



Memo

DATE: October 1st, 2018

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Metro District

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Foundation Unit

SUBJECT: S.P. 1901-184, Replace High Mast Tower Lighting Systems (Metro District)
TH13 at JCT TH77 in Eagan
Foundations Investigation and Recommendations

Project Description

This report provides a Foundation Analysis and Recommendations for constructing foundations for 12 new High Mast Light Towers (HMLTs) on TH13 at junction TH77 in Eagan.

This report also provides a request to keep 3 tower bases intact for an active research project with the University of Minnesota as part of a cooperative effort with the Bridge Office to determine unknown pile lengths of HMLT installations for a future investigation/retrofit program.

Field Investigation and Foundation Conditions

Ten Cone Penetration Tests (CPT Soundings) and one Standard Penetration Test (SPT Borings) were taken by MnDOT in May of 2018 at the High Mast Light Tower foundation locations. One additional old boring taken in 1979 (TE8) for an old light tower near the location of light tower E8 was also used.

The soils at the light tower locations predominantly consist of medium dense silty sand to dense sandy soil. Water was encountered 15 ft. below existing ground (elevation 778.6 ft.) in the one boring (T09) taken at the location of light tower E9.

Copies of the CPT & SPT logs are attached with this report.



Foundation Analysis

The proposed light tower locations and ground elevations were provided by the Metro District. The proposed light towers will be 100 or 120 ft. in height. The HMLT Foundation Standard Design sheets, developed by the Bridge office in December of 2011, provide standard details for supporting light towers on spread footings. At this time, details for pile foundations are being developed by the Bridge office and will be available for use on this project.

Review of Shallow Foundation Option

The spread footing design option utilizes three different square footings depending on tower height and a minimum bottom of footing embedment of 5 ft. below existing ground.

Table 1 below shows the minimum soil strength parameters for a minimum effective unit weight, friction angle and cohesion required for the standard spread footing foundation design.

Table 1: Minimum soil strength parameters for Spread Footing (Standard Plans 5-297.321)

<i>Soil Type</i>	<i>Effective Unit Weight (pcf)</i>	<i>Friction Angle (Φ)</i>	<i>Cohesion (psf)</i>
Sandy Soil	52.5	30	0
Clay Soil	57.5	0	1000

Pile Foundation Option

The tower locations were also assessed for the use of 10x42 and 12-inch diameter CIP piles. Anticipated pile lengths were calculated to meet both compression and tension design requirements. Pile capacity was evaluated using the software *Unipile*. It is assumed that the project will be more cost effective if all tower foundation use the driven pile design because the tower base is smaller, requiring less excavation and concrete. The contractor will also have equipment and materials for installing piling at over half of the towers, so the additional work would not require significantly different mobilization or material shipping costs. Please contact our office if spread footing foundations are preferred for other project reasons.

Table 2 below includes minimum pile depth requirement and type of foundation that can be used for the high mast light towers. A factored structural uplift requirement of 25 tons was used in our calculations, with a LRFD resistance factor of 0.3, for a Nominal geotechnical uplift resistance of 83 tons.



Table 2: Summary of Foundation Recommendations for Light Towers.

Pole #	Pole height (ft.)	CPT Soundings or Borings	Estimated Pile depth for Nominal 200 ton Compression (ft.)	Required Minimum Pile depth for Nominal 83 ton Tension (Uplift) (ft.)*	Estimated Pile embedment for 10x42 H-Pile for 200 ton Nominal Bearing Capacity(ft.)*	Spread Footing is an option at this location**
C1	100	c01	35	35	40	Yes
C2	120	c02	20	25	30	No
C3	100	c03a	20	30	30	Yes
C4	120	c04	25	30	30	Yes
C5	100	c05	20	25	25	Yes
C6	100	c06c	10	25	25	Yes
C7	100	c07c	15	25	25	No
E8	120	TE-8	40	40	40	No
E9	120	T09	45	40	45	No
E10	100	c10	30	25	35	No
E11	100	c11	25	25	25	No
E12	100	c12c	35	25	35	No

*The minimum required pile depth reflects the minimum length of pile below ground to satisfy the uplift requirement. Using the MPF 12 formula, piles could achieve 200 ton nominal capacity prior to this criterion. If 200 tons Nominal Bearing Resistance, using the MPF 12 formula, is not satisfied at this minimum tip elevation, then driving should continue until the bearing resistance is achieved.

**Tower locations C2, C7, E8, E9, E10, E11, and E12 are not suitable for the standard spread footing design. A project specific set of pile design sheets will be required where piling is driven; refer to the recommendations section (piling can be used for all HMLT foundations, as rock was not encountered).

HMLT Unknown Pile Length and Pile Uplift Research

As part of the cooperative project between the Bridge Office and the Office of Materials & Road Research to potentially retrofit existing towers, several sites are needed to study techniques for determining unknown pile lengths. As part of this work, it is desirable to have 3 light tower bases remain above grade (with the towers and power systems removed) for use in testing various methods.

We are interested, as part of this contract, in preserving 3 intact pile-supported tower foundations which are easily accessible, but sufficiently far or protected from traffic so as not to be a safety hazard during the testing

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and research work, or accessing the towers.

After the multi-year instrumentation study and as part of a future contract project, the selected tower foundations would be abandoned similarly to the methods called for in this plan where the top collars are removed and turf established. The anticipated impact to this project would be a slight reduction in the amount of work for tower base removal.

The preferred tower locations are at in-place towers T2C T1, T2C T2 and T2E T10. Refer to Figures 1-3 for the tower site conditions and Figure 4 for a map showing the selected locations.



Figure 1: T2C T1 is located off of MN 77 and is behind protective guardrail with good CPT truck access.



Figure 2: T2C T2 is located in the SE cloverleaf ramp with good sight distances and CPT truck access. This is the deepest existing foundation at the site and different than the estimated depths of the other two towers, making it a preferred location.

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Figure 3: T2E T10 is the most preferred location, from an access and safety perspective; it is along MN 13, where traffic is lighter and the location is well off both the mainline and the ramp. The ground is relatively flat for good CPT truck access.

The towers have been selected for safety, access with a CPT truck rig, and length of foundation piling. The proposed new tower locations are 242 feet from tower T2C T1, 45 feet from tower T2C T2 and 71 feet from tower T2E T10, which should allow adequate space for new towers to be installed without conflicting with the existing foundations. The proposed geotechnical monitoring and instrumentation work will not be concurrent with the project; as such, no delays to the HMLT project work or cost are anticipated.



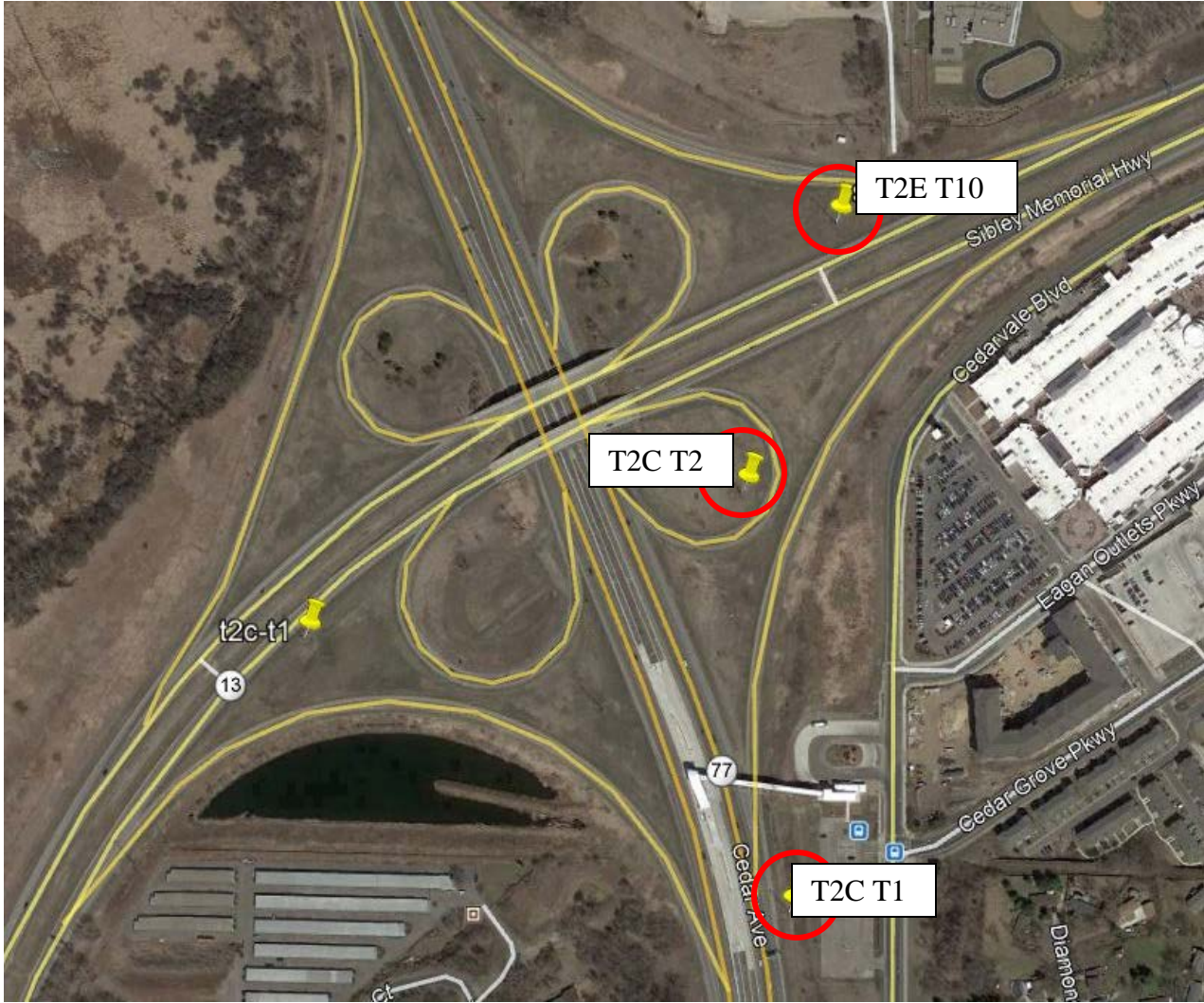


Figure 4: Selected HMLT bases for preservation (remaining in place after towers are removed).

Recommendations

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

1. Support the HMLT foundations using 10x42 driven H-pile foundations as described in the following recommendations using driven pile foundations for all towers.
2. Contact the Bridge Office for a project specific footing design sheet; a standard plan is not available for HMLT founded on piling at this time.
3. Provide piling with the minimum required embedment (tip depth) of piling as shown in **Table 3** and repeated in **Table 5** in the plan sheet format (below) for the piles supporting the HMLT structures. The minimum embedment requirement is to ensure that driven piles have a sufficient embedded length to provide the required uplift resistance. When developing the plan drawings or associated special provisions (if not shown on the plans), provide minimum pile tip embedment as described in

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Table 3 to ensure adequate uplift capacity. The piles may need to be driven beyond the minimum tip depth to satisfy the Nominal Geotechnical Bearing requirement of 200 tons.

Table 3: Summary of Foundation Recommendations for Light Towers.

<i>Pole #</i>	<i>Pole height (feet)</i>	<i>Minimum Pile Embedment for Uplift(Tension) Design 10x42 H-Pile</i>	<i>Nominal Geotechnical Bearing (MPF 12)</i>
C1	100	35	167 tons
C2	120	25	
C3	100	30	
C4	120	30	
C5	100	25	
C6	100	25	
C7	100	25	
E8	120	40	
E9	120	40	
E10	100	25	
E11	100	25	
E12	100	25	

- Use the MnDOT dynamic pile driving formula, MPF12, as the pile driving construction control method. Use the required loads in the Pile Bearing Resistance Table on the standard plan. As this project uses only H-type piles, the information for CIP piles may be crossed out as shown below with an “X” for items not used in this project.

Pile Bearing Resistance Table Required Nominal Pile Bearing Resistance R_n – Tons/Pile ③				
	CIP PILES ④		HP PILES ④	
	ϕ_{dyn}	*R_n	ϕ_{dyn}	* R_n
MnDOT Pile Formula 2012 (MPF 12)	0.50	200	0.6	167
PDA (Pile Driving Analysis w/CAPWAP)	0.65	155	0.65	155

* Factored Design Load = 100 Tons

$$R_n = (\text{Factored design load} / \phi_{dyn})$$



5. Include the following information in the “PILE TABLE” located on the HMLT plan sheet as follows:

Tower No.	Type of Pile	Bottom of Footing Elevation* (ft.)	Estimated Length (ft) ③	Required Min. Pile Length (ft.)	Actual Driven Length of Each Pile** ⑤
C1	H 10x42	[See plan*]	40	35	. .
C2	H 10x42	[See plan*]	30	25	. .
C3	H 10x42	[See plan*]	30	30	. .
C4	H 10x42	[See plan*]	30	30	. .
C5	H 10x42	[See plan*]	25	25	. .
C6	H 10x42	[See plan*]	25	25	. .
C7	H 10x42	[See plan*]	25	25	. .
E8	H 10x42	[See plan*]	40	40	. .
E9	H 10x42	[See plan*]	45	40	. .
E10	H 10x42	[See plan*]	35	25	. .
E11	H 10x42	[See plan*]	25	25	. .
E12	H 10x42	[See plan*]	35	25	. .

*Designer to establish this value based on the project specific plan locations of the towers and proposed final project grading.

**This column to be filled in by contractor with as-built information for submittal to the Bridge Office for transportation asset management.

Information in this table is site specific and is not applicable

Recommendations continue on next page



For this project: As an aid to the unknown foundation length research project (driven piling):

6. Develop contract plans and special provisions to allow for 3 intact foundations to remain in-place above ground. After removing the light tower steel structure, leave the complete concrete foundations intact (including anchor assemblies) at existing towers T2C T1, T2C T2 and T2E T10. A future contract will include removal of the above ground concrete portion of the towers and restoration of vegetation when the HMLT research is complete and a project to determine unknown tower lengths in the metro district is established.

If you have any additional questions regarding these recommendations, or require further assistance, please contact this office.

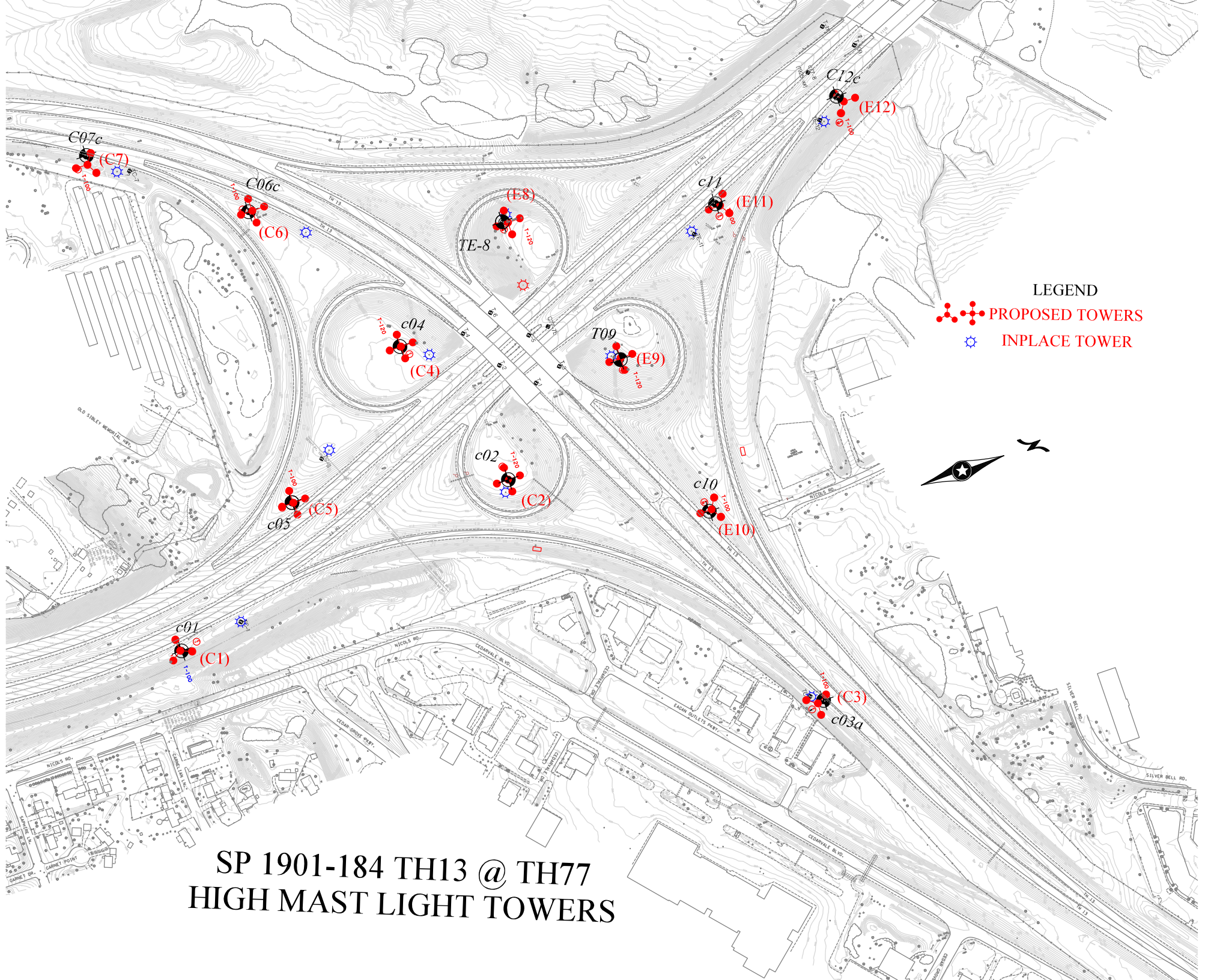
Attachments:

Boring/Sounding Plan	
CPT Index Sheet	
CPT Sounding Logs (C01 – C12c)	(MnDOT Unique Numbers 83094 - 83122)
SPT Index Sheet	
SPT Boring Logs (T09 & TE-8)	(MnDOT Unique Numbers 83116 & 51284)

cc: B. Skow
T. Clyne
P. Rowekamp

File

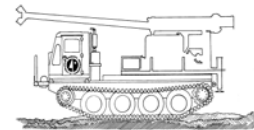




SP 1901-184 TH13 @ TH77
HIGH MAST LIGHT TOWERS



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.

Ratio of sleeve friction over corrected tip resistance.

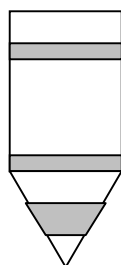
$$FR = f_s / q_t$$

V_s Shear Wave Velocity

A measure of the speed at which a seismic 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.



U2

SBT SOIL BEHAVIOR TYPE

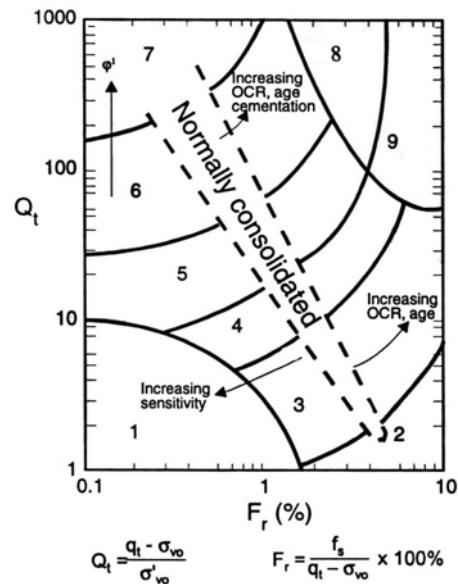
Soil Classification methods for the Cone Penetration Test are based on correlation charts developed from observations of CPT data and conventional borings. Please note that these classification charts are meant to provide a guide to Soil Behavior Type and should not be used to infer a soil classification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

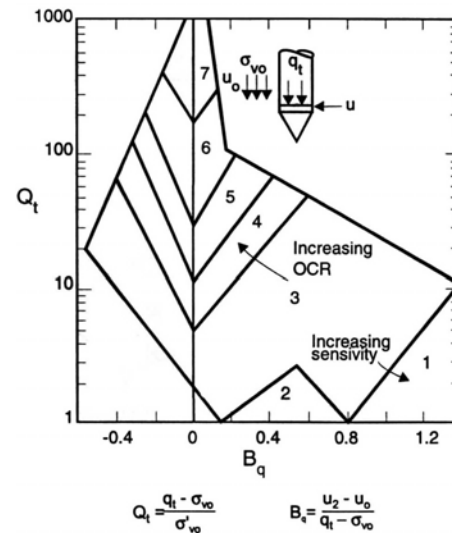
Note that engineering judgment, and comparison with conventional borings is especially important in the proper interpretation of CPT data in certain geo-materials.

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



Robertson CPTU 1990

Soil Behavior type based on pore pressure



where ...

- QT..... normalized cone resistance
- Bq..... pore pressure ratio
- Fr..... Normalized friction ratio
- σ_{vo}..... overburden pressure
- σ'vo..... effective over burden pressure
- u₂..... measured pore pressure
- u₀..... equilibrium pore pressure

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 cm² end area.

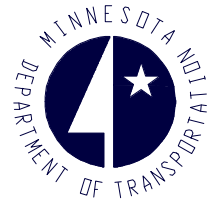
f_s SLEEVE FRICTION RESISTANCE

The resistance along the sleeve of the penetrometer.

FR Friction Ratio

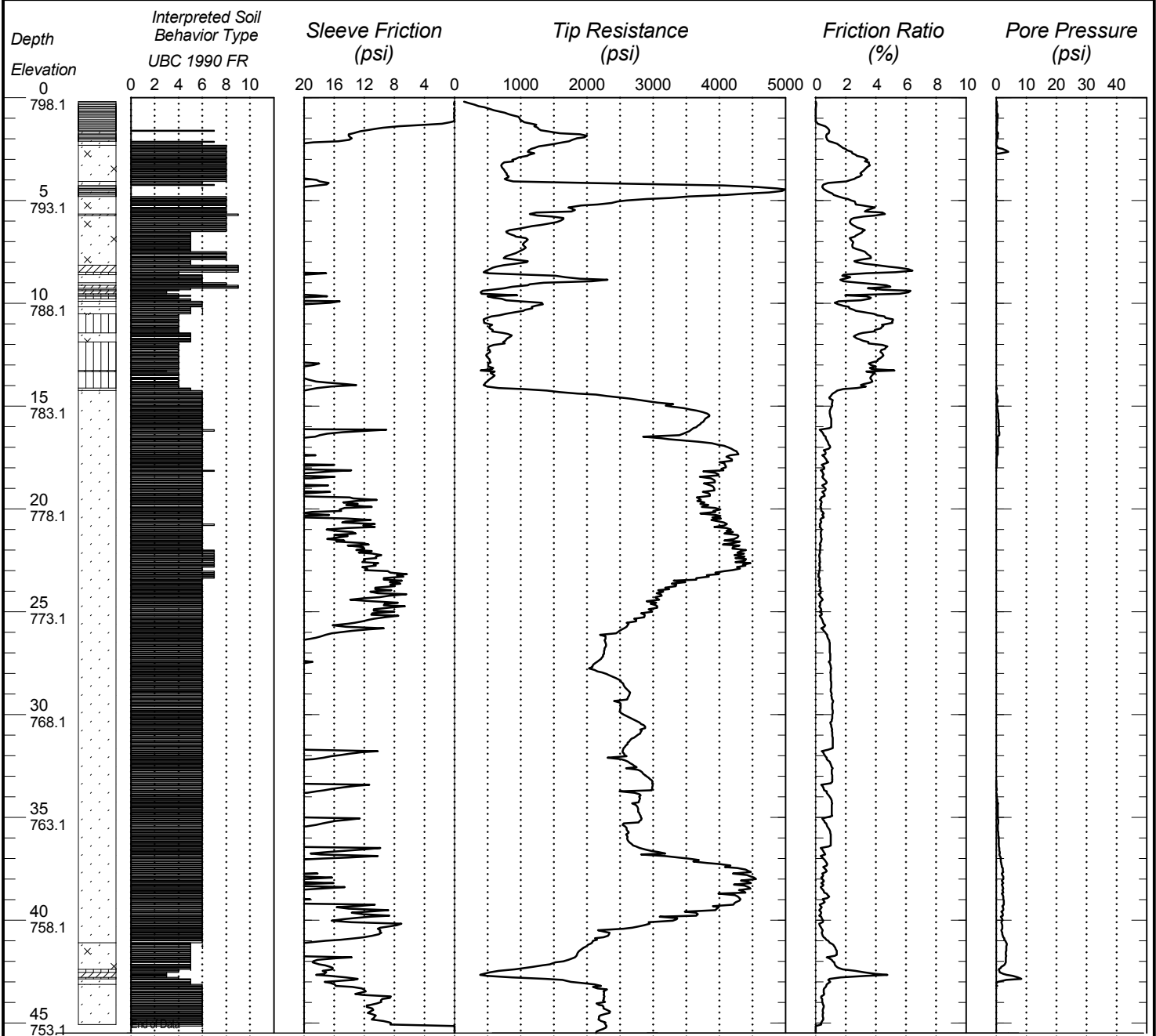
Robertson CPT 1990

Soil Behavior type based on friction ratio



CONE PENETRATION TEST RESULTS
UNIQUE NUMBER 83089
 U.S. Customary Units

State Project 1901-184	Bridge No. or Job Desc. LIGHTING BASE	Trunk Highway/Location TH 13 / TH 77	Sounding No. c02	Ground Elevation 798.1 (DTM)
Location Dakota Co. Coordinate: X=525211 Y=224955 (ft.)		CPT Machine 203094 CPT Truck	SHEET 1 of 1	
Latitude (North)=44°48'52.65" Longitude (West)=93°13'10.29"		CPT Operator ODonnell	Date Completed	
No Station-Offset Information Available		Hole Type CPT-STD	5/22/18	

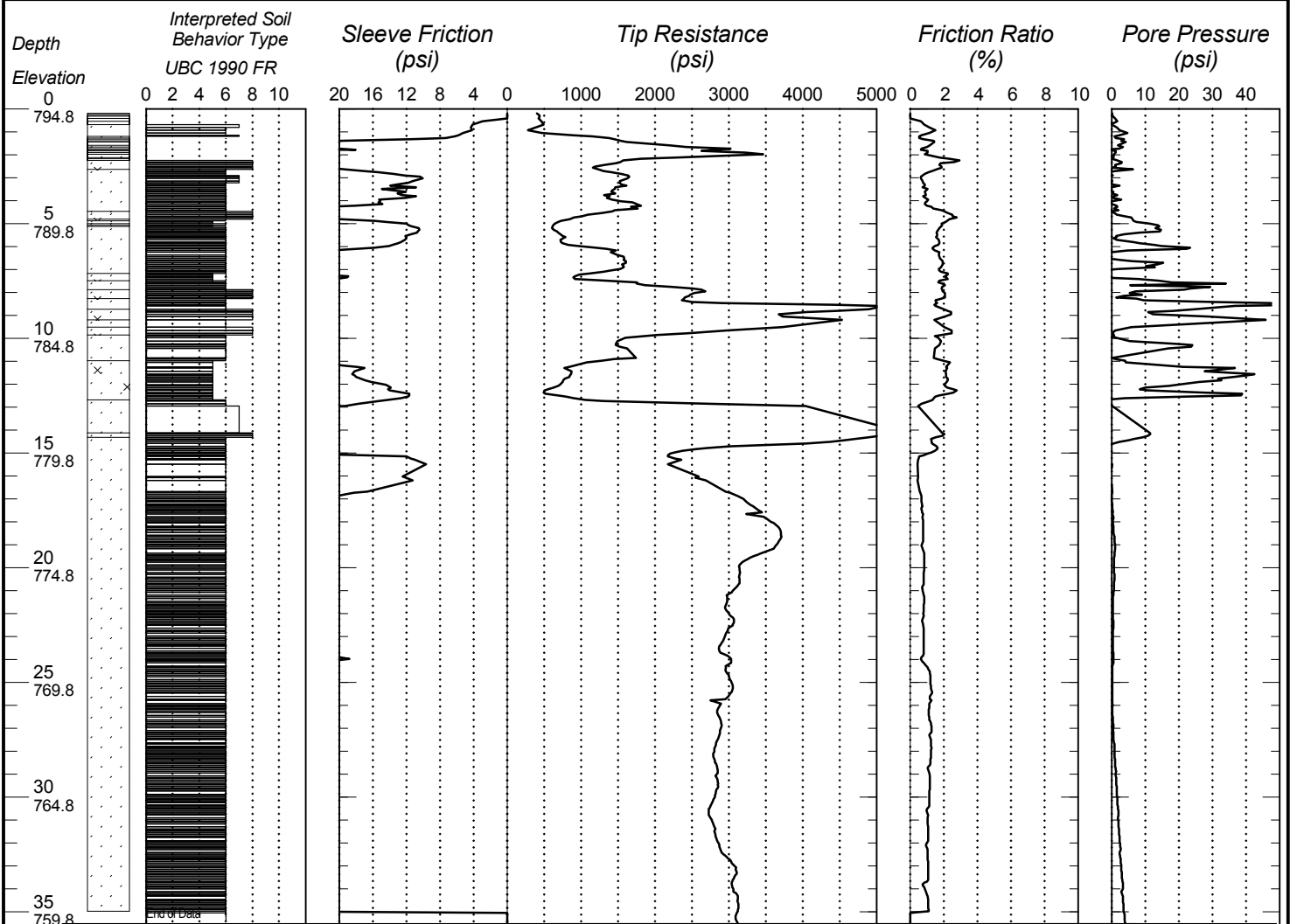


Bottom of Hole 45.49
 Planned Depth:



CONE PENETRATION TEST RESULTS
UNIQUE NUMBER 83095
 U.S. Customary Units

State Project 1901-184	Bridge No. or Job Desc. LIGHTING BASE	Trunk Highway/Location TH 13 / TH 77	Sounding No. c03a	Ground Elevation 794.8 (DTM)
Location Dakota Co. Coordinate: X=526340 Y=225761 (ft.)		CPT Machine 203094 CPT Truck	SHEET 1 of 1	
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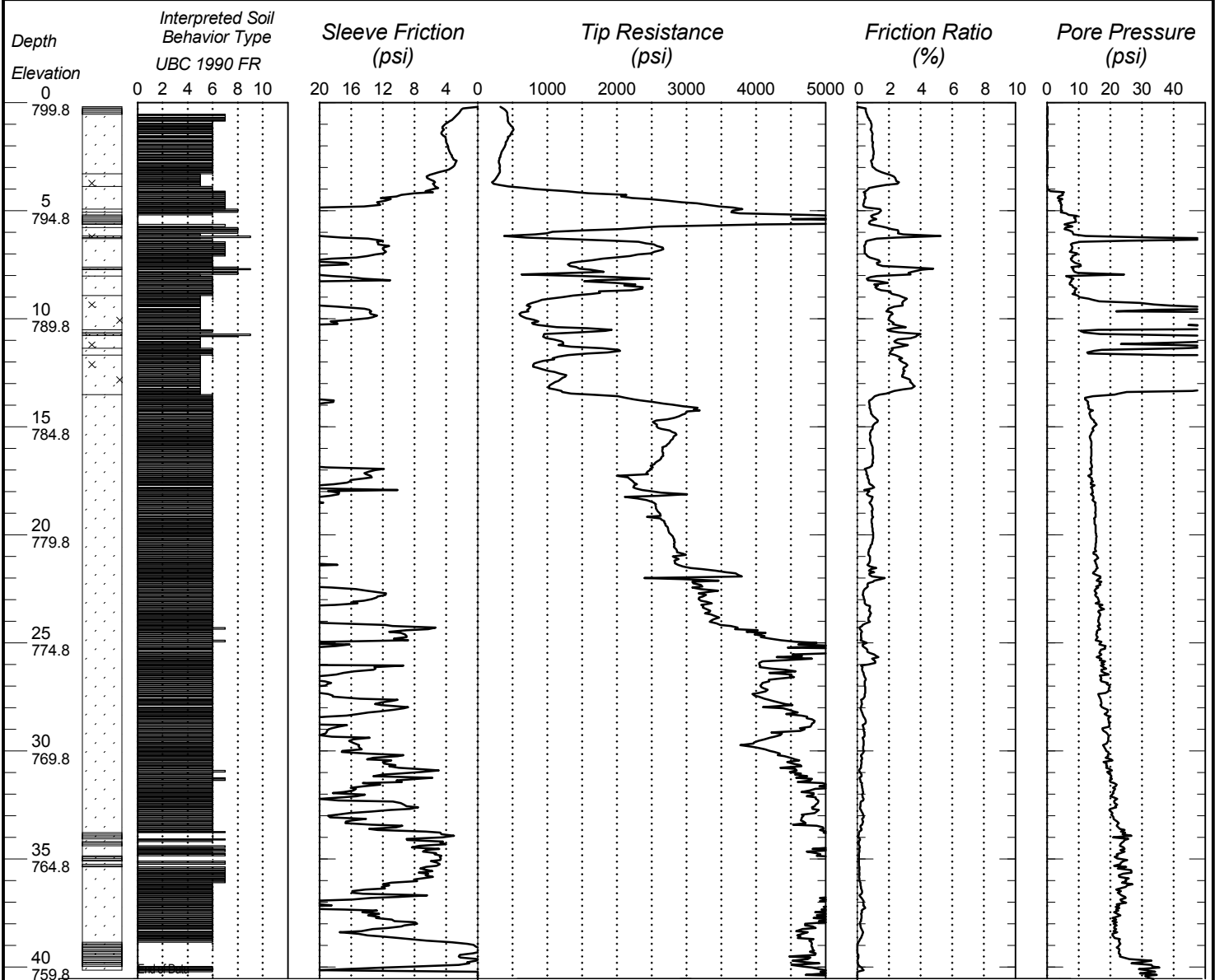


Bottom of Hole 35.51
 Planned Depth:

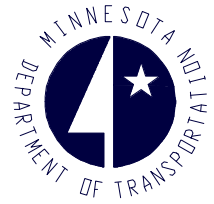


CONE PENETRATION TEST RESULTS
UNIQUE NUMBER 83090
 U.S. Customary Units

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Bottom of Hole 40.55
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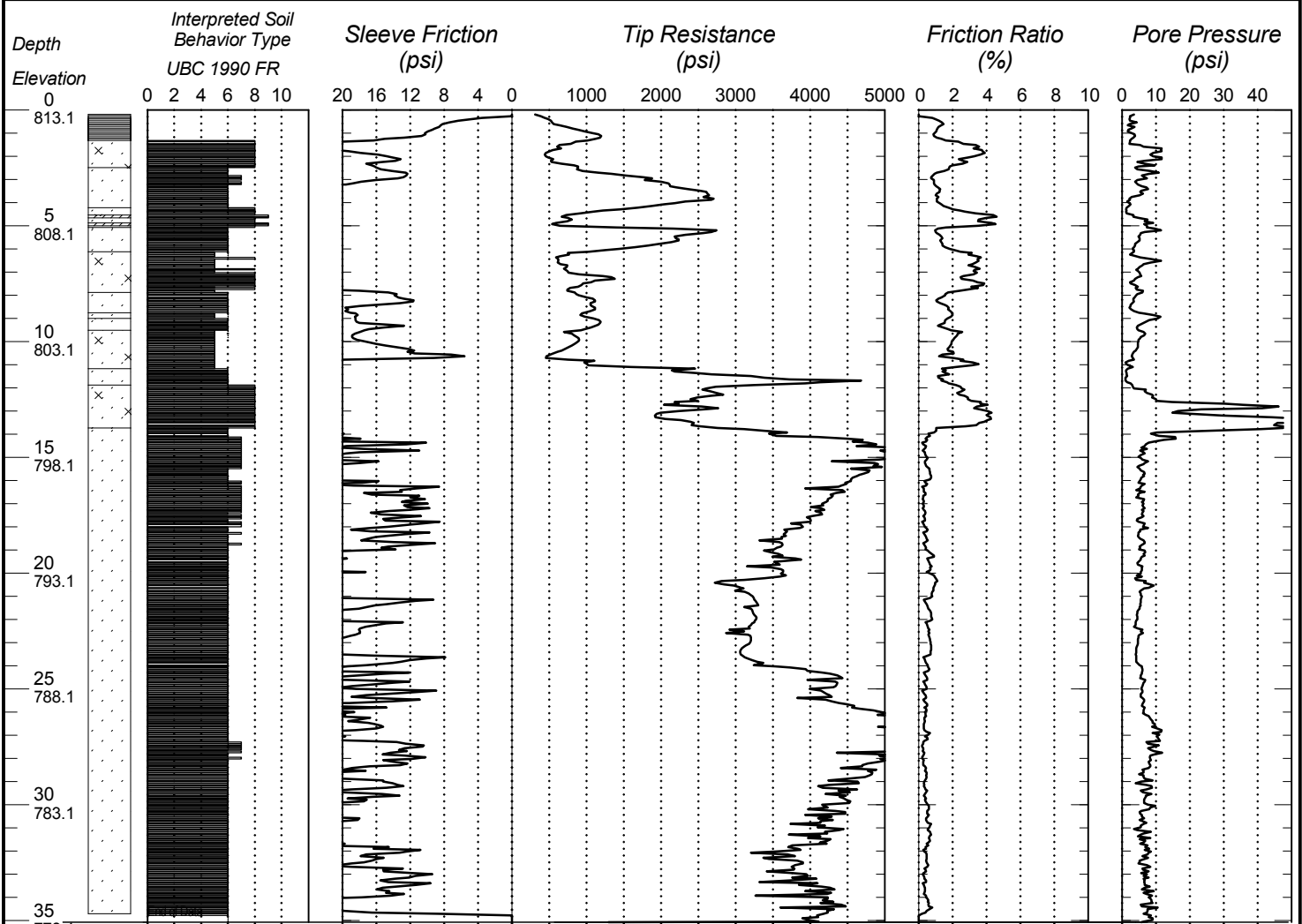


CONE PENETRATION TEST RESULTS

UNIQUE NUMBER 83091

U.S. Customary Units

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Location Dakota Co. Coordinate: X=525029 Y=224192 (ft.)		CPT Machine 203094 CPT Truck	SHEET 1 of 1	
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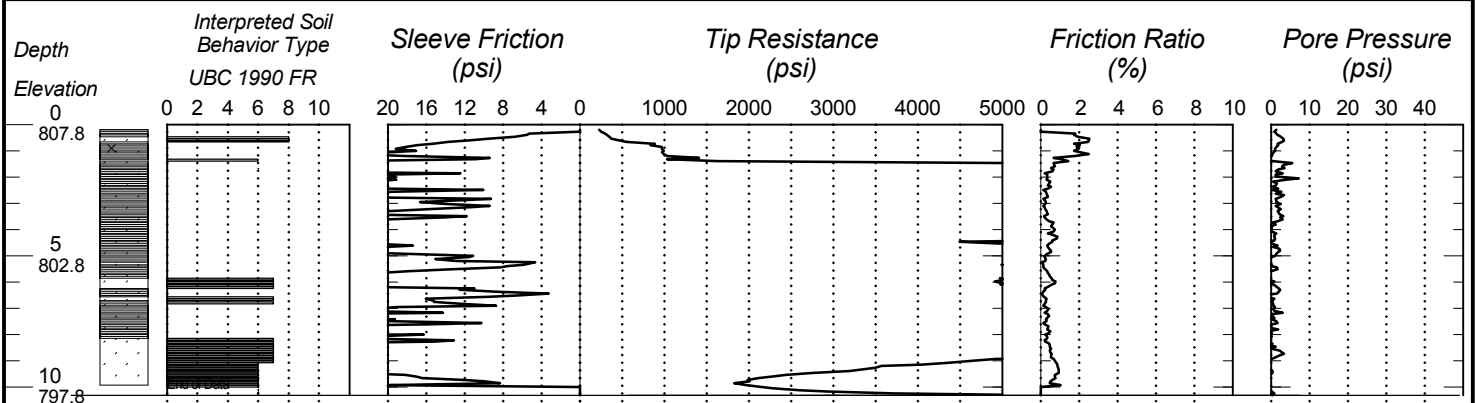


Bottom of Hole 35.07
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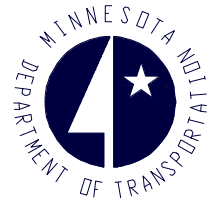


CONE PENETRATION TEST RESULTS
UNIQUE NUMBER 83092
 U.S. Customary Units

State Project 1901-184	Bridge No. or Job Desc. LIGHTING BASE	Trunk Highway/Location TH 13 / TH 77	Sounding No. c06a	Ground Elevation 807.8 (DTM)
Location Dakota Co. Coordinate: X=523987 Y=224395 (ft.)		CPT Machine 203094 CPT Truck		SHEET 1 of 1
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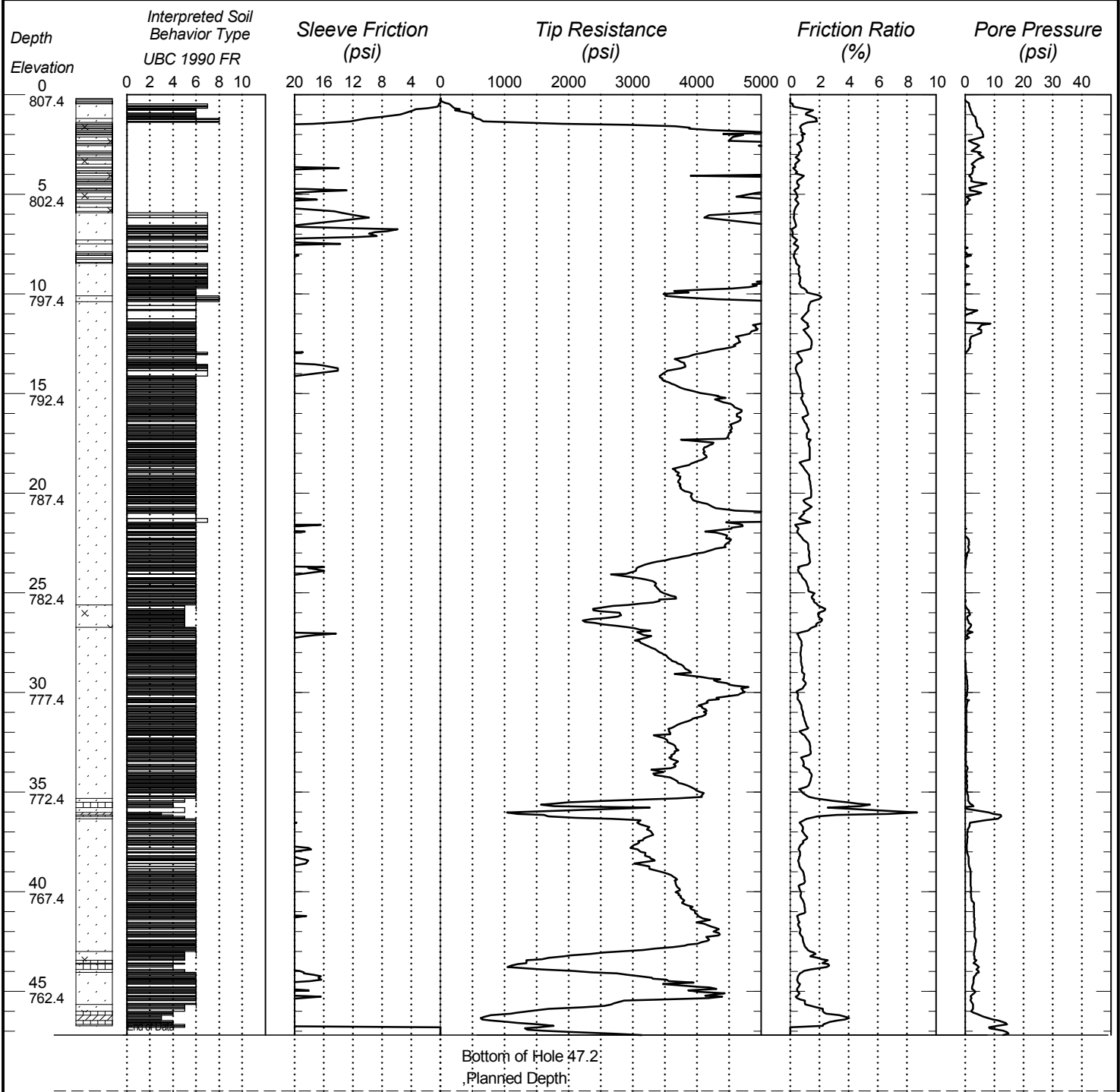


Bottom of Hole 10.31
 Refusal on unknown layer



CONE PENETRATION TEST RESULTS
UNIQUE NUMBER 83120
 U.S. Customary Units

State Project 1901-184	Bridge No. or Job Desc. LIGHTING BASE	Trunk Highway/Location TH 13 / TH 77	Sounding No. C06c	Ground Elevation 807.4 (DTM)
Location Dakota Co. Coordinate: X=523992 Y=224391 (ft.)		CPT Machine 205146 CPT Truck (H)		Sheets SHEET 1 of 1
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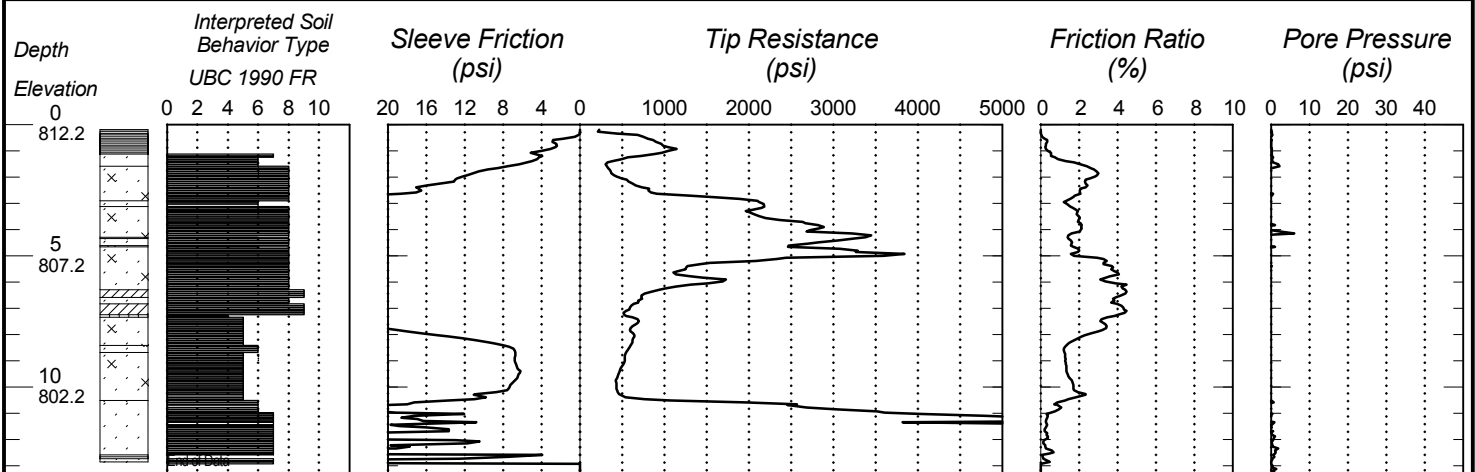


Bottom of Hole 47.2
 Planned Depth:



CONE PENETRATION TEST RESULTS
UNIQUE NUMBER 83093
 U.S. Customary Units

State Project 1901-184	Bridge No. or Job Desc. LIGHTING BASE	Trunk Highway/Location TH 13 / TH 77	Sounding No. c07a	Ground Elevation 812.2 (DTM)
Location Dakota Co. Coordinate: X=523607 Y=223926 (ft.)		CPT Machine 203094 CPT Truck	SHEET 1 of 1	
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No Station-Offset Information Available		Hole Type CPT-STD	5/22/18	



Bottom of Hole 13.26
 Refusal on unknown layer

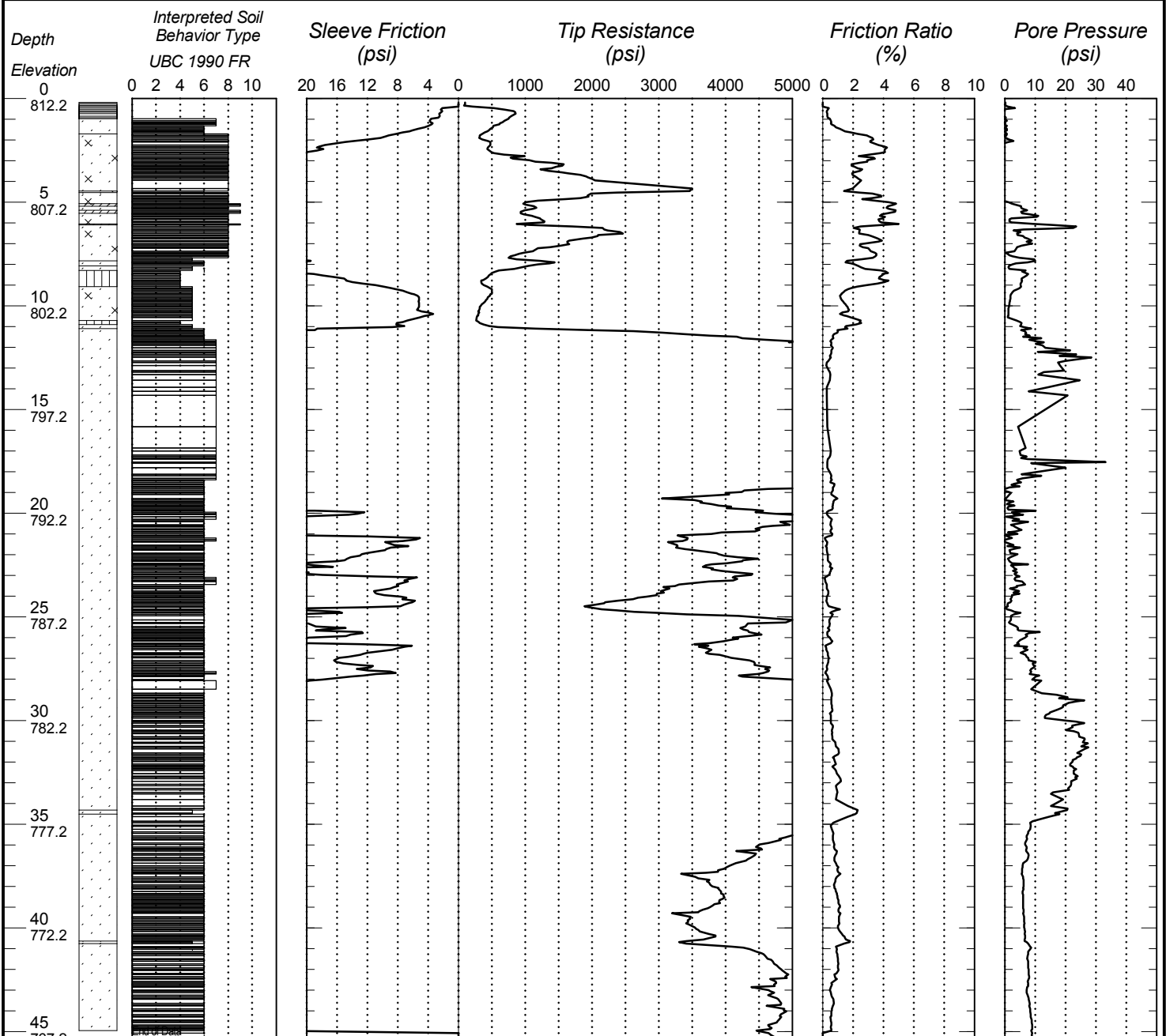


CONE PENETRATION TEST RESULTS

UNIQUE NUMBER 83121

U.S. Customary Units

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Location Dakota Co. Coordinate: X=523602 Y=223911 (ft.)		CPT Machine 205146 CPT Truck (H)		SHEET 1 of 1
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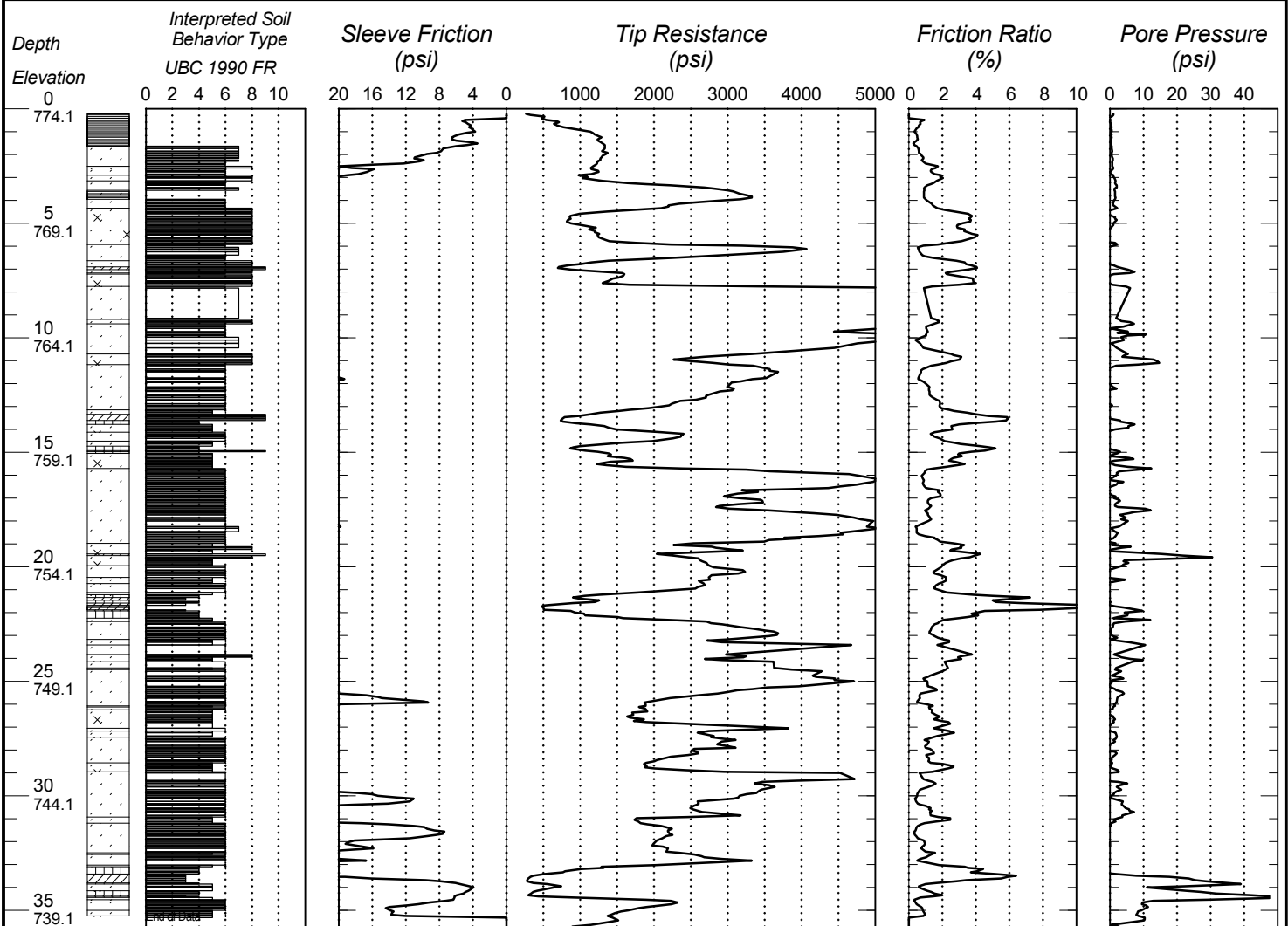


Bottom of Hole 45.42
Planned Depth:



CONE PENETRATION TEST RESULTS
UNIQUE NUMBER 83097
 U.S. Customary Units

State Project 1901-184	Bridge No. or Job Desc. LIGHTING BASE	Trunk Highway/Location TH 13 / TH 77	Sounding No. c11	Ground Elevation 774.1 (DTM)
Location Dakota Co. Coordinate: X=524522 Y=225991 (ft.)		CPT Machine 203094 CPT Truck	SHEET 1 of 1	
Latitude (North)=44°49'02.88" Longitude (West)=93°13'19.83"		CPT Operator O'Donnell	Date Completed	
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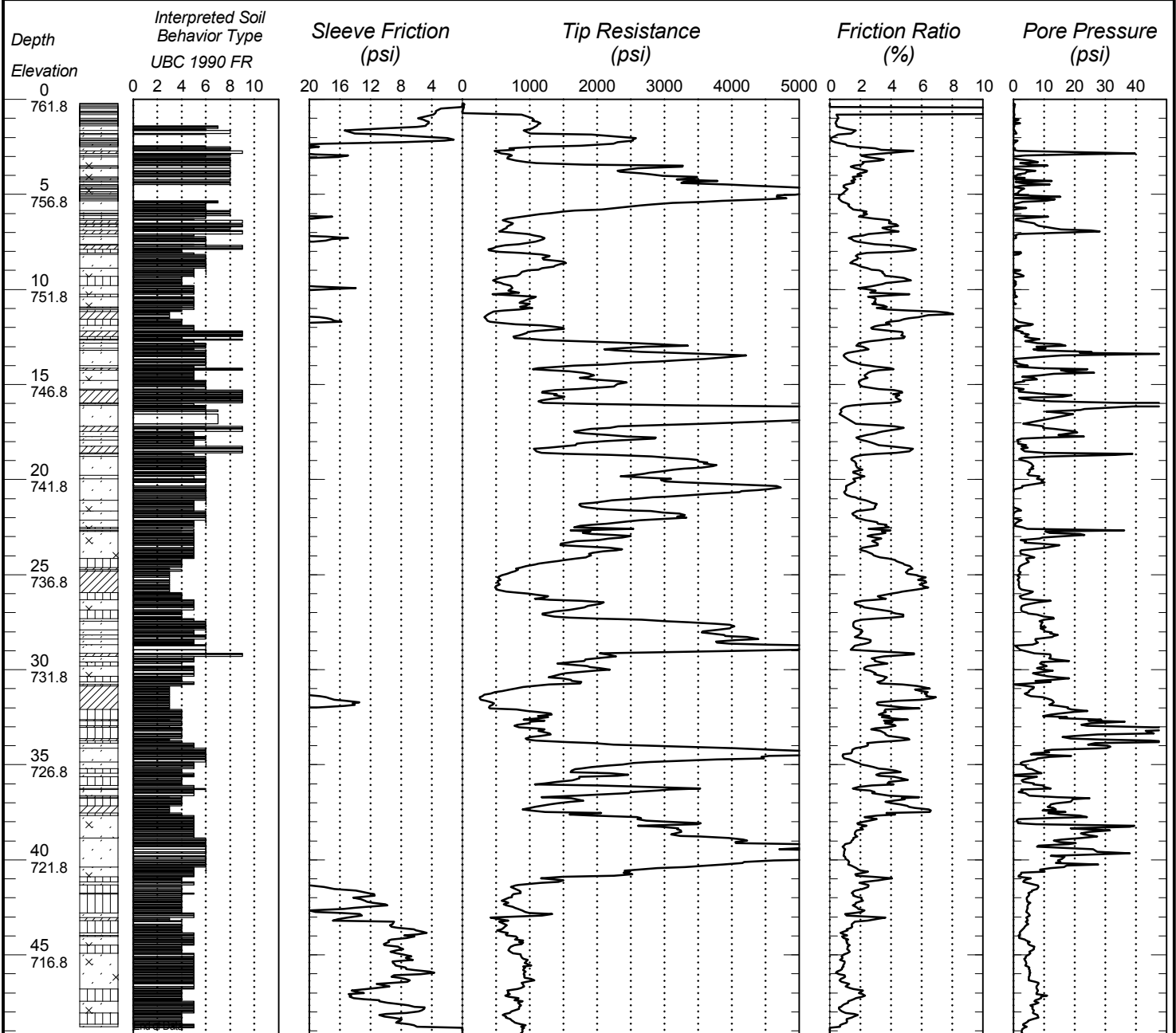


Bottom of Hole 35.71
 Planned Depth:

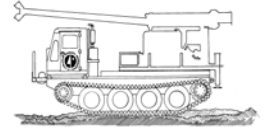


CONE PENETRATION TEST RESULTS
UNIQUE NUMBER 83122
 U.S. Customary Units

State Project 1901-184	Bridge No. or Job Desc. LIGHTING BASE	Trunk Highway/Location TH 13 / TH 77	Sounding No. C12c	Ground Elevation 761.8 (DTM)
Location Dakota Co. Coordinate: X=524302 Y=226531 (ft.)		CPT Machine 205146 CPT Truck (H)	SHEET 1 of 1	
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No Station-Offset Information Available		Hole Type CPT-STD	6/14/18	



Bottom of Hole 49.21
 Planned Depth:



USER NOTES, ABBREVIATIONS AND DEFINITIONS - Additional information available in Geotechnical Manual.

This boring was made by ordinary and conventional methods and with care deemed adequate for the Department's design purposes. Since this boring 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 boring.

Since subsurface conditions outside each borehole 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 boring 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 levels recorded on this log should be used with discretion since the use of drilling fluids in borings may seriously distort the true field conditions. Also, water levels in cohesive soils 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.

- WH** Weight of Hammer
- WR** Weight of Rod
- Mud** Drilling Fluids in Sample
- CS** Continuous Sample

SOIL/CORE TESTS

- SPT N₆₀** ASTM D1586 Modified Blows per foot with 140 lb. hammer and a standard energy of 210 ft-lbs. This energy represents 60% of the potential energy of the system and is the average energy provided by a Rope & Cathead system.
- MC** Moisture Content
- COH** Cohesion
- γ** Sample Density
- LL** Liquid Limit
- PI** Plasticity Index
- Φ** Phi Angle
- REC** Percent Core Recovered
- RQD** Rock Quality Description (Percent of total core interval consisting of unbroken pieces 4 inches or longer)
- ACL** Average Core Length (Average length of core that is greater than 4 inches long)
- Core Breaks** Number of natural core breaks per 2-foot interval.

- very loose 0-4
- loose 5-10
- medium dense 11-24
- dense 25-50
- very dense >50

Consistency - Cohesive Soils BPF

- very soft 0-1
- soft 2-4
- firm 5-8
- stiff 9-15
- very stiff 16-30
- hard 31-60
- very hard > 60

COLOR

- blk** Black
- grn** Green
- org** Orange
- dk** Dark
- IOS** Iron Oxide Stained
- wht** White
- brn** Brown
- yel** Yellow
- lt** Light

GRAIN SIZE /PLASTICITY

- VF** Very Fine
- F** Fine
- Cr** Coarse
- pl** Plastic
- slpl** Slightly Plastic

SOIL/ROCK TERMS

- C** Clay
- L** Loam
- S** Sand
- Si** Silt
- G** Gravel (No. 10 Sieve to 3 inches)
- Bldr** Boulder (over 3 inches)
- T** till (unsorted, nonstratified glacial deposits)
- Lmst** Limestone
- Sst** Sandstone
- Dolo** Dolostone
- wx** weathered

DISCONTINUITY SPACING

- | Fractures | Distance | Bedding |
|------------|--------------|-----------|
| Very Close | <2 inches | Very Thin |
| Close | 2-12 inches | Thin |
| Mod. Close | 12-36 inches | Medium |
| Wide | >36 inches | Thick |

DRILLING SYMBOLS

WATER MEASUREMENT

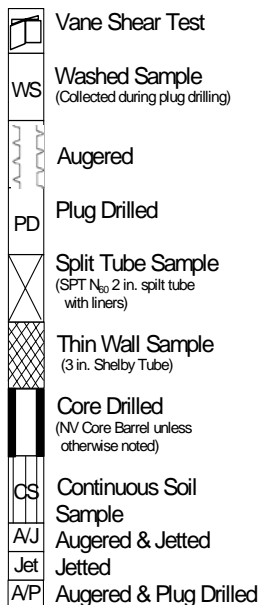
- AB** After Bailing
- AC** After Completion
- AF** After Flushing
- w/C** with Casing
- w/M** with Mud
- WSD** While Sampling/Drilling
- w/AUG** with Hollow Stem Auger

MISCELLANEOUS

- NA** Not Applicable
- w/** with
- w/o** with out
- sat** saturated

DRILLING OPERATIONS

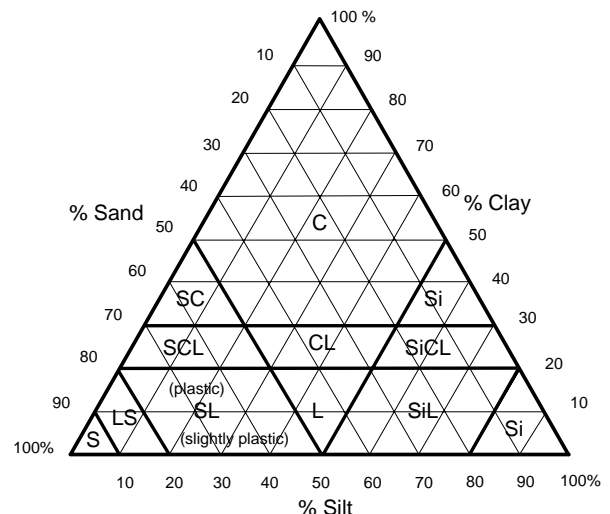
- AUG** Augered
- CD** Core Drilled
- DBD** Disturbed by Drilling
- DBJ** Disturbed by Jetting
- PD** Plug Drilled
- ST** Split Tube (SPT test)
- TW** Thinwall (Shelby Tube)
- WS** Wash Sample
- NSR** No Sample Retrieved
- CS** Continuous Soil Sample
- A/J** Augered & Jetted
- Jet** Jetted
- APV** Augered & Plug Drilled



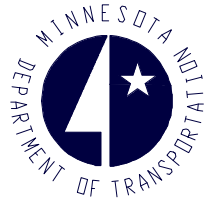
RELATIVE DENSITY

Compactness - Granular Soils BPF

Mn/DOT Triangular Textural Soil Classification System



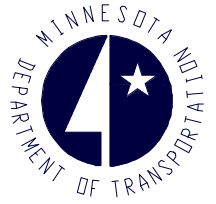
MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION
 LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION



UNIQUE NUMBER 83116
 U.S. Customary Units

State Project 1901-184		Bridge No. or Job Desc. LIGHTING BASE		Trunk Highway/Location MN Trunk Highway TH 13 / TH 77		Boring No. T09		Ground Elevation 793.6 (DTM)		
Location Dakota Coord:X=524937 Y=225480 (ft.)				Drill Machine 217270 CME 55 Track				SHEET 1 of 1		
Latitude (North)=44°48'57.83" Longitude (West)=93°13'14.08"				Hammer CME Automatic Calibrated				Drilling Completed 6/7/18		
No Station-Offset Information Available								Other Tests Or Remarks		
DEPTH	Depth	Lithology	Classification	Drilling Operation	SPT	MC	COH	γ	Soil	Other Tests Or Remarks
	Elev.				N ₆₀	(%)	(psf)	(pcf)		
					REC (%)	RQD (%)	ACL (ft)	Core Breaks	Rock	Formation or Member
	5.0 788.6	Fine Sand with a little Gravel, dark-brown to brown, damp, medium dense				4				
	10.0 783.6	plastic to slightly plastic very fine grained Sandy Loam with high Silt content, brown, moist, very stiff to hard			19	5				rough drilling at 5.0'
	13.7 779.9	Clay Loam with a few pebbles, gray, moist, very stiff to hard			26	18				
	15.0				34	13				
	20.0				22	14				
	25.0				59	11				
	30.0				8					
	35.0				38	12				driller note possible water table
	40.0				47	12				rough drilling 22.5'-23.5'
	41.5 752.1	Silty Clay Loam, gray, wet, hard			PD					
	45.0				35	13				
	49.5 744.1	slightly plastic Sandy Loam, brown to gray, wet, very stiff			32	12				
					PD					
					46	21				rough drilling 37.0'-38.0'
					28	13				
					26	11				
Bottom of Hole -49.5' Water measured at 14.9' with auger										

MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION
 LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION



UNIQUE NUMBER 51284
 U.S. Customary Units

State Project 1925-16		Bridge No. or Job Desc. LIGHT TOWER		Trunk Highway/Location MN Trunk Highway 13		Boring No. TE-8		Ground Elevation 785.3 ()		
Location Dakota Coord:X=524327 Y=225246 (ft.)						Drill Machine 69792			SHEET 1 of 1	
Latitude (North)=44°48'55.53" Longitude (West)=93°13'22.54"						Hammer Rope & Cathead			Drilling Completed 3/6/79	
LOOP B, 4+20, 102' RT										
DEPTH	Depth	Lithology	Classification	Drilling Operation	SPT	MC	COH	γ	Soil	Other Tests
	Elev.				N ₆₀	(%)	(psf)	(pcf)		Or Remarks
					REC	RQD	ACL	Core Breaks	Rock	Formation or Member
					(%)	(%)	(ft)			
5	6.0 779.3	slightly plastic Sandy Loam Till, with Loamy Sand layer approx. 5.5 feet, brown, wet, very stiff			16	11				
10		plastic Sandy Loam Till with traces of Fine Sand, brown, wet, very stiff			22	12				
15	13.5 771.8	Silty Clay Loam with some Thin Fine Sand seams brown, moist			23	11				
20	18.5 766.8	Sand, brown, saturated and dense			30	13				
25	23.5 761.8				34	18				
30		Silty Clay Loam Till, damp, hard to very hard			50	14				
35					71	13	8370			
40	38.5 746.8	Sand, brown, saturated, medium dense			80	14	5270			
	41.5 743.8				24	19				
End boring at 41.5 feet, elevation 743.8 Water measurement taken is not conclusive										