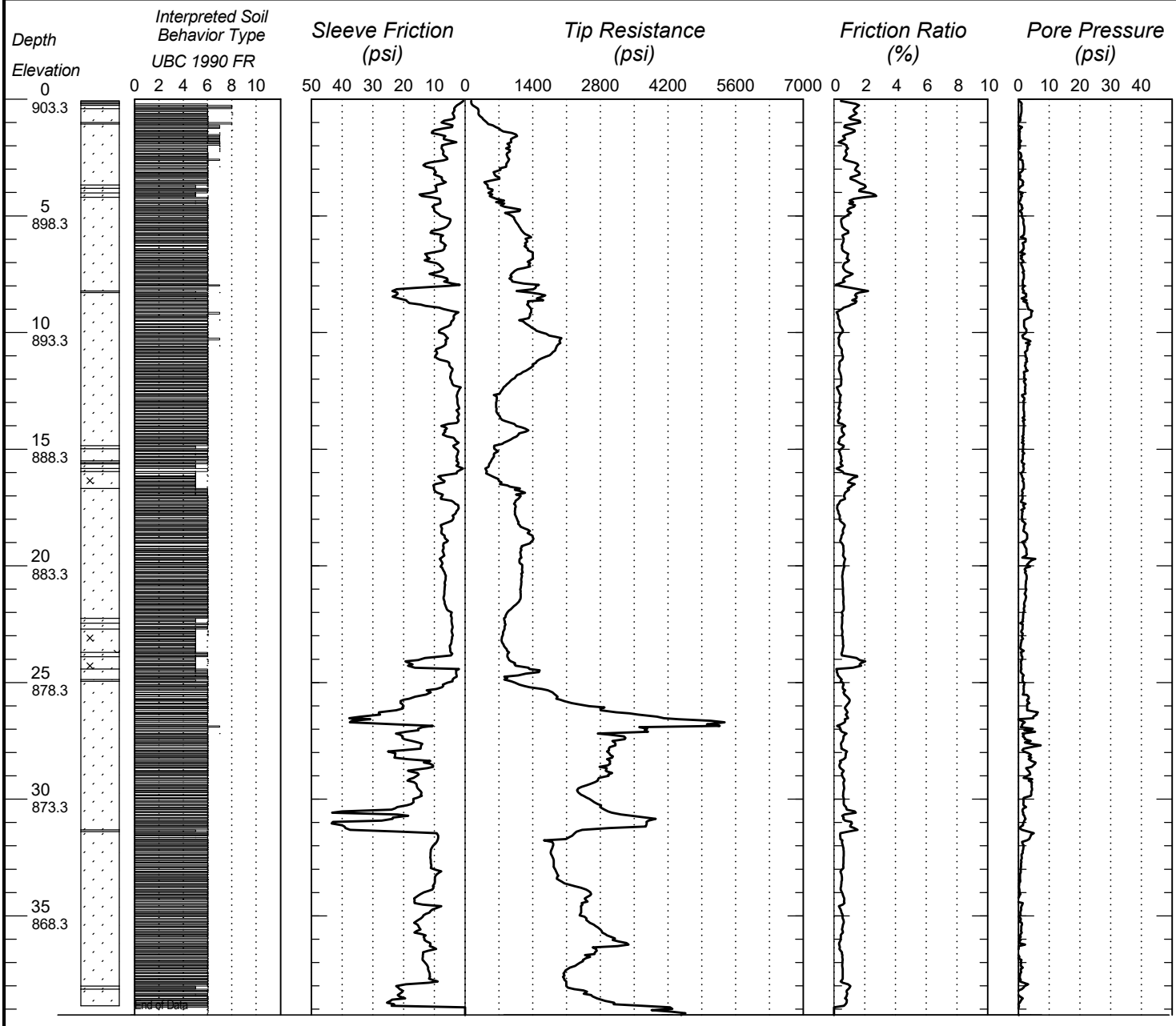
MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

CONE PENETRATION TEST RESULTS

UNIQUE NUMBER 89258

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Sounding No.	Ground Elevation
8825-1155	**Overhead Sign**	**280 NB at ramp to Energy Park**	**c209a**	**903.3** *(GeoXH(DC))*

Location	CPT Machine	SHEET 1 of 1
Ramsey County Coordinate System	**219328 CPT Western Star**	
X=561346 Y=158279	*CPT Operator* **ODonnel**	*Date Completed*
Latitude (North)=44.950703° Longitude (West)=-93.146400°	*Hole Type* **CPT-STD**	**3/6/2024**



Bottom of Hole 39.25

DEPARTMENT OF TRANSPORTATION

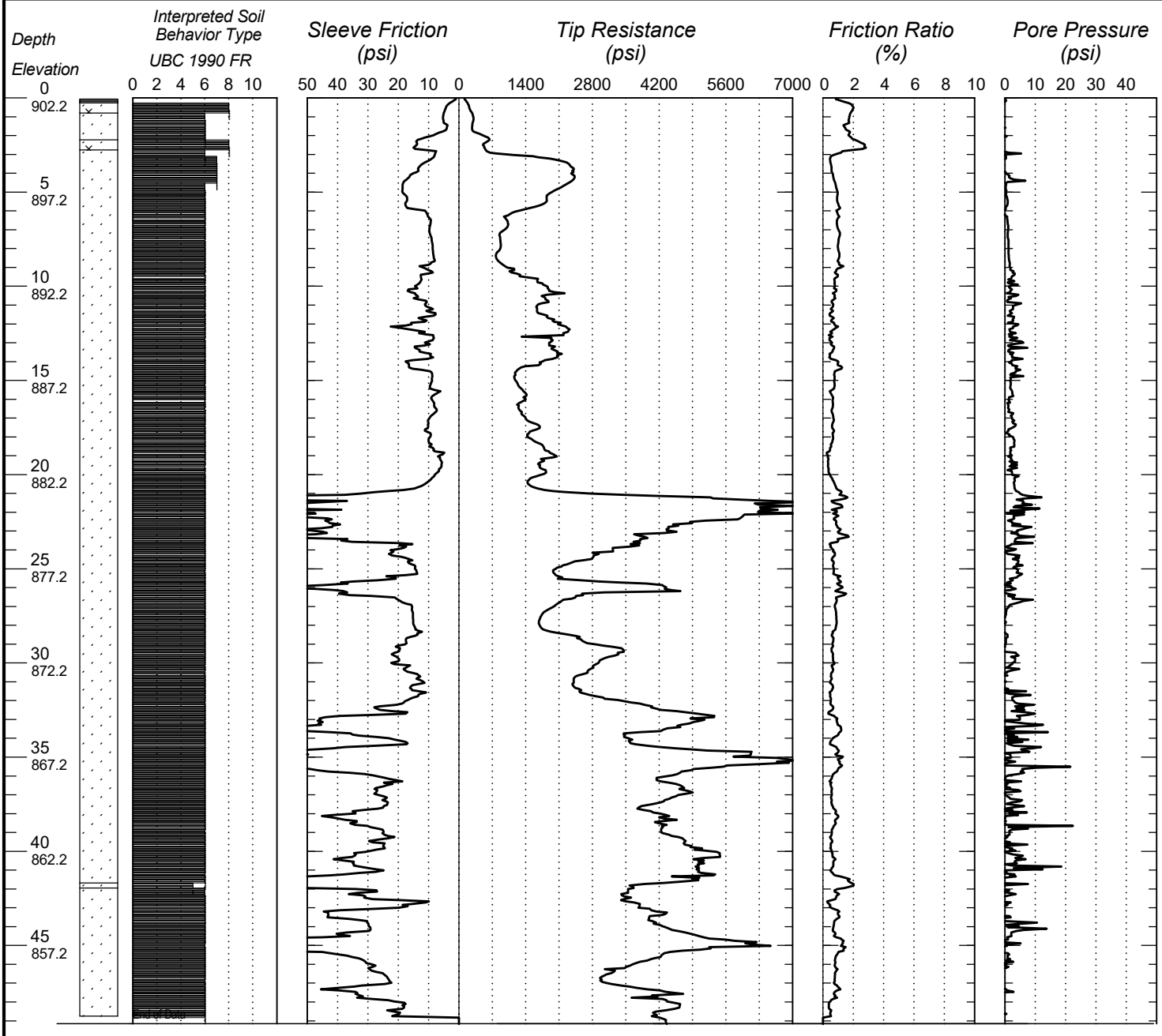
MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

CONE PENETRATION TEST RESULTS

UNIQUE NUMBER 89259

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Sounding No.	Ground Elevation
8825-1155	**Overhead Sign**	**280 NB at ramp to Energy Park**	**c210**	**902.2** *(GeoXH(DC))*

Location	CPT Machine	SHEET 1 of 1
Ramsey County Coordinate System	**219328 CPT Western Star**	
X=561282 Y=158351	*CPT Operator* **ODonnel**	*Date Completed*
Latitude (North)=44.950900° Longitude (West)=-93.146647°	*Hole Type* **CPT-STD**	**3/5/2024**



Bottom of Hole 49.16

DEPARTMENT OF TRANSPORTATION

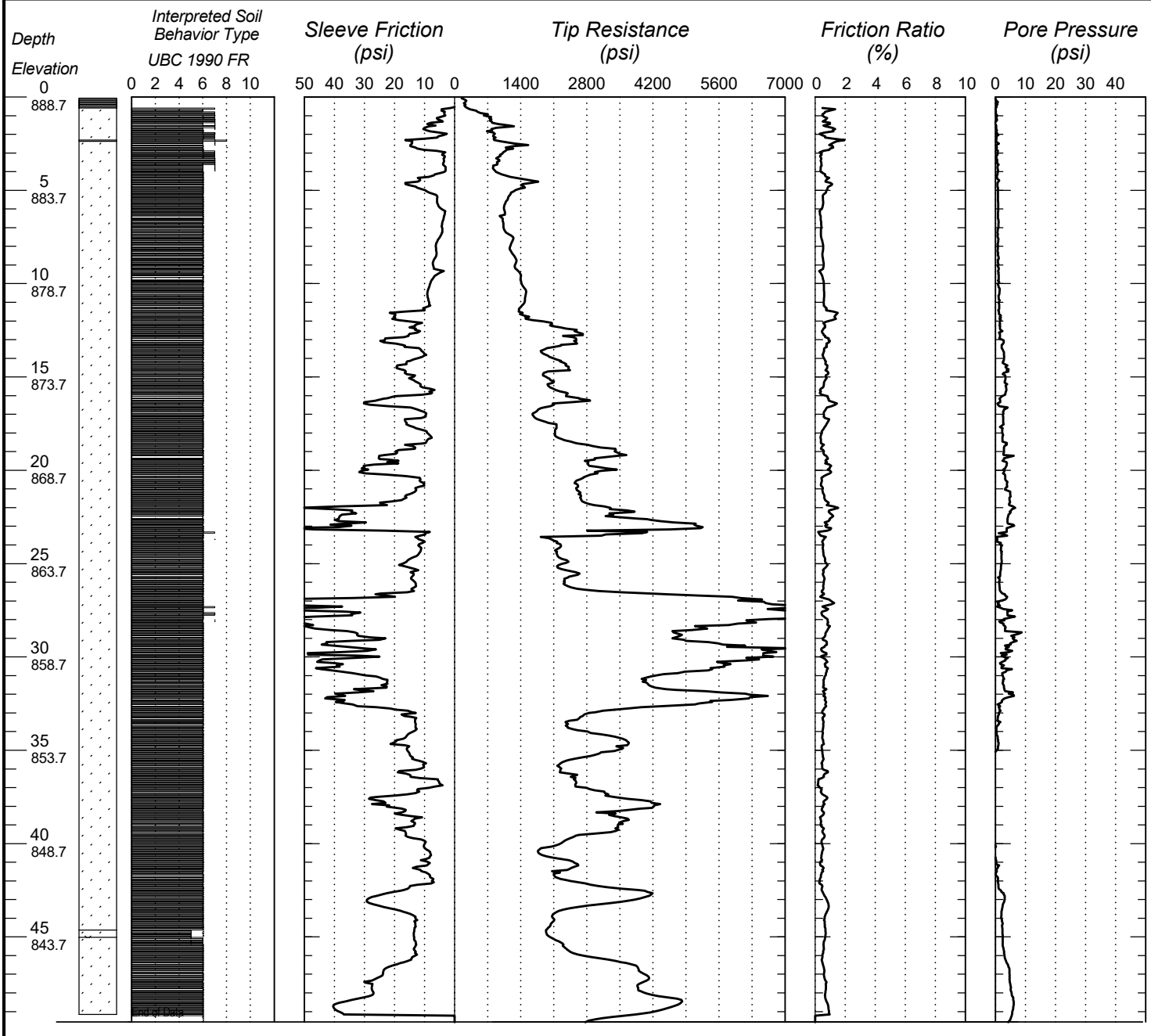
MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

CONE PENETRATION TEST RESULTS

UNIQUE NUMBER 89260

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Sounding No.	Ground Elevation
8825-1155	**Overhead Sign**	**280 NB at ramp to Energy Park**	**c211**	**888.7** *(GeoXH(DC))*

Location	CPT Machine	SHEET 1 of 1
Ramsey County Coordinate System	**219328 CPT Western Star**	
X=561208 Y=158992	CPT Operator **ODonnel**	Date Completed
Latitude (North)=44.952658° Longitude (West)=-93.146925°	Hole Type **CPT-STD**	**3/6/2024**



Bottom of Hole 49.56

DEPARTMENT OF TRANSPORTATION

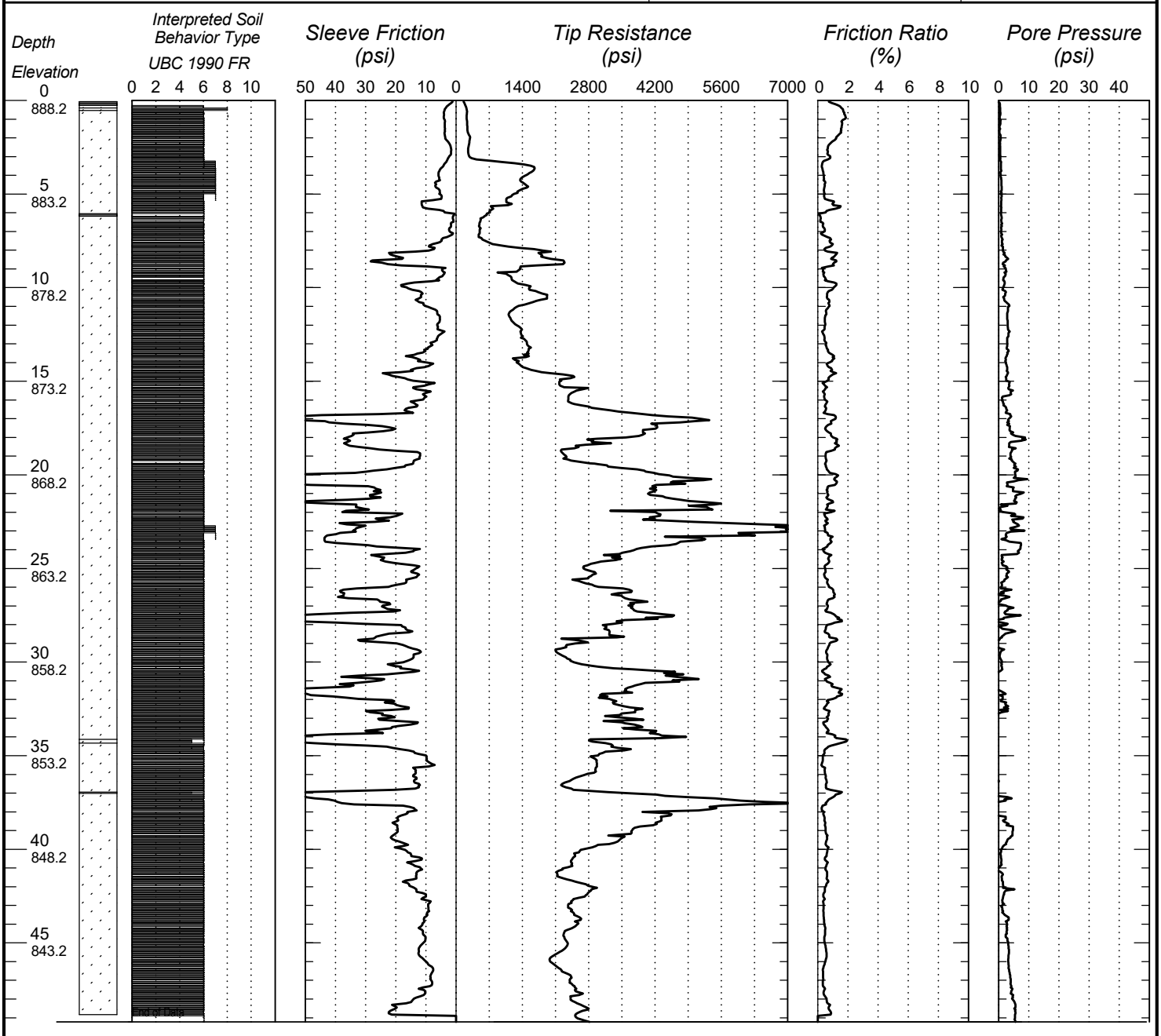
MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

CONE PENETRATION TEST RESULTS

UNIQUE NUMBER 89261

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Sounding No.	Ground Elevation
8825-1155	**Overhead Sign**	**280 NB at ramp to Energy Park**	**c212**	**888.2** *(GeoXH(DC))*

Location	CPT Machine	SHEET 1 of 1
Ramsey County Coordinate System	**219328 CPT Western Star**	
X=561286 Y=159038	CPT Operator **ODonnel**	Date Completed
Latitude (North)=44.952786° Longitude (West)=-93.146622°	Hole Type **CPT-STD**	**3/6/2024**



Bottom of Hole 49.22

DEPARTMENT OF TRANSPORTATION

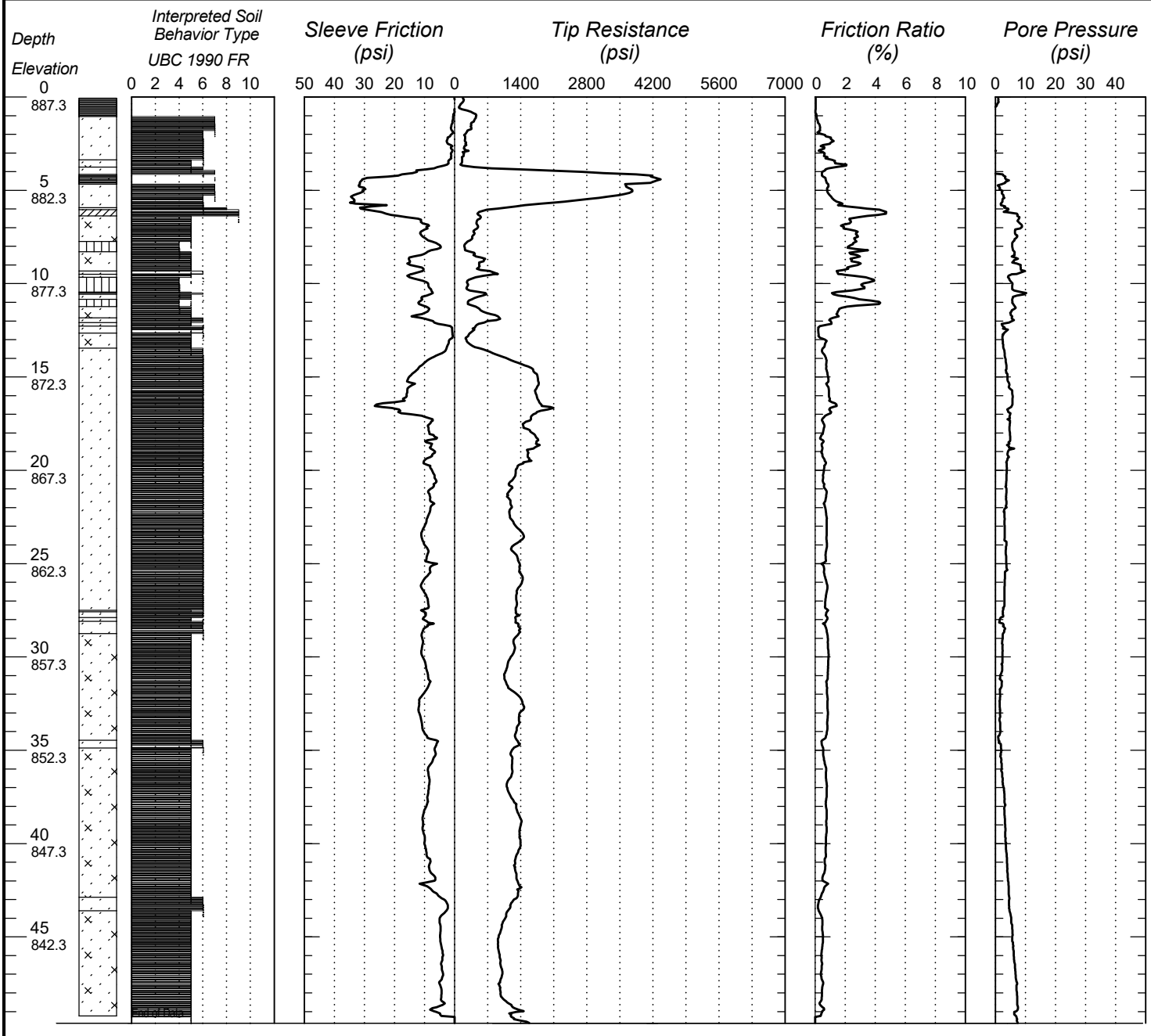
MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

CONE PENETRATION TEST RESULTS

UNIQUE NUMBER 89262

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Sounding No.	Ground Elevation
8825-1155	**Overhead Sign**	**280 NB at ramp to Energy Park**	**c213**	**887.3** *(GeoXH(DC))*

Location	CPT Machine	SHEET 1 of 1
Ramsey County Coordinate System	**219328 CPT Western Star**	
X=585041 Y=180565	*CPT Operator* **ODonnel**	*Date Completed*
Latitude (North)=45.011597° Longitude (West)=-93.054533°	*Hole Type* **CPT-STD**	**3/4/2024**



Bottom of Hole 49.62

DEPARTMENT OF TRANSPORTATION

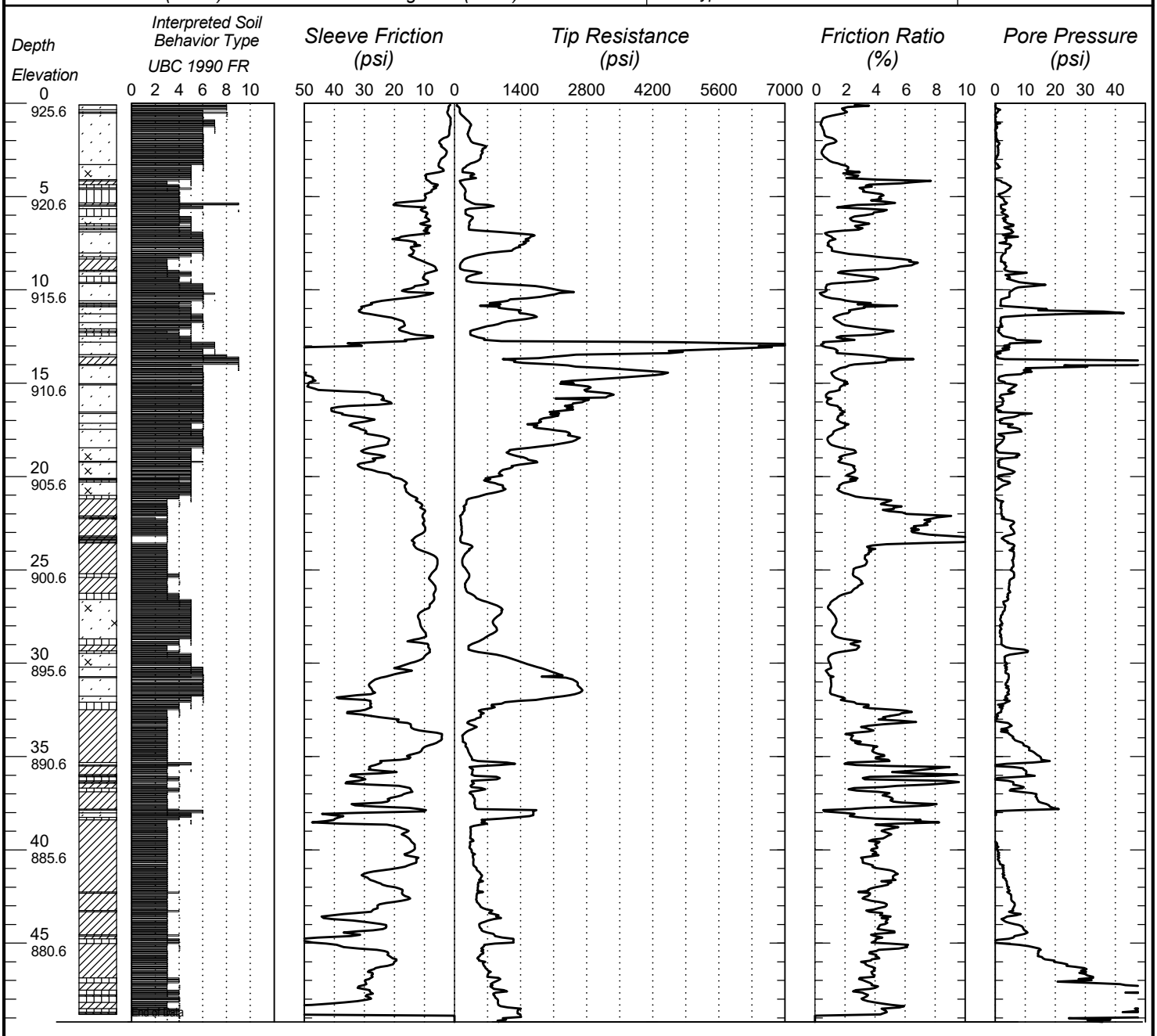
MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

CONE PENETRATION TEST RESULTS

UNIQUE NUMBER 89263

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Sounding No.	Ground Elevation
8825-1155	**Overhead Sign**	**280 NB at ramp to Energy Park**	**c214**	**925.6** *(GeoXH (DC))*

Location	CPT Machine	SHEET 1 of 1
Ramsey County Coordinate System	**221181 CPT Terra Mac**	
X=546903 Y=167058	*CPT Operator* **ODonnel**	*Date Completed*
Latitude (North)=44.974883° Longitude (West)=-93.202106°	*Hole Type* **CPT-STD**	**3/6/2024**



Bottom of Hole 49.22

DEPARTMENT OF TRANSPORTATION

MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

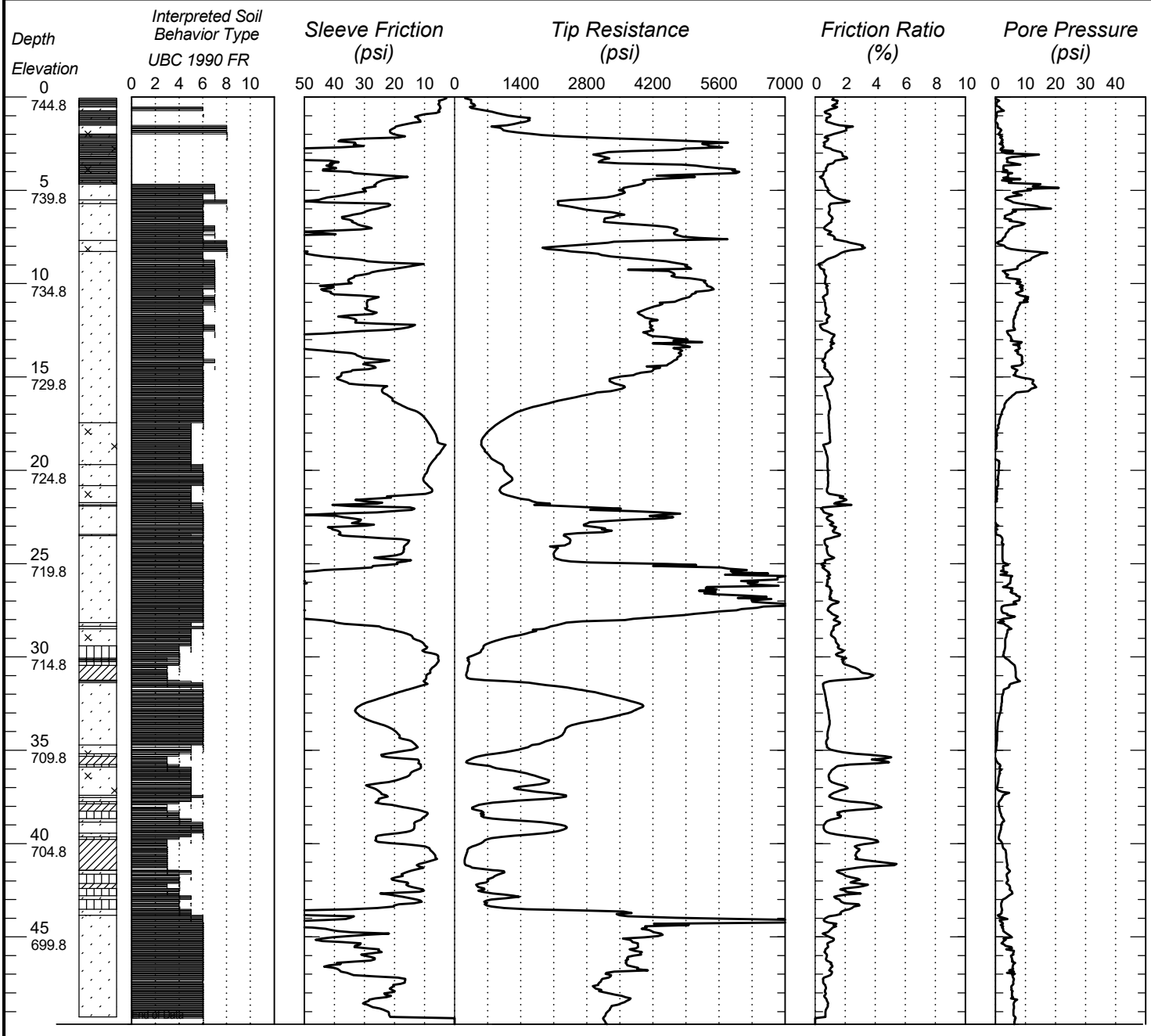
CONE PENETRATION TEST RESULTS

UNIQUE NUMBER 89210

(MDH H400279)

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Sounding No.	Ground Elevation
8825-1155	**Overhead Sign**	**280 NB at ramp to Energy Park**	**c215**	**744.8** *(DTM)*

Location	CPT Machine	
Washington County Coordinate System	**219328 CPT Western Star**	*SHEET 1 of 1*
X=515752 Y=178101	*CPT Operator* **ODonnel**	*Date Completed*
Latitude (North)=44.960011° Longitude (West)=-92.772561°	*Hole Type* **CPT-STD**	**2/20/2024**



Bottom of Hole 49.68

LOG OF BORING

MHD #9647

PROJECT: St. Paul, Minnesota, Capitol Approach

BORING NO: S-21-5

SHEET 1 OF 1

BORING TYPE: Std. P.R. Boring and Rock Coring

SAMPLER DATA: 2" O. D. Split Spoon & Double Tube Core B

GROUND WATER:
AT DRILLING: 8.0
168 HOURS AFTER DRILLING: 12.5
___ HOURS AFTER DRILLING: ___

STATION:
OFFSET: 3' E
BORING STARTED 6-4-62
BORING COMPLETED: 6-4

SURFACE ELEV. 805.5

130' N. College Prod. E. & 25' W. @ Right angle Wabasha

SOIL DESCRIPTION AND REMARKS

SOIL MECHANICS INCORPORATED
SMI ENGINEER Robert C. Sneed and J. Ray Murillo
8:00A.M.

CLASSIFICATION SYSTEM

DEPTH - FEET	SAMPLES	SAMPLE NO & TYPE	STANDARD PENETRATION, RESISTANCE, BLOWS PER FOOT	RECOVERY, %	COMPRESSIVE STRENGTH TSF, POCKET PENETROMETER	DRILLING DATA: BIT SIZE, TYPE, etc: LOSS OR GAIN OF CIRCULATION, TYPE OF DRILLING FLUID	~~CASING SIZE, TYPE, etc.~~ ~~BLOWS PER FOOT~~ ~~WEIGHT OF HAMMER~~ SAMPLE NO
5			6/7-17				205
10							
15	C	C	11/50-	3"	90%		
20	C				90%		
25	C				100%		
30	C				92%		
35	C				50%		
40							
45							
50							
55							
60							

4" Asphalt Pavement - 5" Concrete

Firm gray loamy sandy GRAVEL with clay, semi-plastic — 795.5

Platteville Formation Limestone

2" gray shale stringer 16'-6" - 16'-8"

774.1

Greenish gray shale 31.4' becoming sandy at 35.9' — 769.6

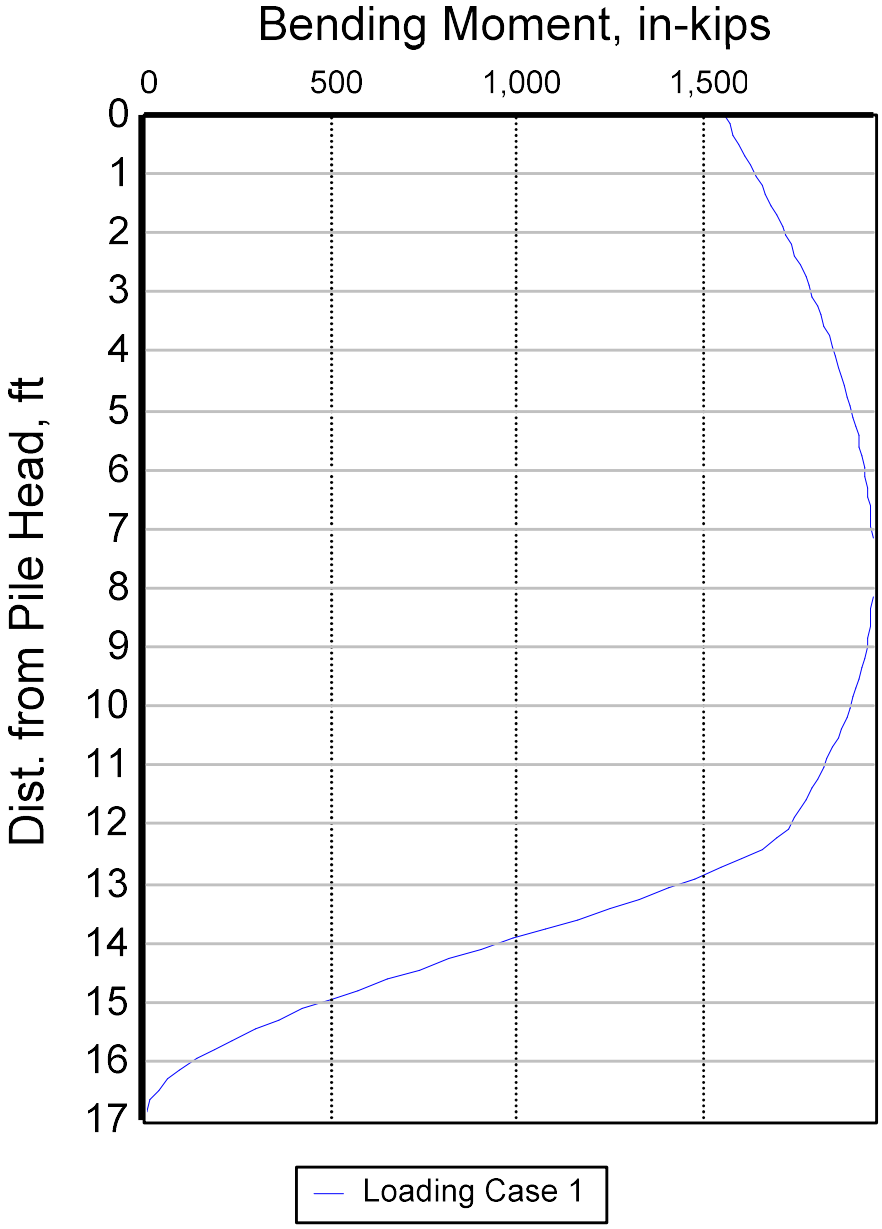
St. Peter Sandstone
very dense medium cementation

Bottom @ 41.3'

PRELIMINARY

Completed at 8:15 P.M.

Bending Moment vs. Depth



Top Deflection vs. Pile Length